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National Institute of Polar Research (NIPR)

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GRENE Arctic Climate Change Research Project
www.nipr.ac.jp/grene/e/

Arctic

News Letter 3

Permafrost in the Arctic strongly affect the soil moisture above, and the changes in soil moisture will affect changes in plant species and cycling of mineral nutrients; thus, they have the potential for further changing ecosystems. The team GRENE-TEA （Terrestrial Ecosystem of the Arctic）is exploring changes in the Arctic by comparing various regions.

Interview with Hiroyuki Enomoto, New Committee Chair of the Japan Consortium for Arctic Environmental Research (JCAR)

Prof. Hiroyuki Enomoto
(National Institute of Polar Research)

It has been two years since the Consortium was created. How do you view the two years that have passed up until now?

The history of Arctic exploration often tells the tales of brave individuals persevering through the harsh conditions of the high north to make discoveries that became the basis of Arctic research. Although there is simplicity and courage in carrying out activities single-handedly, there is much to be gained from cooperation and consultation with others. Research thrives in collaborative settings, not only allowing for cooperation in the lab and field, but between countries and disciplines, that advances scientific understanding and provides a continuity of ideas and efforts unattainable through individual forays into the Arctic.

Given this evolution towards collaborative research, it became clear that a consortium that linked various research institutes and universities would better advance our understanding of the Arctic. JCAR, the Japan Consortium for Arctic environmental Research, was founded in May 2011 by former Committee Chair Dr. Tetsuo Ohata. Over the last two years, JCAR has become recognized by researchers and government ministries alike as the preeminent organization for Arctic research in Japan.

As an indication of JCAR's leading role in Arctic research and at the recommendation of the Science Council of Japan, we will host the 2015 Arctic Science Summit Week (ASSW), a high-level international Arctic research convention in Toyama City. The ASSW will draw members of several scientific councils and Arctic research organizations; in 2015, the International Arctic Science Committee (IASC) will celebrate their 25th anniversary. In addition, the 3rd International Conference on Arctic Research Planning (ICARP-Ⅲ), which serves as a long-term planning body for Arctic research and the 4th International Symposium for Arctic Research (ISAR-4) in which many Arctic research results in various diciplines are presented and discussed, will join this event. We believe that this convention will be one where it is possible to exhibit Japan's contributions to Arctic research.

What kinds of approaches are being taken toward organizational operation?

JCAR aims for researchers of various sectors to be linked as a network, and to "do, as a group, things that used to be separate," while maintaining the freedom of each. Although we are still in the process of growing, in order to make activities expansive, we must make sure that we do not become a stove-piped organization of only disciplinary scientists.

At this time, we have 340 members; and, we consider these members to be stars in the international science arena. No other organization has been able to assemble this many Arctic researchers so quickly. It is really a unique model that sets the standard very high. Even though there are challenges to working in such a diverse research community, we want to praise these "explorers" and continue to grow their ranks. While they may come from different disciplines, different perspectives, and different schools of thought, we ask that our members make themselves heard and to participate in scientific exchanges.

As JCAR matures, we will continue to pursue (1) areas of common scientific need, (2) a capacity for system thinking, (3) integrated responses from its members, (4) the ability to synthesize these inputs, and, although this may be difficult, (5) put those recommendations into action. As we believe that the role of JCAR is to lead the way in many areas of Arctic research, we encourage everyone to participate in this collaborative framework.

Please share some concrete resolutions you have regarding JCAR's activities.

While the current atmosphere is one of limitation – limitation of available personnel and the potential for discontinuities in research due to that lack of expertise – it is possible to feel constricted about advancing Arctic science. I believe the opposite. These "limitations" are going to be the driver that moves us forward, that connects us with new colleagues that will enable leaps in our understanding. It is at this time that JCAR is at its best, an organizational partner that facilitates new discussion and collaborations. JCAR is the conduit that brings together institutions and disciplines to advance Arctic research.

At JCAR, we will grow a new generation of interdisciplinary scientists that will make discoveries with international and long-term relevance, which will be game-changing. There is the opportunity to hone leadership skills and mentor young scientists in the JCAR environment. Scientists at any stage of their career are welcome to allow for a breadth of scientific diversity and experience. JCAR seeks to support all those with an interest in Arctic research, irrespective of age or title. We interact and have grown into the scientists that we are under the care and tutelage of various kinds of people from different generations and different perspectives. Personally, I would like to work in such an environment and provide that real life opportunity for others.

In heading towards the future

The international community has very high expectations from Japan when it comes to Arctic research. Japan has many qualified scientists active in Arctic science, but the volume of inquiries for collaboration exceeds any one person's ability to respond effectively. And now, the pressure comes from international research organizations and multi-disciplinary teams, rather than individual collegial partnerships. At this time, we have the GRENE Arctic Climate Change Research Project, which is overseeing the financial aspects of the secretariat's operation. However, JCAR has the vision for all of its staff, including the secretariat, to have experience in Arctic research, furthering solidifying its role as an international leader in Arctic science. The early career scientists of marine sciences have already forged ahead, bringing together new perspectives in a workshop that will contribute to workforce development and long-term planning for Arctic marine sciences. Other interdisciplinary sciences will shortly follow suit with similar opportunities for broad exchange.

Keeping momentum at the forefront of change is always challenging, but I want to cultivate these seeds, these new scientific ideas, to grow the next generation of explorers and big ideas. It is with this in mind that I hope to build a future for Arctic research, together at JCAR, a framework that will reach 10 or more years into the future, that will produce a strong generation of interdisciplinary scientists, and be a home where dreams for Arctic research are made real through collaboration and exchange.

[Member registration]
There is no membership fee or age restrictions. Members receive the latest information on Arctic research. Applications for member registration are accepted on the JCAR homepage. *http://www.jcar.org/*

Principal Investigator's Perspective

Atsuko Sugimoto (Hokkaido University)

Change in the terrestrial ecosystems of the pan-Arctic and effects on climate

About 50 people were involved in this group, including members that appeared in this news letter. They were divided into 9 teams — 8 teams that are grouped into observation sites, and a ninth team that served as a model team.

Since this research project is going ahead with observations, an enormous amount of time and costs are required in observation. If a project researcher could be employed for each observation site, it would be much easier to make observation at each site and link them together. But as enormous expenditures are incurred in observation, the number of project researchers that are employed for this project is the smallest number among all of the research projects. We are envious of other groups for which many project researchers can be hired.

However, our advantage lies in possessing and being able to obtain field data. We have obtained data that is not easy to observe due to a difficulty of access and other various difficult conditions, and people working in the field fully understands the conditions on the site. What is important in integrating this field data is cooperation within the group. Although multiple groups conducting observations of the arctic areas, including the model, had never come together and thought together, since the GRENE Arctic Climate Change Research Project was initiated, the fact that it has become possible to make progress with this through cooperation while exchanging information with persons involved in arctic research in Japan was groundbreaking. In addition to cooperating and not excluding, we will place emphasis on communication between the observation side and the model side. Fortunately, everyone is of a cooperative spirit, and we would like to link this, as our treasures, to results.

Profile: with curiosity・・・

When I was little, I was a child who wanted to try everything other than sports. I was not the sporty type. Now, whenever I have a break I look forward to going mountain climbing and taking a walk in the hills, but this summer, I wasn't able to enjoy the mountains of Hokkaido as much as I wanted to because of bad weather, and thus could not welcome a change of pace. When I think of the traverse in Hira Mountains (Shiga Prefecture) where I went this spring, I long to go again…and I feel myself full of frustration.

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Cover photo : The underground ice zone (edoma belt) in the North Slope (Tundra) , Alaska /Masao Uchida (National Institute for Environmental Studies)

Impacts of Forest Floor Vegetation on Soil Carbon Accumulation

Tomoaki Morishita (Forestry and Forest Products Research Institute)

When traveling to study sites in Boreal forests, forests viewed from aircraft appear to be composed of single species over wide areas, for example, larch in Siberia or black spruce in Alaska. However, once the forest is entered on foot, it is surprising to see the varieties and thickness of mosses and lichens covering the forest floor. Various mosses and lichens are distributed in patches and their thickness may reach several tens of centimeters. Also, differences are not just species present, but which moss species is dominant or the relative proportions of mosses and lichens are dependent on the age of the forest stand, location on slopes and other factors. For trees, the accumulated layers of mosses and lichens moderate the extreme temperatures exceeding 30ºC in the summer and dropping below –60ºC in the winter as well as providing the water and nutrients necessary for growth. A major area for research is establishing how these functions of mosses and lichens interact with temperature, precipitation amount and other aspects of climate change to affect tree growth and stand development.

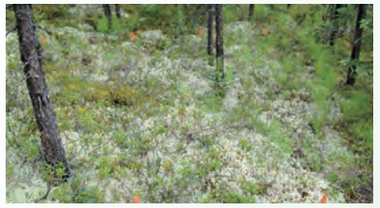


Photo 1 (left) : A black spruce (*Picea mariana*) forest located outside of the inland city of Fairbanks, Alaska. Feather mosses (*Pleurozium schreberi and Hylocomium splendens)* cover most of the forest floor in the upper area of the slope of the study site; there are few lichens.

Photo 2 (right) : The proportion of forest floor covered by moss in the lower area of the slope of the study site (about 800 m down slope from Photo 1 on the same slope, about 90 m elevation difference) is lower and there are many lichens such as reindeer moss (*Cladina sp.*). Patches of sphagnum mosses (*Sphagnum sp.*) can be seen. The white areas of the forest floor are lichens and the green to yellow areas are mosses.

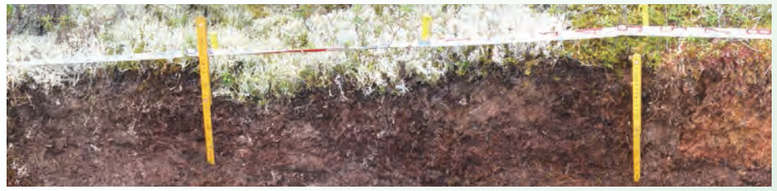
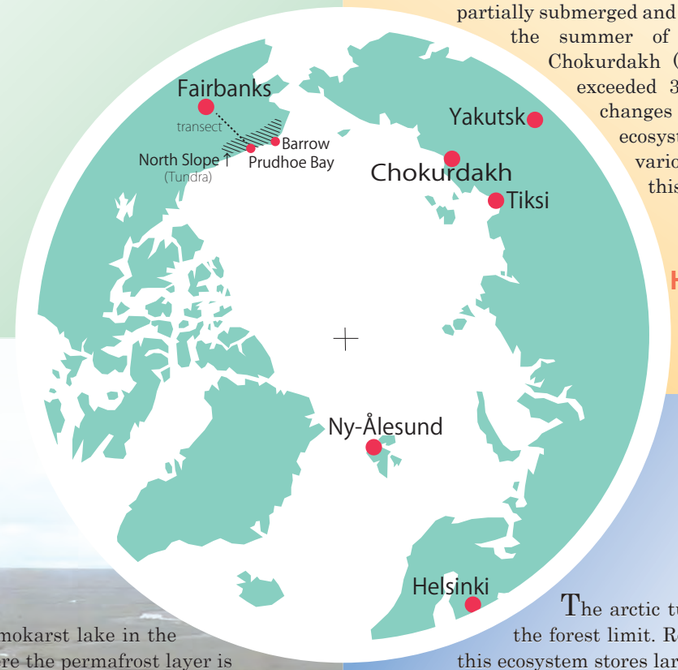


Photo 3 (above) : A 200-cm wide layer of accumulated moss and lichen located in the lower area of the slope. From the right of the photograph, sphagnum mosses, other mosses and lichens cover the surface. The composition of the 20 to 30 cm deep layer of accumulated organic material is roughly the same as the forest floor. The accumulated lichens are breaking down into small pieces while the sphagnum has broken down very little. This difference in breakdown speed may affect the insulating properties of soil and the uptake of nutrients by trees. (Photo : Morishita)



Observation of Methane Emissions from Alaskan Thermokarst Lakes

Masao Uchida (National Institute for Environmental Studies)

A thermokarst lake in the Fairbanks area

Permafrost soil contain about twice the amount of carbon than amount in atmospheric carbon dioxide and about ten times the amount of carbon in the form of methane hydrates than the carbon in atmospheric methane. There are concerns that global warming (rising temperatures) could trigger the melting of permafrost soils, which would become a factor that accelerates global warming.

Obtaining accurate information on the dynamics of methane in response to Arctic warming scenarios is an urgent issue. To clarify the effects of melting permafrost on methane exchange between lakes and the atmosphere, a group of about 40 lakes across 1200 km from south to north Alaska were investigated in both summer and winter seasons of 2012 and the summer of 2013. A thermokarst lakes in the North Slope near the edoma belt was also investigated in 2013.

The relationship between melting of permafrost due to warming and emerging lakes has been pointed out in recent years. Dissolved methane concentrations in lake water were measured in the observation. The results showed extremely high methane flux from a thermokarst lake in the Fairbanks area. In an area where the permafrost layer is 50 m thick, the permafrost layer had melted to 30 m directly below a 1 to 2 m deep lake; this suggests the possibility that the thick melted layer of permafrost is partially a source of methane. The melted layer contains organic materials that have accumulated over several tens of thousands of years; this suggests that in addition to the methane produced by microorganisms consuming organic materials in this layer, the methane trapped in the surrounding permafrost may be discharged as well.

In this study, dissolved methane concentrations in the permafrost zone will continue to be observed. Radiocarbon dating and other isotopic analyses of methane in lake water will be utilized to investigate the origin of the methane and the possibility that the permafrost will thaw. The impact of warming and the mechanisms of methane production due to melting of the permafrost will be elucidated.

The underground ice zone (edoma belt) in the North Slope (tundra) , Alaska was formed during the glacial period. The maximum depth of the permafrost is several hundred meters. According to our calculations, the volume of ice to a depth of 100 m in this area is equivalent to 1 million Tokyo Domes (a domed baseball stadium in Tokyo). (Photo : Masao Uchida)

Flux observation tower
at Spasskaya Pad, Yakutsk

Investigation of Water, Heat and Carbon Cycling in Eastern Siberia

Atsuko Sugimoto (Hokkaido University)

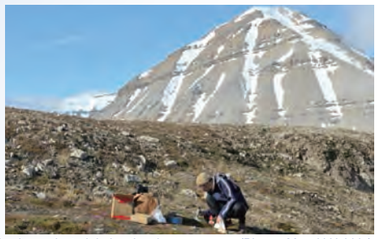
Monitoring of soil moisture, precipitation and other meteorological parameters are being conducted at 4 sites in Eastern Siberia; Tiksi (tundra), Chokurdakh (taiga-tundra boundary), Yakutsk and Ust-Maya (taiga) to investigate water, energy and carbon fluxes. This allows coordinated observations in the same region of how changes in the environment and vegetation accompanying warming affect frozen soil and hydrological processes, methane and carbon dioxide emissions. Yakutsk has been the site of various observations since 1998 and is being used by this program as the super site for the observations of taiga forest ecosystem in Eastern Siberia. Flux observations were begun by this program in the summer of 2013 at Chokurdakh. As examples of the extreme importance of continuing field observations, during 2006–2007 the taiga forest at Yakutsk, which is supposed to be in the continental dry climate zone, was partially submerged and die-off of larch occurred, while in the summer of 2010 high temperatures at Chokurdakh (located at 70ºN in the Arctic) exceeded 30ºC. The effects of these past changes on material cycling in ecosystems are being clarified by the various observation data collected in this project.

Ny-Ålesund Soil Investigation

Masaki Uchida
(National Institute of Polar Research)

The arctic tundra ecosystem exists north of the forest limit. Recently it has become clear that this ecosystem stores large amounts of organic materials in the soil. Microorganisms decompose some of this soil organic matter to gain energy; in the process, they release the greenhouse gas carbon dioxide. It is important to investigate the influence of global warming on the rate and amount of carbon dioxide emitted by soil microorganisms.

Samples of soils from the tundra ecosystem of Ny-Ålesund, Spitzbergen Island were taken to Japan and investigated in detail. Carbon dioxide emissions tended to increase when soil moisture levels increased. Global warming has been predicted to increase the amount of precipitation in the Arctic. More detailed investigation will be needed to assess how much carbon dioxide emissions will increase with increasing precipitation.



Intensive sampling is conducted during the short summers. (Photo : Masaki Uchida)

The larch trees died from extreme wet soil condition at Spasskaya Pad. (Photo : Sugimoto)

Field Observations and Understanding Changes in the Arctic

The terrestrial areas of the Arctic are a vast unobserved area. As field observations were judged to be extremely important, observations are being conducted in the Svalbard Archipelago, Northern Europe, Siberia, Alaska and Canada. The sites vary greatly for factors including vegetation, climate, presence or absence of permafrost and its condition. For each site, fluxes including water, energy and carbon dioxide between ecosystems and the atmosphere, soil temperature and moisture, vegetation growth and carbon accumulation in the ecosystem, methane emission rate and other factors are being investigated. Through comparison of the observation results, it is important to clarify the characteristics of change for each region.

Although various abnormal phenomena can be seen visually, these are also becoming apparent in observation data. Previously it was generally assumed that rising temperature would accelerate growth in northern forests and Arctic ecosystems. However, this is not always true. In the forested zones in some regions, phenomena such as declining forest biomass and lower growth rate of trees are actually occurring. Change in soil moisture condition such as high temperature induced drought and extreme wet condition may be greatly impacting ecosystems.

(Principal Investigator : Atsuko Sugimoto)