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

ACC32-01 Room:101B Time:May 24 09:00-09:15

Spatial distribution of snow chemistry in the Japanese Alps region

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The Japanese Alps region is one of the heaviest snowy regions in Japan. In this area winter precipitation is observed mainly two patterns such as winter monsoon pattern and low pressure pattern. Therefore, the chemical characteristics of the snowpack are different by snowfall types. We conducted a snow pit study immediately after snowfall, on the route from Itoigawa, Joetsu and Iida to Matsumoto. We collected only fresh snow samples in winter season. In this study we aimed to clarify spatial distribution of chemical components in fresh snow at the Japanese Alps region. The samples were melted, then pH, electric conductivity and major ions (Na^+, K^+, Mg^{2+}, Ca^{2+}, Cl^-, NO_3^- and SO_4^{2-}) were analyzed in clean room. The Na+ concentration correlates well with Cl^- concentration. These ions are considered to be sea-salt components. On the other hand, SO_4^{2-} concentrations included non-sea-salt components.

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ACC32-02 Room:101B Time:May 24 09:15-09:30

Reduce of water contaminated radioactive substance by freezing method

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Reduce of water contained radioactive substance by freezing method
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Accident of Fukushima 1st Nuclear power plant broke out a lot of radioactive substance. The power plant made tremendous amount of contaminated water by radioactive substance. Many tanks were made to store the contaminated water. We tought to apply glaciological technique in order to reduce the contaminated water. It is well known that the water contains every substances and elements, but freezing removes every contaminants.

Experiments were carried out for city water, water contained NaCl or H2SO4. Relative concentration was measured by electric conductivity meter. When contaminated water is frozen in vessel of 5 ? in cold room of -10C, obtained ice contained concentration of 1/10˜1/100 to mother liquid. In these case, ice contained air bubble which become origin of contamination. Next, as an another experiment, cooling pipe immesed in contaminated water and ice formed. This freezing attained clear ice and concentration became smaller to 1/1000 compared for mother liquid. We believe that freezing method can apply for reduce of contaminated rarioactive water.

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ACC32-03 Room:101B Time:May 24 09:30-09:45

The physical and chemical factor of snow coverage related to breeding of snow algae during the thaw season in Japan

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It is known that the phototrophic microorganism called snow algae breed on the surface of the snow coverage in thawing season. When snow algae breed, the reflectance of a snow surface decreases and melting snow coverage is promoted. Therefore, it is important to reveal factors of their breeding in order to predict melting of snow coverage. As for breeding of snow algae, it is mentioned that solar radiation required for photosynthesis, the existence of the water in snow coverage, CO2, pH, and nutrient. However, it is not revealed what the most direct related factor is. Therefore, in this study, it aimed at revealing factors of snow algae breeding. In the melting snow coverage of Tohkamachi Experimental Station, Forestry and Forest Products Research Institute in Niigata Prefecture (altitude is 200 m) and Murodou in Tateyama in Toyama Prefecture in Japan (altitude is 2400 m), the seasonal variation of snow alagae was quantitatively revealed using the chlorophyll-a in snow coverage, and the chlorophyll-a was compared with the weather, snow coverage, and snow physics model data.

As a result of measuring the chlorophyll-a concentration on the surface of snow coverage, chlorophyll-a concentration increased notably between in February to march in Tohkamachi Experimental Station, and between in May to July in Tateyama. It is revealed that the time of snow algae breeding differs in both areas. This difference of their breeding time indicates that snow algae does not breed at a specific season, but breeding time is decided by environmental conditions, such as temperature of each area, and conditions of snow coverage.

When the chlorophyll-a concentration was compared with result of the snow coverage conditions is calculated by the snow physics model in Tohkamachi Experimental Station, it was suggested that all layers of the snow coverage change granular snow and snow coverage is melting four days or more through day and night is the conditions on which snow algae starts breeding. It is thought that to change granular snow is conditions for snow algae in the ground under snow coverage swim to the snow surface. It is thought that melting of snow coverage period four days or more through day and night is the conditions for snow algae which arrived at the snow surface breed stably.

When increment of the chlorophyll-a concentration was compared with the melting period through day and night in Tohkamachi Experimental Station, it was thought that the amount of snow algae breeding increased rapidly only by the case melting of snow coverage period over four days through day and night. In case of melting of snow coverage period four days or more through day and night, Chlorophyll-a concentration increased 15 [ug / m2] or more. However, in case of melting of snow coverage period three days or less through day and night, the value of Chlorophyll-a concentration is not more than 15 [ug / m2]. These results indicate that steady breeding of snow algae in snow surface may require four days or more periods, as mentioned above. Furthermore, when Chlorophyll-a concentration was compared with climate conditions, in year with the more amount of rainfall than the amount of solar radiation (2010), the values of Chlorophyll-a concentration became larger. This result indicates a possibility that rain is promoting breeding of snow algae.

From the above result, conditions to start breeding of snow algae on the snow surface in Japan were considered that all layers of snow coverage change granular snow and the continuous melting period of snow surface through day and night is specific or more days. Furthermore, the factors which determines the amount of snow algae breeding were considered to be the length of melting period of snow surface through day and night, and rain.

Keywords: snow algae, consentration of chlorophyll a, snow physics model, water content of snow

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ACC32-04 Room:101B Time:May 24 09:45-10:00

Snow algal commiunity on glaciers in Suntar Khayata region, Russia Siberia

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Snow algae are cold tolerant algae adapted to cold environments. They are observed on glaciers worldwide, they photosynthesize and bloom during melting season.

According to previous studies, the structure of snow algal community varied with regions of the world. It is important to clarify geographic distribution of snow algal community, for understanding the influence on the ecology, evolution and a dispersion process of snow algae, and also frozen snow dissolution.

The Suntar Khayata region, Russia is a mountain range located in the north side in the Sea of Okhotsk. There are about 200 glaciers. In this area, observation about snow algae has not done yet. So, we aim to reveal the snow algal community of this area with quantitative analysis. Investigation places are four glaciers of this area. Sampling carried out twice, July and August.

In this area, two taxa of green algae and five taxa of cyanobacteria were observed. It was thought that these snow algae were common taxa in the ablation period of this area. The total algal biomass was large in the bare ice area, and it fell in the snow coverage area. Within bare ice area, The total biomass shows a tendency to become smaller by the lower stream side. Moreover, the altitudal distributions of each species of snow algae were mostly in agreement between glaciers. Anc. nordenskioldii was dominant species in bare ice area and Chloromonas sp. was dominant species in snow covered area. These features were common among four glaciers which investigated.

On the other hand, it also became clear that there is the different feature for every glacier. At the glacier which flows through the southern slope of a mountain range, the total algal biomass became larger than other glaciers.

With advance of ablation period, it also was observed that the structure of snow algal community on the glacier surface changed. When ablation progressed at a certain point of the glacier and the surface condition changed from snow to ice, the dominant species also changed from Chloromonas sp. to Anc. nordenskioldii. Moreover, filamentous cyanobacteria were not observed in early stages of ablation period at a glacier but, 1 month later, these cyanobacteria observed at same glacier. It revealed that the seasonal change of snow algal community is late for other glaciers in some glaciers.

The result obtained from this research was compared with other glaciers where the previous study already done. The glacier of Suntar Khayata region was dominated by green algae and Anc. Nordenskioldii is observed. These were the features which are common to the glacier of many North Pole regions.

By this research, the feature of the snow algal community of Suntar Khayata region became clear quantitatively for the first time. The structure of snow algal community of this area had a tendency which shows the feature which is common to the glacier of the North Pole region. Moreover, it was confirmed that snow algal community in the same area not only shows common features such as altitudal distribution and dominant species, but also shows characteristic feature such as pattern of the biomass and seasonal variation by glaciers. The possibility that a difference occurred for the process of detailed ablation at the glaciers in the same area and the possibility that the influence to glacier melting by snow algae changes during ablation period were suggested.

Keywords: snow algae, community structure, mountain glacier, arctic, Saiberia, Suntar Khayata

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ACC32-05 Room:101B Time:May 24 10:00-10:15

Comparison study on effect of infiltrated water on snowpack on a flatland and on a slope

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The infiltration of water into the snowpack is an important factor for wet avalanche formation. Several observations of infiltration of the water were carried out on flatland. However it is consider that the difference of water infiltration is exist between the flatland and the slope where avalanches occur. Therefore, we carried out snow pit observations both of in a flatland and in a slope same time and compared the effect of water infiltration into the snowpack. The study sites were set at Tohkamachi Experimental Station, Forestry and Forest Products Research Institute, Tohkamachi, Niigata, Japan. Both of study sites on the flatland and the slope (incline: 40 degrees) were selected at the place where are less effected by the wind erosions and deposition of snow. In addition, we selected the northeast aspect slope to avoid the strong influence of the solar radiation. We found the notable difference on the ratio that the total thickness of the layers consisted of melt form for the thickness of all layers of the snowpack (melt form ratio) between snowpack on the slope and it on the flatland. Average melt form ratio of five times observation results from the early January to the late March 2012 on the slope was 26% higher than it on the flatland. The melt form ratios which were shown the greatest difference were 99% on the slope and 54% on the flatland. It was thought that the cause of the difference of melt form ratio was less formation of vertical water channels on the slope and water infiltrated more uniformly on the slope than the flat land, from our snow pit observations. Then we analyzed it by using the multiple snow layer model including a parameterization of vertical water channel process in snowpack proposed by Katsushima et al., (2009). As results, it was shown that the rate of infiltrated water into vertical water channel for total infiltrated water was 14% at the slope whereas it was 47% at the flatland. Our study has shown the importance of the difference of water infiltration process as a factor in the difference of snowpack between the slope and flatland.

<Reference>
Katsushima, T., Kumakura, T., Takeuchi, Y., 2009. A multiple snow layer model including a parameterization of vertical water channel process in snowpack. Cold Regions Science Technology 59(2-3), 143-151.

Keywords: avalanche, snowpack on the slope, water infiltration, vertical water channel

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ACC32-06 Room:101B Time:May 24 10:15-10:30

Water vapor transportation and change of water stable isotopes of snow due to snow temperature gradient

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In the snow, isotopic composition could change by growth depth hoar, because water vapor transportation and condensation within the snow due to large snow temperature gradient at near-surface snow. However, quantity of change of isotopic composition of low isotopic composition (condition of inland Antarctica) by water vapor transportation is not well known. We try to indicate change of isotopic composition of snow by water vapor transportation within the snow by experiment of snow temperature gradient. We observed isotopic change by water vapor transportation between side by side snow blocks which are different isotopic composition. Snow sample has temperature gradient from 86 to 166 degree C m^{-1} over 7 days in the cold room. We estimated quantity of water vapor transportation and isotopic composition change by isotope fractionation.

Keywords: snow, vapor, water stable isotope, Antarctica

Japan Geoscience Union Meeting 2013
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ACC32-07 Room:101B Time:May 24 10:30-10:45

Energy dissipating effect of forests on the flowing avalanches -Numerical simulation over the terrain of Makunosawa-

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Energy dissipating effect of forests on the flowing avalanches is considered to depend on such as type and scale of the snow-avalanches, kinds, ages, stem diameters, and stand density of trees consisting of the forests, and topographies. But, the relationships among them have not been investigated. Then, the forest effects on the disaster reduction for avalanches have been known empirically but are not known quantitatively. The large-scale dry slab avalanche occurred in the Makunosawa valley in Myoko in February, 2008 and damaged many trees. It was found that the avalanche seemed to stop in the forest and not pass through the forest. Then we could obtain a dataset of an avalanche with forest damage.

In this study, avalanche flow was simulated over the terrain of the Makunosawa valley using the numerical model TITAN2D, in order to verify the effect of forests on reducing velocity and stopping the avalanche of the Makunosawa valley. In the simulations, forest was distinguished from open area without forest by giving the larger bed friction angle. The bed friction angle were regarded as 25 degrees in the forest and 13 - 14 degrees without forest through trial and error according to the actual position of the farthest reach of avalanche, avalanche paths and avalanche velocity estimated from the bending stress of the broken trees. In result of the simulation, if the forest had not existed, the avalanche might have reach 200 m farther than the actual reach in the forest. The distinct effect of forest was shown.

Keywords: snow-avalanche, forest, numerical simulation, Makunosawa-valley

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ACC32-08 Room:101B Time:May 24 11:00-11:15

Behavior of snow glide observed on shrubby slope in early winter

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Snow glide observations were made on shrubby slope during the period from December 7, 2012 to January 16, 2013 at Ojiya, Niigata prefecture. Full-depth avalanche occurred twice on December 17 and January 16, and the glide velocity of not less than 300 mm/h was observed immediately before avalanche release in both cases. Thus, it is considered appropriate to adopt 100 mm/h of glide velocity as an alarm standard in Niigata prefecture in view of the factor of safety. Since the glide velocity was found to be very sensitive to variation in air temperature, it is necessary to solve the rapid decreasing process of resistance force at the interface between snow and ground. Finally, we applied the obtained data to the model of snow glide acceleration, proposed by Nohguchi (1989), to estimate the unknown parameters of the model. Consequently, the estimated values were comparatively close to Nohguchi's values.

Keywords: full-depth avalanche, snow glide

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ACC32-09 Room:101B Time:May 24 11:15-11:30

The snow avalanche experiment and its simulation with TITAN2D.

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In mountainous regions, snow avalanches occasionally cause the traffic hazard on the road. For the disaster prevention, the development of the accurate avalanche model is an essential task. Although numerous models have been launched so far, their accuracies are not always satisfactory.

In this study we applied the mass flow model TITAN2D, which assumes that the flow is an incompressible Coulomb continuum and a depth-averaged, 'shallow water'. And, key parameters involved in are the internal friction angle and the bed friction angle. In order to evaluate the model performance, first all, we carried out the chute flow experiments with two types of granules; size, shape and friction angles are different. Experiments gave us a variety of data, such as flow height, velocities, and width. Substituting the internal and basal friction angles of two granules, we carried out the flow simulation with the TITAN2D and compared with the experimental ones. In addition, the effects of internal friction angle were evaluated in reference to the flow width. Same procedures are planned for the snow flow experiment with the same chute and, then, will be applied to the real avalanches recorded in Hiziori , Yamagata.

Keywords: snow avalanche, titan2d

Japan Geoscience Union Meeting 2013
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ACC32-10 Room:101B Time:May 24 11:30-11:45

Permafrost distribution and its temporal variation on Mt. Fuji: A preliminary assessment

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We started a research project to understand permafrost on Mt. Fuji (3776 m asl.), to monitor its change and to evaluate the impact from changes of climate and volcanic activity on surrounding environments from the summer of 2008. In 2012, we continued to maintain the monitoring systems of ground temperatures and micrometeorological parameters in the summit area. Permafrost temperatures in the 10 m-deep borehole dug in 2010 were successfully monitored through the second year, while the data logger failed in the first winter by lightning. This is the first record of permafrost temperature through one year on Mt. Fuji, although the presence of permafrost had already been suggested until the 1970s.

Contrary to the assumption of the previous studies, permafrost absence was also confirmed in several other boreholes at the summit area. The highly permeable debris allows heat transportation by rain-water infiltration, which prevents the ground from being frozen throughout a year. Permafrost is supposed to exist only below an impermeable layer near the surface on Mt. Fuji. However, the distribution of impermeable layers is difficult to be evaluated because the degree of volcanic welding is largely heterogeneous. In contrast, the ground surface temperatures measured at 20 sites simply reflected air temperature and solar radiation. This indicates that the permafrost which only maintained at the locations less affected rain-water infiltration mainly responds long-term variation in air temperature. Thus, 0.7 deg.C warming from the 1970s to the 2000s recorded at the summit station has a potential to shift the lower boundary of the permafrost up to 100 m in elevation. In addition, according to the measured relationships between the surface temperatures and altitudes both on the north- and south-facing slopes, the monitored ground surface temperatures were spatially extrapolated for whole area of Mt. Fuji using a GIS software. For this calculation, the bench mark data were those of the permafrost monitoring site on the summit. The potential lower boundary of permafrost lies at 3050-3150 m asl. on the north-facing slope and at 3450-3600 m asl. on the south-facing.

Keywords: permafrost, distribution, climate warming, Mt. Fuji

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ACC32-11 Room:101B Time:May 24 11:45-12:00

Glaciological Activities of 54th Japanese Antarctic Research Expedition Inland team

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By the 54th Japanese Antarctic Research Expedition, we carried out the observations from coast to inland Dome Fuji area, Antarctic Ice Sheet. The main observational items are, 1. deep borehole logging, 2. GPS observation, 3. radar echo soundings, 4. shallow ice coring, 5. surface mass balance, 6. automatic weather station, 7. snow pit and surfae snow sampling. We introduce the summary of the observations and some topics.

Keywords: Antarctic ice sheet, Dome Fuji, surface mass balance, borehole logging, radar echo sounding, surface snow sampling

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ACC32-12 Room:101B Time:May 24 12:00-12:15

Recent changes in physical, chemical, and biological conditions on the surface of Tyndall Glacier of the Patagonia

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Melting and shrinkage of glaciers have been recently reported in the many part of the world. The shrinkage is not caused only by global warming but also by surface albedo reduction due to surface dust on glaciers (cryoconite). In this study, we analyzed surface albedo, cryoconite amounts and snow and ice algae collected on Tyndall Glacier in 2012 and these results were compared with those from studies in 1999. Moreover, a satellite image was analyzed to estimate of recent variations in surface albedo in entire surface of the bare ice area.

The surface albedo and amounts of cryoconite were measured at the 3 site on the bare ice surface on Tyndall glacier in 2012, and then were compared with the result of same measurements in 1999. However, there was statistically no significant difference between the two years, indicating that surface albedo and the amounts of cryoconite did not significantly change in the last decade. The analysis of community structure of snow algae on glacier surface showed that there were various snow algae on the ice surface in 2012, however there were statistically no significant differences in their biomass and community structure between in 2012 and 1999. These results suggest that there was no significant physical and biological change on the ice surface of the glacier in the last decade. The analysis of Landsat-7/ETM+ satellite image of the Tyndall Glacier reveals that there was no significant change in surface albedo between 2001 and 2010. Thus, the entire bare ice surface of the Tyndall glacier did not significantly changed in the last decade.

Recent years, the bare ice surface of the Greenland ice sheet has been darkened probably due to increase of cryoconite on the surface, however, our studies showed that that of Patagonia Icefield has not changed significantly. The shrinking on Patagonia Icefield is unlikely due to surface darkening, but to calving effect of glacier margin by marine and lake water. The reason why the Patagonia Icefield is not darkened is uncertain, however, it is important to clarify the reason in order to understand the differences of glacial variations in the world.

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ACC32-13 Room:101B Time:May 24 12:15-12:30

Short to medium-term ice sheet mass changes and long-term mass trends in Antarctica revealed by GRACE

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Antarctic ice sheet mass balance is one of the most concerned topics because it directly affects global sea level changes. It had been a difficult problem to measure the mass changes for a long time. But thanks to the recent satellite observations, the accuracy of the Antarctic ice sheet mass trends has been improved significantly in a couple of past decades. According to the studies based on satellite altimetry, SAR (Synthetic Aperture Radar) interferometry and satellite gravimetry, the mass trends in East and West Antarctica show slightly positive and negative, respectively, for the period from 1992 to 2011. However, due to the limited data periods of the satellite observations, these results may depend on the time spans of the data employed, because the estimated linear mass trends may suffer from the influence of short to medium-term climate anomalies. For a better estimation of the long-term ice sheet mass trend, which connects to century-scale global sea level changes or global warming, it is important to estimate and remove such short to medium-term mass fluctuations. In this study, using the most updated GRACE (Gravity Recovery and Climate Experiment) satellite gravity data for the period from 2002 to 2012, we assessed the effects of short to medium-term climate anomalies on the Antarctic ice sheet mass trend. We first divided Antarctic area into 27 drainage systems in consideration with regionally different mass change mechanism. And then we statistically evaluated the uncertainties of the mass trend values caused by the differences of the data time spans for each area. Further, the estimated mass variations were compared with climate indices and global hydrological/meteorological data sets to identify the dominant sources of the short to medium-term mass anomalies. Finally we discussed the effects of the short to medium-term anomalies on the estimations of the long-term ice sheet mass trends in East and West Antarctica and the global mass balance as well.

Keywords: GRACE, Antarctic ice sheet, mass balance, global sea level changes

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ACC32-14 Room:101B Time:May 24 12:30-12:45

Winter acceleration of the glacier flow in Yukon territory: detection and interpretation

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We examined spatial and temporal changes of the glacier surface velocities at Yukon territory, applying offset-tracking technique to the synthetic aperture radar (SAR) imageries. The SAR images we used are mostly derived from Phased Array-type L-band SAR (PALSAR) sensor on the Advanced Land Observation Satellite (ALOS) launched by JAXA in 2006.

We discovered that many glaciers revealed acceleration signals in winter. No similar signals have been reported so far, and are counter-intuitive in comparison to the well-known spring/summer speed-up signals at many other glaciers in the world. The winter acceleration signals are thus intriguing and could have important implications for the dynamics of surge-type glaciers. Thus, we discuss a possible interpretation for the signal on the basis of field-based studies at Trapridge glacier, Yukon.

Kavanaugh (2009) performed in-situ water pressure change measurements at Trapridge Glacier, and reported that pressure pulse events increased from autumn to winter during 2005-2006. He interpreted this signals resulted from episodic basal motion caused by the till deformations that follows Coulomb-plastic rheology, in which the strain rate increases infinitely when shear stress exceeds the yield stress (Kavanaugh and Clarke, 2006). The yield stress depends linearly on the effective pressure that can vary seasonally. If we follow Kavanaugh's observation and interpretation, we may regard our observed winter acceleration signals as the episodic sediment deformations that occurs more frequently in winter. From summer to winter, the surface-melt water is reduced, and the drainage systems will gradually evolve from efficient well-connected to inefficient ill-connected drainage system. Then, basal water pressure will become locally higher and the yield stress in the sediment get smaller, which could generate more frequent till deformation in winter.

It is known that glacier surges tend to occur from autumn to winter. Our discovery has the probability mini-surges occurred every year. More frequently observations in winter season could be a key to reveal surge generation mechanisms.

Keywords: winter acceleration, Yukon, surge-type glaciers, SAR, offset tracking

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ACC32-15 Room:101B Time:May 24 14:15-14:30

Glacier surface velocity measurement of Pobeda - Khan Tengry massif, Tien Shan, by ALOS/PALSAR

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Pobeda (Chinese Tuomuer) - Khan Tengry massif is the largest glacial area in Tien Shan, located at the northern periphery of central Aisa. Sporadically, research activities have been carried out since 1903 (Glazirin, 2010). The glaciers are the major source of principal rivers in arid region. Many glaciers have been retreating since Little Ice Age, especially since 1970's (Liu & Han, 1992; Holch & Marchenko, 2009). Also, GLOF (Glacier Lake Outburst Flood) occur regularly in summer at Lake Merzbacher, the proglacial lake of Inylchek glacier (Glazirin 2010). For these reasons, the glacier dynamics in this region gathered researcher's attention. Many researches based on field and remote sensing technique have been carried out (Aizen et al., 1997; Mayer et al., 2008; Wang et al., 2011; Han et al., 2010; Li et al., 2013)

Li et al. (2013) detected 2-D velocity map of glaciers based on SAR technique using ALOS/PALSAR archive data (Path 514, Row 830, 8 scenes). They discussed spatio-temporal velocity changes, such as seasonal and annual velocity changes. However, some glaciers were not covered and they did not use all archive data.

We used three path and all PALSAR archive data (Path 513-515, Row 830, total 46 scenes) to cover major glaciers in the massif. Usually, SRTM4 Digital Elevation model (DEM) and ASTER GDEM are applied for co-registration of two SAR image. There are discontinuities on the glacier surface in SRTM4 DEM. We used ASTER GDEM for co-registration. We used offset tracking (feature tracking) method and detected surface velocity field, assumed that glaciers flow parallel to surface topography.

First of all, we paid attention to Inylchek glacier. Inylchek glacier is the largest valley glacier in the massif, covers from 2900 to 7450m a.s.l and has two major branches (Southern and Northern Inylchek glacier). The area of the glacier is 794 km^2 and there are two proglacial lakes between South and North branch. The lower lake is dammed by Southern Inylchek and regularly releases lake water in summer (Glazirin 2010). Also, Northern Inylchek glacier caused glacier surge in 1997 (Mavlyudov, 1999). We will discuss the interaction of glacier velocity change with the drainage of the lake water and glacier surge.

Keywords: SAR, Mountain glacier, Tien Shan, Surface velocity, PALSAR, Offset tracking

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ACC32-16 Room:101B Time:May 24 14:30-14:45

Status of Glacier Area Mapping for Discharge in Asian Mountains Project

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The mean sea level has been risen in recent decades as a result of global warming. The largest contributions to sea level rise are come from thermal expansion and the melting of mountain glaciers and icecaps. And mountain glacier is significant role for water resources in particular arid regions.

Altitudinal distribution of glacier area is required to estimate glacier volume change, although, the information on glacier distribution are limited only glacier area or location at present. Large difference, therefore, can be found between actual glacier volume change and calculated value assuming the altitudinal distribution of glacier area.

Then, the purpose of this project is to estimate contribution of glacier runoff to river runoff would be elucidated by establishing data set of altitudinal distribution of glacier area in the Asian High Mountains.

In this presentation, we will introduce the status of our glacier mapping and the result of the analysis of altitudinal distribution of glacier area.

Keywords: glacier, discharge

Japan Geoscience Union Meeting 2013
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ACC32-17 Room:101B Time:May 24 14:45-15:00

Glacier variation since 1960s in Lunana region, Bhutan Himalaya, using declassified satellite imagery (Corona, Hexagon)

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Corona and Hexagon satellite imagery declassified in 1995 are stereo imagery theoretically enables photogrammetry. And it has been used only for qualitative topographic classification. However, complicated distortion of the imagery hamper digital elevation model (DEM) by photogrammetry softwares. Research group of Europa and U.S. have developed method for correcting the complicated distortion of Corona and Hexagon and generated DEM recently.

In this study, we used the correction method to generate DEMs in 1960s in Lunana region, Bhutan Himalaya for evaluating glacier surface elevation change for long time period. We also use carrier-phased differential GPS data for calibrating and validating generated DEMs.

Keywords: Glacier, Himalaya, DEM, Declassified satellite, Photogrammetry

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Characteristic of glacier lakes and glacier lake outburst floods

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Analyzing satellite data revealed that extensive glacier shrinkage occurred between 1971 and 2007 in the outer ranges of the Tien Shan, where large cities are located. Most of the glacier lakes in this region have appeared since the 1980s, with the shrinkage of glaciers. The GLOF of Tien Shan is small compared to those that occur in the Himalayas. Nevertheless, with the recent development of glacier lakes, floods are becoming an increasing threat to local residents. We report the characteristic of glacier lakes and glacier lake outburst floods in Tien Shan, Central Asia.

Keywords: glacier lake, short-lived glacier lake, satellite data, GLOF, Tien Shan

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Rapid evolution of supra-glacial ponds on Hinku Glacier, eastern Nepal Himalaya: prospect for a larger lake development

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An understanding of the recessional behavior of debris-covered glaciers, especially lake formation, is necessary for hazards assessment and mitigation because glacial lakes that form on them sometimes produce devastating glacier lake outburst floods (GLOFs) which are often several times bigger than normal climatic floods. Generally, a large glacial lake on a debris-covered glacier is formed by expansion and coalescing of supra-glacial ponds. Supra-glacial ponds existing on debris-covered glaciers at present are a precursor to a large glacial lake in the near future; however, not necessarily all supra-glacial ponds turn into a large lake. Glacier surface gradient in the ablation area, greatly dictates whether such ponds expand or coalesce to form a large lake. However, there are limited studies in the Nepal Himalaya on early recognition of potential sites for a large lake formation with scrutinizing lake expansion track and detailed topographic mapping of glacier surface. Objective of this paper is to present formation and growth of supra-glacial ponds on the debris-covered Hinku Glacier in the Nepal Himalaya from 1964 to 2010 and to recognize prospective sites and size for future lake development. We used Corona KH-4A (in 1964), Landsat TM5 (in 1992) and ALOS ANVIR-2 (in 2010) with spatial resolution 2.7-7.6 m, 30 m and 10 m respectively to map supra-glacial ponds for the years while ALOS PRISM data with spatial resolution 2.5 m (in 2006) to produce detailed topographic map with Leica Photogrammetric Suite. There was only one supra-glacial pond in 1964 and 1992 which rose to ten in 2010 with surface area of approx. 5,102, 5,818 and 183,972 m^2 for the respective years as revealed by the satellite data of the years. Rapid evolution of supra-glacial ponds (in numbers and surface areas) on the ablation area of the Hinku Glacier from 1992 to 2010 and spatial proximity of the ponds to coalescing suggest possibility of development of a larger glacial lake in the area. Detailed topographic maps, and subsequently derived digital elevation data and surface profiles of the glacier indicate that the glacier has very low surface gradient (less than or equal to 2 degree) at the terminus part about 3 km long and 0.4 km wide stretch, and has slightly higher surface gradient (2 to 5 degree) in the immediately up-glacier area for about 2.5 km long. After the upper 2.5 km stretch, there exists a rock cliff which separates 5.5 km long down-glacier area from further up-glacier area. Hence, our results suggest that the lowermost terminus part (approx. 3 x 0.4 km) of the glacier can be of highly possible sites to develop a larger lake while the upper stretch (approx. 2.5 x 0.4 km) also remains as potential sites to further lake expansion in later time.

Keywords: Supra-glacial pond, glacial lake development, debris-covered glacier, Hinku Glacier, Nepal Himalaya