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Constraining the Late Miocene paleo-CO2 estimates through GCM model-data comparisons

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The period following the Mid-Miocene Climatic Optimum experienced a continued downward trend in the 18O record - a record acknowledged as a proxy indicator of both ice volume and temperature (Zachos et al., 2001). Given the link between atmospheric CO2 and temperature (IPCC, 2007), it could be thought that the timeline throughout the Late Miocene would show a general decline in CO2 in accordance with the 18O record. However, examination of the palaeo-CO2 record shows a relatively flat profile across this time, or perhaps even a slight increase, but there is a wide variation in the palaeo-CO2 estimate for the differing approximation methods.

We use the fully coupled atmosphere-ocean-vegetation model of the Hadley Centre, HadCM3L, which has a low resolution ocean (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 CO2 sensitivity scenarios for the Late Miocene: 180ppmv, 280ppmv and 400ppmv, as well as a preindustrial control simulation: 280 ppmv. We also run the BIOME4 model offline to produce predicted biome distributions for each of our scenarios. We compare both marine and terrestrial modelled temperatures, and the predicted vegetation distributions for these scenarios against available palaeodata

As we simulate with a coupled dynamic ocean model, we use planktonic and benthic foraminiferal-based proxy palaeotemperature estimates to compare to the modelled marine temperatures at the depths consistent with the reconstructed palaeoecology of the foraminifera. We compare our modelled terrestrial temperatures to vegetation-based proxy palaeotemperatures, and we use a newly compiled vegetation reconstruction for the Late Miocene to compare to our modelled vegetation distributions. The new Late Miocene vegetation reconstruction is based on a 200+ point database of palaeobotanical sites. Each location is classified into a biome consistent with the BIOME4 model, to allow for easy data – model comparison.

We use all these data - model comparisons to constrain the best-fit scenario and the overall most likely Late Miocene CO2 estimate according to the model simulations. Preliminary results suggest that the 400ppmv simulation provides the best fit to the proxy data.