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

ACG36-01 Room:311 Time:April 29 14:15-14:30

Catastrophic reduction of sea-ice in the Arctic Ocean - its impact on the marine ecosystems in the polar region-

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The sea-ice in the Arctic Ocean has dramatically reduced during the past decade. The drastic sea-ice reduction would cause a complicated and difficulty to understand the perspective on marine ecosystem surrounding the Arctic Ocean, because disadvantage phenomena such as ocean acidification and advantage phenomena such as improving light condition for primary producers, respectively, are simultaneously progressing. We have investigated the response of marine organisms caused by catastrophic sea ice reduction in the Chukchi Sea and Northwind abyssal plain at where the sea ice reduction has progressed most seriously in the Arctic Ocean. The aims of our study are No.1 to understand temporal changes in primary production, No.2 to understand the physiological response of marine phyto and zooplanktons having carbonate tests on warming or freshening associated with sea ice melting, No.3 to develop a new model for marine ecosystems in the Arctic Ocean, to reproduce the primary production by using the model and to understand the response of marine ecosystems on the environmental changes caused by rapid sea-ice reduction. In this presentation, we will show an overview of this project composed of three sub-themes, Observation, Culturing, and Modeling. For the observation, we will show a seasonal change in biogenic components flux obtained at the Northwind abyssal plain by a year round time series sediment trap system and seasonal change in dissolution of pteropod tests due to the seasonal change in the ocean acidification. We will also show the potential mechanism of high biogenic fluxes found in the beginning of the sea-ice season using the original Arctic Ocean ecosystem model. For the culture experiment, the physiological response of Emiliania huxleyi, coccolithophorid strain on the environmental changes caused by sea-ice melting will be presented.

Keywords: Arctic Ocean, Biogenic particle, Eddy, Ocean acidification, Coccolithophorid

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ACG36-02 Room:311 Time:April 29 14:30-14:45

Hindcast simulation of the ice and circulation in the Arctic Ocean for 1978-2012: An application of AO-FVCOM.

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A high-resolution, unstructured-grid, finite-volume ice-ocean fully coupled model system, named AO-FVCOM, has been developed for the Arctic Ocean. The governing equations are cast in a generalized terrain-following coordinate system with spatially variable vertical distribution in the vertical and are discretized using flexible non-overlapped triangular grids in the horizontal. This model system includes a) an unstructured grid version of the Los Alamos sea ice model Community Ice CodE (UG-CICE), b) hydrostatic and non-hydrostatic dynamics (NH-FVCOM); c) an unstructured-grid version of the Simulating Wave Nearshore model (SWAN) (named SWAVE), d) 3-D wet/dry point treatment, which can simulate flooding/draining processes in estuaries and wetlands; e) 4-D nudging, OI and Kalman Filters data assimilation algorithms; f) the mass conservative nesting module to integrate multi-domain FVCOM domains; and g) the MPI parallelized visualization tool ViSiT, which allows users to monitor model performance during the simulation and post-process the model output data. An updated version of AO-FVCOM is capable of simulating the ice imbedded in the ocean.

AO-FVCOM is a regional model nested with Global-FVCOM. Two version of AO-FVCOM were configured with a finest horizontal resolution of 300 m and 2 km for the Arctic Ocean, respectively. The 2-km version has run for a period of 1978-2012. Without data assimilation, the model was capable of reproducing the seasonal and interannual variability of the ice coverage area in the Arctic and also significant drops of the ice coverage in 2007 and 2012. The 35-year simulation results for the circulation and water transport are being validated with comparison to field measurement data. The influence of the model resolution on water transport through the Canadian Archipelago has been also examined over seasonal and interannual scales, and an example of the water transport through Nares Strait will be presented.

Keywords: Arctic Ocean Modeling, Global-FVCOM, Arctic-FVCOM, Multi-domain nesting, 35 year Arctic simulation, Ice-Current Interaction

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ACG36-03 Room:311 Time:April 29 14:45-15:00

Changes in the Western Arctic Biogeochemistry over the Last Three Decades: a Modeling Perspective.

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Over the last three decades, the Western Arctic Ocean (WAO) seasonal and permanent sea ice have experienced significant changes, with the summer sea ice extent still shrinking to record low levels and the permanent ice thickness being greatly reduced. Thus, the WAO circulation (e.g. intensification of the Beaufort Gyre), the oceanic heat content and biogeochemistry are directly impacted. We use the coupled pan-arctic Biology/Ice/Ocean Modeling and Assimilation System (BIOMAS) to investigate changes in the physical system, nutrient fluxes and productivity of the planktonic ecosystem between 1988 and 2011. Model simulations show that an earlier phytoplankton bloom and a slight increase in its biomass in general characterize the WAO. The largest response in the secondary producers is seen as an increase in the magnitude of the microzooplankton biomass as well as in the duration of its growing season. Primary productivity while increasing on average over the WAO shows some decrease in the Beaufort Gyre due to its intensification. Under ice blooms such as the one observed during the ICESCAPE (NASA funded program) in July 2011 are also intensified. This research was done in collaboration with colleagues from University of Washington (Dr M. Steele and Dr. J. Zhang), Woods Hole Oceanographic Institution (Dr. C. Ashjian) and University of Rhode Island (Dr. R. Campbell).

Keywords: Arctic, Modeling, Primary Productivity, Climate Change, Food Web

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ACG36-04 Room:311 Time:April 29 15:00-15:15

Relationship of Primary Productivity in Northwind Abyssal Plain with Beaufort Gyre Variation

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The western Arctic marine ecosystem was addressed using a combination year-round mooring observation and multiple numerical models. Our previous studies have revealed eddy-induced biological pump from the Chukchi shelf region to the southern Canada Basin. Whereas this system caused an early-winter peak of sinking flux of Particulate Organic Nitrogen (PON), we then focused on summertime ecological processes. The sediment trap measurements in the Northwind Abyssal Plain (NAP: 75N, 162W) of the western Arctic Ocean captured a maximum diatom flux with dominance of sea ice species in summer 2011. However, the particle fluxes in summer 2012 were considerably suppressed probably due to extension of oligotrophic Beaufort Gyre water to the NAP area. To examine interannual variability in ocean circulation around the target region, the decadal experiment from 1979 to 2012 was performed using the pan-Arctic ice-ocean model COCO. A virtual passive tracer provided inside the Canada Basin certainly suggested that the Beaufort Gyre direction switched southwestward (toward Station NAP) during the early period of 2012. In addition, the three-box lower-trophic model with sea ice species was applied under physical environments at Station NAP to assess an impact of nutrient deficiency on primary production in 2012. Finally, we plan to discuss how to improve existent problems of Arctic marine ecosystem model.

Keywords: Arctic marine ecosystem model, ice algae, oligotrophic water

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ACG36-05 Room:311 Time:April 29 15:15-15:30

Estimating potential habitat for chum salmon (Oncorhynchus keta) in the Western Arctic using a bioenergetics model coupl

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Chum salmon (*Oncorhynchus keta*) are distributed widely in the Northern Pacific and are an important commercial fisheries resource in North Pacific countries. Chum salmon can be divided into North American and Asian groups, and the Asian groups can be divided further into Japanese and Russian groups, which show different migration routes. Japanese and Russian chum salmon stocks are predominant in the Bering Sea during summer and fall. However, recently, several studies reported different tendency. Higher densities of chum salmon were observed within the vicinity of the Bering Strait and the Chukchi Sea than the eastern Bering Sea on September 2007 and alike Japanese chum salmon migrated to northern areas in the Bering Sea on August 2009. Sea surface temperature in the Arctic marginal seas has increased since the mid-1960s, especially since 2000. We speculated that SST increase affect to salmon northing directly. Therefore, we focused on chum salmon migrating northward to the Western Arctic. We estimated the potential habitat for chum salmon in the Western Arctic using a bioenergetics model coupled with a three-dimensional lower trophic ecosystem model (3-D NEMURO). The model domain contained the entire Chukchi Sea and the southern area of the Canada Basin. The horizontal resolution was about 2.5 km, and there were 25 vertical levels (surface to 4000 m). We assumed chum salmon move to a depth where the growth rate is the maximum within 100 m, because chum salmon migrate vertically to below 100 m depth for controlling their body temperature and searching for prey. The model was run for nine months from March to November 2003, thus representing the entire months chum salmon are distributed in the Bering Sea from June to November. In the bioenergetics model, the growth rate of an individual chum salmon was calculated as a function of water temperature, salinity, and prey density, which were obtained from the 3-D NEMURO model results. We calculated the growth rates of chum salmon of 100 gWW to 4000 gWW and defined 'Potential habitat' as 'an area where chum salmon can grow up (i.e., the growth rate is positive)'. The potential habitat reflected the warm and nutrient-rich Pacific water inflowing from the Bering Strait. That was restricted to the southwestern Alaskan coast on June and expanded to the Chukchi Sea and along the Alaskan northwestern coast from July to September and reduced from October. The main limiting factor was the water temperature on June and November and the prey density on July to October. For global warming scenario, we used the modeled monthly water temperature anomaly between 2005 and 2095 under the IPCC SRES-A1B scenario. Under the global warming scenario, the potential habitat for chum salmon increased during early summer and autumn due to the water temperature increase, whereas during summer the potential habitat for smaller chum salmon increased but that for larger chum salmon decreased because the water temperature exceeded the optimal condition, especially in the southern Chukchi Shelf and near the Bering Strait. The water temperature limitation was relaxed with a water temperature increase on June and November, but regionally the water temperature was the main limiting factor during summer.

Keywords: Arctic, marine ecosystem model, Chum salmon

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ACG36-06 Room:311 Time:April 29 15:30-15:45

Seasonal changes in zooplankton swimmer and faecal pellets collected using a sediment trap in the western Arctic Ocean

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Most studies on zooplankton community in the Arctic Ocean have been performed on the basis of net-collected samples. However, seasonal sea ice coverage in this area prevents the accurate evaluation of their seasonal changes. To overcome these challenges, analysis on zooplankton swimmers collected using a moored sediment trap is a powerful tool. In the present study, we analysed the seasonal changes in zooplankton swimmers and faecal pellets collected using a sediment trap moored at the Northwind Abyssal Plain in the western Arctic Ocean.

Samples were collected using a sediment trap moored at 184-260 m at St. NAPt (75N, 162W, bottom depth: 1975 m) in 10-15 day intervals from October 4, 2010 to September 18, 2012. The sample cups were filled with 5% buffered formalin seawater. After the trap was retrieved, a total of 52 samples were gently sieved using a 1-mm mesh, and a fine-size fraction ($<$1 mm) of each sample was filtered using a membrane filter and subsequently weighed. Next, the total mass flux (mg DM m^{-2} day^{-1}) was evaluated. Zooplankton faecal pellets were then quantified in an aliquot of the fine-size fraction, according to four morphological types (oval shape, cylinder shape, spherical shape and brown oval shape). On the basis of both the size fraction samples ($<$1 mm and $\geq$ 1 mm), species identification and enumeration of zooplankton were performed under a dissecting microscope. Furthermore, cluster analysis by Bray-Curtis similarity using the connected unweighted pair group method and the arithmetic mean was performed on the zooplankton flux data (ind. m^{-2} day^{-1}). To identify the species most responsible for the similarity between zooplankton communities, SIMPER analyses were performed on the flux data.

In addition, satellite data were obtained, which revealed the sea ice coverage period (November-June), open water period (August-October), and high chlorophyll a period (August-October). The total mass flux ranged from 0.1-263.3 mg DM m^{-2} day^{-1}, and its peaks occurred in November, which corresponded to the onset of sea ice coverage. In the faecal pellets, oval shaped and spherical shaped morphologies were predominant, and resulted in a total pellet number of 60% and 30%, respectively. With regards to the specific characteristics of the faecal pellets, the brown oval shape occurred only in the open water period (July-August) and their maximum composition during this period reached 80%. The zooplankton flux ranged from 35 to 739 ind. m^{-2} day^{-1} and was significantly higher in September-November compared with other periods (p $<$0.0001, one-way ANOVA). In addition, poecilostomatoid copepods were numerically the most dominant taxa (annual mean$\pm$1sd: 69$\pm$18%). For seasonal dominant taxa, bivalve larvae were found in October-November (53%), and barnacle larvae were abundant in August 2011 (33%) but were not present in 2012. Cluster analysis on the zooplankton flux identified five zooplankton community groups. The occurrence of each group clearly showed seasonality, and alterations in their timings corresponded with the timing of the onset or offset of ice coverage or seasonal changes in daylight hours.

On-board experiments demonstrated that the brown-oval-shaped faecal pellets might be egested by amphipods. Furthermore, the high brown-oval-shaped faecal pellets found during the open water period (July-August) might reflect the massive feeding activity of amphipods. For zooplankton swimmers, seasonal abundant bivalve and barnacle larvae may be transported from a shallower region (e.g., the Chukchi Sea). The annual change in occurrence of barnacle larvae (present in 2011, but not in 2012) may be caused by the annual changes in water mass formation in the upper layer of the St. NAPt.

Keywords: western Arctic Ocean, sediment trap, zooplankton community, faecal pellets

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ACG36-07 Room:311 Time:April 29 15:45-16:00

Volume, heat and freshwater fluxes of Pacific Water through the Barrow Canyon in the Arctic Ocean

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Interest in Pacific Water flowing from the Bering Strait into the Arctic Ocean has increased markedly in recent years, because of warming and increasing of Pacific Water inflow. Barrow Canyon, in the northeast Chukchi Sea, is a major conduit for Pacific Water to enter the interior Arctic basins. Our study focuses on the quantitative estimate of volume, heat and freshwater fluxes through Barrow Canyon by mooring observations with hydrographic surveys. We conducted year-round mooring observations at one station from 2000 to 2001 and at three stations from 2001 to 2013 in the mouth of Barrow Canyon. The annual mean volume, heat and freshwater fluxes through Barrow Canyon were 0.49 Sv, 2.25 TW and 31 mSv, respectively. Annual averaged volume and freshwater fluxes though Barrow Canyon in recent years from 2010 to 2013 were lower than the 2000-2008 averages, mainly due to strong northerly wind. In contrast, heat flux for the period 2010-2013 was higher than the 2000-2008 average. It tended to be three highest maximum in 2007, 2010 and 2012, when summer sea ice extent extraordinary retreats in the Arctic Ocean, mainly because of the warming of Pacific Summer Water. Heat fluxes observed in these years were 3-4 times larger than that observed in summer 1993. It is sufficient to melt 1-m-thick ice over an area of 360,000 km^2, which is equivalent to the total land area of Japan. The heat possibly contributes to both sea-ice melt in summer and a decrease in sea-ice formation during winter because this water typically subsides just below the surface mixed layer in the Canada Basin.

Keywords: Arctic Ocean, Pacific Water, Heat flux, Sea ice extent

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ACG36-08 Room:311 Time:April 29 16:15-16:30

Water masses transporting process from the Bering Sea to the Arctic Ocean revealed from multiple chemical tracers

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The Arctic Ocean is tightly connected to the Pacific Ocean through the only oceanic gateway Bering Strait. Water, heat, nutrients, and other substances inflowing via water masses exchanges affect the marine environment in the Arctic Ocean. In recent decades, the Arctic Ocean has changed dramatically, especially the rapid reduction of sea ice. The changing of water masses through the Bering Strait is thought to be one of the main reasons. Thus, focusing on the process of water masses transporting will contribute to understanding and forecasting the marine environment in the Arctic Ocean. In this research, stable oxygen isotopes, salinity and rare earth elements (REEs) are used to reveal the water masses transporting process from Bering Sea to the Chukchi Sea, which data comes from the Oshoro-Maru C255 cruise during 14June ? 07 August 2013. 182 water samples of δ^{18}O from 31 stations were analyzed by IR-MS (Isotope Ratio Mass Spectrometry). The δ^{18}O composition and salinity are used to separate the different water sources based that river water is highly depleted in δ^{18}O relative to marine waters as well as to sea-ice. Rare earth elements in the sediments from 8 stations were also analyzed by the method of BCR sequential extraction procedure which partitions the elements in sediments among various forms. It aims to trace the material sources, reflecting the water masses transporting process indirectly. The investigations show that in the Bering Sea, δ^{18}O value is around -2 ‰ in the surface increasing to -0.8 ‰ in the bottom water, closed to the δ^{18}O value of Pacific Ocean water, indicating that the up layer water is obviously affected by freshwater. In the Bering Strait, δ^{18}O value is similar in the whole water column, around -1.3 ‰, consistent with salinity, which means that the water is well mixed in the Bering Strait (East side of Bering Strait). In the Chukchi Sea, δ^{18}O value is also affected by sea ice melt water. REEs data shows that different fraction of sediment has different sources, most part of sediments originally come from land, after charged into ocean, they combine with particles or substance under different marine environment.

Keywords: Arctic Ocean, water mass, oxygen isotope, rare earth element

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ACG36-09 Room:311 Time:April 29 16:30-16:45

Influence of the Gulf Stream on the Barents Sea ice retreat and Eurasian coldness

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Abnormal winter sea-ice retreat over the Barents Sea has been considered as a leading clue to the recent midlatitude severe winters. Barents Sea is considered as a hot spot for the rapid Arctic climate change due to the intense air-sea interaction induced by the sea-ice decrease; however, the underlying mechanisms remain uncertain, in particular causal relation of sea-ice retreat and atmospheric forcing and response. To understand this causality, we selected typical cases, defined as averaged warm and averaged cold years of December using the NCEP Climate Forecast System Reanalysis (CFSR). The composite analysis, revealed that anticyclonic anomaly is obvious over the northwestern Eurasia. The western Barents Sea and Sbarvard locates at the strong pressure gradient zone, prevailing southerly winds. Over the Barents Sea, the difference in daily mean air temperature between warm and cold winters is more than 10^{o}C, suggesting that warm advection prevails during warm years. Therefore, during warm years, decrease in sea-ice cover is induced by southerly warm advection. The positive anomalies of precipitation from the southeast of Greenland to Barents Sea and negative anomalies of them from Nordic Sea to western Eurasia means the poleward shift of cyclone tracks, suggesting that the moisture transport is also changed poleward. Because the cyclones tend to shift poleward in less sea ice year over the Barents Sea, it is natural that the snow depth over the sea ice near the Fram Strait shows a positive anomaly during warm winters. Here we show that the poleward shift of sea surface temperature over the Gulf Stream, where is situated upstream from the Barents Sea, modifies the horizontal distribution of tropospheric condensational heating resulted from change in convection over the warm current, likely acting as a bridge to the Barents Sea by forcing planetary waves. This remote atmospheric response modifies cyclone tracks poleward, resulting in anomalous warm advection over the Barents Sea sector.

Keywords: Gulf Stream, Arctic, Barents Sea, Eurasian coldness

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ACG36-10 Room:311 Time:April 29 16:45-17:00

Study of interannual variability of the atmospheric water cycle in the Arctic circumpolar region

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The thawing depth (active layer depth) in late summer drastically deepened and the soil moisture increased from 2005 to 2008 in the middle of the Lena River Basin. This was partly due to the high rainfall in late summer, as well as the high snowfall in winter. Subsequently, permafrost-forest degradations and waterlogging has been detected in the region. To clarify whether high precipitation occurred in the past in this region, we investigate the atmospheric water cycle and water budget using archived precipitation (PREC/L) and atmospheric re-analysis data (JRA-25, JRA-55). Previous studies revealed a negative correlation in the summer atmospheric circulation pattern between the Lena and Ob River Basins. However, little is known about the atmospheric water cycles in the Arctic circumpolar region, including the Mackenzie River Basin. Hence we analyzed the interannual variability of the atmospheric water cycle in the Arctic circumpolar region, comparing the three large North Eurasian river basins (Lena, Yenisei, and Ob) and the Mackenzie river basin. The analyzed results are as follows.

1) In the highest five-year summer net precipitation in the Lena River basin during the period 1958 to 2012, significant cyclonic deviation was present from the Barents Sea towards the region across from the Yenisei and Lena. The deviation distribution of the height field and the water vapor flux from the west to the Lena river basin were significantly increased, so as to form a positive deviation of net precipitation.

2) A significant enhancement of cyclonic circulation was detected from 2005 to 2008 on the Eurasian side of the Arctic Ocean. However, anticyclones appeared over Mongolia. These probably increased the atmospheric moisture convergence over the Lena River Basin in this period.

3) A significant positive trend in the summer precipitation and the summer net precipitation appeared after 1995 between the Lena and Yenisei River Basins. On the contrary, the negative trends between the Lena and the Ob River Basins became unclear from 1993.

Keywords: summer precipitation, summer net precipitation, Lena River Basin, Arctic cyclone

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ACG36-11 Room:311 Time:April 29 17:00-17:15

Evaluation of Large-scale Surface Wetness Variations in Northern High Latitudes During 1980-2010

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Large-scale surface wetness is evaluated by a wetness index (WI), calculated from GPCC precipitation divided by potential evaporation (Ep) using ERA interim data during 1980-2010. The climatological distribution of annual WI agrees with that of surface soil moisture (SSM) in ERA interim. Annomalies of annual WI also have strong relation with that of SSM in each region; the correlation coefficient between SSM and WI is higher than that between SSM and precipitation. Therefore WI corresponds to SSM for climatology and year-to-year variations.

The linear trends of WI, Ep and precipitation are calculated, with an attempt to decompose the factors of WI trend into those of Ep and precipitations. In high latitudes of Eurasia and eastern Canada, the increasing precipitation trends are canceled by the increasing Ep trends, resulting in little WI trends. In central Asia, western North America and Alaska, the decreasing precipitation trends and the increasing Ep trends lead to the decreasing WI trends. The precipitation variations dominate the WI variations in most regions. For example in Alaska, the decreasing precipitation trend contributes 72% to the decreasing WI trend and the increasing Ep trend does 27%. On the other hand, there are some regions where the Ep trend is important for the WI trend. For example in monsoon Asia, the precipitation trend is small and contributes only 3% to the decreasing WI trend, while the increasing Ep trend does 99%.

Consequently, it is shown that WI corresponds to surface soil moisture and indicates surface wet/dry conditions, and that the contributions of precipitation and Ep to its trends are quantified. Further analyses will be applied to the outputs of global climate models (GCMs) to evaluate reproducibilities of the surface energy-water balances in those GCMs.

Keywords: surface wetness, large-scale variations, reanalysis data

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ACG36-12 Room:311 Time:April 29 17:15-17:30

Multidisciplinary in situ and satellite observations for accurate detection of phenology in sub- and Arctic ecosystems

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To accurately evaluate the spatio-temporal variability of ecosystem functions and service in sub- and Arctic regions under rapid meteorological and climate changes, global, long-term, and comprehensive phenological observations are required. Towards this aim, satellite remote-sensing is useful to detect the spatio-temporal variability of plant phenology such as the timing of start (SGS) and end of growing season (EGS). However, from the in situ ecological research viewpoint, the satellite remote-sensing has not been sufficiently tested and validated by ground-truthing. Here, (1) we performed daily field observations with time-lapse digital cameras in boreal forests in Alaska and Siberia; (2) we examined the relationship between satellite-observed vegetation indices and plant phenology; and (3) we evaluated the spatio-temporal variability of the timing of SGS and EGS in sub- and Arctic regions by using MODIS Terra and Aqua-observed green-red vegetation index (GRVI). We found that (1) satellite-observed vegetation indices (i.e. NDVI, EVI, and GRVI) mainly detected the plant phenology of forest floor in sparse forests; (2) large year-to-year variability of the timing of SGS was detected in eastern Siberia and western Ural Mountains, while that of EGS was not clearly detected; and (3) in contrast, large year-to-year variability of the timing of EGS was detected in western Alaska, which is mainly covered by tundra vegetation, while that of SGS was not clearly detected.

Keywords: phenology, remote sensing, terrestrial ecosystem, Siberia, Alaska, ground-truthing

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Estimate of permafrost organic carbon balance in Alaskan boreal and tundra ecosystems using natural radiocarbon tracer

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The high-latitude regions, where a serious warming is expected, currently store large amounts of soil organic carbon in active-layer soils and permafrost, accounting for nearly half of the global belowground organic carbon pool. Despite the importance of these regions in the present carbon cycle, the soil C fluxes and budget are still only poorly known. Here, we use radiocarbon as the tool for quantifying the C balance of the inputs and decomposition in tundra and boreal soil. We evaluated the C inputs (I) and decomposition rates (k, inverse of turnover time) and net C accumulation (CA), using ^{14}C approaches.

Tundra and boreal soils show different patterns of depth distribution and C storage. Cumulative organic carbon stocks in boreal forest are 5.3 and 19.2 kgCm^{-2}, in surface organic layer (0-25 cm), and deep organic and mineral layers (25-70 cm), respectively. Large annual C input (0.25 kgCm^{-2} yr^{-1}) and relatively slow decomposition (27 years) lead to rapid CA (0.05 kgCm^{-2} yr^{-1}) in surface organic layer in boreal forest. Deep organic and mineral layers including near-surface permafrost show slower rate of input (0.03 kgCm^{-2} yr^{-1}) and turnover (617 years) and CA about 20 times slower (0.003 kgCm^{-2} yr^{-1}) than surface organic layer. Decomposition organic matter (Rh), which in accord with C losses from both surface and subsurface layers, was 0.23 kgCm^{-2}yr^{-1}. This value agreed well with Rh (0.23 kgCm^{-2} yr^{-1}) simulated by process-based models that simulate the biogeochemical and hydrologic cycle, where Rh averaged 45% of ecosystem respiration and 59% of soil respiration.

In contrast, large amount of SOC (36.4 kg m^{-2}) have accumulated over millennia (turnover time: 4540 yrs) below the thin organic layer in tundra. The CA of mineral layer and permafrost is close to zero (0.003 kgCm^{-2} yr^{-1}), and Rh is 0.008 kgCm^{-2} yr^{-1}. Our radiocarbon data show that the most SOC in tundra soil was mode of stabilizing OC by permafrost and steady-state SOC stocks under current C balance.

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

ACG36-14 Room:311 Time:April 29 17:45-18:00

Large-Scale Forest Fires in Alaska: Weather Conditions in 2004 and 2005

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In Alaska, large-scale forest fires mainly occurred in the boreal forest of the Interior (area roughly around 400 x 800 km) in 2004 and 2005. Number of large-scale forest fires (burnt area more than 500km^2) were 17 in 2004 and 12 in 2005. These large-scale forest fires boosted up burnt areas 26,000km^2 in 2004 and 18,800km^2 in 2005. Their areas were largest and third largest among the past 58 years from 1956 to 2013.

In order to evaluate large-scale forest fires in both years, statistical analysis for the fire data in the past 58 years was carried out. As a result, annual average burnt area was 3,480 km^2, and the coefficients of standard deviation (sigma) were +4.25 for 2004 and +2.88 for 2004. In the background of these large standard deviation coefficients, only 11-year could show large burnt area of more than 6,000km^2, and burnt area of other 47-year were less than 5,000km^2. In addition to this trend, the occurrence of fire year with burnt area more than 6,000 km^2 was once per decade from the 1950s to the 1980's. But from the 1990's, fire year tended to occur more frequently. That is, they were 1957 (2nd largest), 1969 (6th), 1977 (7th), 1988 (8th), and these frequencies were once per decade. However, from the 1990s, fire years occurred in 1990 (4th largest), 1997 (9th), and 1991 (11th). From the 2000s, four fire years observed in 2004 (largest), 2005 (3rd largest), 2009 (5th), and 2002 (10th). The frequent occurrence trend of such fire year may be suggesting close relationship with the rapid reduction of sea ice in the Arctic Ocean under a rapid climate change.

From the comprehensive analysis in this paper, largest burnt areas in 2004 happened under the condition made by ridge extended from Canada lasted about three month from June to August. The very severe fires observed in August 2005 occurred along with the movement of the high pressure system from the Gulf of Alaska to the Beaufort Sea.

Keywords: Forest Fire, Hotspot, Climate Change, Lightning, Jet Stream, Sea ice

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

ACG36-15 Room:311 Time:April 30 09:00-09:15

Detection and attribution of changes in arctic ecosystems and atmospheric CO2

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Atmospheric CO_2 responds to terrestrial ecosystem activity widely from sub-hourly to decadal time scales primarily due to photosynthesis, weather and climate variations. The measurements of CO_2 thus consist of source signals from anthropogenic as well as natural ecosystem activities convolved with atmospheric transport. Since the records of CO_2 concentration in ambient air at monthly or finer time resolution began in the late 1950s, the seasonal ecosystem dynamics has enhanced significantly in the recent years (Graven et al., 2013). We further analyse the relative contributions of fossil fuel emissions and atmospheric transport on the CO_2 at a greater number of surface measurement sites since the 1980s using the CCSR/NIES/FRCGC atmospheric general circulation model (AGCM)-based chemistry transport model (ACTM). Our results suggest the trends in fossil fuel emissions and transport have detectable contribution to the CO_2 seasonal cycle chances at the sites in northern tropics to mid-latitudes, and that the seasonal cycle increase in the arctic region is governed mainly by the terrestrial ecosystem.

To attribute causes for the recent changes in carbon cycle dynamics we have chosen the period of 1999-2011, which is covered by high quality process oriented ecosystem parameters from remote sensing and atmospheric CO_2 measurements at the largest network of sites for flux inversion. Our analysis suggests that the early greening by several days in the Alaskan tundra region closely correlated with the amplitude of CO_2 seasonal cycle at Point Barrow, Alaska. But no clear trend in the greening onset is detectable at semi-arid grasslands near Ulaanbaatar, Mongolia, except for the closely coupled interannual variations in greening onset time and CO_2 seasonal cycle amplitude. We estimated CO_2 fluxes from 84-regions of the globe at monthly time intervals using measurements from about 100 sites. The terrestrial CO2 fluxes are estimated after removing the effects of fossil fuel emissions and oceanic fluxes in measured CO_2 concentrations. We find the carbon exchange of the Alaska region of our inversion is increased both for the seasonal cycle amplitude and net annual uptake over the period of 2002-2011.

Our results have large implications for developing the future and validating the present earth system models for studying climate-carbon-biosphere interactions.

Keywords: CO2 seasonal cycle, Ecosystem phenology, Arctic environment

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ACG36-16 Room:311 Time:April 30 09:15-09:30

Epoch difference of water cycles in eastern and western Siberia

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Among all the rivers flowing into the Arctic Ocean, the three great Siberian rivers; Lena, Yenisei and Ob, are the three largest in terms of water discharge (R), and they are a large source of freshwater. We examined the relationship of long-term water cycle variability between eastern and western Siberia on the basis of net precipitation (P-E) estimated from an atmospheric reanalysis, and Rs from observations at the river months and from a reconstruction based on tree rings.

The relationship of summer (P-E)s between the Lena and Ob Rivers is different in the first half and the second half of the past three decades. During 1980s to mid-90s, the (P-E)s have a strong negative correlation. These variations were affected by the east-west seesaw pattern of moisture flux. These results are consistent with Fukutomi et al. (2003). The decomposition analysis revealed that the stationary component of moisture flux dominates the seesaw pattern during the period. After mid-1990s, the correlation of the (P-E)s between the Lena and Ob becomes weak. During mid-1990s to 2000s, the P-E over the Lena was affected by cyclonic moisture flux over the basin. In addition to the stationary component, the transient component of moisture flux also affects the P-E variation in this period.

Long-term records revealed that the Rs of the Lena and Ob Rivers have moderate or weak positive correlations and strong negative correlations before the 1980s. Interestingly, the correlations tend to be distributed in the negative side. It implies that the east-west seesaw pattern frequently appear over Siberia. In conclusion, the moisture transport processes over Siberia are different in each era and they result in the different variability of the Rs and (P-E)s of the Lena and Ob Rivers.

Keywords: Siberian rivers, moisture transport process, net precipitation, river discharge, interannual variation, long-term variability

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

ACG36-17 Room:311 Time:April 30 09:30-09:45

The Structure Change of Arctic Cyclones on Cyclone Phase Space

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In this study, we investigated the structure change of the Arctic cyclone’s life cycle on a cyclone phase space.

Keywords: Arctic cyclone, Structure change, Cyclone phase space

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

ACG36-18 Room:311 Time:April 30 09:45-10:00

A negative phase shift of winter AO/NAO due to the recent Arctic sea ice reduction in late autumn

NAKAMURA, Tetsu[1*] ; YAMAZAKI, Koji[1] ; IWAMOTO, Katsushi[1] ; HONDA, Meiji[2] ; UKITA, Jinro[2] ; MIYOSHI, Yasunobu[3] ; OGAWA, Yasunobu[1]

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Attribution of the long-term changes in the wintertime Arctic Oscillation (AO)/North Atlantic Oscillation (NAO) to the recent Arctic sea ice reduction is studied. Observations using ERA interim reanalysis and Merged Hadley/OI-SST show that small (large) sea ice area in summer to autumn leads the negative (positive) phase of AO in early winter and NAO in late winter. Relationship with winter AO/NAO is the strongest with the sea ice variability in November rather than September. To separate influences of sea ice variability and sea surface temperature (SST) anomalies, sensitivity experiments are performed with atmospheric general circulation model (AGCM for Earth Simulator, AFES4.1), in which observed changes (anomalies of 2005-2009 from 1979-1983) of the sea ice and SST are prescribed. The Arctic ice reduction generates the negative AO/NAO pattern that brings cold winter in mid-latitude continental regions. Both SST anomalies in the tropics and mid-/high-latitudes mask the continental cooling. Model-based analysis reveals that stationary Rossby wave response to the ice reduction in Barents Sea induces anomalous meridional circulation corresponding to the negative AO. The ice reduction increases (decreases) a frequency of the large negative (positive) AO occurrence about a twice (half). The anomalous meridional circulation warms the Arctic and cools the mid-latitudes. This provides additional Arctic heating about 25% of heat release due to the ice reduction. As a response to ice reduction, transient eddy activity over northern Eurasia is reduced and the change in the eddy damps the stationary responses.

Keywords: Arctic sea ice loss, Arctic Oscillation, long-term changes

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

ACG36-19 Room:311 Time:April 30 10:00-10:15

Cross spectral analysis of the AO index using the AOI equation

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Arctic Oscillation (AO) is explained as an atmospheric dynamical eigenmode. There is an argument, however, that the AO is a statistical illusion by the EOF analysis. Tanaka and Matsueda (2005) showed AO mode as the most unstable standing mode in the barotropic atmosphere. In addition to the zero frequency of the mode, the growth rate becomes also zero for adequate frictional force and interaction with transient eddies. Such a mode can be amplified resonantly by quasi-situational forcing. This idea of the AO is called singular eigenmode theory. For the problem of missing correlation in surface pressure between the Pacific and Atlantic is explained by Suzuki and Tanaka (2007) by analyzing barotropic height instead of the surface pressure. The barotropic height indicates significant correlation between the two regions. The missing correlation is thus explained by the baroclinic component of the atmosphere. We support the singular eigenmode theory, but a further analysis is required by the data analysis of the AO index. In this study we derived an equation called AOI equation from the definition of the AOI differentiated with respect to time, and substituting the primitive equation. According to the analysis result of the NCEP/NCAR reanalysis for 62 years of data, it is found that the AOI time series is proportional to the linear term of the AOI equation. The nonlinear term and external forcing term indicate inverse correlation with the AOI, which tend to damp the AOI to the normal. The fact that the linear term of the primitive equation is proportional to the AO structure, i.e., $L*x = a*x$ implies that the AO is an eigensolution of the dynamical system. The present study supports the singular eigenmode theory from the data analysis using the AOI equation.

Keywords: Arctic Oscillation, Global warming, Low-frequency variability, Singular eigenmode theory, Normal mode, Barotropic instability

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

ACG36-20 Room:311 Time:April 30 10:15-10:30

Cryospheric studies using satellite data in the GRENE Arctic Project

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GRENE Arctic Climate Research project aims to establish interdisciplinary collaborations of different scientific area. The GRENE project constructed the Arctic Data archive System (ADS) at NIPR to support this researching frame. ADS stores the field data obtained by the project, satellite data by collaboration with JAXA and modelling output from climate models. This presentation introduces activity of data archiving in GRENE Arctic project and ADS for multiple studies.

This study investigates cryospheric change using satellite data stored in the ADS and other satellite programs.

Keywords: Arctic, Cryosphere, Satellite, data archive

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

ACG36-21 Room:311 Time:April 30 10:30-10:45

Recent changes of satellite-derived snow grain size and glacial microbial activities in Greenland ice sheet

AOKI, Teruo[1*] ; KUCHIKI, Katsuyuki[1] ; NIWANO, Masashi[1] ; TANIKAWA, Tomonori[2] ; HORI, Masahiro[2] ; SHIMADA, Rigen[3] ; TAKEUCHI, Nozomu[3] ; STAMNES, Knut[4] ; LI, Wei[4]

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Snow surface albedo strongly depends on snow grain size and mass concentration of light absorbing impurities. These snow parameters are uncertain factors for the recent drastic snow and ice meltings in the Arctic. Particularly, Greenland ice sheet (GrIS) is presently undergoing drastic changes. In 2012 a record melting event of surface snow/ice occurred over the GrIS. When air temperature increases, snow grain size is also increased by accelerating the snow metamorphism and thus the albedo is reduced (positive albedo feedback). This process is mainly dominant in the accumulation areas. On the other hand, the bare ice area is extended by snow melting on ice associate with air temperature raise in ablation areas. It is recently reported that wide bare-ice areas in GrIS are covered with glacial microbes whose albedos are lower than that of blue ice surface. This albedo reduction effect is also another positive albedo feedback effect by glacial microbes. To examin these feedback effects by snow grain growth and glacial microbial activities in conjunction with air temperature increase, we retrieved snow grain size and glacial microbe concentration from Moderate Resolution Imaging Spectroradiometer (MODIS) data. The employed algorithm is based on a look-up table method for bidirectional reflectance distribution function at the top of the atmosphere as functions of snow grain size, snow impurity (soot) concentration, solar and satellite geometry. The employed satellite channels are 0.46, 0.86, 1.24, and 1.64 μm. Since the snow impurity concentrations in accumulation area are the same or lower level of the detection limit of soot concentration in GrIS, we use this retrieval result as an indicator of microbial activities in bear ice areas. The monthly averages of snow grain size and snow impurity concentration from 2000 to 2013 in GrIS derived from Terra/MODIS revealed the following facts. (1) The areas of large grain size changed year by year. (2) There is no constant increasing trend, but the larger values were observed in recent years (2009-2012) and especially for 2012 the remarkable increase in whole Greenland. (3) Larger snow grain size and high impurity concentration, which indicate the areas of high glacial microbial activities, are distributed in coastal regions of GrIS in June (mainly in southern part), July and August. These parameters in colder summer of 2013 than the recent several years, were almost the same as those in 2000.

Keywords: Greenland, snow grain size, glacial microbe, albedo, satellite remote sensing, MODIS

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

ACG36-22 Room:311 Time:April 30 11:00-11:15

Acceleration and deceleration of ice thickness variations in Greenland from ICESat laser altimetry (2003-2009)

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The laser altimeter mission ICESat, launched by NASA in January 2003, measures the Earth's surface elevation with a precision of several cm. ICESat has performed campaign observation of about 90 days a year between September 2003 and October 2009. The spatial resolution of the measurement in Greenland is about 20 km in average. In this study, we analyze acceleration/deceleration of ice thickness variations in Greenland from ICESat elevation data. We employ Plane fitting method (e.g. Zwally et al., 2011) to correct topographic effect coming from gaps of repeat-track paths, and fit the time-series of surface elevation variations with a linear combination of linear and quadratic terms by least-squares method at every 700m interval. The quadratic trend signal thus extracted represents accelerated/decelerated variations.

The obtained linear variation suggests significant ice thinning trend in southeastern and western Greenland. Their thinning rates attain to about 1.5-2 m/yr. On the other hands, inland area shows ice thickening trend with a rate of 0.3 m/yr. Assuming the firn density as 700 kg/m^3 in ice thinning area and 300 kg/m^3 in ice thickening area, we obtain the total ice loss rate of about -200 Gt/yr, which is equivalent to about 0.55 mm/yr sea level rise. This agrees well with GRACE gravimetric estimate.

Next we focus on the quadratic variation. Western Greenland shows significant negative quadratic variations, suggesting acceleration of ice thinning rate. Such trend is particularly noticeable in Jakobshavn glacier and Qaanaaq area. On the other hands, southern Greenland shows different behaviors: negative quadratic variations (accelerated ice thinning) in Helheim glacier and Kangerdlugssuag glacier, and positive quadratic variations (decelerated ice thinning) in other coastal area. We speculate that accelerated ice thinning in the above outlet glaciers reflects recent global warming, while decelerated ice thinning in other coastal area of southern Greenland does anomalous precipitation of Arctic Oscillation with positive phase during the winter of 2007-2008.

Keywords: Greenland, Ice thickness variation, Climate change, Space geodesy, ICESat, GRACE

Japan Geoscience Union Meeting 2014
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ACG36-23 Room:311 Time:April 30 11:15-11:30

Sensitivity of Response of Greenland Ice Sheet to Global Warming on Surface Mass Balance and Initialization methods

SAITO, Fuyuki[1*] ; ABE-OUCHI, Ayako[2] ; TAKAHASHI, Kunio[1]

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We present a series of numerical experiments of Greenland ice sheet under global warming condition using Ice sheet model for Integrated Earth system Studies (IcIES).
In this study, influence on the simulation from the difference in the method to compute the surface mass balance is focused.
Typically, ice sheet simulation is driven by a *reference-anomaly* method, in which the surface temperature and/or the accumulation are decomposed into the reference terms (e.g., observation), the anomaly (e.g., climate scenario from climate models).
Then the surface melting is computed using parameterization such as positive degree-day (PDD) method with the temperature.
These decomposed terms have own uncertainties, which may influence the ice-sheet simulation.
In this study, impact of these properties to the present-day control case, as well as the response under uniform warming condition are discussed, which is thought be a useful and basic information of the property/sensitivity of the Greenland ice sheet.

In addition, several initialization methods (free spin-up, fixed-topography spin-up, etc) are applied to IcIES in order to evaluate the influence of the error in the present-day simulated topography to the short-term response of Greenland ice sheet.

Keywords: Greenland ice sheet, Ice-sheet model

Japan Geoscience Union Meeting 2014
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ACG36-24 Room:311 Time:April 30 11:30-11:45

Ice thickness change of Bowdoin Gletscher, northwestern Greenland

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Ice discharge from calving glaciers in the Greenland ice sheet (GrIS) has recently increased through the acceleration of glaciers, and this increase plays an important role in the ice volume change of GrIS and sea level rise. Previous studies have used remote-sensing (RS) data to assess surface lowering of calving glaciers in GrIS. However, because of the remoteness of these glaciers, relatively few field data are available on the surface elevation change. Consequently, RS data have been used without calibration with filed data. The accuracy of such studies relies on digital elevation models (DEMs) derived from satellite data.

In this study, surface elevation was measured along longitudinal and three transverse profiles in Bowdoin Gletscher (77^{o}41'18"N, 68^{o}29'47"W) in July 2013. DEMs of Bowdoin Gletscher in August 20, 2007 and September 4, 2010 were generated by Advanced Land Observing Satellite (ALOS) Panchromatic remote-sensing Instrument for Stereo Mapping (PRISM) images with a 50 m grid mesh, and calibrated using field data. Mean surface elevation change along the field survey profiles were -16.3$\pm$4.0 m (5.3 m yr^{-1}) in 2007-2010 and -10.8$\pm$4.0 m (-3.8 m yr^{-1}) in 2007-2013. Surface elevation change along the lower most transverse profile (800 m from the calving front) was more negative than those along the other profiles in the upper reaches. Surface lowering rate at all profiles has decreased from 2007-2010 to 2010-2013.

Keywords: Calving glacier, Greenland

Japan Geoscience Union Meeting 2014
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ACG36-25 Room:311 Time:April 30 11:45-12:00

Estimation of glacier motions at Svalbard, NovayaZemlya with ALOS/PALSAR

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While the Greenland Ice Sheet's mass loss is equivalent to 0.6mm/yr sea level rise, a half of them is attributed to the changes in glacier dynamics (Broeke et al., 2009). Namely, surface velocities of many glaciers in Greenland have increased in the recent decade (Moon et al., 2012). We thus wonder if glacier velocities outside Greenland have also increased or not.

Svalbard and NovayaZemlya are arctic islands located at 78 degrees north and 74 degrees north, respectively, and have many glaciers. Stozzi et al. (2008) estimated glacier motions in these islands with SAR in 1990s. However, there are not any studies with SAR in recent decade.

We examined Duvebreen glacier in Svalbard and Vize Glacier in NovayaZemlya. In this study, we used PALSAR derived by the ALOS satellite launched from Japan. The PALSAR data were acquired 10 times at Duvebreen glacier from July 2007 to October 2010, 13 times at Vize Glacier from February 2007 to December 2010. We compared the result with 1990s velocity in previous study.

Accordingly, two glaciers in Svalbard and NovayaZemlya speeded up from 1990s. This result suggests that velocity of other arctic glaciers increase as Greenland's glaciers.

Keywords: svalbard, novaya zemlya, glacier, alos, duvebreen, vize glacier

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

ACG36-26 Room:311 Time:April 30 12:00-12:15

Snow impurity concentration and snow grain size measured in Ny-Alesund, Svalbard

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Mass concentration of light absorbing impurities in snow and snow grain size are important parameters controlling snow albedo. An increase in light absorbing impurities such as black carbon (BC) reduces the visible albedo and that in snow grain size reduces the near-infrared albedo. To monitor these snow physical parameters and evaluate those effects on snow albedo in the Arctic, we have measured the snow parameters using a ground-based spectral radiometer system for albedo and flux (GSAF) in Ny-Alesund, Svalbard (78^{o}55'N, 11^{o}55'E). The BC concentration in snow and snow grain sizes in the topmost and subsurface layers were retrieved from spectral albedos measured using the GSAF from March to June, 2013. Furthermore, the retrieved snow parameters were validated by comparing with in-situ measurements based on snow pit work and snow sampling in April, 2013. The collected snow samples were filtrated, and then elemental carbon (EC), organic carbon (OC) and dust concentrations in snow were measured by filter weighing and thermal optical analysis.

The snow depth gradually increased up to 40 cm during the polar night from late October to late February. It maintained around 40 cm until the middle of May, and then rapidly decreased to 0 cm in early June. The BC concentrations retrieved from the GSAF varied little during March to June with about 110 and 40 ppbw for external and internal mixture models employed in the retrieval algorithm, respectively. The in-situ measured EC, OC and dust concentrations were 8-35, 32-190 and 570-3180, respectively. The BC-equivalent concentrations estimated from the light absorbing effects of both EC and dust were 18-43 ppbw, which agreed with the GSAF-derived BC concentrations using the internal mixture model. The topmost layer snow grain radius retrieved from the GSAF were varied within the range 30-300 μm until the middle of May, then increased more than 1000 μm with the snow melting. The snow grain sizes in the subsurface layer were generally larger than those in the topmost layer, which was consistent with the in-situ measurement. We estimated the possible albedo reduction by snow impurities using a physically based snow albedo model with the GSAF-derived snow parameters. The albedo reduction was enhanced to -0.038 during snow melting period after the mid-May, compared with -0.027 before the mid-May, mainly due to the increase in snow grain size.

Keywords: light absorbing snow impurity, black carbon, dust, snow grain size, Ny-Alesund

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ACG36-27 Room:311 Time:April 30 12:15-12:30

New 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, ADS, Visualization, VISION

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ACG36-28 Room:311 Time:April 30 12:30-12:45

Recent advance in discussions on the Arctic Environmental Studies

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This presentation introduces rescent activities of the discussion on Arctic environmental studies. There are many national and international discussions on the Arctic study. Japan Consortium for Arctic Environmental Research (JCAR) has started discussions on thefuture study plan. IASC and ICARP-III discusses on the enhancement of present and future Arctic research and coordinations.

Keywords: Arctic, Environmetal study, planning