Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

ACG31-01 Room:201B Time:May 25 15:15-15:30

GRENE Arctic Climate Change Research Project in Final Phase

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Recently, due to abrupt retreat in summer sea ice area associated with global warming, rapid warming in surface air temperature, reduction of glaciers, melting permafrost and many other changes, the Arctic becomes the hot topic not only just of a scientific aspect, but also of the society. We have started a Japanese initiative **Arctic Climate Change Research Project** within the framework of the GRENE (Green Network of Excellence) Program funded by the Ministry of Education, Culture, Sports, Science and Technology, Japan (MEXT), in 2011. This Project targeted understanding and forecasting *Rapid Change of the Arctic Climate System a*
Four strategic research targets are set:

1. Understanding the mechanism of warming amplification in the Arctic,
2. Understanding the Arctic climate system for global climate and future change,
3. Evaluation of the impacts of Arctic change on weather and climate in Japan, marine ecosystems and fisheries,
4. Projection of sea ice distribution and Arctic sea routes.

As the network of universities and institutions in Japan, this 5-year Project involves more than 300 scientists from 35 institutions and universities. National Institute of Polar Research (NIPR) works as the core institute and Japan Agency for Marine-Earth Science and Technology (JAMSTEC) joins as the supporting institute. There are 7 bottom up research projects on atmosphere, terrestrial ecosystem, cryosphere, marine ecology and fishery, sea ice and Northern sea route and modeling as follows:

(1) Improvement of coupled general circulation models based on validations of Arctic climate reproducibility and on mechanism analyses of Arctic climate change and variability,
(2) Change in the terrestrial ecosystems of the pan-Arctic and effects on climate,
(3) Atmospheric studies on Arctic change and its global impacts,
(4) The role of Arctic cryosphere in global change,
(5) Studies on greenhouse gas cycles in the Arctic and their responses to climate change,
(6) Ecosystem studies on the Arctic Ocean declining sea ice,
(7) Projection of sea ice distribution and Arctic sea routes.

The Project will realize multi-disciplinal study of Arctic region and connect to the projection of future Arctic and global climatic change by modeling.

4 years have already passed since the beginning of the project in 2011. During that time, pan Arctic observation has been carried out in many locations, such as Svalbard, Russian Siberia, Alaska, Canada, Greenland and the Arctic Ocean. In particular, Cloud Radar in high precision was established at Ny-Alesund, Svalbard, and intensive atmospheric observations were carried out. In addition, the Arctic Ocean cruises by *Mirai* and other icebreakers were conducted and also mooring buoy observations were carried out. The retrieved data were accumulated in the Arctic Data Archive (ADS) and served with interfaces for analysis. In addition, modeling study has been promoted using from fundamental physical model to general circulation model. Through these observations and research, new research results are originated.

Now is the time to finalize. Research outputs on each issue are being born out and the creation of new scientific outcomes resulted for strategic research targets are required. In order to produce *answers* to the strategic research targets, research outcomes are examined and discussed with support of the project coordinator. As a result of the implementation of the project, clear messages to the community and society, *what could be concluded as a whole*, are requested, with the central axis of Arctic warming amplification. This review process will also become evolutionary issues to proceed to the next step (the next Arctic Research Projects).

Keywords: Arctic, sea ice, climate change, warming amplification, global warming

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ACG31-02 Room:201B Time:May 25 15:30-15:45

The effect of atmospheric heat and moisture transport on Arctic warming under the elevated CO_2 experiment

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It is well known that, under the elevated atmospheric CO_2 concentration, the Arctic experiences larger warming than the rest of the world. In this so-called Arctic amplification, ice albedo feedback plays a central role (Yoshimori et al., 2014a). While the ice albedo feedback is a process unique to the polar region, the magnitude of the Arctic warming is well correlated to the global mean warming among climate models, indicating a strong coupling of the Arctic to the rest of the world. In order to elucidate how the extra-Arctic warming remotely influences the Arctic warming, we conducted sensitivity experiments which isolate the remote and local effect by using an atmospheric general circulation model with thermally interactive and non-interactive ocean mixed layer depending on the region. We note, however, that the effect of ocean circulation change is not considered here. The resulting Arctic warming is generally larger when the model is forced by the remote warming, rather than responding to the local CO_2 increase. This indicates that much of the Arctic warming under the elevated CO_2 condition is initially induced by the lower latitude warming via the increased atmospheric heat transport. An additional experiment separates the following two effects: the initial Arctic atmospheric response to the remote warming and the subsequent effect of ice-ocean changes on the Arctic warming. In addition to the surface energy balance analysis, the climate feedback and response analysis method (CFRAM) following Yoshimori et al. (2014b) reveals that the remote warming initially warms the Arctic surface via the increased downward longwave radiation due to an enhanced greenhouse effect of water vapor and cloud as well as via the increased large-scale condensation and decreased evaporative cooling. Once the ocean temperature and sea ice cover is allowed to respond, the greenhouse effect of cloud increases substantially (positive feedback) while the evaporative cooling increases (negative feedback).

Yoshimori et al. (2014a) Clim. Dyn., 42, 1613-1630.
Yoshimori et al. (2014b) J. Climate, 27, 6358-6375.

Keywords: climate modelling, Arctic amplification

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ACG31-03 Room:201B Time:May 25 15:45-16:00

Seasonal Change and Long-term Trend in the Arctic Cryospheric -Discussion from Bi-polar perspective-

ENOMOTO, Hiroyuki[1*] ; TAMURA, Takeshi[1] ; HORI, Masahiro[2] ; HIRASAWA, Naohiko[1] ; YAMANOUCHI, Takashi[1] ; YABUKI, Hironori[3]

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Arctic sea ice declining has been rapidly in 2000’s with the summer minimum record in 2012. Sea ice in 2013 and 2014 summers recorded increase however the ice situation is still low expand level. On the other hand, Antarctic sea ice is increasing in winter. Sea ice in the Antarctic in 2014 austral winter recorded the maximum area since the satellite observation became available. Dynamic changes in snow cover, snow fall and ice sheet are also reportedchange are reported recently. This study summarizes common feature and differences in these evidences and current understanding of possible causes.

Keywords: Arctic, cryosphere, bi-polar

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ACG31-04 Room:201B Time:May 25 16:15-16:30

Satellite-derived snow grain size variation during 2000-2014 on Greenland ice sheet

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Satellite-derived albedo of Greenland ice sheet (GrIS) in summer season reveals a remarkable decreasing trend since 2009. Snow surface albedo depends on snow grain size (SGS) and concentrations of light absorbing snow impurities (LASIs). In accumulation area of GrIS, the surface albedo strongly controlled by the SGS variation because the concentrations of LASIs are generally not high to reduce the albedo significantly. When air temperature increases, the SGS also increases by accelerating snow metamorphism and thus the albedo decreases. Hence, it is important to monitor the annual and seasonal changes of SGS distribution over GrIS. We have developed an algorithm to retrieve SGS for Second Generation Global Imager (SGLI) algorithms for Global Change Observation Mission - Climate (GCOM-C). The algorithm is based on a look-up table method for bidirectional reflectance distribution function at the top of the atmosphere as functions of SGS, LASI concentration and solar and satellite geometries. We employed a two-snow-layer model, which consists of the topmost layer (depth of 5 mm fixed) and the subsurface layer, for the retrievals of SGSs in those two snow layers (Rs1 and Rs2), respectively. We validated the Rs1 derived from Terra/Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) data with the in-situ measurements synchronized with the satellite overpasses at Summit (73 ^{0} N, 38 ^{0} W, 3,216 m a.s.l.) in 2011 and at SIGMA-A (78 ^{0} N, 67 ^{0} W, 1,490 m a.s.l.) in 2012. The results showed the excellent agreement for a wide range of SGS.

Using this algorithm, Rs1 and Rs2 over Greenland ice sheet were retrieved with Terra/MODIS data from 2000 to 2015 and the monthly averages were calculated for different elevation areas. The results showed that Rs1 and Rs2 for all of the GrIS except the areas higher than 3,000 m have an increasing trend from June to August during the observed period, which are 28 μm and 174 μm per decade in case the area of an elevation higher than 1,000 m in June. These values become small for the higher elevation areas from June to August and are close to zero or negative for all areas in April and September, indicating the warming influence to SGS is remarkable over the lower elevation areas than 3,000 m in summer season.

Keywords: Greenland ice sheet, snow grain size, albedo, light absorbing snow impurities, satellite remote sensing

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ACG31-05 Room:201B Time:May 25 16:30-16:45

Study of the vertical coupling of the atmosphere at Tromsoe, Norway

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We will present results of the vertical coupling at Tromsoe (69.6N, 19.2E) in northern Scandinavia. At the EISCAT Tromsoe site, we have operated the sodium LIDAR, the MF radar, and the meteor radar to study dynamics of the polar mesosphere and lower thermosphere. By combining these datasets together with EISCAT radar datasets, we can obtain wind data from 70 to 120 km. In this talk, we will present results of two topics: (1) altitude variation of the semidiurnal tide, and (2) response of the upper mesosphere/lower thermosphere to Sudden Stratospheric Warming (SSW) events.

The MF radar and the meteor radar at Tromsoe provide continually horizontal wind data between 70 and 91 km and 80 and 100 km since November 1998 and October 2003, respectively. The sodium LIDAR was installed in March 2010, and started observations of the neutral temperature and the sodium density between 80 and 110 km in October 2010. The sodium LIDAR started observations of five directions of the wind velocity (vertical, south, north, west, and east) in October 2012. In total, to date, we have obtained about 2800 hours of neutral temperature and sodium density data, and about 1700 hours of wind velocity data by using the sodium LIDAR.

We have investigated altitude variations of the semidiurnal tide using both wind and temperature data, whose temporal length is longer than or equal to 12 hours, obtained by the sodium LIDAR for 62 nights. There appear two typical altitude profiles of the amplitude: one is that the amplitude maximizes at around 90 km, and decreases above, and again increases with increasing altitude, and the other is that the amplitude gradually increases with increasing altitude up to 100 km or higher. We will discuss possible causes of the difference of the altitude profiles.

Sudden Stratospheric Warming (SSW) is a large disturbance phenomenon occurring in the stratosphere in winter due to breaking of planetary waves. The response of the upper mesosphere, thermosphere, and ionosphere to SSWs has been widely investigated by using observational data and model predictions. We have analyzed variations of the temperature and winds above Tromsoe using sodium LIDAR data, meteor radar data, and EISCAT radar data in the upper stratosphere, mesosphere, and lower thermosphere. We will present those results and discuss differences of timing of the changes at different altitudes.

Keywords: Vertical coupling of the atmosphere, Tromsoe, EISCAT, sodium LIDAR, SSW, tidal waves

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ACG31-06 Room:201B Time:May 25 16:45-17:00

Discussion about new indices which display condition of disturbance in the mesosphere during Arctic winter

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Purpose of this research is to clarify relationship between solar activity and disturbance in the middle atmosphere during Arctic winter. In this research we consider stratospheric sudden warming (SSW), which is a typical phenomenon in Arctic winter, as disturbance in the middle atmosphere including the mesosphere. Previous research [ex. Labitzke, 2005] reported effect of 11-year solar cycle on thermal structure only in the Stratosphere.

Traditional classification of SSW is not suited for quantitative comparison with other indices. Therefore we are exploring new indices which display condition of disturbance in the mesosphere. To get thing started, we selected daily bottom altitude of easterly wind area, which corresponds to SSW, in the zonal mean horizontal wind. Averaged value of those during one SSW event is used for quantitative comparison with solar activity and QBO index. No clear relationship was found between the selected new value (ZEW index) and two indexes. However we confirm that the ZEW index represents well the degree of disturbance. In the next step, we calculate AO index in the altitude range from 1000 hPa to 0.1 hPa (65km alt). AO index also represents well the degree of disturbance in the middle atmosphere.

In this presentation, we will examine and discuss in more detail about ZEW and AO index using meteorological data in order to confirm which condition these two new indices display in the middle atmosphere.

Keywords: Middle atmosphere disturbance, Solar activity, Arctic Oscillation, QBO, Arctic region, Stratospheric sudden warming

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ACG31-07 Room:201B Time:May 25 17:00-17:15

MF radar observations of gravity wave variation with 12-/24-hr periods

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Intensive observational studies have been conducted in past of interaction between atmospheric gravity waves (GWs) and tides in the mesosphere and lower thermosphere. Tidal winds can be background winds for small-scale and/or high-frequency GWs. If mesospheric tides play a role in the mesospheric GW momentum dissipation process, the tides may be a substantial element for the mean flow acceleration process since there are tides every day and every months in the middle atmosphere almost all over the globe. In this study, we employed 10-year horizontal wind velocity datasets in the mesosphere and lower thermosphere observed with MF radars at Poker Flat, Alaska and at Tromso, Norway. The data analysis was carried out for 1999 ? 2008, to show daily and seasonal behaviors of mesospheric gravity waves and the 12 and 24 hour components of horizontal winds. The wind velocity component with the wave periods of 1-4 hours are analyzed as short-period gravity waves, to which a harmonic analysis was applied in terms of temporal variations with periods of 24, 12, and 8 hours with the 5-day running window shifted by every 30 min. Sinusoidal curve fitting is not the best fit model for the behavior of GW kinetic energy (GW-KE), but the fitted amplitude and phase can be used as measures of GW activity variation with a target period (24, 12, or 8hrs) and local time identification where GW-KE enhances and decreases. In case studies that we have carried out, phase relation between the 12-hr components of zonal wind and GW-KE shows that their phases are locked for more than 10 days, in several cases in multiple years at the both observation sites. We confirmed a phase lock phenomena at both Tromso and Poker Flat continued for about 20 days from November to December in 2000. However, between Tromso and Poker Flat, the phases of 12 hour component of GW-KE are almost in anti-phase or differed by approximately 180 degrees. We plan to discuss climatological aspects and also more detail of underlying physical processes, focusing on gravity wave drags and background state of horizontal wind velocities at both sites.

Keywords: mesosphere, atmospheric gravity waves, atmospheric tide, interaction, MF radar

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ACG31-08 Room:201B Time:May 25 17:15-17:30

A plan of new millimeter-wave observations of atmospheric molecules from stratosphere to lower-thermosphere at Tromsoe

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Minor constituents in the middle atmosphere play important roles in the radiation energy transfer and photo-chemistry. Energetic particle precipitation (EPP) onto the middle atmosphere triggers the ion-molecular reactions resulting in the enhancement of NOx and HOx and depletion of ozone in the polar regions. In order to study such EPP effects on the atmospheric composition observationally, we installed a millimeter-wave spectroscopic radiometer at Syowa Station in the 52th Japan Antarctic Research Expedition (JARE52) and have carried out monitoring of NO since January 2012 with the space and upper atmospheric science group in National Institute of Polar Research, NIPR. As a result of the monitoring, we have found that NO column density shows seasonal variation increasing in the polar night periods and short-term variation (enhancement) within a few days. We revealed that the photo-dissociation and total amount of precipitating electrons play major role for the seasonal variation and that the short-term enhancements are caused by energetic electron from the radiation belt precipitated due to the geo-magnetic storms.

In order to study these phenomena in detail, we plan to install a new millimeter-wave radiometer at the EISCAT site in Tromsoe, Norway. In collaboration with the preexistent instruments, such as EISCAT radar, meteor radar, sodium lidar, aurora imager, we can more precisely assess the environmental chemical and dynamical condition where the NO column density changes due to the energetic particle precipitation. We will present the plan in more detail and discuss the aim of this project in this presentation.

Keywords: millimeter-wave spectroscopy, polar atmosphere, stratosphere, mesosphere, lower thermosphere

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ACG31-09 Room:201B Time:May 25 17:30-17:45

Improvements in AOGCM by the introduction of a simple wetland scheme

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In projections of future climate change, reduction of biases in general circulation models (GCMs) is necessary in order to improve their reliability. In particular, warm bias over middle and high latitude land is a common feature among many GCMs. In the Arctic region, snow melt water remains as temporal ponds so that atmosphere-land interaction changes land surface heat and water balance. However, this effect has yet to be included in the GCM land. Nitta et al. (2014) introduced a simple wetland scheme into a GCM land sub-model and revealed that wetland reduces the warm bias. In the present study, we introduced this simple wetland scheme into a GCM and investigated the effect of this new scheme upon the climate system. We also performed global warming experiments by quadrupling the atmospheric carbon dioxide concentration with this new scheme to evaluate the effect of melt water under global warming.

Keywords: general circulation model, surface energy balance, Arctic region

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ACG31-10 Room:201B Time:May 25 17:45-18:00

Developments of Arctic Data archive System(ADS)

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Arctic is the region where the global warming is mostly amplificated, and the atmosphere/ ocean/ cryosphere/ land system is changing. Active promotion of Arctic environmental research, it is large and responsible for observational data. Promotion of Arctic research in Japan, has not been subjected to independent in their respective fields.

In the National Institute of Polar Research, perform the integration and sharing of data across a multi-disciplinary such as atmosphere, ocean, snow and ice, land, ecosystem, model, for the purpose of cooperation and integration across disciplines, we build a Arctic Data archive System (ADS).

Arctic Data archive System (ADS), to promote the mutual use of the data across a multi-disciplinary to collect and share data sets, such as observational data, satellite data, numerical experiment data. Through these data sets, clarify of actual conditions and processes of climate change on the Arctic region, and further contribute to assessment of the impact of global warming in the Arctic environmental change, to improve the future prediction accuracy.

ADS developed the the online visualization system (VISION) of grid data (a satellite and model simulation), which observational researcher was not good. This VISION which can easily visualize special change can become effective for not only the understanding of the phenomenon but also the design of the observation for an observational researcher.

Keywords: Arctic, Environment, Global Warming, Visualization, VISION, VISHOP

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ACG31-11 Room:201B Time:May 26 09:00-09:15

Comparison of snow depth on the sea ice between buoys and CFSR data

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To understand snow depth distribution on Arctic sea ice, we compared the snow depth data on the Arctic multiyear sea ice obtained by Ice Mass Balance (IMB) buoys developed by CRREL (Cold Region Research and Engineering Laboratory) with reanalysis data of the Climate Forecast System Reanalysis (CFSR) provided by National Centers for Environmental Prediction (NCEP). In this study, we examined 23 buoys in 2002-2013. Although mean annual cycle of snow depth from the CFSR was reproduced well, the reanalysis data has a positive bias during winter and spring, and a negative bias during summer and autumn. Because the correlation coefficients between the reanalysis and observation are around 0.70 between October and December. Sea-ice thickness in the reanalysis was approximately 1 m thicker than the observations during all seasons. We investigated recent changes in snow depth and sea-ice growth rate during autumn and early winter using the reanalysis data. Due to enhanced cyclone activity and enhanced surface evaporation from the ice-free ocean, the increases in precipitation (i.e., snow depth) are seen over Chukchi and Beaufort seas, resulting in reduction of growth of thin ice during November. However, ice thickness anomaly in the CFSR reduced an insulating effect of the snow depth on sea-ice growth. We will discuss about sea ice thickness anomaly in the CFSR using 1-D thermodynamic model.

Keywords: Snow depth, Sea ice thickness, buoy, arctic

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ACG31-12 Room:201B Time:May 26 09:15-09:30

Seasonal cycle of surface energy balance in the northwest Greenland ice sheet

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The Greenland ice sheet (GrIS) has lost its mass during the last two decades significantly, and the rate of ice loss has accelerated since 1992. It is hypothesized that the recent ice loss can be partitioned in approximately similar amounts between surface melt and outlet glacier discharge (IPCC AR5). In the present study, we investigate physical mechanism of surface melt in recent years from the standpoint of surface energy balance (SEB) using data from automated weather station (AWS) in the northwest GrIS. The AWS was installed at the SIGMA-A site (78^{o}03'N, 67^{o}38'W, 1490 m a.s.l.) in June 2012 (Aoki et al., 2014), and data is now open at ADS (https://ads.nipr.ac.jp/kiwa/Summary.action?selectFile=A20140714-002&downloadList=&scr=top). SEB at SIGMA-A during 2012-2014 was calculated using a one-dimensional multi-layered physical snowpack model SMAP (Niwano et al., 2012; 2014), where observed albedo and snow surface temperature were forced to drive. Obtained monthly mean SEB values at SIGMA-A indicates that the main contributor for melt energy available for the surface melt was net shortwave radiant flux throughout all summer seasons, however, melt energy during July 2012 (GrIS experienced a record-breaking surface melt extent) was exceptionally high (more than 25 W m^{-2}) compared to other summer (JJA) months (lower than 5 W m^{-2}). The annual maximum of melt energy was recorded during July in 2012 and 2014, however it was reached during August in 2013. This result suggests that the melting period of GrIS snowpack differs from year to year, and the further monitoring of surface climate is necessary in order to understand long-term interannual variability of GrIS surface melt.

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Surface elevation change of Bowdoin and Tugto Glacier in northwestern Greenland

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Ice discharge from marine-terminating outlet glaciers has increased in the Greenland ice sheet (GrIS), and this increase plays important roles in the volume change of GrIS and its contribution to sea level rise. Thinning of GrIS marine-terminating outlet glaciers has been studied by differencing digital elevation models (DEMs) derived by satellite remote-sensing (RS). Such studies rely on the accuracy of DEMs, but calibration of RS data with ground based data is difficult because field data on GrIS marine-terminating outlet glaciers are few. Bowdoin Glacier is a marine-terminating outlet glacier in northwestern Greenland (77^{o}41'18"N, 68^{o}29'47"W). The fast flowing part of the glacier is approximately 3 km wide and 10 km long. Tugto Glacier is a 10 km long land-terminating glacier. These two glaciers are located adjacently, and those altitudinal range is almost same (0 - 350 m a.s.l.). Because those glaciers of different shape of the terminus are located under the same climate condition, comparing surface elevation change of those glaciers is crucial to better understand the influence of ice dynamics on the glacier thinning. In this study, we compare surface elevation change and ice flow regime near the terminus of Bowdoin and Tugto Glacier.

We measured the surface elevation over the glacier on August 20, 2007 and September 4, 2010, by analyzing Advanced Land Observing Satellite (ALOS), Panchromatic remote-sensing Instrument for Stereo Mapping (PRISM) images. We also measured surface elevation on bedrock in the eastern flank of Bowdoin Glacier by using the global positioning system on July 18, 2014. We calibrated the satellite derived elevation data with our field measurements, and generated a DEM for each year with a 25 m grid mesh. The DEMs were compared to calculate recent glacier elevation change. Mean surface elevation change for on Bowdoin Glacier increases downglacier from -13 to -20 m, whereas that in Tugto Glacier is spatially uniform (-11 to -12 m). The mean elevation change in Bowdoin Glacier is significantly greater than those observed on ice caps in the region, and similar to those reported for other marine-terminating outlet glaciers in northwestern Greenland. Ice flow velocity increases downglacier in Bowdoin Glacier, whereas no significant gradient of ice velocity was measured in Tugto Glacier. We suggest that a certain portion of the thinning in Bowdoin Glacier was due to stretching flow enhanced by acceleration of ice flow. Our study demonstrate that calving Bowdoin Glacier is losing more ice than land-terminating Tugto Glacier, which suggests the importance of ice dynamics and/or ice-ocean interaction in the ice mass loss in Greenland.

Keywords: Glacier, Greenland

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Growth conditions of snow algae inferred from snowpack observations in Greenland

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Snow algae are photosynthetic microbes growing on snow and ice and are commonly found on glaciers and snowfields in many parts of the world. Bloom of snow algae can change color of snow to red or green, and reduce its albedo, then accelerate melting of snow. Therefore, it is important to determine factors of their growth in order to project melting of snowpack. However, it is still not known what the most major factor for the growth is.

In this study, we aim to determine the factors of initiation and growth of snow algae on snowpack based on field study on Qaanaaq ice cap in the northwest Greenland (N 77, W 69). The field study was carried out from June to August of 2013 and 2014. We measured physical and chemical properties of surface snow and collected the snow samples at two locations (Site-A 550m, Site-B 950m a.s.l) on the glacier every week. In a laboratory, we counted cells of algae using a microscope and analyzed chlorophyll-a concentration (*Chl-a*) using a fluorescence meter in snow samples to observe temporal change of algal growth on the snow surfaces. These data were compared with other physical properties of snow surface and meteorological conditions in order to determine the factors driving the snow algal growth.

Red snow visibly appeared on the snow surface on August 3 at Sites-A, but didn't appear at Site-B during the study period in 2013, while it appeared on July 20 at Site-A and August 3 at Site-B in 2014. *Chl-a* concentration on the snow surface started to increase when the red snow appeared. The algal cell concentration also showed a similar temporal trend to the *Chl-a*. Daily mean temperature exceeded 0 ℃ on June 8 at Site-A in 2013, and on June 2 at Sites-A and B in 2014. These timing were 49-63 days prior to the appearance of red snow. The positive degree-day sum at the appearance of red snow were 106-140 ℃ day at Site-A in 2013, 116-141 ℃ day at Site-A and 93-107 ℃ day at Site-B in 2014. When the red snow appeared, no significant change was observed in physical or chemical conditions on the snow surface including solar radiation, snow density, water content, EC, and pH. These results suggest that initiation of snow algae does not require a certain physical or chemical condition of snow surface, but may require a certain period of surface melting or positive degree-day sum.

Keywords: snow algae, red snow, chlorophyll-a, positive degree-day, Greenland

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

ACG31-15 Room:201B Time:May 26 10:00-10:15

The snow and ice algal communities of mountain glaciers in Suntar Khayata region, Eastern Siberia

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Snow and ice algae are photosynthetic microorganisms which can grow on snow and ice and they are observed in many parts of the world. Blooms of them can reduce the surface albedo of snow and ice and accelerate their melting since the algal cells are usually occupied with pigments. Understanding their ecology is important both to the biology and the geophysics of glaciers.

Our previous works revealed that snow and ice algal community shows geographical variation. The structures on glaciers vary among geographical locations of world. For example, the algal community is dominated by green algae in Alaskan glacier while it is dominated by filamentous cyanobacteria and contains little green algae in central Asian glacier. In particular, the letter community can compose cryoconite granule which has large effect on glacier melting.

We investigated four glaciers in Suntar Khayata Mountain Range, eastern Siberia, where the one of the blank area of algal study from 2012 to 2014.

Two taxa of green algae and five taxa of cyanobacteria were observed. The algal community was dominated by green algae: *Ancylonema nordenskioldii* in bare ice area and *Chloromonas* sp. snow covered area. The total algal biomass showed the highest on the middle part of the glacier. These characteristics of community structure are also observed on other Alaskan and Greenlandic glaciers but differ from those on Central Asian glaciers. The algal community of Suntar Khayata region can classify to 'Arctic type' snow and ice algal community.

These characteristics of algal community were approximately common in all four glaciers which we investigated in this region and did not show annual change for three years. The dominant taxa did not change and total algal biomass showed the highest on middle part of glacier. This fact support the suggestion which our result shows characteristics of algal community which are common in current years. The exception was the average value of total algal biomass. However we conducted investigations at same period every year, the average total algal biomass of whole glacier in 2013 was one-tenth of that in 2012. In contrast to cryoconite granule which can be preserved on glacier surface every year, it is indicated that green algae decrease under snow cover during winter and re-increase in summer. It is thought that the total algal biomass was affected by annual weather condition and showed greatly change because of the dominance of green algae in algal community of this region.

Keywords: Snow and ice algae, Arctic region, Mountain glacier, Annual change, Community structure, Regional characteristics

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The spatial variations in characteristics of cryoconite on glaciers in northwest Svalbard

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Cryoconite is insoluble impurity on glacier surface and consists of mineral particles and organic matter. They usually form spherical aggregates called cryoconite granules. Their size is approximately 1 mm and color is dark due to humic substances produced by bacteria. Structure and optical characteristics of cryoconite granules are generally uniform on Asian glaciers since abundant windblown dust is supplied from desert and microbial productivity is active. In contrast,, they spatially vary on Arctic glaciers, probably due to relatively greater effects of local environments around the glaciers. The spatial variations in characteristics of cryoconite is important to evaluate an impact of cryoconite on surface albedo of glaciers. This study aims to reveal spatial variations in characteristic of cryoconite on three glaciers (Pedersenbreen, midtrelovenbreen, and AustreBroggerbreen) located in northwest Svalbard. Microscopy of cryoconite revealed that cryoconite granules of all of study site contained mineral particles and filamentous cyanobacteria. Microscopy of internal structure of granules revealed that most of them did not have specific inner structure, but some granules contained two or more subgranules, suggesting that life time of most cryoconite granules are one year. Analyses revealed that chemical and optical properties of cryoconite spatially varied on the glaciers. The cryoconite of the upper site of AustreBroggerbreen and on the sites on Pedersenbreen and midtrelovenbreen had greater organic matter content and lower optical reflectivity, while cryoconite of the lower two sites of AustreBroggerbreen had relatively less organic matter and higher reflectivity. Their optical reflectivity was also relatively lower. This difference is probably due to sources and abundance of mineral particles on the glaciers.

Keywords: cryoconite, spatial variations in characteristics, mineral particles

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Studies on changes of Greenland ice sheet under the East Greenland Ice Core Project (EGRIP)

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Greenland Ice Sheet has been recently experiencing drastic changes such as extended summer melting and increasing mass losses. There is an urgent need to understand the mechanisms of such changes, since they are directly linked to the global sea level rise. Greenland ice cores have so far provided valuable information on melt events and changes in the surface mass balance in the past. Moreover, the data obtained from multiple deep ice cores drilled during the last few decades, combined with modeling studies, have recently enabled us to reconstruct the past changes of Greenland Ice Sheet elevation. The previous ice cores were drilled at sites with minimal horizontal ice flow, as the main purpose of the past ice coring projects were to reconstruct the past climate and environment at the drill sites. Information on ice flow dynamics obtained from such ice cores has therefore been limited.

Understanding of the mechanisms of basal sliding and ice deformation is prerequisite for better projections of the future changes of Greenland Ice Sheet and sea level rise. To understand the Greenland Ice Sheet dynamics, East Greenland Ice Core Project (EGRIP) was proposed by the University of Copenhagen. Japan, Germany, France and Switzerland have been invited to participate in this international project. Under EGRIP, a deep ice core to the bed will be drilled at the onset of the North Greenland Ice Stream (NEGIS), where horizontal flow velocity is expected to be several tens of kilometers per year. As NEGIS is the largest ice stream in Greenland, the EGRIP ice core will certainly advance our knowledge on the dynamics and past changes of Greenland Ice Sheet. The EGRIP core will also give us an ideal opportunity to reconstruct the climate and environment changes during the early Holocene, which was considered to be warmer than today and would be an excellent analogue to the future Greenland affected by global warming. The results from the EGRIP core will fill the gap of our knowledge due to the lack of the high resolution and detailed ice core records from early Holocene.

Keywords: Greenland, Deep ice core, EGRIP, Ice sheet dynamics, Ice stream

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ACG31-18 Room:201B Time:May 26 11:00-11:15

Data assimilation experiments with simulated LAI observations and the dynamic global vegetation model SEIB-DGVM

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Vegetation dynamics is strongly tied to the global carbon cycle and is an important part of the Earth System Model (ESM) to simulate the climate change. The dynamical vegetation model is also useful to predict the biodiversity change. However, vegetation models tend to have large uncertainties. Data assimilation provides an approach to dealing with the uncertainties, and recently started to be applied to the ecological studies. In this study, we develop an ensemble data assimilation system with a dynamical global vegetation model known as the SEIB-DGVM (Spatially Explicit Individual Base Dynamic Global Vegetation Model). As the first step, data assimilation experiments are performed with the SEIB-DGVM using simulated LAI observations. The results suggest that the LAI and parameters related to the phenology be a key to designing an appropriate data assimilation system for the SEIB-DGVM.

Keywords: data assimilation, terrestrial ecosystem, simulation

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Decadal changes of the terrestrial water storage in the Lena River basin, eastern Siberia detected by GRACE

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Velicogna et al. (2012) showed that the terrestrial water storage (TWS) in the Lena River basin observed by GRACE (Gravity Recovery and Climate Experiment) had an upward trend throughout the whole basin, primarily due to the increase in groundwater in the discontinuous permafrost zone.

Moreover, Vey et al. (2013) showed that there was no trend in TWS in the Lena River basin when results were extended to 2011. A decrease began in 2008 and continued afterwards, which was unlike the tendency in the amount stored before 2007. No trend in TWS in the same basin was observed over the period of 2003 - 2011.

These changes in the TWS in the Lena River basin have been interpreted as being in accordance with changes in the active layer and groundwater. However, because the analysis period was short, the primary factor controlling the changes in TWS in the Lena River basin is not yet clear. To determine this, further data accumulation is necessary, and the analysis of data for a long time period is required.

In this research, we extended the period of the TWS anomaly in the Lena River basin untill March, 2014. Then, we analyzed the factors leading to variations in the TWS, using re-analyzed data from the Global Land Data Assimilation System (GLDAS).

Our results indicated a trend for an increase of about 4 mm per year in the western Lena. The location of this positive trend was similar to that identified by Velicogna et al. (2012), although the trend itself was smaller than their values, probably because our analysis period (2002-2014) was longer than theirs (2002-2010). Although Velicogna et al. (2012) identified a positive trend of the TWS anomaly in the Lena River basin, the results of our study revealed that a large negative trend existed in areas downstream of the Lena and at the Arctic Ocean coast. To better understand this negative trend of TWS anomaly, we considered two possible explanations. First, Gunther et al. (2013) showed that the permafrost layer, which contains ice from the Arctic Ocean coast, melted and eroded in response to heat from the ocean, which caused a retreat in the coastline. The trend for a reduction in the TWS at the Arctic Ocean coast or in the downstream area of the Lena River, as revealed by GRACE, suggests a possible influence from the ocean as well as the atmosphere. Second, a decrease in the area of lakes and wetlands, or the melting of ice-rich permafrost can affect, but thoese changes were not clear.

When the basin average TWS values from GLDAS and GRACE results were compared, a very high correlation (correlation coefficient = 0.73) was recorded. From this relation, it was considered that it was possible to interpret the TWS anomaly at the basin-scale using GLDAS, and that the primary factor controlling the changes in TWS could be analyzed. The details will be given in our presentation.