Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

ACC03-01 Room:101B Time:May 22 09:00-09:20

Polar amplification: major drivers and implications for global climate

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Surface albedo feedback is widely believed to be the principle contributor to polar amplification. However, a number of studies have shown that coupled ocean-atmosphere models without ice albedo feedbacks still produce significant polar amplification in 2xCO2 runs due to atmospheric heat transports and their interaction with surface conditions. The relative importance of atmospheric heat transport and surface albedo is assessed in a hierarchy of models. While both processes are shown to contribute to the polar amplified response of the model, feedback analysis points to a tendency for surface albedo to mask the effect of atmospheric heat transport in the full model.

Global climate models predict polar amplified pattern of warming in the Northern Hemisphere (NH) high- to middle latitudes during boreal winter. However, recent trends in observed NH winter surface land temperatures diverge from these projections. For the last two decades, large-scale cooling trends have existed instead across large stretches of eastern North America and northern Eurasia. We argue that this unforeseen trend is probably not due to internal variability alone. Delayed freeze-up in the Arctic and the consequent heat input in the atmosphere lead to significant changes in the circulation caused by a number of factors. Those factors include a direct response to the heat anomaly over the open ocean and a dynamic response to changes in the snow cover in northern Eurasia. Understanding this counterintuitive response to radiative warming of the climate system has the potential for improving climate predictions at seasonal and longer timescales.

Keywords: global warming, polar amplification

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ACC03-02 Room:101B Time:May 22 09:20-09:40

Coupled Hydrological and Thermal Modeling of Permafrost Dynamics: Implications to Permafrost Carbon Pool

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Thawing and freezing of Arctic soils is affected by many factors, with air temperature, vegetation, snow accumulation, and soil moisture among the most significant. To investigate how changes in these factors influence permafrost dynamics in the Arctic, we developed a Geophysical Institute Permafrost Lab (GIPL) permafrost dynamics model. This model simulates soil temperature dynamics and depth of seasonal freezing and thawing by solving a non-linear heat equation with phase change numerically.

Although the GIPL model is helpful for understanding the effects of climatic and landscape factors on heat flow and phase change in soil retrospectively and prognostically, it does not simulate soil moisture dynamics and storage across diverse landscapes. Coupling of the GIPL model with a suitably-scaled hydrological model captures thresholds and highly non-linear feedback processes induced by changes in hydrology and the temperature regime over the pan-Arctic. We developed a robust coupling of a GIPL Permafrost Model and modified version of the pan-Arctic Water Balance Model (P/WBM) developed at the University of Alaska Fairbanks and the University of New Hampshire, respectively. Through explicit coupling of the Permafrost Model with the PWBM we are able to simulate the temporal and spatial variability in soil water/ice content, active layer thickness, and associated large-scale hydrology that are driven by contemporary and future climate variability and change.

We assess the changes in permafrost characteristics in Northern regions of Eurasia using a coupled, large scale, grid-based water balance/permafrost model that simulates hydrological budgets, the distribution of soil temperature and active layer dynamics, permafrost thawing and freezing, using a number of projections of future climate for the next century. The model takes into account the geographic distribution of organic soils and peatlands, vegetation cover and soil properties, and is tested against a number of permafrost temperature records for the last century. We report results of simulations for a number of different climate scenarios derived from IPCC climate models outputs. Despite the slower rate of soil warming in peatland areas and a slower degradation of permafrost under peat soils, a considerable volume of peat (approximately 20% of the total volume of peat in Northern Eurasia) could be thawed by the end of the current century. The potential release of carbon and the net effect of this thawing will depend on the balance between increased productivity and respiration, and will be mitigated by peat moisture.

Keywords: Permafrost, Active Layer, Hydrology, Modeling, Peatland

ACC03-03 Room:101B Time:May 22 09:40-09:55

Global warming and changes in Siberian terrestrial environments

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High levels of precipitation in the Lena River Basin, Siberia, from 2005 to 2008 led to tremendous changes in terrestrial environments. The changes observed include a deepening and moistening of the active layers, hindrance of tree growth, and the expansion of water surfaces due to floods. The anomalously wet condition of forest soils caused larch trees to wither at our forest monitoring site in the middle part of the basin. However an analysis of satellite data revealed that such tree withering occurred only at certain points. On the basis of our permafrost-ecosystem models, we have identified increases in thawing depth and surface soil moisture, and an increase in net primary production. The annual maximum thawing depth (AMTD) was revealed to have gradually increased (deepened) on a decadal scale. Increase in terrestrial water storage in the Lena River Basin generated increases in river base flows during the open water season. Our results also indicated that between 1950 and 2008 the basin-scale AMTD increased at an average rate of approximately 1 cm/year in the region. Moistening and warming of surface soil affect methane emissions from Siberian terrestrial ecosystems. Regional methane fluxes were estimated using an inversion model with data collected from aircraft and tower measurements in Siberia. In 2007 and 2008, enhanced methane fluxes from the wetlands in Western Siberia were estimated under relatively wet conditions with high temperatures. Interestingly, methane fluxes after 2008 have gradually decreased but those in Eastern Siberia have increased unsymmetrically. Such an unsymmetrical (seesaw) pattern between Western and Eastern Siberia has also been observed for carbon dioxide exchanges in terrestrial ecosystems. Gross primary production and ecosystem respiration in the 2000s were estimated using our permafrost-ecosystem models, which showed a decreasing trend in Western Siberia and an increasing trend in Eastern Siberia. These differences were primarily due to the differences in the trends of temperature and precipitation between the two regions.

Keywords: global warming, waterlogging, permafrost, thawing, green-house gases

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ACC03-04 Room:101B Time:May 22 09:55-10:10

Climatological features of atmospheric and terrestrial water cycles in the three great Siberian rivers

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We examined several climatological features of atmospheric and terrestrial water cycles including river discharge, net precipitation (precipitation minus evapotranspiration) and moisture transport in the three great Siberian rivers; Lena, Yenisei and Ob. River discharge at the mouth of the river is outflow of water into the Arctic Ocean. On the other hand, net precipitation averaged over a river basin is net inflow of water from atmosphere to surface. In this study, the net precipitation is estimated by six atmospheric reanalyses (JRA25, ERA40, ERAI, MERRA, NCEP2 and CFSR) by means of atmospheric water budget method without using P and E datasets.

As expected from the terrestrial water budget, on average during 1980-2008, the amounts of net precipitation over the basins of the Lena, Ob and Yenisei Rivers were found to be comparable in magnitude to the observed river discharges at the mouths of each river. This indicates that the estimation of net precipitation on the basis of the atmospheric reanalysis is an effective way to evaluate and quantify the atmospheric and terrestrial water cycles of a large river basin. While the precipitation over the Ob River basin is largest among the three Siberian rivers, the river discharge and net precipitation of the Ob are smallest among them. The river discharge and precipitation of the Lena are smaller than that of the Yenisei, while the net precipitation over the Lena is as large as that over the Yenisei. These results indicate that the regional differences in evapotranspiration over Siberia result in those differences in river discharges and net precipitation among the Siberian rivers.

Seasonal cycles of the Lena, Yenisei and Ob River discharges show maximums in June due to river ice melting. While the precipitations over the three river basins show maximums in July, the net precipitations in that month show minimums at nearly zero flow over the Lena and Yenisei, and at large negative flow over the Ob. This indicates that the evapotranspirations in the warm season are as large as the precipitation over the Lena and Yenisei, and much larger than the precipitation over the Ob. Because these basins are covered with vast area of boreal forest, the transpiration from the forest may account for large part of the evapotranspiration and which plays an important role for the terrestrial water cycles.

During the past three decades, the annual mean river discharge of each of the three Siberian rivers is positively correlated with the net precipitation over each of the basins, respectively. While the annual mean discharge of the Lena corresponds to the net precipitation over the basin, those of the Yenisei and Ob Rivers show some differences. The correlation coefficients between the river discharge and net precipitation of the two basins are weak and amplitudes of the discharge are smaller than that of the net precipitation. We consider these differences are mainly due to the time lag between the river discharge and net precipitation. In addition, these variables do not show any significant trends during the past three decades (1980-2008).

Keywords: Siberia, Water Cycle, River Discharge, Net Precipitation, Atmospheric Reanalysis data

ACC03-05 Room:101B Time:May 22 10:10-10:25

Land Surface Phenologies and Seasonalities Using Earthlight to Monitor Changes in High-Latitude Croplands

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Phenology and seasonality are complementary aspects of ecosystem functioning: phenology deals with timing of biotic phenomena; whereas, seasonality concerns temporal patterns of abiotic variables. Enhanced land surface parameters derived from passive microwave data enable improved temporal monitoring of agricultural land surface dynamics compared to the vegetation index data available from optical data. Despite a coarser spatial resolution, the AMSR-E data products are more sensitive to intra-seasonal changes in surface moisture than MODIS data products. Accordingly, the AMSR-E data are better able to detect both flash droughts and the onset of drought. We compare and contrast land surface phenologies using data from 2003-2010 in the Volga River Basin of Russia, and the spring wheat belts of the USA and Canada. We find reasonable relationships between retrieved air temperature, fractional open water, surface moisture, and vegetation optical depth at three microwave frequencies. We focus in particular on the extraordinary heat wave that impacts Russia in 2010. The results suggest possible applications for data from the new microwave radiometer AMSR2 launched in 2012.

Keywords: passive microwave, land surface phenology, croplands, Russia, North America, 2010 heat wave

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ACC03-06 Room:101B Time:May 22 10:25-10:45

Projected impacts of the 21st century climate change on the forests and major conifer species in Russia

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Global simulations have demonstrated the potential for profound effects of GCM-projected climate change on the distribution of terrestrial ecosystems and individual species at all hierarchical levels. We modeled progressions of potential vegetation cover, forest-forming tree species and forest types in Russia in the warming climate during the 21st century. Large-scale bioclimatic models were developed to predict Russian zonal vegetation (RuBCliM), forests, forest-forming tree species and forest types (ForCliM). A forest type was defined as a combination of a dominant tree conifer and a ground layer (2-3 dominant species). Distributions of vegetation zones (zonobiomes), conifer species and forest types were simulated based on three bioclimatic indices (1) growing degree-days above 5 degrees Celcius; (2) negative degree-days below 0 degrees Celcius; and (3) an annual moisture index (ratio of growing degree days to annual precipitation). Additionally, the presence or absence of continuous permafrost, identified by active layer depth of 2 m, was explicitly included in the models as limiting the forests and tree species distribution in Siberia. All simulations to predict vegetation change across Russia were run by coupling our bioclimatic models with bioclimatic indices and the permafrost distribution for the baseline period 1971-2000 and for the future decades of 2011-2020, 2041-2050 and 2091-2100. To provide a range of warming we used three global climate models (CGCM3.1, HadCM3 and IPSLCM4) and three climate change scenarios (A1B, A2 and B1). The CGCM model and the B1 scenario projected the smallest temperature increases, and the IPSL model and the A2 scenario projected the greatest temperature increases.

With these projected climates, the zonobiomes would need to shift far to the north in order to reach equilibrium with the change in climate. Under the warmer and drier projected future climate, at least half of Russia would be suitable for the forest-steppe ecotone and grasslands rather than for forests. Water stress tolerant light-needled taiga (Pinus sylvestris and Larix spp.) would have an increased advantage over water-loving dark-needled taiga (Pinus sibica, Abies sibirica, Picea obovata) in a new climate. The permafrost-tolerant L. dahurica taiga would remain the dominant forest type in the many current permafrost areas because permafrost would not retreat fast. An increase in severe fire weather would lead to increases in large, high-severity fires, especially at the southern forest border and in interior Siberia (Yakutia), which are expected to facilitate vegetation progression towards equilibrium with the climate.

Adaptation to climate change may be facilitated by: (1) assisting migration of forests and tree species by seed transfer from locations where current climate is most similar to that projected in the future in order to establish genotypes that may be more ecologically suited as climate changes; and (2) introduction of suitable agricultural crops that currently may not be present in the region but may be potentially used in a warmer climate in steppe and forest-steppe areas that are expected to replace the retreating forests.

Keywords: Vegetation, forest types, forest-forming trees, bioclimatic modeling, climate change, 21st century, Russia

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ACC03-07 Room:101B Time:May 22 11:00-11:30

A Modeling Analysis of Carbon and Water Cycles in Northern Eurasia during the Past and This Century

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The temperature increase and extreme climate change occurred in the past century are projected to continue during this century in northern Eurasia according to climate models. The changing climate may expedite permafrost thawing and intensify the hydrological cycle, in turn, accelerate the carbon greenhouse gas cycling in this region. Using a suite of hydrology, permafrost, biogeography, biogeochemistry and climate models, we explore how vegetation distribution, landscape (wet vs. dry), permafrost, hydrology, and carbon cycle have changed in the last century and will be affected during the 21st century. Our preliminary analyses indicate that the region was a consistent methane source in the past century and the source strength will increase by 60%. In contrast, the region was a carbon sink and the sink will double by the end of this century. As a result, the region will act as a strengthened greenhouse gas sink during this century. In the presentation, I will also present how regional water cycle is modeled considering the effects of climate, plant physiology, and snow and permafrost dynamics in various landscapes.

Keywords: Greenhouse gas cycling, biogeochemistry, permafrost, water, hydrology, earth system modeling

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ACC03-08 Room:101B Time:May 22 11:30-11:45

Changes of snow cover characteristics over Eurasia in the context of the ongoing climate changes

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Global changes of the surface air temperature have been well documented for the past 130 years (period of mass instrumental observations). In the past 50 years, global, hemispheric, Arctic, and continental temperatures have been rising {under}decade by decade{/under} and the last decade was the warmest for the past 130 years. Another feature of these changes is a stronger warming in high latitudes than in the tropics, over the continents than over the oceans, and in the cold season than in the warm season. But, in winter the variance of the surface air temperature over Northern Eurasia is about 10 times higher than in summer. This structure of the global warming has led to (a) reduction of meridional surface air temperature gradients, especially in winter, (b) weakening and northward shifts of the major storm tracks, and (c) retreat of the seasonal Arctic sea ice and its transformation from multiannual into a thinner seasonal sea ice cover of lesser concentrations. In the cold season the last feature, like a complete or partial removal of the boiling tea kettle lid, affects heat and water vapor fluxes from the Arctic Ocean into the atmosphere and may generate increases of the frequency of colder anticyclonic weather conditions in the interior of the mid-latitude continents and affect/interact with the seasonal snow cover characteristics, in particular over Eurasia.

Snow cover extent (SCE) over the Northern Hemisphere has not changed substantially in the early winter months and notably decreased in the late spring (especially over Eurasia and Russia). However (probably due to a further sea ice retreat in the Eurasian Sector of the Arctic), in the last two decades late spring SCE over the Russian Federation has stabilized (except the westernmost part of the nation) and several snow cover characteristics have increased. Our analyses show that over most of Russia: duration of the snow cover has decreased while maximum winter snow depth, maximum snow water equivalent, and the number of days with snow depth above 20 cm have increased. At the same time, maximum winter snowpack density has decreased. Thus, in the Russian Federation the tendencies of snow cover changes can be formulated as follows: in the cold season snowpack has become thicker, more porous, and moister but remained on the ground for a shorter period of time.

Associated with snow cover change climatic variables include: (a) the days with thaw defined as the days when the mean daily temperature is above -2 degrees Celsius while snow on the ground is above 5 cm; (b) spring onset characteristics such as the dates of the snowmelt completion, the dates of beginning of the vegetation and no-frost seasons; and(c) duration of the vegetation period. We show that all these characteristics have significantly changed over Belarus, Russia, and Kazakhstan during the post-World War II period.

Keywords: Snow cover, Eurasia, climatic change, snowpack

ACC03-09 Room:101B Time:May 22 11:45-12:00

Analysis of CO_2 concentrations simulated by NIES transport model and retrieved from GOSAT in the subarctic regions

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The arctic and subarctic regions are large soil carbon reservoirs in the world. Permafrost soils covering about 25% of the land surface in the Northern Hemisphere store almost twice as much carbon as is currently present in the atmosphere. However, the rates of carbon release from permafrost soils due to permafrost thaw and the microbial decomposition of previously frozen organic carbon are highly uncertain. Moreover, the carbon cycle in the subarctic remains poorly investigated due to the insufficient observations. At present, the spatial coverage of direct carbon flux measurements needed to map the fluxes accurately is not enough, especially in the high-latitudes of the Northern hemisphere.

This work describes investigation of carbon dioxide distribution in the subarctic regions using numerical simulation with the National Institute for Environmental Studies (NIES) three-dimensional transport model (TM) and retrievals from the Greenhouse gases Observing SATellite (GOSAT). Simulated by NIES TM with several flux combinations column-averaged dry air mole fractions of atmospheric CO_2 (XCO_2) was compared with GOSAT data for different latitude bands over land in the subarctic. We revealed relatively large deviations between XCO_2 modeled and retrieved from GOSAT with positive bias in spring/summer and negative in autumn, indicating some fluxes inaccuracy, which may be caused by uncertainty in emission/sink of CO_2. We analyzed flux uncertainty reduction and improvements in seasonal cycle reproduction following fluxes optimization with the inverse modeling system. XCO_2 simulated with optimized fluxes was evaluated against the Total Carbon Column Observing Network (TCCON) ground-based high-resolution Fourier Transform Spectrometer (FTS) measurements at two the most northern sites Ny Alesund and Sodankyla. CO_2 distribution obtained through inverse modeling using the ground based, aircraft observations and GOSAT data together appear to be closer to FTS measurements, than without GOSAT data. Thus, we have shown XCO_2 retrieved from GOSAT can be used to evaluate modeled results and as additional constrain in flux optimization with inverse model in the subarctic regions.

Keywords: carbon dioxide, atmospheric forward and inverse modeling, remote sensing

ACC03-P01 Room:Convention Hall Time:May 22 18:15-19:30

Northern Eurasia Earth Science Partnership Initiative in the past 12 months: An Update

Pavel Groisman[1*]

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Eight years ago Northern Eurasia Earth Science Partnership Initiative (NEESPI) was launched with the release of its Science Plan (http://neespi.org). Gradually, the Initiative was joined by numerous international projects launched in EU, Russia, the United States, Canada, Japan, and China. Throughout its duration, NEESPI served and is serving as an umbrella for more than 155 individual international research projects. Currently, the total number of the ongoing NEESPI projects (as on January 2013) is 48 and has changed but slightly compared to its peak (87 in 2008). The past 12 months (from the previous JpGU Annual Meeting) were extremely productive in the NEESPI outreach. We organized three Open Science Sessions at the three major Geoscience Unions/Assembly Meetings (AGU, EGU, and this JpGU Session) and three International NEESPI Workshops. The programs of two of these Workshops (in Yoshkar Ola and Irkutsk, Russia) included Summer Schools for early career scientists. More than 155 peer-reviewed papers, books, and/or book chapters were published in 2012 or are in press (this list was still incomplete at the time of preparation of this abstract). In particular, a suite of 25 peer-reviewed NEESPI articles was published in the Forth Special NEESPI Issue of "Environmental Research Letters" (ERL) http://iopscience.iop.org/1748-9326/focus/NEESPI3 (this is the third ERL Issue). In December 2012, the next Special ERL NEESPI Issue was launched http://iopscience.iop.org/1748-9326/focus/NEESPI4. Northern Eurasia is a large study domain. Therefore, it was decided to describe the latest findings related to its environmental changes in several regional monographs in English. Three books on Environmental Changes in the NEESPI domain were published by the University of Helsinki (Groisman et al. 2012), Akademperiodyka (Groisman and Lyalko 2012), and Springer Publishing House (Groisman and Gutman 2013) being devoted to the high latitudes of Eurasia, to Eastern Europe, and to Siberia respectively. We expect that one more book (Chen et al. 2013) will be published simultaneously by Higher Education Press and De Gruyter Publ. House prior to commence of this Meeting.

In this presentation, the description of the NEESPI Program will be complemented with an overview of the results presented in the latest our books Earth System Change over Eastern Europe, Regional Environmental Changes in Siberia and Their Global Consequences, and Dryland East Asia: Land Dynamics amid Social and Climate Change and the future of the Initiative will be discussed.

Cited references:

? Groisman, P.Ya., A. Reissell, and Marjut Kaukolehto (eds.) 2012: Proceedings of the Northern Eurasian Earth Science Partnership Initiative (NEESPI) Regional Science Team Meeting devoted to the High Latitudes. Report Series in Aerosol Science, No. 130, Helsinki, Finland, 153 pp.

? Groisman, P.Ya. and V.I. Lyalko (eds.) 2012: Earth Systems Change over Eastern Europe. Akademperiodyka, Kiev, The Ukraine, 488 pp. ISBN 978-966-360-195-3.

? Groisman and Gutman (eds.) 2013: Environmental Changes in Siberia: Regional Changes and their Global Consequences. Springer, Amsterdam, The Netherlands, 357 pp. doi:10.1007/978-94-007-4569-8

? Chen, J., S. Wan, J. Qi, G. Henebry, M Kappas, and G. Sun (eds.) 2013: Region of East Asia: Land Dynamics amid Social and Climate Change. Beijing: Higher Education Press and Berlin: De Gruyter. (in press)

Keywords: Northern Eurasia Earth Science Partnership Initiative

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ACC03-P02 Room:Convention Hall Time:May 22 18:15-19:30

Icing conditions in the northern extratropics in changing climate

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A general increase in atmospheric humidity is expected with global warming, projected with GCMs, reported with remote sensing and in situ observations (Trenberth et al. 2005; Dessler, and Davis 2010; IPCC 2007, Zhang et al. 2012). In the Arctic this increase has been and will be especially prominent triggered by the dramatic retreat of the sea ice. In the warm season this retreat provides an abundant water vapor supply to the dry Arctic atmosphere. The contemporary sea ice changes are especially visible in the Eastern Hemisphere and after the two extremely anomalous low-ice years (2007 and 2012) it is right time to look for the impact of these changes in the high latitudinal hydrological cycle: first of all in the atmospheric humidity and precipitation changes.

Usually, humidity (unless extremely high or low) does not critically affect the human activities and life style. However, in the high latitudes this characteristic has an additional facet: higher humidity causes higher ice condensation from the air (icing and hoar frost) on the infrastructure and transports in the absence of precipitation. The hoar frost and icing (in Russian: gololed) are measured at the Russian meteorological network and reports of icing of the wires are quantitative measurements. While hoar frost can be considered as a minor annoyance, icing may have important societal repercussions. In the Arctic icing occurs mostly during relatively warm months when atmosphere holds maximum amount of water vapor (and is projected to have more). Freezing rain and drizzle contribute to gololed formation and thus this variable (being above some thresholds) presents an important characteristic that can affect the infrastructure (communication lines elevated at the telegraph poles, antennas, etc.), became a Socially-Important climatic Variable (SIV).

The former USSR observational program includes gololed among the documented weather phenomena and this allowed RIHMI to create Electronic Reference Book on Climate of the Russian Federation for the national territory. This Reference Book addresses the current state of these weather phenomena. However, the ongoing and projected humidity changes in the high latitudes will strongly affect the circum-polar area (land and ocean) and impact the frequency and intensity of these potentially dangerous weather phenomena across the entire extratropical land area. Therefore the goal of the present study is to quantify icing conditions over the northern extratropics.

Our analysis includes data of 958 Russian stations from 1984 to 2011. Regional analysis of gololed characteristics was carried out using quasi-homogeneous climatic regions. Maps (climatology, trends) are presented mostly for visualization purposes. The area-averaging technique using station values converted to anomalies with respect to a common reference period (in this study, from 1984 to 2011). Anomalies were arithmetically averaged first within 1N x 2E grid cells and thereafter by a weighted average value derived over the quasi-homogeneous climatic regions. This approach provides a more uniform spatial field for averaging.

Keywords: hoar frost and icing, northern extratropics, quasi-homogeneous climatic regions, Socially-Important climatic Variable

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ACC03-P03 Room:Convention Hall Time:May 22 18:15-19:30

Quantifying the uncertainty of global snow simulation using ensemble experiments of land surface model MATSIRO

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Macro-scale snow simulation has been used to produce snow estimates and attribute the change of snow into hydrological variables. However, its uncertainties due to model structure, model parameters, and meteorological forcing have not been well documented. In the present study, we examined the uncertainty of global snow simulation due to the snow schemes, model parameters, and precipitation forcing, using ensemble simulation of MATSIRO land surface model. For snow scheme ensemble simulation, MATSIRO is augmented by SSNOWD subgrid snow cover parameterization, the liquid water storage, the prognostic density and the elevation mosaic schemes, and is simplified with the simplified snow albedo parameterization, no liquid water refreeze, and no partial snow cover schemes. They were forced with a global meteorological dataset, which combined the JRA25 atmospheric reanalysis data with 5 observed precipitation datasets. The simulation period is from 2001 to 2007 and the horizontal resolution is 1 degree by 1 degree. We used standard deviation of ensemble members to evaluate the uncertainty of monthly snow water equivalent for major Arctic river basins from October 2005 to June 2006. It is shown that the precipitation uncertainty is large and snow scheme and parameter uncertainty is small in the accumulation season. In ablation season, parameter uncertainty become larger, and the range of ensemble members is from half to twice of standard simulation. The uncertainty of snow scheme is also larger in the ablation season than the accumulation season. This study shows that more accurate precipitation observation may effectively reduce the uncertainty throughout the snow season, and improvements of snow schemes and appropriate evaluation of parameters may reduce the uncertainty in the melting season. We also evaluate the parameter uncertainty of 3 models with different complexity.

Keywords: snow, land surface model, uncertainty analysis

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ACC03-P04 Room:Convention Hall Time:May 22 18:15-19:30

50-years meteo-glaciological change of Toll glacier in Bennett Island, DeLong Archipelago, Siberian Arctic

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[1]JAMSTEC

Rapid environmental change is seen in DeLong Archipelago, Siberian Arctic which is one of the areas of extensive warming on the Earth. To quantitate glaciological change since 1980s, the climate, mass balance, and ELA of Toll glacier in Bennett Island were analyzed. Air temperature was increasing and solid precipitation was decreasing since 1960s, especially after 2000. Hence, cumulative mass balance of Toll glacier is in negative trend since 1960s and reached to ca. -20m w.e. until 2000, which is one of the largest changes in the arctic. The warming trend is correlated with mass balance decrease of glaciers and sea ice distribution in the Siberian Arctic. ELA of Toll glacier may reach at 380m, which is the top of the ice cap, in 2020s. These changes are much larger than in west Russian Arctic.

Keywords: glacier, arctic, mass balance

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The heat and gas exchange in the polar tundra

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Recent climate warming in the Arctic requires improvements in permafrost and carbon cycle monitoring, accomplished here by setting up long-term observation sites with high-quality in situ measurements of turbulent atmospheric energy fluxes applying the eddy covariance method. Eddy covariance measurements of energy and gas fluxes have been performed in Arctic (Tiksi) and Antarctic (King George island), a commonly occurring tundra ecosystem type in circumpolar middle and high Arctic areas, allowing for detailed investigations of relationships between energy fluxes and meteorological and soil physical characteristics.

Accurate quantification and well-adapted parameterizations of turbulent energy fluxes, e.g., during neutral to stable stratified conditions, are a fundamental problem in soil?snow?ice?vegetation?atmosphere interaction studies. We present results from our experiments performed during the summer in polar tundra regions that focus on data correction and quality assessment, on synoptic weather conditions, as well as site-specific micrometeorological features. A quality assessment and data correction adapted to the environmental conditions of polar regions demonstrates that specific measurement errors common at a high Arctic landscape could be minimized. Recommendations and improvements regarding the interpretation of eddy flux data as well as the arrangement of the instrumentation under polar distinct exchange conditions and (extreme) weather situations are presented.

Essential interannual variations of average energy exchange characteristics above different underlying surfaces due to variability of large-scale hydrometeorological conditions in the Arctic and Antarctic tundra regions are founded. Aerodynamic Drag coefficient and roughness parameter of the surface, influencing on energy exchange characteristics, are changed substantially in time and in space, and largely depend on the state of snow cover, the atmospheric stability, wind velocity and directions, variability of which is connected with the climatic situation. The data set are used to understand how the land surface and the atmosphere interact in terms of regional climate change. In addition, its are used to monitor how polar terrestrial ecosystem responds to the possible climate change.

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Keywords: turbulent fluxes, eddy-correlation, drag coefficient, roughness, gas exchange

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Recent variation of West Siberian wetland CH4 fluxes estimated from atmospheric CH4

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The world's largest extent of wetlands occurs in West Siberia, where wetlands account for 27% of the area of West Siberia (Peregon et al. 2009). The vast wetlands emit methane (CH4) to the air and the magnitude depends highly on soil temperature and the water table. A large increase of atmospheric CH4 was observed globally in 2007 and Siberian wetland emission enhanced by high temperature was mentioned as one of main contributor to the increase at northern high-latitudes (Dlugokencky et al. 2009; Bloom et al. 2010). This study shows the year-to-year variation of CH4 emissions from West Siberian wetlands estimated from atmospheric CH4 observed by a tower network (JR-STATION: Japan-Russia Siberian Tall Tower Inland Observation Network) and aircraft over Siberia, using inverse model of atmospheric CH4 transport based on a fixed-lag Kalman smoother. We also use flask sampling and continuous measurement data of atmospheric CH4 archived at WDCGG (World Data Centre for Greenhouse Gases) in flux estimates. Interannually varying CH4 emissions are used to calculate CH4 transport with NIES transport model including chemical sink rates developed in TransCom-CH4 project (Patra et al. 2011): wetland and rice paddy emissions and soil sinks simulated with a process-based biogeochemical model (VISIT), biomass burning emissions of GFED v3.1, anthropogenic emissions of EDGAR v4.2, and interannually repeating termite emissions of GISS.

Annual mean of Siberian wetland CH4 flux was estimated to be 6.9 +/- 1.1 Tg/yr in 2006-2010 and high wetland flux was concentrated between (57.5N, 65.0E) and (67.5N, 90.0E) in West Siberia (called WL area), occupying 57% (3.9 +/- 0.2 Tg/yr) of the estimated Siberian wetland flux. The annual mean of WL area was very close to that for VISIT emission (3.8 Tg/yr), but a larger year-to-year variation was estimated in wetland flux of WL area (0.8 Tg/yr). A higher wetland flux of WL area was estimated in 2007 and 2008, but lower in 2006 and 2010. The enhanced wetland fluxes in 2007 and 2008 coincided with higher surface air temperature of NCEP/NCAR and greater precipitation of GPCP than those means in 1991-2010 over WL area and explained high CH4 concentration observed in May-Sep 2007 and 2008 at Demyanskoe and Karasevoe near extensive wetlands in WL area. The year-to-year variation of observed CH4 concentration was well reproduced with inverse model-estimated fluxes, showing high positive correlation between observed and predicted CH4 concentrations (r = 0.85 and 0.98 at Demyanskoe and Karasevoe, respectively). In WL area, we found a high positive correlation of annual mean of inverse model-estimated wetland flux with annual mean surface air temperature (r = 0.89) and liquid water equivalent thickness of GRACE (r = 0.92), but relatively low correlation (r = 0.37) for precipitation.

Acknowledgment: We thank to WDCGG data contributors for atmospheric CH4 observations and TransCom-CH4 project for developing a simulation setup.

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Comparative research on nitrogen dynamics with nitrogen isotope ratio of plant and soil among ecosystems

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Nitrogen isotope ratio (delta15N) of plant and soil is widely known as an indicator to trace the nitrogen movement in a ecosystem. Based on the global data collection of delta15N plant and soil, recent research has focused on the consistent trend of delta15N change with regions which has different climate(mean annual precipitation(MAP),mean annual temperature(MAT))(Austin and Vitousek 1998;Austin and Sala 1999;Schuur and Matson 2001;Amundson et al.2003). However the reasonable explanation which connects MAP difference, Nitrogen movement difference, and delta15N plant and soil difference among ecosystems does not exist so far. This study aims to clarify the above mechanism, and evaluate the water effect on delta15N plant and soil. For the purpose we have set the study sites with different water status in several spatial scales ; 2 regions which have extremely different MAP, Several sites with different MAP in each region, and several points along a slope which have different degree of nitrogen loss as leaching.

Taiga forest in northern Mongolia and temperate forest in Hokkaido (Japan) were selected as 2 regions. The MAP of study sites ranges 215~353mm, 701~1731mm in Mongolia and Hokkaido, respectively. From 2003 to 2012 the plant leaf (include wood and grass) and soil(0~50cm depth) were collected along the slope per one site, and analyzed for delta15N(per-mill vs.Air-N2), N content (wt per-cent), soil water content(wt per-cent),extractable nitrate (NO3-) and ammonium(NH4+) content in soil(mgN gdw-1).

Regional comparison between Mongolia and Hokkaido showed that delta15Nleaf had more variability and higher in Mongolia(-6~+6per-mill) than in Hokkaido(-8~0per-mill),although different plant species were compared. With respect to the smaller scale comparison along slope, delta15Nleaf decrease from upper to lower slope were observed at 5 of 7 sites in Mongolia, while no change at all sites in Hokkaido. One factor for the regional and slope scale difference in delta15Nleaf is nitrogen movement with water flow, however grazing effect in Mongolia should be as another factor. Combined the delta15Nleaf result to the other soil data result, we will discuss the water effect on delta15N plant,soil and regional difference in nitrogen movement.

Keywords: nitrogen isotope ratio, plant and soil, nitrogen movement, water status, taiga-grassland boundary, Mongolia

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Nitrogen as a controlling factor of larch growth in taiga-tundra ecotone in arctic region, northeastern Siberia

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Eastern Eurasia is covered by permafrost which is the largest and the deepest in the world, and in arctic region, larch dominated taiga-tundra boundary ecosystem, exists on it. It is expected that larch growth in arctic ecosystem is greatly affected by warming-mediated changes in soil moisture condition and possible availability of N. It is necessary to investigate the biogeochemical relationship between larch growth and soil property which governs soil N and soil moisture. Observations were conducted across the sites that varied in tree density and topography, near Chokurdakh (70.6°N,147.9°E), Sakha, Russia, in every July from 2009 to 2011. Photosynthetic rate, N content, C and N stable isotope ratios of needle, and needle mass as well as tree size were observed for larch. Besides, soil N and soil moisture were measured.

Wet area without trees growing showed considerable higher soil moisture than places grown by the trees. The needle delta C-13 was positively correlated with needle nitrogen content and needle mass across the sites. Needle N content was related to soil NH_4^+pool. The sites with higher the topography level and lower soil moisture showed larger needle mass and larger tree sizes than the sites with wetter condition. Nitrogen content of needle in the year was positively correlated with needle delta C-13 in the following year.

These results show that soil moisture plays an important role in larch survival and soil N availability contributes to larch growth, which is possibly limited by high soil moisture.

Keywords: Warming climate, Photosynthesis, Carbon stable isotope, Nitrogen availability

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Seasonal dynamics of nitrogen and source of nitrogen for larch in the taiga forest in north-eastern Siberia

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Nitrogen (N) is known to be one of the major limiting factors for plant growth in the northern hemisphere. CO_2 assimilation is directly related to N contents in the plant leaf as it is the major component of photosynthetic system.

We conducted the study on N dynamics at Spasskaya Pad Experimental forest station located near Yakutsk city, Russia in 2009-2011 years. Amount of N input with atmospheric deposition occurred to be very low (about 48 mgN m^{-2} $year^{-1}$). It was found that in the beginning of the growing season the content of inorganic N in the soil pool was very few (about 1 to 2 gN m^{-2} was observed at depth 0 to 50 cm mineral layer of soil). From the mid-July (when soil temperatures at 20 cm depth reached about 300 degree days) intensive mineralization of N started. The largest content of inorganic N was observed in the end of August (about 14 gN m^{-2} at the same soil depth). And then, in the beginning of the next growing season, soil inorganic N pool was small again, which indicated large amount of microbial immobilization. Ammonium dominated soil inorganic N pool. Amount of water extractable N in the soil was much lower than KCl extractable, because ammonium was bound to clay particles in the soil.

Results of tracer $^{13}C^{15}N$-amino acid, ^{15}N-ammonium and ^{15}N-nitrate experiments showed that larch did not uptake organic N and inorganic N was the source of N for larch. Also in the beginning of growing season amino acid was not mineralized to inorganic N within two days but rather stayed in the soil or was immobilized by microbes.

Allocation of N uptaken from soil by larch varied during growing season. N that was uptaken in the beginning of growing season (June) was used for the growth of new organs: new shoots and needles; however, N that was uptaken in the middle of growing season (from the mid-July) was stored in the tree perennial parts (branches, trunk and short branches carrying buds) to be used in the beginning of the next growing season. Also, retranslocation of N prior to needle senescence was very high (60 to 70% of needle N content).

Needle N content was affected by environmental conditions (soil water and temperature) in the previous growing season. This can be explained by observed discrepancy between timing of N mineralization by soil microorganisms (in the late summer) and plant N demand (in the beginning of summer during larch needle and new shoot formation). Needle N content affected amount of litterfall also with one year delay. Therefore, there was a positive relationship between N availability and amount of CO_2 assimilated by larch trees in the area of study.

Keywords: boreal forest, taiga, nitrogen cycle, organic nitrogen uptake, soil nitrogen pool, nitrogen allocation

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Impact of uncertainties in vegetation type on biomass burning emission estimates in Siberia

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Wildfires in Russia have the potential to influence regional and global climate systems through both direct and indirect effects due to the large carbon stocks accumulated in forests and peat bogs. Biomass burning emissions vary depending on vegetation type and fuel loading, current and past weather conditions, and topography, all of which affect fire behavior. Estimates of carbon emissions from fires in Russian boreal forests vary greatly depending on the methods and datasets used. The uncertainties in ecosystem types burned in Siberia were estimated on the basis of different vegetation maps (GLC-2000, Globcover-2009, MODIS Land Cover Collections 4 and 5, and the Digitized Ecosystem map of the Former Soviet Union). While there is an agreement in the overall trend in area burned by different land cover categories, there is substantial disagreement in ecosystems burned for the same year between these vegetation maps. Also, this variation differs from year to year, which results from the spatial heterogeneity of the land cover products. The difference in the estimated proportion of area burned by ecosystem type can vary 1.5-fold and more from lowest to highest values. This results in 60% and more difference in carbon emission estimates for Siberia. Verification and validation of land cover datasets along with the development of fuel maps and combustion models are essential for accurate Siberian wildfire emission estimates, which are needed in order to better understand the relationship between wildland fire emissions and changing climate, and to develop strategies to mitigate negative smoke impacts on the environment and human health.

Keywords: wildfires, land cover maps, carbon emissions, uncertainties, Siberia

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Fire impact on carbon emissions and ecosystems components in conifer forests of Siberia

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Fires cover annually millions ha of closed boreal forests, of which the biggest part is in Siberia. Emissions released from biomass burning influence atmospheric chemistry and global carbon cycling. In effort to assess fire influence on carbon balance, emissions, and forest ecosystem sustainability, experimental fires aimed at modeling fire behavior were conducted in larch and Scots pine stands of central Siberia in the framework of Fire Bear (Fire Effects in the Boreal Eurasia Region) Project. Carbon emission ranged 2.39 to 22.60 t C/ha in our experimental surface fires in Scots pine stands. The greatest amount of carbon released from feather moss, lichen, and forest floor burning (60-80% of the total carbon emission). A close correlation was found between fire carbon emission and weather conditions. Fire influenced all forest ecosystem components including the overstory, living ground vegetation, soil structure, microorganisms, and invertebrates. Our long-term experiments allowed us to identify vegetation succession patterns after fires of known behavior. Ground vegetation in Scots pine plots was determined to degrade after fires of any intensity, where it was dominated by small shrubs, lichens, and feather moss. The initial postfire succession stage is known to depend on site conditions, pre-fire forest type, and the last fire type and severity. Fires have a profound impact on forest-atmospheric carbon exchange and make ecosystem carbon sources for a long time after burning. Southern and central taiga Scots pine stands with lichen- and feather moss-dominated ground vegetation were carbon sinks prior to burning; they accumulated 1.4-1.7 t C/ha annually. First several post-fire years carbon efflux increased due to increasing tree mortality and duff accumulation. As a result, these stands functioned as carbon sources releasing -1.39 to -1.85 tC/ha/yr and -0.03 to -0.25 tC/ha/yr after a high- and a low-intensity fire, respectively. Fire frequency has increased in boreal forests over the past several decades and is expected to increase more under climate change. This would result in greater carbon loss and efflux to the atmosphere.

Keywords: forest fire, fire intensity, boreal forests, postfire succession, ecosystem, carbon balance

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Energy and mass exchange in a larch forest on permafrost in Central Siberia, Russia

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Summary.
Daily, seasonal and annual dynamics of energy and mass (water and carbon dioxide) exchange between the atmosphere and larch ecosystem was analyzed from eddy covariance measurements obtained during growing seasons of 2004, 2005, 2007, 2008. Ecosystem was found to be a carbon sink of a different strength: -53, -60, -67 and -107 g C m^{-2} $season^{-1}$ at these years respectively.

Abstract

Systematic long-term annual eddy covariance measurements in mature *Larix gmeilini* (Rupr.) Rupr. stand in permafrost area of Central Siberia, Russia (64^{o}16'N, 100^{o}12'E) were initiated in 2004 by the Institute of Forest, Krasnoyarsk, Russia and FFPRI, Tsukuba, Japan. Energy, water and CO_2 fluxes were analyzed from eddy covariance measurements obtained during growing seasons (June?early September, approximately 90 days).

Eddy covariance tower was installed in study area. Various meteorological parameters were measured by corresponding meteorological instruments and carbon dioxide and water vapor concentrations were measured by infrared gas analyzers. The sensors were installed at a height of 20 meters. Data for all meteorological and CO_2 parameters were registered every 10 sec and averaged for 30 min. The fluxes were calculated as covariances of 30-min. high-frequency time series of vertical wind velocity with air temperature, $H_2$0, or CO_2 atmospheric concentrations. Half-hourly values of each parameter were elaborated using criteria the eddy covariance method (Baldocchi et al. 1988, Foken and Wichura 1995, Baldochhi et al. 1996, Nakai et al. 2008).

Found that daily average air temperature and relative air humidity were 10-15^{o}C and 50-70% respectively. Under these conditions daily maximum half-hourly NEE reached 9-11 mcmol m^{-2} s^{-1} in 2007 and 2008 years and 5-6 mcmol m^{-2} s^{-1} in 2004 and 2005. It was observed in mid July and associated with maximum of precipitation in these months. Daily CO_2 flux dynamic has similar pattern for years we studied. Comparing to another ecosystems our data are close to *Larix cajanderi* Mayr in Central Yakutia (-7 mcmol m^{-2} s^{-1}, Schulze et al. 1999) and *Picea mariana* (P. Mill.) B.S.P. in North America (-9 -10 mcmol m^{-2} s^{-1}, Jarvis et al. 1997; Pattey et al. 1997). Established that flux dioxide rate has positive correlation with relative humidity (R=0,51) and negatively correlated with air temperature (R=-0,47).

Daily averages CO_2 assimilation in the beginning of growing season were 1 g C m^{-2} day^{-1}. At the end of June it increased up to 4 g C m^{-2} day^{-1}, in July ? up to 4,6 g C m^{-2} day^{-1} (with peak values reached 7,7 g C m^{-2} day^{-1}). August is characterized by decreasing of assimilation rate to 2,5 g C m^{-2} day^{-1}. Ecosystem daily average emission slightly increases from 0,8 g C m^{-2} day^{-1} at growing season beginning to 3-4 g C m^{-2} day^{-1} at its end. Carbon dioxide NEE decreases during growing season from 3 g C m^{-2} day^{-1} to 1,2 g C m^{-2} day^{-1}. In wet seasons (2007, 2008) daily averages values of assimilation and emission increases as much as 2-4 times when net exchange increases as much as 1.5-2.5 times only.

Thus, seasonal NEE in northern larch ecosystem on continuous permafrost varies from -53 to -107 g C m^{-2} $season^{-1}$ increasing according to the amount of precipitation.

The data obtained were compared with that of Scots pine ecosystem located on frostless area (Tchebakova 2006). Larch forest is characterized by CO_2 exchange maximal rate of 9-11 mcmol m^{-2} sec^{-1}, emission of 86,6 g C m^{-2}, assimilation of -159,1 g C m^{-2} and NEE of -72,5 g C m-$^{-2}$ versus that of Scots pine forest being equal to 10-12 mcmol m^{-2} sec^{-1}, 372 g C m^{-2}, -534 g C m^{-2} and -156 g C m^{-2} respectively.

The estimations of seasonal ecosystem carbon dioxide exchange obtained in Gmelin larch ecosystem appeared to be the lowest among both Siberian larch forests and boreal ecosystems worldwide.

Keywords: CO2 exchange, permafrost, Siberia, larch ecosystem, eddy covariance

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Investigation of Effects of Transported Aerosols over Semi-arid Region in Indian Subcontinent

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Semi-arid regions located in between arid and sub humid areas, mainly situated in the mid-latitude inner continental areas where potential evaporation dominates over the precipitation, play an important role in the climate change. Recent research works reported that semi-arid regions are sensitive areas for causing the climate change due to continuous changing in atmospheric composition by recent growing anthropogenic activities. This paper presents radiative effects of high altitude atmospheric aerosols using ground-based measurements over Mt. Abu (24.65^o N, 72.786^o E, 1.7 km asl) and multi-satellite observations over Indian semi-arid region centered over Mt. Abu during December 2006 - June 2007. Ground-based and space-borne measurements and back-trajectories analysis indicate that significant pollutants are transported to over the semi-arid region from Indo-Gangetic Basin (IGB) during Dec-Apr while desert dust dominated during Mar-Jun. Thereby, during Mar-Apr (MA), there is existence of both, dust and pollutants, at high-altitudes making the period very important to be investigated. Transported pollutants result in high BC of about 0.84 and 0.86 micro-g m^{-3} at Mt. Abu during Dec-Feb (DJF) and MA, and low of about 0.31 micro-g m^{-3} during May-Jun (MJ). However, AOD is observed to be a minimum of about 0.09 during DJF and maximum of about 0.18 during MA, followed by 0.16 during MJ. Mt. Abu experiences shallow winter-time boundary layer aerosols within 2 km which cause minimum AOD during DJF. However during MA, pollutants and desert dust are loaded within 6 km which maximize AOD at hill-top region while only desert dust contributes for AOD during MJ. The contribution of hill-top AOD to the total columnar AOD is only 10% during DJF while it is 55% and 50% during MA, and MJ, respectively, showing that pollutants and desert dust contribute maximum to AOD. In the present study, radiative transfer code is used to estimate high-altitude atmospheric aerosol radiative forcing and heating rate in fine atmospheric layers of 100 meter thickness and found to be about 4.6, 18.8, 13.8 Wm^{-2} and 0.2, 0.42, 0.22 K day^{-1} during DJF, MA, and MJ, respectively. The contribution of high-altitude aerosols to total columnar aerosol heating rate is found to be a maximum of about 30% during MA, followed by 25% during MJ and 15% during DJF. This high contribution in warming effect due to coexistence of dust and BC layers during MA can cause significant changes in hydrological cycle over the Indian subcontinent.

Keywords: Dust, Black Carbon, Transport, Semi-Arid Region