Suborbital-scale CO_2 reconstructions from the earliest Miocene based on fossil leaves

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Determining the CO_2 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 CO_2 concentrations across a 100,000-year interval of the earliest Miocene (~23 million years ago), based on carbon isotopes ($\delta^{13}C$) 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. CO_2 estimates previously developed from this archive were made using $\delta^{13}C$ values of sedimentary leaf waxes and stomatal conductance values determined from fossil leaves, and indicated a large and transient CO_2 rise associated with the termination of the Mi-1 Antarctic glaciation (Reichgelt et al., 2017). We will present new CO_2 estimates from the site, based on paired whole fossil leaf $\delta^{13}C$ measurements and stomatal measurements made on the same fossil leaf specimens ($n > 150$). Leaves were identified to the family level and taxon-specific CO_2 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 $\delta^{13}C$ values and stomatal conductance measurements used for CO_2 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.