G5-P1

Cancelled

G5–P2

SOIL CARBON FLUX IN BLACK SPRUCE FOREST AFTER FOREST FIRE, INTERIOR ALASKA

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Northern boreal forests represent approximately 35% of the world's forest and contain ca. 66% of the world's forest soil carbon pools. Because boreal forests uptake atmospheric carbon dioxide and slowly decompose litter, fibric and humic substances, the ecosystems are known as carbon sinks. Forest fire is a major disturbance in boreal forests, with its occurrence closely coupled to climate patterns, resulting in changes in Arctic climate. Here, we present soil carbon efflux in burned black spruce forest with the succession on after 2004 forest fire that is the most severe damaged year. After 5 years, we have measured soil carbon efflux using automated chamber system that consists of 6 chambers (each three transparent- and opaque-material), controller included data-logger, 12 solenoid valves and pump, and thermocouples. Common hair moss (*Polytrichum commune*) grew natural plant after the fire. The NPP (net primary productivity), Re (ecosystem respiration) and GPP (gross primary productivity; GPP = Re - NPP) of the moss was measured using transparent- and opaque-material chambers, which mean NEE, Re and GPP were -0.03±1.19, 1.09±0.71, and 1.12±1.51 μgC/m^2/sec, respectively. Mean microbial respiration after the fire 0.78±0.41 μgC/m^2/sec, averaged four chambers in no plants from August to October of 2009. These carbon fluxes have exponential correlations to temperature, indicating the Q_{10} values on temperature of air, soil 5 cm and 10 cm below the surface were 1.66, 2.73, and 3.23, respectively. NEP (net ecosystem productivity) of Common hair moss was roughly -0.81μgC/m^2/sec, suggesting the losing carbon of 3.15 gC/m^2 for 45-day. This data will compare with NEP by eddy covariance tower.

G5–P3

CRYOSPHERICAL COHESIVE REGIONS AS TERRESTRIAL RESEARCH IN ALASKA FOR A COLLABORATIVE FRAMEWORK BETWEEN JAMSTEC AND IARC

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JAMSTEC-IARC Collaboration Study (JICS) is planned as a five-year project from 2009 JFY through 2013 JFY. Our approach has been to carefully examine the ongoing physical and biological processes and determine the underlying drivers and inherent linkages among system components. Research has been conducted to understand multi-scale interactions in the Arctic system, to quantify the impact of observing system components, and to utilize observations in tests and validation experiments for modeling and remote sensing. Providing the observation tower in the JICS supersite located to the north of Fairbanks, Alaska, is expected to contribute to a base for understanding terrestrial processes and variation on a mesoscale. Simultaneously, regional field surveys have been carried out at selected areas in Alaska. This paper introduces investigations related to the regional field surveys in Alaska.

Regarding ecosystem research, the above-ground biomass (AGB) of 29 forests along the south-north transect which profiles from boreal forest to tundra in Alaska was measured to construct the estimation algorithm of forest AGB by ALOS/PALSAR data. In some forests, temporal biomass changes have been monitored. Regarding permafrost research, physical properties of the surface and sub-surface have been measured at the interior (taiga), western (tundra) and southern (maritime) coastal sites. Large variations were found in near-surface soil thermal and hydrologic regime across short distances, with wet troughs experiencing freeze-up about a month later that the dry and exposed rims. The climatic gradient of soil and snow property that will be used in large-scale climate models has been surveyed by *in-situ* measurements and by lab analysis. Regarding snow cover research, snow surveys have been continuously carried out and several time-lapse cameras were installed in a longitudinal section of Alaska. A blowing snow sensor was installed at the northern tundra site. In addition, a physically based snow-atmosphere-ground-vegetation model has been developed, with inclusion of blowing snow processes. Regarding greenhouse gas research, diurnal and seasonal variations of floor CO_2 exchange in the interior taiga site have been continuously measured. A process-based terrestrial ecosystem model simulated greenhouse gas budget of northern terrestrial ecosystems, daily soil respiration, and global distribution of annual CH_4 emission from wetlands and paddy fields. Regarding hydrological research, a coupled hydrological and biogeochemical model (CHANGE) simulated inter-annual variations of hydrological processes over the pan-Arctic. A seesaw pattern in interannual variations of active layer thickness (ALT) was found between Lena and Mackenzie basins, which was significant when the Arctic air temperature entered into a warming phase, implicated with changing snow cover and soil moisture. While it is widely believed that ALT will increase with global warming, this hypothesis may need modification because the ALT shows responses to variations in snow depth and soil moisture that can over-ride the effect of air temperature.

It is necessary for systematic framework to improve understanding of linkages and feedbacks among Arctic climate system components on a mesoscale to a synoptic scale in future, in addition to further continuous data collection and analysis.

G5–P4

THE JAMSTEC-IARC SUPERSITE ENHANCES UNDERSTANDING OF THE ARCTIC CLIMATE SYSTEM – BIOGEOCHEMICAL OBSERVATIONS –

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Under the JAMSTEC-IARC Collaboration Study (JICS), the supersite was established in the Poker Flat Research Range (PFRR) of the University of Alaska Fairbanks in 2010, and observations on biogeochemical studies in the black spruce forest have been intensely carried out in addition to observations for hydro-meteorological studies. This paper introduces biogeochemical observations which are being taken place at the JICS supersite in PFRR.

Tree census survey was conducted at the 30m x 30m quadrat of the black spruce forest near the JICS tower in July 2010 to delineate the forest structure. The result of the census survey clarified that the density of tree stand (over 1.3m) was 3967 tree ha^{-1}. Also we cut down 16 trees in the forest in August 2012, and made the allometry equation for the estimation of the leaf area index and the above-ground biomass of black spruce tree. The forest landscape is always being monitored by the automatic digital fisheye camera installed on the top of the 17m JICS tower with 3 hours interval. Those pictures by the camera provide us valuable ideas to interpret the satellite data that show the seasonal change. The floor-level carbon dynamics are monitored with the automated open/close chamber (AOCC) system that has 16 chambers in the forest. By combining the floor-level flux data with the atmosphere-level flux data measured at the tower, the roles of forest canopy and floor in gas exchanges will be elucidated.

These biogeochemical observations are integrated with the hydro-meteorological observations of the supersite, and the data will be utilized for various studies included the study of biogeochemical modeling such as Vegetation Integrative Simulator for Trace Gases (VISIT). Moreover the knowledge and understandings which are created based on the supersite observations will substantially enhance the study on Arctic climate system.

Black spruce forest in the JICS supersite viewed from the top of the 17m JICS tower (July 2010).

G5–P5

THE JAMSTEC-IARC SUPERSITE ENHANCES UNDERSTANDING OF THE ARCTIC CLIMATE SYSTEM – HYDRO-METEOROLOGICAL OBSERVATIONS –

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As the key observational resource of the JAMSTEC-IARC Collaboration Study (JICS), a supersite was established in 2010 in a permafrost black spruce forest at the Poker Flat Research Range (PFRR) of the University of Alaska, located in Interior Alaska. A 17-m scaffold tower was built to conduct the hydro-meteorological and biogeochemical observations, including detailed remote sensing studies for estimations of the biomass of black spruce trees. Here, we introduce the hydro-meteorological observations.

To clarify characteristics of the energy, water, and carbon balance in this forest, sensible and latent heat flux and CO_2 flux were observed above the canopy and on the forest floor. Sensible and latent heat flux at both levels were nearly the same. Considering the footprint of the forest floor measurements, the contribution of the forest floor to the total evapotranspiration was suggested to be dominant in this forest. Energy balance was almost closed in early summer, and the mean energy balance ratio was 86.5 % over the whole summer, though a large energy balance deficit was observed in the spring. This deficit was explained by the energy consumed by snowmelt. The decoupling coefficient was very small, and the mean value was 0.06 in summer. Thus, evapotranspiration from this forest is mostly explained by the component from the dryness of the air, which results from the aerodynamically rough surface of this forest.

In order to evaluate the hydro-climatic and glaciological processes, snow depth, precipitation, snow and soil temperatures, soil moisture, and time-lapse imagery were all continuously monitored. Recently, snow pillow measurement began. A distributed temperature sensing (DTS) system with fiber optics monitors spatially continuous temperature. The obtained knowledge will be utilized by the Coupled Hydrological and Biogeochemical Model (CHANGE) and other models for the Pan-Arctic terrestrial region.

ENVIRONMENTAL QUALITY MONITORING OF BIODIVERSITY WITHIN CRYOLITHOZONE OF THE SAKHA REPUBLIC (YAKUTIA) IN THE CONDITIONS OF ECONOMIC USE AND GLOBAL CLIMATE CHANGE

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Today the Sakha Republic (Yakutia) establishes its own network of ecological monitoring because there is not any biosphere nature reserve over the spacious territory of the republic. It includes the network of hydrometeorological stations under Rosgidromet and observation stations belonging to the system of the Ministry of Nature protection of the Republic. In 2008 a public institution “Republican Information Analytical Center of Ecological Monitoring” was organized under the auspices of the MNP SR(Ya). There are also polygons performing their activity in Sakha affiliated to the Permafrost Institute SB RAS on monitoring concerning the state of permafrost grounds, to the Institute of Cosmic Research and Aeronomy SB RAS on monitoring of solar-terrestrial relation, space weather, thunderstorm activity and condition of works and spread of forest fires, to the Institute for Biological Problems of Cryolithozone SB RAS on monitoring of greenhouse effect, carbon emission, photosynthetic intensity, structure and functioning of subarctic, mountain and alas-taiga ecosystems. There are 2 state nature reserves and a lot of specially protected natural territories under the status of the Republic, which perform their activity on the ecological monitoring over their territories. Though functioning all these departments are not integrated in one unit with unified objectives and tasks, this network is not complex in full sense, so monitoring of many environmental parameters is conducted by different offices and institutions independently without due interaction with each other.

Since 2004 through 2007 the IBPC SB RAS was performing research in the Framework Programs of the joint academic council on life sciences on the project “Create a united network of complex ecological monitoring on biodiversity of frozen ecosystems over the model territories of Yakutia boreal forests, tundra and forest-tundra”. By the combined efforts of the institutes working in the system of the Yakut Science Center SB RAS and participation of the foreign partnership serious investigations of the theoretical principals of methodology and practice on ecological monitoring in Yakutia are carried out. Monitoring on the state of rare and endangered animal and plant species is held, activity related to their conservation and restoration in number are developed, more and more remote aerospace techniques of research of the animal habitats, satellite location of animals during their migration are applied. Financial maintenance of the foreign partnership contributes to setting up a network of field stations and polygons to perform long-term studies of ecosystems’ state and development of the methods for optimization of biological resources management in the national economy. Some field stations are fitted with specific scientific equipment and devices and join in the World Network of stations on ecological monitoring. On a monitoring network basis existed before and mainly owing to the previously implemented work realization of a real complex ecological monitoring with collaboration of research institutes Siberian Branch RAS, other research institutions of the Republic, Yakut State University, Ministry of Nature Protection and other interested bodies of Sakha is feasible. All data received will be used at the economical development of the region with consideration of strategy and tactics of management of the natural resources according to the National strategy of biological diversity preservation in Russia.

PHOTOSYNTHESIS OF *LARIX LARICINA* IN NORTHERN CANADA PERMAFROST AREA

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Photosynthesis of larch (*Larix laricina*) in North Canadian permafrost area was investigated during a week and compared with that of *Larix cajanderi* growing in permafrost boreal forest of Yakutia, Siberia, Russia.

Daily dynamics curves of net-photosynthesis (*A*) were bell-shaped, with maxima falling within 9-12 a.m. and the magnitudes of 4-5 μmoles m^{-2} s^{-1} that is at lower boundary of the range for *L.cajanderi*. Daily courses of respiration taking place in darkness (R_{dark}) were reverse parabolic with maxima mainly within 2-5 p.m. of up to -4 (mean -1.7) μmoles m^{-2} s^{-1}. R_{dark} in common was 50% of *A* at early morning, 11-32% at *A* pre-midday peak, and reaching 50% at evening. Considering available respiration data for *L.cajanderi*, R_{dark} patterns of the both species do not differ much.

The points of *A* light saturation and compensation were 950 and 106 μmoles m^{-2} s^{-1} respectively that are nearly threefold of *L.cajanderi* in Yakutia, probably reflecting high demand for radiation.

CO_2-saturated maximal *A* of *L.laricina* was quite low and made only 10-11 μmoles m^{-2} s^{-1}, that of *L.cajanderi* varying from 21 to 32.

Analysis on maximal carboxylation efficiency (Vc_{max}) and electron transport (J_{max}) rates revealed very low magnitudes of 16 and 50 μmoles m^{-2} s^{-1} respectively that are 2-3 times lesser than those of *L.cajanderi*. The J_{max} to Vc_{max} ratio of 3.2, on the contrary, is quite high (at usual 2-2.7 for the majority of plants), which is the case for Yakutian larch as well.

Collectively, photosynthetic data suggest that *L.laricina* in Northern Canada, being clearly different in morphology and in growing conditions from *L.cajanderi* in Yakutia, shows rather similar photosynthetic activity, except obscure light and biochemical parameters that could be a result of short-term measurements.

G5–P8

METHANE AND NITROUS OXIDE EXCHANGES BY DROPPINGS OF SVALBARD REINDEER ORIGINATED FROM WINTER FOOD

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Svalbard reindeer (*Rangifer tarandus platyrhynchus*) affects the carbon (C) and nitrogen (N) cycles in the tundra ecosystem through their activities such as grazing, scratching, and excretion. Droppings of reindeer, rich in organic matters, are also involved in the C and N cycles and might have a role in the atmosphere-land exchanges of methane (CH_4) and nitrous oxide (N_2O). The present study aimed to quantify the exchange potentials of CH_4 and N_2O for droppings of reindeer and/or soil. Droppings of reindeer originated from the last winter diet, which had a shape of pellets with blackish color, were collected at a site near Ny-Ålesund. Subsoil of regosols excluding the surface crust was also collected in the same area. The exchange potentials of CH_4 and N_2O were measured by an incubation experiment for two weeks using polyethylene bottles with the collected droppings and soils. The soil properties are: texture, sandy loam; soil pH, 7.6; total C, 1.72%; total N, 0.097%; CN ratio, 17.8; ammonium, 0.52 mg N kg^{-1}; nitrate, 0.081 mg N kg^{-1}. Those of the droppings are: total C, 42.1%; total N, 1.24%; CN ratio, 33.8; ammonium, 30.3 mg N kg^{-1}; nitrate, 0.053 mg N kg^{-1}. Treatments were soil only or soil with droppings (900-930 g dry matter m^{-2}) in combination with three moisture conditions for soil, i.e., no water addition; 15% of water content; and 25% of water content (n = 5). The incubation bottles were normally opened, and were closed when measuring the fluxes. The sample air was collected using a syringe at 1 and 30 minutes, in principle, after the closure of the bottles. The fluxes of CH_4 and N_2O were calculated using the determined air concentrations and mass balance in conjunction with the air pressure, air temperature, volume of bottle, and area of soil surface. Figure 1 shows an example of the results, where N_2O emission occurred just after the beginning of the incubation for the treatment with droppings. In general, tendencies of absorption and emission were found for CH_4 and N_2O, respectively.

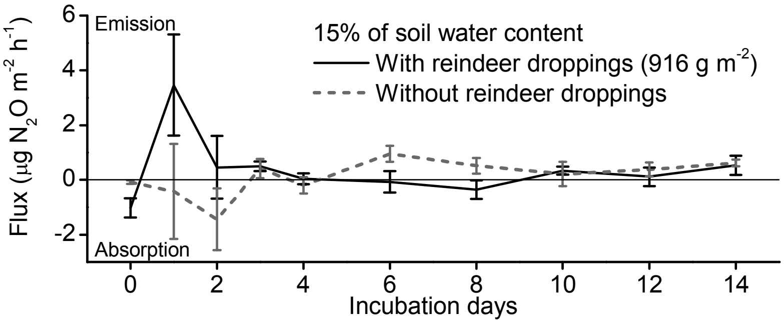

Fig. 1 Exchange flux of N_2O. The bars denote the standard error (n = 5).

G5–P9

CHEMICAL CHANGES AND FUNGAL COLONIZATION OF *SALIX ARCTICA* LEAF AND STEM LITTER ON DEGLACIATED MORAINES IN HIGH-ARCTIC CANADA

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Relationships between chemical changes in decomposing leaf and stem litter of *Salix arctica* and fungal colonization were examined in arctic tundra, located within the proglacial field of the southern front of Arklio Glacier in the Kreiger Mountains near Oobloyah Bay, Ellesmere Island, Nunavut, Canada. Samples were collected in 2003 from five glacial moraines with different development periods since the Last Glacial, the order of establishment of which is apparent based on the distance from the glacier snout and the moraines (Osono et al. 2012). Samples of dead leaves and stems were divided into three and five decay classes, respectively, using visual criteria and used for chemical analysis, hyphal length estimation, and fungal isolation. Contents of acid unhydrolyzable residues, extractives, and C varied significantly with the moraine and the decay class of both leaves and stems. Contents of total carbohydrates, N, P, K, Ca, Mg, C/N ratio, and $\delta^{15}N$ varied significantly with either the moraine or decay class in leaves or stems. Total hyphal length ranged from 673 to 9470 m/g dry material in leaves and from 537 to 4404 m/g for stems and varied significantly with the decay class in leaves and stems. Four morphotaxa were frequently isolated from leaves and stems, and frequencies of occurrence of two morphotaxa varied significantly with the decay class. Total hyphal length and frequencies of fungal morphotaxa significantly correlated with contents of acid-unhydrolyzable residue, total carbohydrates, extractives, N, P, K, Ca, Mg, C/N ratio, and/or $\delta^{15}N$ in leaves and stems, suggesting organic chemical and nutritional controls on fungal colonization.

Osono, T., Ueno, T., Uchida, M., Kanda, H., 2012. Abundance and diversity of fungi in relation to chemical changes in arctic moss profiles. Polar Sci. 6, 121-131.

G5–P10

The relationship between plant and soil bacterial community in tundra soil, Alaska

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Permafrost affected soil in Alaska contains large amount of organic carbon due to high moisture content and low temperature. Increased temperature by warming maystimulate biological activity and carbon decomposition in Alaska as well as other permafrost affected area. As the first step to understand biological components in this permafrost affected soil, we studied spatial distribution of soil bacteria and plant community and their relationships with soil properties. Here, we asked the question: 1) which kinds of plants are dominant, 2) the dominant plants affect to the bacterial communities structure? and 3) which environmental factors affect to the plant and bacterial community structure? To answer these questions, we surveyed plant cover using quadrate (30 cm x 30 cm) at 36 points (25 m interval between points) and the soil bacterial community structure using 16S rRNA gene pyrosequencing. Generally, Cotton grass (tussock), blue berry and moss are dominant. Bacterial communities showed difference between up (surface-10 cm) and down layer (10-20 cm) of soil as showing Alpha-proteobacteria is dominant in up layer, whereas Acidobacteria and Actinobacteria are dominant in down layer. The most abundant OTUs (operational taxonomic units), Bradyrhizobiaceae sp. and Rhizobialse sp., abundant in both layer. The statistical analyses for observing the relationships between soil properties and plant and bacterial community are now processing.

G5–P11

PERMAFROST DEPTH, FOREST FLOOR, AND FOREST BIOMASS ACCUMULATION OF UPLAND BLACK SPRUCE STANDS IN INTERIOR ALASKA

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Black spruce (Picea mariana) stands are widely distributed in Interior Alaska, both on the bottom flat land and on the north-facing upland slope topography. These habitats are quite different in terms of soil parent materials, soil moisture condition, and successional trajectories characterized by ground flora species composition. The north-facing slope, on which mature black spruce stands dominate, is accompanied by underlying permafrost. We selected a ca. two-kilometer long north-facing slope toposequence, including lower to upper slope extending to crest flat topography in Caribou Poker Creek Research Watershed (CPCRW). Soil profile survey and soil penetration test for permafrost table detection, Tree census of diameter at breast height and tree height were measured at seven sites. Soils were classified into Gelisol order, Typic Haplorthels. Active layer thickness (permafrost depth in growing season) varied much among the profiles, ranging from 40 to 120 cm. Permafrost depth was deeper in the upper position of the slope, and the deepest near the crest flat position. The shallowest active layer depth was recorded at the lower position near foot slope. All profiles were covered with thick moss-lichen layer, with ranging from 20 to 35 cm thickness. Species composition of forest floor vegetation under mature black spruce forest is one of suitable indicator showing moisture condition. Forest floor of moss-lichen complex showed typical species replacement along the moisture gradient. The most prevailing moss species under mesic water condition were Hylocomium splendens, Pleurozium schreberi and Ptilium crista-castrensis. Sphagnum moss was not dominated in the mesic condition. The growth of annual stem length of Hylocomium splendens were measured along the slope. Hylocomium population grown at upper site showed longer annual growth than lower ones during recent five years. According to census data and allometric relationship, the larger C accumulation in plant biomass more than 60 Mg C ha^{-1} occurred at upper position of the slope. Carbon accumulation in plants less than 10 Mg C ha^{-1} occurred at three stands located on lower position of the slope. The smallest value of C accumulation in plant biomass was 5.3 Mg C ha^{-1}. Carbon accumulation in plant biomass at the upper position is nearly ten times larger than that of the lower position of the slope.

G5–P12

ESTIMATION OF C LOSS BY FIRE IN A BURNED BLACK SPRUCE FOREST IN INTERIOR ALASKA USING RADIOCARBON.

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Carbon loss from forest floor/top soil by wildfire was estimated at a burned boreal forest site in Interior Alaska, using radiocarbon ($\Delta^{14}C$). By comparing organic C storage and radiocarbon profile at burned forest with those of a mature forest, we estimated C loss from forest floor/top soil. Soil profiles were surveyed at the mature black spruce forest in University of Alaska Fairbanks, and the burned black spruce forest in Poker Flat Research Range, which burned in 2004 summer. The $\Delta^{14}C$ profiles at the mature forest show clear bomb ^{14}C peak after 1960's, and plant litter and soil organic C at top of the 15cm was fixed over the past 50 years. Burned boreal forest site were similar $\Delta^{14}C$ profiles to the mature forest, but top of 10cm was lost. Organic carbon storage in each forest was estimated by bulk density and C contents. Decline of carbon storage after wildfire was estimated, assuming that C storage in the mature forest were same regime of C storage as burned stands before wildfire. Compare with mature forest, 4.4 kg C m^{-2} was lost. Wildfire disturbance in 2004 caused much C loss from forest floor, corresponding to 53% of accumulated C over the past 50 years.

G5–P13

RESPONSE OF ECOSYSTEM CARBON CYCLE TO CLIMATE CHANGE IN A GLACIER FORELAND OF THE HIGH ARCTIC

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Global circulation models predict warming and increased precipitation in Arctic regions throughout the 21st century. Since large amounts of organic matter accumulate in soils, we need to know how carbon flows in the Arctic terrestrial ecosystem will respond to projected climate change. In this study, we construct a process-based model for simulating stand-level photosynthesis, root respiration and heterotrophic respiration at Svalbard in the High Arctic. Using this model, responses of net ecosystem production (NEP) to temperature and precipitation increases and to lengthening of growing season are examined.

The study site was in the glacier foreland of Austre Brøggerbreen near Ny-Ålesund in Svalbard. A mixed community of *Salix polaris* and the moss *Sanionia uncinata* was selected for study, because it is the dominant vegetation of the late successional stage of the glacier foreland. The model was composed of six carbon pools: aboveground and belowground biomasses of vascular plants, biomass of cryptogams, organic layers of vascular plants and cryptogams, and mineral soil layer. Responses of each carbon flow to environmental factors were expressed by functions determined in previous studies (Nakatsubo et al. 1998; Muraoka et al. 2002; Uchida et al. 2002; Bekku et al. 2003).

To evaluate model calculations and determine model coefficients, we selected three study plots (A, B, C) with different coverages of *S. polaris* in the glacier foreland. In the 2001 summer season, NEP was measured in these plots using a portable photosynthesis system with an assimilation chamber. Carbon pools in each plot were investigated after this measurement.

In situ NEP values in the growing season varied widely among the three plots, ranging from 17 to 110 mg CO_2-C m^{-2} h^{-1}. Seasonal variation within a plot was also considerable, but there was close correlation between model-estimated values and those determined in the field. This shows that the model effectively simulates NEP in the growing season at the plot level.

We used the model to examine NEP response to temperature, precipitation and lengthening of the growing season. Effects of temperature increases of +2°C, +4°C and +6°C on NEP were calculated. It was shown that NEP decreases rapidly with increasing temperature. In two of the three plots, NEP became a CO_2 source to the atmosphere with an increase by 2°C. All three plots became such a source with a 4°C increase. The effect of precipitation increase was examined by 5, 10 and 15% increases. Our result suggests that this effect on NEP was extremely small. On the other hand, lengthening the foliage period of *S. polaris* significantly increased NEP, partially compensating the negative effect of temperature increase.