Cooperation on Arctic Research between Japan and Russia 2017

Japan and Russia Joint Group on Arctic Research

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Preface

This report will describe the past and present condition of Russia-Japan Cooperation and the new topics and results of discussions at the Russia-Japan Workshop on Arctic Research, held in Moscow March 20–21, 2017. This workshop is the second following the two 2014 workshops held in Tokyo.

The venue of the workshop was the Institute of Geology of Ore Deposits, Petrography, Mineralogy and Biochemistry (IGEM) of the Russian Academy of Sciences (RAS), and the organizers are grateful for their cooperation and support.

The organizers and participants in the workshop this year hope that the discussions shown in this report will be developed and realized in some way with the support of the funding agencies. Since research conditions in the Arctic will change internationally and at the two present countries in the coming years, a workshop such as this is recommended to be held every few years.

The organizers of the workshop are grateful for the financial support from the Research Organization of Information and Systems (ROIS) and the Japan Arctic Research Network Center (J-ARC Net).

February 1, 2018

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1. Introduction

Understanding and projection of Arctic change are important issues not only for Arctic countries but also for non-Arctic countries, and both need to be solved under multistate and bilateral international cooperation. Researchers in Japan and Russia have been cooperating as far back as the 1970s and recognized that there is a need to cooperate more due to the urgent issues arising around Arctic change.

Under governmental direction between the two countries, intensive talks on research cooperation were started from 2014 through two workshops in Tokyo and publication of the Report on Cooperative Research in 2015 (AERC, 2015; hereinafter denoted as Report 2015). As was recommended in this report, a follow-up workshop was planned and held in March 2017. During the three years, the environment for cooperation has been changing slightly due to changes in international conditions, such as the agreement among Arctic countries based on discussions at the Science Cooperation Task Force of the Arctic Council (SCTF) that was finally concluded in May 2017, activities of the International Science Initiative in the Russian Arctic (ISIRA) Group of the International Arctic Science Committee (IASC), and development of national programs in Arctic and non-Arctic countries. There was also additional information concerning Arctic research issues, such as release of the Snow, Water, Ice, Permafrost in the Arctic (SWIPA) Report in 2017.

The present report will include the progress and implementation of the workshop that was held March 20–21, 2017, in Moscow (sections 3 to 6), and other matters related to building up cooperation between the researchers of the two countries (section 2).

It should be noted that discussions on cooperation among scientists was not only made by senior scientists but was also done recently by group of young scientists. This workshop was held in October 2016 in Moscow, and it means that cooperation is promoted by a wide range of generations.

This report consists of the history and present conditions of cooperation, about the workshop, the themes presented, discussion matters, and information in the Appendix.

Reference

AERC (2015): Cooperation on Arctic Research between Japan and Russia. AERC Report 2015-1, 88pp. (www.nipr.ac.jp/aerc/e/info/20141028report.pdf)

2. Japanese and Russian cooperation on Arctic Research

2.1 History of cooperation

Cooperative research on the Arctic in Russia can be said to have been initiated in the 1970s. The Permafrost Conference organized by the International Permafrost Association (IPA) held in Yakutsk in 1973 was an important conference, since several Japanese scientists attended that meeting and also directly visited the permafrost landscape to understand the extraordinary phenomena there. This was a chance for the Japanese community to become acquainted with the vast permafrost region of Siberia.

The Hokkaido University (HU) Group started their research activities in eastern Siberia with the institute in Yakutsk in the early 1970s. They engaged in sporadic research observation after that, and did research work at Tiksi and other sites, and continued research under the topic of permafrost degradation due to forest fires in the 1990s. The National Institute of Environmental Science (NIES) initiated greenhouse gas (GHG) studies with the Central Aerological Observatory for the Siberia Region starting in 1991, and has cooperated with other institutes since then. They used an old tower to monitor GHGs near Yakutsk, and carried out aircraft measurement of GHGs in western Siberia; this is still continuing. The National Institute of Polar Research (NIPR) implemented snow-cover observations for a limited period in the latter half of the 1990s in eastern Siberia in cooperation with the Melnikov Permafrost Institute (MPI).

The greatest interaction on Arctic research between Japan and Russia started in 1997, when the World Climate Research Program (WCRP)-Asian Monsoon Experiment GAME (GEWEX) Project started and selected the Lena River Basin as the target region. Experts from the leading Russian scientific centers representing mainly the RAS and Federal Hydrometeorology and Environmental Monitoring Service of Russia (Roshydromet) have taken part in this program. They included the Institute of Geography (IG) as the leading organization, MPI, the Institute of Biological Problems of Cryolithozone (IBPC), the Siberian Branch (SB) of the RAS in Yakutsk, the Institute of Physical and Technical Problems of the North, the Polar Geocosmophysics Observatory of RAS in Tiksi, the State Hydrological Institute (SHI), the Central Aerologic Observatory (CAO), the All-Russia Research Institute of Hydrometeorological Information World Data Center (RIHMI-WDC) of Roshydromet, the Institute of Agrophysics of the Russian Academy of Agriculture Sciences in St. Petersburg, and so on.

As a symbolic event, the IBPC and Japanese Universities, including HU, Nagoya University (NU), and others, constructed a 32-m-tall observation tower for meteorological and surface observation at Spasskaya Pad. Another Arctic observation site was constructed at Tiksi at the same time, and land surface processes were studied. This study was later enhanced by the participation of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and also by other countries, such as a group from the Netherlands. As glaciological and meteorological observations on glaciers, helicopter photos and infrared camera surveys of all the glaciers of the Suntar-Khayata Mountains were organized by the IG of RAS in cooperation with Japanese universities in the first half of the 2000s.

The cooperation between Japan and Russia mainly occurred in the region of eastern Siberia on the topics of permafrost, the water cycle, GHGs, and land-surface processes on an institute basis, and this is still continuing under the present project. Cooperation on the other research subjects and other regions was carried out on a smaller scale.

2.2 Recent situation of Arctic research in Russia

Large Russian and international scientific programs study the dynamics of processes in Arctic regions of Russia. The Presidium of the Russian Academy of Sciences Program titled "Fundamental Scientific Program for the Development of the Arctic Zone of the Russian Federation," whose entire section is devoted to the study of the region's environment, is among the largest Russian programs. Special attention is given to the study of climate and processes in the atmosphere, in the Arctic Ocean and adjacent seas, including the dynamics of ice cover, interaction between land-ocean and atmosphere, glaciers and permafrost, rivers and water bodies, terrestrial ecosystems in a changing climate and environment, circulation of greenhouse gases, and other issues. This program, to a great extent, serves as the base of Russia-Japan cooperation in fundamental research of the Arctic.

Recently, the results of over 25 years of Russia-Japan research were summarized at the anniversary international symposium titled "C-H_2O-Energy Balance and Climate over the Boreal and Arctic Regions with Special Emphasis on Eastern Eurasia," held November 14, 2016, in Yakutsk and attended by scientists from Russia, Japan, Sweden, Italy, Switzerland, and other countries.

Since 2014, a new stage of the development of scientific cooperation between Russia and Japan has begun, when Japan put forward an initiative to organize an integrated Russia-Japan program of joint research in the Russian Arctic. The seminar, held in October 2014 in Tokyo, formulated the main areas of joint research, including such relevant topics as "Climate Impacts of Black Carbon (BC) and Aerosols in the Arctic," "The Polar Prediction Project, "Comparative Study On Carbon and Water in the Permafrost Ecosystem of Siberia," "Glacier Research in the Russian Arctic and Sub-Arctic," "Contemporary Changes of Water, Heat, and Dissolved and Suspended Organic-Inorganic Matter Fluxes From Siberian Rivers into the Arctic Ocean," "Variability of Snow Cover Including Blowing Snow and Snowmelt Processes of the Permafrost Area Under Arctic Environment Change," "Permafrost Changes in Siberia in the Past and Future Based On Projections of Climate Warming," "Ecosystems and Biodiversity," and others (Report 2015). The interaction of scientific teams from leading centers of Russia and Japan was established. Among them are the Russian Academy of Sciences scientific organizations such as the newly established Federal Research Center for Integrated Arctic Studies (FCIArctic) and IG,Institute of Atmospheric Physics (IAP), MPI, and IBPC, other academy structures, and the Arctic and Antarctic Research Institute (AARI), as well as NIPR, HU, NU, JAMSTEC, and others.

2.3 Recent situation of Arctic research in Japan

Japan has long history of Arctic research dating back to the International Geophysical Year (IGY) period (1957–1959) in various parts of the Arctic region, including Russian territory and in the Arctic Ocean. However, this consisted of ad-hoc research done by small-groups. This has been enhanced since the 1990s, when NIPR established an Arctic Environment Research Center and a research station was built in Svalbard. NIES initiated joint research on the carbon budget since 1991 in Siberia. JAMSTEC initiated its Arctic sailings in 1997, several large projects such as GAME started in 1996, and some others started later on. Long-term observations under institute-level agreements were initiated then. In the 2000s, research projects of various scales were initiated, but they were not interconnected. From the middle of the 2000s, Japanese scientists and institutes started to exchange information among research areas and groups and started to interact to build interdisciplinary research topics.

Based on such activities, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) started the new Green Network of Excellence (GRENE) Arctic Project in 2011 to enhance Arctic research in addition to what was being done by the institutes and various research activities of university groups. The research under the GRENE Project, in cooperation with Russia, mainly covered the area of on-site research in the Siberian region through cooperation with institutes such as the MPI and IBPC of RAS. Specific glacier study was made in the Suntar-Khayata Mountains. Japan started a consortium called the Japan Consortium for Arctic Environmental Research (JCAR), which is composed of individual scientists, to enhance research activities on various aspects of Arctic science.

At the government level, Japan became an observer of the Arctic Council in 2013, and the Arctic Policy of Japan (the Headquarters for Ocean Policy, 2015) was completed in 2015. These movements are enhancing Arctic Research in Japan. At MEXT, the Strategic Committee on Arctic Research discusses important issues.

In addition to the all-Japan Arctic research under the GRENE Arctic Project (2011–2016) are the cruises made by the RV *Mirai* and other foreign vessels of JAMSTEC, various research studies at Svalbard, where NIPR has a research station, and other institutional and group research such as that done in Greenland, and also research being done in wider research areas, such as the upper atmosphere and paleoclimate studies, in the recent years.

After four years of GRENE, MEXT initiated a new project titled Arctic Change and Sustainability (ArCS) since 2015 as the successor of GRENE. At the same time, MEXT established the Japan Arctic Research Network Center at HU. The center was established in order to enhance collaboration mainly among the Japanese research community, but to a certain degree also the international community.

ArCS aims to contribute to Arctic scientific issues under cooperation especially with AC countries as well as AC activities. New cooperation with Russia is included in this, and an attempt is being made to start joint observation at Baranova Station of AARI in Severnaya Zemlya.

In the recent years, interchange among young scientists from Russia and other countries is increasingly influenced by the International Association of Polar Early Career Scientists (APECS) activity. One of the events with Japan and Russia related to this was the meeting titled Prospects of Joint Investigations in Polar Regions of the Planet, held October 10–12, 2016, in Moscow (see the reference below). This was the first time that young scientists convened to discuss Arctic issues. Shunsuke Tei and Ayumi Kotani were the organizers for the Japan side, and altogether nearly 50 Russian and Japanese scientists attended.

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The Headquarters for Ocean Policy (2015): Japan's Arctic Policy. October 16, 2015, http://www.kantei.go.jp/jp/singi/kaiyou/arcticpolicy/jpn_arcticpolicy/Japans_Arctic_Policy[ENG].pdf.

Moscow Meeting

https://istina.msu.ru/conferences/30360344/ (in Russian)
https://www.jcar.org/newsletter/ (in Japanese)

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3. Outline of the Russia-Japan WS 2017

3.1 Objective of the WS

After the WS in 2014, and publication of the report in March 2015, presentation of the results was made at the 12th Meeting of the Russia-Japan Joint Committee for Science and Technology held on September 10, 2015, in Moscow, and the result of the collaboration activity was welcomed at the meeting. Afterward, follow-up of 2014–2015 activities was discussed between the organizers of the present workshop after then, since the topics treated in 2014–2015 were limited and new developments were arising in both countries.

The objectives of the WS was to present and discuss ongoing collaboration themes and potential themes in the future, obtain common understandings of the scientists in both countries, and discuss the realization of cooperation. The outcome of the WS will be material for the next meeting of the Russia-Japan Joint Committee for Science and Technology, planned to be held in 2017.

3.2 Preparation of the WS

V. Pavlenko for Russia. Ohata and Y. Kodama for Japan searched the possibility of a second WS since March 2016 by having discussions at the occasion of Arctic Science Summit Week (ASSW) 2016 in Fairbanks, Alaska. The Japanese side was able to obtain funding from ROIS in April, and then actual talks on the WS started. During the planning stage, J-ARC Net offered funds for the WS, and finally it was possible to hold the WS at a reasonable scale. The IGEM cooperated by preparing the venue of the WS in central Moscow. The WS was held on March 20 and 21, 2017, at this institute.

3.3 Program and participants in the WS

The program and participants of the WS are shown in appendixes 1 and 2. Altogether 35 researchers participated. Among them, 19 were from Japan and 16 were from all over Russia, including researchers from Yakutsk and St. Petersburg.

As seen in the program (Appendix 1), WS was composed of talks on the general situation of Arctic research in both countries, scientific presentations from researchers, and a wrap-up talk concerning cooperation. Concerning the presentations, some were themes previously proposed in 2014, including themes implemented afterward and themes that were not implemented due to certain circumstances. In addition to these, more than half the themes were newly proposed.

Figure 1. Participants in the Russia-Japan Workshop 2017 on Arctic Research, March 2017.

Figure 2. Scene of the WS in the seminar room at IGEM, March 2017.

4. Proposal of Joint Research

Among the research themes presented at the WS were the following three types. The type of theme as shown in the following section appears in parentheses.

(1) Research theme already proposed in 2014 (included in Report 2015), and being implemented (Theme 1).

(2) Research theme already proposed in 2014 (included in Report 2015), but implementation is not realized by 2017 (Theme 3, Theme 5).

(3) New research theme proposed at the WS2017 (Theme 2, Theme 4, Theme 6).

For some of the themes in categories (1) and (2) above, the content of the proposal have been changed or modified.

The following list of the proposed research themes are roughly in the order of Atmosphere, Ocean, Glaciology, Land/Ecosystem, and Social/Human Science, and the style and content differ slightly among the themes.

4.1 Theme 1: Predictability studies using extra radiosonde observations during the Year of Polar Prediction (YOPP)

(1) PIs

Jun Inoue (NIPR) and Vasilii Kustov (AARI)

(2) Collaborating scientists

Kazutoshi Sato (NIPR) and Alexander Makshtas (AARI)

(3) Introduction and background of the theme

Radiosonde data over the Arctic Ocean is very limited due to the difficulty of operational observations. The number of radiosondes launched over the Arctic Ocean has been very limited; however, the impact of Arctic radiosonde observations on weather forecasts and reanalysis data has not been fully investigated. Improved weather forecasting capacity over the ice-free Arctic Ocean is vital for safe ship navigation on the Northern Sea Route and the Northwest Passage, because storms can generate strong winds, high waves, icing on the ship surfaces, and sea-ice advection (Inoue et al. 2015). A precise prediction depends on not only a sophisticated model itself, but also in situ observations. Expansion of the Arctic observation network would also help improve weather forecasting over the mid-latitudes (Sato et al. 2017). Therefore, the impact of a special sounding array on local and remote atmospheric circulations will be investigated by expanding the observation network with international collaboration. Japan has led the Arctic Research Collaboration for Radiosonde Observing System Experiment (ARCROSE) since the autumn of 2013 (Inoue et al. 2015), which consists of intensified Arctic sounding network and data assimilation experiments. The aim of this joint project is to understand the uncertainty of Arctic atmospheric circulation and to propose a future observation network.

(4) Definition of questions and goals

In a timely manner, this scientific direction fits with the Polar Prediction Project (PPP), which has been formally established by the WMO's World Weather Research Programme (WWRP). One of the key elements of the PPP is the YOPP, which will consider both the Arctic and Antarctic, and is scheduled to take place from May 15, 2017, to mid-2019. The intention is to have an extended period of coordinated intensive observational and modeling activities in order to improve polar prediction capabilities on a wide range of time scales. The YOPP encompasses four major elements: special observing periods (SOPs), a complementary intensive modeling and forecasting period, a period of enhanced monitoring of forecast use in decision-making including verification, and a special educational effort. This joint project will contribute to the YOPP observing activity and investigate the impact of such extra soundings on atmospheric and sea ice forecasting over the Arctic and beyond.

(5) Justification as cooperative research between Russia and Japan

A process for an agreement on this collaborative work is ongoing.

(6) Approach and Method

Using the AFES-LETKF data assimilation system developed by JAMSTEC, called ALEDAS2, the impact of extra observations in 2017 and 2018 at Cape Baranova, with two launches per day, and the RV *Mirai,* with four launches per day, will be investigated.

(7) Expected outcome or product

Data will be open for operational weather forecasts through the Global Telecommunication System (GTS). The data will also be used for generating atmospheric reanalysis products. The impact of such observations on extreme atmospheric and sea-ice events will be assessed.

(8) Progress and Problems

Joint analysis using extra radiosondes at Cape Baranova with the RVs *Araon* and *Polarstern* has started since 2016. The target events are the Arctic cyclone that developed in late August 2016 and Typhoon Lionrock near the Japan at the same time. The predictability study using the Japanese data assimilation system ALEDAS2 and forecast outputs initialized by the two sets of ensemble reanalyses, which include and exclude the special Arctic radiosondes, show that the track of the typhoon was well predicted when observation data was assimilated into the initial fields. The results will be submitted to an international peer reviewed journal.

As for the collaborative radiosonde observations at Cape Baranova during the YOPP, the trial campaign will be made during late summer 2017, mainly covered with the RV *Mirai* Arctic cruise from August 23 to October 2, 2017. The other existing land stations, such as Ny-Alesund, will also increase the frequency of radiosonde observations. The big issue related to the Cape Baranova operation is that the data transmission through GTS is not stable. In particular, the number of cases succeeding in transferring to the GTS has been just a few days in February 2017 so far. If this trial campaign is not effective in terms of real-time data transmission, subsequent campaigns such as YOPP special observing periods (SOPs) would not be considered under this Japan-Russian framework. In addition to this problem, there are several logistical issues to implement the joint observations. The first is that AARI researchers did not attend the Japan-Russian workshop in March 2017, which substantially delays the process of paperwork to make a contract. The second is that a shipping process from Japan to Cape Baranova is very unclear for the Japanese side. Especially, the preparation of helium gas for radiosonde observations is hard to negotiate with the third party, such as the German gas company.

(9) References

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Sato, K., J. Inoue, A. Yamazaki, J.-H. Kim, M. Maturilli, K. Dethloff, S. R. Hudson, and M. A. Granskog. 2017. Improved Forecasts of Winter Weather Extremes over Mid-latitudes with Extra Arctic Observations. *J. Geophys. Res.* 122, 775–87.

4.2 Theme 2: Central Aerological Observatory offers of collaboration

(1) PIs

Nikolay Sitnikov (CAO, Pervomayskaya 3, Dolgoprudny, Moscow region, Russia, 141700)

(2) Introduction and background of the theme

Developments of new methods and instruments for atmospheric investigations using unmanned aerial vehicles (UAV) are carried out in CAO. There are onboard instruments for the measurements of meteorological parameters, and some gas and aerosol species are sampled Meteorological sound for meteorological parameters (temperature, pressure, humidity, wind speed, and wind direction) based on a UAV is developed. Developments of returnable aerological sound for balloon sounding of the atmosphere have been carried out.

(3) Advantages to using UAVs for environmental monitoring tasks, atmospheric investigations, and satellite validation:

- Possibility to provide remote measurements by in-situ onboard instruments.
- Mobility: UAVs can be brought at any point by any type of transport: trains, cars, aircraft, ships, and so on.
- Small size and weight; do not need special places and hangars for storage.
- Do not need a large service staff.
- Comparably low cost.
- Possibility to provide operational monitoring in dangerous places: radioactive pollution, natural and anthropogenic disasters, accidents in chemical plants and nuclear power plants, monitoring of space infrastructure, and so on.

(4) Tasks that can be solved using UAVs:

- High-resolution measurements of horizontal and vertical distribution of meteorological parameters as well as gas and aerosol composition of the atmosphere.
- Environmental monitoring in dangerous regions: places of anthropogenic disasters including atomic stations and chemical production, as well as forest fires, volcanoes, and so on.
- Monitoring of atmospheric pollution.
- Monitoring of biomass burning products.
- Investigation of processes in atmospheric boundary layers.
- Monitoring of greenhouse gases.
- Investigation of clouds.
- Sampling of gas and aerosol species (including biological aerosols, viruses, and bacteria) at different altitudes.
- Control of transboundary pollution.
- Satellite validation.
- Validation of mathematical models.
- Validation and calibration of remote sounding methods and instruments (meteorological radiolocation, radiometric, acoustic) and so on.

4.3 Theme 3: Assessment of the influence of water vapor diffusion on heat transfer in snow cover based on mathematical modeling

(1) PIs

A. Sosnovsky and N. Osokin (IG, RAS)

(2) Introduction, background and content of the theme

Snow cover is an important factor in heat exchange in the atmosphere–surface cover–soil system (Osokin and Sosnovsky 2015, Osokin and Sosnovsky 2016a, Osokin and Sosnovsky 2016b). The thermal protective properties of snow cover are determined by its thermal conductivity (Osokin et al. 2013a). The coefficient of thermal conductivity depends on snow density, structure, and its temperature regime. Diffusion of water vapor increases the effective coefficient of the thermal conductivity of snow. The variability of snow structure and its temperature lead to a large range of thermal conductivity coefficient (Osokin et al. 2013b).

The study shows that an error in the evaluation of the thermal conductivity by 2 times gives the same consequences as an error in the thickness of the snow cover by 2 times. Therefore, it is important to calculate the coefficient of thermal conductivity of snow as accurately as possible and to investigate all the factors that affect it.

A mathematical model of heat transfer in snow cover that takes into account the water vapor diffusion and sublimation-condensation was used to assess the impact of water vapor diffusion on the heat transfer in snowpack and the coefficient of thermal conductivity of snow. Numerical experiments were performed. The temperature distribution in snow cover was calculated by the Fourier equation, taking into account the diffusion of water vapor, sublimation, and condensation (Kotlyakov et al. 2004).

$$A\frac{\partial T_s}{\partial \tau}=\frac{\partial}{\partial z}\left(\lambda_s\frac{\partial T_s}{\partial z}\right)+F(z,\tau) \tag{1}$$

where the coefficient A takes into account the effect of sublimation-condensation of vapor on the temperature of snow.

$$A=\rho_s c_s+L_e\frac{\partial e}{\partial T_s} \tag{2}$$

The effective coefficient of thermal conductivity λ_s is the sum of conductive and convective heat transfer, due to the diffusion of water vapor.

$$\lambda_s=\lambda_c+L_e D\frac{\partial e}{\partial T_s} \tag{3}$$

where T_s is the temperature of the snow in K; z is the coordinate along the depth of the snow layer; τ is time; c_s is the specific heat of the snow; λ_c is conductive thermal conductivity of snow; L_e is the specific heat of evaporation; D is the diffusion coefficient of water vapor in the snow cover; and e is the density of saturated water vapor.

The condition of heat exchange of atmosphere with snow cover surface is

$$\lambda_s \frac{\partial T_s}{\partial z} = Q_\Sigma \quad (4)$$

$Q_\Sigma = Q_c + Q_e + Q_r$ is the total heat flux due to convective heat transfer, evaporation, and effective radiation of the surface, respectively.

For calculations, we used the snow density values ρ = 180 and 250 kg/m^3. The initial snow temperature was assumed to be 0°C. The diurnal variation of the air temperature $T_{a\tau}$ was taken using the sinusoidal dependence $T_{a\tau} = 0.5\Delta T_в \sin(\pi\tau/12) + T_a$ with an average daily temperature T_a = –4 or –10°C and the amplitude of diurnal oscillations ΔT_a = 4 and10°C, respectively. At lower air temperatures diffusion is small.

In the calculations, the conduction thermal conductivity of snow λ_c was adopted for medium snow, according to the international classification for seasonally falling snow, by the formula of A. V. Pavlov (2008), λ_{cP}, and for soft snow by the formula of M. Sturm (1997).

The formula of A.V. Pavlov is

$$\lambda_{sP} = \lambda_{cP} K_P, \quad (5)$$

where λ_{cP} is the coefficient of conduction thermal conductivity of snow (at $t_s < –25$°C) that is equal to

$\lambda_{cP} = 0,035 + 0,353\rho_s – 0,206\rho_s^2 + 2,62\rho_s^3$, at $0,12 < \rho_s < 0,35$ (ρ_s, g/cm^3)

K_P –temperature coefficient: $K_P = 1 + 1,18\exp(0,15t_s)$, where t_s – is the snow temperature, °C.

The formula of M. Sturm is

$$\lambda_{sg} = 0,138 – 1,01\rho_s + 3,233\rho_s^2, \text{ at } 0,156 < \rho_s < 0,6 \ (\rho_s, \text{g/cm}^3) \quad (6)$$

The temperature distribution in the snow cover was calculated. Calculations were performed for different types of snow, density, and temperature. Depth of penetration of the temperature front -1°C in snow in 24 hours was estimated, taking into account the diffusion of water vapor and without it. It allowed evaluation of the effect of diffusion of water vapor on heat transfer into snow. The results of calculations with snow temperature of T_a = -10°C, ΔT_a = 10°C, and snow density ρ = 180 kg/m^3 are presented in figure 1.

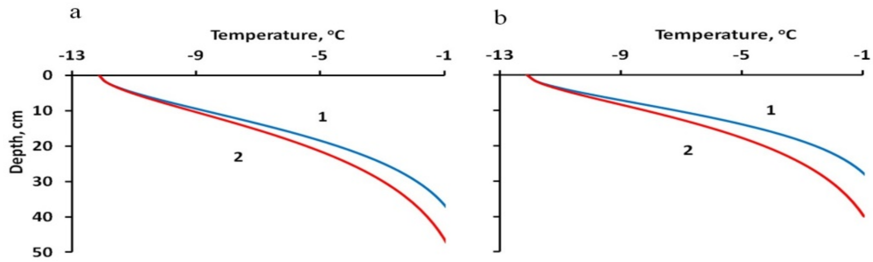

Figure 1. Temperature distribution in snow after 24 hours for medium snow (a) and soft snow (b). 1: no diffusion; 2: with diffusion of water vapor.

Given the diffusion of water vapor, the depth of cold front penetration with temperature −1°C increases by 28–43% for snow density 180 kg·m^{-3} (fig. 1) and by 20–30% for snow density 250 kg·m^{-3}. For snow of lower density, the effect of diffusion of water vapor on heat transfer is greater than for snow of higher density.

The value $k_d = (\lambda_s - \lambda_c)/\lambda_s$ shows the fraction of diffusion in the coefficient of thermal conductivity of the snow. With the growth of the value of k_d, the effect of diffusion on the coefficient of thermal conductivity of the snow increases. We assessed the influence of snow temperature and density on heat transfer related with the water vapor diffusion. When the snow temperature increases from −30°C to −1°C, the value k_d increases from 0.06 to 0.48 for snow with a density of 150 kg/m^3 and from 0.02 to 0.21 for snow with a density of 400 kg/m^3.

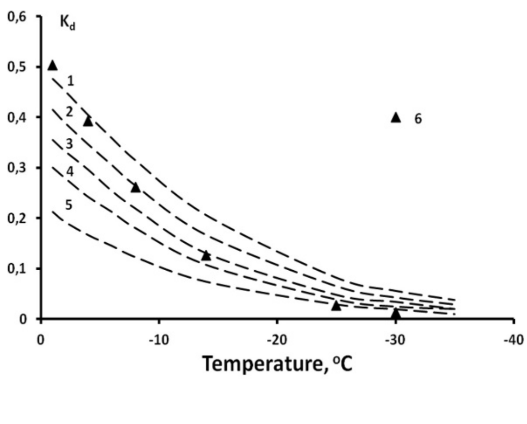

Figure 2. The value k_d at snow density 1: 150; 2: 200; 3: 250; 4: 300; 5: 400 kg/m^3; 6: according to A. V. Pavlov's formula (5).

The calculations have shown that the simulating of heat transfer in the atmosphere–snow cover–soil system requires using dependencies to determine the thermal conductivity of the snow, corresponding to the temperature conditions of the process or to apply the values of conductive coefficient of thermal conductivity of snow with addition of heat transfer due to the diffusion of water vapor.

(3) References

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4.4 Theme 4: Change of land ice under climate change in northeastern Asia

(1) PIs

Russian PI

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Mailing Address: Staromonetny per 29

(2) Collaborating scientists

Tetsuo Ohata (NIPR) and/or Shuhei Takahashi

Askar Iliyasov (Lomonosov State University) and Andrey Mikhailov (IG, RAS)

(3) Introduction and background of the theme

Northeastern Asia, in terms of glaciological and climatic issues, is still quite a poorly studied region. It is distant and can be accessed with special transpiration, which is expensive. Because of that, so far remote sensing methods are optimal for solving such questions as:

- Assessment of glacier state in the present by high-resolution satellite images in the study region, comparison with existing inventories, and archival satellite images
- Estimation of the climatic situation in northeastern Asia and the relationship with the glacier state, trend analysis, factor analysis by data of weather stations, reanalysis
- Modeling future change of glaciers of the study region involving our methods and approaches under various scenarios, such as atmosphere-ocean general circulation models (AOGCMs), statistical extrapolation

(4) Definition of questions and goals

See the previous points

(5) Justification as cooperative research between Russia and Japan

Japanese scientists are quite experienced in Arctic and Subarctic research; the study region is familiar for them. The Japanese side can provide satellite images of high resolution and take part in deciphering and analysis with success.

It can also share the Japanese climate models scenario for assessment of the future state of the cryosphere of the Russia Arctic.

(6) Approach and method

Assessment of present glacier state by high-resolution satellite images
Statistical and factor analysis of weather, meteorological data
Modeling of future change of glaciers by climate data and climatic scenarios
Validation of modeling by in situ evidence

(7) Expected outcome or product

Mutual paper in a high level journal besides the report

(8) Progress and problems

None

(9) Other matters that need to be cited concerning cooperation

None

(10) References

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Ananicheva, Maria D., and Andrey Karpachevsky. Glaciers of the Orulgan Range: Assessment of the Current State and Possible Development for the Middle of the 21st Century. *Environmental Earth Sciences* 74:3 (August 2015), 1985–95, http://link.springer.com/search?query=+Orulgan&search-within=Journal&facet-journal-id=12665#page-2.

Takahashi, Shuhei, Konosuke Sugiura, Takao Kameda, Hiroyuki Enomoto, Yury Kononov, Maria D. Ananicheva, and Gregory Kapustin. 2011. Response of Glaciers in the Suntar–Khayata Range, Eastern Siberia, to Climate Change. *Annals of Glaciology* 52(58), 185–92.

4.5 Theme 5: HyARCrio: Hydrology of pan-ARCtic rivers and its impact on the ocean

(1)PIs

Russia: Aleksandr Georgiadi (IG, RAS)

Japan: Tetsuya Hiyama (Institute for Space-Earth Environmental Research, NU)

(2) Collaborating scientists

Russia: Anatoly Prokushkin (V. N. Sukachev Institute of Forest, SB, RAS)

Irina Fedorova (Arctic and Antarctic Research Institute, St. Petersburg State University, St. Petersburg)

Nikita Tananaev (Melnikov Permafrost Institute SB RAS, Yakutsk)

Japan: Michiyo Yamamoto-Kawai (Tokyo University of Marine Science and Technology [TUMST])

(3) Introduction and background of the theme

There has been noticeable warming during the last few decades in the vast Siberian region, an area of about 10 million km^2. It has been accompanied by a rise in air temperature, and to lesser degree by increased precipitation. These changes are characterized by considerable spatial heterogeneity and significant changes in the hydrological regime, fluxes of heat, and dissolved or suspended matter. River runoff changes have a significant impact on the surrounding seas, affecting the circulation of seawater masses, the formation and dynamics of multiyear sea ice, and the balance of biogeochemical substances. The phase of long-term climate cooling, which began in the 1940s, continued until the 1970s and 1980s. After that, the phase of climate warming has continued to the present. It could be that the phase of global warming will stop temporally, and it could change due to a decadal mature phase in the near future, which would lead to corresponding hydrological changes. Anthropogenic factors could also have a significant impact on the considered hydrological characteristics. They must be characterized by considerable spatial heterogeneity, and their scale and impacts could have changed markedly in recent decades.

Various aspects of long-term changes in different characteristics such as runoff, fluxes of heat, and suspended sediment and dissolved matter in major rivers in the region have been studied (Alekseevsky 2007; Georgiadi and Kashutina 2011, 2014, 2016; Georgiadi et al. 2011; Gordeev 2012; Holmes et al. 2012; Lammers et al. 2007; Nikanorov et al. 2007; Shiklomanov et al. 2007; Stuefer et al. 2016, Georgiadi and Fukushima 1999; Shiklomanov 2008; Yang et al. 2002, Baggard et al. 2011; Pokrovsky et al. 2012, Amon et al. 2012; Myers-Pigg et al. 2015).

However, there is no developed complex assessment of the long-term spatiotemporal dynamics of the main geo-runoff components of major Eurasian rivers, the degree of their synchronicities in time and space, and climatic-anthropogenic contributions to the long-term dynamics.

(4) Definition of questions and goals

The overall goal of this study is to investigate contemporary changes in river water runoff, heat, and dissolved or suspended organic or inorganic matter fluxes of the three largest Siberian rivers (the Lena, the Yenisei, and the Ob) due to climatic and anthropogenic impacts, using long-term data sets of state-hydrological station networks as well as conducting special field work.

There are four topical research issues in this study:

1) Water temperature and dissolved organic or inorganic matter, which affects sea ice extent and the primary production of the Arctic Ocean, will be monitored in the three largest Siberian rivers at the main junctions of tributaries as well as at the river mouths.

2) Spatial and temporal changes in river discharge, heat, and material fluxes due to climate or anthropogenic impacts will be investigated.

3) Differences of hydro-geochemical processes between delta-river (the Lena) and estuary-river (the Ob and the Yenisei) interaction under climate change will be investigated.

4) Redistribution and reaction of the terrigenous matter in river-ocean mixing zones of the surrounding sea (i.e., Kara, Laptev, and East Siberia) will be observed.

(5) Justification as cooperative research between Russia and Japan

In order to achieve this study, cooperation among scientists from different specialties and countries is particularly necessary. Cooperation by experts from Russia and Japan will allow us to obtain significant results as modern technologies for determination of a number of investigated characteristics. Specifically the first concerns on water -quality analysis will allow us to obtain more reliable results.

(6) Approach and method

We will apply the following methodologies.

(a) Long-term data set analysis

Geographical regionalization using geographical information system (GIS) is planned in order to explore seasonal, inter-annual, and long-term changes of characteristics and the types of human impacts on the hydrological regime. Methods for naturalization of river runoff based on river indicators of climate conditions and methods of hydrograph transformation will be used. Methods for analysis of long-term and short-term changes of characteristics, such as Fourier and wavelet analyses, will also be performed. Additionally, statistical approaches in order to detect characteristics of regressions for two periods with different types of climate and anthropogenic influences are planned.

(b) Use of a three-dimensional hydrodynamic model

The Princeton Ocean Model (POM) will be used to detect seasonal hydrological processes, including ice processes. Using the model, long-term changes in the seasonal processes of interaction between the river and sea in the Ob and Yenisei estuaries will be performed. Boundary conditions using data from state network stations to calculate the characteristics of hydrological processes in these estuaries will be applied.

(c) Conducting field measurements and laboratory analysis of water samples

DOC, DIC, DON, DIN, together with C and N isotopes, as well as water isotopes and major cations and anions will be monitored. The sampling sites will be major junctions of tributaries as well as main streams and the river-ocean mixing zone.

(7) Expected outcome or product

Knowledge regarding temporal and spatial regularities of long-term changes for the complex of characteristics within this huge region caused by changes of climate and anthropogenic influence will be improved by this proposed research. The investigated results will be disseminated through a special website and joint publications.

(8) Progress and problems

1) Long-term phases of multiyear changes of water flow and heat flux for the largest Siberian rivers (the Ob, the Yenisei, and the Lena) were analyzed. Their associativity with air temperature changes and the macroscale atmospheric circulation, presented in the form of commonplace indexes, was examined. Features of these phases have been revealed on the basis of normalized cumulative sum curves, showing that long-term changes of water flow and heat flux, as well as water temperature, are characterized by two main long-term phases. The phase of their decreased values began in the 1930s and 1940s and proceeded for some decades. In the 1970s and 1980s, and in the 1990s for the heat flux of the Yenisei, it was replaced by a long-term phase of their increased values (fig. 1). Phase synchronism of their long-term changes with increase or decrease of air temperature and rising or weakening of the intensity of zonal flux in the atmosphere is revealed.

2). Usual runoff of suspended, dissolved, and solid material to the Arctic Ocean has been calculated according to the element measurements on the last cross -sections (gauge lines) of the Arctic rivers. These are Salekhard for the Ob, Dudinka for the Yenisei, and Kusur for the Lena. Our investigations downstream on the Lena show another transformation of material. For instance, maximal turbidity occurs before the Lena delta: near the Vilyui River tributary, the turbidity can reach 260 mg per liter, while on the delta head it was 40 mg/l and only 3–5 mg/l on the coastal line of the delta. So, the calculations can be 5–8 times or more higher than real runoff of suspended material. Geochemical barriers in the mixing zones are also not taken into account, unfortunately. The last information about the colored dissolved organic matter (CDOM) parameter shows it dissolving downstream in the Lena River due to permafrost thawing and possible ice complex melting. Therefore, mid- and small geochemical processes should be investigated better and be included in marine ecosystem modeling.

(9) Other matters need to be cited concerning cooperation

Following is a summary of the group discussion held on March 21, 2017, after the Russia-Japan Workshop on Arctic Research 2017, which was held at IGEM:

1) Processed-based (including chemical processes) and physical-based modeling are needed. However, the purpose of modeling chemical processes should be made clearer. We have a scale-gap for implementing processed-based and physical-based modeling.

2) Focusing on water sampling and analyzing measurements, the upstream region and the downstream or river mouth, which is the mixing zone, should be applied separately. For the mixing zone, chlorophyll, pCO_2, nutrients such as nitrate and phosphate, silicate indicating turbidity, and dissolved organic carbon are very important for ocean production. Suspended material and sediments should also be sampled at the mixing zone. Mixing zone measurements in the coastal line should be employed using a ship. Buoy measurements on all sensors and hundreds of data loggers should be applied not only for the upstream region but also for the downstream and/or mixing zone. Most of all, the mixing zone should be analyzed between isohaline 1‰ and riverine part of the estuaries and deltas under tidal and surge effects because exactly these regions can have organic and inorganic avalanche sedimentation and consequent biodiversity increase.

3) In the beginning, nonfrozen seasons such as September will be targeted. Then the frozen season and peak flood season will also be targeted. We should start at the Yenisei and Lena river basins. Both rivers are unique in that they have different water resources on the catchments and hydrodynamic condition at the mouths; the Yenisei has a longer plume of material to the surrounding sea, while the Lena River, in contrast, accumulates material within; the Yenisei is regulated by reservoirs, unlike the Lena. In addition, winter season is underestimated on all Arctic rivers due to the measurement complexity on the biggest large rivers, with huge ice thickness, hazardous weather conditions, and flooding in spring. Special scientific stations Igarka on the mouth of the Yenisei and Samoylov at the

mouth of the Lena are participants in field experience during winter, and new approaches and equipment provide the possibility to extend knowledge about unstudied processes. It is well known that some algae have maximum activity under thin ice before a flood period but there are not enough data about these specifically on the large Arctic river mouths. Planned methods for this project will allow receiving new information to clarify these unknown processes.

(10)References

More than 20 papers were published in 2015–2016. Among them:

Bring, A., I. Fedorova, Y. Dibike, L. Hinzman, J. Mård, S. H. Mernild, T. Prowse, O. Semenova, S. L. Stuefer, and M.-K. Woo. 2016. Arctic Terrestrial Hydrology: A Synthesis of Processes, Regional Effects, and Research Challenges. *Journal of Geophysical Research G: Biogeosciences* 121 (3), 621–49.

Georgiadi, A. G., and E. A. Kashutina. 2016. Long-Term Runoff Changes of the Largest Siberian Rivers. *Izvestiya Rossiiskoi Akademii Nauk. Seriya Geograficheskaya* 5: 70-81.

Georgiadi, A. G., E. A. Kashutina, and I. P. Milyukova. 2016. Long-Term Changes of Geo-Runoff Components in Russian Arctic Rivers. East Siberian Shelf: Observations, Data Analysis, Modelling Efforts, LenaDNM project. DOI:10.5281/zenodo.236945: 23.

Fedorova, I., A. Chetverova, D. Bolshiyanov, A. Makarov, J. Boike, B. Heim, A. Morgenstern, P. P. Overduin, C. Wegner, V. Kashina, A. Eulenburg, E. Dobrotina, and I. Lena Sidorina. 2015. Delta Hydrology and Geochemistry: Long-Term Hydrological Data and Recent Field Observations. *Biogeosciences* 12 (2), 345–63.

Tananaev, N. I. 2015. Hysteresis Effects of Suspended Sediment Transport in Relation to Geomorphic Conditions and Dominant Sediment Sources in Medium and Large Rivers of the Russian Arctic. *Hydrology Research* 46(2), 232–43, doi:10.2166/nh.2013.199.

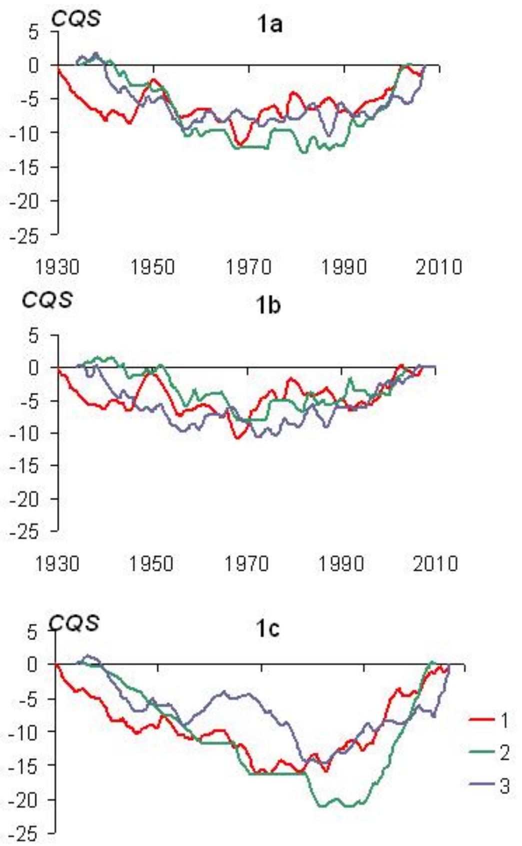

Figure 1. Long-term phases of increased and decreased values of naturalized mean annual water flow: (1a) water flow of the May–August high water period; (1b) of the November–April winter season; (1c) on the Ob at Salekhard (1), the Yenisei at Igarka (2), and the Lena at Kyusyur (3).

4.6 Theme 6: Effects of boreal forest fires on the global environment

First step: Analysis of weather conditions for concurrent widespread forest fires

(1) PIs and Collaborating scientists

Japan:

Hiroshi Hayasaka (Arctic Research Center, HU)

Russia:

Solovyev Vladimir (temporary, Institute of Cosmophysical Research and Aeronomy, SB, RAS)

Evgenii Ponomarev (Sukachev Institute of Forest, SB, RAS, Federal Research Center, Krasnoyarsk)

Lena Tarabukina (Institute of Cosmophysical Research and Aeronomy, SB, RAS)

(2) Introduction and background of the problem

In the vast Russian boreal forest, forest fires occur every year in various places. By analyzing Moderate Resolution Imaging Spectroradiometer (MODIS) hotspot data for more than 10 years, frequent fire regions in the Russian Forest are gradually becoming evident. In this study, we will show the results of analyzing weather conditions of large forest fires in the boreal forest of southern Sakha. In the boreal forest of Southern Sakha, large-scale forest fires occurred in 2002, 2008, 2011, 2012, and 2014. Hotspot distributions in 2002 and 2012 are shown in figure 1 with different colors (red for 2002, yellow for 2012). As a result of examining the weather conditions of seven active fire periods in the above five fire years, a low-pressure weather pattern was commonly confirmed. Low pressure near southern Sakha played an important role in making active fires. Figure 2 is prepared with a NASA worldview image with a superimposed weather map. Fire hotspots are shown by a red dot in figure 2.The steep gradient of contour lines indicating average height over the study area shown by a yellow rectangle in figure 2 suggests relatively strong wind speed or one of fire weather conditions. This situation is created by a low-pressure system located in northwest of the study area.

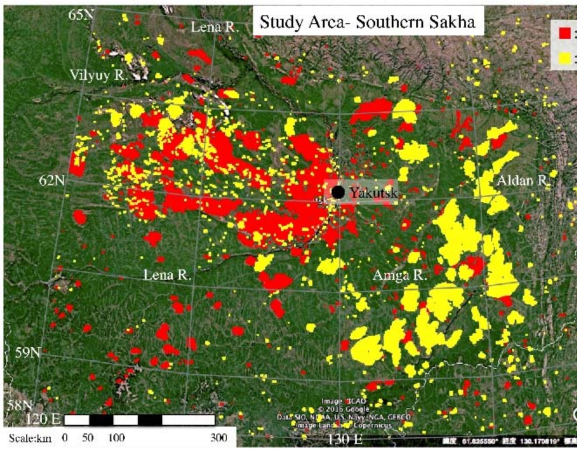

Figure 1. Study area of southern Sakha

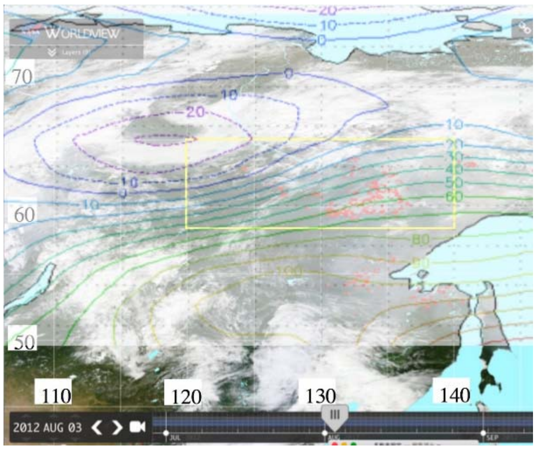

Figure 2. Fire weather map, August 2012

(3) Definition of questions and goals

Questions: Why and how did the largest fires in Siberia occur in the last decades? What weather conditions cause concurrent widespread fires in boreal forest? Is there any climate change effect on boreal forest fires?

Goals: The final goal is to clarify the effect of recent active boreal forest fires under climate change on the global environment. Based on our analysis results, measures to reduce the impact of boreal forest fires and mitigate global warming will be proposed. As the first step, we will clarify fire weather conditions of each fire-prone area. Then, the comprehensive fire regime of each area could be defined by considering vegetation, climate, weather, fire, and terrain. Finally, we could establish a suitable strategy to control boreal forest fires based on scientific knowledge. This approach will be one of ways to mitigate global warming.

(4) Justification as cooperative research between Russia and Japan

Recent analysis results for boreal forest fires done by Russian researchers using satellite data for 1996–2016 will be needed to carry out this research theme promptly. In addition, detailed data on vegetation, climate, weather, fire, and terrain from Russian researchers are also needed to establish the comprehensive fire regime.

(5) Approach and method

The proposer of this research already analyzed synoptic-scale fire weather conditions for Alaskan boreal forest fires. Large fire-weather conditions in Alaska clearly showed the comprehensive fire regime in the of interior Alaska. A similar analysis approach will be carried out for several boreal forest fire areas in Russia. Then, the comprehensive fire regime will be established.

(6) Expected outcome or product

The effects of boreal forest fires on the global environment will be clear based on results from this first-step research—analysis of weather conditions for concurrent widespread forest fires. The quantitative characteristics will be evaluated for the model scenarios of fire danger during fire season at the level of subregions of Siberia as well as the relative forests burning. By understanding the fire regimes of Siberian boreal forests through this research, we could evaluate recent active fires more scientifically and improve the present fire forecast.

(7) Progress and problems

New theme

(8) Other matters need to be cited concerning cooperation

None

(9) References

Hayasaka H., H. L. Tanaka, and P. A. Bieniek, 2016. Synoptic-Scale Fire Weather Conditions in Alaska. *Polar Science* 10:3, 217–26, http://dx.doi.org/10.1016/j.polar.2016.05.001.

Ponomarev, Evgenii I., Viacheslav I. Kharuk, and Kenneth J. Ranson. 2016. Wildfires Dynamics in Siberian Larch Forests. *Forests* 7:125, 9, doi:10.3390/f7060125, http://www.mdpi.com/1999-4907/7/6/125.

Tomshin, O. A., and V. S. Solovyev. 2014. The Impact of large-Scale Forest Fires on Atmospheric Aerosol Characteristics. *International Journal of Remote Sensing* 35:15, 5742–49.

5. Discussions at the WS

Discussions made concerning the conditions and environment of cooperative research during the presentation sessions and the wrap-up sessions can be summarized as follows. Many parts of the following text refer to the issues discussed in the 2014 workshop and compiled in Report 2015.

5.1 Human resources development

In Report 2015, many pages were devoted to discussions and proposals on this issue. This area is very important, since sound research through the coming years will depend heavily on the younger generations. The Japanese community thinks that to provide opportunities for young Japanese researchers is important, especially for enhancing the fieldwork of Japan in the Arctic region. HU has already been taking a role to undertake interactions in the Siberian region concerning human resources development. The Joint Research Laboratory has been established by HU and Northeast Federal University (NEFU) in 2016. Secondly, the Joint Master's Course Program was started by NEFU and HU in 2017. An overall program called the RJE3 project, including Arctic regions and combining universities such as HU, NEFU, the Eastern Federal University (FEFU), Irkutsk, Pacific National, and Sakhalin University, was initiated in 2014. Institutional effort is put into these activities.

In the eastern part of Russia, the Center for Integrated Arctic Studies was established in 2016 at Arkhangelsk, and it will enhance research, including early career scientists.

Another interesting event last year related to the activities of young scientists was a conference held by young scientists titled International Russian-Japanese Conference of Young Polar Scientists: Prospects of Joint Investigations in Polar Regions of the Planet. It was part of international APECS activity, and was held October 10–12, 2016, at Red Hall of the Presidium RAS, with the attendance of 24 people. The two objectives were:

1. To promote the interaction of scientists from Russia and Japan to study the issues of the Arctic and Antarctic as an ecosystem both potentially promising in terms of economic development of natural resources and, at the same time, the most vulnerable to human impact in terms of the sustainability.
2. To strengthen existing interdisciplinary scientific relations and creation of new ones between young scientists of Russia and Japan.

5.2 Cooperation at the Russian research base and network

In Report 2015, a proposal for usage of the Russian Arctic Research Base was made by AARI scientists. Afterward, talk on cooperation at these stations started between AARI and NIPR, and through longtime negotiation, MOU and Research Agreement was concluded between AARI and NIPR in August 2017, just before publication of this report. This is a milestone event, since this MOU was between the core Institute for Arctic and Antarctic Research in Russia and in Japan, even though these two countries had field cooperation in the Antarctic from time to time without a formal document of cooperation. Cooperation in the Arctic will start on observation and research on black carbon using facilities at the Baranova Station. This research is a part of the ArCS Project.

Concerning other cooperation on the observation network in the Arctic region of Russia, not much has moved forward. For such cooperation, specific stable funding is needed, and there is a need to secure funding in both Russia and Japan. It may be an important issue for Japan to obtain such funding in the next round of the governmental Arctic Program, which will succeed the ArCS Program of 2015–2020.

5.3 Data archive

In Report 2015, data-sharing principles were proposed by the Japanese side, but no advance has been made concerning data up to now, including disclosure of detailed conditions of data policy in Russia in general. It is hoped that data-sharing will advance in the near future, since it is the basis of advancing science and good cooperation.

5.4 Various regulations in Russia confronting research in Russia

It can be said that no clear progress has been made since 2015.

One big event related to regulation for research in Russia for foreigners was the conclusion of the Agreement on Enhancing Science Cooperation in the Arctic (reference below) in May 2017, signed by Ministers of the Eight Arctic Countries, including Russia. Apparently, this is an Agreement among eight countries, but one of the items discusses the application of the same rules to non-Arctic countries when Arctic countries cooperate with non-Arctic countries. If this agreement is applied to Russia-Japan Cooperation, some obstacles mentioned in Report 2015 would be resolved. However, we do not know, at present, how Russia will apply this agreement to cooperation with non-Arctic countries such as Japan.

This agreement was referred to during the discussion session of this workshop, but no Russian participants, including Dr. Pavlenko, were able to answer on potential changes in Russia. We need more time to see how this agreement will be favorable for Russia-Japan Cooperation.

Reference

https://oaarchive.arctic-council.org/handle/11374/1916

6. Special remarks and conclusion of the WS

A discussion of the prospects for developing joint research involved organizational issues as well as issues of developing and using an available instrumental base of remote sensing of Arctic marine and land areas and specific regions of eastern Siberia. The seminar participants agreed on a list of certain projects, the implementation of which is scheduled for 2017–2018, and also discussed the capabilities of Russian and Japanese parties to organize joint research expeditions to the Arctic and northern regions of Siberia. The Japanese party announced the 5th International Symposium on Arctic Research (ISAR-5).

The Moscow WS has become another important step toward developing scientific cooperation between Russia and Japan in studying large-scale natural processes and phenomena in the Arctic, and strengthening and establishing new contacts between Russian and Japanese scientists.

To note, IASC is planning to hold a two-day meeting of the International Study Initiative on Arctic Russia in November 2017 in Moscow in order to discuss in depth the issues of scientific cooperation between Russia and other countries. Some advances may come out from this meeting concerning scientific cooperation between Russia and Japan.

Appendix 1. Program

Russia-Japan Workshop on Arctic Research 2017

(Resultant Program)

Date and Time: March 20 and 21, 2017.
Venue: IGEM (Institute of Institute of Geology of Ore Deposits Petrography Mineralogy and Geochemistry, Staromonetnyy per., 35c2, Moskva, Russia, 119017) See map.
Organizers: Russian and Japanese Group for WS (Vladimir Pavlenko, Aleksandr Gieorgiadi, Tetsuo Ohata, Hiroyuki Enomoto, Yuji Kodama, Atsuko Sugimoto)
Supporting Organization: FCIArctic, National Institute of Polar Research, Japan Arctic Research Network Center, Japan Consortium for Arctic Research

1. Program
Duration of talk: 15 minutes for each presentation.

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March 20 (Monday)
9:30-11:00: Opening and general talk on cooperative research (chair: Ohata)
(1) Opening Speech: Vladimir Pavlenko (FCIArctic, RAS), Hiroyuki Enomoto (NIPR)
(2) Objective and what we do at this WS: Tetsuo Ohata (NIPR)
(3) Arctic Research in Japan Hiroyuki Enomoto (NIPR)
(4) Cooperative Research between Russia and Japan: Atsuko Sugimoto (HU)
(5) Report on the workshop "International Russian-Japanese Conference of Young Polar Scientists; Prospects of Joint Investigations in Polar Regions of the Planet "：Shunsuke Tei (HU.)

11:00-13:00 Presentation of Research Themes (from each research area)
Part 1: Atmospheric Research (chair: Pavlenko)
Jun Inoue (NIPR): Japanese predictability studies using extra radiosondes during YOPP
Kazutoshi Sato (NIPR): Impact of extra Arctic radiosonde observations during summer on weather forecasts over the northern hemisphere
Roman Petrov (IBPC, SB, RAS): 25 years Russian-Japanese studies on climate change in north eastern Russia
Mikhail A. Strunin (CAO) : Experience of using Russian aircraft-laboratory Yak-42D "Roshydromet" in Arctic region.
Ryoichi Imasu(University of Tokyo (UT)) : Objective of simulation study (short introduction by Strunin)
Hiroyuki Enomoto (NIPR): TBD

14:00-16:20
Part 2: Cryosphere (chair: Sueyoshi)
A.V. Sosnofsky, N.I. Osokin (IG RAS). Evaluation of the effect of water vapour diffusion on heat transfer in snow cover
Maria Annanicheva. (IG RAS): Present state of Chukotka and Kolyma highlands' glaciers and assessment of their evolution in near future

Mamoru Ishikawa (HU.): Permafrost change in northeastern Asia, past present and future

Yoshihiro Iijima (Mie University (Mie-U): Permafrost changes in Siberia in the past and future based on projections of climate warming

Part 3. Hydrological Cycle and Ocean (chair: Georgiadi)

T. Hiyama (NU), M. Kawai (TUMST.), A. Georgiadi (IG RAS), A. Prokushkin (VN Sukachev Inst. Forest, SB RAS) : HyARCrio: Hydrology of pan-ARCtic rivers and its impact on the ocean

A. Georgiadi, E. Kashutina, I. Milyukova (IG RAS): Long-term changes of geo-runoff components in Russian Arctic rivers

A. Prokushkin (VN Sukachev Inst. Forest, SB RAS): Hydrological flux of carbon within the Yenisei River basin

M. Kawai (the TUMST.): Distribution of river water in the Arctic Ocean

Ilina Feudrova: TBD (Short introduction by Georgiadi)

16:50-18:30

Part 4: Terrestrial (Chair: Sugimoto)

Atsuko, Sugimoto (H.): Innovation for sustainable use of forest ecosystem on permafrost

M.M. Arzhanov, S.N. Denisov, I.I. Mokhov (Obukov Inst. Atmos. Phys., RAS): Modeling of thermal regime of the soil and methane emissions in permafrost regions in the past and future.

Go Iwahana (HU./ International Arctic Research Center (IARC)): Assessing and projecting thermokarst and associated carbon release due to abrupt permafrost degradation

Yumiko Miyamoto (HU): Forest soil carbon dynamics in the permafrost regions of northeastern Siberia

Noriyoshi Tsuchiya (Tohoku University (TU)): Tectonic evolution of the Central Asia orogenic belt and other earth scientific projects

Diana Mindaleva (TU): Hydration, dehydration and hydrothermal brecciation of the earth's crust: An example from Sør Rondane Mountains, East Antarctica.

March 21(Tuesday)

9:30-11:45 (chair: Ohata)

Vladimir Pavlenko (FCIArctic, RAS): Arctic Research in Russia:

Hiroshi Hayasaka (NPO Hokkaido Inst. Hydro-Climate): Effects of boreal forest fires on global environment (first step: Analysis of weather conditions for concurrent widespread forest fires)

Part 5 Ecology (chair: Petrov)

Elena Lappo (IG RAS): Declining of Arctic waders on the EastAsian Flyway

Kanichiro Matsumura (UT. Agriculture): Applying a drone observation along Sakhalin to Sea of Okhotsk

Shirow Tatsuzawa (HU): Ecology and conservation of migratory birds between Russia and Japan.

Shirow Tatsuzawa (HU) : Ecology and community-based management of wildlife in Sakha Republic (Yakutia).

Shunsuke Tei (HU): A comparison of observational data in eastern Siberia for improving our understanding of forest ecosystem response to climate change

Part 6: Others

12:00-13:00 General Discussions on Cooperative Research

〇Issues, problems, questions concerning cooperative research

〇Summary　of WS and Report

Adjourn

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Appendix 2. Participants List

Participants in the Russia-Japan Workshop on Arctic Research 2017

Russia

Name		**Position**	**Organization**
Roman	Petrov	Researcher	IBPC, SB, RAS
Anatoly	Alexanin	Head of Laboratory	Institute for Automation and Control Processes (IACP), Far-east Branch (FEB) RAS
Maria	Ananicheva	Leading Researcher	IG, RAS
Mikhail	Strunin	Head of Laboratory	CAO
Elena	Lappo	Senior Researcher	IG, RAS
Alexandr	Georgiadi	Leading Researcher	IG, RAS
Alexander	Sosnovsky	Work Center Coordinator	IG, RAS
Innokentiy	Okhlopkov	Scientific Secretary	IBPC, SB, RAS
Sergey	Denisov		IAP, RAS
Maxim	Arzhanov		IAP, RAS
Vladimir	Pavlenko	Director	ARHSC, RAS
Vladimir	Sukhov		Presidium, RAS
Nikolay	Sitnikov		CAO
zArkadiy	Tishkov	Deputy Director	IG, RAS
Irina	Fedorova	Associate Professor	AARI, St. P. SU
Anatoly	Prokushkin	Head of Laboratory	V. N. Sukachev Institute of Forest, SB, RAS

Japan

Diana	Mindaleva	Student (Masters Course)	TU
Hiroyuki	Enomoto	Deputy Director	NIPR
Jun	Inoue	Associate Professor	NIPR
Noriyoshi	Tsuchiya	Professor	TU
Yoshihiro	Iijima	Associate Professor	Mie-U

Hiroshi	Hayasaka	Researcher	HU
Mamoru	Ishikawa	Associate Professor	HU
Atsuko	Sugimoto	Professor	HU
Tetsuya	Hiyama	Professor	NU.
Kanichiro	Matsumura	Professor	UT Agriculture
Kazutoshi	Sato	Postdoctoral Scientist	NIPR
Yumiko	Miyamoto	Postdoctoral Fellow	HU
Shunsuke	Tei	Researcher	HU
Michiyo	Yamamoto-Kawai	Associate Professor	TUMST
Tetsuo	Sueyoshi	Research Administrator	NIPR
Tetsuo	Ohata	Project Professor	NIPR
Yuji	Kodama	Project Associate Professor	NIPR
Shirow	Tatsuzawa	Assistant Professor	HU
Go	Iwahana	Research Assistant Professor	University of Alaska Fairbanks (UAF)

Appendix 3. Acronyms of Organization and Institutes

The acronyms below include those used in this report and also in Report 2015.

Organization

AARI: Arctic and Antarctic Research Institute, Roshydromet (St. Petersburg, Russia)

AC: Arctic Council (Tromso, Norway)

AERC: Arctic Environment Research Center, NIPR (Tachikawa, Japan)

APECS: Association of Polar Early Career Scientists (Tromso, Norway)

ARHSC: Arkhangelsk Scientific Center, Ural Branch (UB), RAS (Arkhangelsk, Russia)

ASSW: Arctic Science Summit Week

CAO: Central Aerological Observatory (Moscow, Russia)

FCIArctic: Federal Research Center for Integrated Arctic Studies

FEB: Far East Branch, RAS (Vladivostok, Russia)

FFPRI: Forest Products Research Institute, Ministry of Agriculture and Forestry (Tsukuba, Japan)

GEOKHI: Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS

HU: Hokkaido University (Sapporo, Japan)

IACP: Institute for Automation and Control Processes

IAP: Institute of Atmospheric Physics, RAS (Moscow, Russia)

IARC: International Arctic Research Center

IASC: International Arctic Science Committee (Akureyri, Iceland)

IB: Institute of Biology, Karelian Research Center, RAS (Petrozavodsk, Russia)

IBP: Institute of Biophysics, SB, RAS (Krasnoyarsk, Japan)

IBPC: Institute of Biological Problems of the Cliolithzone (Yakutsk, Russia)

IG: Institute of Geography, RAS (Moscow, Russia)

IGEM: Institute of Geology of Ore Deposits, Petrography, Mineralogy and Biochemistry

IPA: International Permafrost Association. (Longyearbyen, Svalbard)

IPOI: Iyichev Pacific Oceanological Institute, FEB, RAS (Vladivostok, Russia)

ISIRA: International Science Initiative in the Russian Arctic (Akureyri, Iceland)

ISTC: International Science and Technology Center (Moscow, Russia)

JAMSTEC: Japan Agency for Marine-Earth Science and Technology (Yokosuka, Japan)

J-ARC Net: Japan Arctic Research Network Center (Sapporo, Japan)

JAXA: Japan Aerospace Exploration Agency (Tsukuba, Japan)

JCAR: Japan Consortium for Arctic Environment Research (Tachikawa, Japan)

KIT: Kitami Institute of Technology (Kitami, Japan)

KIP: Kirensky Institute of Physics, SB, RAS (Krasnoyarsk, Russia)

MEXT: Ministry of Education, Culture, Sports, Science and Technology (Tokyo, Japan)

Mie-U: Mie University (Tsu, Japan)

MPI: Melnikov Permafrost Institute, SB, RAS (Yakutsk, Russia)
NEFU: Northeast Federal University (Yakutsk, Russia)
NIES: National Institute of Environmental Science, Ministry of Environment (Tuskuba, Japan)
NIPR: National Institute of Polar Research (Tachikawa, Japan)
NU: Nagoya University (Nagoya, Japan)
RAS: Russian Academy of Sciences (Moscow, Russia)
RIHMI-WDC: All-Russia Research Institute of Hydrometeorological Information World Data Center (Obninsk, Russia)
ROIS: Research Organization of Information and Systems (Tokyo, Japan)
Roshydromet: Federal Hydrometeorology and Environmental Monitoring Service of Russia
SB: Siberian Branch, RAS (Nobosibirsk, Russia)
SCTF: Science Cooperation Task Force of Arctic Council (Tromso, Norway)
SHI: State Hydrological Institute, Roshydromet (St. Petersburg, Russia)
SIEE: Sevetsov Institute of Ecology and Evolution, RAS (Moscow, Russia)
SIF: Sukachev Institute of Forest, SB, RAS (Krasnoyarsk, Russia)
TU: Tohoku University (Sendai, Japan)
UB: Ural Branch, RAS
UT: University of Tokyo (Tokyo, Japan)
UT: University of Toyama (Toyama, Japan)
TUMST: Tokyo University of Marine Science and Technology (Tokyo, Japan)
WIM: V. E. Zuev Institute of Atmospheric Optics, SB, RAS (Tomsk, Russia)
ZIN: Zoological Institute, RAS (St. Petersburg, Russia)

Others

AOGCMs: Atmosphere-Ocean General Circulation Models
ARCROSE: Arctic Research Collaboration for Radiosonde Observing System Experiment
ArCS: Arctic Challenge for Sustainability
BC: black carbon
CDOM: colored dissolved organic matter
GAME: GEWEX Asian Monsoon Experiment
GIS: geographical information system
GHG: greenhouse gas
GRENE: Green Network of Excellence
GTS: global telecommunication system
IGY: International Geophysical Year
ISAR-5: the 5th International Symposium on Arctic Research

MATCH: Determination of Stratospheric Polar Ozone Losses
MODIS: Moderate Resolution Imaging Spectroradiometer
NABOS: Nansen and Amundsen Basins Observational System
POM: Princeton Ocean Model
PPP: Polar Prediction Project
SOPs: special observing periods
SWIPA: Snow, Water, Ice, Permafrost in the Arctic
UAV: unmanned aerial vehicles
WCRP: World Climate Research Program
WWRP: World Weather Research Programme
YOPP: Year of Polar Prediction