Timing of climatic events for Termination II from O_2/N_2, $\delta^{18}O_{atm}$ and CH_4 records of the Dome Fuji ice core, Antarctica

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Understanding the mechanisms of glacial terminations and associated global climatic changes is an important area of paleoclimatic research because the terminations involve various interactions between the atmosphere, ocean, ice and solid earth over multiple timescales. The last interglacial period and the penultimate termination are particularly important for a better understanding of the mechanisms of warming and ice-sheet reductions with strong orbital forcing. However, the climatic reconstructions for these periods are relatively poor compared with the last deglaciation because of the limitations of available proxies, their time resolution and chronological controls.

An independent Dome Fuji (DF) ice core chronology over the last 340 kyr was constructed by synchronizing variations in the O_2/N_2 ratio of occluded air with local summer insolation (Kawamura et al., 2007) with stated uncertainty of less than ~2.5 kyr in general. The accuracy of the chronology is generally supported by the comparison with a radiometric (U-Th) dating of Chinese speleothem records (Cheng et al., 2009), but relatively large errors were recently found around the last interglacial period (Fujita et al., 2015). Here, we newly analyzed the O_2/N_2 ratio of the DF core with improved methods for ice sample treatment, air extraction and mass spectrometry, between 57 and 165 kyr BP to revise the DF chronology. The end of Termination II with the new O_2/N_2 chronology agrees within 1.2 kyr with 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.

The isotopic ratio of O_2 ($\delta^{18}O_{atm}$) and CH_4 concentration in the atmosphere are also reconstructed from the measurements of the same ice samples as used for the O_2/N_2 measurements. We found that$\delta^{18}O_{atm}$ became heavier when CH_4 concentration abruptly increased in the penultimate glacial maximum (PGM). The same relationship is observed at Heinrich Events during the last glacial period (Severinghaus et al., 2009; Rhodes et al., 2015), suggesting that a massive iceberg discharge event occurred in the penultimate glacial maximum. Unlike in the LGM, the CH_4 concentration after the Heirinch-like event in the PGM did not return to lower values, and it continued to increase towards the last interglacial. Thus, the iceberg discharge event in the PGM also appears to be connected with the onset of deglaciation.

References

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