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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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