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

ACC32-P01 Room:Convention Hall Time:May 24 16:15-17:30

Ecological analysis of glacial biology on tropical glaciers of Ruwenzori mountains,Uganda,Africa

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Introduction

Ruwenzori mountains are located at the westernmost of uganda, tropical africa. Although in the equatorial area(0N, 29E), there are glaciers(4700-5000m a.s.l.) In africa, only three mountains have glaciers, Kilimanjaro, Mt.Kenya, and Ruwenzori, and some scientists said that all of these glaciers will disappear during 2020s. So, it is urgent to research this area as soon as possible.

On glacier's surface, there are some psychrophylic microorganisms like snow algae. And almost no glacial biological research was carried out on tropical region. So, we took researches on Ruwenzori mountains on Feb.2012 and Feb.2013.

We analyzed altitudinal distribution and biomass of snow algae and also analyzed optimum temperature of yeasts which were collected in Ruwenzori mountains.

Methods

Sampling was held on 4 sites, the one one the Mt.Speke and the others on the Stanley Plateau Glacier(S1=4714m,S2=4740m,S3=4850m) We sampled glacier surface ice by a stainless scoop rinsed with ice around the site. After melting, we put formalin into sample. Volume of formaline is about 3% of melting ice4.

First, we counted snow algae in this sample by a fluorescence microscope and calculated algal biomass.

Second, we analyzed the optimum temperature of yeasts which was picked on Ruwenzori glaciers. We put the yeasts into YEPD liquid culture medium and cultivated it on different temeperature(5-30 degrees Celsius, with 5 degree interval). After cultivation, we measured optical density by absorption photometer(filter:660nm).

Results

On first experimental work, 5 kinds of snow algae are found.

These are; Cylindrocystis brebissonii, Ceratodon purpureus(The mosses), green round unicellular organisms, red round unicellular organisms, and protonema algae, which has never reported on other glacial biological research.

Cylindrocystis brebissonii are found all altitude. It was found at only lower ablation area of glacier in himalaya and patagonia, so that suggest all of Ruwenzori glacier has become ablation area. Ceratodon purpureus are found only ST-S1. It is also no report that mosses inhabit on glacier surface.

On second experimental work, we analyzed several kinds of yeasts, but for all yeasts, their optimum temperature is 20-30 degrees Celsius, not cold but middle-high temperature, although they are picked at glacier surface, which is considered as cold environment.

It suggest that there are positive feedback effect on melting glaciers. If glacier surface are becoming warm by some trigger such as global warming, glacial microorganisms which has middle-high optimum temperature are increasing and reducing glacier surface albedo. After that, because of reducing surface albedo, glacier surface has more heating energy and becoming warm, so some microorganisms are more increasing... it is positive feedback.

We suggest that glacier melting will occur more rapidly than we expected because of this positive feedback.

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Measurement of snow depth distribution in the Kamikochi-Azusa river basin using an airborne laser scanning

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For the purpose of surveying the distribution of snow depth in the Kamikochi-Azusa river basin, airborne laser scanning was conducted. Snow depth was estimated as the difference in elevation between the snow and the ground surface.

Keywords: snow depth, Kamikochi-Azusa river, airborne laser scanning

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Comparison investigation of contribution of the sublimation to the air by blowing snow

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If a strong wind blows in a snow cover region, snow particles which once lay move in the air and are transported to the leeward with energy exchange between the air and the snow cover. Since this blowing snow is generated not only in land but in the vast snow cover region including the sea ice, the influence of the energy exchange will reach far and wide.

On the other hand, according to climate models, temperature rising is predicted in the snow cover region of high latitude which blowing snow also occurs, and the uncertainty of warming prediction has been widely discussed.

Therefore, in this research, the mean stress falls on the influence of the water vapor in the snow cover region. The water vapor has the greatest contribution as greenhouse gas. If blowing snow occurs, the snow particles moving in the air sublimate and change the water vapor amount of the air. Little attention has been given to the point. It is because the field observation under a fixed climate condition is difficult, observation using instruments which measures blowing snow correctly is hardly carried out in windy regions where sublimation is produced, and so on. In this presentation, the past blowing snow research carried out in the snow cover region is compared, the estimate of the amount of sublimation is arranged, and the contribution of the sublimation to the atmosphere by blowing snow is investigated.

Keywords: sublimation, snow cover, blowing snow, climate change

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Dynamics and GPR stratigraphy of the Ikenotan-migimata perennial snow patch in Mt. Tsurugi, the northern Japanese Alps,

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We have investigated surface flow velocity and ice thickness of the Ikenotan-migimata perennial snow patch in Mt. Tsurugi (2999 m asl) in the northern Japanese Alps, central Japan since 2012.

We found the thick ice mass (about 40 m in thickness) in the lower part of the Ikenotan-migimata perennial snow patch based on the GPR sounding in the autumn of 2012. We measured that the ice mass had flowed 10-15 cm month-1 in the autumn of 2012. Thus, we regard the snow patch as small active glacier.

Keywords: glacier, perennial snow patch, Mt. Tsurugi, glacier flow, GPR

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Surface Velocities and Ice-Front Positions of Eight Major Glaciers in the Southern Patagonian Ice Field, South America,

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The Patagonian Ice Field is known to have undergone rapid retreat of frontal positions and significant thinning of its glaciers over the past decades. However, surface velocities have been measured at only a few of these glaciers. Thus, it remains uncertain if and to what extent the glacier dynamics have changed over time and contributed to ice loss in these ice field. In this study, we examine the temporal evolution of flow velocities and ice-front positions at eight major glaciers in the Southern Patagonian Ice Field.

In this study, we measured flow velocity fields of 8 large calving glaciers in Southern Patagonia Icefield (Jorge Montt, Occidental, Pio XI, O'Higgins, Viedma, Upsala, Perito Moreno, and Grey), applying pixel-offset (feature tracking) technique to the radar images derived from ALOS/PALSAR and Envisat/ASAR. We assumed that glacier flows parallel to surface slope based on SRTM4 digital elevation model. In addition, we measured positions of glacier front using SAR intensity images, and compared with the temporal changes of flow velocities.

Of the 8 glaciers we examined, Glacier Upsala, Jorge Montt and Occidental experienced significant speed-up and terminus retreat. These glaciers showed large accelerations near the glacier fronts, which indicates that they underwent longitudinal strain accelerations. It will increase the crevasse-depth, and drive the speed-up of calving. This result seems to support a calving model based on crevasse-depth criteria (Benn et al., 2007; Nick et al., 2010). Meanwhile, Glacier Pio XI revealed large spatial and temporal changes in the flow velocity without significant retreat.

Keywords: SAR, Patagonia, calving glaciers

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Surface mass balance of Potanin Glacier, Mongolian Altai, since 2005

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The Mongolian Altai area has undergone few glaciological surveys and glacier balance studies. In this study, stake observations and pollen analysis with pit observations were used for the estimation of the surface mass balance of the Potanin glacier in the Mongolian Altai. The mass balance was estimated to be -0.58 and -1.03 and -0.17 m w.e. for the mass balance years of 2005, 2008 and 2009. The observed less negative mass balance in 2005 and 2009 and more negative mass balance in 2008 were due to higher solid precipitation in 2004-2005 and 2008-2009 than in 2007-2008 and high summer temperatures in 2008 than in 2005 and 2009. A comparison with Maliy Aktru Glacier in the Russian Altai demonstrated that the two glaciers share the same tendency in mass balance fluctuation from 2005 to 2009. Potanin Glacier has a smaller accumulation area ratio (AAR) and higher equilibrium line altitude (ELA) than Maliy Aktru Glacier. We concluded that the higher negative mass balance at Potanin Glacier compared to Maliy Aktru glacier is due to 1) small AAR due to higher ELA against glacier-existing altitude range, 2) drier and warmer climate of the region and 3) the longer response time to climate change.

Keywords: glacier, mass balance, Altai

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Spatial debris-cover effect on the maritime glaciers of Mount Gongga, south-eastern Tibetan Plateau

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The Tibetan Plateau and surroundings contain a large number of debris-covered glaciers, on which debris cover affects glacier response to climate change by altering ice melting rates and spatial patterns of mass loss. Insufficient spatial distribution of debris thickness data makes it difficult to analyze regional debris-cover effects. Mount Gongga offers an opportunity to study a monsoonal maritime glacier system with debris-covered and debris-free glaciers in the south-eastern Tibetan Plateau, where specific, though incomplete, information is available for both the glaciology and meteorology. Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)-derived thermal property of the debris layer reveals that 68% of Mount Gongga glaciers have extensive mantles of supraglacial debris in the ablation zones, where the debris-covered proportions of the total glacier area vary from 1.74% to 53.0%. These glaciers show a general downglacier increasing trend in debris thickness with significant spatial inhomogeneity at each site. High-resolution in situ measurements of debris thickness indicate that thin debris thicknesses of $<$ 0.03 m are widely distributed on the glaciers. Against the background of global warming, we find that although the presence of supraglacial debris has a significant insulating effect on the trend of greater negative mass balance on the debris-covered glaciers, especially on the glaciers with debris-covered proportions $>$ 20%, it accelerates the trend of faster ice melting on ˜ 10.2% of the total ablation area and produces a more negative mass balance, which is primarily caused by temperature rise, on ˜25% of the debris-covered glaciers on Mount Gongga, with the consequence that regionally averaged mass balance of debris-covered glaciers is not statistically different from that of debris-free glaciers, all showing an intensive negative mass balance trend on Mount Gongga. Also, the intensely inhomogeneous ice melting caused by widespread debris cover in association with high ice velocities and relatively steep surface leads to active terminus regions of the debris-covered glaciers, of which the terminus retreat rates are faster than those of the debris-free glaciers. In addition, regional differences in the debris-cover effect are apparent, highlighting the importance of debris cover for understanding glacier status and hydrology in both the Tibetan Plateau and other mountain ranges around the world.

Keywords: debris, melting, effect, Tibetan Plateau

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Full Stokes dynamics at the Shirase Drainage Basin, Antarctica and comparison to the shallow ice approximation

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Covering an area of 2 x 105 km^2, the Shirase Drainage Basin is located in East Antarctica (37-50^o E, 70-78^o S). The basin is characterized by the convergence of the ice flow towards the Shirase glacier, one of the fastest flowing glacier in Antarctica. The Shirase glacier flows at a speed of 2.3 km a^{-1} at the grounding line (Rignot, 2002; Pattyn and Derauw, 2002; Nakamura and others, 2008) and drains about 10 Gt a^{-1} of ice through a narrow outlet into the Lutzow-Holm Bay (Fujii, 1981). With nearly 90% of total ice discharge from the basin being calved by the glacier, the fast flowing nature of the Shirase glacier is important for the investigation of the ice sheet mass budget in this region.

The dynamics of the Shirase glacier is investigated by means of the full Stokes equations and the shallow ice approximation. The model Elmer/Ice (http://elmerice.elmerfem.org) is applied to the Shirase Drainage Basin and employs the finite element method to solve the full Stokes equations, the temperature evolution equation and the evolution equation of the free surface. The shallow ice approximation is also implemented into Elmer/Ice so that both the full Stokes and the shallow ice approximation are computed on the same mesh. Data for the present geometry (surface and basal topographies with no shelf) are obtained from the BEDMAP2 data set (Fretwell and others, 2012) and a mesh of the computational domain is created using an initial footprint which contains elements from 15 km to 500 m horizontal resolution. The footprint is vertically extruded to form a 3D mesh of 240720 elements with 21 equidistant, terrain-following layers.

The approach taken in this study is to compare the response of the glacier to dynamical and climate forcings when separately the full Stokes and the shallow ice approximation are employed. The sensitivity experiments are modeled after the SeaRISE 2011 experiments (http://tinyurl.com/srise-lanl, http://tinyurl.com/srise-umt). Set C (three experiments) applies a change to the surface precipitation and temperature, Set S (three experiments) applies an amplification factor to change the basal sliding velocity and Set T (one experiment) combines the forcings. The experiments are compared to a constant climate control run beginning at present (epoch 2004-1-1 0:0:0) and running up to 100 years holding the climate constant to its present state. The present state of the glacier velocities and temperature field is obtained by computing a steady-state configuration for both the full Stokes as well as the shallow ice model.

Keywords: Shirase drainage basin, Antarctica, full Stokes, ice sheet modeling