S2–O1

Acceleration of the arctic water cycle: evidence from the Lena Basin, Siberia

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Trends and feedbacks in arctic hydroclimatology are explored from station observations and a land surface model. Our analysis of the Lena river basin in Siberia shows canonical acceleration of the hydrologic cycle and amplification of warming, despite several apparent paradoxes. Data analysis shows that though most of warming in the Lena basin is occurring when the ground is covered by snow, increases in frozen precipitation are contributing to permafrost thawing by increasing insulation. Hydrologic baseflow is increasing due to a deepening active layer. A deeper active layer holds mode soil moisture and is leading to increasing evapotranspiration (shown in the model), increased hydrologic baseflow (modeled and observed), and increased summer cloudiness (observed). Earlier onset of snowcover in autumn traps the modest summer warming, further deepening the active layer. These observed and modeled feedbacks point to an increasingly wet Arctic.

S2–O2

RECENT VEGETATION FIRE INCIDENCE IN RUSSIA

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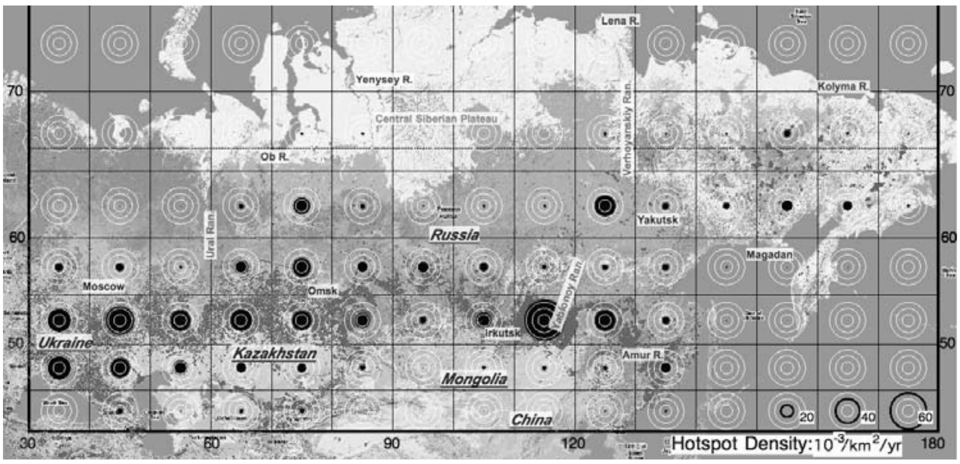
Vegetation change due to fire incidence, deforestation, cultivation and so on in Russia may have great effect on recent rapid climate change because the Russian Federation is the largest country in the world (total area: 17,075,400 km^2) and contains about 6,200,000 km^2 of boreal forest. Remote sensing is the most effective tool for large countries like Russia because it is very hard to obtain exact and detailed forest fire data. Accumulated MODIS hotspot data from 2002 to 2012 may allow us to assess recent changes in the vegetation fire incidence in Russia. Fire intensity and severity, burnt area, fire return interval, and emission of greenhouse gas such as CO_2 were estimated by using various satellite data. This paper discusses recent changes in the incidence of vegetation fires across the entire area of Russia based on analysis results of MODIS hotspot data. Firstly, Russia and its vicinity (covered area: 30-75°N, 30-180°E) were divided into 135 regions with equal intervals of 5° latitude and 10° longitude. By introducing an annual mean hotspot density measure (AMHD, number of hotspots/km^2/yr), Russian regional and seasonal fires were determined. In addition to this analysis, a detailed analysis was carried out for the Yakutsk region of Sakha using long-term weather data from 1830 to the present, recent daily weather data, hotspot data in 2002, and other data. The background to the intense fire activity near Sakha was determined by showing drought conditions and the daily changes of air temperatures.



S2–O3

VEGETATION GROWTH AND METHANE EMISSION AT TAIGA–TUNDRA BOUNDARY ECOSYSTEM IN EASTERN SIBERIA

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Recent warming is affecting the terrestrial system in Arctic region. Terrestrial system is expected to be greatly affected by warming not only through temperature rise but also degradation of permafrost system. Moisture condition caused by the change in permafrost may bring about a change in vegetation and greenhouse gas emission, then, as a result feedbacks to the global climate system. GRENE Arctic Climate Change Research Project funded by the Ministry of Education, Culture, Sports, Science and Technology, Japan, started in 2011. One of the research projects, “Change in the terrestrial ecosystem of the pan-Arctic and effects on climate”, is for terrestrial ecosystem of Arctic (GRENE-TEA).

Taiga-tundra boundary is an ecotone which is sensitive to environmental change, therefore, strong impact of warming on terrestrial system is expected. To know the response of the system, observations on vegetation (growth, photosynthesis, C and N contents and their isotope ratio, and nutrient status for larch trees) and methane dynamics with permafrost hydrological processes were conducted at taiga-tundra boundary ecosystem near Chokurdakh (70N, 148E) in eastern Siberia, Yakutka, Russia. Distribution of larch trees (dominant species) was depending on the moisture condition which reflected the topography, while, larch tree growth seemed to be controlled by radiation. Nitrogen availability may also affect the growth of larch trees. Methane emission also depended on the surface vegetation.

S2–O4

THAW LAKE EVOLUTION AND LONG TERM CARBON EMISSION FROM PERMAFROST.

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Thaw (thermokarst) lakes have attracted attention as major sources of CH_4. This source may increase as a result of climate change in the future, resulting in a positive feedback in the climate system. This interesting link between gemorphology and the carbon cycle is reviewed in this paper.

The evidence on thermokarst lake expansion is mixed, and shows stability, net contraction or expansion in various regions of the Arctic permafrost realm. The evidence may also differ with lake size: net expansion for smaller lakes and ponds, while the area of larger lakes contracts due to drainage of larger lakes. Next, evolution of lakes may differ in relation to physographic setting.

The assumption of the existence of a thaw lake cycle, that consists of a repeating cycle of lake formation by permafrost thaw, drainage of lakes and re-establishment of ice-rich permafrost, is crucial in the interpretation of lake area changes. The thaw lake cycle implies that expansion or contraction of thaw lake area may not necessarily relate to climate change. However, the existance of a thaw lake cycle is disputed.

Examples from eastern Siberia and Alaska also suggest a more complicated evolution. In the northeast Siberian lowlands, rapid lake expansion starts from existing lakes and appears restricted largely to areas with remnants of ice-rich Pleistocene permafrost. Localized pond formation appears the dominant mode of permafrost thaw. Lake expansion replaces dry terrestrial environments with CH_4 emitting lake environments.Terrestrialization mainly occurs by partial drainage after contact with rivers, resulting in integration of the lakes into the river floodplain. Talik development is probably insufficient for subsurface drainage of lakes. More complete lake drainage is likely to result only from river downcutting. Integration into the river floodplain may result in continued CH_4 emission but also carbon sequestration in sediments, complete drainage may result in a net greenhouse gas sink created by peat accumulation.

In more southerly located areas in eastern Siberia, subsurface drainage and changes in lake level by changes in precipitation and evaporation are more important. Evidence for a thaw lake cycle is absent (Pestryakova et al, 2012); most lakes originate from the Late Glacial and Early Holocene, although at present there is ample evidence of present-day lake formation and expansion.

Modeling of the evolution of thermokarst in ice-rich permafrost is still in its infancy. Hence, prediction of future lake area evolution is highly uncertain. Given the complexities of lake evolution, paleo-environmental research on lake sediment may prove to be crucial to understand past and future lake evolution and the resulting greenhouse gas emissions, and to improve existing models.

Pestryakova, L.A., Herzschuh, U., Wetterich, S., Ulrich, M 2012: Present-day variability and Holocene dynamics of permafrost-affected lakes in central Yakutia (Eastern Siberia) inferred from diatom records. Quaternary Science Reviews 51, 56-70.

S2–O5

UPSCALING OF METHANE FLUXES FROM ARCTIC WETLANDS USING PEATLAND-VU MODEL AND FOOTPRINT MODELING

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Arctic wetlands are considered to be a major natural methane (CH_4) source to the atmosphere. However, it is quite difficult to properly quantify CH_4 emissions from these areas on large scales due to high heterogeneity of vegetation cover and hydrological conditions.

We address this issue by using the process-based PEATLAND-VU model to estimate CH_4 emissions from different vegetation types and upscale them to eddy covariance scale by using Kormann & Meixner, 2001 analytical footprint model as well as high-resolution vegetation map. We then test our results against eddy covariance measurements of CH_4 collected at the Kytalyk Resource Reserve site in Russia.

Hitherto, CH_4 process models are rarely validated on ecosystem scale. Our upscaling of model results to eddy covariance scale shows that using this approach it is possible to reconstruct temporal dynamics of eddy covariance observations albeit with some mismatch. We are currently working on refinement of our method to produce more accurate comparison.

S2–O6

CH_4 AND N_2O DYNAMICS OF A *LARIX GMELINII* FOREST IN CONTINUOUS PERMAFROST REGION OF CENTRAL SIBERIA

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Methane (CH_4) and nitrous oxide (N_2O) are major greenhouse gases, and generally, forest soils are sink of CH_4 and source of N_2O. However, the climate of central Siberia is more continental than that of the other boreal forest regions because of lower temperature and smaller precipitation. To characterize of the gases dynamics in central Siberia, we measured CH_4 and N_2O fluxes from a forest soil in relation to floor vegetation types with soil temperature and moisture, the gases concentration in the soil air and river water. From the soil surface, both CH_4 uptake and emission were observed at the site. N_2O also were emitted and taken up into the soil. CH_4 flux increased with soil moisture, on the other hand, N_2O flux decreased with soil moisture. Therefore, N_2O uptake was occurred due to denitrification process. From the river water, both CH_4 and N_2O were emitted. Thus, in this region, it is considered that the forest soil acts as both source and sink of CH_4 and N_2O, however, the river acts as a source of both gases.

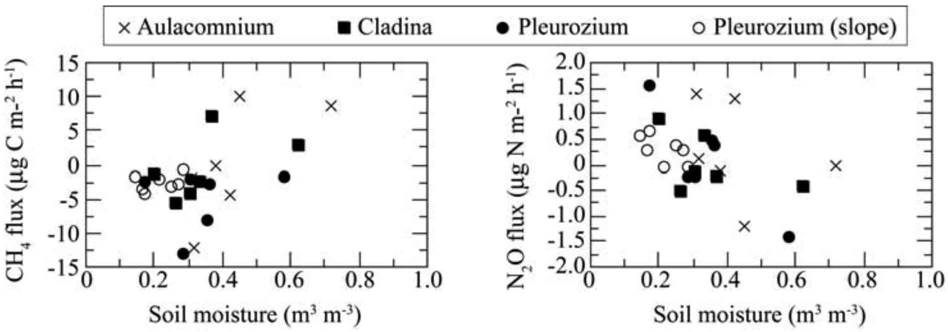

Figure Relationship between the CH_4 and N_2O flux and soil moisture.