Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

ACC32-P01 Room:Convention Hall Time:May 24 13:30-14:30

Antarctic ice sheet surface temperature change derived from MODIS and AWS

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Antarctic ice sheet holds approximately 70% of the fresh water on earth. If it melts, sea level will rise about 57m. So, it is important to know the dynamics.

Temperature rise in the entire Antarctic ice sheet in the past 50 years have been reported from studies using ice sheet surface temperature derived from satellites and atmospheric surface temperature observed by meteorological observation.

These two types of temperature are different from the view of radiation balance, however, often used on same time and confused in these studies. In addition, their difference is not considered.

In this study, we show the difference and structure of Antarctic ice sheet near surface temperature from same point and same time comparison of ice sheet surface temperature derived from MODIS Daily Land Surface Temperature Product (MODIS LST Product) and Atmospheric surface temperature observed by AWS. And we also show the Antarctic ice sheet near surface temperature change in recent years considering its features.

MODIS LST Product estimates land surface temperature based on split window method using thermal infrared bands. Spatial resolution is 1km and its automatic geometric correction accuracy has improved.

Automatic Weather Station set on the whole region of Antarctica by AMRC, Wisconsin University, and so on. And it is observing Atmospheric surface temperature, pressure, wind speed and wind direction per 10 minutes of 3 meters height. In this analysis, we use 90 points Atmospheric surface temperature since 2002 to 2010.

As a result, ice sheet surface temperature is lower than Atmospheric surface temperature. This difference shows inverse temperature structure from ordinary one in troposphere and it changes seasonally. Especially, the difference is large in summer night and winter.

It is considered that the difference is caused by surface inversion layer occurred to balance of solar radiation and radiative cooling. Because, MODIS LST Product is ice sheet surface temperature, however, AWS is Atmospheric surface temperature of three meters height. So, their difference of observation height causes temperature difference.

The difference is classified to latitude. Low latitude area, temperature difference is same as the features on whole region. On the other hand high latitude area, temperature difference almost doesn't change during a day.

It is considered that this difference is caused by change of solar radiation quantity with change of solar height.

From the results obtained in the entire Antarctic ice sheet surface temperature changes from 2002 to 2010 from MODIS, temperature rate of change shows a downward trend in whole region. Rate of change of temperature is determined at each pixel of the image while the entire Antarctic tends to decrease in a wide region, the surface temperature tends to be elevated in most of the coastal area of East Antarctica, coastal area of the Antarctic Peninsula and slope area.

Possible upward trend in the slope of the temperature, which can be attributed to the influence of thermal belt has increased. That tends to shrink from the temperature difference indicated by the comparison of MODIS and AWS in slope area, considered as ground inversion layer has weakened in recent years is the driving force of the katabatic wind, thermal belt slope becomes relatively temperate belt that steal the sensible heat transport and effect of cold is reduced in recent years are likely to appearance will be considered, and that caused the global warming in the slope.

Keywords: Antarctic ice sheet, Surface temperature, Surface inversion

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Spatial and temporal variability of snow accumulation rate and snow chemistry at East Antarctic ice sheet

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Snow stakes along the traverse routes have been observed for long term monitoring program 'the variation of ice sheet surface mass balance' from the 1960's by the Japanese Antarctic Research Expedition in Shirase glacier drainage basin, East Antarctica. During the traverse route between coastal S16 point (69 02'S, 40 03'E, 580m a.s.l.) to inland Dome Fuji (77 22'S, 39 42'E, 3,810m a.s.l.), the snow stake observations every 2 km have been carried out from 1993. Latest stake heights were measured in January 2011 and February 2011. Yearly net snow accumulations from S16 to Dome Fuji were calculated. Heavy snow events were shown in 1998, 2004, 2005, 2008-2009 and 2010. Otherwise, in 1994, 1996, 1999, 2000, 2001, 2002 and 2006, light snow events were observed. They were different in way accumulating spatial pattern depending on places. The yearly accumulation rates were compared with seasonal change of AAO-index (SAM). As a result, yearly accumulation rate and AAO-index showed the positive correlation.

We would indicate the spatial distributions of air parcel origins. So we calculate air transport by using the NITRAM trajectory model (Tomikawa and Sato, 2005) and ERA-Interim meteorological data set in 1990-2009. The time duration is 5 days and we suppose the origin of air parcel is the point of trajectory at 5 days ago. The starting points are distributed on 1 deg. x 1 deg. grids over Antarctica and its altitude is 1,300m above the surface. We indicate the spatial distributions of air parcel origins to Antarctica. If there were high ratios of sea origin atmosphere in the inland, there was much snow. It is indicated that the humid air from the sea is the main origin of snowfall. But such relations were not seen on the coast.

We try to understand the cause of heavy snow and light snow event with snow chemistry.

Keywords: Antarctic ice sheet, snow accumulation rate, snow chemistry, spatial and temporal variability

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Characteristic Seismic Waves Associated with Cryosphere Dynamics in Eastern Dronning Maud Land, East Antarctica

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Several kinds of natural source signals are recorded by seismic exploration stations on the continental ice-sheet in Eastern Dronning Maud Land, East Antarctica, during 2002 austral summer. They include not only tectonic earthquakes, but also ice related phenomena possibly involving recent global climate change. The recorded signals are classified into (1) teleseismic events, (2) local ice-quakes and (3) unidentified events (X-phases). The teleseismic waves show the high signal-to-noise ratio in spite of the small magnitude of the event: this indicates that it is highly feasible to study not only the local shallow structure but also the deep structure of the earth by using teleseismic events. Frequency spectra of the all waveforms represent discordances along the observation seismic profile. The abrupt change of topography in the valley along the seismic profile might cause both the anomalous frequency content and travel-times. Finally, an origin of the X-phases is speculated as the intra-plate earthquakes or possibly large ice-quakes (glacial earthquakes) around Antarctica, involving global warming appeared in polar region.

The characteristic seismic waveforms from various natural sources (teleseismic, local ice-quakes and unknown X-phases) are obtained by the SEAL-2002 exploration in Eastern Dronning Maud Land, East Antarctica. Interesting features of the seismic wave propagation around Antarctica are significantly demonstrated. Anomalous behavior of the waves characterized by the focusing/defocusing effects is possibly caused by a valley structure beneath the stations located at the middle of the seismic profile. Several characteristics were identified by detailed spectra analyses. A difference of the response generated from the valley structure might exist for different kinds of incident waves: i.e. P-wave incidence on the valley results in a frequency gap while on the other hand, S-wave incidence produces both the gap and the peak with a sufficient delay of the arrival-time. Although the origin of X-phases is not accurately identified, the most plausible candidates are an intra-plate earthquake or a large ice-quake (glacial earthquake) in the Antarctic. Maybe the pre-cursor vibration of the break-off process at the Larsen B Ice Shelf could be the most plausible candidate to cause the X-phases.

Keywords: Cryosphere dynamics, seismic waves, Antarctica, ice-sheet, Larsen-B, X-phases

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Study on mass balance at debris-covered Khumbu Glacier in the Nepal Himalaya

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A lot of large glaciers are covered with thick debris at the lower part in the Nepal Himalaya. Furthermore, ice cliffs and ponds, which absorb heat for melt much larger than debris-covered ice, are distributed at the surface. And those often form and vanish. Those effect make it difficult to estimate mass balance of debris-covered glaciers. Nakawo and Young (198*) has established mass balance model of debris-covered glacier using thermal resistance. But, only few studies on comparison between the calculation using model and verification data has conducted so far.

We calculated mass balance at the Khumbu Glacier using Thermal Resistance model. Thermal Resistance has derived from the ASTER satellite image data and Meteorological data at Pyramid has used.

Mass balance profile deduced from the residual value between surface lowering and emergence velocity.

Those mass balance profile have compared and analysed. Results will be shown in the presentation.

Keywords: debris-covered glacier, thermal resistance, emergence velocity, mass balance

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Snow algal communities on Urumqi Glacier No.1 in Tienshan mountains, China

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Snow algae are algae which was adapted for cold environment, and is photosynthesizing and breeding on the glacier surface.

It is known that especially the glacier covered with the granules called the Cryoconite which made by cyanobacteria will dissolve by one the speed of 3 times of this.

Moreover, snow algae are used also for ice core research, and it can be said that it is important for earth science to get to know their ecology.

However, quantitive analysis of the snow algae is still restricted.

The glacier treated by this research is Wulumuqi No.1 glacier located in China Tien Shan.

Various researches including observation of mass income and outgo have accomplished here for many years, and acquisition of information other than snow algae is easy.

By the analysis of the sample in the 2007 fiscal year conducted before, and comparison of an analysis result with other glaciers in the world, it was showed that although cyanobacteria are dominance but small numbers of greenalgae also be there, and it was suggested that this formation factor is an arid region of the circumference of a glacier.

This feature differs from all of the glacier of other Asian areas where analysis of the snow algae was conducted similarly.

This time, the newly extracted sample in the 2011 fiscal year was analyzed, and the feature of the snow algal community of Wulumuqi No.1 glacier and the further understanding of the formation factor were tried.

As aresult, same feature as the above was seen also in 2011. This may be the general feature in Wulumuqi No.1 glacier in recent years. Furthrmore, there are the other features common to that in 2007 and 2011. Many kind of cyanobacterium are observed rather than greenalgae. The total biomass being large at ice area and falling in a snow area. Cyanobacterium are dominance in ice area, and greenalgae are dominance in snow area.

On the other hand, some change was also seen.

It is that the biomass increased on the whole, and that the altitude over which many Oscillatoriaceae cyanobacterium 2 are distributed was changing from the glacier lower stream to the middle class, etc.

As one of the factors which change of such a feature generated, change of the chemical component concentration on the surface of a glacier can be considered.

In addition, analysis of the sample in the 2006 fiscal year is also advancing as further candidate for comparison now.

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Three years mass balance and its longterm fluctuation of Potanin glacier, Mongolian Aitai

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In order to understand global climate change, it is necessary to extend the observation network of the mass balance of as many as glaciers in the world. It has been reported that Potanin glacier in western Mongolia is shrinking. However, mass balance research is not sufficiently done. Potanin glacier (49 09 N, 87 55 E) in Mongolian Altai is 10.44 km in length, 2 km in width and ranges from 4373 to 2900 m a.s.l. and the area was 24.34 km2 in 2003. Precipitation is remarkably large and summer (JJA) mean temperature is positive. Stakes measurements and pi works have been done with 14 stakes in 2005, 2008 and 2990 mass balance year. Pollen of Betulaceae, Pinus and Artemisia are detected in the pits and are used as seasonal indicators.

Mass balance of Potanin glacier in the mass balance year of 2008 was extremely negative and of 2009 was less negative. Mass balance of Potanin glacier showed more negative mass balance Compared to Maliy Aktru glacier in Russian Altai. Although both showed decreasing tendency, the difference is due to topography and climate of the regions. It is probable that precipitation as snow or rain had an influence on mass balance. Mass balance of glaciers in Altai may continue decreasing in future.

Keywords: glacier, Altai, mass balance, Mongolia, glacier fluctuation, glacier meteorology

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Reconstruction of depositional environment at upstream of Potanin Glacier, Mongolian Altai using pollen analysis

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This study analyzed pollen in snow pits dug in September of 2008 and 2009 at upstream of Potanin glacier in Mongolian Altai to investigate the environment of recent snow deposits. The snow pit observations in both years were carried out at site 0 and 4 of 3752 m and 3890 m above sea level, respectively. In the 2008 observation, the pollen analysis revealed that the pit at site 0 included the deposition from summer of 2007 to autumn of 2008, while that at site 4 included the deposition between the autumns of 2007 to 2008. On the other hand, the pollen analysis in the 2009 observation showed the snow pit at site 0 contained the deposition between the autumns of 2007 to 2009, while the pit of site 4 covered the deposition from the winter of 2008/2009. In the layers of 2007 and 2008, concentration peaks of pollen taxon that scattered from spring to summer seasons were found at the same depths. This indicated that the summer melt reached the spring layer being previous season. Accordingly, pollen grains in the melted layer concentrated at the summer melt surface, causing pollen peaks. In contrast, each concentration peak of pollen taxon that scatters in different seasons appeared at the different depth of the 2009 layer. This suggested the degree of melting was weaker than that in 2007 and 2008. The interpretation was supported by summer temperature data (June?August) in this region. The anomalies of monthly air temperatures in summer during 1990 and 2009 remained negative in 2009, while they remained positive in 2007 and 2008. Annual depositions were estimated by *Artemisia* pollen concentration peak that was used as a marker of autumn season in this study. The annual snow depositions at site 0 were 1.18 m (0.61 m water equivalent) and 1.69 m (0.69 m water equivalent) for the autumns of 2007 to 2008 and the autumns of 2008 to 2009, respectively. Also, the respective snow depositions for the same periods at site 4 were 2.44 m (1.04 m water equivalent) and more than 3.34 m (1.38 m water equivalent).

Keywords: glacier, pollen analysis, Altai, Mongol, snow deposition, Potanin glacier

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Quest of the first Japanese glacier in Mts. Tateyama and Mt. Tsurugi, the northern Japanese Alps

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In order to find the first Japanese glacier, we have researched surface flow velocity and ice thickness of the Gozenzawa perennial snow patch in Mts. Tateyama (3015 m asl), the Sannomado and the Komado perennial snow patches in Mt. Tsurugi (2999 m asl) in the northern Japanese Alps, central Japan since 2009.

The Sannomado and the Komado perennial snow patches have large ice masses (>30 m in thickness). We measured that the both ice masses had flowed over 30 cm month^{-1} in the autumn of 2011. Thus, we regard the both snow patches as active glaciers.

The Gozenzawa perennial snow patch has also a large ice mass (27 m in thickness). We identified that the ice mass had slightly flowed (less than 10 cm month^{-1}) in the autumns of 2010 and 2011. Thus, we also regard the snow patch as active glacier.

Keywords: glacier, perennial snow patch, Mts. Tateyama, Mt. Tsurugi, glacier flow

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Snow Particle Speed in Blowing Snow obtained with SPC 2

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The transport of snow by the wind has major implications in engineering and geophysical fields. On roads, drifting snow causes snowdrifts and reduced visibility. In mountainous regions, non-uniform distribution of snow due to blowing snow, such as locally increased snow drift and snow cornices on the leeward of slopes, leads to avalanche release. Redistribution of snow by the wind is also important for hydrological processes and mass balance, especially in Arctic and Antarctic regions.

In the last decade, large progress has been made in modelling blowing snow. However, interaction between snow particles and air, that is one of the key processes in the model, is still poorly understood. In this study we tried to obtain the snow particle speeds in the blowing snow directly with the Snow Particle Counter (SPC). The SPC is able to sense particle diameter as well as particle number and, in general, is used to measure the change in the mass flux with time, such as every second. However, the high frequency recordings of the signal from the transducer make possible to deduce the particle speed one by one. Analysis was carried out using the data measured not only in the cold wind tunnel but also at the Col du Lac Blanc, French Alps and Mizuho Station, Antarctica.

Then, obtained particle speed distribution was discussed with wind speed profiles, hardness of the snow surface and so on. Further, comparison was made with the Lagrangian stochastic model, which accounts for the turbulence effects on the suspension of snow grains and also includes aerodynamic entrainment, the grain-bed collision process, wind modification by grains, and a distribution of grain sizes.

Keywords: blowing snow, SPC

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A report on the yukigata watching held by the International Yukigata Society

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When a seasonal snow cover disappears on a plain and a snow line of seasonal snow cover retreats on a mountain in spring, a complex pattern of white domains covered with remaining snow and dark domains of the ground surface appears on a mountain-side. Some of the white domains of remaining snow and the dark domains of ground surface are likened to men, animals, tools, etc., and are called yukigata in Japanese, which means snow and form. This paper is the A report on the yukigata watching held by the International Yukigata Society

Keywords: yukigata, International Yukigata Society, yukigata watchin

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Snowpack estimations in the starting zone of large-scale snow avalanches using the SNOWPACK model

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The Makunosawa valley in Myoko is ideally suited to study how meteorological elements influence avalanche activity, because snow avalanches have often occurred there. Since 2000, five large-scale snow avalanches with a running distance exceeded 2000 m have been observed and some characteristics on avalanches in this valley have been obtained from the 12 winter seasons up to 2011. However the characteristics of snowpack in the starting zone of the large-scale avalanches have not been obtained, because it is too difficult to approach there and snow pit observation have not been carried out in the starting zone. We simulated the snow profile and stability index of the snowpack in the starting zone using the SNOWPACK model. Meteorological data (air temperature, relative humidity, precipitation, global radiation, atmospheric radiation and wind speed) was used as input data for the simulation. Air temperature was corrected for the starting zone altitude (1700 m a.s.l.) considering a lapse rate of 6.5 x 10^{-3} ^{o}C m^{-1}. The slope angle (40 degrees) and the direction were inputted as same as those in the starting zone. In the results, similar characteristics were found in the snowpack before the three dry-snow avalanches occurred in February. That is to say, faceted grains were formed near the snow surface due to large temperature gradient during nighttime and much snow was deposited on the faceted snow layer in succession. The avalanches were considered to have been released because of the faceted snow layer with small shear strength and rapid loading from snowfall. On the other hand, the faceted snow layer was not found before one avalanche occurred in January and the sliding surface of the avalanche was presumed to be new snow. The only wet-snow avalanche was considered to be released because the decrease in the shear strength due to infiltration of meltwater and increase in the liquid-water content in the boundary of two layers with different grain sizes.

Keywords: SNOWPACK model, snow avalanche