G3–P1

MRI LAND SURFACE SCHEME HAL

Masahiro Hosaka[1]

[1]*Meteorological Research Institute, 1-1 Nagamine Tsukuba Ibaraki Japan*

E-mail: mhosaka@mri-jma.go.jp

We have been developping a land surface model HAL mainly for climate research purposes. HAL is originated from SiB (SImple Biosphere model) and is working in the MRI-ESM1, which is participating in CMIP5.

Better modelling of the cryosphere is one of HAL's major targets. HAL has much more snow and soil layers than original SiB, and it can represent detailed changes of the snow and soil. SMAP model, which calculates snow albedo and solar heating profile in snowpack considering effects of snow grain size and snow impurities explicitly, has been installed in HAL and it helps physically based appropriate simulations of the snow regions.

G3–P2

RECENT VARIABILITY OF AIR TEMPERATURE IN NORTH-EAST EURASIA AND ITS EFFECT ON PERMAFROST LANDSCAPES

Fedorov A.N.[1], Konstantinov P.Y.[1], Ivanova R.N.[1], Y. Iijima[2], H.Park[2]

[1] *Melnikov Permafrost Institute SB RAS, Yakutsk, Russia*
[2] *Research Institute for Global Change, Yokosuka, Japan*

fedorov@mpi.ysn.ru

Variability's of air temperature in 38 weather stations in North-East Eurasia are analyzed from the Yenisei-river to the Chukotka peninsula on such types of natural complexes as tundra, a forest-tundra area, a northern and middle taiga. We analyze mean deviations of annual air temperature, thawing and freezing indexes, ground temperature, active layer thickness and activity of cryogenic processes since 1930 to present.

Climate of the North-East Eurasia is extreme and various. On the Arctic seaboards main climate forming factors are a position in the high latitudes and an influence of cold arctic seas. Moving off seaboards, a climate is getting a strongly continental and arid. It is an effect of not only geographic position but a peculiarity of atmospheric processes.

Many authors show that in last decades occurs very high increasing of air temperature especially in high latitudes. We agree with this statement and we would like indicate available variations of air temperature dynamics in North-East Eurasia.

There were the characteristic periods, when the climatic warming occurred in this region: 1935-1945, 1988-1995 and 2005-2009. The 1935-1945 warming had a biggest effect in the tundra, the forest-tundra area and the northern taiga, 1988-1995 – in northern and main taiga, and 2005-2009 – above all landscape's zones. These phases of climatic warming had strong impact on the development of permafrost landscapes. Our observation shows that in these time ground temperature increased, cryogenic processes were activated in the open and disturbance places. Activation of cryogenic processes negatively impacts the landscapes and the economic infrastructures.

G3–P3

THE USE OF SITES WITH A THICK GRID OF THAW TUBES TO OBSERVATION THE DEPTH OF SEASONAL THAWING IN CENTRAL YAKUTIA

P.Ya.Konstantinov[1], A.N.Fedorov[1], I.S.Ugarov[1], R.N.Argunov[1], Y.Iijima[2]

[1] *Melnikov Permafrost Institute SB RAS, Yakutsk, Russia*

[2] *Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, Yokosuka-city, Japan*

konstantinov@mpi.ysn.ru

Dry soils with deep thawing generally predominate in Central Yakutia, which considerably impedes the application of a probe for mass measurements. The best results in this case can be achieved with the help of thaw tubes. However, a small number of them within the investigated landscape is not enough to objectively assess the multi-year dynamics of seasonal thawing. In order to increase the statistical validity of the obtained data, in 2008 two sites near Yakutsk were equipped with a thick grid of thaw tubes. Site 1 located at the second terrace above the flood-plain of the Lena River within a grass meadow numbers 77 thaw tubes. 36 thaw tubes are installed at site 2 located in the native larch forest at the destructional and constructional plain. The research gave preliminary results on the influence of different meteorological factors on interannual variability in the thickness of the seasonally thawed layer (STL). The data on the maximum STL thickness collected at different points of each experimental site have low variability. This indicates that the landscape conditions are homogeneous enough to regard the selected sites as optimal for the study of the multi-year dynamics of seasonal thawing depth. In 2012, the sites have been included in the CALM database as R42 and R43.

G3–P4

PERMAFROST DEGRADATION AND FLOOD OCCURRENCE IN THE FAR NORTH OF SIBERIA

Toru Sakai[1], Tetsuya Hiyama[1], Junko Fujiwara[1], Semen Gotovtsev[2], Leonid Gagarin[2] and Yasushi Yamaguchi[3]

[1] *Research Institute for Humanity and Nature, Kyoto 603-8047, JAPAN*

[2] *Melnikov Permafrost Institute, Yakutsk 677010, RUSSIA*

[3] *Nagoya University, Nagoya 464-8601, JAPAN*

E-mail: torus@chikyu.ac.jp

High latitude regions are experiencing the greatest climate warming. Effects on permafrost thawing are particularly important for global climate, because permafrost thawing promotes decomposition of soil carbon, and releases greenhouse gases such as methane into the atmosphere. It is said that high latitude regions contain one third of the global terrestrial pool of soil carbon. In addition, permafrost thawing also changes water balance. Flood is caused when a large amount of the thawed water flows into the river. Extreme hydrologic events such as flood have already been observed, and are predicted to further increase in the frequency and magnitude. The objectives of this research are to monitor the process of permafrost thawing using microwave remote sensing, and advance the knowledge regarding climate change in the far north of Siberia.

Although Alazeya region was consistently low precipitation area, air temperature in 2007 was drastically high. Therefore, much permafrost melted in summer of this year, and big flood was caused due to the permafrost degradation. In the permafrost, ice wedge is included. (i) When permafrost melts due to the increased air temperature, active layer grows thick and ice wedge melts. (ii) After ice wedge melting, the melted water gushes from the ground. (iii) Then, the melted water flows into a nearby river, leading to floods. After permafrost degradation, the ground sinks. Ground subsidence by permafrost degradation was measured using microwave remote sensing. Differential interferometric synthetic aperture radar (DInSAR) can provide measures of vertical movement at landscape scale. Two images in 2007 and 2008 were used to analyse ground subsidence at Andryushkino. The ground sinked approximately 20 cm for a year. The amount was larger near the Alazeya river. There are many factor of ground subsidence, such as earthquake, landslide, volcano and so on. However, probability of permafrost degradation would be high in Alazeya.

G3–P5

IMPROVED ALGORITHM FOR MODELLING OF HEAT DYNAMICS IN FROZEN SOILS

Olga Semenova[1,2,3], Yury Vinogradov[1,2,3], Lyudmila Lebedeva[4,2,3]

1 Gidrotehproekt Ltd

2 Hydrograph Model Research Group

3 State Hydrological Institute

4 Nansen Centre

omakarieva@gmail.com

The details of the method to simulate the processes of ground thaw-freeze accounting for phase transformations in soils will be presented. It is based on several approaches which simplify the differential equation of heat transfer in soil profile and allow deriving its analytical solution. Additional information is given on the techniques of estimation heat transfer and conductivity characteristics of soil and snow in different states.
The methods are integrated into calculating algorithms of the hydrological model Hydrograph. Physical properties of soil horizons used as the model parameters allow for robust assessment of their values according to landscape characteristics. Verification of proposed approaches was conducted with the use of observational data of thaw/ freeze depth in different landscapes of the Kolyma water-balance station (continuous permafrost zone, North-East of Russia). Study sites included slope and plateau with thaw depths varying from 0.5 to 1.8 m across landscapes characterized distinctly as rocky talus, mountain tundra with dwarf tree brush, moss-lichen sparse growth forest or larch forest. Soil-vegetation profile schematization and corresponding model parameters were developed for each landscape. The model was run for continuous period of 1960-1990 with daily step interval and simulated values have shown good agreement with observed ones at all studied sites.

MODELLING OF ACTIVE LAYER DEPTH DYNAMICS AND RUNOFF FORMATION AT SMALL WATERSHED ENTIRELY COVERED BY BARE ROCKS

Lyudmila Lebedeva[1,2], Olga Semenova[2,3], Tatyana Vinogradova[2,4], Evgeny Boyarintsev[4]
[1]*Nansen Centre, 14 line V.O., 7, St. Petersburg, Russia*
[2]*State Hydrological Institute, 2 line V.O, 23, St. Petersburg, Russia*
[3]*Gidrotehproekt Ltd., pr. Toreza 44-2, St. Petersburg, Russia*
[4]*St. Petersburg State University, Universitetskaya nab.7-9, St. Petersburg, Russia*
[4]*Odessa State Ecological University, Lvovskaya str., 15, Odessa, Ukraine*
lyudmilaslebedeva@gmail.com

In the zone of continuous permafrost frozen ground usually acts like impermeable layer but at the territories covered by bare rocks runoff formation mechanisms are different from “normal” ones. The goal of the study was the analysis and combined modelling of ground thaw/freeze and flow formation processes in small Morozova Creek watershed (area 0.63 km2) entirely covered by bare rocks. It is located in the Upper Kolyma river basin in mountainous zone of continuous permafrost. The ground profile thaws quickly and deeply, up to the 1.5-2.5 m. During the freshet snowmelt water refreezes in upper 1-1.5 m of ground profile but never fully saturates all pore volume. The rest of the melt water and liquid precipitation percolates to frozen aquiclude and reaches the creek channel quickly forming subsurface flow. High porosity and very low water holding capacity of rock stratum prevent water accumulation in the profile.

The Hydrograph, a process-based hydrological model, was applied in this study. The model describes all components of land hydrological cycle and integrates coupled algorithms of water and heat dynamics in soil profile. Main model parameters are observable land cover properties that can be systematized according to landscapes.The parameters were derived based on literature review, measurement data and modelling experiments. Simulations of ground thawing and runoff were conducted for period of 1969–1990 with daily step for the Morozova Creek watershed. Good agreement of observed and simulated values enables to conclude that assessed model parameters and its algorithms have potential for applications in similar conditions including ungauged basins.

GEOCRYOLOGICAL CHARACTERISTICS OF THE SEDIMENT NEAR THE PERMAFROST TABLE IN THE DOWNSTREAM FLOOD PLANE OF THE INDIGIRGA RIVER, RUSSIA

G. Iwahana[1], S. Takano[2], S. Tei[2], R. Shingubara[2], T. C. Maximov[3], A. Sugimoto[2]
[1]*IARC, University of Alaska, 930 Koyukuk Dr., Fairbanks, Alaska, U.S.A.*
[2]*Graduate School of Environmental Science, Hokkaido University, N10W5 Sapporo, 060-0810 JAPAN*
[3]*Institute for Biological Problems of Cryolithozone SB RAS, 677980, 41, Lenin Ave., Yakutsk, Republic of Sakha (Yakutia)*
giwahana@alaska.edu

Information about geocryological characteristics of frozen sediment, such as ice content, cryostructure, or stable isotope ratio of included water is essential for predicting consequences of the projected permafrost thaw in response to the global warming. This information determines the extent of thermokarst and controls the hydrological regime, and hence vegetation growth, especially in areas of high latitude. It also yields knowledge about the history of changes in the hydrological regime. To obtain these fundamental data, unfrozen and frozen surface sediments from 25 boreholes down to 3-m depth at five sites near Chokurda, Russia were sampled and analyzed. Profiles of volumetric ice content in the upper permafrost have a large variation, ranging from 30 to 90%, with an average of 70%. This large amount of ground ice takes the form of ice lenses or veins, mainly due to ice segregation during the frost heave of the water-saturated and highly frost-susceptible sediment. Furthermore, networks of active or inactive ice wedges are distributed, raising the amount of ground ice at these sites. Most parts of the analyzed sediment were supersaturated with segregated ice, which will cause thermokarst when melted. From the analysis of the water stable isotope and cryostructure of the upper permafrost, a strong influence of repeated flooding on vegetation growth and plane development is suggested.

G3–P8

MONITERING OF SURFACE AND SUBSURFACE CONDITIONS IN PERMAFROST AREA AFTER WILDFIRE, ALASKA

Koichiro Harada[1], Kenji Narita[2], Kazuyuki Saito[3], Yuki Sawada[4], Go Iwahana[5], Masami Fukuda[4]

[1]*Miyagi University, Sendai 9820215, JAPAN*

[2]*Akita University, Akita 0108502, JAPAN*

[3]*JAMSTEC, Yokohama 2360001, JAPAN*

[4]*Fukuyama City University, Fukuyama 7210964, JAPAN*

[5]*University of Alaska Fairbanks, Fairbanks AK 99775-7340, USA*

E-mail address of corresponding author; Koichiro Harada: haradak@myu.ac.jp

In Seward Peninsula, western Alaska, large tundra fires burned a wide area, underlain by discontinuous permafrost, near the Kougarok River in 1971 and 2002. Fires destroyed the vegetation, and the ground surface thermal condition was altered. The objective of this research is to understand the characteristics of the post-fire variations in the permafrost distribution and condition, and the attributional changes in thermal and water conditions in active layer.

Summer field observations were conducted at both burned and unburned sites since 2005. The average thaw depth at the burned sites in 2012 was deeper by 30% than those at unburned sites. The differences in thaw depth have decreased in time, which were deeper by more than 50% in 2005. Boring surveys up to 2m depth conducted in 2012 confirmed the presence of massive ice at the both sites. It implies a possibility of thermokarst development after wildfires due to thawing of permafrost. The visible satellite image for the burned site detected white-colored areas (corresponding to growing areas of *Clamagrostis canadensis*), surrounded by green-colored areas, in which thaw depths were deeper by 60% than the surrounding areas. Values of surface roughness were also high at white-colored areas, suggesting that the ground ice has been thawing due to the change in surface thermal condition and surface subsidence. Then, by using any satellite images of areas after wildfires, in case of detection of distribution of rough surface, that area may have a deeper thaw depth and have a possibility of development of thermokarst.

G3-P9

Cancelled

G3–P10

AGE ESTIMATION OF SUPRA-PERMAFROST AND INTRA-PERMAFROST GROUNDWATER IN YAKUTSK REGION, EASTERN SIBERIA

Tetsuya Hiyama[1], Kazuyoshi Asai[2], Leonid Gagarin[3] and Alexander Kolesnikov[3]

[1] Research Institute for Humanity and Nature, Kyoto 603-8047, Japan

[2] Geo-Science Laboratory, Nagoya 468-0007, Japan

[3] Melnikov Permafrost Institute, Siberian Branch of the Russian Academy of Sciences, Yakutsk 677010, The Republic of Sakha (Yakutia), Russia

E-mail: hiyama@chikyu.ac.jp

Change in the hydrological cycles of permafrost regions is a critical issue to address given current problems caused by global warming. Better understanding of groundwater dynamics in permafrost regions is needed to assess the vulnerability of such regions to changing climate. However, not much is known about the age of groundwater in the region. To determine the groundwater age, i.e. residence time of the permafrost groundwater, hydrologic tracers including tritium, chlorofluorocarbons, and sulfur hexafluoride were used to analyze the supra-permafrost and intra-permafrost groundwater in the Yakutsk region of Eastern Siberia. Tritium concentration of a famous spring discharge “Buluus” was similar both in surface-layer frozen (early spring) season and in surface-layer thawing (summer) season. This means that Buluus spring discharge always derived from intra-permafrost groundwater mainly. Its age ranged from around 5 to 25 years old. On the contrary, tritium concentration of another spring discharge “Ulakhan-Taryn” shows lower in surface-layer frozen season and higher in surface-layer thawing season. This means Ulakhan-Taryn summer discharge was contributed from supra-permafrost groundwater in some extent. The age of intra-permafrost groundwater of Ulakhan-Taryn, which was estimated from the tritium concentration of spring discharge in the surface-layer frozen, was older than 55 years old. These differences might be related to size of reservoir, amount and thawing rate of ground-ice, and lake-talik-groundwater system of each spring discharge.

G3–P11

WESTERN AND CENTRAL SIBERIA HYDROLOGICAL CYCLE FROM SATELLITE AND IN SITU OBSERVATIONS

Zakharova E.A.[1,2], Kouraev A.V.[3,2], Kirpotin S.N[4,] Krylenko I.[5]

1) CNRS; LEGOS, F-31400 Toulouse, France
2) State Oceanography Institute, St. Petersburg branch, Russia
3) Universite de Toulouse; UPS (OMP-PCA), LEGOS, F-31400 Toulouse, France
4) Tomsk State University, Tomsk, Russia
5) Moscow State University, Moscow, Russia

In the Western and Central Siberia a multitude of interconnected natural objects - large and small rivers streams, large floodplains, lakes, bogs etc is formed. Flooded areas and bogs also act as a buffer zone, providing a dampening "sponge" effect on the water redistribution within the river system. Central Siberia and northern part of the Western Siberia are located in the permafrost zone and have dynamic thermokarst processes. Western Siberia is also influenced by human activity (construction of roads, gaz and oil pipelines etc) that affects the primary hydrological network.

We present the results of systematization and classification of landscape patterns, as well as study of variability of hydrological processes in the study region at different temporal (from multi-year to seasonal) and spatial (from local to regional) scales through a multidisciplinary approach based on *in situ* and remote sensing data. Radar altimetry, radiometry and optical satellite data are used in combination with the in situ observations and the recent field studies done in 2008-2012.

We present the variability of water level (from radar altimetry) and surface properties (from altimeter waveforms parameters) for different studied watersheds. Seasonal and interannual variability of water abundance is studied using radar altimetry and radiometry. We also analyse the role of the snow cover in the formation and seasonal distribution of runoff in the region of Poluy, Nadym, Pur and Taz rivers (Northern part of Western Siberia) by using in situ and satellite estimates of the snow water equivalent, and present results of the hydrological numerical modelling for this region.

This research has been done in the framework of the Russian-French cooperation GDRI "CAR-WET-SIB", French ANR "CLASSIQUE" and CNES TOSCA SWOT projects, Russian FZP 1.5 and FP7 MONARCH-A projects.