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Middle Miocene climate and vegetation modelling with PLASIM and CARAIB

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In a long-term climatic cooling trend, the Middle Miocene represents one of the last warm periods of the Neogene, culminating with the Miocene Climatic Optimum, MCO (17-15 My). Palynological studies suggest that the warmer climatic conditions prevailing during the MCO allowed warm forests to expand poleward of the subtropical zone, with evergreen forests proliferating in North America and Europe (Jimenez-Moreno and Suc, 2007, Palaeogeogr. Palaeoclimatol. Palaeoecol. 253: 208-225).

In this work, we used the Planet Simulator (Fraedrich et al., 2005, Meteorol. Z. 14: 299-304 and 305-314), an Earth system model of intermediate complexity, to carry out several simulation experiments, where we have assessed the effects of the absence of ice on the continents, the opening of the Central American and Eastern Tethys seaways, the lowering of the topography on land and the effect of various atmospheric CO_2 concentrations, in agreement with the values reported in the litterature. We then produced several vegetation distributions, using the dynamic vegetation model CARAIB (Galy et al., 2008, Quat. Sci. Rev. 27: 1396-1409), to analyse if the climatic forcings considered are sufficient to explain the expansion of warmer forest types to higher latitudes.

Our results indicate that an increase of atmospheric CO_2 concentration, higher than the present-day one, is necessary to allow subtropical forest types to expand poleward. This result agrees wih recent paleo-atmospheric CO_2 reconstruction from stomatal frequency analysis, which suggests 500 ppmv of CO_2 during the MCO. However, the required warming may be due to processes not considered in our setup (e.g. full oceanic circulation or other greenhouse gases).