Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P01 Room:Poster Time:April 30 18:15-19:30

Sea ice and ocean primary production and phenology in the Arctic Ocean

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In the Arctic Ocean, both phytoplankton and sea ice algae are important contributors to primary production and the arctic food web. We use a coupled ice algal and pelagic ecosystem model embedded in the global physical model POP-CICE (Parallel Ocean Program- Los Alamos Sea Ice Model) to study the ecosystem response to climate changes. The model results showed a mean seasonal cycle of ice algal production from March to May and subsequent ocean production from May to September in the Arctic. The ice algal production, although smaller than that of the ocean, is of ecological importance as a food source for higher trophic levels during the long arctic winter before ice melt. The simulated mean open-ocean upper 100m primary production within the Arctic Circle was 413 Tg C/yrin the years 1998 to 2006, close to the remote sensing derived estimate of 419 Tg C /yr but with higher interannual variations. The mean sea ice algal production in the Northern Hemisphere from 1998 to 2007 was 21.3 Tg C/yr, which is in the range of multi-observational estimations of 9 to 73 Tg C/yr based on in situ measurements. Arctic organisms are adapted to the strong seasonality of environmental forcing. Climate warming causes shrinking ice coverage and earlier ice retreat in the Arctic, which is likely to change the timing of primary production. Using a synthesis of available satellite observation data and the coupled ice-ocean ecosystem model, we found that, over a large portion of the Arctic marginal seas, the timing variability of ice retreat at a specific location has a strong impact on the timing variability of pelagic phytoplankton peaks but weak or no impact on the timing of ice-algae blooms in those regions. The model predicts latitudinal and regional differences in the timing of ice algae biomass peak (varying from April to May) and the time lags between ice algae and pelagic phytoplankton peaks (varying from 45 to 90 days). The correlation between the time lag and ice retreat is significant in areas where ice retreat has no significant impact on ice-algae peak timing, suggesting that changes in pelagic phytoplankton peak timing control the variability of time lags. Phenological variability of primary production is likely to have consequences for higher trophic levels, particularly for the zooplankton grazers, whose main food source is composed of the dually pulsed algae production of the Arctic.

Keywords: Arctic Ocean, primary production, phenology, sea ice algae, phytoplankton

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P02 Room:Poster Time:April 30 18:15-19:30

The effect of meteorological condition on energy and carbon budget on taiga-tundra boundary in North-eastern Siberia

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1. Introduction

In Arctic, temperature has increased almost twice the global average rate in the past 100 years. We aim to clarify the land-atmosphere interaction over the boundary between taiga and tundra in northeastern Siberia, where the climate change effect might be remarkable. We have started the energy, water and carbon fluxes observation as well as hydro-meteorological observation in northeastern Siberia, Sakha Republic, Russia in June 2013.

2. Material and methods

Our observation site is located at Kodack site (70.564 N, 148.267E, altitude 7m) about 100km south from East Siberian Sea in Arctic Ocean near Chokurdakh city in the North-Eastern Siberia, Sakha Republic, Russia. The Kodack site is belong to Indigirka river basin (drainage area: 324,244km^2) which flow to the East Siberian Sea. The annual air temperature and precipitation are -13.4 deg. C and 200mm respectively (1979-2008, Baseline Meteorological Data in Siberia (BMDS) Ver.5.0, Yabuki et al., 2011). The surface is covered by snow except July and August and the maximum snow depth is 40cm in April. In this region, the permafrost exits and the active layer depth ranges from 25cm to 40cm (van der Molen et al., 2007). The topography at the site consists of higher mounds and lower wet lands, where the difference of the height are about 50cm. At the higher mound, the shrubs and larches are dominant, while the sphagnum are prevailing at the lower wet land. The meteorological and flux observation has been carried out over the mound area.

The air temperature, relative humidity, wind speed and direction, air pressure, precipitation were observed at 1.5m height. The incoming and outgoing shortwave and longwave radiation were observed by 4-compnent radiometer at 1.37m height. The soil heat flux was observed by heat flux plate at 0.05m depth. The soil temperature was observed by platinum sensor at depths of 0.025, 0.05, 0.225, 0.425, and 0.625 m. The soil moisture was observed by capacitance sensor and frequency domain reflectometry sensor at depths of 0.035, 0.145, 0.335, and 0.535 m. The energy and carbon fluxes were calculated by the eddy covariance method from the observed values of the sonic anemo-thermometer at 2.55m height.

3. Results

The analysis results from 23 June to 27 October 2013 will be shown. The daily mean air temperature and relative humidity varied from 0.5 to 21.9 deg. C and from 53.9 to 90.0%, respectively. The total precipitation was 29.5 mm, and the maximum daily precipitation was 9 mm?day-1. The daily mean wind speed varied from 1.3 to 6.1 m s^{-1}. There was clear relationship between the daily mean air temperature and wind direction. When the wind direction was northerly (southerly), the air temperature was low (high). The soil temperature (Ts) at surface varied from 2.8 to 10.8 deg. C while Ts at deeper than 0.425 m kept below 0 deg. C, which implies the frozen soil. The Ts at depth of 0.225m increased from -0.4 to 1.8 deg. C. The soil water content (SWC) was higher than 50% in surface layer of wet land while SWC at dry mound was lower than 11%. The net radiation varied from 50 to 200 W m^{-2} and soil heat flux varied from 11 to 40 W m^{-2}. The daily mean latent heat flux (average during analysis period: 39 W m^{-2} was little higher than the daily mean sensible heat flux (26 W m^{-2}). The daily mean net ecosystem exchange (NEE) on 24 and 26 June was 0.32 and 0.41 g C m^{-2} day^{-1}, respectively, which implies the carbon was released from the surface to the atmosphere while the NEE of the other days was negative value which implies the carbon was uptaken from the atmosphere. The accumulated NEE during analysis period was about -64 g C m^{-2} day^{-1}, which was smaller uptake than the value observed at tundra (-92g C m^{-2} day^{-1}; van der Molen et al., 2007). As our observation was started about half month after the start of growing season (late May), further analysis using the next year observation is necessary.

Keywords: Taiga-Tundra boundary, Siberia, Energy and carbon budget

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P03 Room:Poster Time:April 30 18:15-19:30

Year to year variations in larch growth and their controlling factors in taiga-tundra boundary ecosystem, NE Siberia

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Eastern Eurasia is covered by permafrost which is the largest and the deepest in the world. In its arctic region of lowland of Indigirka River, taiga-tundra boundary ecosystem covers the area. For better understanding of this boundary ecosystem, it is important to understand controlling factors on the growth of larch trees which is the dominate tree species of taiga. Larch growth can vary spatially and temporally. In spatial variation, we found that high soil moisture influences mortality of the larch trees and N availability explains differences in trees ability of C assimilation among the sites. To know the controlling factors on temporal variation of larch growth, we conducted field measurements on photosynthesis, needle nitrogen (N) content, needle mass and isotopic ratios in larch needle and stem in every summer from 2009 to 2013 at four sites in the Indigirka River Basin, near Chokurdakh (70^{o}37'N,147^{o}53'E), northeastern Siberia.

There was no seasonal variation in needle mass during the growing season after needles were fully open, while needle N content showed seasonality. Needle N content in the year positively correlated with July air temperature and stem δ^{13}C and following year needle δ^{13}C. These results indicates that, in the year with higher July air temperature, more N was allocated to needle and larch trees exhibited higher photosynthetic rate and photosynthetic C used for needle production was one year delayed. Higher air temperature in the year possibly indicates higher solar radiation based on positive correlation between July temperature and sun hours. Therefore, it can be said that larch growth shows strong dependence on solar radiation. In terms of temperature itself, we found higher temperature could limit photosynthetic rate. In addition, wet event, occurred at some sites in 2011 and 2012, caused low photosynthetic rate and low needle N content in 2012, and higher needle δ^{13}C in 2012 and 2013. These results indicate that high soil moisture could limit larch photosynthesis and reduce N uptake and cause stomata closure as well.

Our observational results indicate that solar radiation is one of the most important controlling factors on larch growth, and high soil moisture and high temperature can limit larch growth.

Keywords: Carbon and nitrogen isotopes, Needle N content, Photosynthesis, Air temperature and solar radiation, Soil moisture, Vegetation change

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P04 Room:Poster Time:April 30 18:15-19:30

Spacial distribution of vegetation at taiga-tundra boundary ecosystem in eastern Siberia

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Vegetation types, species compositions were observed with physical environment such as micro topography and soil moisture at taiga-tundra boundary ecosystem in lowland of Indigirka river in north eastern Siberia near Chokurdahk village(70^oN,148^oE)in July 2012 and 2013. There are 4 types of plant communities: driest Tree mound(*Larix gmelnii* etc.), Shrub(*Betula nana* etc.), Sphagnum(*Sphagnum* sp. etc.), wettest Hollow(*Eriophorum angustifolium* etc.). Large area is also covered by Willow(*Salix udensis* etc.) along the river. Soil moisture is the most important factor controlling vegetation and other biogeochemical cycles, such as methane emission. Thus, it is necessary to make a vegetation map with a classification as a key for estimating methane emission.

The objective of this study is classify land cover vegetation using remote sensing approach on satellite images and photographs. In remote sensing approach we used high resolution satellite multispectral image(GeoEye-1, WorldView-2) and aerial photo by radio-control helicopter. Supervised classification was conducted for spacial distribution of vegetation based on aerial photos. This vegetation map will be used for upscaling of biogeochemical cycle process such as greenhouse gases.

Keywords: Taiga-Tundra boundary, vegetation map, remote sensing, Siberia

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P05 Room:Poster Time:April 30 18:15-19:30

Satellite observation of cryospheric change using Arctic Data archive System (ADS)

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Arctic Data archive System (ADS) has been constructed in the GRENE Arctic Climate Research project. ADS is useful for quick look of data and visualizing satellite data in the Arctic. The decline of sea ice area in the Arctic influences on the environment and industrial activities in the coastal region and people's life. Satellite microwave data since 1978 was archived in ADS. They are SMMR, SSM/I, AMSR, AMSR-E and AMSR2. These data sets enable to analyze more than 35-years time series of snow conditions, sea ice conditions in the Arctic.

The data is available for all-weather, even during the polar night season. The data enables climatological analysis for more than 30-years time spanThis study demonstrates ADS capabilities for long-time monitoring and snow and ice conditions.

Keywords: Arctic, Cryosphere, Satellite, Data archive

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P06 Room:Poster Time:April 30 18:15-19:30

Age of the Pacific Winter Water in the Canada Basin estimated from SF6

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In the Pacific sector of the Arctic Ocean, Pacific Winter Water (PWW) distributes between 100m and 200m depths. Because the PWW has high nutrient concentrations and low pH, its spreading pathway has implications on primary production and ocean acidification in the Arctic Ocean. In this study, we have observed distribution of SF6, a transient tracer alternative to CFCs, in order to trace newly formed PWW into the Canada Basin.

Sampling was carried out in summer of 2013 on the CCGS Louis S. St-Laurent. Seawater at the core of PWW (salinity = 33.1) were collected in Niskin bottles and then transferred into custom-made glass bottles. Samples were kept at low temperature and brought back to Japan. Concentrations of SF_6 in seawater samples were determined by an ECD-GC following the method described in Bullister and Wisegarver (2008).

Results show that younger PWW distributes at the periphery of the Beaufort Gyre, a major anticyclonic circulation in Canada Basin. The age of PWW estimated from SF_6 was 13∼15 years in the center of the gyre, whereas age was 6∼9 years around the gyre. From the distributions of SF_6 age, dissolved oxygen and nutrients, it is suggested that there is a pathway of PWW from the Siberian shelves or slopes into the northeastern Canada Basin.

Keywords: arctic ocean, time transit tracer, SF6, ocean circulation

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P07 Room:Poster Time:April 30 18:15-19:30

Mineralization Rate of Soil Organic Carbon at the Lowland of Indigirka River in Northeastern Siberia

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The Arctic has a large amount of organic carbon accumulated in the soil. If the enhanced warming under the Anctic amplification leads to higher soil temperature or deepening of the active layer, emission of greenhouse gases, i.e. CO_2 and CH_4 can increase. The decomposition rate of organic matter, which is an important factor of CO_2 and CH_4 emission, depends not only on the quantity of organic matter, but also on that quality. In this work, surface soils from the lowland of Indigirka river in Northeastern Siberia were incubated at constant temperatures (5, 10 ℃) to evaluate the production rates of CH_4 and CO_2 and to know the degradability of the soil organic matter.

The study site is around Chokurdakh (70.62 N, 147.90 E) located in the continuous permafrost of Eastern Siberia and situated in the boundary of tundra and taiga. Surface soil layers (ca. 10-60 cm deep) were sampled at 7 points of a drier mound with larch trees and of wetter areas with sedges and *Sphagnum spp.*. Besides thawed layers (10, 20, 30 cm deep) sampled in July were incubated at Chokurdakh for 8 days anaerobically, frozen soil layers sampled in the early summer of June (13-62 cm) were incubated in Japan for 34-42 days both anaerobically and aerobically. These soils include the active layer (ca. 20-50 cm) and the top of the permafrost of this region.

CH_4 production was not detected in the mound soils while CO_2 production was, suggesting areas with dry condition have few methanogens and will not produce CH_4 even if they turn into anaerobic condition. On the other hand, soils from wet areas produced CH_4 (0-0.88 μmol (g dry soil)$^{-1}$ day^{-1}) and the production as well as that of CO_2 was more active at the shallower layers, representing larger amount of labile organic matter. The rate of CH_4 production at 10 ℃ were found to be 0.9-1.1 times of that at 5 ℃ in the shallower layers (ca. 10-40 cm), while 1.9-3.3 times in the deeper layers (32-45 cm). It indicates that the temperature dependency of CH_4 production is higher in the middle to the bottom of the active layer than in the top layer.

Keywords: methane, carbon dioxide, incubation experiment, Eastern Siberia, taiga-tundra boundary, stable isotope ratio

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P08 Room:Poster Time:April 30 18:15-19:30

Accurate snowfall measurement at Yakutsk, Russia

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In association with global warming, the water cycle in the atmosphere also changes for every climatic region on the globe. In polar regions, change in snowfall turns in change in distribution of snow surface and snow cover period, which will drive the ice-albedo feedback process. In order to know the present condition of the water cycle of polar regions and to study the trajectory of the polar climate systems in future, we have to observe not only air property such as temperature but also hydrological property such as snowfall amount, snow depth and so.

In spite of the development in accurate measurements for air temperature, pressure, wind speed and direction, the accuracy of snowfall measurement is not sufficiently high. While heated raingauge is currently generally deployed all over the world, the capture rate of snow particles falls together with wind speed, e.g., around 0.5 of the rate at 5 m/s. It means we measure only a half of the true value of snowfall amount at 5 m/s. This effect has been known for long time as wind loss. Evaporation loss also is more important in the polar regions than the other regions because many snowfall events have the smaller amounts in the total and lower snowfall rates according to the lower-temperature condition in the polar regions. Now, the accurate measurement of snowfall amount is one of the top issues in polar climate science.

The purpose of this study is to measure the accurate snowfall amount in the Arctic region. Moreover, based upon the results, we intend to correct other data which are measured in other region and in past years and also contribute to improve climate model by provideing accurate snowfall data. This study deploys a disdrometer, which measures diameter and fall velocity for each particle and out put the statistics minutely. It is not affected by wind loss and evaporation loss. This presentation shows a snowfall event observed at Yakutsk in early winter of 2013/14.

Keywords: Yakutsk, Snowfall, Disdrometer

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P09 Room:Poster Time:April 30 18:15-19:30

Continuous measurements of the atmospheric O2/N2 ratio at Ny-Alesund, Svalbard

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Simultaneous observations of atmospheric O_2 (defined as O_2/N_2 ratio) and CO_2 concentrations provide valuable information about the global carbon cycle. For a better understanding of the global carbon cycle, several laboratories have developed precise measurement systems for the O_2/N_2 ratio and carried out systematic observations since the early 1990s. To elucidate the variations of the atmospheric O_2/N_2 ratio in detail and to contribute to a better understanding of the role of Arctic region on the regional and global carbon cycle, we developed a continuous measurement system using a differential fuel-cell O_2 analyzer, and then initiated systematic observation at Ny-Ålesund, Svalbard in November 2012, which is the first continuous observation in the Arctic region. The system is equipped with NDIR analyzer to measure CO_2 concentration simultaneously. The analytical precisions of O_2/N_2 ratio and CO_2 are estimated to be $\pm$1.4 per meg and $\pm$0.03 ppmv, respectively. Here, we will present observational results of the first year.

The O_2/N_2 ratio observed at Ny-Ålesund shows a clear seasonal cycle with peak-to-peak amplitude of about 120 per meg, which reaches a minimum in late March to early April and a maximum in August. On the other hand, the CO_2 concentration varies seasonally in opposite phase with the O_2/N_2 ratio, showing the amplitude of 16 ppm. Short-term variations on time scales of several hours to several days are also clearly seen. In winter, it is often observed that the O_2/N_2 ratio sharply declines in a short time, accompanied by an increase in the CO_2 concentration, and the low values last for several hours or days. The O_2:CO_2 exchange ratio defined as the slope of a linear regression line between the measured values of O_2/N_2 ratio and CO_2 range between -1.6 and -1.5 ppm/ppm, which are close to the average O_2:CO_2 exchange ratio expected from fossil fuel burning in Europe. The results of backward trajectory analysis indicated that the air masses arrived at Ny-Ålesund during the periods when such short-term variations were observed passed near or over Scandinavian Peninsula. Therefore, such a decline in the O_2/N_2 ratio is ascribed to transport of urban air influenced by human activities in Europe. In spring to summer, irregular fluctuations of O_2/N_2 ratio are often observed. The amplitude of such fluctuations reaches 50-60 per meg (corresponding to about 10-13 ppm). Similar fluctuations of CO_2 are also found in opposite phase with O_2/N_2 ratio. However, their amplitudes are 5 ppmv at most. The comparison of backward trajectories of air parcels with the distributions of marine biotic net primary production suggests that such fluctuations of O_2/N_2 ratio are closely related to O_2 emission due to marine biological activity near Norwegian Sea.

Keywords: atmospheric O2, carbon cycle, O2:CO2 exchange ratio, air-sea O2 flux

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P10 Room:Poster Time:April 30 18:15-19:30

Geographical variations in formation process of cryoconite granules on Arctic glaciers

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The dark colored impurities deposited on the glacier ice are called cryoconite. Cryoconite is consisted of mineral particles, organic matter and microbes, including snow algae, cyanobacteria and bacteria. They usually form small spherical aggregates known as cryoconite granules. The spherical shape is maintained by filamentous cyanobacteria. The satellite images of Greenland ice sheet revealed that the dark colored bare ice surface has expanded recently and may have a big impact on the melting of ice. The darkening may be due to increase of cryoconite on the surface. Therefore, the understanding of the structure and formation process of the cryoconite granules is important for studies of the influence on the glacier ecosystem and mass balance of glaciers. In this study, we analyzed the structure and characteristics of cryoconite granules on Arctic glaciers and we clarified the differences in the formation process with the glaciers.

We analyzed the cryoconite samples collected on the northwestern part of the Greenland ice sheet, the Longyearbreen glacier of the Svalbard, the Suntar-Khayata glacier of the Siberia, the Gulkana glacier of the Alaska. We observed the cryoconite granules using a microscope in order to clarify the characteristic of the composition, the granule size. Furthermore, to observe inner structures, thin sections of cryoconite granules were made.

Microscopy of cryoconite granules revealed that their size and coloration differed among the glaciers. The size of granules was the largest for Svalbard followed by Siberia, Alaska, and Greenland. The coloration of cryoconite granules was brown for Svalbard, black for Siveria, gray for Alaska, and black to brown for Greenland. Cross section of the granules also showed the disticnct features. The granules from Greenland had mostly subgranules inside. The granules from Svalbard had some concentric layers of dense organic matter. The granules from Siberia had a large mineral particle inside. The granules from Alaska had no specific inner structure. These differences of cryoconite granules may reflect physical and/or chemical conditions of each glacier.

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ACG36-P11 Room:Poster Time:April 30 18:15-19:30

Development of a Palsa along the Denali Highway, Alaska

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Palsa is a peaty permafrost mound distributing in continuous and discontinuous permafrost zones. Main mechanism of the development the mounds is frost heave by ice segregation of peat or mineral soil material. Upper part of palsa usually consists of peat and lower part of a core of alternating layer of segregated ice and mineral soil material. History of paleo-environment around the period of last glacial retrieve in surrounding area can be inferred from analysis of palsa cores and stratigraphy. Our target palsa was located along the Denali Highway, Alaska, and the mound was truncated during highway construction in 1957. The outcrop of palsa have been eroded away from the highway line about 20m partly exposing the internal structure. This permafrost mound was firstly introduced as palsa by Pewe in 1983, and from dating of basal peat, deglaciation of this area occurred at least about 10500 year BP. History of palsa development and environment change was reconstructed from results of analysis from 6.5m core and ground temperature.

Keywords: Alaska, Denali Highway, Palsa

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P12 Room:Poster Time:April 30 18:15-19:30

Sr-Nd isotopic ratios of mineral dust in Arctic snow

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Snow and ice on glaciers contain various atmospheric depositions, such as soot and mineral dusts. These light-absorbing impurities can reduce surface albedo and affect melting of glaciers. Thus, it is important to understand how these impurities were supplied on glaciers.

Stable isotopic ratios of Sr and Nd provide a means of identifying sources of substances and can use for the dusts in snow because it requires low samples for analysis. In this study, we analyzed Sr and Nd isotopic ratio of the mineral dusts collected from snow in several Arctic regions (Mongol, Alaska, and Greenland).

The Sr and Nd isotopic ratios of mineral dusts in Arctic snow showed geographical variations among the sampling sites. The ratios of dust collected from snow in Mongol showed higher Sr and lower Nd values, while those of Greenland were higher Sr and lower Nd values, and were close to the ratios that have been reported in loess, desert sand, soil, or moraine around each region. This result indicates that mineral dusts in snow on the two sampling sites were mainly derived from surrounding regions. On the other hand, the isotopic ratios of dust in snow of Alaska were close to those of deserts in Kazakhstan and Taklamakan Desert, suggesting that the mineral dusts originated from such further deserts were likely to be long-range transported to Alaska.

Keywords: Sr-Nd isotopic ratio, mineral dust in snow, Arctic region

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P13 Room:Poster Time:April 30 18:15-19:30

Intercomparison of Arctic atmospheric reanalysis data: Deriving observation-based forcing data for terrestrial models

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The goals of the modeling group in the terrestrial research project of the GRENE Arctic Climate Change Research Project (GRENE-TEA) are to a) feed to the CGCM research project for the possible improvement of the physical and ecological processes for the Arctic terrestrial modeling (excl. glaciers and ice sheets) in the extant terrestrial schemes in the coupled global climate models (CGCMs), and b) lay the foundations of the future-generation Arctic terrestrial model development.

In GTMIP (GRENE-TEA Model Intercomparison Project), we utilize the GRENE-TEA site observations to drive and validate the participating models. However, the observation data are prone to missing or lack of the necessary variables or parameters to drive the model. Therefore, we create continuous forcing data in the following manner: First, we create 30-year hourly time series (version 0; v0) of 7 meteorological components from the closest point data of the reanalysis products (a model-based dataset for the sub-monthly variations, and the observation-based CRU for the monthly). Then, v0 is merged with the observation data to create site-fit continuous data (v1) for each GRENE-TEA site. Use of this v1 expects to reduce the systematic biases in the input data in comparing the model outputs with the site observations, to delineate the variations among the models.

So far several atmospheric reanalysis datasets, for example NCEP-NCAR or JRA-55 are available as model input data. In this study, six atmospheric reanalysis datasets are compared in terms of the climatic reproducibility in the region north of 60^{o}N to select the one to be used for constructing the v0 data. The compared datasets are ERA Interim, JRA-55, MERRA, NCEP/NCAR Reanalysis 1, NCEP-DOE Reanalysis 2, and NCEP-CFSR. The CRU dataset is used as a representative of the ground-level observations. We take air temperature at 2m high and precipitation as the key parameters representing the climate condition.

Keywords: Arctic region, Terrestrial model, Reanalysis dataset

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P14 Room:Poster Time:April 30 18:15-19:30

Automatic measurement of gas emission/uptake of Alaskan permafrost soils

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The release of carbon from the decomposition of organic matters in permafrost soils are very important for the acceleration of global watming . We applied our dynamic system to Alaskan soils and measured temperature dependence of gas (CO2, CH4, N2O, NO, H2, CO) emission/uptake. The Four core samples were placed on petri-dishes which were put into chambers where temperature was controlled. CO2 emission from soils showed variations different from sample to sample. Even at -5C, CO2 emissions were observed. From the time series of CO2 emission rates, we estimated Q10 values. Q10 values were similar between 5-15C and 15 and 25C. Some soils also temperature-dependently emit NO, CO and N2O.

Keywords: permafrost soil, Alaska, CO2, NO, laboratory experiment

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P15 Room:Poster Time:April 30 18:15-19:30

Simulating effects of natural fire disturbance on soil carbon storage of boreal forest and tundra ecosystems in Alaska

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Boreal forest and tundra are the major ecosystems in the northern high latitudes and represent one of the largest reservoirs of carbon over terrestrial ecosystems in the world. Most of the carbon is stored in permafrost where frozen organic matter is protected from decomposition due to biotic activity in the underlying soil. The surface humus layers that should work as the protective layers insulate the permafrost soil far away from the effect of climate warming. Hence, the removal of protective layers by natural fire episodes increases the vulnerability of permafrost to thaw, and the carbon stored in permafrost to decomposition under climate warming in the near future. To elucidate effects of fire severity and temperature sensitivity on the soil carbon storage of boreal forest and tundra ecosystems in Alaska, we conducted simulations using the Physical and Biogeochemical Soil organic carbon Dynamics Model (PB-SDM), which consists of meteorologically-relevant land surface model and soil organic carbon dynamics model. The PB-SDM model of fire severity, designed from the analysis of the field observations, describes the effects of fire characteristics in frequency and size on the reduction of the soil organic layer. The simulation captured realistic annual variations in soil organic carbon storage and thickness in boreal forest and tundra ecosystems individually by finding optimal model parameters in terms of the frequency and size of fire events and temperature sensitivity. The result reveals that our model can be used for predicting soil carbon storage in boreal forest and tundra ecosystems at regional scales where fire regimes play a key role in the soil organic carbon storage as affected by climate warming.

Keywords: High-latitude soil, fire severity, Soil organic carbon, boreal forest, tundra

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P16 Room:Poster Time:April 30 18:15-19:30

Methane Oxidation Potential of Arctic Wetland Soil of a Taiga-Tundra Ecotone in Northeastern Siberia

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Arctic wetlands are significant sources of atmospheric methane and the observed accelerated warming of the arctic causes increased methane formation in water-saturated tundra soil with deepened permafrost thawing. Methane oxidation is regarded as the key process to regulate methane emission from wetlands. In this study we determined the potential methane oxidation rate of the wetland soils of a Taiga-Tundra transition zone in Northeastern Siberia with special reference of the spatial heterogeneity and response to environmental parameters. The surface peat soil samples (0-10 cm) were collected in the summer of 2012 and 2013 from depressions that were covered with tussocks of sedges and Sphagnum spp. and mounds vegetated with moss and larch trees. The potential methane oxidation rate was estimated by a bottle incubation experiment in which homogenized soil samples were incubated with methane at the initial concentration of 0.5-0.8 %v/v. Soil samples from the mounds showed no detectable methane oxidation, whilst the soils collected from depressions exhibited active methane oxidation with no lag. The potential methane oxidation rates at 15 oC were of 270 and 190 nmol h^{-1} g^{-1} dw in the moss- and sedge-dominated zones, respectively. Methane oxidation was active over the depths including the water-saturated anoxic layers, suggesting the resilience of methane oxidizing bacteria. The maximum methane oxidation rate was recorded in the layer above the water-saturated layer: the surface (0-2cm) layer in the sedge-dominated zone and in the middle (4-6 cm) layer in the moss-dominated zone. Temperature-dependent methane oxidation was observed at the range of temperature from 0 to 15 oC. The estimated threshold temperature of methane oxidation was -4 to -11 oC, which suggested methane oxidation at subzero temperatures. Treatment with inorganic nutrients and black carbon did not affect the potential methane oxidation rate.

Keywords: Methane oxidation, tundra, peat

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P17 Room:Poster Time:April 30 18:15-19:30

Online visualization tool ”VISION” on Arctic Data archive System (ADS)

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We are constructing an online archive system of data about Arctic research that many researchers and institutes have collected, which is named ADS (Arctic Date archive System). We aim at that the many researchers specializing in the various fields of the Arctic research - such as atmosphere, ocean, land, physical and chemical analysis and computer simulation, etc - can become to mutually use their data across their own fields through our data archive. For this purpose, it is necessary for us not only to manage data systematically, but to build the system where researchers can easily grasp the contents of the data archive.

However, it is difficult to exactly understand contents of the data that others made. The researchers try to understand the contents of the data of their own fields and succeed in many cases. But it is not easy for them even to judge the contents of the data out of their fields. Therefore, we developed GUI-based online data visualization application named “ VISION ”, which all the researchers engaged in the Arctic research can easily operate. It can be expected that “ VISION ” facilitates an understanding the data of the various fields of the Arctic research among the researchers, then the researchers become also use the data out of their own fields.

We will introduce a structure and function of “ VISION ” and demonstrate an operation of this system.

Keywords: online visualization, satellite data, SSMI, AMSR

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P18 Room:Poster Time:April 30 18:15-19:30

Shrinking glaciers in Suntar Khayata, east Siberia

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Introduction

Since Northern Hemisphere high latitude regions are noticeable trend of global warming and climate change, appearance of its impact is interest. Northeastern Eurasia is area of blank of observational research. One of a few regions studied in the past is Suntar Khayata in east Siberia, where Russian scientists carried out wide range of study during IGY (1957-1959).

Study area

Suntar Khayata region, located in the latitudes between 62and 63 degree north and in the longitudes between 140.7 and 142 degree east, forms a divide between the Arctic Sea and the Sea of Okhotsk. Oymyakon depression, known as the cold pole in the Northern Hemisphere, is located to the northeast. Glacier inventory of this region was prepared based on the aerial photographs taken in 1944-1947 (Koreisha, 1963). Total number and area of glaciers were 205 and 206.28 km^2. Three glacierized region are recognized, namely Northern massif, Central massif and Southern massif. The highest elevation of each massif is 2959 m, 2933 m and 2944 m.

Glaciers observed are No. 29 to 33 in Northern massif including No. 31 which was intensively studied during IGY.

Observation

We carried out glaciological observations such as mass balance (stake method), ice thickness measurement (radio-echo soundings), and topographic survey (DGPS) in July/August in 2012 and 2013. Automatic weather stations were also set on/around the glaciers.

Results

Glacier-wide mass balance in 2012/2013 was -1.04 m w.e. for a glacier complex (Glaciers No. 29, 30 and 31). This value shows more negative state than those in 1957-1959.

We generated DEMs of surface and bed of the Glacier No. 31 using ice thicknesses obtained by radio-echo soundings and surface elevations by GPS survey, then we estimated the volume of the glacier to be 0.20 km^3 (area: 3.02 km^2, mean thickness: 62 m). Ice thicknesses in its tongue reduced by 110-60 m (terminus to upstream) since 1957.

Based on multi-temporal aerial and satellite imagery, 18 investigated glaciers reduced in area by approximately 36% from 1945 to 2011.

Concluding remark

Summer (July-August) air temperature observed on the glacier in 2012 and 2013 were higher than those in 1957-1959, which brought about more negative mass balance than those in 1957-1959. Superimposed ice formation was also very limited in 2012/2013. This resulted in disappearance of accumulation area. Reconstruction of long-term mass balance history is present target.

Acknowledgement

This study has been jointly carried out by JAMSTEC (Northern Cryosphere Research Program) and GRENE Arctic Climate Change Research Project (The role of arctic cryosphere in global change).

Keywords: glacier, Siberia, Suntar Khayata, shrink

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P19 Room:Poster Time:April 30 18:15-19:30

Effect of snow depth on pan-Arctic permafrost thermal regimes

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This study quantitatively evaluated how insulation by snow depth (SND) affected the soil thermal regime and permafrost degradation in the pan-Arctic area, and more generally defined the characteristics of soil temperature (T_{SOIL}) and SND from 1901-2009. This was achieved through experiments performed with the land surface model CHANGE, to assess sensitivity to winter precipitation as well as air temperature. Simulated T_{SOIL}, active layer thickness (ALT), and SND were generally comparable with in-situ or satellite observations at large scales and over long periods. Northernmost regions had snow that remained relatively stable and in a thicker state during the past four decades, generating greater increases in the T_{SOIL}. Changes in SND have led to changes in the thermal state of the underlying soil, which is strongly dependent on both the magnitude and the timing of changes in snowfall. Simulations of the period 2001-2009 revealed significant differences in the extent of near-surface permafrost, ranging from 15.6 to 18.7 million km^2. This spread was the result of differences in the model$'$s treatment of meteorology. Permafrost loss was greater when SND increased in the autumn rather than in the winter, due to insulation of the soil from the early cooling. Simulations revealed that T_{SOIL} tended to increase over most of the pan-Arctic from 1901-2009, and this increase was significant in northern regions, especially in northeastern Siberia where SND is responsible for 50% or more of the changes in TSOIL at a depth of 3.6 m. In the same region, ALT also increased at a rate of approximately 2.3 cm per decade. The most sensitive response of ALT to changes in SND appeared in the southern boundary regions of permafrost, in contrast to permafrost temperatures within the 60^o-80^oN region, which were more sensitive to changes in the SND. Finally, the modeling performed in this study suggests that snow cover contributes to the warming of permafrost in northern regions and could play a more important role under conditions of future Arctic warming.

Keywords: active layer thickness, land surface model, permafrost, snow depth, soil temperature

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P20 Room:Poster Time:April 30 18:15-19:30

Fixed-point observation of diatom biocoenosis and water mass condition in the northern Chukchi Sea during September 2013

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In order to estimate the relationship between diatom flora and water mass condition in the northern Chukchi Sea, fixed-point ocean observation was conducted at Station 41 (72.45N, 168.24W, 56 m water depth) by R/V Mirai (Cruise MR13-06) in 10-25 September 2013. The optical equipment named ”Multi-wave length excitation fluorescence photometer (Multi-Exciter)” was applied with CTD observation for the estimation of chlorophyll concentration in each major phytoplankton groups (diatom, green algae, and blue algae). Chlorophyll concentration gradually increased with the weakening of summer stratification by intensified sea-surface wind. The Multi-Exciter showed the clear increase of diatom in upper water column, which were also suggested by size-fractionated analysis of chlorophyll concentration and microscopic observation by scanning electron microscope and light microscope. However, the increase of diatom cell abundance was minor compared to the increase of total chlorophyll concentration. The dominance of large diatom genus *Proboscia* and the increased chlorophyll concentration in one diatom cell were the main causes on the increase of total chlorophyll concentration. The 3-6 fold increase of chlorophyll concentration within 6 hours was rarely observed around chlorophyll maximum layer during the middle observation period, which is probably explained by not only improved habitat environment for diatom but also movement of water masses such as lateral input of high chlorophyll waters.

Keywords: Arctic Ocean, Chukchi Sea, diatom, excitation fluorescence, chlorophyll concentration

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

ACG36-P21 Room:Poster Time:April 30 18:15-19:30

Reconstruction of paleoenvironmental changes in the Chukchi Borderland over the last 15.5kyr

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Knowledge on past variability of sedimentary organic carbon in the Arctic Ocean is important to assess natural carbon cycling and transport processes related to global climate changes. However, the late Pleistocene oceanographic history of the Arctic is still poorly understood. In the present study we show sedimentary records of organic carbon(TOC, δ13C), CaCO3, benthic and planktonic foraminiferal δ18O, BIT index for terrestrial organic carbon input, IP25 for sea ice condition, and the coarse grain size fraction. The 8m length sediment core was retrieved in the northern Northwind Ridge in the far western Arctic Ocean, during the MR08-05 cruise by R/V Mirai. An age model based on oxygen isotope stratigraphy, radiocarbon dating and lithological constraints suggests that the core records paleoenvironmental changes of the last 155 kyr. In this conference, we discuss presented millennial scales records of glacial erosion, intermediate water and/or surface water and sea ice variabilities during cold/warm episodes of the last two glacial interglacial cycles in the light of ice sheet and ocean-atmosphere dynamics.