Research Organization of Information and Systems
National Institute of Polar Research (NIPR)
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GRENE Arctic Climate Change Research Project
www.nipr.ac.jp/grene/

Arctic

News Letter 5

GPS survey for ice flow speed
(photo:Sin Sugiyama)

Various approaches to elucidating Cryospheric changes in the Arctic

Hiroyuki Enomoto / Professor, National Institute of Polar Research

Snow and ice are undergoing rapid changes in the Arctic region. As members of the snow and ice research group, we are researching the mechanisms of these changes and the mechanisms of rapid warming .

Even a few centimeters of snow can greatly change the reflective properties of the earth' s surface. Winter snow cover acts as heat insulation which suppresses heat loss of the ground, while high albedo suppresses temperature increases due to the spring-time insolation. However, as it has been pointed out, there are still uncertainties in predicting when snow will start melting and when it will start disappearing in the spring. In the fundamental seasonal processes in the cryosphere related to Arctic warming processes and its influences, many components are still insufficiently understood or incapable of being predicted.

Another major concern is the effect on snow and ice albedo change due to microscopic carbon particles and other impurities falling onto the snow. Since their situations remain unknown, we are struggling with measurement work even in the Arctic' s coldest winter months. JAXA makes satellite observation data available for cryosphere research. This is indispensable support for research as the cryosphere is expansive, rapid changing and often inaccessible.

Glaciers and ice sheets are also experiencing rapid depletion. At the Greenland ice sheet, melting water seeps underneath the ice sheet. This seepage increases glacier flow and the collapse of glacier tips is estimated to explain 50% of the ice-sheet reduction in Greenland. Research has been conducted to investigate the effects of melted ice from the glacier flow, which is still not well understood.

Additionally, groups of glaciers are shrinking throughout the Arctic; the activities underway are local on-field measurements, database construction, and future climate forecasts.

Snow cover measurement and variation analysis

Konosuke Sugiura / Associate Professor, University of Toyama

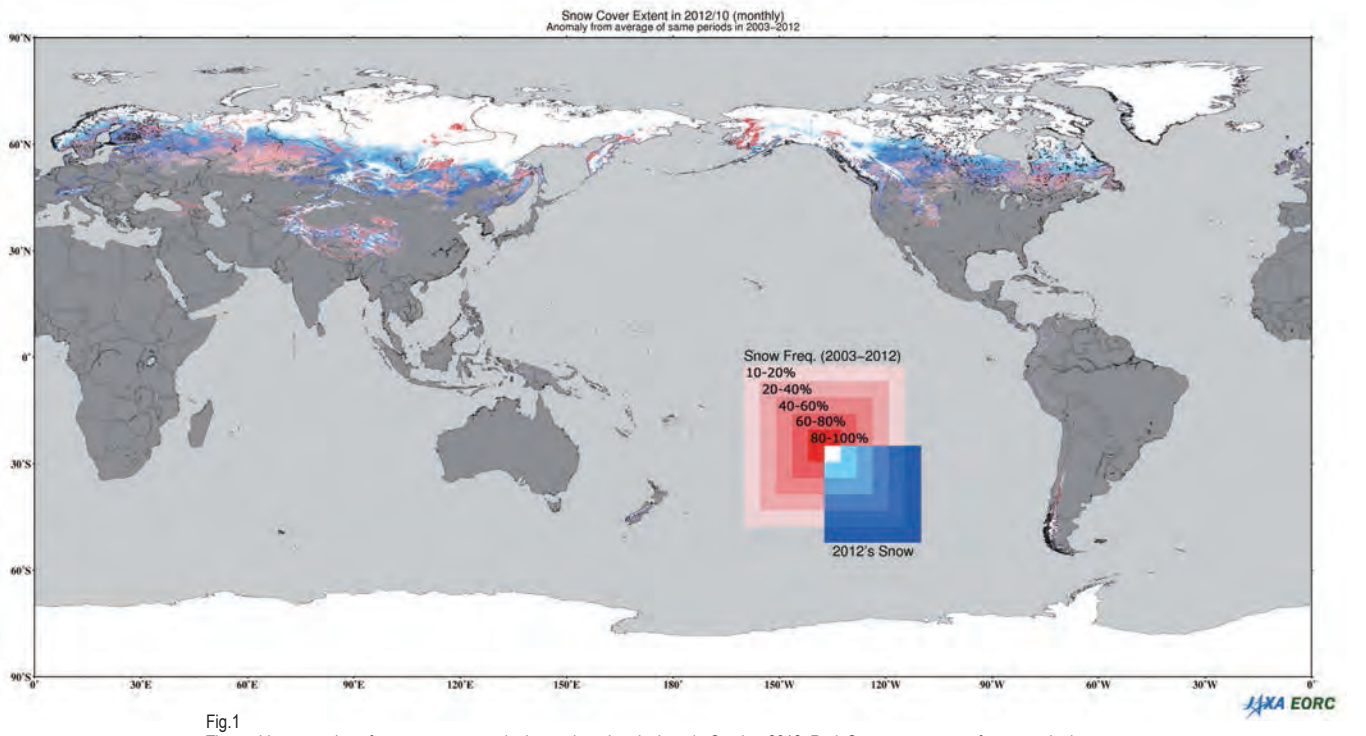


Fig.1
The rapid progression of snow cover extent in the northern hemisphere in October 2012. Red: Snow cover extent frequency in the ten years from 2003 to 2012. Blue: Snow cover extent in 2012. White: Snow cover extent in both the ten years from 2003 to 2012 and 2012 itself (MODIS Monthly data from NASA / GSFC and JASMES -JAXA Satellite Monitoring for Environmental Studies- from JAXA).

The characteristics of snow, including its high albedo, low thermal conductivity, large energy associated with phase change, and temperatures of 0 degrees Celsius and below, are suspected of being responsible for the changes occurring over a wide area and for having an effect on climatic systems. The extent of the effect varies depending on the amount of snow. Melting snow is also suspected to have a time-lag effect on climatic systems through a number of processes. What is more, snow cover itself is affected and changed by some of the processes. Thus, snow cover is a key factor in climatic system behavior.

Satellite data are an effective means of ascertaining the distribution of snow cover over a wide area. However, it is difficult to claim that satellites provide sufficiently accurate measurements for, in particular, the snow water equivalent and snow physical parameters. Also, while there are many datasets of snow cover extent over a wide range, there are discrepancies among these datasets. For this reason, dataset accuracy is first evaluated based on terrestrial snow data, and the satellite data is then used to explain how snow varies, particularly in the Arctic (Example: After the smallest sea ice extent on record was recorded in the Arctic in September 2012, snow cover extent accelerated over a wide area in October, as shown in Fig.1). Additionally, MODIS global 5-km grid brightness data for snow cover extent from 2000 to the present has been connected with data from 2000 back to 1978 from other sensors (AVHRR) for analysis of changes in snow cover extent over a period of over 35 years.

In addition to this research, studies on spatial and temporal variations of black carbon (BC) in snow cover are also carried out.

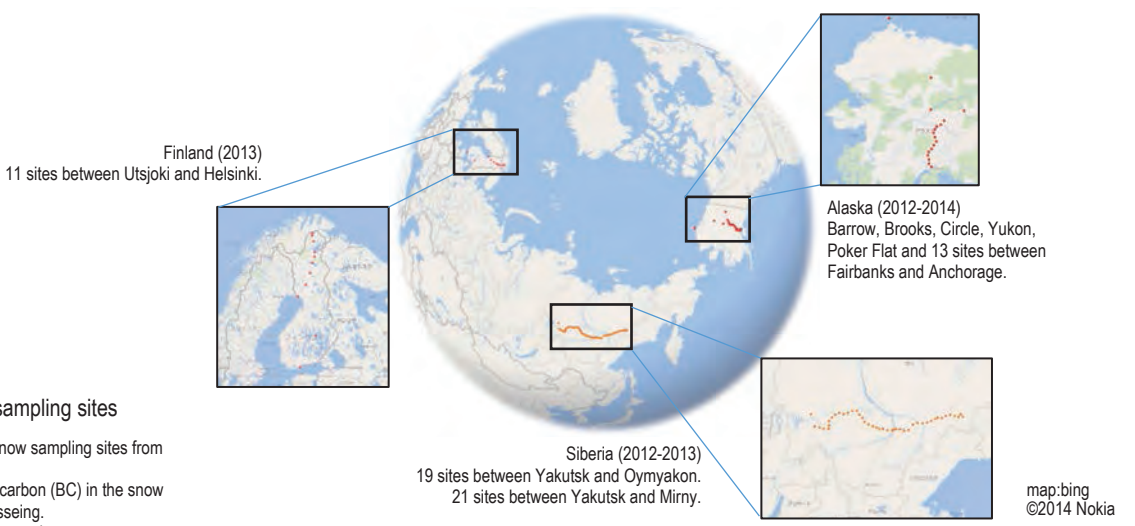


Fig.2
Map of snow sampling sites

This map shows snow sampling sites from 2012 to 2014.
Analyses of black carbon (BC) in the snow have been progresseing.
(figure:Yoshimi Ogawa)

Snow * Ice * Glaciers

The role of Arctic cryosphere in global change

Snow sampling site near the Denali national park, Alaska
(photo:Yoshimi Ogawa / National Institute of Polar Research)

Shapes and size distribution of black carbon in snow

Kumiko Goto-Azuma / Associate Professor,
National Institute of Polar Research

Black carbon, thought to lower the snow albedo and accelerate melting, is one of the hot topics of climate change research. However, due to the lack of reliable analytical technique and systematic observations across the Arctic, there have been large uncertainties in black carbon concentrations in the Arctic snow. Analytical errors in previous studies often have been greater than 100 %. Under the GRENE-Arctic project, glaciologists and atmospheric scientists have been collaborating to study spatial and temporal variations of black carbon concentrations in the Arctic snow.

A combination of new analytical technique developed by the University of Tokyo and a nebulizer proposed by the National Institute of Polar Research(NIPR) has enabled us to detect large black carbon particles over 1μm in diameter; this advance has led to accurate measurements of particle size distributions and mass concentrations. This new method has been used on snow samples from Alaska, Siberia, and Finland. Large regional differences in size distributions and concentrations of black carbon have been found. Black carbon concentrations were lower in Alaska than in Siberia or Finland, but Alaska was characterized by the presence of many large particles exceeding 1μm in diameter. Observations with a newly installed scanning electron microscope at NIPR also showed regional differences in the shapes of black carbon particles.

Since size distributions and shapes, as well as concentrations, of black carbon affect albedo, more in-depth research on this topic is planned. Transportation and deposition processes also will be studied under the GRENE-Arctic project.

Ice mass loss in Greenland

Sin Sugiyama / Associate Professor, Hokkaido University

Greenland is the world' s largest island, located to the north of North America and lying between the North Atlantic Ocean and Arctic Ocean. The ice that covers Greenland—the largest such ice masses in the northern hemisphere is rapidly losing mass. The GRENE Arctic Climate Change Research Project has been pursued to quantify Greenland' s ice mass loss and to clarify the processes of the rapid changes on the ice. The research has focused on ice sheets, glaciers, and ice caps around Qaanaaq in northwest Greenland, and since 2012 it has included three local observational expeditions and analytical studies of satellite data and numerical simulations.

The focus of the observations is the area around the terminus of the Bowdoin Glacier, an outlet glacier flowing from the ice sheet down into Bowdoin Fjord; a glacier flowing into water is called a "calving glacier." The rapid retreat of calving glaciers holds the key to ice mass loss in Greenland. In July 2014, the GRENE Arctic Climate Change Research Project in cooperation with the Swiss Federal Institute of Technology, drilled a 260-meter-thick glacier two kilometers upstream of Bowdoin Fjord (○ in the photograph below). This drilling operation was the first attempt in Greenland to drill to the glacier bed this close to the ocean. The mechanisms of the glacial change are investigated within and beneath the glacier. Additionally, researchers in boats measured ocean bed topography, water temperature, and salt concentration. The results of these operations will be applied to test on the hypothesis that the warming ocean is eroding Greenland ice.

Along the coasts of Greenland many ice caps and glaciers are distributed being separated from the ice sheet. The low elevation of this ice leads to higher temperatures and drastically rapid ice melting. Field measurement and satellite analysis revealed that ice caps around Qaanaaq are thinning at a rate of 1-2 meters annually, which is significantly faster than the previous estimate. We propose that the observed rapid melt rate increase is accelated by ice surface darkening and acceleration of the ice due to meltwater lubrication at the glacier bed.

Darkening ice surface (photo:Sugiyama)

The website for this Greenland project is:
http://wwwice.lowtem.hokudai.ac.jp/~sugishin/research/hokudai2/greenland/greenland.html

Drilling operation (photo:Sugiyama)

Bowdoin Glacier: ○ indicates the drillin site (photo:Sugiyama)

Early Career Scientists just visit to the Arctic

The fellowships for Japanese Early Career Scientists (ECSs) to visit Alaska or Canada has started since this summer. Two researchers reported their studies.

Study of Glaciology in UAF

Keiko Konya (JAMSTEC)

(photo:Konya)

There was very little time for preparation between being selected for the first round of the Fellowships for Japanese Early Career Scientist (ECS) for Arctic Environmental Research and my departure. However, in July 2014, I stayed for around one month at Geophysical Institute, the University of Alaska Fairbanks (UAF).

At UAF, I have conducted the research on glacier mass balance models. I learned about the models from the host researchers and did the test-run of the model.

There are many glaciers in Alaska, particularly in the Alaska Range, visible from Fairbanks. Alaska's major difference with Japan is that it is possible to visit glaciers with a single day trip. The University of Alaska has a history of glacier research, but the nature of the research has changed as staff have been substituted and replaced. Currently, it seems that not all of the researchers are studying glaciers in the Alaska Range and many were focused on Greenland instead. There are many visitors from overseas as well as the enrolled graduate students and post-doc fellows in the laboratory. Some seminars about the glaciers in Greenland and New Zealand were held in the laboratory during the period. The University of Alaska has also strong research facilities and activities on auroras and volcanos. I have participated in the tour, which is open for the general public to see the research facilities.

As Alaska is in the United States, it is necessary to cover one's own research fees and it is apparently tough to secure research positions. The seat I occupied was used by another post-doc until he was moved to another project days before my arrival.

I saw most of the members of the laboratory only at the lunch-time. When the host-researcher baked a cake for me right before I returned to Japan, the members of the lab gathered to eat.

My experience with the fellowships for Japanese Early Career Scientists

Takeshi Ise (Kyoto University)

This image is a sample of circular fisheye lens photographic data.
It is possible to estimate leaf area index and basal area from such data.
(photo:Ise)

I am normally engaged in computer simulation research on the Arctic terrestrial ecosystem. I merely specialize in simulation and have lacked the opportunity to conduct on-site measurements for myself, instead learning about local conditions indirectly through the papers and data of other researchers. However, when I learned about the Fellowships for Japanese Early Career Scientists (ECS) for Arctic Environmental Research, I immediately applied. I was interested in experiencing the polar opposite of my everyday work: research fully centered on field work and measurement. Fortunately, I was selected for participation. I was permitted to plan and pursue my own study without any compromise whatsoever.

However, that is not to say that I undertook my study out of pure interest. I created a plan to acquire data that would supplement the weak areas of my research, aiming for ever further advancement of that research. I visited the conifer forests of western Canada, where I used circular fisheye lens photography to a study the leaf area index and basal area of the forest in a nondestructive, contact-free way. In this way, I was able to survey a large area of forest using a single protocol. I hope to use the results of this work to improve the accuracy of vegetation data estimates from satellites, improving understanding of vegetation changes over a wide area as well as improving forecasts of such changes. Having now seen an extensive northern forest comprised of a single type of tree as far as the eye can see, I will continue to mentally imagine such forests as I aim to recreate them in simulations for my research.

ASSW 2015 Toyama

The Arctic Science Summit Week (ASSW) is the annual gathering of the international organizations engaged in supporting and facilitating Arctic research.

ASSW is an initiative of IASC. The purpose of the summit is to provide opportunities for coordination, collaboration and cooperation in all areas of Arctic science. The summit attracts scientists, students, policy makers and other professionals from all over the world. In April 2015, ASSW will be held for the first time in Toyama, Japan.

Schedule

April 23 (Thurs.) – April 25 (Sat.)	ASSW Business Meetings
April 26 (Sun.)	Public Lecture, Excursions
April 27 (Mon.) – April 30 (Thurs.)	ISAR-4 / ICARP III Symposium

Venue

Toyama International Conference Center, Toyama, Japan

Web

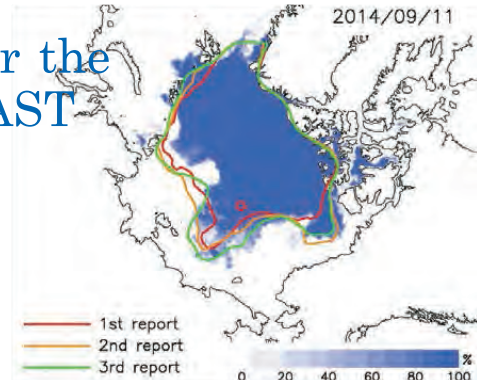
http://www.assw2015.org

Topics Research Project 7

Comparison of results with predictions for the 2014 SUMMER ARCTIC SEA ICE FORECAST

In the previous issue, 'Sea ice prediction and construction of an ice navigation support system for the Arctic sea routes (Hajime Yamaguchi, the University of Tokyo professor, principal Investigator)' reported this summer's Arctic sea ice forecast. The first report was issued on May 30, the second report on June 30, and the third report on July 31. This summer, sea ice area reached its minimum in mid-September before beginning its increase on into winter. We will now examine how accurate the sea ice forecasts truly were.

Although the minimum sea ice area was somewhat lower than last year, it did not shrink to levels predicted by the first report, and it achieved approximately the levels forecasted in the second and third reports. The Arctic sea routes were predicted in the first and second reports to open on the Russian side around August 11 and on the Canadian coast on July 26. Reality was almost precisely in line with these predictions, with the Russian side opening around August 10 and the Canadian side around July 30. In the individual sea zones, it was forecasted that sea ice would retreat quickly in the Laptev Sea and retreat slowly in the East Siberian Sea. This also followed the forecasts, but Laptev Sea ice showed even greater retreating than was forecasted.



Sea ice distribution as measured by the Shizuku satellite' s AMSR2 on September 11, alongside the sea ice distribution forecasts for September 11 of the first, second, and third reports (Location of the 30% concentration level)

WEB http://www.nipr.ac.jp/grene/
http://www.1.k.u-tokyo.ac.jp/

This year's forecasts can be said to have been quite accurate, especially regarding the Arctic sea route. The forecasts of the second and third reports came increasingly closer to the actual outcome, as incorporation of the latest data into forecasts proved effective.

The group will refer to this year's results in its ongoing work to further improve the accuracy and effectiveness of forecasts in the years ahead.

Open Lecture: Toward the commercial use of the Arctic sea routes

Monday, November 17, 2014 Rakusikaikan, Tokyo University of Marine Science and Technology

The GRENE-Arctic Project has already been producing many research results. In this lecture, researchers working at the front line of the sea ice project presented what they have found so far to general public. There were full of attentive audiencet being encharged in various business circles; researchers, students, shipping agencies,shipbuilding companies, insurance companies,government and municipal offices and the press.

Principal Investigator's Perspective

Koji Shimada

Tokyo University of Marine Science and Technology

Projection of sea ice distribution and Arctic sea routes

Research Project 7 is comprised of three sub-research projects that are pursued at the intersection of science and technology in an endogenous social-economic system, and it is anticipated that it will successfully achieve GRENE's five-year Strategic Research Target 4, "Projection of sea ice distribution and [its connection to availabilities of] Arctic sea routes." The achievement of the five-year goal is, as symbolized by the word "connection of dots" in its name, identification of key items that should be connected to reduce uncertainties of forecast models for safety use of Arctic Sea route near future.

A middle-term sea ice forecasting model is still in the development stages, but predicted results are published as-is and in real-time via ADS. This is important data to the industrial world in ensuring the execution of projects for enabling the use of Artic sea routes.

This Research Project is characterized by the development of a model jointly with improvements of satellite data algorithm and filed observation aboard ice breakers. For example, an algorism has been developed for monitoring the thickness of first-year ice that has occupied the majority of the Arctic Ocean; a method has been developed for estimating the status of the ocean circulation and stratification that affect sea ice growth during winter. Key data and processes for improving model accuracy are now identified. Now that the project is in its fourth year, it is at the stage where the necessary parts required for the projection of sea ice distribution have all taken shape.

The key word, "connection", in the Research Project title emphasizes importance of further tight cooperation between industry, academia, and government in the next phase. Under the mutual cooperation, we hope to develop basic science, applied technology, social sciences, and economics among the international community.

Hajime Yamaguchi
(Sub-Research Project 7-1)
We are pursuing wide-ranging research related to decision-making standards needed for the use of the Arctic sea routes. This research is on topics including short-term and medium-term forecasts for Arctic sea ice, on-site observation and the creation of a remote-sensing sea ice algorithm, impact of ice pieces on ships, icing on ship hulls, the economic viability of using Arctic sea routes, and optimal sea route search. Close cooperation has been achieved with clear goals, and we are very busy but also enjoying ourselves.

Since I was a child, I have always loved the sea and boats, and it simply became my job. I do not participate in any marine leisure activities, but I am happy to always be with the sea that I love. I have been too busy to enjoy my hobbies from my high school days—traditional Noh song and dance—and I have participated in neither for around ten years. I wonder if I will ever pick them up again?

Hiroyasu Hasumi
(Sub-Research Project 7-2)
We are conducting researches from both observation and modeling, with a major focus on the mechanisms responsible for the formation and maintenance of the stratified structure of the Arctic Ocean. These mechanisms are deeply related to the conditions of the existence of Arctic sea ice and possible future occurrence of drastic changes therein. We have been engaged in close research collaborations since long before the beginning of this project, and in this project we believe that we have been making a good use of that experience in pursuit of the "coordination" in our sub-research project title.

As far as off-time recreation is concerned, ten years ago I would have immediately replied "horse-racing," but recently I am not pursuing any hobbies at all. I started thinking about becoming a scientist when I was in primary school, though I imagined a chemist at that time whose shape in laboratory looked really like a scientist to me.

Koji Shimada
(Sub-Research Project 7-3)
My childhood and eternal hero is Naomi Uemura. The "Shirase" is the name of the ice breaker for the Antarctic research, then I hope the name of new icebreaker for the Arctic research is the "Naomi Uemura"—with the full name. I joined total of twenty science cruises in the Arctic Ocean since 1996, and I take each and every Arctic observation expedition as a special, once-in-a-lifetime encounter. My hobbies are mountains, skiing, sea-kayaking, and history.

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