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Postdepositional changes in water stable isotope in snowpack at Dome Fuji, Antarctica

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At the inland of Antarctica, annual snow accumulation is extremely low due to the cold air temperature, low precipitation and erosion by strong wind. As the result of these conditions, water stable isotopes and concentrations of some other ions change after the deposition due to the water vapor transport within the sub-surface snow. The mechanism of such postdepositional change is important for the interpretation of isotope data from ice cores, which is used for paleoenvironment reconstructions. The purpose of this study is to reveal the postdepositional change of stable isotope due to water vapor transport in the snow using 4 m deep snow pit data obtained in December 2007 at Dome Fuji station, Antarctica.
Five-year cycle of oxygen isotope was found in the snow profile by dating with non-sea-salt SO_4^{2-} and oxygen isotope profiles and utilizing the data in the previous study (1999 at Dome Fuji snow pit). Since this cycle could not be correlated with the air temperature oscillation at Dome Fuji, it is suggested that it was formed after the snow deposition. It is known, that at the inland of Antarctica the vertical transport of water vapor is a function of high temperature gradients near the snow surface. Thus it could be assumed that this cycle was formed due to a convergence of water vapor, and should be relevant to water vapor transport within the snow.
Calculations of the water vapor flux by using the snow temperature data from 2003 to 2004 indicated that the water vapor transport was directed downward from the depth of 0.1 m, and that it converged at the depth of 0.2 to 0.3 m in summer (November to January). However, if I assume that quantity of the convergence of water vapor and the snow accumulation rate were constant, the oxygen isotope cycle would not be formed by the water vapor transport. Therefore, two other processes were considered as possible factors controlling the formation of the cycle: annual variations of the water vapor flux and of the snow accumulation rate. Making use of the observation data for the snow temperature for 4 years and the snow accumulation data for 12 years at Dome Fuji, the vapor transport in the snow was estimated. Calculations indicated that variation of snow temperature in a year caused the change in the quantity of the water vapor convergence, and that the variation of snow accumulation rate regulated the budget of the water vapor in the snow. In addition, it is apparent that variation of snow accumulation rate formed the several years cycle of water vapor convergence in the snow layer. The cycle had a good correlation between the quantity of the convergence of water vapor at the snow layer and oxygen isotope of snow pit. Consequently, it is suggested that non constant snow accumulation at the inland of Antarctica differs the quantity of the water vapor convergence in the snow layer, and formed the oxygen isotope cycle. Variations of oxygen isotope estimated through the Rayleigh fractionation process of condensation, change of snow accumulation rate revealed that oxygen isotope variation due to water vapor convergence.