ACC33-P01 Room:Convention Hall Time:May 23 18:15-19:30

modelled response of the volume and thickness of the Antarctic ice sheets to transient retreat of the grounding lines

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The volume of Antarctic ice sheet is about 60 meters equivalent sea level.
besides of climate change, interaction between ice shelves and ocean may be significant to Antarctic ice sheet.
The grounding line shift is a important factor in considering interaction between ice shelf and ocean. The position of grounding line is thought to be governed by ice flow and mass balance between ice shelves and ocean. Last retreat of grounding line (20ka to present) is reconstructed from marine data.
To simulate evolution of Antarctic ice sheet, explicit treatment of grounding line movement also should be included. However, simulation of transient behavior of the grounding line is still difficult using a numerical large-area ice sheet model. Instead, grounding line is prescribed as a boundary condition.
According to Saito and Abe-Ouchi (2010) , grounding line position is a most important factor of Antarctic Ice Volume while climate factor is relatively small.

In this study, Antarctic ice sheet volume at prescribed grounding line patterns and Antarctic ice sheet volume change since last glacial maximum by retreat of grounding line is tested. Results show that Antarctic ice sheet volume has high sensitivity to grounding line in a term of deglaciation.

Keywords: Antarctica, Ice sheet, Ice shelf, Grounding Line, Sea level, Ice shelf-Ocean Interaction

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The relationship between metal composition and climate change derived from the Dome Fuji ice core

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Aerosol was deposited into the surface of the ice sheet and preserved in the ice layer. The study of particulate matters in the ice sheet is important in understanding for the past climatic change because aerosol originated from various sources on the Earth, this chemical composition reflects the environmental change. Previously, several studies have reported about the physical and chemical properties of Dome Fuji ice core. Significant parts of the metallic elements in the ice core are insoluble particle. However, the study of metallic elements of insoluble particle is not sufficiently achieved, because previous studies have focused on dissolved components. In this research, we measured total (particulate + dissolved) concentration of metallic elements in the Dome Fuji ice core by applying a full-digestion analysis, and clarified the climate change.

The composition of metal components is close to the average of the crustal composition during the glacial, and close to the average of the ocean composition during the interglacial. Metal elements can be divide into two categories, (1) Group of elements composition between the crust and the ocean, and (2) Group of elements that is large variation range and unstable. These results suggest that response to change in source is different for each element. In addition, it was found that the fluctuation pattern of Sr and Ba were different boundary about 340 kyr. In this report, we discuss the relationship of these metal composition and environmental change.

Keywords: ice core, aerosol, climate change

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SP2 analysis of black carbon in snow at NEEM, Greenland

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We measured concentrations of black carbon particles (BC) in snow at NEEM, Greenland. These samples were collected in 2010 from a 3.4m deep pit. BC in melted snow was analyzed with the SP2 (Single Particle Soot Photometer) method developed by Ohata et al. (2011). BC particles in water were aerosolized by an ultrasonic nebulizer and then masses of individual BC particles were measured by SP2, which is based on the laser-induced incandescence technique. Calibration of incandescence signal was carried out with fullerene soot. In order to correcting for the loss of BC during aerosolizing, we calculated nebulizer efficiencies using five different sizes of PSLs (polystyrene latex spheres) standard solutions. We evaluated seasonal variations of BC concentrations with respect to those of stable isotopes. We also compared seasonal variations of BC and ionic species.

Keywords: black carbon, NEEM, Greenland

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Kinetic fractionation of gases by deep air convection in polar firn

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A previously unrecognized type of gas fractionation occurs in firn air columns subjected to intense convection. It is a form of kinetic fractionation that depends on the fact that different gases have different molecular diffusivities. Convective mixing continually disturbs diffusive equilibrium, and gases diffuse back toward diffusive equilibrium under the influence of gravity and thermal gradients. In near-surface firn where convection and diffusion compete as gas transport mechanisms, slow-diffusing gases such as krypton and xenon are more heavily impacted by convection than fast diffusing gases such as nitrogen and argon, and the signals are preserved in deep firn and ice. We show a simple theory that predicts this kinetic effect, and the theory is confirmed by observations of stable gas isotopes from the Megadunes field site on the East Antarctic plateau. Numerical simulations confirm the effect's magnitude at this site. A main purpose of this work is to support the development of a proxy indicator of past convection in firn, for use in ice-core gas records. To this aim, we also show with the simulations that the magnitude of kinetic effect is fairly insensitive to the exact profile of convective strength, if the overall thickness of convective zone is kept constant.

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Evolution of the anisotropic structure of ice and pore spaces in firn at NEEM

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The evolution of the structure of firn core recovered at NEEM camp was investigated in order to improve our understanding of firn densification and bubble formation processes. The relative dielectric permittivities in both the vertical and horizontal planes were measured at ~35 GHz. The results were compared with those of firn at Dome Fuji in East Antarctica. Results are summarized as follows. Down to ~20 m, permittivity exhibited a positive correlation with the strength of dielectric anisotropy along the vertical. In contrast, the correlation is negative in deeper firn. This is a feature of the density crossover. We found that the crossover density is almost the same at NEEM and at Dome Fuji, confirming earlier studies of the polar firn. A remarkable difference between two sites is that strength of dielectric anisotropy at NEEM is only two thirds of that at Dome Fuji. In addition, negative correlation between permittivity and dielectric anisotropy is much more developed at NEEM. This fact suggests that the 3-D vertical anisotropic structure decreases rapidly in firn at NEEM and that limited layers deform rapidly by some factor. In contrast, at Dome Fuji, 3-D vertical anisotropic structure is preserved much longer period of time than NEEM. We speculate that at NEEM impurity plays a major role for selective deformation and that at Dome Fuji texture plays a major role for selective deformation.

Keywords: Greenland, ice sheet, firn, metamorphism, densification, NEEM

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Limit of the ice-sheet thickness and the subglacial lake

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It is said that there is the water at the bottom of thick ice-sheet, there is a water cycle of freezing and melting and re-freezing in there. In this study, I explored basic structure of the ice under high pressure at the bottom of the ice-sheet, and I discussed the limits of the ice-sheet thickness.

1) Formation of the subglacial lake

The subglacial lakes were found over a wide range under East Antarctica ice-sheet by the permeable radar on ICESat satellite, and to be confirmed the water is present. It is considered that the water temperature of the subglacial lakes are about -2˜-3’C. The subglacial lakes have keeping the liquid for high pressure by the ice load, and that is the temperature at which melting point of the ice and temperature gradient crosses. Lake Vostok is largest the subglacial lake in the Antarctica, there are about 3,800m under the ice-sheet, total area is 14,000km2, and average depth of the lake is 125m.

2) Ice transition under high pressure

Inside pressure of the ice-sheet is going to increase gradually due to snow load. This pressure reaches about 30MPa at the bottom of the Antarctica ice-sheet. The air of the earth’s surface is captured between the snow particles in this consolidation course, and the air bubbles isolate about 200m depth (Ice-Gas phase region). Reaches about 1,000m depth, this high-pressure air bubbles constitute a new crystal due to reacts with the ice, and Clathrate-hydrate is generated (Ice-Hydrate phase region). In addition, going to the higher pressure into the ice sheet, reach the region where Hydrate-water is produced by melting ice (Water-Hydrate phase region). Thereby, I think the water of the ice-sheet bottom is generated in the state of pressure melting under the ice-sheet.

3) Fracture strength of the ice and limit of the ice-sheet thickness

According to pressurization experiments of the ice under hydrostatic pressure, hydrostatic pressure was increased, which increased fracture strength. But, to compare hydrostatic pressure of 55MPa and 30MPa, fracture strength was reversed, because 30MPa was higher than 55MPa. From this fact, maximum fracture strength is expected to be about 35MPa (Thick of ice-sheet is 4,100m). Therefore, in high-pressure portion under the ice-sheet over about 4,000m occurs ductile fracture that continued plastic deformation without brittle fracture beyond the yield point. And, the state of pressure melting under the ice-sheet increase liquidity by the generated water, further, the strength is reduced

It is said that thickness of the Antarctic ice-sheet is maximum 4,000m for the ice-snow. Maximum depth of digging in the Antarctic ice-sheet is 3,800m at Vostok base, by adding depth of the subglacial lake under the ice-sheet, it will be about 4,000m. Therefore, limit of the ice-sheet thickness is about 4,000m, and by exceeding the limit thickness, the water is generated by plastic flow occurs under the ice-sheet. I think that a space to generated water has become the subglacial lake.

Keywords: Ice-sheet thickness, Subglacial lake, Pressure melting