



## Reconstructing atmospheric CO<sub>2</sub> during the Late Miocene Cooling Event

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During the Late Miocene, starting about seven million years ago, both hemispheres on Earth witnessed synchronous cooling and large areas of the continents experienced drying and enhanced seasonality. Coinciding with this climatic shift were significant changes in ecology, including the rise of C<sub>4</sub>-photosynthesizing terrestrial plants and the emergence of so-called "vital effects" in oceanic coccolithophores. These changes are collectively hypothesized to be induced by declining atmospheric CO<sub>2</sub>, coherent with a recently observed, substantial long-term and large-magnitude ocean surface cooling. However, the sparse proxy data available for this time interval limits our understanding of the link between these changes and atmospheric greenhouse gas fluctuations and has let people to propose a "climate-CO<sub>2</sub> decoupling".

In this study, the alkenone based *p*CO<sub>2</sub> proxy is used to reconstruct the first high resolution *p*CO<sub>2</sub> record for the time interval between 4.5 and 8.5 Ma. Estimations are based on the carbon isotopic fractionation during photosynthesis ( $\epsilon_p$ ) and a new statistical multilinear regression model based on an analysis of culture and sediment data. Past coccolithophore growth rates are reconstructed using several microfossil and isotopic-based proxies. These are either related to water column structure, favouring or limiting nutrient supply to the photic zone, or indicating changes in total biomass production rates and the amount of carbon exported from the photic zone. Estimated *p*CO<sub>2</sub> concentrations synchronously decline with the observed long-term cooling (5°C) from ~800 ppm around 6.8 Ma to ~320 ppm around 5.9 Ma, periodically decreasing to sufficiently low values of <200 ppm to favour Northern Hemisphere glaciation. CO<sub>2</sub> concentrations during the Late Miocene Cooling Event are thus successfully reproduced in this study and allow a reasonable interpretation of past conditions as has not yet been previously achieved in the relevant literature.