

EGU2020-11480

<https://doi.org/10.5194/egusphere-egu2020-11480>

EGU General Assembly 2020

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Atmospheric CO₂ during the Mid-Piacenzian Warm Period and the M2 glaciation.

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The Piacenzian stage of the Pliocene (2.6 to 3.6 Ma) is the most recent past interval of sustained global warmth with mean global temperatures markedly higher (by ~2-3 °C) than today. Quantifying CO₂ levels during the mid-Piacenzian Warm Period (mPWP) provides a means, therefore, to deepen our understanding of Earth System behaviour in a warm climate state. Here we present a new high-resolution record of atmospheric CO₂ using the δ¹¹B-pH proxy from 3.35 to 3.15 million years ago (Ma) at a temporal resolution of 1 sample per 3-6 thousand years. Our study interval covers both the coolest marine isotope stage of the mPWP, M2 (~3.3 Ma) and the transition into its warmest phase including interglacial KM5c (centered on ~3.205 Ma) which has a similar orbital configuration to present. We find that CO₂ ranged from ca. 390 ppm to ca. 330 ppm, with CO₂ during the KM5c interglacial being ca. 370 ppm. Our findings corroborate the idea that changes in atmospheric CO₂ levels played a distinct role in climate variability during the mPWP. They also facilitate ongoing data-model comparisons and suggest that, at present rates of human emissions, there will be more CO₂ in Earth's atmosphere by 2025 than at any time for at least the last 3.3 million years.