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On the effect of orbital forcing on mid-Pliocene vegetation: results from an Earth system model of intermediate complexity.

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There are strong evidences from paleodata that the spatial distribution of vegetation during the mid-Pliocene warm period (3.3-3 Mya) was substantially different from present with major differences in the high northern latitudes where taiga forests replaced tundra over wide regions. Combined model-data based reconstruction approaches were used to create gridded vegetation fields to be used as boundary conditions for mid-Pliocene climate simulations. Other studies used the BIOME4 vegetation model to simulate the vegetation at equilibrium with various atmospheric CO_2 concentrations, but so far the impact of orbital forcing on vegetation distribution and the role of vegetation feedbacks for the mid-Pliocene have not been systematically analyzed.
We present results of transient simulations of mid-Pliocene climate (3.3-3 Mya) using the Earth system model of intermediate complexity CLIMBER-2 driven by time-dependent orbital forcing and different levels of constant CO_2 concentration. Experiments with variable, prescribed present day and prescribed PRISM3 reconstructed vegetation are performed.
Results show that orbital forcing causes large temporal variations in vegetation cover, particularly in high northern latitudes. Hence it is clearly inappropriate to consider the vegetation during the mid-Pliocene as a time independent boundary condition.
Experiments with constant present day orbital forcing and constant CO_2 concentrations (350ppm, 400ppm) cannot explain the northward expansion of forests in high latitudes compatible with paleoclimate reconstructions. The simulated vegetation cover is in reasonably good agreement with PRISM3 dataset only if time-dependent orbital forcing is taken into account and if the reconstructions are assumed to be representative of the warmest periods during the orbital cycles.
Vegetation feedback estimated from simulations with prescribed and interactive vegetation acts to increase global mean temperature and generally as an amplifier of the orbital forcing signal.