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A possible late-Oligocene evolutionary niche for C4 grasses?

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The Late Miocene expansion of C4 grasses has been documented through changes in delta-C-13 of fossil mammalian tooth enamel, reflecting the balance of C3 and C4 vegetation in the mammalian diet. This expansion was originally attributed to changes in levels of atmospheric CO2 through the early to mid-Miocene, but reconstructions of atmospheric CO2 from this period appear to rule this out - CO2 concentrations were generally rather constant during this time. As an alternative mechanism triggering the expansion of C4 grasslands, Pagani et al. speculate that changes in seasonal patterns of precipitation may have favoured the expansion of C4 plants, since modern C4 grasses are favoured by strong seasonal (warm-season) precipitation and there is evidence for a shift to such a regime during the middle to late Miocene.

To investigate these two hypotheses, we use the UK Met Office Atmosphere-Ocean General Circulation Model (AOGCM), HadCM3, in order to produce climatologies pertaining to the time periods of interest. We then use the results from this AOGCM to force the LPJ dynamic global vegetation model, which predicts many ecological variables, including the fractional coverage of different plant functional types, including C4 and C3 grasses.

In this paper, we present evidence from these modelling studies which indicates that neither changes to CO2 or precipitation were the main driving force in the expansion of C4 grasslands. Indeed, the results indicate that the climatic regime as far back as the late-Oligocene was favourable for a significant tropical population of C4 grasses. The question as to whether or not this evolutionary niche was filled, and why, remains unanswered.