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Millennial variations of atmospheric CO2 during the early Holocene (11.7–7.4 ka)

Content

The early Holocene (11.7–7.0 ka), is known as a relatively stable period in comparison with glacial periods. However, multiple studies report climate variations on millennial time scales, which were observed in climate proxy records for ice sheet collapse in the North Atlantic, sea ice extent variations in the Southern Ocean, and El Niño–like and La Niña–like variations in the eastern equatorial Pacific. We may expect atmospheric CO2 concentration change during the early Holocene because CO2 is controlled by physical and biological processes in ocean and land. Existing early Holocene CO2 record from EPICA Dome C, however, has low data resolution and the chronological control is not sufficient to address CO2 variations on millennial timescales (Monnin et al., 2001). In this study, we obtained a new high-resolution record of atmospheric CO2 that covers the early Holocene from the Siple Dome ice core, Antarctica. Our new record quantifies natural CO2 variability on millennial timescales under interglacial climate conditions. Atmospheric CO2 decreased by ~10 ppm between 11.3 and 7.3 ka. The decrease was punctuated by local minima at 11.1, 10.1, 9.1 and 8.3 ka with amplitudes of 2–6 ppm. These variations correlate with proxies for solar forcing and local climate in the South East Atlantic polar front, East Equatorial Pacific and North Atlantic. The relationships with the proxies are consistent with changes in several different mechanisms that could impact atmospheric CO2 on millennial time scales including changing CO2 outgassing from the Southern Ocean and the East Equatorial Pacific, and changing terrestrial carbon storage in the Northern Hemisphere. Our new observations may improve our understanding of the relationship between interglacial climate and carbon cycles on millennial time scales under insignificant anthropogenic CO2 perturbations.

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