Available online at www.sciencedirect.com
SciVerse ScienceDirect
Polar Science 7 (2013) 49–52
http://ees.elsevier.com/polar/

Editorial

JAMSTEC-IARC international collaboration enhancing understanding of the Arctic climate system

Available online 10 May 2013

Abstract

Collaborations amongst researchers from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan and the International Arctic research Center (IARC), University of Alaska Fairbanks (UAF), U.S., have been on-going since 1998 and resulted in a great number and magnitude of accomplishments that could not have been achieved without this close partnership. The Arctic represents an important region for Japan, the U.S. and the world, and many opportunities and challenges press for immediate understanding to enable wise decisions and policy making. We have many common interests and our countries face many common problems and goals. Addressing the tremendous scientific challenges of the Arctic requires such massive investment of manpower and resources that sharing efforts, data and working together on expeditions are in our mutual best interests.

This issue presents a compilation of selected results on recent analyses conducted in the five-year (2009–2014) research term related to observational studies, model development and remote sensing applications of the Arctic Ocean, adjacent marginal seas, and the surrounding terrestrial regions. 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 these collaborations, Japanese and UAF Arctic researchers can achieve our goals of developing a quantitative understanding of the Arctic System.

1. Introduction

This issue includes 11 papers from research projects conducted as part of the JAMSTEC–IARC Collaboration Study (JICS). This program is a partnership among more than 110 researchers from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and the International Arctic Research Center (IARC) at the University of Alaska Fairbanks (UAF) (Fig. 1). We are working together to examine common problems of mutual interest to both Japan and the United States and are engaged in challenges that are best suited to collaborative investigation. These papers demonstrate that greater advancements are possible when we share resources, understanding, data and efforts, working together to achieve more.

2. Background and justification

We have strived to conduct process studies and collect field measurements that may provide the understanding needed to expand our understanding of the Arctic, as a system. Examples include quantifying the variability in distribution, age structure and thickness of perennial sea ice. This understanding is central to the development of coupled models of atmospheric dynamics, oceanic circulation and sea ice degradation and export. The physical and biological controls of carbon fluxes are at the core of global change, yet quantifying methane and CO_2 fluxes in the Arctic and assessing their feedbacks are among the greatest challenges facing the Arctic research community. Documenting physical changes in the climate will contribute nothing

1873-9652/$ - see front matter
http://dx.doi.org/10.1016/j.polar.2013.05.001

Fig. 1. The JICS logo demonstrates our focus on the geographic area of the Arctic and the cryospheric sciences. Additionally, our commitment has been to attack problems that would benefit from the combined resources and intellectual capacity of our joined forces.

to our understanding if we do not synthesize those observations into higher-level analyses of ecosystem responses. All of these activities are key components of the Arctic System and will provide the tools and understanding needed to predict the system level responses to a changing climate.

3. Contribution of thematic papers to Arctic System science

These papers introduce a compilation of results on recent collaborative analyses related to observational studies, model development and remote sensing applications of the Arctic Ocean, adjacent marginal seas, and the surrounding terrestrial regions. 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.

High-latitude regions play a crucial role in global climate change, and the Arctic Ocean is a major source region for the surface waters of the sub-polar seas, in which weak stratification leads to deep convection, a key part of the global thermohaline circulation. Thus, high-latitude processes including decay of arctic perennial sea-ice is predicted to have profound effects on climate on regional-to-global scales. The goal of this research has been to gain an accurate knowledge of processes occurring in the Arctic Ocean and terrestrial regions using observational data and modeling. The Arctic Ocean plays an essential role in the high-latitude climate system. The Atlantic Ocean supplies vast quantities of heat to the Arctic Ocean, for example—so much, in fact, that the Atlantic Water (AW) heat presently stored in the polar basins is enough to melt Arctic ice several times over. Pnyushkov et al. (2013) describe changes observed in deep AW inflows to the Arctic Basin and utilize modeling analyses to understand the potential effects on climate.

Further, sea ice deformation rates throughout the Arctic have been observed to be increasing, and the scientific community can expect to see further increases in sea ice deformation results by way of increased divergence (opening) or convergence and shear (ridging/rafting) of pack ice. Regional patterns of divergence may also change in time. Other drastic changes have also occurred throughout the Arctic climate system, and Arctic-lower latitude climate interactions have been enhanced. As a consequence, extreme events have occurred more frequently, including record-low sea ice covers in 2007 and 2012. Also playing a major role in Arctic System studies are atmospheric reanalysis products, developed as a result of data assimilation into an atmospheric model. These products are widely used to force sea ice, ocean, and terrestrial models; to analyze climate systems' variability; and to explain and understand the relationships among system components, as well as causes for their change. Here Panteleev et al. (2013) use data assimilation and optimization analyses to enhance observational capabilities and efficiencies.

Biogeochemical data and ecosystem knowledge are limited in vast areas of the Arctic Ocean and subarctic seas. Over the last decade, IARC and JAMSTEC scientists have begun to address this gap in knowledge by making observations in arctic and subarctic waters. Goals for our study have included the quantification of key biogeochemical fluxes in the land-shelf-basin system of the Arctic Ocean, as well as the integration of observations and process studies. Such aims will shed light on the regional linkage and differences between biogeochemical processes under the pan-Arctic climate system. Aguilar-Islas et al. (2013) present the results obtained during the cruise in autumn 2010 by the JAMSTEC *R/V Mirai.* They examine mechanisms limiting transport of iron from the shelves to the deep basin and consider potential impacts on biological productivity.

Vegetation drives the carbon cycle between the atmosphere and the land surface primarily through photosynthesis and respiration. Accurate monitoring of vegetation structure and function in Alaska is essential for the understanding of vegetative response to climate change. To extract spatial and temporal variations in vegetation, we conducted both satellite and ground-based monitoring. Frozen ground, snow, and vegetation constitute a critical environmental subsystem of the Arctic eco-climate by way of interactions and feedbacks between energy, water, and materials (carbon, nitrogen, etc.). This subsystem has shown an enhanced response to the recent global warming trend. Suzuki et al. (2013) present results of the Advanced Land Observing Satellite (ALOS)/Phased-array-type L-band SAR (PALSAR) data to extract information on important vegetation characteristics including above ground biomass. Iwata et al. (2013) conduct additional observational studies and remote sensing analyses of the Terra satellite Moderate-resolution Imaging Spectroradiometer (MODIS) data to relate absorption of photosynthetically active radiation to Leaf Area Index and Vegetation Index. Nagai et al. (2013) investigated the application of digital cameras to monitor daily changes in forest floor and tree canopies in an Alaskan open-canopy black spruce forest and a Japanese closed-canopy cedar forest and demonstrated such analyses can provide useful information on phenology of coniferous forests. Nakai et al. (2013) analyze data from a sophisticated observational system to quantify the surface energy and water balance quantifying the energy supplied by net radiation and utilized in sublimation, snowmelt, evapotranspiration, and ground warming.

Snow is one of the most important processes for energy balance in the earth climate system. The lack of subgrid snow distribution representations in most climate models has been identified as a deficiency in snow cover evolution and atmospheric interaction simulations. Widely observable satellite remote sensing techniques also illustrate uncertainties in subgrid snow distributions. It is essential to better understand snow processes in the Arctic climate system and to reduce the uncertainty in reliably estimating the amount of snow in the cryosphere. Sugiura et al. (2013) have conducted extensive observational studies of snow distribution and properties. In this paper they present analyses of time-lapse photography and Terra/MODIS to examine relationships with the normalized difference vegetation index (NDVI), normalized difference snow index (NDSI), and normalized difference water index (NDWI).

Evaluation of the greenhouse gas budget of terrestrial ecosystems in the Arctic is also essential for a more complete and reliable estimation of the overall greenhouse gas budget (CO_2, CH_4, and N_2O) in boreal and Arctic regions. Changes in this complex Arctic terrestrial system, interrelated through a network of feedbacks and multi-dependent interactions, can initiate a cascade of regional and global effects. Kim et al. (2013) have conducted an extensive observational study of CO_2 flux in a transect across sub-Arctic and Arctic Alaska in boreal forest and tundra sites. This research has demonstrated the influence of soil moisture and temperature, and concluded that winter flux contributes 24% of the annual CO_2 efflux from the tundra and boreal forest ecosystems of Alaska.

JICS contributions to Arctic System science have been motivated by the need to bring greater and more diverse expertise into JICS modeling and to drive process studies into the broader international arena of Earth System modeling. An integrated land surface model would strengthen the science community's understanding of these interconnections. The major aim here is to develop a model that establishes clear quantitative insight into the interplay of climate, ecosystems, and hydrology interactions in the changing Arctic terrestrial system. Park et al. (2013) present the results of their land surface model CHANGE with particular emphases upon the changes in sea ice extent, snow cover and their influence upon terrestrial climate dynamics. Walsh et al. (2013) have conducted a synthesis of information on climate changes in eastern Siberia and the Alaska-Yukon area to show the projected changes by the late 21st Century are qualitatively similar to the changes that have been ongoing over the past 60 years, although the rate of change increases modestly under mid-range forcing scenarios.

References

Aguilar-Islas, A.M., Rember, R., Nishino, S., Kikuchi, T., Itoh, M., 2013. Partitioning and lateral transport of iron to the Canada Basin. Polar Science 7 (2), 82–99.

Iwata, H., Ueyama, M., Iwama, C., Harazono, Y., 2013. A variation in the fraction of absorbed photosynthetically active radiation, and a comparison with MODIS data in burned black spruce forests of interior Alaska. Polar Science 7 (2), 113–124.

Kim, Y., Kim, S.-D., Enomoto, H., Kushida, K., Kondoh, M., Uchida, M., 2013. Latitudinal distribution of soil CO2 efflux and temperature along the Dalton Highway, Alaska. Polar Science 7 (2), 162–173.

Nagai, S., Nakai, T., Saitoh, T.M., Busey, R.C., Kobayashi, H., Suzuki, R., Muraoka, H., Kim, Y., 2013. Seasonal changes in camera-based indices from 1 an open canopy black spruce forest in Alaska, and comparison with indices from a closed canopy evergreen coniferous forest in Japan. Polar Science 7 (2), 125–135.

Nakai, T., Kim, Y., Busey, R.C., Suzuki, R., Nagai, S., Kobayashi, H., Sugiura, K., Ito, A., 2013. Characteristics of evapotranspiration from a permafrost black spruce forest in interior Alaska. Polar Science 7 (2), 136–148.

Panteleev, G., Yaremchuk, M., Francis, Oceana, Kikuchi, T., 2013. Configuring high frequency radar observations in the Southern Chukchi Sea. Polar Science 7 (2), 72–81.

Park, H., Walsh, J.E., Kim, Y., Nakai, T., Ohata, T., 2013. The role of declining Arctic sea ice in recent decreasing terrestrial Arctic snow depths. Polar Science 7 (2), 174–187.

Pnyushkov, A., Polyakov, I., Ivanov, V.V., Kikuchi, T., 2013. Structure of the Fram Strait branch of the boundary current in the Eurasian Basin of the Arctic Ocean. Polar Science 7 (2), 53–71.

Sugiura, K., Nagai, S., Nakai, T., Suzuki, R., 2013. Application of time-lapse digital imagery for ground-truth verification of satellite indices in the boreal forests of Alaska. Polar Science 7 (2), 149–161.

Suzuki, R., Kim, Y., Ishii, R., 2013. Sensitivity of the backscatter intensity of ALOS/PALSAR to the above-ground biomass and other biophysical parameters of boreal forest in Alaska. Polar Science 7 (2), 100–112.

Walsh, J.E., Park, H., Chapman, W.L., Ohata, T., 2013. Relationships between variations of the land-ocean-atmosphere system of northeastern Asia and northwestern North America. Polar Science 7 (2), 188–203.

Larry D. Hinzman*
International Arctic Research Center, University of Alaska Fairbanks, Fairbanks, AK 99775-7340, United States

Tetsuo Ohata
Japan Agency for Marine-Earth Science and Technology, Japan

Igor V. Polyakov
International Arctic Research Center, University of Alaska Fairbanks, Fairbanks, AK 99775-7340, United States

Rikie Suzuki
Japan Agency for Marine-Earth Science and Technology, Japan

John E. Walsh
International Arctic Research Center, University of Alaska Fairbanks, Fairbanks, AK 99775-7340, United States

11 April 2013

*Corresponding author. Tel.: +1 907 474 7331; fax: +1 907 474 5662.
E-mail address: lhinzman@iarc.uaf.edu