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Rapid atmospheric CO2 rise during Heinrich Stadials

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The recent discovery of centennial-scale rises in atmospheric carbon dioxide (CO2) during Heinrich Stadials (HS) sheds new light on the role of CO2 during rapid climate shifts (Bauska et al. 2021). Resolving the precise timing, rate, and magnitude of each CO2 rise, however, remains a challenge. This study examines CO2 variability at sub-centennial resolution during HS 2-5. We sampled at 0.2 to 0.5 m intervals along select depths from the West Antarctic Ice Sheet Divide ice core (WDC), which translates to 7 to 30 years between each sample. Each sampled depth was replicated to within 1ppm. Due to the site's high accumulation rate (presently 20 cm/yr) and the excellent chronologic constraints for the WDC, CO2 variations can now be documented down to decadal timescales. Preliminary results suggest a near 20 ppm rise of CO2 over the span of a century from 39.58 to 39.47 kyrs before present (ka) on the WD2014 chronology, with the fastest rate currently resolved to nearly 5 ppm in a single decade. Our results reveal that the rise in atmospheric CO2 during HS 4 is similar in rate and magnitude to the CO2 pulses observed during the last deglaciation (Marcott et al. 2014). Rapid yet lower magnitude CO2 pluses during HS 5 (7 ppm between 48.59 and 48.31 ka) and HS 2 (7 ppm between 24.10 and 24.07 ka) have also been resolved. Atmospheric CO2 pulses during HS 2, 4 and 5 are synchronous with a distinct pulse in methane (CH4) recorded in WDC, which is interpreted as a rapid reorganization of the global carbon cycle. Little variation in atmospheric CO2 is observed during HS 3, which is consistent with minimal change in WDC CH4 at this time. While the exact forcings of abrupt CO2 changes remain unclear, our findings point to a mechanism operating at sub-centennial timescales that is ultimately linked to Northern Hemisphere climate shifts.

Bauska et al. (2021) Abrupt changes in the global carbon cycle during the last glacial period. Nature Geoscience 14 91-96.

Marcott et al. (2014) Centennial-scale changes in the global carbon cycle during the last deglaciation. Nature 514 616–619.

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