Arctic sea ice and climate change
Will the sea ice disappear in this century?
Staff
At the end of 1999, the Nansen Center employed a staff of 52 from nine countries. Three staff members of the Nansen Center hold part time faculty positions at the University of Bergen, while four faculty members of the University of Bergen have part time positions at the Nansen Center. Dr. Johnny A. Johannessen returned from ESA ESTEC after 5 years of leave. He has taken up the position as Research Director for Remote Sensing Research. The Director of the Nansen International Center in St. Petersburg, Dr. Leonid Bobylev, has a part time position in Bergen. Dr. Knud Simonsen, previously at the Nansen Center, now Associate Professor at the University of Faroe Islands has also been appointed as a senior adjunct scientist at the Nansen Center. In addition we have had several visiting scientists and students from different countries working at the Nansen Center for a period of up to three months. The Nansen Center staff includes 12 Dr. Scient candidates (Ph.D.) and an administrative staff of six people.

Production
The high lights of publications were: the paper in Science «Satellite Evidence for an Arctic Sea Ice Cover in Transformation» by O.M. Johannessen, E.S. Shalina and M. Miles (Science Volume 286, December 3 1999) and two papers in Nature «Rapid Changes in the Mechanism of Ocean Convection during the Last Glacial Period» by T.M. Dokken and E. Jansen (Nature, Vol.40, 30 September 1999) and «Mixing and Convection in the Greenland Sea from a tracer-release Experiment» Watson et al including K. Simonsen (Nature Vol.40, 28 October 1999). Furthermore the publication of the book «Limnology and Remote Sensing, A Contemporary Approach» by K.Ya.Kondratyev et al including O.M. Johannessen (Springer-Praxis Series in Remote Sensing 1999). In 1999, 11 scientific articles were published in international refereee journals in addition to one book publication. Furthermore, 33 papers were published in conference proceedings and 35 reports were produced for our clients. In addition, six popular-science articles were published, adding up to 86 publications all together.

Doctoral and Master thesis
Students are an important component of the Nansen Center staff. In 1999 two Dr. Scient theses were defended, one at the Department of Mathematics and one at the Geophysical Institute. Three Cand. Scient theses were finished; one at the department of Mathematics, one at the Botanical Institute and one at Geological Institute, all at the University of Bergen.

International Activities
The Nansen Center participates in 27 EU research projects under MAST, Environment and Climate and Transport programs and is the coordinator in seven of these projects. The Nansen Center has now matured to be a major partner in the EU network. The Nansen Center has also a number of Announcement of Opportunity projects (AO) with European Space Agency (ESA), the Canadian Space Agency and NASA. The Nansen Center was one of the founding members of the EuroGOOS and is expanding its activities in operational oceanography. Prof. O.M. Johannessen is the chairman of the EuroGOOS Arctic Task Team and L.H. Pettersson is co-chairing the EuroGOOS Projects Group. S. Sandven is the coordinator of several EU projects on remote sensing applications for ice monitoring in the Northern hemisphere. Furthermore, Prof. G. Evensen is the coordinator of the EuroGOOS related DIadem EU project, which focuses on data assimilation for operational oceanography.

Several ocean modeling projects for international consortiums of oil companies are under development and one of these projects, NWAG is dealing with ocean modeling of current in the region north west of UK under the leadership of Prof. Geir Evensen.

Co-operation with the Faeroe Fisheries Laboratory and the University of Faeroe Islands is being further developed with focus on tidal modeling around the Faeroes. Dr. K. Simonsen, now working in the Faeroe Islands, is involved in this cooperative agreement.

The Nansen Center is extending its co-operation with scientists through its sister institute, the Nansen International Environmental and Remote Sensing Center in St. Petersburg, where Dr. Leonid Bobylev is the Director. The focus on research is high latitude global change. The center employs 13 full-time scientists, 16 Ph.D. candidates funded through the Nansen Fellowships program and an associate staff of 20 scientists. In addition, the University of Bergen and the Nansen Center supports financially 10 Ph.D. candidates at the St. Petersburg State University. The Nansen Centers receive major funding from the Research Council of Norway for the Nansen Fellowship program.
In 1997, the Nansen Center initiated the establishment of a Nansen Environmental Research Center India in Kochin in the coastal State of Kerela, India. The focus of research and applications is on coastal zone and Indian Ocean circulation. The Center is now formally registered and we are recruiting the staff.

The co-operation with the Institute of Atmospheric Physics at the Chinese Academy of Sciences, Beijing is being developed further within the field of global modeling and planning of joint research projects are under way. A doctoral investigation is carried out at the Nansen Center in Bergen by Y. Gao from the Institute of Atmospheric Physics, in Beijing.

G.C. Rieber Climate Institute
The G.C. Rieber Climate Institute is a part of the Nansen Center, and is led by Dr. Helge Drange. At the end of 1999, the center employed four scientists, four Dr. Scient. students and one Cand. Scient. Student. The main activity at the institute is devoted to the stability and the dynamic properties of the North Atlantic Current system. This work is performed by both ocean only models and a fully coupled, global atmosphere-sea ice-ocean model (the latter activity is in collaboration with the Geophysical Institute, University of Bergen). Here the Norwegian Research Council project RegClim is an important contributor to the work. Other important topics are modeling of the natural cycling of carbon and plant nutrients in the ocean, and ocean storage of the greenhouse gas CO2. The G.C. Rieber Trusts support the institute with NOK 0.4 mill on an annual basis for recruiting climate modelers in Norway.

Arctica
«Arctica» is a small public adventure at the Nansen Center. Among the attractions are: a wide-screen movie «Svalbard - Arctic Seasons», a slide presentation on Fridtjof Nansen and an exhibition in the «Science Room». Arctica was formally opened in November 1999.

Financial situation
The Nansen Center is an independent non-profit research institute without basic public funding. The income in 1999 amounted to NOK 24.7 mill. - an increase of NOK 2.8 mill. compared to 1998. The 1999 project income has mainly come from the Commission of the European Communities (EU), the Research Council of Norway, oil companies, European Space Agency and the Norwegian Space Center. Financial support has also been received from G.C. Rieber, O. Kavli and K. Kavli’s funds. The annual net income for 1999 totaled to 1.008 mill. NOK of which 0.813 mill. NOK came from financial income. This is a slight improvement from 1998 - where these numbers were 0.771 mill. NOK and 0.553 mill. NOK respectively. The equity capital amounts to NOK 16.3 mill. out of a total balance of NOK 25.7 mill.

Prospects for 2000
We are expecting a small increase in our activities in year 2000. Fortunately the EU 5th. Framework program started in 1999. Several new projects have already been granted for year 2000.

Bergen 29.05.2000

Bjørn. J. Landmark (Chairman)
Ulf Lie (vice Chairman)
Eirik Sundvor
Bjart Nygaard
Ola M. Johannessen (Director)
Lasse H. Pettersson

Terra Orbit A/S and COTO A/S
The Nansen Center is the owner of these two companies. The purpose is to commercialize some of the research products which are developed by the Nansen Centers in Bergen, St. Petersburg and Kochin, India. We are now developing a new business plan and have appointed an experienced and well qualified director, Geir Jevne. Terra Orbit is focusing on environmental IT products and COTO on CO2 mitigation from industrial sources. These companies are also «know-how» companies giving advice and consultant services to industry and governmental agencies.

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Also chair in Remote Sensing/Oceanography at Geophysical Institute, University of Bergen

Applied Remote Sensing
Vice-Director Stein Sandven

Modelling and Data assimilation
Director Professor Dr. Geir Evensen
Also Professor II at Department of Mathematics, University of Bergen.

Remote Sensing Research
Director Professor Dr. Jonny A. Johannessen

G.C. Rieber Climate Institute
Director Dr. Helge Drange

International Affairs and Marketing
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Managing Director Rolf Skår
Norwegian Space Centre
Chief Engineer Per Strass, STATOIL
remote sensing
stein sandven
johnny a. johannessen

A three year project to develop satellite remote sensing in climate and marine monitoring of importance for Norway started with support from the Norwegian Space Centre. The objective of this project is to develop further use of satellite data within three areas: SAR ocean monitoring, optical remote sensing of Norwegian waters, and use of satellite data in climate models at high latitudes.

Several sea ice remote sensing projects funded by EU were completed during the year: IMSI - Integrated Microwave remote sensing of Sea Ice, which was co-ordinated by the Nansen Center, ARCODEV - Arctic Demonstration and Exploratory Voyage, and ICE STATE where the Nansen Center contributed with both modelling and remote sensing of sea ice in the Baltic Sea. The work in these projects have included SAR ice classification and validation, practical ice monitoring in near real time in the Northern Sea Route, and integrated use of SAR ice parameter retrieval and mesoscale modelling in studies of sea ice dynamics and deformation. A SAR ice interpretation manual has been developed to help users of ice data to understand SAR ice signatures. The manual contains about 50 examples of analysed SAR ice images, covering a wide range of different ice situations which occur in the Arctic. All the ice projects have included cooperation with the NIERSC staff in St. Petersburg. A new ice-related proposal (IWICOS - Integrated Weather, Ice and Ocean System Service) was prepared and got funding from EU’s IST programme, starting on 1 January 2000.

In ocean and coastal remote sensing two EU-funded projects coordinated by the Nansen Center has been completed: COASTMON, which has studied different applications of microwave satellite data, primarily SAR, to observe wind, waves, currents, eddies, fronts and oil slicks, and OPERALT which has focused on use of altimeter data to observe ocean current parameters needed by the offshore industry operating in deepwater areas. In addition to altimeter studies, eddies and fronts have been studied by use of SAR data off Mid-Norway in support of the Metocean project coordinated by Norske Shell.

Four projects have been carried out for the CEO programme at the Joint Research Centre: a feasibility study for coastal zones and inland waters where parameters and processes observable by remote sensing have been reviewed, a sea ice remote sensing training course which is available on Internet, and production of an inventory of airborne photographs and digital elevation models. Finally, a market study on SAR derived wind energy has been conducted. This study will continue in WEMSAR, a new three year project funded by EU which will develop SAR wind energy mapping further.

The ARSGISIP project continued in its second year, studying use of optical satellite data, in combination with GIS, for estimation of parameters which are important for hydrological modelling. These parameters, which are related to vegetation, soil, topography, geology and land use change, are investigated in a test area in Østerdalen and the results can be used by Norwegian Water and Energy Administration to improve flood forecasting.

modelling and assimilation
geir evensen

The ambitious strategy of the modelling and data assimilation group is two fold:
1. to establish the Nansen Center as a world leading center for carrying out hind cast ocean modelling studies for the oil industry,
2. to take a lead in the development of pre-operational monitoring and prediction systems for the ocean and marine ecosystem.

A challenge and a major activity has been to develop a nested model system which allows for high resolution simulations in targeted areas and where the model is capable of reproducing the observed water masses and current variability in the ocean. This model development was motivated by demands for current statistics within the oil industry operating in deep waters along the Atlantic Margin north of Scotland.

Much of this activity was funded by the North Western Approaches Group (NWAG) which comprises about 16 oil companies.

Within a number of research projects, methodologies for data assimilation in preoperational models for the ocean and marine ecosystem have been developed. In particular the EC-funded DIADEM project and a number of related projects have lead to an assimilation capability where satellite observed Sea Surface Height, Sea Surface Temperature and Ocean Colour data are now assimilated in the model in an application for the North Atlantic.

This system will be operational in forecasting mode during second half of year 2000. Building on these activities a new EC funded project, TOPAZ, starting mid 2000, will integrate the assimilation systems from DIADEM with the high resolution industry modelling to form an operational prediction system supporting offshore oil production and operations along the Atlantic Margin.

In addition to a few major projects which are steering the activities, there is a number of related projects involving post docs and Ph.D. students, which are either applying the model system in various areas, e.g. the Atlantic, Mediterranean, Indian Ocean and the Arctic, or are working on implementation and validation of new modules for the system.
The mild and pleasant climate in Scandinavia is mainly governed by the transport and loss of heat from the North Atlantic Drift. In fact, the annual mean surface temperature over Scandinavia and the Norwegian Sea region is between 5 to 10 deg C higher than at similar latitudes. The anomalous climate in this region, together with significant natural variations in the present day and glacial climate system, calls for improved understanding of the mean state of the system, how the system is affected by and responds to natural variations in internal and external forcings, how stable the system is for human induced changes to the global climate system, and possible ecological and socio-economic implications thereof.

To gain understanding of the climate system and how it operates, collection and analysis of proxy (or paleo) and instrumental observations, together with numerical modelling, is required. The staff at the climate institute is mainly working on numerical modelling of the coupled atmosphere-sea ice-ocean system in the region.

To validate the models, instrumental and paleo observations are provided through national and international projects and collaboration.

Several numerical models are in use, including a coupled ocean and sea ice model for the Atlantic and Arctic Oceans, and a coupled global atmosphere-sea ice-ocean model, the latter activity in close collaboration with the Department of Geophysics at the University of Bergen. In addition, marine ecosystem and carbon chemistry modules are coupled to both model systems, yielding the possibility to examine the response of natural and man made variations in climate on the marine ecosystem and the exchange of CO$_2$ across the air-sea interface.

Analysis of the simulated ocean and sea ice state for the last 40 years shows that the present day state-of-the-art climate models are able to describe observed features of the system like the Great Salinity Anomaly in the late 60s and the 70s, the northward propagation of temperature anomalies in the North Atlantic, and the variability in the extent of sea ice in the Arctic.

The next step is to apply the developed model systems to examine the sensitivity of the climate system to increased atmospheric greenhouse gas concentrations, and to assess how the climate system may respond to massive melting of the Arctic sea ice, and to various global change scenarios.

The major contributors to the modelling activities at the institute is donation from the Rieber Foundations, the co-ordinated Norwegian Research Council project RegClim, and several EU projects. In addition, three PhD positions are supported by the Research Council of Norway.
publications

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F. Bideux & S. Grane: Havsstrømmer i Nord-Atlanteren 
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O.M. Johannessen & H. Espedal: Derivation of wind 
energy maps from synthetic aperture radar images. GIS 
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Dr. Fridtjof Nansen (1861-1930), pioneer scientist, diplomat and humanist, with colleagues doing measurements on the Arctic pack ice during the FRAM expedition 1893-96.

Nansen Group Leader: Prof. Ola M. Johannessen

If man do not take time to think about future, there will be no future for man.

Ola M. Johannessen, October, 1999