Inauguration of

the “Mohn-Sverdrup Center for Global Ocean Studies and Operational Oceanography”
October 20th 2004

Annual Report 2004
Nansen Environmental and Remote Sensing Center
Bergen - Norway
affiliated with the University of Bergen
public outreach has been done through newspapers at national and international level - including TV and radio. Popular scientific lectures for school children, students and the public have been given in the Nansen Center’s adventure center “Arctica”.

DOCTORAL THESIS
Mohamed Babiker from Sudan made his Doctoral dissertations on the 18th of June at the Department of Earth Sciences, University of Bergen.

INTERNATIONAL ACTIVITIES
By the end of 2004, the Nansen Center participated in 14 EU projects and co-ordinated four of these. The Nansen Center also co-ordinated one INTAS (International Association for the promotion of co-operation with scientists from the New Independent State of the former Soviet Union) project and one ESA/IAF GMES networking project with participation from Russia and Ukraine. Furthermore the Nansen Center participates in organizing “The International Polar year 2007-2008 (IPY)”. The co-operation with the “Institute of Atmospheric Physics” at the Chinese Academy of Science in Beijing has been expanded with mutual exchange of students and scientists. Several Announcement of Opportunity (AO) projects from the European Space Agency (ESA) for the ENVISAT satellite are now being implemented for coastal, oceanic and Arctic areas.

The Nansen Center is a major partner in EuroGOOS. This is for example realized within the scope of the EU project “Marine Environment and Security in the European Area” (MERSEA), as well as through web-publishing of weekly forecasts of temperature, salinity, ice conditions and currents for the Atlantic and Arctic regions. These products are derived from satellite observations and advanced assimilation and modelling systems. Furthermore Ola M. Johannessen is a member of the EuroGOOS Board and Stein Sandven is the chairman of the Arctic task team. Ola M. Johannessen is also member of the WMO Steering Committee for “Global Climate Observing System (GCOS)” – where Johnny A. Johannessen is a member of the GCOS panel; “Ocean Observing Panel for Climate (OOPC)”. The Nansen Center is one of the founders of the “European Climate Forum (ECF)” and Ola M. Johannessen was in 2004 elected as a member of the board. Both the Nansen Centers in Bergen and in Beijing were involved in organizing the ECF Beijing Symposium “Key vulnerabilities regions and climate change – what is dangerous climate change?” in October 2004.

The co-operation with the Nansen Center in St. Petersburg, where Ola M. Johannessen is the President, Dr. Leonid Bobylev the Director and Lasse H. Pettersson the Secretary General, is expanding. Several book manuscripts are under preparation, among others about “the White Sea” and the “Northern Sea Route”. The Nansen Center in Bergen bought in 2004 new office premises (290 m²) in St. Petersburg, which will be rented by the Nansen Center in St. Petersburg.

G.C. RIEBER CLIMATE INSTITUTE
The G.C. Rieber Climate Institute is a part of the Nansen Center, and is led by Prof. Helge Drange. His Professorship II at the Geophysical Institute, University of Bergen is a donation from the G.C. Rieber Foundations. The main activity of the institute is devoted to the stability and the dynamic properties of the North Atlantic and Arctic climate system. The Institute is a major partner in the Bjerknes co-operation in Climate Research established in Bergen between the Institute of Marine Research and the Nansen Center. This co-operation, coordinated through the Bjerknes Center at the University of Bergen, got the status as a Center of Excellence by the Research Council of Norway. Helge Drange is a member of the leader team and Ola M. Johannessen is the chairman of the board. Furthermore Helge Drange is a member of CLIVAR “Working group for Ocean Model Development” in The World Climate program, and “Vestnordisk Oceanklima” for Nordisk Ministerråd.

The G.C. Rieber Foundations support the institute with NOK 0.4 mill. annually for recruitment of Master students to climate research in Norway. The Board thanks the G.C. Rieber Foundations for its important support during many years.

MOHN-SVERDRUP CENTER FOR GLOBALE OCEAN STUDIES AND OPERATIONAL OCEANOGRAPHY
One of the main focus areas for the Nansen Center is global ocean studies and operational oceanography. Unfortunately it has been very difficult to get satisfactory funding in Norway in this field. Therefore we were very glad when we received a donation of
Several school classes and other exhibitions in the "Science Room". An exhibition on Fridtjof Nansen and an "Svalbard – Arctic Seasons" slide presentation. "Arctica" is a small public adventure which has existed for a three years period. The Mohn-Sverdrup Center will have a staff of 20 scientists and students.

The Mohn-Sverdrup Center was officially opened on October 20th 2004 by the Mayor of Bergen, Herman Freie, Trond Mohn (a relative of Henrik Mohn) and Anne Margrethe Sverdrup Hamre (Harald U. Sverdrup’s daughter). There were several speakers from abroad; Professor Walter Munk from "Scripps Institute of Oceanography, University of California", San Diego, U.S.A. (Harald U. Sverdrup’s first Ph.D. Student), Professor Lennart Bengtsson and Professor Klaus Hasselmann from "Max Planck Institute for Meteorology" in Hamburg, Germany, Dr. Yves Desaubies from "Laboratoire de Physique des Océans, IFREMER", Brest in France, Dr. Anver Ghazi, "Adviser to the Director General, EU Research Directorate" in Brussel, Dr. Stephen Briggs, "European Space Agency" in Italy and Dr. Ralph Rayner from "Ocean Numerics" in UK – as well as several national speakers.

The University of Bergen also presented two substantial donations to "ocean forecasting" at the Mohn-Sverdrup Centre/Geophysical Institute; a four years Ph.D. scholarship from the Faculty of Mathematics and Natural Sciences by Dean Dag Aksnes and 1 million NOK from the Administration of the University by Director General Kåre Rommetveit. The Board expresses it’s gratitude for these substantial donations, both from Trond Mohn and from the University. Furthermore, the Research Council of Norway funds (after application) the Center with one Post Doc position and one Ph.D. scholarship – both for a three years period.

**ARCTICA**

"Arctica" is a small public adventure Center at the Nansen Center. Among the attractions is a wide-screen movie "Svalbard – Arctic Seasons", a slide exhibition on Fridtjof Nansen and an exhibition in the "Science Room". Several school classes and other groups have visited “Arctica” during 2004.

**TERRA ORBIT AS / COTO AS / OCEAN NUMERICS LTD**

The Nansen Center is the owner of the companies Terra Orbit AS and COTO AS and a shareholder in Ocean Numerics Ltd. The goal of these companies is to offer services in respect to the environment, ocean monitoring and forecasting, which in turn will contribute to the scientific development in the areas the Nansen Centers focus its main research and development activities. Ocean Numeric forecasts e.g. currents and eddies in “the Gulf of Mexico” for the oil and gas industry.

**FINANCIAL SITUATION**

The Nansen Center is an independent non-profit research institute without basic public funding. The income in 2004 amounted to NOK 35.385.438. The 2004 project income has mainly come from the European Communities (EU), The Research Council of Norway, European Space Agency, oil companies, the Norwegian Space Center and INTEAS. Substantial financial supports have been received from G.C. Rieber trusts and Frank Mohn ASA by Trond Mohn.

The annual net surplus for 2004 amounted to NOK 2.948.693 of which NOK 402.130 came from financial income. NOK 948.693 of the annual income will be transferred to other equity capital and NOK 2 millions to a planned foundation “Nansen Scientific Society”, which will be operate as “a mother organization” for the Nansen Centers in Norway, Russia, India and China. The main aim for “Nansen Scientific Society” will be to co-ordinate and help to finance activities at these Centers. The equity capital amounts to NOK 25.766.653 out of a total balance of NOK 41.554.798.

**PROSPECTS FOR 2005**

We are expecting a slight expansion of our research activities in 2005, primarily due to a small increase in the funding level in Norway, and a limited number of new EU projects.

Bergen, April 26th 2005

Bjørn J. Landmark (Chairman)
Bjart Nygaard (Vice-Chairman)
Dag Aksnes
Anton Kjelaas
Lasse H. Pettersson
Ola M. Johannessen (Director)

**Leader Team**

**Founding Director**

Professor Ola M. Johannessen, also chair in Remote Sensing/Oceanography at Geophysical Institute, University of Bergen

**Mohn-Sverdrup Center for Global Ocean Studies and Operational Oceanography**

Director Ola M. Johannessen, and Deputy director Dr. Laurent Bertino

**G.C. Rieber Climate Institute**

Director Dr. Helge Drange, also Professor II at Geophysical Institute, University of Bergen

**Polar & Environmental Remote Sensing**

Research Director Stein Sandven also Vice-Director

**Coastal & Ocean Remote Sensing**

Research Director Dr. Johnny A. Johannessen, also Professor II at Geophysical Institute, University of Bergen

**International Relations & Marketing**

Director Lasse H. Pettersson

**Administration**

Director Bente E. Johannessen

**Economy**

Director Lars Gunnar Veland

**The Board**

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Professor Dr. Bjart Nygaard, Rieber Eiendom, Vice Chairman

Professor Dr. Dag L. Aksnes, Dean, Faculty of Mathematics and Natural Sciences, University of Bergen

Dr. Anton Kjelaas, UNIFOB

Lasse H. Pettersson, Representative of the employees

Professor Ola M. Johannessen, Director

**The Scientific Council**

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Director of London Office Arild Blixrud, Innovation Norway

Dep. Director General Harald Dowland, Norwegian Ministry of Environment

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District Director John Ingrid Hagen, Norwegian National Coastal Directorate

Professor Dr. Hartmut Graßl, Director Max Planck Institute for Meteorology, Hamburg, Germany

Professor Dr. Einar Hope, Norwegian School of Economics and Business Administration

Executive Director Jacqueline McGlade, European Environmental Agency

Director Jan Petter Myklebust, University of Bergen, International Division

Managing Director Sven Rong, Rieber Shipping ASA

Senior Vice President Dr. Robert A. Shuchman, ALTARUM, Ann Arbor, U.S.A.

Director General Rolf Skår, Norwegian Space Centre

Professor Ola M. Johannessen, Director
The highlight of 2004 was the inauguration of the Mohn-Sverdrup Center on October 20th, which was possible due to an endowment from Trond Mohn, Frank Mohn ASA in Bergen.

The objectives of the Mohn-Sverdrup Center are to improve the understanding of the ocean processes and circulation and to provide the best possible ocean forecasts from days to seasons ahead. These goals will be achieved through integrated use of numerical models, in situ and remote sensing data using data assimilation techniques.

The development and demonstration activities of Mohn-Sverdrup Center involves:
- Large-scale and high-resolution regional modelling
- Development and application of advanced data assimilation methodologies
- Coupled physical and ecosystem modelling for basin scale and coastal systems
- Dissemination of ocean forecasts to the public
- Education and training of a new generation of "ocean forecasters"

The understanding of the TOPAZ Atlantic and Arctic forecasting system (Figure 1) has progressed after a critical assessment. A complete upgrade of the HYCOM model revealed the importance of the Montgomery potential for shallow water regions and greatly improved the model properties of the Nordic Seas. Higher order numerical schemes for the advection of momentum have also proven to improve the models in different regions (North Sea, Skagerrak, Gulf of Mexico and the Gulf Stream). A useful comparison against three other models of the North Atlantic Ocean (the French MERCATOR, the US HYCOM-NRL and the UK FOAM model systems) also identified some limitations and lead to improvements of our TOPAZ model system. The model comparison confirmed that the TOPAZ system is competitive within the Global Ocean Data Assimilation Experiment (GODAE).

The understanding of the assimilation processes has progressed both within this experiment comparison and through mathematical work on preferential Monte-Carlo sampling strategies. Methodological work on bias reduction in data assimilation has shown promising results for assimilation of sea ice thickness in the coupled ocean and sea ice model system.

An operational eddy forecasting exercise for the Gulf of Mexico has been conducted in the summer. The information provided by the model system was insufficient for supporting operational offshore activities, but sufficiently convincing to get major companies involved in further research and development activities, including the Barents Sea (Figure 2).

The ocean model system is now implemented at three major different scales covering basin, regional and eddy resolving scales (Figure 1). Practically the basin scale models are now in use for the Atlantic, Indian and Pacific Oceans. The regional scale models covers the Nordic Seas, the Arctic, Arabian Sea and Bay of Bengal and the eddy resolving fine scale models are implemented for the Norwegian and Barents Seas, Gulf of Mexico, Arabian Sea and the south China Sea.

The near future R&D perspectives of the Center include exhaustive model evaluation and development. A fully coupled physical and biochemical model are under implementation for both oceanic and coastal waters, with the aim to able to predict both algae blooms and marine primary production. Multi-category sea ice model is implemented for the Arctic Ocean and will be developed and validated for both simulation of sea ice dynamics and iceberg drift predictions. Studies of extreme environmental events are important for marine operational activities and dedicated studies of e.g. hurricane induced currents will be undertaken. Wave-current interactions studies and modelling are planned.

The worldwide geographical expan-
sion of the model setup is scheduled and the model system will be set up to provide forecasts for more regional seas of the world oceans. Real-time assimilation of new observational data will include operational use of temperature and salinity profiles from the Argo floats program and XBT data. Sea ice thickness will be assimilated when new satellite Earth observation data becomes available from the ESA CRYOSAT satellite. Sea surface salinity data from the SMOS and Aqua satellite sensors will be also be assimilated into the model system. New ocean colour satellite data products will be of significant use in the coupled biochemical model for coastal and oceanic waters, which will open for more extensive assimilation of data products from both the MERIS and MODIS satellite ocean colour sensors. Having these new and comprehensive data sources available for near real-time assimilation into the system makes the further development of EnKF data assimilation scheme an essential task of the R&D activities of the Center.

The staff of the Mohn-Sverdrup Center comprises in spring 2005 six scientists (three part-time), three post-doc scientists, seven Ph.D. students and three master students, namely:
1. Prof. Ola M. Johannessen, director
2. Dr. Laurent Bertino, deputy director
3. Dr. G. Evensen, research dir. II (part time)
4. Dr. Hanne Sagen, scientist (part time)
5. Dr. Alexander Korablev, scientist (part-time)
6. Knut Arild Lisæter, scientist
7. Dr. Annette Samuelsen, postdoc
8. Dr. Frode Hoydalsvik, postdoc
9. Nina Winther, postdoc
10. Cathrine Myrmehl, PhD
11. François Counillon, PhD
12. Cecileie Hansen, PhD
13. Intissar Kergouche, PhD
14. Belma Batlak, PhD
15. Rahman Manketikkara, PhD
16. Swapna George, PhD
17. Bjørn Backeberg, MSc
18. Katrine Dale, MSc
19. Virginia Antonijevic, MSc

The G.C. Rieber Climate Research Center
Prof. Helge Drange, research director
The year 2004 was productive for the G. C. Rieber Climate Institute with 13 papers published and 9 papers accepted in international peer-review journals.

The major part of the activity at the Institute has been devoted to studies with the Ocean General Circulation Model (GCM) MICOM and the Bergen Climate Model (BCM), and observation-model comparisons. Both MICOM and BCM have been used to identify the mechanisms governing the natural variability and stability of the Atlantic Meridional Overturning Circulation (AMOC). Key findings are that the decadal-scale variability of the AMOC is mainly governed by variability in the formation of intermediate and deep waters in the North Atlantic sub-polar gyre, and not by similar processes within the Nordic Seas. Also, the AMOC was found to be more stable to fresh water perturbations than what could be inferred from previous research. Furthermore, MICOM has been used to extensively assess the transport and mixing processes of man-made tracers like CFC-11 and 137Cs, demonstrating the uniqueness of these tracers to diagnose the magnitude of unresolved mixing processes in the ocean.

A recent focus of the institute is modelling the processes relating to the “climate” fluxes across the air-sea interface, e.g., open ocean convection and the turbulent heat fluxes of the atmospheric boundary layer. An advanced turbulence-resolving model (LESNIC) has been developed for the atmospheric boundary layer. Particularly, observation-model comparisons based on the LESNIC model have demonstrated the large impact the stability of the lower atmosphere has on turbulent mixing. This impact is, as of today, not explicitly accounted for in climate-type GCMs. It is speculated that this failure may lead to problems in accurately describing the characteristics and evolution of the high-latitude climate-warming signal. A variety of ocean process studies have also been done.

The non-hydrostatic MITgcm model was used to corroborate the most detailed observations to date of a convective chimney in the northern Greenland Sea. Another study traced out the pathways of such ventilated sub-surface waters from the northern parts of the Nordic Seas to the North Atlantic. The transport was found to be critically sensitive to the varying climatic wind forcing in the region, leading to substantial differences in the southward transport of ventilated water through the Denmark Strait and the Faroe-Bank Channel.

Figure 3. a) Example of ENVISAT ASAR image covering the Fram Strait and superimposed drift vectors showing ice displacement over three days in February 2004. b) The drift vectors are interpolated across the Fram Strait at 79 N for estimation of the ice area flux.
Polar and Environmental Remote Sensing and sea ice monitoring

Stein Sandven, research director

The main activity has been to utilize ENVISAT ASAR wide-swath images for research and monitoring of sea ice processes in the Arctic. The ASAR wide-swath images makes it possible to cover large sea ice areas regularly. The Icemon project, which is one of the ESA’s initial projects for the consolidation phase of GMES, has established a network of sea ice monitoring products and services based on EO data in the Arctic Ocean and surrounding seas. In addition to coordinating the projects, the Nansen Center has used SAR data from ENVISAT to monitor the ice drift in the Fram Strait. By using a sequence of images obtained every three days, ice drift vectors and ice area flux profiles across 79°N have been calculated (Figure 3).

Ice area flux, combined with ice thickness data will be used to estimate volume flux, which is a key parameter for monitoring sea ice changes in the Arctic. In the Svalbard area, SAR data have been used for detailed analysis of the sea ice variability during the winter season. This analysis shows the various stages of ice growth and dynamic response of sea ice to wind and currents.

In the Kara Sea region classification of sea ice properties have been done using data fusion of SAR and optical images and neural network techniques. SAR data from ENVISAT have also been used to map sea ice in the Kara Sea during the winter season. These data have been processed and distributed to icebreakers operating in the Northern Sea Route. DISMAR (Data Integration System for Marine Pollution and Water Quality) is a GMES project coordinated by NERSC and funded by the IST-programme under EC FP5. DISMAR develops a distributed system for monitoring and forecasting of the marine environment, integrating data from various observing platforms and modelling systems. This distributed system will be used to improve the management of natural or man-made pollution crises in the coastal and ocean regions of Europe. DISMAR provides a single entry point, via a web portal, to several services delivering many types of observations and model results, and conforming to international standards for both metadata and data. DISMAR offers a multi-tier system with four main groups of components: user applications, geo-processing and catalogue services, catalogues and content repositories. Implementation is based on INSPIRE, OpenGIS and W3C standards, using Open Source software where available. All data products and services are described in an accompanying metadata file in XML format. The DISMAR system is tested in six coastal zone and ocean areas in Europe where Web Map servers are installed. NERSC is involved in demonstrating the system for the North Sea / Skagerrak area and will use this as a basis for our further dissemination environmental data in the context of among other GMES.

Open Ocean and Coastal Remote Sensing

Prof. Johnny A. Johannessen, research director

The primary activities during the year has included both starting-up and termination of several EU and ESA funded projects, participation to conferences and workshops, generation of new projects as well as organization and participation in progress meetings of several national and international funded projects. We were also invited by ESA to take part in the establishment and execution of a 3 years bilateral DRAGON program between China and ESA member states to highlight and advance the use of satellite remote sensing data for marine monitoring of Chinese waters.

Several papers were also published in international review journals, books and proceedings.

The MERSEA Strand-1 initial project on Global Monitoring for Environment and Security (GMES) ended in June 2004 followed by the delivery of the final report in September. The complementary ESA funded ROSES project under the GMES Service Element (GSE) was also terminated in November 2004. These projects, jointly with additional national funded projects such as MONOCOZE and SatHav, have stimulated significant advances of the integrated marine monitoring system whereby remote sensing combined with in situ data and models provide more reliable product information and services for coastal variability and water quality applications.

The group was also strongly represented at the ENVISAT Symposium in September 2004. Group members acted both as session co-chairmen and gave four oral presentations in different sessions dealing with the use of imaging spectrometers and radars for monitoring and studies of algal blooms and mesoscale ocean current variability.

Finally, the active collaboration with national and international partners, in particular including NERSC in St. Petersburg, continuous with mutual benefits for generation of new projects as well as scientific research and publication of papers in international review journals. Regarding the latter new quantitative retrieval of surface current features from imaging radars and more reliable atmospheric corrections and water leaving radiances from imaging spectrometers have been developed.

publications

Referee papers in international journals

Climate research


Doney, S.C., K. Lindsay, K. Caldeira, J.M. Campin, H. Drange, J.C. Dutay, M. Follows, V.F. Zakharov, L.P. Bobylev, J.C. Dutay, M. Follows, and X. Lang: “Effect of Diapycnal Mixing conforming to international standards observations and model results, and eral services delivering many types of Europe. DISMAR provides a single network of sea ice monitoring products and services based on EO data in the Arctic Ocean and surrounding seas. In addition to coordinating the project, the Nansen Center has used SAR data from ENVISAT to monitor the ice drift in the Fram Strait. By using a sequence of images obtained every three days, ice drift vectors and ice area flux profiles across 79°N have been calculated (Figure 3).

Ice area flux, combined with ice thickness data will be used to estimate volume flux, which is a key parameter for monitoring sea ice changes in the Arctic. In the Svalbard area, SAR data have been used for detailed analysis of the sea ice variability during the winter season. This analysis shows the various stages of ice growth and dynamic response of sea ice to wind and currents.

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Climate research


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The Nansen Group
Leader: Prof. Ola M. Johannessen