G5–O1

CROSS-DISCIPLINARY RESEARCH COLLABORATION FOR EARLY DETECTION OF BIOLOGICAL FEEDBACKS

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To predict global climate change and its influence on ecosystems and human societies, reliable understanding of land surface - atmosphere interactions is essential. We will report current status and issues of international cross-disciplinary research collaborations focusing on early detection of biological feedbacks to climatic change. One of our urgent tasks is to develop monitoring systems for the spatial distribution and temporal variation of fluxes of energy, water, carbon and various biogenic trace gases at scales ranging from point to continental. Relevant programs and the potential of collaboration will be introduced based on Asian regional activities in international projects such as iLEAPS*, FLUXNET**, and ILTER network***.

Positive biological feedbacks include higher temperatures bringing higher emissions of GHGs (CO_2 and CH_4) and irreversible changes that may occur in vulnerable ecosystems such as permafrost and peatlands. Negative feedbacks include higher temperatures expanding the growth area of plants in arctic regions and the rising atmospheric CO_2 concentration enhancing the growth rate of plants by a fertilization effect. To detect such biological feedbacks in regional and continental scales, cross-disciplinary research collaboration helps scientists develop integrated long-term observation networks. In mid-latitudes, JapanFlux (a sub-network in FLUXNET) and JaLTER (Japan national network in ILTER) have started working together by sharing sites, data, and observational skills toward maintaining long-term comprehensive observation networks. The long-term ground observations of phenology are also expanding using spectral radiometers and camera images for verification of satellite remote sensing.

Cross-disciplinary research collaboration at integrated observations helps us develop comprehensive datasets, which accelerate the development and testing of various process-based ecosystem models. Long-term ground-truth datasets with appropriate spatial resolution will have high value for direct comparison with airborne and satellite remote sensing. The research communities growing at integrated observation platforms will also contribute to educating the next generation of scientists by bridging different disciplines.

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*iLEAPS: integrated Land Ecosystem - Atmosphere Process Study; the land-atmosphere core project of the International Geosphere-Biosphere Programme (IGBP).

**FLUXNET: The worldwide network of monitoring sites for energy, water vapor, and CO_2 fluxes over terrestrial ecosystems;. an iLEAPS recognized project.

***LTER network: International Long Term Ecological Research; an endorsed network of the Global Land Project (GLP), a joint core Project of IGBP and the International Human Dimensions Programme (IHDP).

G5–O2

LONG TERM VARIABILITY OF CARBON IN PERMAFROST-DOMINATED ECOSYSTEMS

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This report is compiled on the results of multi-year investigations conducted within the frameworks of international scientific programs in cooperation with scientists from Japan and European Union on the study of carbon and water cycles in permafrost region, as well as execution of thematic plans of the IBPC SB RAS.

For the first time in the conditions of Eastern Siberia an attempt has been made to ground the photosynthetic productivity of plants in terms of physiology, and quantitative parameters of the productive process were obtained. Original data on sink-source system of plants are stated at the levels of whole plant organism and community. A number of specific results have been got: 1) conclusion was made about high depositing role of the root system of high latitude plants; 2) micrometeorological estimates of carbon balance were done; 3) quantitative dependence of CO_2 concentration on the season period, weather condition and forest fire intensity was shown; 4) carbon parameters of forest and tundra ecosystems were investigated; 5) attention was drawn to short vegetative period of plant development – this feature contributes to enrichment of the atmosphere of high latitudes by carbon dioxide.

The growth of plant species in Eastern Siberia during growing season is provided by high rates of photosynthesis and transpiration at relatively low dark expenses on respiration and maintenance. High inter annual variability of photosynthesis and dark respiration testifies to high adaptability of plants to the specific conditions of cryolithozone.

The productive process of plant species in Eastern Siberia is limited both by endogenous (stomatal conductance) and exogenous (provision with moisture and nutrients, nitrogen specifically) factors.

Permafrost forest and tundra ecosystems at present are estimated by carbon budget as areas of significant carbon sink. However, under predicted climate warming, their functions as carbon absorbers will essentially depend on the result of coordination of antagonistic processes: 1) increasing of carbon accumulation owing to prolonged vegetative period and elevated summer air temperatures; 2) frequency raise of forest fires that result in increased carbon dioxide emission into the atmosphere.

G5–O3

ESTIMATING LARGE SCALE, REGIONAL, NET CO_2 AND CH_4 FLUXES USING NESTED TOWER, AIRCRAFT FLUX, REMOTE SENSING, AND MODELING APPROACHES

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Estimating current and predicting future greenhouse gas fluxes from the Arctic is of great importance but is also exceedingly difficult. In addition to remote locations, logistic limitations, and difficult environmental conditions, especially during non-summer periods, landscape heterogeneity make measuring, quantifying, and modeling greenhouse gas fluxes challenging. Here we investigate some of the implications of landscape heterogeneity on GHG fluxes in the Arctic, and consider how these can be measured and scaled to better inform current and future generations of land surface models dealing with arctic regions. Landscape heterogeneity and microtopography affect processes that control CO_2 and CH_4 fluxes in a non-linear fashion. It is therefore currently not possible to describe, "average conditions" or "average responses" to a change in temperature or moisture for a region of the Arctic that adequately describes current or predicts future fluxes. A combination of measurements from plot to aircraft scales and nested models can be used to evaluate current understanding and develop new algorithms for the next generation of LSM for Arctic areas.

G5-O4

Cancelled

G5–O5

Impact of Climate Change on ecosystem functioning and GHG emission in Arctic tundra across multiple scales

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Arctic tundra ecosystem present a large level of heterogeneity, in terms of species composition, micro-topography, and greenhouse gas (GHG) emission. In particular, GHG emission (CH_4 and CO_2) may double even in the meter scale, making very challenging to scale up these fluxes to the regional and global scale. On the other hand, another challenge may arise from understating if these large scale investigations allow us to understand the response of arctic ecosystems to climate change. In this presentation I will introduce some of these important issues and describe the results from several years of research in the Arctic tundra in Alaska, and the challenges that I am planning to address with my future research.

G5–O6

REMOTE SENSING OF DECIDUOUS SHRUBS AND PHYTOMASS IN ALASKAN ARCTIC TUNDRA

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The relationships among spectral indices, phytomass, and plant functional types were determined through field observations of moist acidic tundra (MAT), moist non-acidic tundra (MNT), and heath tundra (HTT) in the Toolik Lake Long Term Ecological Research (LTER) site and sedge-shrub tundra (SST) in the Arctic National Wildlife Refuge (ANWR), Alaska, USA. For MAT, MNT, and HTT, among aboveground phytomass, aboveground vascular phytomass, and vascular plant green phytomass, the last showed the best fit to an exponential function of the normalized difference vegetation index (NDVI). Overall, the vascular plant green phytomass was more strongly correlated to exponential functions of NDVI and two-band enhanced vegetation index (EVI2) (The coefficients of determination (R^2) of 0.59 and 0.57, respectively) than to the other spectral indices. On the other hand, for deciduous shrub green phytomass, the strongest correlation was with the product of an exponential function of EVI2 and a spectral index (B+G–R)/(B+G+R) (DSI, R^2 of 0.66). Here, B, G, and R denote the blue, green, and red bands, respectively. Results offer empirical evidence that a new spectral index DSI provides the distributions of deciduous-shrub and leaf carbon and nitrogen turnovers, which influences on the interactions between the tundra ecosystems and the atmosphere.

G5–O7

The climatic effect to North Eurasia ecosystems. Analysis of 30-years satellite data

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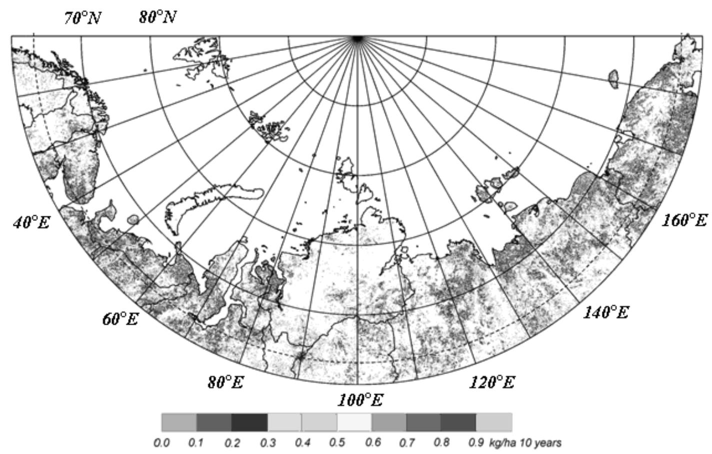
The temporal series of satellite images NOAA-AVHRR (1982-2006 years period, 15 days periodicity), SPOT-Vegetation (1998-2004 years, 10 days periodicity), Terra-MODIS (2000-2009 years, 16 days periodicity), Landsat (1973-2010 years, episodically) were used for selection of statistically significant trends of natural positive and negative dynamics of vegetation production. The selected plots of North-Europe Russia were investigated by geobotanical and aerovisual methods then. The increasing of vegetation community's biomass was mainly related with growing amount and biomass of shrubs in areas with constant permafrost soils. On basis of comparable analyses of time-series satellite data was developed technology for quantitative estimation of features of vegetation in model area (carbon accumulation, projective chlorophyll content, biomass, productivity). Estimation of seasonal changes of parameters of native vegetation for years of first decade of 2000 demonstrate more stable level of variations for area then early supposed. The trend of increasing of aboveground green biomass in this regions is near 7-30 kgC*ha per year $^{-1}$. The investigation was supported by program of scientific research of UrD RAS «Reaction of cryolithozone ecosystems of European North and west Siberia to climatic fluctuation» (*12-C-4-1018*).



The model of intensity of projective chlorophyll dynamic changes in vegetation for North Eurasia for 2000-2011. The MODIS satellite data.

G5–O8

Ground-truth for satellite observation by performing daily field studies in an open-canopy black spruce forest in Alaska and a closed-canopy evergreen coniferous forest in Japan

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Evergreen coniferous forests are widely found across cool-temperate and boreal regions, and accurate *in site* and satellite observations of the spatio-temporal dynamics of such forests are required to evaluate the carbon, water, and energy balances under global climate changes. Recent studies identify that daily digital photographs are useful to evaluate relationships among phenology, gross primarily productivity (GPP) and meteorological parameters, and to obtain ground-truth of satellite observations. In this study, we examined the characteristics of relationship between seasonal patterns of red, green and blue digital numbers extracted from daily canopy surface images, eddy-covariance-based GPP and satellite-observed vegetation indices by performing field studies in an open-canopy black spruce forest in Alaska and a closed-canopy cedar forest in Japan. Although the ratio of green digital number to total digital numbers, green excess index (GEI) and one of image characteristic index; hue (in HSV colour model) showed the bell-shaped seasonal patterns as well as GPP at both sites, canopy surface images at an open-canopy black spruce forest and a closed-canopy cedar forest mainly detected the seasonal changes of forest floor vegetation and tree canopy, respectively. In contrast, the different seasonal patterns of the ratios of red and blue digital numbers to total digital numbers and satellite-observed vegetation indices were shown between two sites. They might be caused by different characteristics of forest structure and leaf colour change on canopy surface. These facts suggest that characteristics of forest structure such as a degree of canopy openness and seasonal changes on forest floor should be considered to continuously observe phenology in evergreen coniferous forests by using near-surface and/or satellite remote sensing techniques.