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Atmospheric CO_2 and Climate Variability During Antarctic Deglaciation in the Early Miocene

A rise in atmospheric CO_2 is believed to be necessary for the termination of large-scale glaciations. Although the Antarctic Ice Sheet is estimated to have melted from 125% to 50% its modern size, there is thus far no evidence for an increase in atmospheric CO_2 associated with the Mi-1 glacial termination in the earliest Miocene. I will present evidence from a high-resolution terrestrial record of leaf physiological change in southern New Zealand for an abrupt increase in atmospheric CO_2 coincident with the termination of the Mi-1 glaciation. The quantitative pCO_2 estimates, made using a leaf gas exchange model, suggest that atmospheric CO_2 levels may have doubled during this period, from 500 ± 100 ppm to 1100 ± 400 ppm, and subsequently returned back to 425 ± 50 ppm.
The fossil leaves and $\delta^{13}C$ measurements used to reconstruct atmospheric CO_2 are from a drill core of annually laminated sediments that accumulated in a maar crater lake for a ~100,000-yr period, spanning the Oligocene/Miocene boundary. The lake had a large and stable anoxic zone leading to remarkable preservation of organic material, including exquisitely preserved fossil leaves. The terrestrial ecosystem surrounding the lake also responded to large-scale hydrological changes during the 100,000-yr period, and I will present a rationale for using leaf wax dD values and $d^{13}C$ values to distinguish the ecosystem’s hydrological response from its response to atmospheric CO_2 changes. Lastly, using varve-thickness measurements from the drill cores, I will examine evidence for ENSO forcing of the climate of southern New Zealand during the early Miocene.