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Prospects of Antarctic climate and ice sheet studies based on ice cores

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Ice cores from Antarctica have provided valuable information on past climate changes and interactions over various spacial and temporal scales. In particular, the Japanese ice core and climate modeling communities have made efforts to collect and analyze deep ice cores from Antarctic inland site, Dome Fuji. The orbital tuning of O2/N2 ratio with the local summer insolation based on physical link enables us to construct an accurate age model for this ice core and hence for histories of atmospheric CO2 concentrations and various Antarctic environmental parameters such as temperature, accumulation rate and aerosol fluxes and forcings (e.g. Kawamura et al., 2007 Nature; Iizuka et al., 2012 Nature; Uemura et al., 2012 Clim. Past)). The accurate age scale also enabled the IPCC-class climate and ice sheet models to run with realistic history of greenhouse-gas radiative forcing, and it was a key to the successful simulation of the glacial-interglacial cycles with realistic timing and amplitude (Abe-Ouchi et al., 2013 Nature).

An important next challenge for the Antarctic paleoclimate community is to understand the Antarctic ice sheet changes and feedbacks in response to external forcing such as changes in greenhouse effect and ocean temperature. For example, paleo-sea-level studies have suggested that sea level was higher than present by more than 4m during the last interglacial (Marine Isotope Stage 5e), and by up to ˜20 m (with high uncertainty) during the interglacial some 420,000 years ago (MIS 11). Together with Greenland ice mass and ice-core evidences, Antarctic ice sheet is suggested to have contributed to the both sea-level high stands. However, the CO2 level in those periods were not particularly high compared to the Holocene preindustrial level, and the orbital forcing (northern summer insolation) is weak during MIS 11. To solve the enigma, it is not enough to study the interglacials in relation to the instantaneous forcings such as insolation and CO2, but it is also necessary to study the histories of climatic components such as temperature, ice volume and bedrock, from the preceding glacial periods to the interglacials.

Other aspects of Antarctic ice-core paleoclimate will also be covered in the presentation. For example, ice cores from inland and coastal regions should be measured with process studies for better reconstructions and understanding of aerosol radiative forcing and sea ice extent around Antarctica.

Keywords: Ice core, Antarctic ice sheet, Climate change