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The role of vegetation and CO2 in the climate of the Late Miocene, with implications for ocean dynamics and ice sheets

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The Late Miocene saw a number of major tectonic developments that resulted in large changes to global climate system dynamics and significant development towards the glaciation of the polar regions. These include the restrictions in the Panamanian and Indonesian ocean gateways, the reduction in the size of the Paratethys Sea, and the uplift of the world's major mountain chains.

There is evidence in the paleorecord for significant differences in the vegetation distribution compared to the modern, and efforts have been made to reconstruct the vegetation distribution of the Miocene through the use of vegetation models. Vegetation feedbacks have been shown to be important in considering the global climate system, yet these are rarely incorporated into the modelling of global climate. There is also much debate surrounding the likely atmospheric CO2 concentration of the Late Miocene, and many studies indicate that a CO2 level forcing which is higher than today's is required in the global climate models in order to match the climate model output with the proxy data, and to match the output of the vegetation models to the vegetation paleorecord.

We use the fully coupled atmosphere-ocean-vegetation model HadCM3L (Hadley Centre Coupled Model, Version 3 - low resolution ocean) with TRIFFID (Top-down Representation of Interactive Foliage and Flora Including Dynamics: Cox, 2001) to generate a comprehensive set of sensitivity scenarios for the Late Miocene. We show that changes to the boundary conditions alone, with no change to the prescribed CO2 level, can explain some of the warmth of the Late Miocene compared to the preindustrial. We also conduct experiments where the vegetation and the prescribed CO2 level are altered independently in order to test the relative significance of these two components on changes to atmospheric and oceanic dynamics.

Finally, we use the ice sheet model BASISM (British Antarctic Survey Ice Sheet Model: Hindmarsh, 1999; 2000) to investigate the impact of the sensitivity test scenario climates on the potential ice sheet extent and thickness for the East Antarctic and Greenland.