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The Dome Fuji ice core DF2021 chronology (0 – 207 kyr BP)

Content

Precise ice-core chronologies are essential for identifying the timing and duration of polar climatic changes as well as their phasing with the changes in other parts of the globe. However, existing ice-core chronologies beyond the last 60 kyr show relatively large disagreements with each other and with U-Th chronologies of speleothems. Here, we constructed new ice and gas age scales for the Dome Fuji (DF) core (DF2021) over the last 207 kyr by combining a Bayesian dating model and firn densification model, constrained by various types of chronological and glaciological information including new O2/N2 age markers, precise synchronization to other high-quality chronologies (volcanic, cosmogenic, and CH4 signals), and high-resolution δ15N of N2 (reflecting past firn thickness). The new chronology is tightly constrained by synchronization to other well-dated records for the last 60 kyr, whereas it is independent from other chronologies for the older period. For the last 60 kyr, the DF2021 chronology agrees with the layer-counted ice core chronologies (GICC05 and a part of WD2014) and U-Th chronologies of speleothems within ~200 years. For the period 60 – 130 kyr BP, the timing of all Dansgaard-Oeschger warming events on DF2021 agree with those of corresponding events in the U-Th dated Chinese or European speleothems mostly within 1 kyr (well within 2σ uncertainty of DF2021). The excellent agreement suggests high accuracy of our chronology, and supports the assumption of negligible phasing between the past local summer solstice insolation and O2/N2 fractionation at bubble close-off (the basis for constructing the O2/N2 age markers). Between 130 and 207 kyr BP (penultimate glacial period), there is a lower degree of similarity between the variations in atmospheric CH4 and speleothem calcite δ18O than in the last glacial period, making the age comparison challenging. The comparison of DF2021 with 9 U-Th dates at 7 abrupt events shows the mean difference of -0.2 ± 0.8 kyr, which is within the DF2021 uncertainty (on the order of 1.5 kyr). The DF2021 chronology agrees with the AICC2012 chronology within 2 kyr except between ~103 and 128 kyr BP where AICC2012 is likely too young by up to ~4 kyr. By analyzing the lag between δ18O of O2 (δ18Oatm) on DF2021 and 65°N summer solstice insolation, the relatively large error in AICC2012 is found to originate in three δ18Oatm age markers assuming a constant lag, which are off by more than 3 kyr. The phasing between δ18Oatm and orbital forcing identified in this study may be useful for future ice core dating, especially where other age constraints are weak or lacking.

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