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and  
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ANNUAL REPORT  
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Introduction

The faculty, staff, and students of International Arctic Research Center are pleased to continue our ongoing collaborations with our colleagues at the Japan Agency for Marine-Earth Science and Technology and look forward to increased scientific exchanges and cooperation. We have a great many common interests and our counties share many common problems and goals, so sharing efforts, data and working together on expeditions is in our mutual best interests.

In this annual report, we present a very brief overview of many activities. In order to make this report most easily readable, we do not present extensive details, but provide appropriate reference to applicable publications. This is our most recent research, so in most cases, these results have not yet been published. If the reader desires additional information on any topic, please feel free to contact us and we will provide more comprehensive explanations.

This report presents results on recent analyses related to observational studies, model development, and remote sensing applications of the Arctic Ocean and adjacent marginal seas, including the Bering Sea and new instrument development. Observational analyses include studies of the anomalous pulses of warm Atlantic water into the Arctic Basin, terrestrial CO₂ and methane fluxes from tundra and boreal forests. Model development includes sea ice physics and circulation, marine ecosystem studies, variational data assimilation techniques, terrestrial ecosystem studies, sea ice and freshwater flux through the Arctic Basin and impacts of extreme events upon coastal erosion. Remote sensing analyses include SeaWiFS (Sea-viewing Wide Field-of-view Sensor), AVHRR (Advanced Very High Resolution Radiometer) and SSM-I (Special Sensor Microwave Imager). We also report on development of a new instrument that was needed for monitoring extreme storm events.

All of these studies are intended to provide a better understanding of how individual components and processes interact to form a complex and dynamic arctic system. Through collaborations with Arctic researchers throughout the world, we can achieve our goals of developing a quantitative understanding of the Arctic System.
Projects

Ocean Ecosystem Modeling and CCSR/NIES/FRCGC Model Diagnosis
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2. Summary of Research Activities and Accomplishments

Improvement of the Coupled Ice-ocean Model for Development of the Ice-Ocean-Ecosystem Model

We specifically improved the ice-melting scheme and demonstrated that we could simulate realistic ice-ocean circulation in the Chukchi/Beaufort Sea, regarding the seasonal cycle of sea ice distribution and landfast ice.

Satellite Data Analyses

We investigated the satellite datasets derived from the SeaWiFS (Sea-viewing Wide Field-of-view Sensor), AVHRR (Advanced Very High Resolution Radiometer) and SSM-I (Special Sensor Microwave Imager) and revealed that recent warming in the Chukchi Sea suppressed phytoplankton bloom in the surface layer (Figure 1).

Figure 1: the SeaWiFS chlorophyll-a (chl-a) concentration map in a) August 2001 and b) August 2004. Chlorophyll value was estimated by the Ocean Color 4 Linear Algorithm (Wang and Cota, 2003). After 2002, low chl-a area was widely distributed in the Chukchi Sea.
Marginal Ice Zone of the Bering Sea

Ice-associated phytoplankton blooms critically impact polar marine food web structure and hence the transformations and transport of elements involved in biogeochemical cycles. By coupling pelagic and sea ice algal components in our 1-D ecosystem model, we successfully reproduced the observed ice-associated phytoplankton blooms in 1997 and 1999 at the NOAA/PMEL mooring M2 in the Bering Sea. The model results suggest that the ice-associated blooms were seeded by sea ice algae released from the melting ice. For an ice-associated bloom to grow, ice-melt resulting in low-salinity stratification must be followed by thermal stratification. The ice-associated blooms had little impact on the annual primary production, but had significant impact in terms of shifting phytoplankton species, and the timing and magnitude of the bloom.

Land-fast Ice on the Chukchi Sea Shelf

Applying our 1-D model to the land-fast ice ocean ecosystem on the Chukchi Sea shelf, model sensitivity studies show that net ice algal primary production increased almost in proportion to the initial nutrient concentrations in the water column and doubling light (PAR) shifted the ice algal bloom one week earlier.

1-D modeling of Interactions between Biogeochemical Cycles and Marine Ecosystems

By adding the inorganic carbon (carbonate) system to our 1-D ocean ecosystem model for the Bering Sea, we were able to reproduce observed temporal variability in surface seawater pCO2 that is governed primarily by biological processes. The capability of the model to simulate DMS biogeochemical cycling at three different stations was tested through participation in a Surface Ocean - Lower Atmosphere Study (SOLAS)-sponsored International DMS Ecosystem Modeling Intercomparison Study.

The CCSR/NIES/FRCG global GCM output was analyzed to reveal Arctic Oscillation (AO) and Arctic Dipole Anomaly (DA), and their relationship with sea ice export. The atmospheric circulation patterns were reasonably compared to the NCEP reanalysis. The sea ice thickness and velocity anomalies due to the AO and DA (Figure 2) reveal DA is more important than AO dynamically in driving sea ice out of Arctic Ocean.

Figure 2. Composite sea ice thickness and velocity differences between the positive and negative phases of AO (left), and between the positive and negative DA (right). DA’s dynamic driving sea ice out of Arctic Ocean is more important than the AO.
Arctic Ocean Models and Observations
Igor Polyakov - Lead Scientist

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2. Summary of Research Activities and Accomplishments
Over the last decade the North Atlantic supply of warm water (AW) into the Arctic Ocean has substantially increased (Figure 1, left). New pulse of anomalously warm water, including unprecedented warmth in the region east of Svalbard had entered the Arctic Ocean interior in 2006 (Figure 1, right). Translation of strong seasonal cycle in this anomalously warm Atlantic Water into the Arctic Ocean interior may have important implications for decaying sea ice.
Arctic Ocean Freshwater Content (FWC) Changes. The FWC record shows two periods in the 1920-30s and in recent decades when the central Arctic Ocean was saltier and two periods in the earlier 20th century and in the 1940-70s when it was fresher. The FWC anomalies on Arctic shelves (including river discharge anomalies) and those caused by net atmospheric precipitation were too small to trigger long-term FWC variations in the central Arctic Ocean. Ice production/decay was the key process in shaping long-term upper Arctic Ocean FWC changes. Strength of the outflow of the Arctic waters dominates the supply of fresh water to sub-polar basins. Publication is in press in J. Climate.

Modeling of Dense Water Cascading

Dense water outflow from continental shelves (cascading) is an important process contributing to shelf-deep ocean exchange. The Laptev Sea shelf in the Arctic Ocean is believed to be a potential site of dense water formation through ice freezing and brine ejection. Model simulations have shown that the volume flux associated with the Laptev Sea cascade is equal to 0.04-0.06 Sv, which is of the same order of magnitude as the other known Arctic cascades. Negative heat flux associated with this cascade is large enough to provide occasional cooling and freshening of warm Atlantic Water, which propagates along the Siberian continental slope.

Variational data assimilation of the oceanic data into the non-linear ocean model is the natural and mathematically correct way for the model-data synthesis. Application of this approach in several Arctic and sub-Arctic regions provided the following results. New estimates of the volume and heat/salt transport through the Aleutian Passes and new estimate of the reference Sea Surface Height distribution were obtained in the Bering Sea.
Optimized quasi-steady circulation was reconstructed in the Kara Sea. Optimized, time-dependent circulation was reconstructed in the Chukchi Sea for the 1990 fall (Figure 2). The work at extension of capabilities of assimilation algorithm resulted in: (i) development of new semi-implicit, s-grid, curvilinear coordinate ocean model, (ii) development of the variational algorithm for processing of hydrographic sections.

**Coupled Ice-Ocean Model (CIOM) in the Bering, Beaufort, and Chukchi Seas**

An IARC regional CIOM (Coupled Ice-Ocean Model) based on POM was used to simulate the downscaling ice and ocean processes with a 3.4-km resolution. This approach combining the global model for the 20th century climate simulation with the regional downscaling/nesting simulation helps understanding of both large-scale sea ice variability and small-scale sea ice dynamics. In the Chukchi Sea, the Bering inflow separates into three branches: the first main branch flows along the Alaska’s coast that is the Alaska Coastal Water (ACW); the second branch flows northward and turns to the right, joining the ACW along the Beaufort coast; and the third branch flows toward the Northwind Ridge. The Beaufort Gyre is well reproduced, superimposed by numerous mesoscale eddies, with anticyclones outnumbering cyclones. Sea ice breaks up offshore piece by piece with landfast ice untouched along the Beaufort Sea coast. Sea ice cracks from pack ice with irregular shapes due to 1) complex ocean circulation, coastal current, and mesoscale eddies, 2) multi-category sea ice dynamics, and 3) complex and high-resolution geometry and topography. Sea ice ridging, rafting, and openings/leads can be well reproduced in sea ice thickness and concentration.

**Assessment of Arctic Climate Change in the IPCC AR4 Model**

The assessment of the IPCC AR4 model simulations was focused on sea ice and ocean freshwater budgets. Systematic bias in the model simulations was analyzed. The study
about sea ice projection has been included in the new *IPCC AR4* and in the Highlights of Recent Research of the 2007 U.S. National Annual Report “*Our Changing Planet*”. A projection of the spatial distribution of sea ice extent in the 21st century will appear in the June issue of the *National Geographic Magazine*. The bias analysis will be presented in a WCRP workshop. In the freshwater budgets study, we developed correction methods based on basic physics and diagnosed variability and change of Arctic water budgets based on the corrected database. The results from this study help to understand phenomena and underlying physics of the recently manifested intensification of freshwater cycle.

**Sea Ice Mechanics and its Interactions with the Ocean and Atmosphere**

We have coordinated development of a next-generation sea-ice dynamics model with observation programs (e.g. ISPOL 2004) to improve understanding of the contribution of sea ice dynamics to mass balance of the arctic cryosphere. A pan-arctic sea ice module of the Arctic System Model is under development and includes Coulombic-like deformation, tidal and inertial oscillations. It is being verified against International Arctic Buoy Program and IARC buoy arrays across the Arctic Basin (Figure 3). A major international field campaign lead by IARC (APLIS, Spring 2007) is cultivating data-model synthesis of dynamic scaling impacts on the sea ice thickness distribution. Our work has identified important physical considerations in ice-ocean coupling not represented in many current Earth System Models that we are now working to include in the Arctic System Model.

![Figure 3.](image)

*Figure 3. (Left) Estimates of sea ice reduction in the late 20th century by different models. Multi-model ensemble mean is shown in light blue. (Right) Summer sea ice extent in the SRES scenario A1B. Multi-model composite of median for the last 20 years of the 21st century is shown in white.*
Terrestrial Ecosystem Models and Observations
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2. Summary of Research Activities and Accomplishments
Goals of this group are to assess 1) the winter emissions of CO₂ and CH₄ through the snowpack and 2) the monitoring of CO₂ emission in burned boreal forest soils, which play significant roles in the regional carbon budget in boreal forests and tundra ecosystems.

Regional Carbon Budget in Alaska Boreal Forest and Tundra
Our main aim is to effectively estimate the regional carbon budget in boreal forest and tundra environments of Alaska terrestrial ecosystem. Because vegetation and permafrost are vulnerable to climate change, flux measurements of CO₂ and CH₄ are required for a better understanding of spatiotemporal variations of CO₂ and CH₄ along a trans-Alaska pipeline and at west-ridge UAF. Taking advantage of the accumulated flux measurements, we need to collaborate with other IARC scientists on the Carbon Cycle and Arctic Climate Change Prediction. Though observation stations and the acquired flux-data are limited, this sub-group has also tried to investigate using models and remote sensing techniques.

Winter Emissions of CO₂ and CH₄ along an Alaska Transect
Winter emissions of CO₂ and CH₄ from terrestrial ecosystem soils are significant sources of atmospheric CO₂ and CH₄ that can account for up to half of the annual emissions of CO₂ and CH₄ from Arctic tundra and taiga ecosystems (Oechel et al., 1998; Panikov and Dedysh, 2000; Panikov et al., 2006). However, because these sites are limited to specific ecosystems, the spatial and temporal variations of winter CO₂ and CH₄ emissions cannot be elucidated. Here, we conducted winter flux measurements of CO₂ and CH₄ along an Alaska transect that total is ca 700 km along the trans-Alaska pipeline. Each site is located at an interval of 32 km (Figure 1). The research stations are from boreal forest (station 1 to 11) to tundra along the pipeline (station 12 to 21). We obtained chamber flux-measurements of CO₂ and CH₄ as well as the snow depth, snow temperature, whole snow water equivalent (SWE) and density during January 2005, February 2006, and February 2007. During 2005, 2006, and 2007, flux-measurements and other snow pit observation were depended on the weather condition. The averaged snow depths were...
66±26 cm and 33±15 cm in boreal forest and tundra during 2005, and 48±13 cm and 30±13 cm in boreal forest and tundra during 2006, and 35±12 cm and 24±10 cm in boreal forest and tundra during 2007. The averaged SWE were 13.7±3.1 g/cm² and 4.9±1.2 g/cm² in boreal forest and tundra during 2005, and 10.3±2.8 g/cm² and 7.7±2.0 g/cm² in boreal forest and tundra during 2006, and 6.0±2.8 g/cm² and 5.5±2.9 g/cm² in boreal forest and tundra during 2007. This suggests that the annual snow depth trend to decrease rates of 15.2 cm/year and 4.5 cm/year in boreal forest and tundra during three years, respectively. Figure 2 shows spatiotemporal variations of snow depth and SWE along a trans-Alaska pipeline during 2005, 2006 and 2007.

Figure 1. Locations of the winter fluxes of CO₂ and CH₄ observations along an Alaska transect observation of January 2005 and February 2006 and 2007.

Figure 2. Spatio-temporal variations of snow depth and snow density along an Alaska transect observation of January 2005 and February 2006 and 2007.

Spatiotemporal variations of CO₂ and CH₄ fluxes showed in Figure 3. The 3-year averaged winter CO₂ and CH₄ emissions were 0.60±0.19 gCO₂-C/m²/d and 2.6±1.7
mgCH₄-C/m²/d in taiga and 0.39±0.18 gCO₂-C/m²/d and 2.7±2.4 mgCH₄-C/m²/d in tundra, respectively. Winter emissions of CO₂ and CH₄ are related to the snow depth; the correlation coefficients of CO₂ and CH₄ (R) are 0.69 and 0.71, suggesting that snow depth plays a significant role in winter CO₂ and CH₄ emissions in snow-covered boreal forests and tundra during winter of 2005. Also, the air temperature measured at each site has a good correlation with winter emissions of CO₂ and CH₄, which have correlation coefficients (R) of 0.88 and 0.63 during January 2005, respectively. Therefore, winter emissions of CO₂ and CH₄ are very significant in evaluation of winter carbon budget in the Arctic, corresponding to 115±47 gC/m²/(winter season) of CO₂ emission and 0.60±0.45 gC/m²/(winter season) of CH₄ emission through tundra and boreal forest, Alaska during three winters.

Figure 3. Spatio-temporal variations of (a) CO₂ and (b) CH₄ fluxes along an Alaska transect observation of January 2005 and February 2006 and 2007.

Winter Emissions of CO₂ and CH₄ along an Alaska Transect

This research was carried out to estimate the winter fluxes of CO₂ and CH₄ using the concentration profile method (indirect) and the chamber method (direct) in black spruce forest soils in central Alaska during the winter of 2004/5. The average winter fluxes of CO₂ and CH₄ by the indirect and direct methods were 0.24±0.06 (SE; standard error) and 0.21±0.06 gCO₂-C/m²/d, and 21.4±5.6 and 21.4±14 µgCH₄-C/m²/h. This suggests that the fluxes estimated by the two methods are not significantly different based on a one-way ANOVA with a 95% confidence level; however, the flux ratios of chamber to profile methods are greater than unity, indicating that the higher chamber flux-measurements were due to the presence of tree wells and to the temporal transformation of accumulated snow at the surface. The winter CO₂ emission corresponds to 23% of the annual CO₂ emitted from Alaska black spruce forest soils, which resulted in the decomposition of organic matter based on the d¹³CO₂ of -22.5‰. The average winter emissions of CO₂ and CH₄ were 49±13 gCO₂-C/m² and 0.11±0.07 gCH₄-C/m², respectively. This implies that winter emissions of CO₂ and CH₄ are an important part of the annual carbon budget in seasonally snow-covered terrain of typical boreal forest soils. The CH₄ emission newly measured in boreal forest oxidized soils of central Alaska is a significant source of methane emitted through the snowpack to the atmosphere. The potential mechanism of
CH$_4$ production and transport was showed in Figure 4, which is 1) the pressure in the carpet is steadily enhanced by the freezing from both directions with time, 2) the frozen moss surface seals off the air-filled pore space, 3) the atmospheric O$_2$ does not reach the soil any more, 4) the soil CO$_2$ begins to reduce to CH$_4$ under suboxic/anoxic environments in the Sphagnum moss, 5) the pressured CH$_4$ (higher CH$_4$ concentration) moves to the tussock, and finally 6) the higher concentration CH$_4$ releases to the vascular plants at a top of a tussock (20 cm) and then the atmosphere through the snowpack. We report this winter methane emission by performing an inter-comparison of CH$_4$ fluxes measured by chamber, profile, and tower observations in the snow-covered boreal forest soils, Alaska.

Figure 4. Schematic drawing of the soil-originated CH$_4$ flow in tussock and sphagnum moss regime. The moss layer began to freeze the end of September; the layer was completely frozen to 30 cm depth below the surface since mid-October. The curves in the moss layer denote the freezing depth with time, and the depth is affected downward by the cold air temperature and upward by the permafrost. It suggests that the pore space in dead moss is getting narrower and then the soil air is steadily pressured with time. The stars denote the frozen phases (Kim et al., 2007).
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2. Summary of Research Activities and Accomplishments

Northern Hemisphere Storm Tracks

The literature contains greater focus on winter season storm activity than summer. Work recently conducted by D. Atkinson used a storms database based on relative vorticity to explore climatological properties of northern hemisphere summer extratropical storm tracks. Results contrasting summer and winter patterns for several storm parameters indicated general similarity at the largest scales, including the prominent track corridors of the middle latitude ocean regions and the mid-continental and east coast genesis zones. Variations between seasons generally consisted of differences in the strength and position of these major features. Two important results underscored by this study are 1) summer storms have longer life-spans than their winter counterparts, and 2) the primary track corridor in summer is positioned over northern Europe, whereas in winter it is farther north, over Scandinavia. Summertime intensity is also slightly greater over the Pacific than the Atlantic (Figure 1).
Figure 1: Northern Hemisphere summertime storm intensity. Maximum situated in N. Pacific (Aleutians) region (dashed contour line).

Other work undertaken included an effort to contrast different types of storm identification algorithms for the north Pacific/Bering Sea region. This work showed that, although often, close agreement is observed amongst methods, strong differences and tendencies can also be present. This can be a by-product of the meteorological parameters used to define a “storm.” For example, methods based on sea-level-pressure minima tended to have higher counts in topographically sheltered regions such as the Gulf of Alaska whereas relative vorticity would not capture these events as well.

Ongoing work in this direction is going to continue and expand storm track algorithms comparison work. These efforts are important because the different storm track methods do not always produce comparable results and a lot of derivative work is based on these results.

Coastal Weather Issues

This large effort by D. Atkinson encompasses research into storms and specifics of storm dynamics, including return-frequency analysis, ocean waves and swell, land-fast sea ice modeling, impacts of wave energy in the coastal zone, and recently the human implications of all this.

An important result to date is a close examination of the specific parameters that cause explosive deepening of Bering Sea storms. For the particular case of the October 2004 event (min SLP = 941mb) there were found to be several factors that contributed to its rapid re-intensification: moisture brought up from lower latitudes via absorption of a decaying typhoon, the high vorticity of a secondary low system combined with the vorticity of the Siberian feature, and the presence of a jet streak aloft.

A large project has been set up to link storm and bad weather observations made at the community level with weather systems at the synoptic level. This facilitates use of model output to analyze synoptic/climatological patterns that are most problematic for villages.
This work in turn is of use to coastal residents and planners to develop response strategies.

Other work consisted of development of a return-frequency calculation system for strong winds in the coastal environment.

*Mount Augustine Eruption*

In January 2006, Mt. Augustine volcano in Alaska erupted. This eruption was monitored using surface LIDAR, satellite observations, atmospheric chemical sampling, and dispersion model runs. These eruptions are very dangerous for polar air travel – for this reason a lot of effort is directed at their study. As part of this particular effort, D. Atkinson provided the synoptic meteorological context and flow conditions (Figure 2) to help validate and assess the dispersion model that was run to predict chemical concentrations and altitudes.

![Figure 2: Mt. Augustine eruption – mid-level (500mb) flow during the most active phase of the eruption.](image)

*New Instrument: Mountain Anemometer*

A period of design and development inspired by severe operational requirements led to the creation of a new type of anemometer for use in areas of high-elevation, rough terrain, extreme winds and icing conditions, or any combination of these challenges. Specifically targeted for Mt. McKinley, the instrument is small and portable enough that it can be carried by a mountain climber yet is strong, has no moving parts, is electrically simple, and can measure winds in any direction in excess of 100m/s (Figure 3). Testing in a wind tunnel environment as well as simulations in a computational fluid dynamics (CFD) environment on the Alaska Region Supercomputer Center (ARSC) will begin as soon as senior engineering students can be secured to conduct the tests, led by D. Atkinson.

![Figure 3: New prototype of a mountain anemometer for work on Mt. McKinley in Alaska. Designed to measure winds >100m/s in X/Y/Z (3-D) planes.](image)
Multidecadal Variability

U. Bhatt has been working with I. Polyakov, J. Polyakova, and V. Alexeev on trying to understand more about why the NAO paradigm falls apart sometimes. We made epochal analysis of COADS sensible heat flux, latent heat flux, sea level pressure and winds. In addition, we are examining the multi-decadal variability in a suite of CCSM simulations. Our focus has been spent on the observational analysis. We find significant large scale patterns of climate differences between a period when the NAO paradigm holds and one where it does not. Polyakov and Alexeev have done complimentary analysis.

Influence of Sea Ice on the Atmosphere

U. Bhatt and his collaborators have been analyzing the mechanism of CCSM response to sea ice extremes in the summer of 1995. We have extracted the diabatic heat forcing, and transient eddy forcing and run a linear baroclinic model to analysis which mechanism is more important for the response. We have summarized the results of the Linear Baroclinic Model and are close to submitting our manuscript.

Arctic Climate Patterns and Modeling

J. Wang and E. Watanabe investigated the winter dipole anomaly (DA) in the Arctic atmosphere and its contribution to sea ice export are investigated by using a high-resolution coupled general circulation model. The spatial distributions of the first two leading EOF modes of winter mean sea level pressure and geopotential height at 500 hPa north of 70°N obtained by the long-term simulation (1900-2010) are highly similar to them derived from the NCEP/NCAR reanalysis datasets (1948-2004). The first leading mode corresponds to the Arctic Oscillation (AO). The DA is defined as the second-leading mode. The AO and DA account for 66 % and 13 % of the variance, respectively (Figure 4).

Figure 4. Arctic Dipole Anomaly (DA) vs. AO and sea ice export using CCSR/NIES/FRCGC model (1900-2010; left penal) and NCEP reanalysis (right penal)

Composite spatial patterns of sea level pressure, sea ice thickness and velocity in the extreme years when both the absolute values of PC1 and PC2 exceed 1.0 indicate that the DA plays a great important role in sea ice export from the Arctic Ocean to the Greenland Sea due to its strong meridionality (Figure 5). Sea ice export is highly promoted
(restricted) in the positive (negative) DA phase. The dependence of sea ice export on the DA is comparable to or rather larger than that on the AO. However, whether the DA is physically independent of the AO or not has been unknown yet. Composite SLP fields suggest that the location of the most dominant anomaly in the Arctic seems to be characterized by the DA, while the sign of the anomaly is represented by the AO. In future, we should clarify the mechanism for existence of the DA.

Figure 5. Composite sea ice export: 4 scenarios, forced by DA +/- and AO+/- wind stress anomaly.

Detection and Attribution of Arctic Climate Variability and Long-term Change

X. Zhang detected long-term variability and change in the Arctic freshwater budgets and attribution. He also conducted analysis and comparison of Arctic cloudiness changes in multiple observational datasets. In his continuing work on the assessment of the IPCC AR4 model simulations of the Arctic sea ice coverage, they further examined sea ice spatial distribution and analyzed systematic bias. The study about sea ice projection has been included in the new IPCC AR4 and in the Highlights of Recent Research of the 2007 U.S. National Annual Report “Our Changing Planet”. A projection of the spatial distribution of sea ice extent in the 21st century will appear in the June issue of the National Geographic Magazine. In the freshwater budgets study, they developed correction methods based on basic physics and diagnosed variability and change of Arctic water budgets based on the corrected database. The results from this study help to understand phenomena and underlying physics of the recently manifested intensification of freshwater cycle. Following up their previous work, they investigated regional storm activity over the Arctic region. The result shows that the storm activity intensifies along the Eurasian coastal oceans. In the interior Arctic Ocean, storm activity was significantly amplified corresponding to the enhanced positive phase of the Arctic Oscillation around 1990 (Figure 6).
Figure 6. Regional variability and changes of Arctic storm activity during the period from 1948-2004.
Project Website Addresses

http://nabos.iarc.uaf.edu
http://nabos.iarc.uaf.edu/NABOS/cruise/2004/
http://research.iarc.uaf.edu/amg/
http://research.iarc.uaf.edu/IRG/
http://www.iarc.uaf.edu/education_outreach/summer/iarc_2005/
http://www.iarc.uaf.edu/highlights/coupled_marine_ecosystem/index.php
http://www.iarc.uaf.edu/highlights/DMS/index.php
http://research.iarc.uaf.edu/SOVACC
January 2007, Modeling the land-fast ice-ocean ecosystem offshore Barrow, Alaska, Arctic Frontiers Science Conference, Tromso, Norway, Clara Deal, Meibing Jin, Jia Wang, and Rolf Gradinger.


January 2006, Summer chlorophyll distributions related to the runoff-ocean-ice interaction in the Beaufort/Chukchi Sea, Marine Science Symposium, Anchorage, Kohei Mizobata and Jia Wang.


February 2007, Downscaling ice-ocean characteristics in the Beaufort-Chukchi seas simulated by an IARC Coupled Ice-Ocean Model (CIOM), AYK-SSI Science Meeting, Anchorage, poster, Jia Wang, and Haoguo Hu, Kohei. Mizobata.


February 2007, 7th International Conference on Global Change: Connection to the Arctic, Fairbanks, Impacts of wildfire on the hydrological environment in Interior Alaska, Yoshiyuki Ishii, Yuji Kodama, Yongwon Kim, Koichiro Harada, Yuki Sawada, and Masami Fukuda.

February 2007, 7th International Conference on Global Change: Connection to the Arctic, Fairbanks, Alaska, Observation of soil CO₂ efflux at Poker Flat wildfire burned site in 2005 and 2006, Yuji Kodama, Yoshiyuki Ishii, Yongwon Kim.

February 2007, 7th International Conference on Global Change: Connection to the Arctic, Fairbanks, Alaska, Satellite observations of snow cover, melting and property changes over Alaska, Shizuka Kimura, Hiroyuki Enomoto, Tomonori Tanikawa, Ryo Toshiro, Yongwon Kim, and Yoshihiko Saito.


March 2006, Arctic Week, PAG/AOSB Meetings, Potsdam, Germany, Igor Polyakov.
March 2007, IARC Arctic modeling progress: Combination of large-scale and
downscaling, simulation, JAMSTEC Annual Symposium, Yokohama, Japan, Jia
Wang.
April 2006, Colloquium at IFM-GEOMAR, Kiel, I. Polyakov.
April 2007, The Arctic winter atmospheric Dipole Anomaly (DA) and sea ice motion:
Data analysis and modeling, Old Dominion University, Norfolk, Virginia, Jia Wang.
April 2006, EGU Annual Conference, Vienna, Austria, I. Polyakov.
May 2006, Poster, Multidecadal variability in the Arctic/North Atlantic climate system,
Arctic Forum, Washington DC, Polyakov, I., U. Bhatt D. Walsh, H.L. Simmons, J.E.
May 2006, Workshop on Predicting Salmon Habitat in Alaska: Dynamical Downscaling
of Climate Variables over Alaska, invited presentation, U.S. Bhatt.
May 2006, Investigating the link between DMS and marine wildlife distributions: Large-
scale GIS modeling of marine hotspots, 4th International Symposium on DMS(P),
University of East Anglia, Norwich, United Kingdom, Clara Deal, F. Huettmann,
David Atkinson and A. Weaver.
May 2006, Sea Ice-Ocean-oil spill Modeling System (SIOMS) for the near shore
Beaufort and Chukchi Seas: Improvement and parameterization (Phase II), MMS
Modeling, Jia Wang.
June 2006, Poster, Arctic-Atlantic Multi-Decadal Variability in the CCSM, NCAR
CCSM meeting, Brekenridge, CO, U.S. Bhatt, K. Sterling, and I. Polyakov.
June 2006, Regional and seasonal perspectives of Arctic cyclone activity, Workshop on
Arctic Weather Extremes, Bergen, Norway, Xiangdong Zhang.
August 2006, Coastal Threats: Understanding the Forcings. Preventing and Responding
to Coastal Erosion meeting, Dillingham, AK, USA, D.E. Atkinson.
September 2006, Shelf-Basin Interaction Meeting, Sopot, Poland, Vladimir Ivanov.
September 2006, Joint IGAC/CACGP/WMO Symposium of Atmospheric Chemistry at
the Interfaces, Cape Town, South Africa, Winter Emissions of CO2 and CH4 along
Latitudinal Alaska Transect, Yongwon Kim, Yoshi Saitoh, Tomo Tanikawa, Hiroshi
Enomoto, and Gaku Kadosaki.
September 2006, Joint IGAC/CACGP/WMO Symposium of Atmospheric Chemistry at
the Interfaces, Cape Town, South Africa, The Role of Black Carbon Soot on
Shrinkage of Arctic Sea Ice and Alaska Glacier Regime, Yongwon Kim, Hiroaki
Hatsushika, Reginald R. Muskett, and Koji Yamazaki.
September 2006, SBE meeting, Sopot, Poland, Vladimir Ivanov.
October 2006, Improving Coastal Zone Emergency Response: A pathway from Research
to Human Benefits. American Association for the Advancement of Science Arctic
Division Annual Meeting, Fairbanks, Alaska, Atkinson, D.E., J. Marra, O. Francis-
Chythlook, J. Partain, D. Levinson, and J. Jensen.
October 2006, Investigating the link between DMS and marine wildlife distributions:
Large-scale GIS modeling of marine hotspots, AAAS Arctic Science Conference,
Deal, C.J., F. Huettmann, and David Atkinson.
October 2006, Arctic Science Conference of AAAS, Fairbanks, Alaska, Potential Effect
of Boreal Wildfire Soot on Arctic Sea Ice and Alaska Glaciers, Yongwon Kim,
Hiroaki Hatsushika, Reginald R. Muskett, and Koji Yamazaki.
October 2006, Arctic Science Conference of AAAS, Fairbanks, Alaska, Winter fluxes of 
CO₂ and CH₄ in boreal forest soils of central Alaska estimated by the profile 
method and the chamber method: An implication for the regional carbon budget, Yongwon 
Kim, Masahito Ueyama, Fumiko Nakagawa, Urumu Tsunogai, Yoshinobu Harazono, 
and Noriyuki Tanaka.

Educational Partnership Program 4th Education and Science Forum, Larsen, C., D.E. 

October 2006, Arctic atmospheric Dipole Anomaly and sea ice export as simulated using 
a climate GCM, UCLA, LA, Jia Wang.

November 2006, NABOS open meeting, St.-Petersburg, Russia, NABOS team members, 
I. Polyakov.

December 2006, PhEcoM-DMS, SOLAS Comparison of DMS Modeling Workshop, 
Brussels, Belgium, Clara Deal and Meibing Jin.

December 2006, AGU Fall Meeting, San Francisco, California, Igor Polyakov.

December 2006, AGU Fall Meeting, San Francisco, California, Vladimir Ivanov.

December 10-15, 2006 Modeling the 20th century Arctic climate using a global climate 

December 2006, Detecting Seasonality and Regionality of Changes in Arctic Storm 
Activity, AGU Fall Meeting, San Francisco, California, Xiangdong Zhang.

December 2006, AGU Fall Meeting, San Francisco, USA, Assessment of winter fluxes of 
CO₂, and CH₄ in boreal forest soils of central Alaska estimated by the profile method 
and the chamber method: a new discovery of CH₄ emission and implications for the 
regional carbon budget, Yongwon Kim, Masahito Ueyama, Fumiko Nakagawa, 
Urumu Tsunogai, Yoshinobu Harazono, and Noriyuki Tanaka.

December 2006, AGU Fall Meeting, San Francisco, Evaluation of burn severity of an 
interior Alaskan black spruce forest with ALOS AVNIR-2 and PALSAR remote 
sensors, Keiji Kushida, Shiro Tsuyuzaki, Yongwon Kim, Kenji Narit, Yuji Kodama, 
Yoshiyuki Ishii, Koichiro Harada, Yuki Sawada, Gaku Kadosaki, and Masami 
Fukuda.

December 2006, Chukchi Sea storm densities derived from various algorithms. Talk 
A24A-05, American Geophysical Union, San Francisco, D.E. Atkinson, M. Mesquita, 
J. Gottschalck, and A. Sorteberg.

December 2006, Extreme Value Wind Analysis in Alaska. Poster A21A-0828, AGU San 

December 2006, Characteristics and Variability of Storm Tracks in Alaska, Poster 


Seminars and Workshops Attended

January 2007, University of Alaska Anchorage, Science to Technology Workshop, Anchorage, Alaska, David Atkinson.
March 2006, AARI Seminar, St.-Petersburg, Russia, Igor Polyakov.
March 2006, AARI Seminar, St.-Petersburg, Russia, Igor Polyakov.
April 2007, Coastal Erosion: Strategies for Alaska workshop, Fairbanks, Alaska, organized by David Atkinson (IARC) and Orson Smith, (University of Alaska Anchorage).
August 2006, Dillingham, Alaska, David Atkinson.
October 2006, 6th Arctic Coastal Dynamics Workshop, Holland, David Atkinson.
October 2006, Winter fluxes of CO₂ and CH₄ in snow-covered boreal forest soils seminar, Alaska, Kitami Institute of Technology, Kitami, Japan, Yongwon Kim.
October 2006, Dynamics of CH₄ in Alaska, invited Seminar, Tohoku University, Sendai, Japan, Yongwon Kim.
October 2006, Dynamics of greenhouse gases in Alaska terrestrial ecosystem seminar, Hokkaido, University, Japan, Yongwon Kim.
November 2006, Bering Sea Sub-Network Workshop, Anchorage, Alaska, David Atkinson.
November 2006, What happens the Alaska by the Arctic Warming?, seminar, Yonsei University, Korea, Yongwon Kim.
November 8, 2006, Response of Alaska by the Arctic Climate Change Seminar, Korea Polar Research Institute, Korea, Yongwon Kim.
December 2006, Proudman Oceanographic Laboratory, seminar, Liverpool, UK, V. Ivanov.
December 2006, University of Plymouth, School of Earth Ocean and Environmental Science Seminar, Plymouth, UK, Vladimir Ivanov.
December 2006, SOLAS Comparison of DMS Modeling Workshop, Brussels, Belgium, Kohei Mizobata.
December 2006, American Geophysical Union, San Francisco, David Atkinson.
Hosted Visitors or Other Special Guests

Bekryaev, Roman Arctic and Antarctic Research Institute, Russia, December 2006-January 2007.
Blackwell, Pearl, Tohoku University, Japan, August 1-September 15, 2005.
Brown, Harvey, Woods Hole Oceanographic Institution, USA, January 15-current.
Follows, Mick, Massachusetts Institute of Technology, USA, August 20-25, 2006
Gosselin, Michel, University of Quebec at Rimouski, Canada, October 1-5, 2006
He, Juanxiong, Chinese Academy of Sciences, China, April-June 2006.
Publications


