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

ACC31-P01 Room:Convention Hall Time:May 23 13:45-15:15

Variability of sea ice distribution and polar front in the Southern Ocean since the last glacial period

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The Southern Ocean has played a significant role in the global climate system during the geologic past. In order to understand the paleoceanographic variations with the polar front system and Antarctic Circumpolar Current (ACC), we conducted the paleoceanographic studies using two piston cores COR-1bPC (54 deg S) from the Conrad Rise and DCR-1PC (46 deg S) from the Del Cano Rise. Based on our paleoceanographic researches, a winter sea ice limit and the Antarctic Polar Front were migrated to the north during the last glacial period.

Keywords: Southern Ocean, sea ice, Antarctic Circumpolar Current, polar front

ACC31-P02 Room:Convention Hall Time:May 23 13:45-15:15

Dust-climate couplings over the past 800-kyr

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Secular dust fluctuations have been hardly paid attention from the viewpoint of Milankovitch theory. In the present study, we address dust records from Antarctica ice core.

Dust may have passive and active effects on climate. As dust depends on the climate, dust values gradually increase or decrease under the surrounding environments such as dust origin. On the other hand, dust can force on the climate through its albedo effects. We have considered these two effects from the feature of past 800-kyr dust fluctuations.

We have analyzed each climatic cycles for small dust values (dust tend to be subject to climate) and large values (dust tend to affect climate) using spectral analysis. To examine what phenomena relates the two effects, dust fluctuations are compared with other records such as insolation, ice volume and atmospheric CO_2 records. Moreover, we researched the duration for each passive and active period of dust and the relation with temperature from the accumulation curve of dust masses.

When dust is in the subsidiary state for climate, it behaves locally on polar region, and seems to relate ice volume fluctuations, whereas as dust has predominant effects on climate, its fluctuations are global, which may relate to CO_2 fluctuations such as carbon cycle. The accumulation curve of dust masses suggests relatively long passive stage for about 60˜70-kyr, and restrained active stage for about 10˜20-kyr.

We discuss the linkages between these features of dust fluctuations and climate shift on glacial-interglacial timescales.

Keywords: Milankovitch theory, glacial-interglacial cycle, eolian dust

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ACC31-P03 Room:Convention Hall Time:May 23 13:45-15:15

Formation and metamorphism of stratified firn at sites located under spatial variations of accumulation rate and wind sp

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The initial stage of postdepositional metamorphism in polar firn was investigated at sites located under spatial variations of accumulation rate and wind speed along the East Antarctic ice divide near Dome Fuji. A better understanding of this process is important for interpreting local insolation proxies used for astronomical dating of deep ice cores. Three 2-4 m deep pits were excavated and physical properties, including density, grain size D, reflectance R of near infrared light and microwave dielectric anisotropy, were investigated at high spatial resolution. We found that dielectric anisotropy ranges between 0.028 and 0.067 and that such high values occur in the surface ˜0.1 m. In addition, short scale variations of density are correlated with those of dielectric anisotropy, and inversely correlated with those of D, confirming contrasting development of initially higher density layers and initially lower density layers. Moreover, postdepositional metamorphism makes these contrasts more distinct with increasing depths. Both the contrasts and dielectric anisotropy for given values of density are higher under lower accumulation rate conditions and under less windy conditions. Insolation efficiently causes evolution of strata of firn at the ice sheet surface under such conditions. Under more windy conditions, the strata contain more wind-driven hard layers with higher density and dielectric anisotropy and thus have larger fluctuations of density and dielectric anisotropy. We suggest that the initial variability of density at the surface and the duration of exposure to diurnal and seasonal temperature gradients play sequential roles in determining the physical/mechanical properties of firn, which is retained throughout the densification process.

Keywords: Antarctica, ice sheet, firn, metamorphism, accumulation rate, wind speed

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ACC31-P04 Room:Convention Hall Time:May 23 13:45-15:15

Constructing the age of Dome Fuji ice core using a dating model

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Past climate change is regarded as a key knowledge for predicting future climate changes. Milankovich theory has explained the climate changes from Glacial to Interglacial periods with variations of seasonal solar radiation caused by Earth's orbital parameters (eccentricity of orbit, obliquity and precession of rotation axis). Kawamura et al. (2007) indicated that Antarctic temperature rose during deglaciations following or at the same time of the solar radiation increase in Northern Hemisphere summer. In addition, the greenhouse gas, which facilitates the air temperature to rise, is thought as another important element for the past climate change.

To estimate the contribution of orbital and carbon dioxide forcings to the climate changes, especially at the start of the deglaciation, we have make construct the age of ice core and air occluded in it. The difference in age between the ice and gas at the same depth occurs in firn (consolidated snow) while they are compressed to become ice from snow. The gap between these ages was estimated to be about 5,000 years in glacial maxima, but the time lag between temperature and carbon dioxide is on the order of 0-1000 years. Therefore, we should make accurate adjustment of the age of the ice and the age of gas, in order to discuss the contributions of carbon dioxide for the temperature rising at the deglaciation.

In particular, the second Dome Fuji deep ice core needs accurate estimation of thinning function in the bottom part (within ~500 m from the bed corresponding to 340-700 kyr ago). The thinning function, which expresses the horizontal stretching and vertical compression of an ice layer, would be changed for geothermal heat in the bottom of the ice sheet. We tried to adjust the parameters, thinning function, accumulation rate and the difference of age between the ice and the gas in the ice. In the presentation, we will present results from the adjusted ice age and gas age.

Keywords: ice core, dating, paleoclimate

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ACC31-P05 Room:Convention Hall Time:May 23 13:45-15:15

Numerical simulation of isotopic ratio in snow using an offline model

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Given that ice cores consist of past snowfall in a chronologic and systematic order, we can utilize stable water isotope (SWI) information in ice cores to reconstruct the past climate. Several modeling studies have tried to simulate the past SWI in precipitation preserved in ice cores (Werner and Heiman, 2002, Sjolte et al, 2011), but they are limited only on high latitude area. In such region, we do not have to consider post-depositional isotopic processes due to the extremely low temperature all over a year. However, when one wants to simulate the past SWI in ice cores in mid- and low-latitudinal areas, he has to consider the isotopic effects of the post-depositional processes because snow undergoes melt, sublimation and erosion by wind, by which SWI in snow are easily affected. Otherwise the reconstructed information of the past would be distorted and misleading.

In this study, we developed a new off-line isotopic snow-icecore model: it simulates isotopic effects due to the post-depositional processes while precipitated snow is eventually transformed into an ice core. The model is based on the snow layer submodel of Iso-MATSIRO (Yoshimura et al., 2006) with a particular purpose to simulate a vertical profile of SWI at a glacier or ice sheet. Unlimited number of snow layers with a 20mm thickness increment is incorporated, whereas the original Iso-MATSIRO snow submodel has only three layers. It also newly includes the impact of wind erosion process, including blizzard. Using this model forced with the output from IsoRSM (Yoshimura et al., 2010), i.e., an isotope enabled meso-scale climate model forced with historical meteorological reanalysis data, we simulated SWI in snow pits drilled at Belukha, Siberian Altai, and Gregoriev, Tien Shan, which are close to ice core drilling sites. The preliminary simulation period is for 1997-2007. With the new off-line model, the simulated SWI vertical profile of the snow layers shows a better correlation with the observed snow pit SWI than the simulation without the model. This study aim to simulate SWI of ice cores in mid- and /or low latitudes for more than hundred years, and it is expected to present the latest updates at the conference.

ACC31-P06 Room:Convention Hall Time:May 23 13:45-15:15

The variations in pollen abundance and composition in Holocene of an ice core of Kyrgyz Tienshan, Central Asia

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Various pollens are preserved in ice cores, in particular, ice cores from mountain glaciers in low- or mid lattitude. Pollen grain concentration in ice cores can be used to distinguish annual and seasonal layers, and also are indicative to past vagitation around glaciers. In 2007, ice cores were successfully drilled on Grigoriev Ice Cap located in the Tien Shan Mountains, Kyrgyztan. The elevation of the drilling site was 4600 m a.s.l. and entire core length was 87 m. Radiocarbon dating revealed that the soil corrected from the bottom of the ice core was 12,500 cal year bp. Microscopy revealed that fourspecies of pollens were preserved in the ice core, and their abundance and composition varied in the last millenium.

Keywords: ice core, pollen, Plaeoenvironment, glacier, Holocene

ACC31-P07 Room:Convention Hall Time:May 23 13:45-15:15

Dissolved Chemical ions in ice core drilled from Grigoriev Ice Cap in Kyrgyz Tien Shan

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Glacieres and ice sheets receive various chemical components from organic and inorganic matter supplied from surrounding atmosphere and soil, after that they change themselves conditions. Ice Cores drilled from such glacial areas have chronologically retained the snow which laid thick in the past dozens to ten thousands, and capable of holding unknown valuable paleoenvironment information. Therefore the analysis of dissolved chemical ions in ice cores drilled from all parts of the world is a convincing clue to show interpretation about a climate and environment that the earth experienced until now. Then, in this study, we intend to clarify long-term climatic and environmental variation in Tien Shan and the Central Asia based on the analysis of the dissolved main chemical ions in ice cores drilled from the cultivation area of Grigoriev Ice Cap in Tien Shan in September, 2011.

This ice core included Ca in richness through all layers. And, this core is 86.87 m in length, and maintains information until approximately 12,000 years ago. This means that the ice cap might strongly receive influence of sand (CaCO3) of huge drying area of the Central Asia, the Taklamakan from a last years of Pleistocene last glacial epoch. Moreover, as a result of having found the mean concentration of the chemical ions which dissolved in this ice core, Ca was with approximately 120 micro-Eq/kg, other (Cl, NO3, SO4, Na, NH4, K, Mg) less than 30 micro-Eq/kg. This result was similar to the chemical concentration of other glaciers, Urumqi No.1 Glacier in Tien Shan, Muztagata Glacier in Pamir and Chongce Ice Cap in Kunlun, located around the Taklamakan. This result suggest that Tian Shan is affected by the Taklamakan regardless of the west edge or the east edge and is the environment where the uniform chemical supply is accomplished.

The depth profile about dissolved chemical concentration of this ice cores showed large and small plural peaks. Especially, a peak of abnormal density (about 10-60 times of the mean) was confirmed approximately around 53.5 m in all ions. As a result of dating of this core, it was revealed that this peak was located in the layer about 1833. Because the oxygen stable isotope ratio profile of this time showed a change unlike the average year, the ice cap might experience some kind of specific snowfall events for the same period. And, as a result of having found the mean concentration of the chemical ions which dissolved in this ice core after 1990, Ca was with approximately 50 micro-Eq/kg, other (Cl, NO3, SO4, Na, NH4, K, Mg) less than 12 micro-Eq/kg. These density is approximately 40% of the mean concentration in all layers. This suggest that dissolved chemical ions in the ice cap is a tendency to decrement in late years.

Keywords: Tien Shan, Grigoriev Ice Cap, ice core, Dissolved chemical ions, oxygen stable isotope ratio, climatic and environmental variation

ACC31-P08 Room:Convention Hall Time:May 23 13:45-15:15

Snow algae in an ice core drilled on Grigoriev Ice cap in the Kyrgyz Tien Shen Mountains

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Snow algae are photosynthetic microorganisms and are living on the surfase of glaciers. They grow on melting surface from spring to summer and their biomass and community structure are changed with physical and chemical conditions on glaciers. Ice cores drilled from glaciers also contain snow algae that grew in the past. Studying biomass and community structure of snow algae in ice cores could reveal the temporal variation in snow algae in the past, and also environmental conditions relating propagation of snow algae. In this study, we aim to describe snow algae in an ice core of Grigoriev Ice cap located in eastern Kyrgyzstan of the central Asia.

The samples of ice core collected on the top of the glacier contained three taxa of filamentous cyanobacteria, an unicellular cyanobacterium, and two green algae. The quantitative analyses of the algae in the 25 m deep ice core samples revealed that the algal biomass showed several peaks. Based on the dating by pollen grains, the 25 m core covers 61 years. The results suggest that the snow algae did not grow every year on the top of the ice cap, and their biomass and community structure varied greatly from year to year. The peak of biomass at the depth of 20 m contained significant amounts of the filamentous cyanobacteria that was observed in the lower part of the ice cap. This suggests that the year of the peak was significantly warmer than usual and the entire surface of the ice cap melted.

Keywords: snow algae, ice core

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Variations in pollen grains in an shallow ice core drilled from Fedchanko Glacier in Pamir, Central Asia.

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Ice cores drilled from the polar or alpine glaciers contain pollen grains blown from vegetation surrounding the glaciers. Abundance and compositions of pollen grains in ice cores could be a proxy of paleoenvironment, but there are only few studies on pollen grains in ice cores. In this study, we analyzed the pollen grains in two pits and an shallow icecore drilled on Fedchanko Glacier in Pamir, Central Asia. We found seven species of pollen grains in the ice core and they could be reflective of surrounding vegetation and be used to identify annal summer layers.