Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

ACG033-01 Room:201B Time:May 25 14:15-14:30

Numerical simulation of stratospheric sudden warming in January 2009 using NICAM and the reconsideration of gravity wave

Hiroshi Tanaka[1*], Yoshihiro Yashiro[1]

[1]CCS University of Tsukuba

In this study, the major stratospheric sudden warming (SSW) occurred in January 2009 is simulated using the cloud-resolving non-hydrostatic global model NICAM with G-level 10 (7 km resolution). The results of the prediction are compared with the operational prediction by the Global Spectral Model (GSM) of the JMA with 20 km resolution. According to the results, the major warming was predicted well by NICAM, but the intensity was weaker than the observation and GSM. However, the deceleration of westerly of the polar night jet was stronger in NICAM than GSM. It is interesting to note that large amplitude gravity waves are superimposed in NICAM on the planetary waves of the wavenumber 2 type SSW. Those gravity waves are not seen in GSM and they have been parameterized as the gravity wave drags in the previous global models. We find by NICAM that the stratospheric circulation is filled by abundant gravity waves as inferred by previous observations.

Keywords: Stratospheric Sudden Warming, Cloud resolving GCM, NICAM, Gravity wave drag, Gravity waves, PSC

Japan Geoscience Union Meeting 2011
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ACG033-02 Room:201B Time:May 25 14:30-14:45

PSCs in the Northern Hemisphere and Southern Hemisphere Simulated by the Global Cloud Resolving Model NICAM

Takuro Aizawa[1*], Hiroshi Tanaka[2], Ohya Manami[1], Hideaki Nakajima[3]

[1]Life and Env. Sci., Univ. of Tsukuba, [2]CCS, University of Tsukuba, [3]NIES

In this study, a cloud-resolving atmospheric general circulation model NICAM is applied to numerical simulations with a simple cloud microphysics scheme g98 of polar stratospheric clouds (PSCs). NICAM (Nonhydrostatic ICosahedral Atmospheric Model) is developed and being improved by Atmosphere and Ocean Research Institute, University of Tokyo and Frontier Research Center for Global Change/Japan Agency for Marine-Earth Sciences and Technology, and is installed at the high-performance computing system T2K-Tsukuba at University of Tsukuba.

PSCs are optically thin clouds which appear regularly in the winter polar stratosphere at 15 to 25 km altitudes. PSCs are divided into Type I and Type II depending on their forming temperature. Type I is called NAT (Nitric Acid Trihydrate) and appears at temperature below 189.1K (-77C) about 55hPa (19km altitudes), and Type II are ice particles that form when the temperature falls below -84C.

Keywords: NICAM, Polar Stratosphere Clouds, Cloud ice mixing ratio

Japan Geoscience Union Meeting 2011
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ACG033-03 Room:201B Time:May 25 14:45-15:00

Increased stable carbon isotopic ratios of dicarboxylic acids in the Arctic aerosols during and after polar sunrise

Kimitaka Kawamura[2*], Leonard Barrie[1]

[1]Hokkaido University, [2]The Cyprus Institute

Stable carbon isotopic ratios (d13C) of low molecular weight dicarboxylic acids and ketocarboxylic acids were measured in the Arctic aerosols collected from late winter to early summer including dark winter and polar sunrise seasons after derivatization to butyl esters and/or dibutoxy acetals using a capillary gas chromatography combined to on-line combustion/isotope ratio mass spectrometer. We found that d13C of oxalic acid (C2) increased from -23 permil in early March (before polar sunrise) to -5 permil in May (after polar sunrise). Malonic acid (C3) also showed an increase of d13C from late February (-25 permil) to May 8 (-17 permil). Glyoxylic acid (2-oxoethanoic acid), a precursor of oxalic acid, also showed similar increase from -18 permil in late February to -10 permil in May. In contrast, isotopic composition of succinic acid (-32 permil to -24 permil) did not show a systematic trend. Concentrations of oxalic acid and glyoxylic acid preferentially declined when the isotopic ratios of C2, wC2 and C3 increased. We interpret that the enrichment of 13C occurred in the course of increased solar radiation during polar sunrise as a result of preferential decomposition of small diacids and ketoacid that are enriched with 12C. We consider that 12C-12C bond decay preferentially over 12C-13C bond of oxalic and other acids during photochemical decomposition. Here, we propose that d13C of oxalic acid can be used as a tracer to evaluate photochemical aging of organic aerosols.

Keywords: Arctic, Aerosols, Water soluble organic compounds, Dicarboxylic acids, Stable carbon isotopic composition

Japan Geoscience Union Meeting 2011
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ACG033-04 Room:201B Time:May 25 15:00-15:15

Studies of the upper atmosphere in the arctic region from observations and numerical simulations

Hitoshi Fujiwara[1*], Yasunobu Ogawa[2], Yoshihiro Tomikawa[2], Satonori Nozawa[3], Yasunobu Miyoshi[4], Hidekatsu Jin[5], Hiroyuki Shinagawa[5]

[1]Dept. of Geophysics, Tohoku University, [2]National Institute of Polar Research, [3]STEL, Nagoya University, [4]Kyushu University, [5]NICT

The polar upper atmosphere shows significant variations due to the energy inputs from the solar X-ray and EUV radiation and from the magnetosphere. The auroral phenomena are manifestation of the energy inputs from the magnetosphere. In addition, recent observational and simulation studies have revealed spatio-temporal variations in the upper atmosphere caused by effects from the lower atmosphere. For example, decrease and increase in temperature are found in the mesosphere and lower-thermosphere, respectively, during sudden stratospheric warming (SSW) events. The ionospheric electrons also vary due to upward-propagating tidal waves during SSW events. The problem of the global warming is one of the main interests in the world in the 21st century. The temperature in the upper atmosphere seems to show decreasing trend during several decades, suggesting the global cooling in the region. The increase of greenhouse gases warms the troposphere while cooling the middle and upper atmosphere. In addition, some people reported visually-apparent noctilucent clouds in the mid-latitude region for several years. This also suggests decrease in temperature in the mesosphere. As mentioned above, the polar upper atmosphere is strongly coupled with the upper and lower regions (the magnetosphere or near Earth space, troposphere, and stratosphere) through the processes of energy and momentum transfer and photochemical processes. The sciences of the coupling regions will enable us to open up the area for the atmospheric science and to take a broad view of the Earth's environment.

We present an overview of our research activities in the arctic region. Some research projects using radars and optical instruments, which have been developed for several decades, and numerical models (e.g., Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy: GAIA) are shown in this presentation as well as some research products.

Keywords: Upper Atmosphere, atmospheric vertical coupling, aurora, noctilucent cloud, radar-optical observations, numerical simulation

Japan Geoscience Union Meeting 2011
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ACG033-05 Room:201B Time:May 25 15:15-15:30

Satellite monitoring for the Arctic sea ice thickness

Kazutaka Tateyama[1*], Hiroyuki Enomoto[1]

[1]Kitami Institute of Technology

Arctic Ocean freezes up entirely in winter, about 60 % of ice such as second-year and multi-year ice survives over summer. Summer sea ice reflects 90% of sunlight. Therefore it has an important role in cooling as a radiator of earth system. In 2007, a large decrease occurred beyond the the Global Warming scenarios [Levinson and Lawrimore, 2008; Strove et al., 2008]. Changing the Arctic Ocean into seasonal ice covered area may accelerate global warming larger. On the other hand, a remarkable multi-year ice thinning (0.5m/decade) have been reported from field observations [Rothrock et al., 2008]. Those field observations were limited time and place has been. Therefore developing of quantitative satellite monitoring of sea ice thickness is one of the important for international research project.

This study aims to estimate the Arctic sea ice thickness from satellite sensors based on the field observations in the Canada Basin using an electromagnetic induction ice thickness profiler (EM) and passive microwave radiometer (Passive Microwave Radiometer: PMR) mounted on the icebreakers since 2008. An ice thickness estimation algorithm has been developed from the record of EM thicknesses and PMR brightness temperatures distribution. this algorithm applied to satellite PMR data to survey long-term changes of Arctic ice thickness since 1978.

Keywords: Arctic Ocean, Sea ice thickness, Satellite remote sensing

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

ACG033-06 Room:201B Time:May 25 15:30-15:45

Interannual changes in sea ice conditions on the Northern Sea Routes obtained by satellite microwave sensors

Hiroki Shibata[1*], Koh Izumiyama[2], Kazutaka Tateyama[1], Hiroyuki Enomoto[1], Shuhei Takahashi[1]

[1]Kitami Institute of Technology, [2]North Japan Port Consultants Ltd.

This study sets seven sea areas and three temporal segmentations for the analysis of NSR and examined sea ice area by sea area using data obtained from SMMR, SSM/I and AMSR-E. In analyze using SMMR and SSM/I, the results indicated the sea ice was in the decreasing tendency from first phase to third phase. Recently sea ice area decreased in third phase compared with in first phase and second phase as an example in southwestern Chukchi Sea and western East Siberian Sea. And, we research region that sea ice conditions was severe in first phase like western Laptev Sea, northeastern Kara Sea and eastern East Siberian Sea. In third phase, western Laptev Sea and northeastern Kara Sea is still severe region for navigation. On the contrary, in eastern East Siberian Sea, sea ice area was a decreased greatly in third phase comparison with first phase and second phase. Furthermore, we analyzed sea ice area using AMSR-E data because we analyzed by high resolution data. Most sea ice disappears during summer in the sea near doorway of Arctic Ocean such as southwestern Chukchi Sea and southwestern Kara Sea. Sea ice area in western Laptev Sea was severe region as well as analysis using SMMR and SSM/I. Also decrease of sea ice in western Laptev Sea was hardly seen during 2007 that sea ice decreases remarkably. In analysis of standard deviation, western Laptev Sea indicated high values. Therefore around western Laptev Sea is key area for navigation such as prediction of sea ice condition or sailing plan of ship.

Keywords: Sea ice, Arctic Ocean, Northern Sea Route

Japan Geoscience Union Meeting 2011
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ACG033-07 Room:201B Time:May 25 15:45-16:00

Detection of Melt Pond in the Acrtic

Yasuhiro Tanaka[1*], Kazutaka Tateyama,[1], Shuhei Takahashi[1], Hiroyuki Enomoto[1], Shuki Ushio[2]

[1]Kitami Institute of Technology, [2]National Institute of Polar Research

Once ice area decrease by the ice-albedo feedback effect, it depends and absorbs short wave radiation because the open water increase, and reflectance falls and promotes melting. This becomes important to understand arctic climate change. In recent years, a number of melt pond is molded in arctic sea ice surface with arctic sea ice area decrease. There seems to be promotes melting ,and absorption of the sunlight on the sea ice increases by a feedback effect when rate of melt pond on the sea ice increase.

This study analyzed melt pond and ice concentration distribution by using icebreaker in situ data in the Arctic Ocean by American observation project HOTRAX2005 from August September in 2005, by a Chinese observation team August 9 from September 4 in 2008, by observation project JOIS2009 of Canada from September 17 to October 15 in 2009. Sea ice and melt pond distribution was obtained by the front camera image on boaded on icebreaker.

The result are shown in figure. In 2005, the highly ice-covered area(over 90%) successively seen from 78N to 84N of section and melt pond is formed to Arctic center neighborhood. In 2008, latitude is the higher, the increaser tendency ice concentration, but the highly ice-covered area is not seen. In comparison with 2005, melt pond develops, and sea ice melting to developing. In 2009, melt pond is not almost seen because there was observation of after the freeze began.

Keywords: Detection of Melt Pond in the Acrtic

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

ACG033-08 Room:201B Time:May 25 16:00-16:15

The GreenLand Ice Sheet monitoring Network (GLISN)

Masaki Kanao[1], Seiji Tsuboi[2*], Yoko Tono[2], Tetsuto Himeno[1], Genti Toyokuni[1]

[1]NIPR, [2]JAMSTEC

The Greenland Ice Sheet and its response to climate change have potentially a great impact upon mankind, both through long-term sea level rise and through modulation of fresh water input to the oceans. Internationally monitoring the dynamic response of the Greenland Ice Sheet to climate change is a fundamental component of long-term observational efforts for monitoring climate change. Glacial earthquakes have been observed along the edges of Greenland with strong seasonality and increasing frequency since 2002 (Ekstrom et al, 2003, 2006) by continuously monitoring data from the Global Seismographic Network (GSN). These glacial earthquakes in the magnitude range 4.6-5.1 may be modeled as a large glacial ice mass sliding downhill several meters on its basal surface over duration of 30 to 60 seconds. The detection, enumeration, and characterization of smaller glacial earthquakes are limited by the propagation distance to globally distributed seismic stations, i.e., the Global Seismographic Network (GSN) with the International Federation of Digital Seismograph Networks (FDSN). Glacial earthquakes have been observed at seismic stations within Greenland (Larsen et al, 2006), but the current coverage is very sparse. In order to define the fine structure and detailed mechanisms of glacial earthquakes within the Greenland Ice Sheet, a broadband, real-time seismic network needs to be installed throughout Greenland's Ice Sheet and perimeter. The International Polar Year 2007-2008 was a good chance to initiate this program with international collaboration. All of the partners are committed to free, unrestricted, open access to all data from The GreenLand Ice Sheet monitoring Network (GLISN) in real-time. In this presentation, seismicity around the Greenland region, including glacial related signals are presented with discussion associated with recent global warming.

Keywords: Greenland, global warming, glacial earthquakes, broadband seismometer, monitoring

Japan Geoscience Union Meeting 2011
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ACG033-09 Room:201B Time:May 25 16:30-16:45

New progress in the structure of Arctic Environmental Research

Tetsuo Ohata[1*], Takashi Yamanouchi[2], Tetsuzo Yasunari[3], Hiroyuki Enomoto[4]

[1]JAMSTEC, [2]NIPR, [3]Nagoya University, [4]Kitami Institute of Technology

Arctic is the region where the global warming is mostly amplificated, and the atmosphere/ocean/cryosphere/land system is changing. Since last year, new move on the Arctic Environmental Research (AER) has started at MEXT. Arctic Research Examination Working Group was formed under the Earth Observation Promotion Committee. Discussion on the future of the AER was made at this Committee, and determination of important research themes, formation of Consortium, and development of new Program on Arctic Climate variation was proposed in July 2010. Afterwards, there were actions to realize this, and now a new research structure in Japan is being developed (February, 2011). This presentation will inform the latest condition about the new structure of AER to Arctic Scientists.

Keywords: Arctic, Environment, Global Warming, Promotion, Cryosphere

Japan Geoscience Union Meeting 2011
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ACG033-10 Room:201B Time:May 25 16:45-17:00

Observation of spectral reflectance of boreal forest in Alaska for GCOM-C/SGLI

Rikie Suzuki[1*], Shin Nagai[1], Taro Nakai[2], Yongwon Kim[2], Hideki Kobayashi[1]

[1]RIGC, JAMSTEC, [2]IARC, UAF

The ”Second-generation Global Imager (SGLI)” of the satellite ”Global Change Observation Mission (GCOM)-C”, planned in 2014 or 2015, is a multi-viewing angle optical sensor. The sensor observes the reflected radiation from the land surface at 45 degree slant viewing angles (forward and backward along the orbit) in addition to the nadir. This function enables us to consider the Bidirectional Reflectance Factor (BRF) of the forest, and to construct robust 3D forest radiative transfer models for the simulation of the forest structure included Leaf Area Index (LAI) and above-ground biomass. To acquire *in-situ* BRF data of the forest for the validation of GCOM-C/SGLI data, we carried out the survey of BRF at a boreal forest in Alaska.

A black spruce forest, a typical boreal forest in Alaska, located in the Poker Flat Research Range (PFRR) of University of Alaska Fairbanks (210 m MSL) was targeted. Since the forest homogeneously extends about 500 m wide and the terrain is relatively even, this forest site is highly suitable for the validation of the remote sensing measurement. The tree stand ($>$ 1.3m) density was about 4000 tree/ha.

The observation of the BRF was taken place around the noon of July 7 and 8, 2010 from the top of the tower (17 m) that was constructed in the forest by the JAMSTEC and IARC Collaboration Study (JICS). We measured the reflected irradiance from the forest by the spectroradiometer (MS-720; EKO Instruments) changing the viewing angle from 20 to 70 degrees and -20 to -70 degrees (off-nadir angle; positive and negative angles mean forward and back scatter angles, respectively) with 5 degrees step in the principal plane and the orthogonal (cross) plane. The global radiation was simultaneously measured by the other spectroradiometer for the calculation of the reflectance.

The BRF in the principle plane showed a kind of bowl-shape distribution with its minimum and maximum at approximately 30 and -70 degrees in visible and near-infrared bands, respectively, that is, the forward scatter was generally smaller than the back scatter. However the Normalized Difference Vegetation Index (NDVI) showed larger value in the forward scatter than in the back scatter. The observation in snow-cover season is planned in March 2011.

Keywords: boreal forest, 3D radiative transfer model, leaf area index, BRDF, black spruce, satellite remote sensing

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ACG033-11 Room:201B Time:May 25 17:00-17:15

Study of the ice changes in Southeast Alaska based on the geodetic observations on the ground

Tadahiro Sato[1*], S. Miura[1], W. Sun[2], T. Sugano[3], Y. Ohta[1], H. Fujimoto[1], D. Inazu[1], C.F. Larsen[4], A.M. Kaufman[4], R.J. Motyka[5], J.T. Freymueller[4]

[1]RCPEVE, Tohoku Univ., [2]G. Univ., Chinese Academy of Science, [3]ERI, Univ. Tokyo, [4]Univ. Alaska, Fairbanks, [5]Univ. Alaska, South East

Southeast Alaska (SE-AK) shows very rapid uplifting (peak rate exceeding 30 mm/yr), which is mainly caused by Glacier Isostatic Adjustment (GIA) due to the unloading effects of the past-ices and the present-day ice changes. Geodetic observations with GPS and Absolute Gravity (AG) carried out in SE-AK clearly detect the effects of ice changes. Comparisons between the observed rates and the model predictions indicate that, in the order of the magnitudes, three of the LIA ices, the present-day ices (PDI) and the LGM ices contribute to the observed gravity and uplift rates. An important result obtained from the comparisons is; The observations clearly detect not only the effects of the PDI changes but also their rate changes that is considered to be an effect of the recent global warming. From the study in SE-AK, we have confirmed that combining the GPS observation with the AG observation provides useful data to study the ice changes in the glacial areas and to discuss the effects of the past-ices and the PDI separately. On the other hand, the AG and GPS observations on the ground will also provide useful data to be applied to the calibration and the validation of such satellite measurements as GRACE, GOCE and IceSat and so on.

Keywords: Southeast Alaska, glacier changes, Absolute gravity observation, GPS observation, load deformation, global warming

Japan Geoscience Union Meeting 2011
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ACG033-12 Room:201B Time:May 25 17:15-17:30

A wildfire monitoring system as a platform of remote sensing study

Koji Nakau[1*]

[1]JAXA/EORC

Wildfire emits carbon into atmosphere for 1.7 to 4.1GtC/yr in entire earth (IPCC AR4, Mack et al. 1996, Andreae et al. 2001). Although this amount corresponds to 3-5% of GPP (Gross Primary Product), it corresponds around one quarter to one half amount of GHGs emission by anthropogenic fuel combustion. With consideration of existence of much human induced wildfire, this amount should not be negligible. Thus, studies of accurate impact of wild fire are quite important for climate study as well as disaster management of wild fire.

On the other hand, Arctic and Subarctic region is suitable for research and development of wildfire remote sensing, because frequent observation comparing low- and mid- latitude area and because much fire occur in this area. Therefore JAXA is developing a wildfire monitoring system in IJIS (IARC-JAXA Information System) and IJ-Dir (IARC-JAXA Research Directory) system.

In IJ-Dir system, not only holding meta-data of research activities related to IARC but also satellite imagery including RGB, infrared and hotspots of wildfire as near real time products of MODIS. We can overlay our own research plots and wildfire hotspots over MODIS RGB or Infrared imagery on same day.

This system is easy for researchers to handle satellite imagery and to compare their own ground observation datasets and satellite imagery as a first step of remote sensing study using satellite imagery. Therefore it should be useful for making a plan of ground observation, or should be useful to induce a new remote sensing study by researchers who is not specialist of remote sensing.

Keywords: Remote sensing, Arctic, Forest fire, Wildfire, Disaster

Japan Geoscience Union Meeting 2011
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ACG033-13 Room:201B Time:May 25 17:30-17:45

Global Warming and the Human-Nature Dimension in Siberia

Tetsuya Hiyama[1*], Yasushi Yamaguchi[2], Takeshi Ohta[3], Hiroki Takakura[4], Gen Inoue[1]

[1]RIHN, Japan, [2]GSES, Nagoya University, Japan, [3]GSBS, Nagoya University, Japan, [4]CNAS, Tohoku University, Japan

Siberia is one of the areas where global warming will be evident. Perceivable changes in the ecosystem and cryosphere environment have already been reported such as damage to the forest or frequent flood. We have launched a research project in 2009 at Research Institute for Humanity and Nature (RIHN) to elucidate following three aspects in Siberia, from both the natural and the human social science perspectives. These are, 1) grasp of variations in water and carbon cycles and predictions into the near future, 2) field observation of the characteristics of the water and carbon cycles including those environmental driving forces, and 3) understanding of the capability of multi-ethnic people, who have historically unique social systems, to adapt to the changes in climate and terrestrial ecosystem. The Lena River Basin in Eastern Siberia, in which larch forest occupies the region in spite of little precipitation because of the existence of permafrost, has been selected as the epitome of the global warming. In order to achieve the goals, three research groups were organized. The Siberia bird's-eye group (Group 1) tries to understand the climate and the social changes using climatic and satellite remote sensing data, from the bird's eye point of view. The water cycle and ecosystem interaction process study group (Group 2) makes clear interaction between the climate and the vegetation through dendrochronology, isotope-analysis, flux monitoring, and hydrological aspects. The human ecology group (Group 3) seeks to elucidate influence level on the residential life in the city and agricultural districts in Eastern Siberia. The culture and the social system of the minorities are also studied to address the environmental adaptation. In this presentation, we will introduce the research structure and some new results of this project.

Keywords: global warming, permafrost, taiga, flood, adaptation

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ACG033-14 Room:201B Time:May 25 17:45-18:00

Remote sensing of burnt moss fractional areas during an Alaskan spruce forest fire

Keiji Kushida[1*], Shiro Tsuyuzaki[2], Masami Fukuda[3]

[1]University of Toyama, [2]Hokkaido University, [3]Alaska University

We evaluated the fractional area of burnt mosses during wildfires in an Alaskan black spruce forest. The spectral reflectance of the burnt areas, live mosses, and damaged mosses were measured just after a forest fire in a black spruce forest, interior Alaska. These spectral data was used for estimating the fractional areas of these landcovers after Alaskan black spruce forest fires from the moderate resolution imaging spectroradiometer (MODIS) sensor onboard Terra satellite. The accuracy of the estimation was evaluated by comparing with the fractional areas interpreted from aerial photographs acquired from an airplane. The fractional moss burnt areas concern with vegetation recovery after fire as well as carbon dioxide release during the combustion.

Keywords: Remote sensing, boreal forest, wildfire

Japan Geoscience Union Meeting 2011
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ACG033-15 Room:201B Time:May 25 18:00-18:15

Sedimentary organic matter variations in the Chukchi Borderland since the last interglacial period

Stephan Rella[1*], Masao Uchida[1]

[1]NIES, Tsukuba

It is well established that anthropogenic climate change has a particularly strong impact on the Arctic through decreasing sea ice extent, northward vegetation shifts, permafrost thawing, changes in the hydrological cycle, coastal erosion, river discharge and marine productivity. These changes in turn lead to changes in carbon cycling potentially affecting atmospheric carbon dioxide and methane concentrations. In order to assess the future impact of anthropogenic influence on the carbon cycle in the Arctic, it is essential to reconstruct the range of natural carbon cycle variation and associated environmental conditions during the last glacial-interglacial cycle. For this reason sediment piston cores have been recovered in recent years from the so far poorly studied continental margins of the Chukchi Borderland region, an area potentially strongly responding to climate change through changing ocean currents, summer sea ice extent, as well as variable marine and terrigenous organic matter supply. In this study we would like to present organic matter variations in the Chukchi Borderland since the last interglacial period and discuss implications for oceanic and climatic conditions in the Chukchi Sea area and adjacent land masses.

Keywords: organic carbon, coastal erosion, freshwater influx, glacial-interglacial cycle, sediment transport

Japan Geoscience Union Meeting 2011
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ACG033-16 Room:201B Time:May 25 18:15-18:30

Effect of vegetation change upon the polar amplification

Ryouta O'ishi[1*], Ayako Abe-Ouchi[1]

[1]AORI, the University of Tokyo, [2]JAMSTEC

In the present study, we investigated the effect of vegetation change upon the polar amplification in two warming experimants, 6ka (climate optimum) and doubled atmospheric CO2, using an atmosphere-ocean-vegetation coupled general circulation model. The result indicates vegetation change and related albedo-feedback in both experiments strengthenes the polar amplification.

Keywords: GCM, Atmosphere-vegetation interaction, polar amplification

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ACG033-P01 Room:Convention Hall Time:May 25 10:30-13:00

Northern Hemisphere atmospheric blocking in 228-year ensemble simulation with the MRI-AGCM3.2

Mio MATSUEDA[1*], Hirokazu ENDO[2]

[1]JAMSTEC, [2]MRI

In this study, we conducted 228-year ensemble integration using a 60-km-mesh MRI-AGCM (TL319L64). Model integration was conducted for the period 1872-2099 using observed and prescribed, interannually varying SSTs as lower boundary conditions. The prescribed SST was estimated by the CMIP3 multi-model ensemble mean to which the detrended interannual variations in HadISST have been added. The IPCC SRES A1B scenario was assumed for future emissions of greenhouse gases. We focused on Euro-Atlantic (EA) and Pacific (PA) atmospheric blockings in winter (November-February) and summer (May-August).

The TL319L64 AGCM performs well in simulating the blocking frequency and duration throughout the year, compared with the NCEP/NCAR reanalysis data for the period 1950-2005. It is known that there are significant relationships between PA blocking and the El Nino(EL)/La Nina(LA) conditions: wintertime western PA blocking is observed more frequently during the LA condition than during the EL condition, whereas wintertime eastern PA and summertime PA blockings are observed more frequently during the EL condition than during the LA conditions. The relationships between the PA blocking and the EL/LA conditions are well simulated for the period 1950-2005. No apparent relationships between EA blocking and the EL/LA conditions are observed and simulated for the period 1950-2005.

In terms of the timeseries of simulated areal-mean blocking frequency for the period 1872-2099, the wintertime EA blocking frequencies show the most remarkable decreasing trend, whereas the summertime EA blocking frequencies show a decrease trend mainly in the 21st Century. Given that EL condition is predicted to be preferable in the future climate and that there are no possible relationships between the EA blocking and the EL/LA conditions, the reduction in the EA blocking frequency might result from other possible reasons. On the other hand, the wintertime western and eastern PA blocking frequencies show decreasing and increasing trends for the period 1872-2099, respectively. The trends in the PA blocking frequency might be related to preferable EL condition in the future climate, unlike that in the EA blocking frequency.

Keywords: high-resolution climate model, atmospheric blocking, extreme events, long-term variation

Japan Geoscience Union Meeting 2011
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ACG033-P02 Room:Convention Hall Time:May 25 10:30-13:00

Estimation of global warming trend without the contributions from decadal variability of the Arctic Oscillation

Yuta Nagato[1*], Hiroshi Tanaka[2]

[1]University of Tsukuba, [2]CCS, University of Tsukuba

Climate change associated with recent global warming is most prominent in the Arctic and subarctic. The Arctic Oscillation (AO) is a dominant atmospheric phenomenon in the Northern Hemisphere characterized as opposing atmospheric pressure patterns between the middle and high latitudes. Decadal variability of surface temperature associated with the Arctic Oscillation Index (AOI) shows high correlation with recent global warming trend.

In this study, recent global warming trend is separated in contributions from increasing anthropogenic greenhouse gas and decadal variabilities by the AO.

It is found that the AO is an atmospheric eigenmode with zero eigenvalue, excited mostly by internal nonlinear dynamics. AO may thus be regarded as a natural variability which is basically unpredictable. According to our analysis, the global mean temperature decreased during 1940-1970 associated with the negative AOI. The global warming pattern in the Northern Hemisphere shows that the rapid warming during 1970-1990 contains a large fraction of natural variability due to the AO. Conversely, the period 1990-2010 indicates a clear negative trend AOI. The global warming seems to have ceased in response to the recent negative trend of the AOI. There is a considerable decadal variability of the global mean temperature associated with the natural variability due to the AO.

However, it is found in this study that the AO has large amplitude in local as EOF-1, but the AO is almost dynamically orthogonal to the global warming component for the global mean. The AO can be related to the decadal variability of the global mean temperature only through the feedback by climate sub-systems.

Keywords: Arctic Oscillation, Global warming, Decadal variability

Japan Geoscience Union Meeting 2011
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ACG033-P03 Room:Convention Hall Time:May 25 10:30-13:00

Cimate - ice-sheet - vegetation system in the Arctic region during the mid-Pliocene warm period

Youichi Kamae[1*], Hiroaki Ueda[1], Akio Kitoh[2]

[1]Life and Environ. Sciences, Tsukuba Univ, [2]MRI

The most prominent climate change is appeared in the Arctic region under the global warming through the atmosphere-ocean-sea ice-land interaction. Paleoclimatic studies about the Arctic climate variability during the past warm/cold periods (e.g., mid-Holocene, last glacial maximum, last interglaciation) could help for the future warming projection (e.g., Otto-Bliesner et al. 2006). The warmer climate sustained for long time during the mid-Pliocene warm period (MPWP) when the atmospheric CO2 concentration is higher (360˜425ppmv) and the global-mean surface temperature is higher (˜+3K) than the pre-industrial value. The efforts for simulating the climate in this interval are expected to make substantial contributions to advanced validation of climate models predicting future climate change (e.g., Jansen et al. 2007). The reconstruction of the sea surface temperature during MPWP by the deep sea sediments (Haywood et al. 2010) revealed extremely warmer environment particularly around the northern North Atlantic Ocean. The integrated study about the paleobotanical proxy data showed relatively small ice sheet and poleward shift of the boundaries between temperate forest, boreal forest, and tundra during MPWP (Salzmann et al. 2008) which means the significantly warm climate in the high latitude region.

Although the proxy records are not enough for the sea-ice reconstruction during MPWP for the reasons of the restriction of the geological data, the estimation for the amount of the perennial sea ice by use of the benthic foraminifera accumulation rate and the reconstructed sea surface temperature. Robinson (2009) revealed the possibility about the extremely warmer sea surface (˜+18K) than the present day and the seasonal ice-free condition during MPWP estimated from Ocean Drilling Program Sites in the Nordic Seas and the Arctic Ocean based on the ratio of magnesium to calcium in foraminifera and the alkenone unsaturation indices. These new data imply a major reduction of sea ice during MPWP similar to what has been observed in recent summers.

The climate system during MPWP is an example for the equilibrium system under the higher atmospheric CO2 concentration containing the ”slow feedback of the vegetation and ice sheet” (Lunt et al. 2010). Further studies about the Arctic climate during MPWP would help for the development of the knowledge about the climate-vegetation-sea ice interaction system which emphasizes the earth system under the CO2 forcing.

Keywords: paleoclimate, mid-Pliocene warm period, climate change, atmosphere-sea ice interaction, atmosphere-land interaction

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(May 22-27 2011 at Makuhari, Chiba, Japan)

ACG033-P04 Room:Convention Hall Time:May 25 10:30-13:00

Modification of the Baroclinic Instability associated with AO Index: A Theoretical Proof of the Positive Feedback

Sawaka Seki[1*], Hiroshi L. Tanaka[2]

[1]Environmental Science, Univ. Tsukuba, [2]CCS, Univ. Tsukuba

The modification of the baroclinic instability associated with positive and negative Arctic Oscillation Index (AOI) is theoretically investigated using a linearized 3D spectral primitive equation model.

According to the observational analysis, the AOI tends to be positive due to the enhanced northward eddy momentum flux by the transient baroclinic waves which intensify the polar jet in high latitudes and weaken the subtropical jet. Conversely, the AOI tends to be negative when the eddy momentum flux becomes southward in high latitudes causing weaker polar jet and stronger subtropical jet.

In this study the baroclinic instability problem is solved for zonal mean basic states for AOI positive and negative cases by adding and subtracting AO patterns of the zonal mean winds onto the normal basic state. The linear instability analysis shows that the most unstable Charney mode M_C changes its structure to intensify or weaken the polar jet by the eddy momentum flux associated with the positive or negative AOI. More importantly, the meridionally dipole Charney mode M_2 is modified into the monopole Charney mode M_1 (see Tanaka and Tokinaga 2002) to transport eddy momentum flux northward under the positive AOI condition. It is found that this modification is essential to intensify the polar jet during the AOI positive phase. Hence, we have theoretically confirmed that there are positive feedbacks between the baroclinic instability waves and the Arctic Oscillation characterized by the intensity of the polar jet.

Keywords: Arctic Oscillation, Baroclinic Instability, 3 dimensional normal mode

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Response of Greenland ice sheet to global warming simulated by a high-resolution ice sheet model

Fuyuki SAITO[1*], Ayako Abe-Ouchi[2], Kunio Takahashi[1]

[1]JAMSTEC, [2]AORI, Univ. of Tokyo

We present numerical experiments of Greenland ice sheet to global warming using Ice sheet model for Integrated Earth system Studies (IcIES). A high resolution (until around 5km horizontally) is chosen in order to better resolve locally high velocity regions of ice-stream. The ice sheet model is forced by the results of global warming experiments simulated by climate models. Effect of ice-sheet dynamics on changes in the ice sheet volume will be compared with that of that of climate condition such as changes in melting and accumulation due to the global warming. Uncertainties in the model result due to the horizontal resolution are also compared with those to several factors such as parameterization schemes in the model.

Keywords: ice sheet, global warming

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Evaluation of distribution of surface albedo and temporal variation in the bare ice area of the western parts of the Gre

Hiroki Ito[1*], Nozomu Takeuchi[1], Kohshima Shiro[2], Jun Uetake[3]

[1]Graduate School of Science, Chiba Univ, [2]Wildlife Research Center of Kyoto Univ, [3]National Institute of Polar Research

The Greenland ice sheet has recently been reported to be significantly shrinked, especially, in the western ablation area (at latitude 65-71 north and longitude 49 west). In this area, visibly dark-colored ice surface, called dark region, has been found. Such a dark ice surface must affect the melting of ice because of its low albedo. Therefore, it is important to understand the present spatial distribution and formation process of the dark region on the ice sheet to evaluate its mass balance. This study aims to describe the spatial distribution and temporal variation of the dark region in the bare ice area of the Greenland ice sheet using MODIS and Landsat-7/ETM+ satellite images.

The dark regions, defined by the albedo between 0.15 and 0.30, were generally found in the ablation ice area from north to south of the western side of the ice sheet (at latitude 61-83 north). The dark regions were located at the margin of the ice sheet in the northern and southern areas while they were located at the area 50 ? 100 km away from the margin in the middle area. Temporal variations in the dark regions show that their areas generally increased and their mean albedo decreased from 2001 to 2010. In particular, the expansion of the dark region in the middle area was significant after 2005. Spectral reflectances of the dark regions indicate that their low albedo is due to surface impurities.

Landsat images revealed that the dark region in the middle area has the stripe features of blue and black ices. Comparison between 2000 and 2010 images revealed the increase of the black ice area of the stripe feature, suggesting that mineral particles supplied from the ice body accumulated at the surface. Furthermore, the band 2-3 ratio, which is indicative to amounts of red algal snow on the ice surface, showed the significant increase of the area of red snow. This suggests that snow algal production increased in this area. Therefore, it can be concluded that the expansions of the dark region is caused by accumulations of mineral particles from outcropping ice layers that contains a large amount of dusts and of organic matter derived from photosynthetic snow algae.

Keywords: albedo, dark region, temporal variation, impurities

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Roles of Mountain Ranges on Water Field in Eastern Siberia

Ryuhei Yoshida[1*], Masahiro Sawada[1], Takeshi Yamazaki[1], Ayumi Kotani[2], Takeshi Ohta[2], Tetsuya Hiyama[3], Gen Inoue[3]

[1]Grad. Sci. Tohoku Univ., [2]Grad. Sci. Nagoya Univ., [3]RIHN

In Eastern Siberia, 40% of precipitation is maintained by water supply from ocean. Water vapor transport is affected by mountain range and it also affects to precipitation distribution. There were a few previous studies focusing on precipitation distribution and factors that decides distribution. To make clear water field in Eastern Siberia, we conducted forest survey at first because it was thought tree size was affected by precipitation amount. Then, we investigated precipitation distribution and water vapor transport. At last, roles of three mountain ranges (Verkhoyansk, Dzhudgzhur and Stanovoy mountain range) in Eastern Siberia are analyzed using three-dimensional atmospheric model.

Starting point of this study was forest survey in Elgeeii site (relatively south in Lena basin) and its comparison with Spasskaya Pad site (350km northwest from Elgeeii). Averaged tree height and maximum tree height took larger value in Elgeeii site, thus it was thought that southern Siberia was favorable environment for tree growth, such as much precipitation. According to routine station data, much precipitation in southern Siberia was found not only relation between Elgeeii and Spasskaya Pad but also overall Eastern Siberia.

Precipitation and water vapor flux have strong relationship each other, thus water vapor flux budget was investigated for Eastern Siberia. Taking budget box encircled with line of 59-71N and 116-138E, mainstream of vertical integrated water vapor flux was inflow through west-side and outflow through east-side. This trend became different when net flux separated into incoming and outgoing component; incoming and outgoing water vapor flux through south-side was large as much as water vapor flux through west-side. There is Stanovoy mountain range in just south of the budget box, therefore water vapor flux and precipitation may be affected by the mountain range. Not only Stanovoy mountain range but also other two mountain ranges, Verkhoyansk and Dzhugdzhur mountain ranges, are located in Eastern Siberia. Therefore sensitivity experiment of mountain range disappearance was conducted to make clear roles of mountain ranges in Eastern Siberia.

Averaging from 110-140E, it was found that Verkhoyansk mountain range had little effect on precipitation. Precipitation decrease was 0.2 mm day-1 with 200-400 m topography excavation, it was around half of other two mountain ranges. This small precipitation change was caused by lower specific humidity. However, when we focused on 133E cross-section, relatively higher specific humidity could not keep in Lena basin without Verkhoyansk mountain range.

Dzhugdzhur mountain range had larger precipitation decrease than Verkhoyansk mountain range with its disappearance. Precipitation decreased area was good agreement with elevation decrease area, therefore precipitation over Dzhugdzhur mountain range was maintained by orographical effect.

Stanovoy mountain range had similar precipitation decrease with its disappearance. Both eastern and western edges of precipitation decrease area had corresponded to elevation decrease area, however, precipitation of saddle part did not decrease even if the saddle part had been removed. In control run, there were two precipitation patterns associated with Stanovoy mountain range: low pressure pattern and frontal precipitation pattern. Low pressure pattern passed over the saddle part in control run, however, it did not disappear in no Stanovoy mountain range run. Thus eastern and western part of Stanovoy mountain range is orographical effect precipitation area and the saddle part is non-orographical precipitation area such as low pressure pattern.

Keywords: Eastern Siberia, Mountain Range, Precipitation

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ACG033-P08 Room:Convention Hall Time:May 25 10:30-13:00

Observation of frozen road along the 700km transect, Northern Alaska

Nuerasimuguli Alimasi[1*], Hiroyuki Enomoto[2], Shuhei Takahashi[1], Fumiaki Nakamura[1], Yongwon Kim[3]

[1]Kitami Institute of Technology, [2]National Institute of Polar Research, [3]University of Alaska

This study introduces snow survey and road freezing conditions realized over 700km along the Dalton Highway. This survey covers from inland forest and Brooks Range and Tundra in the North Slope. Satellite observations indicate spatial and temporal change of melting area. These data indicates rapid change of load condition in the snow melting season.

Keywords: Alaska, snow melting, freezing, Road

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ACG033-P09 Room:Convention Hall Time:May 25 10:30-13:00

Recent environmental changes in a tundra area in northern Siberia

Yuji Kodama[1*], Hironori Yabuki[2]

[1]Hokkaido University, [2]JAMSTEC

Recent climatic change in the Arctic is beyond the prediction. For example, the minimum sea ice extent of the Arctic Ocean in 2007 was unable to be predicted by any GCMs. Those changes in the Arctic have influences the environment over land and appear as increase in summer precipitation, increase in active layer soil temperature, discharge increase of northern rivers, and so on (Iijima et al. 2010). The influence of the sea ice extent reduction in Arctic Ocean could be appeared over surrounding land, such as tundra area, however, not so many reports based on observation were made so far. In the presentation, analyzing the observed meteorological and of active layer data, the recent changes over tundra area along the coast of Arctic Ocean in northern Siberia are reported.

Keywords: tundra, active layer, terrestrial change, Arctic Ocean

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ACG033-P10 Room:Convention Hall Time:May 25 10:30-13:00

Stable isotope ratios of water in permafrost and river

Shinya Takano[1*], Go Iwahana[2], Atsuko Sugimoto[3]

[1]Grad. Env. Sci., Hokkaido Univ., [2]Fac. Env. Earth. Sci., Hokkaido Univ., [3]Fac. Env. Earth. Sci., Hokkaido Univ.

Eastern Siberia is covered by permafrost which is the largest and the deepest in the world, and permafrost plays an important role for hydrologic cycles in the area. Degradation of permafrost system, therefore, may have a great impact on the hydrologic regime, consequently, on the material cycling including greenhouse gas emission, through vegetation changes. Isotopic composition of water is powerful tool for investigation of hydrological processes.

Observations on the water isotope ratios of soil moisture and permafrost ice were conducted near Yakutsk and Chokurdakh, Russia. Lena and Indigirka rivers and ground water at Yakutsk city were also sampled, in order to know the hydrological processes in both areas.

Lena river water and groundwater (well water) showed the same variation during the period from 2003-2005, whereas they showed the different trend in 2006 and 2007. This may be caused by the heavy rainfall in the summer of 2006. This means that runoff from this occurred during winter after heavy rainfall, although runoff from this area is not significant usually because of dry climate and permafrost condition.

Chokurdakha is a boundary area between taiga and tundra. Surface water and ice in hallow layer of permafrost showed evaporative isotope signature depending on the surface vegetation. Our observational results showed tight relationship among hydrologic regime, vegetation, and greenhouse emission.

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Photosynthetic characteristics of vascular plants under primary succession stages in a High Arctic glacier foreland

Yukiko Tanabe[1*]

[1]National Institute of Polar Research

Photosynthetic characteristics of vascular plants were investigated to know initial colonization and establishment after deglaciation in High Arctic. The study area was located in the deglaciated area of Austre Broggerbreen, Ny-Alesund in Kongsfjorden, Svalbard, Norway. Two sites that represented different stages of succession after glacier retreat in this area were selected: transient stage and late stage. These sites were separated by a floodplain. Leaf photosynthetic characteristics were measured for the four vascular plants (*Salix polaris, Saxifraga oppositifolia, Silene uralensis, and Cerastium arcticum*) at the two sites corresponding to different stages of succession in mid-July 2010. *Salix polaris* and *Saxifraga oppositifolia* are common pioneers in the transient stage of succession, on the other hand, *Silene uralensis* and *Cerastium arcticum* are rare in the transient stage but common in the late stage. All of the measurements were performed at the peak bloom period of the each plant because the photosynthetic rate varies depending on the leaf age (Muraoka et al. 2002). Light - rETR (relative electron transport rate) curves were determined using a PAM fluorometer (PAM-2100), Walz) with control and analysis software under seven stepwise actinic light intensities and saturating pulse. The photosynthetic rate was expressed as the rETR, and rETRmax (maximum rETR) was calculated by the fitting equations as described by Eilers & Peeters (1988).

The maximum yield of PSII (photosystem II; PSII yields under no actinic light) indicated that the four vascular plants were in the healthy non-stressed condition in both the transient and late stages of succession. However, rETRmax obtained by the measurements of light-photosynthesis curve were different between the common pioneer plants (*Salix polaris, Saxifraga oppositifolia*) and otherwise (*Silene uralensis, Cerastium arcticum*) depending on the stages of succession. The common pioneer plants were measured at the almost same rETRmax in the both transient and late stages, but the value of the other two plants were lower in the transient stage than in the late stage.

Keywords: photosynthesis, primary succession, glacier foreland, arctic, tundra ecosystem, vascular plant

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Effect of tar spot disease on photosynthetic production of Salix polaris in the Norwegian High Arctic

Masaki Uchida[1*], Shota Masumoto[2], Motoaki Tojyo[3], Satoshi Imura[1]

[1]National Institute of Polar Research, [2]SOKENDAI, [3]Osaka Prefecture University

In accordance with GCM predictions, average Arctic temperatures have increased rapidly, at almost twice the global average rate in the past 100 years. It has been predicted that the climate change will influence not only plant but plant pathogen. However, little is known about ecophysiological characteristics of plant pathogen and effect of pathogen on plant in the Arctic terrestrial ecosystem. In this study, we aimed to clarify the effect of plant disease on net production of vascular plant in the Arctic ecosystem.

Study site was situated in polar semi desert in Ny-Alesund, Spitsbergen Island, Norway. In summer of 2009 and 2010, distribution, incidence, growth rate of a pathogen (tar spot disease) and ecophysiological characteristics of a vascular plant (Salix polaris) were investigated. In order to know effect of the disease on net production of S. polaris, we estimated the net production of the infected and uninfected leaves using a model.

Distribution of tar spot was widespread but the incidence was very low. Tar spot symptom emerged after the leaves attained full size. The symptom extended its area for a month and finally covered 16-58% (average 25%) of a leaf. There was no significant difference between the photosynthetic activity of infected leaf and uninfected leaf. Tar spot covered area in itself had no photosynthetic activity. In contrast, photosynthetic activity of green part of infected leaf was similar level with the activity of uninfected leaf. It was calculated that net production per leaf decreased about 5-13% (average 7%) by infection of tar spot disease.

In leaf level, it was estimated that small but significant effect of the disease on the net production of S. polaris. However, in community level, the effect would be negligible because of low incidence of the disease.

Keywords: Arctic, plant pathogen, net primary production, Salix polaris, tar spot disease

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Observations on photosynthesis and C and N stable isotopes of arctic ecosystem in Eastern Siberia

Maochang Liang[1*], Shunsuke Tei[1], Go Iwahana[2], Atsuko Sugimoto[2]

[1]Grad. Env. Sci., Hokkaido Univ., [2]Fac. Env. Earth. Sci., Hokkaido Univ.

North Eastern Eurasia is covered by permafrost which is the largest and the deepest in the world, and taiga forest (deciduous conifer larch) exists on it. It is expected that northern edge of taiga (taiga-tundra boundary) is greatly affected by global warming, and change in vegetation may cause greenhouse gas emission. Northward expansion of taiga forest ecosystem or expansion of tundra ecosystem may affect greenhouse emission opposite direction. Therefore, it is very important to know the vegetation change and its controlling factors.

Field observation on photosynthesis of larch and C and N isotope ratios of plants were carried out in taiga-tundra boundary ecosystem at Chokurdakh in 2008, 2009 and 2010 to investigate the response of the photosynthesis on various environmental factors. Observed rate of photosynthesis changed with PAR, and decreased when the chamber temperature was more than 20 centigrade. N content and N and C isotope ratios of larch needles varied among years and also among the sites. Needle delta C-13 was higher in 2009 than in 2008 and 2010, and needles N content was negatively consistent with delta C-13. No significant difference in larch needle delta N-15 was found between 2009 and 2010. Larch trees are generally found on tree mound which consists of sphagnum, however several trees were found growing at wet area where landscape was similar to wetland. Larch needle delta C-13 at wet area was lower than the trees at the other sites, so were the needle delta N-15 and N content. Needle delta C-13 value would usually increase with N content among the larch trees growing sites, however, needle delta C-13 value decreased with N content changed from 2008 to 2010 within the same growing site. Needle delta N-15 value would usually increase with N content among the larch trees growing sites. Within the same growing site, delta N-15 usually did not change with N content observed from 2008 to 2010. To compare morphological difference of the larch trees growing at tree mound area and wet area, the needle length showed that the average needle length was significantly shorter at tree wet area than in mound area.