Suborbital-scale CO₂ reconstructions from the earliest Miocene based on fossil leaves

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Determining the CO₂ concentration of Earth’s atmosphere at different times in the past is important for understanding Earth’s climate sensitivity to this important greenhouse gas. Here we report estimates of atmospheric CO₂ concentrations across a 100,000-year interval of the earliest Miocene (~23 million years ago), based on carbon isotopes (δ¹³C) and stomatal conductance measurements made on exquisitely preserved fossil leaves from the Foulden Maar Diatomite, a lacustrine sedimentary deposit located in central Otago, New Zealand. CO₂ estimates previously developed from this archive were made using δ¹³C values of sedimentary leaf waxes and stomatal conductance values determined from fossil leaves, and indicated a large and transient CO₂ rise associated with the termination of the Mi-1 Antarctic glaciation (Reichgelt et al., 2017). We will present new CO₂ estimates from the site, based on paired whole fossil leaf δ¹³C measurements and stomatal measurements made on the same fossil leaf specimens (n > 150). Leaves were identified to the family level and taxon-specific CO₂ estimates across the 100,000-year interval were made based on different members of the ancient forest ecosystem. The results highlight the importance of the source and specificity of δ¹³C values and stomatal conductance measurements used for CO₂ reconstructions based on stomatal gas diffusion models. This study represents the most comprehensive investigation to date of leaf-specific responses of different members of a forest ecosystem to environmental changes occurring at orbital and sub-orbital timescales.