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Accurate age scale of the Dome Fuji ice core, Antarctica from O_2/N_2 ratio of trapped air

K. Kawamura (1), S. Aoki (2), T. Nakazawa (2), K. Suzuki (3), and F. Parrenin (4)

(1) National Institute of Polar Research, Tokyo, Japan (kawamura@nipr.ac.jp), (2) Center for Atmospheric and Oceanic Studies, Tohoku University, Sendai, Japan, (3) The Institute of Statistical Mathematics, Tokyo, Japan, (4) Laboratoire de Glaciologie et Géophysique de l'Environnement, Saint-Martin-d'Hères, France

Chronology of the first Dome Fuji deep ice core (core length: 2,500 m, ice thickness: 3,035 m) for the age range from 80 kyr to 340 kyr ago was established by orbital tuning of measured O_2/N_2 ratios in trapped air to local summer insolation, with precision better than about 2,000 years (Kawamura *et al*., 2007). The O_2/N_2 ratios found in polar ice cores are slightly lower than the atmospheric ratio because of size-dependent molecular fractionation during bubble close-off. The magnitude of this gas fractionation is believed to be governed by the magnitude of snow metamorphism when the layer was originally at the surface, which in turn is controlled by local summer insolation (Fujita *et al*., 2009). A strong advantage of the O_2/N_2 chronology is that there is no need to assume a lag between climatic records in the ice core and orbital forcings, becacuse O_2/N_2 ratios record local insolation through physical processes. Accuracy of the chronology was validated by comparing the O_2/N_2 chronology with U-Th radiometric chronology of speleothem records (Cheng *et al*., 2009) for the ends of Terminations II, III and IV, as well as several large climatic events, for which both ice-core CH_4 and speleothem $\delta^{18}O$ (a proxy for precipitation) show abrupt shifts as seen in the last glacial period. All ages from O_2/N_2 and U-Th chronology agreed with each other within $\sim$2,000 yr. The O_2/N_2 chronology permits comparisons between Antarctic climate, greenhouse gases, astronomically calculated orbital parameters, and radiometrically-dated sea level and monsoon records.

Here, we completed the measurements of O_2/N_2 ratios of the second Dome Fuji ice core, which reached bedrock, for the range from 2,400 to 3,028 m (320 - 700 kyr ago) at approximately 2,000-year time resolution. We made significant improvements in ice core storage practices and mass spectrometry. In particular, the ice core samples were stored at about -50 ˚C until the air extraction, except during short periods of transportation, in order to prevent size-dependent fractionation due to gas loss during storage. The precision of the new O_2/N_2 data set is improved by a factor of 3 over the previous data. Clear imprint of local insolation is recognizable in the O_2/N_2 data towards the deepest depths, even around 400 kyr ago when summer insolation wiggles are small due to small orbital eccentricity. A new chronology using this O_2/N_2 data set will be established by applying the inverse method for EDC3 age scale (Parrenin et al., 2007) for the entire 700 kyr, and climatic implications will also be discussed especially on Terminations and interglacial periods.

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