Annual Report 2005

The scientific foundation

Nansen International Environmental and Remote Sensing Centre

Saint Petersburg, Russia

The Greenland Ice Sheet - a wild card in the climate system

Founders of the Foundation

Bergen University Research Foundation (UNIFOB) *Bergen, Norway*

Max Planck Society *Munich, Germany*

Nansen Environmental and Remote Sensing Center *Bergen, Norway*

Northern Water Problems Institute of the Russian Academy of Sciences, Karelian Research Centre *Petrozavodsk, Republic of Karelia, Russia*

Saint-Petersburg State University *Saint-Petersburg, Russia*

Scientific Research Center for Ecological Safety of the Russian Academy of Sciences, *Saint-Petersburg, Russia*

Director

Dr. Leonid P. Bobylev

NIERSC Leader Team

Dr. Leonid P. Bobylev, Director, Leader of Climate Group

Prof. Dmitry V. Pozdnyakov, of Research Director for Aquatic Ecosystems and Optical Remote Sensing Group

Dr. Vladimir N. Kudryavtsev, Research Director for Air-sea-ice Interactions Group

Dr. Vladimir A. Volkov. Research Director for MetOcean Group

Ms. Maria V. Samsova, Chief Accountant

Dr. Julia S. Merkulova, Lawyer

Co-Presidents

Prof. Ola M. Johannessen

Founding Director, Nansen Environmental and Remote Sensing Center, also Professor at Geophysical Institute, University of Bergen, *Bergen, Norway*

Prof. Jean-Pierre Contzen

Chairman, Institute of Advanced Studies, the United Nations University, *Tokyo, Japan* and Professor at Technical University of Lisbon, *Portugal*

Vice-Presidents

Prof. Hartmut Grassl

Max Planck Institute for Meteorology and University of Hamburg, *Hamburg, Germany*

Prof. Vladimir N. Troyan

Vice-rector, St. Petersburg State University *Saint-Petersburg, Russia*

Secretary General

Mr. Lasse H. Pettersson

Director, International Relations, Nansen Environmental and Remote Sensing Center *Bergen, Norway*

Guardian Board

Mr. Kaare Rommetveit, *Chair*

Director General, University of Bergen *Bergen, Norway*

Mr. Anatoly G. Gorshkovsky

Head of Unit, Norilsk Nickel Company, *Moscow, Russia*

Prof. Igor V. Murin

First Vice-Rector, St. Petersburg State University, *St. Petersburg, Russia*

Dr. Nina N. Novikova

Director, Scientific Center for Earth Operative Monitoring, Roscosmos, *Moscow, Russia*

The Nansen scholar

Prof. Dr. Kirill Ya. Kondratyev

Academician, Counsellor of Russian Academy of Sciences, died on 1. May 2006.
He has participated in the Nansen Centre activities from its early foundation and had an essential role in the establishment of NIERSC as a scientific research foundation. We are very grateful to his efforts and contributions.

Cover: Greenland Ice Sheet.

Report from the Founders

Vision

To understand, monitor and predict climate and environmental changes in the high northern latitudes.

The major research areas are:

- Climate variability and change in High Northern Latitudes
- Aquatic ecosystems in response to global change with focus on optical remote sensing and modelling
- Air-sea-ice interactions by radio-wave sensing and modelling
- Applied meteorological and oceanographic research for industrial activities.

Organization

The Scientific Foundation "Nansen International Environmental and Remote Sensing Centre" (Nansen Centre, NIERSC) is an independent non-profit international research institution founded by Russian, Norwegian and German partners. It conducts basic and applied environmental and climate research funded by national and international governmental agencies, research councils, space agencies and industry. Additionally the Nansen International Centre receives basic funding from its Founders. NIERSC was founded in 1992 and reregistered at the St. Petersburg Administration Registration Chamber into a non-profit scientific foundation on 2. July 2001. The Centre was registered at the Ministry for Taxes and Charges of the Russian Federation on 17. January 2003. The Centre got accreditation by the Ministry of Industry, Science and Technology of Russian Federation as a scientific institution on 26. December 2002 and got license for conducting meteorological and oceanographic observa-tions from RosHydromet on 3. July 2006.

According to the strategy of the Nansen Centre, a new research group on applied meteorological and oceanographic research for industrial activities (*Met-Ocean Group*) was established in 2005. It was created in order to develop applied research at NIERSC for support of ice navigation, oil and gas exploration and other industrial activities in the Arctic and ice covered waters elsewhere.

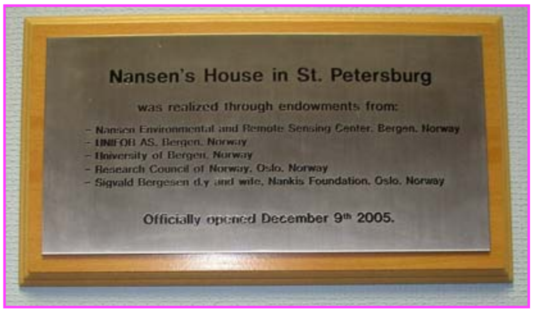
Staff

At the end of 2005 the Nansen Centre staff incorporated 30 employees comprising core scientists, including two full Doctors of Science and eight with a Ph.D. degree, part-time researchers, Ph.D. students and administrative personnel.

Office and Environment

In 2005 Nansen Centre moved to the newly established offices (300 m^2) named "*Nansen House*" and located at Vasilievsky Island - the historical centre of St. Petersburg. These office premises were bought by Nansen Center in Bergen especially for use by NIERSC. The official opening of the Nansen House took place on 9. December 2005. Many distinguished guests attended the official opening ceremony, including the Consul General of Norway Mr. Otto Mamelund, who unveiled the first bust of Fridtjof Nansen in St. Petersburg. The new offices are very satisfactory.

The bust of Fridtjof Nansen at the Centre, made by sculptor Eugeny Rotanov.



Production

During the year 2005, totally 34 publications were published including one book, nine papers in referee journals - of which one in Science - three papers in other journals and 21 conference proceedings. The Science paper titled "*Recent Ice-Sheet Growth in the Interior of Greenland*" (O.M. Johannessen, **K.S. Khvorostovsky**, M.W. Miles, **L.P. Bobylev**) gave a significant contribution to the understanding of the Greenland Ice Sheet variation.

Public outreach has been done through the Russian and international newspapers, TV and radio interviews, especially in relation to receiving the prestigious EU Descartes Prize (see below) and the opening of the new premises.

Awards

One of the major achievements in 2005 was winning the prestigious EU Descartes Prize, Panel of Earth Science, for the project "Climate and Environmental Changes in the Arctic – CECA". NIERSC became a Descartes Prize Laureate as a member of the international team consisting of Nansen Center from Bergen, Norway with its Director Prof. Ola M. Johannessen as project leader and coordinator, and Lasse H. Pettersson as project deputy coordinator, as well as Max-Planck Institute for Meteorology from Hamburg, Germany with Prof. Lennart Bengtsson, and St. Petersburg Nansen Centre with Dr. Leonid Bobylev as partners.

The prize award money will be used at NIERSC in St. Petersburg in a dedicated three-year program for further studies of the Arctic climate change, supporting particularly young Russian scientists and Ph.D. students.

National and International Activities

NIERSC has a long-lasting national cooperation with the St. Petersburg State University, many institutions of the Russian Academy of Sciences, Federal Space Agency, Federal Service for Hydrometeorology and Environmental Monitoring including the Northern Water Problems Institute, Scientific Research Centre for Ecological Safety, Arctic and Antarctic Research Institute, Voeikov Main Geophysical Observatory, Murmansk Marine Biological Institute, Research Centre of Operative Earth Monitoring and others, totally about 40 Russian institutions.

Fruitful relations are established also with number of foreign and international organizations, universities and institutions, including Max-Planck Institute for Meteorology, GKSS Research Centre, Friedrich-Schiller-University Jena from Germany, Finnish Institute of Marine Research and Institut Français de recherche pour l'exploitation de la mer (IFREMER) from Brest, France and especially with NIERSC founders – the University of Bergen and Nansen Center.

By the end of 2005 Nansen Centre participated in three EU, two INTAS, three ESA, four Research Council of Norway and two USA funded projects. The Centre was the coordinator of two of the EU projects. Additionally three ESA Announcement of Opportunity (AO) projects for the Envisat satellite mission are now being implemented for the Arctic and Northern Russia regions. Furthermore, the Nansen Centre takes part in several preparations for the International Polar Year (IPY) 2007-2008.

One of the major events in 2005 was hosting the 31st. International Symposium on Remote Sensing of Environment (31st. ISRSE) in St. Petersburg on June 20. – 24.. NIERSC was the local organizer and Dr. L.P. Bobylev was the co-chairman of the Symposium. The overall topic of the 31st. ISRSE was "*Global Monitoring for Sustainability and Security*" and the program focused on the implementation of the Global Earth Observation System of Systems (GEOSS) approved at the Earth Observation Summit. 435 scientists from 15 countries took part in the ISRSE Symposium and the four pre-symposium workshops. A special thanks is given to the staff and students for their efforts organizing the Symposium.

Funding Sources

The major project funding sources for the Centre are the EU 6th. Framework Program (FP6), European Space Agency, Research Council of Norway, International Association for the Promotion of Co-operation with Scientists from the New Independent States of the Former Soviet Union (INTAS), Norwegian Space Centre, Altarum Institute, USA and the Russian Fund for Basic Research. We are also very thankful to the Norwegian Minister of Education and Research Mr. Øystein Djupedal for a grant to NIERSC on 180.000 Euro for the period 2006-2008 in order to further develop the bilateral research and education cooperation between Norway and Russia.

Prospects for 2006

We are expecting an expansion of NIERSC research activities in 2006 mostly within the fields of Arctic climate and environment research, assured by activities initiated under the CECA Descartes Research Program and the grant from the Ministry of Education and Science of Norway.

Our extensive experience in sea ice studies and monitoring is expectedly highly relevant to the expanding oil and gas exploration activities in the Russian Arctic waters and in the Caspian Sea. The newly established Met-Ocean Group will develop these activities. The general task of this group will be establishing contacts and links with oil, gas, transport and other companies and develop products, tools and services for potential users.

Saint Petersburg, 1. June 2006

Ola M. Johannessen, NERSC (Co-President)

Jean-Pierre Contzen (Co-President)

Hartmut Grassl, Max-Plank Society (Vice-President)

Vladimir Troyan, SPbU (Vice-President)

Vladislav Donchenko, SRCES RAS

Nickolay Filatov, NWPI RAS

Arne Svindland, UNIFOB

Lasse H. Pettersson, NERSC (Secretary General)

Leonid P. Bobylev (Director)

Scientific Report

Climate and Environmental Change in the Arctic

Dr. Leonid P. Bobylev, Director

The research focus is on quantifying the relationship between the cryosphere and climate, interactions between climate sensitive sea-ice variables, atmospheric parameters, sea level pressure and ocean circulation indices using an ensemble of comprehensive state-of-art data sets spanning up to one century long.

In 2005 NIERSC participated in the projects: "*Material fluxes from the Russian Rivers Ob' and Yenisey: Interactions with climate and Effects on Arctic Seas (MAREAS)*" (funded by the Research Council of Norway), "*Sea Ice Thickness Observation System (SITHOS)*" (funded by EC), "*International Polar Year-Climate of the Arctic and its Role for Europe (IPY-CARE)*" (funded by EC).

One of the major scientific achievements of 2005 was the EC selection of the project "*Climate and Environmental Changes in Arctic – CECA*" as the laureate of the EC Descartes Prize in Earth Science. Among the major CECA results is that the increased warming observed in the Arctic in the period 1920 to 1940 with the subsequent cooling during 1940 to 1960 was due to natural climate variability, whereas the current, largest warming is basically due to human impact through increasing releases of greenhouse gases to the atmosphere (Johannessen et al, 2004). Since 1978 the total sea-ice cover in the Arctic has decreased by 3% per decade, while the multi-year ice extent has decreased by 7% per decade (Johannessen et al., 1999). These results, along with results from climate model simulations, bring us to the conclusion that by the end of this century the sea ice in the Arctic will disappear during summer assuming a doubling of atmospheric CO_2 concentrations (Johannessen et al, 2004). CECA also has come to a conclusion that the increasing amount of greenhouse gases will strengthen the low-pressure systems between Greenland and Iceland, consequently leading to a warmer, wetter and wilder (w-w-w) climate in Northern Europe during this century (Bengtsson et al., 2004).

The thickness of the inner part of the Greenland Ice Sheet over the last decade proved to increase, due to increased precipitation. The observations revealed a 5.6 cm increase in thickness per year, for the inner regions (heights above 1500 m). In the rim areas – i.e. for the altitudes below 1500 m – the thickness was reduced, due to warming and melting (Johannessen et al., 2005).

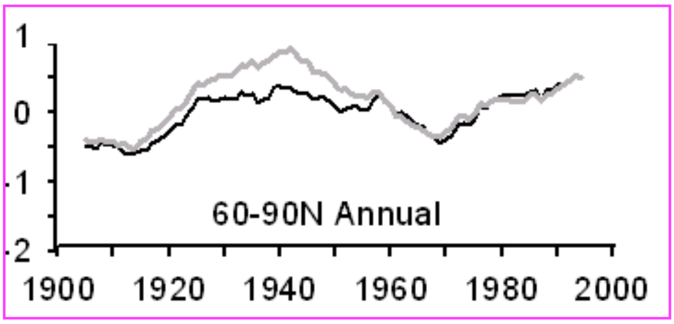


Fig. 1. Time evolution of SAT anomalies for the new objectively analyzed dataset (grey) and CRUTEM2v dataset (black).

The scientific results of the CECA project (http://www.nersc.no/ceca) implies with great certainty both positive and negative impact of climate change. These consequences for human activities will have impact on fisheries, oil and gas exploration and production, transport through the Northern Sea Route and for the ocean circulation, including the North Atlantic Current as well as on the climate in Europe.

Study of processes determining Arctic climate variability and change

Dr. Svetlana I. Kuzmina, Senior Scientist

In the framework of the MACESIZ Project - "*Marine Climate and Ecosystems in the Seasonal Ice Zone*" (funded by the Research Council of Norway) several gridded surface air temperature (SAT) datasets, all which are widely used in climate studies, were reviewed. The regional differences between the datasets were determined and explanations were suggested. Analysis of time evolution of averaged temperature anomalies for different latitude zones indicated large differences between the various datasets reaching up to 3°C. The largest discrepancies occurred during the warming period from 1920-1940 for the area 60°-90°N. Incomplete spatial sampling can result in significant errors of the (linear) trends of the SAT, especially during the early part of the 20th century. A maximum difference of ~0.76°/100yr. was found in trends for July for the polar region during the last century (Kuzmina et al., 2005).

A new objectively analyzed and gridded SAT dataset for the area north of 40°N has been created for the period 1900-2000 using all available data from land based meteorological stations, ARGOS buoy data, Russian and international drifting stations and research cruises. Quantitative and qualitative estimates of the typical SAT distributions and trends for different time periods were determined.

The new SAT dataset proves to agree better with several observational data records, which are widely used in climate research studies. The uniqueness of the new data set is its enhanced spatial coverage that provides a better SAT representation for the Arctic, especially for the first half of the 20th century, when observations were scarce.

Spatial-temporal Greenland Ice Sheet elevation changes

Dr. Kirill S. Khvorostovsky, Research Scientist

The Greenland Ice Sheet is a wild card in the climate change debate for at least two reasons. First, a hypothetical complete melting of the ice sheet would raise the global sea level up to 7 meters. This melting process for the Greenland Ice Shelf, expected to occur on a 1000 years time scale, would begin when the critical about 3°C threshold for climate warming is crossed, perhaps already before the end of this Century. Second, increased melting of the Greenland Ice Sheet will cause increased freshwater input into the northern North Atlantic Ocean. This effect has been theorized to weaken or even disrupt the global thermohaline circulation on a relatively rapid - multidecadal - time scale. We have investigated changes in the surface elevation of the Greenland Ice Sheet, which is pertinent to both of these critical issues through glacier mass balance.

An analysis of the merged ERS-1 and -2 satellite radar altimeter measurements for the period 1992 to 2003 has been performed and the main results of this study were published in Science Journal (Johannessen et al., 2005). Ice sheet elevation change was calculated for 0.5° lat. × 1.0° long. grid cells using two methods to analyze both spatial and temporal surface elevation variability.

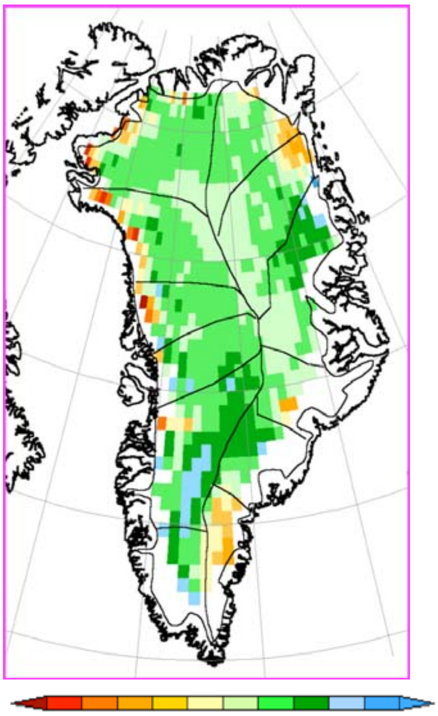


Fig. 2. Spatial distribution of the average Greenland Ice Sheet elevation change rate over 1992-2003.

In order to merge ERS-1 and -2 data, the bias between the two altimeters was determined for each grid cell. The bias is spatially variable and the effect of the bias on determining the elevation change rate (dH/dt) varied from few cm/year over the interior plateau to several tens cm/year over the ice sheet margins. Positive dH/dt values are in general found over most of the high-elevation areas, with largest values of up to 10–20 cm/year in south-western part (<69°N) and eastern Greenland between 74–77°N (Fig. 2). The largest negative values, –25 to –30 cm/year, are found in several parts of western Greenland. Reduced thickness is also found in southeastern Greenland (63°–66°N) and the northeastern ice stream (78°–80°N), with values in the range –10 to –15 cm/year. The regional differences in elevation change reflect to a varying degree the location of different ice regimes, most notably between southwest and southeast Greenland. Some of the significant reduction in thickness is observed over outlet glacier areas, implying the impact of ice sheet dynamic in addition to changes in precipitation and melting. For the entire Greenland Ice Sheet a positive change rate of 5.4 ± 0.2 cm/year or ~60 cm during the period of observations, was found. When corrected for the average isostatic uplift the ice-thickness increase was found to ~5 cm/year. This is in contrast to the high-elevation balance reported previously - results based on various spatially and temporally discontinuous observation records. However, the marginal areas are not measured sufficiently using ERS-1/-2 altimetry, and it was recently reported (Johannessen et al., 2005) that pronounced ablation in low-elevation marginal areas offset the elevation increases that we observed in the interior areas. Time-series analysis of elevation changes spatially averaged for the entire Greenland Ice Sheet indicates seasonal and inter-annual variability of up to tens of cm. As an interpretation of the results ice-sheet elevation changes was compared with North Atlantic Oscillation (NAO), which significantly affect regional temperature and precipitation. We found that inter-annual variability in the NAO and ice-sheet elevation changes in winter are negatively correlated ($r \leq -0.9$), when time-lagged one month. At the same time there is large inter-annual to decadal variability in the high-latitude climate system including the NAO, implying that our 11-year long radar altimetry dataset remains too short to establish the long-term trend and changes.

Aquatic ecosystems in response to global change with focus on optical remote sensing and modelling

Prof. Dmitry Pozdnyakov, Research Director

The main activity in 2005 was focused on applications and validation of our new developed operational bio-optical algorithm to studying biotic and abiotic processes in a range of marine and inland water bodies (Pozdnyakov et al., 2005a). SeaWiFS, MODIS and MERIS, AVHRR satellite Earth observation (EO) data are used to derive the water constituents such as chlorophyll, sediments, dissolved organic matter and sea surface temperature.

Under the INTAS project "*Synergistic Sensing*", temporal and spatial variations in water quality parameters and SST have been studied for the White Sea (WS). All the salient features of the WS hydrology, hydrochemistry and hydrobiology have been revealed on a perennial and inter-annual time-scales for 1998 to 2004. These satellite-based parameters have been validated against *in situ* data providing a high degree of consistency. The remote sensing and *in situ* data on in-water processes of the WS were complemented with the simulations using a 3D biogeochemical ocean model. Together, these data have given a new insight into the spatial and temporal distributions of surface manifestations of biotic and abiotic processes. The location of thermal fronts and their relevance to biotic processes were established. The impact of the marginal coastal zone has a significant effect on the spatial distribution of water quality parameters in the entire WS. The surface pattern and variability of river- and tidal-driven fronts are found both in SST, water quality parameters and model simulation results.

Based on the seven year sequence of SeaWiFS data, it is found that the WS ecological state rapidly responds to the ongoing climate change (increase in both SST and atmospheric precipitation): there is evidence that the light climate in the WS water column deteriorates due to increased water turbidity, which in turn is driven by the increased land and river runoff as a consequence of atmospheric precipitation rise.

Within the INTAS "*Synergistic Sensing*" projects, SeaWiFS visible images and MODIS infrared data were also utilized to monitor surface expressions of in water thermo-hydrodynamic and chemical and biological processes in Lake Ladoga - the largest fresh water body in Europe. The satellite data provided quantitative assessments of the thermobar displacement across the lake during both phases of the lake water warming and cooling. It is shown that the biogeochemical processes seasonal variations are highly dependant on the thermobar temporal and spatial dynamics.

It is shown that during the vegetation period the areas of enhanced phytoplankton chlorophyll content progressively displace from southern to northern regions of the lake along the eastern coastline. The existence of this phenomenon has been implied by fragmentary *in situ* data and ecological modelling, but has never been explicitly shown, as done through our use of both SST and phytoplankton chlorophyll data.

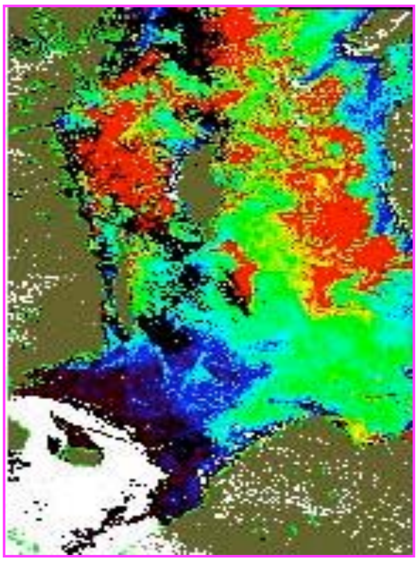


Fig. 3 Harmful algae blooms revealed by MERIS/ENVISAT in the central part of the Baltic Sea in July 2005.

Under a project with ALTARUM, synergistic satellite monitoring of Lake Michigan using visible, infrared and microwave EO data has been accomplished (SeaWiFS, Quicksat, AVHRR and other sensors were used). Seven year monitoring results have explicitly shown deep and multifaceted inter-relationships between the phenomenon of spring sediment resuspension and autumnal precipitation of calcium carbonate and spatial and temporal dynamics of water quality parameters. Quantitative assessments of resuspended sediment transport along the eastern coastline of Lake Michigan proved to be in very good compliance with independent indirect assessments. It was shown that synergistic remote sensing is an efficient tool in revealing and monitoring of lake ecology changes.

The investigations conducted in 2005 have shown that the developed operational bio-optical algorithm tool is highly instrumental in studying the ecology of natural water body and its responsiveness to changes in external forcing.

The EC funded project "*ECOMON – Current state of Russian marine ecosystem monitoring for the White Sea and relevance to the Water framework directive*" was completed in 2005. This one-year project has revealed several salient discrepancies in the methodology and concept of monitoring of coastal and open marine environments, but also highlighted compliance in the approaches and practice adopted in both communities. One of the important outcomes of the project was publication of the book "*White Sea - Its marine environment and ecosystem dynamics influenced by global change*" (Filatov et al, 2005). An International Workshop on monitoring of the marine ecology was organized by NIERSC prior to the 31st International Symposium on Remote Sensing of Environment (June 2005). The workshop was attended by scientists from more than 20 countries and demonstrated the importance of a more active use of satellite remote sensing means into the routine of marine ecological monitoring.

The "*MAREAS – material fluxes from the Russian Ob and Yenisei: Interactions with climate and effects on Arctic Seas*" project was dedicated to the monitoring of the Kara Sea completed in 2005. The NIERSC participated in the field campaign collecting data on *in situ* measurements of water quality parameters. Analysis of previous years of MODIS data was published as a cover in the IJRS (Pozdnyakov et al., 2005b). Further elaboration of these results is due for integration in a joint publication from the project in 2006.

Air-sea-ice Interactions by Radio-wave Sensing and Modelling

Prof. Vladimir Kudryavtsev, Research Director

The primary activity of the group during the year included;

- Investigation of effect of sea drops on the atmospheric boundary layer (ABL);
- Analysis of aircraft dual polarization C-band radar measurements and validation of the radar scattering model;
- Development of radar scattering model from the sea surface covered by natural biogenic films and oil spills;
- Further advancing of Radar Imaging Model in order to simulate Doppler shift in SAR-signal.

Sea Drops: A model of effect of sea drops on atmospheric boundary layer (ABL) at high winds was developed (Kudryavtsev, 2006). The mechanism is based on the direct effect of sea drops as heavy particles on the turbulent mixing. As found, spume drops, being torn off from breaking crests and sprayed inside the air flow, significantly suppress the turbulent mixing that result in acceleration of the airflow in the lower part of the ABL and reduction of the sea surface drag. At highest wind speeds (60-80 m/s) the model actually predicts an effect of the "slippery surface" when the drag coefficient is reduced about 10-times. A comparison with available observations is encouraging.

The aircraft radar experiment and model validation: An analysis of radar observations in C-Band (performed by CETP, France; see Mouche et al., 2005) combined with the models was proposed to study sea surface properties and their relation with the backscatter (Mouche et al., 2006). Different types of the electromagnetic part of the models were tested: composite Bragg model with or without effect of wave breaking, geometrical optics and small-slope approximations. The sea surface description was based on the wave spectrum proposed by (Kudryavtsev et al. 2003, 2005), but tests with other spectrum models were also discussed to assess the conclusions. It was shown that HH and VV observed radar scattering properties cannot be explained unless an additional non-polarized contribution from breaking waves is invoked. Model of wave breaking scattering (Kudryavtsev et al., 2003; 2005) combined with the composite model gives good agreement with radar measurements in both polarizations.

Biogenic films and oil spills: A model of wind wave spectrum and radar scattering from the sea surface covered by biogenic films and oil spills had been proposed. This model extends recently developed Radar Imaging Model (Kudryavtsev et al. 2005) by means of modification of viscous dissipation due to presence of the sea surface films. Two types of model extensions recently developed Radar Imaging Model (Kudryavtsev et al. 2005) by means of modification of viscous dissipation due to presence of the sea surface films. Two types of viscous damping model were adopted: Levich for monomolecular films, and Jenkins and Jakobs for surface films of a finite thickness. Important element of the wave model is that it includes non-linear energy transfer from longer waves to shorter one, that explains observed feature of surface slicks, - non-vanishing of radar returns inside the slick. The model was verified against well-controlled lab and dedicated field experiments, and in overall good agreement was achieved.

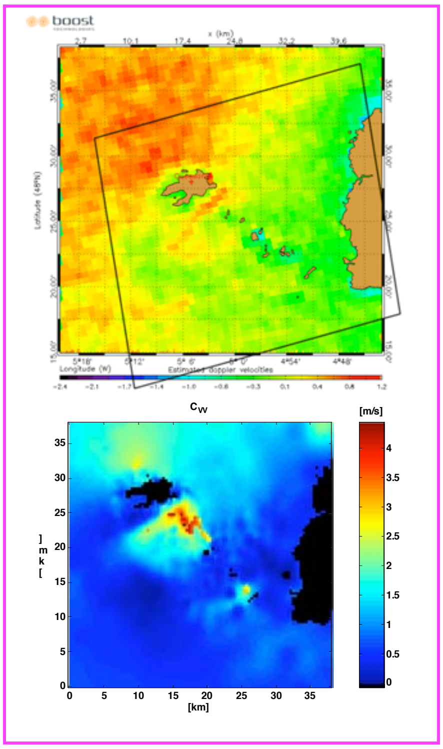


Fig. 4. Measured Doppler velocity (upper) and simulated total Doppler velocity (lower). The insert in the upper image marks the position of the model field.

DopRim activity: Recently, two new methods for quantitative studies of SAR imaging of current features were presented in the July 2005 issue of JGR Oceans: Doppler shift approach and radar imaging modelling (RIM) approach (Kudryavtsev et al. 2005; Johannessen et al., 2005). In order to combine these two approaches, a new "DopRim" model was proposed. Forward simulations of SAR images using "DopRim" model were conducted for two test areas around the French coast. 3D model current fields and wind field retrieved from the respective SAR images were served as the input for the "DopRim" modelling. Preliminary results show that fields of surface current and its deformation can be derived in consistence with the SAR backscatter anomalies and the measured Doppler shifts (see Fig. 4). The inverse module, when fully tested, is expected to significantly advance the use of SAR imagery in quantitative studies of ocean mesoscale features.

Applied meteorological and oceanographic research for industrial activities

Dr. Vladimir A. Volkov,
Research Director

In 2005 Met Ocean Group contributed to NIERSC activities in the framework of the following activities:

The European Commission has funded the project "*Generic Model Simulations (GMS) of spreading of marine pollutants in the Arctic environment during the 21st Century*". The GMS project aimed at assessing the use of ocean climate models for simulation of radioactive contaminants in the marine environment for simulations of spreading of other industrial contaminants in the Arctic environment. The general goal was to increase the efficiency of future environmental monitoring and scientific research in order to contribute to the management of environmental risks associated with man-made impact and industrial pollution in the Arctic marine environment.

Under the INTAS project "*The Nordic Seas in the global climate system*" comparative analysis of oceanographic data, obtained from various oceanographic databases of Nordic Seas for the Norwegian and Greenland Seas, the most energetic due to the interaction of the North Atlantic and Arctic waters, was carried out. The comparison was fulfilled for the two last century major warming periods: 1920-1940 and the period of 1990-tie to present.

Three research projects focused on studies of the sea ice regime:

The manuscript for the book "*Remote sensing of sea ice in the Northern Sea Route*" (funded by European Space Agency) has been carried out in cooperation with NERSC and Arctic and Antarctic research Institute (AARI). In 2005 the major parts of the book have been finished and the book are due for publication in early fall 2006 by Springer-Praxis.

Jointly with NERSC the "*ENVISAT AO: Ice monitoring in the Northern Sea Route using ENVISAT data (ICEWATCH II)*" project has provided large amount of ASAR data available for support of icebreaker navigation and sea ice studies in the Russian Arctic waters. Major work included coordination of ASAR data acquisition, near real-time analysis of SAR images and collocated *in-situ* data.

NIERSC was a subcontractor under NERSC in "*Sea Ice Thickness Observation System (SITHOS)*" project funded by the European Commission. In this project analysis the accuracy of ice thickness retrieval from radar-altimeter data was conducted.

Publications

Book

Filatov. N.N., ***D.V. Pozdnyakov****, O.M. Johannessen, L.H. Pettersson,* ***L.P Bobylev****.* White Sea: Its Marine Environment and Ecosystem Dynamics Influenced by Global Change. ISBN: 3-540-20541-1, Springer-Praxis, 2005, 472 p.

Referee papers

Climate Research

Johannessen O.M., ***K.S. Khvorostovsky****, M.W. Miles,* ***L.P. Bobylev.*** Recent Ice-Sheet Growth in the Interior of Greenland. Science, Vol. 310, No 5750, pp. 1013-1016, 11 November 2005

Kuzmina S.I.*, L. Bengtsson, O.M. Johannessen, H. Drange,* ***L.P. Bobylev,*** *M.W. Miles.* The North Atlantic Oscillation and Greenhouse-gas Forcing. Geophysical Research Letters, Vol. 32, L04703, doi: 10.1029/2004GL021064, 2005

Aquatic Ecosystems

Pozdnyakov D.V., A.A. Korosov*, H. Grassl and L.H. Pettersson.* An advanced algorithm for operational retrieval of water quality from satellite data in the visible. Int. J. Rem. Sens., Vol. 26, N12, pp. 2669- 2688, 2005

Pozdnyakov D.V., A.A. Korosov*, L.H. Pettersson,* ***V.V. Ionov****.* New operational algorithm of natural water quality retrieval from satellite data. 2005, Earth Obs. Rem. Sens., N4, pp. 17 – 29 (In Russian)

Pozdnyakov D.V., A.A. Korosov*, L.H. Pettersson, O.M. Johannessen.* MODIS evidences the river run-off impact on the Kara Sea trophy. Int. J. Rem. Sens., Vol. 26, N17, pp. 3641- 3648, 2005

Pozdnyakov D.V., *R.A. Shuchman*, ***A.A. Korosov***, *C. Hatt.* Operational Algorithm for the Retrieval of Water Quality in the Great Lakes. Remote Sensing of Environment, Vol. 97, pp. 352-370, 2005

Air-sea-ice Interactions

Johannessen J.A., ***V.N. Kudryavtsev, D.B. Akimov***, *T. Eldevik, N. Winther, and B. Chapron.* On radar imaging of current features. Part 2: Mesoscale eddy and current front detection. J. Geophys. Res., Vol. 110, C07017, doi:10.1029/2004JC002802, 2005

Kudryavtsev V.N., D.B. Akimov, *J.A. Johannessen, B. Chapron*. On radar imaging of current features. Part 1: Model and comparison with observations. J. Geophys. Res., Vol. 110, C07016, doi: 10.1029/2004JC002505, 2005

Met-Ocean Support

Bogdanov A.V., S. Sandven, O.M. Johannessen, ***V.Yu. Alexandrov*** *and* ***L.P. Bobylev***. Multisensor Approach to Automated Classification of Sea Ice Image Data. IEEE Transactions on Geoscience and Remote Sensing, Vol. 43, No 7, pp. 1648-1664, 2005

Other Publications

Johannessen O.M., ***L.P. Bobylev, E.V. Shalina, S.I. Kuzmina, K.S. Khvorostovsky***. Arctic Climate Change – a Part of Global Change. Computational Technologies, N10, pp. 56-62, 2005 (in Russian)

Maderich V., N. Dziuba, V. Koshebutsky, M. Zheleznyak, ***V.A. Volkov***. An assessment of flux of radionuclide contamination through the large Siberian rivers to the Kara Sea. Radioprotection, Suppl. 1, Vol. 40, pp. 413-419, 2005

Pozdnyakov D.V. Water Colour of Inland and Marine Coastal Waters: A Methodology of its Interpretation and Application For Studying In-Water Processes From Space. Ann-Arbor: ALTARUM Publ., Vol. 26, No. 17, pp. 3641-3648, 2005

Proceedings

Alekseev G., L. Bulatov, V. Zakharov, A. Korablev, A. Pnyushkov, P. Golovin, ***V. Ionov***. Warming and cooling events in the Arctic Ocean and Nordic Seas during XX century. Proceedings of the “European Geosciences Union General Assembly 2005”, 24 - 29 April 2005, Vienna, Austria, Geophysical Research Abstracts, EGU05-A-04983

Bobylev L.P., E.V. Shalina, V.Yu. Alexandrov, S.I. Kuzmina, O.I. Babina. Observed and modelled sea ice variability in the Arctic. Proceedings of the “European Geosciences Union General Assembly 2005”, 24 - 29 April 2005, Vienna, Austria, Geophysical Research Abstracts, EGU05-A-04983

Zabolotskikh E.V., L.P. Bobylev, *L.M. Mitnik, M.L. Mitnik, O.M. Johannessen.* Atmospheric total water vapour content retrievals using Aqua AMSR-E data: theoretical and experimental results. Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Alexandrov V.Yu., *K. Kloster*, ***L.P. Bobylev, M.V. Alexandrov***, *O.M. Johannessen*, ***O.I. Babina***. Comparison of SSM/I- and SAR-derived estimates of old ice area in the Arctic. Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Khvorostovsky K., L.P. Bobylev, *O.M. Johannessen.* Assessment of Greenland Ice Sheet elevation changes using merged ERS-1/2 radar altimeter measurements. Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Sandven S., C. Haas, H. Sagen, K. Kloster, R. Forsberg, ***Alexandrov V.Yu.*** CRYOSAT pre-launch CalVal study for sea ice thickness. Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Pozdnyakov D.V., A.A. Korosov, *R.A. Shuchman, C. Hatt, S. Savage*. Lake Michigan Time Series Productivity Measurements Obtained from a New SeaWiFS and MODIS Satellite Retrieval Algorithm. Proceedings of the 8th International Conference on Remote Sensing for Marine and Coastal Environments, 17-19 May 2005, Halifax, Nova Scotia, Canada (on CD)

Korosov A.A., D.V. Pozdnyakov, *N.N. Filatov, O.J. Johannessen, I.A. Neelov, O.P. Savchuck, L.H. Pettersson.* Realization of a Dedicated Synergistic Study of Onega Bay of the White Sea Based on Spaceborne, Shipborne and Ecological Means. Proceedings of the 8th International Conference on Remote Sensing for Marine and Coastal Environments, 17-19 May 2005, Halifax, Nova Scotia, Canada (on CD)

Filatov N.N., ***A.A. Korosov, D.V. Pozdnyakov***, *L.H. Pettersson, O.M. Johannessen.* A dedicated synergistic study of the White Sea based on remote sensing, in situ determinations and biogeoecological simulations. Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Schuhman R.A., ***A.A. Korosov, D.V. Pozdnyakov***, *C. Hatt*. SeaWiFS and MODIS-observed multi-year seasonal and spatial dynamics in biotic and abiotic processes in Lake Michigan as obtained from a new water quality retrieval algorithm. Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Mouche A., D. Hauser, ***V.N. Kudryavstev***. Observations and Modelling of the Ocean Radar Backscatter at C-Band in HH- and VV-Polarizations. Proceedings of the International Geoscience and Remote Sensing Symposium-IGARSS 2005, IEEE Press, pp. 4, 2005

Akimov D.B., *B. Chapron, J.A. Johannessen* ***V.N. Kudryavtsev***. On Radar Imaging of Current Features: Model and Comparison with Observations. Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Johannessen J.A., B. Chapron, ***D.B. Akimov***, *N. Winther, T. Eldevik*, ***V.N. Kudryavtsev***. On Radar Imaging of Surface Current Features: Mesoscale Eddy and Current Front Detection. Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Kudryavtsev V.N. Marine oil spills control: SAR monitoring and model prediction. Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Zabolotskikh E.V., L.P. Bobylev, *L.M. Mitnik, M.L. Mitnik, O.M. Johannessen*. Sea surface wind speed retrievals using satellite radiometer data: errors of global and regional algorithms. Proceedings of the 3rd All-Russian Conference “Present-day Problems of Remote Sensing of the Earth from Space”, 14-17 November 2005, Moscow, Russia (on CD)

Melentyev V.V., *L.H. Pettersson*, ***L.P. Bobylev***, *S. Sandven*. Winter hydrology and ice regime of the Ob -Yenisey estuaries: results of SAR satellite comprehensive studies. Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Melentyev V.V., *M. Shubina, S. Sandven, V. Chernook*. Multi-spectral polarimetric SAR/SLR airborne studies of saline and fresh-water ice in the Russian Arctic. Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Melentyev V.V., *S. Sandven, V. Chernook.* Satellite-airborne integrated studies of behaviour ecology of ice form of seals (harp seals as example). Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Johannessen O.M., K. Kloster, L.H. Pettersson, ***L.P. Bobylev***, *S. Sandven*, ***V.Yu. Alexandrov***. Demonstration of SAR data for sea ice monitoring in the Northern Sea Route, Proceedings of the 31st International Symposium on Remote Sensing of Environment, 20-24 June 2005, St. Petersburg, Russia (on CD)

Johannessen O.M., S. Sandven, K. Kloster, L.H. Pettersson, ***V.Y. Alexandrov***, *and* ***L.P. Bobylev***. ENVISAT ASAR monitoring in the Northern Sea Route. Proceedings of 31st ISRSE Symposium, St. Petersburg, 2005

ADDRESS/LINKS;

Scientific foundation Nansen International Environmental and Remote Sensing Centre – Nansen Centre

14th Line no. 7A, Office 49, Vasilievsky Island, 199034 Saint Petersburg, RUSSIA

Phone: +7 (812) 324 51 03, Fax: +7 (812) 324 51 02

E-mail: adm@niersc.spb.ru http://www.niersc.spb.ru