



Timing of penultimate glacial-interglacial transition from gas measurements of the Dome Fuji ice core, Antarctica

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Paleoclimatic proxies provide information about the variations of climate forcings and responses, such as atmospheric CO₂ concentration, temperature and sea level, as well as their magnitudes and phase relationships. Accurate chronological constraints are particularly important for numerical simulations, both for their input and validation data, to better understand the transient behaviors of climate and ice sheets. A chronology of the Dome Fuji (DF) ice core was constructed by synchronizing variations in O₂/N₂ ratio of occluded air with local summer insolation (Kawamura et al., 2007), but relatively large errors were later reported around the last interglacial (Fujita et al., 2015). Here, we reanalyzed O₂/N₂ ratio of the DF core by improving the methods for sample treatment, air extraction and mass spectrometry between 57 and 165 kyr BP to revise the DF chronology. The new chronology agrees within 1.2 kyr with a radiometric (U-Th) chronology of Chinese speleothems, whose stated error is less than 1 kyr (Cheng et al., 2009), suggesting successful improvement of our ice-core chronology. Using $\delta^{18}\text{O}$ of atmospheric O₂ ($\delta^{18}\text{O}_{\text{atm}}$) and CH₄ records measured on the same ice samples as used for the O₂/N₂ measurements, we investigate climatic variations during the penultimate glacial period and deglaciation. We found that $\delta^{18}\text{O}_{\text{atm}}$ becomes heavier while CH₄ concentration increased at 138.4 kyr BP during the penultimate glacial maximum; this characteristic relationship was observed at Heinrich Event 2 (at ~24 kyr BP) during the last glacial maximum (Severinghaus et al., 2009; Rhodes et al., 2015). Other well-dated paleoclimatic records show major climatic changes around 138 kyr BP; an abrupt weakening of the Asian monsoon occurred at 138 kyr BP (Wang et al., 2008), and the onset of relative sea level rise was suggested at 139±1 kyr BP from seawater $\delta^{18}\text{O}$ of Red Sea (Grant et al., 2012) and at 137 kyr BP from U-Th dating of Tahiti fossil corals (Thomas et al., 2009). The similarity of these ages suggests that a massive iceberg discharge event occurred at ~138 kyr BP, and it marked the onset of penultimate deglaciation. Our new data may provide better chronological constraints on the climatic forcings and responses around the penultimate deglaciation and last interglacial period.

References

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