EGU22-12044
https://doi.org/10.5194/egusphere-egu22-12044
EGU General Assembly 2022

A new conceptual model to explain the mid-Pleistocene transition

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Pleistocene climate is primarily driven by changes of the Earth's orbital parameters. However, the Mid-Pleistocene Transition (MPT) (~0.8-1.2Myr) which corresponds to a gradual change of interglacial-glacial cyclicity from weak 40kyr climatic cycles to the current strong 100kyr cycles, remains largely unexplained. So far, models only based on orbital forcing were not capable to reproduce this transition, discarding the hypothesis of an orbitally-driven transition. Internal Earth system climate causes were thus explored as primary drivers of the MPT, as a gradual decrease in atmospheric CO2 concentrations or the removal of the regolith beneath the northern hemisphere ice sheets.
Here we present an improved version of the conceptual model of Parrenin and Paillard (2012) modelling ice volume variations over the past 2Myr. Our model switches between two states, a glaciation state and a deglaciation one, following a threshold mechanism related to the input parameters and the modelled ice volume itself. The modelled ice volume is compared to the ice volume reconstructions inferred from paleodata.
We reproduced the MPT using three different models. The "orbital" model which only use orbital forcing parameters as input. The "gradual" model, which is similar to the orbital model plus a continuous drop of a physical parameter in addition to orbital forcing parameters. The "abrupt" model, also similar to the orbital model plus a time-determined abrupt variation of a physical parameter in addition to orbital forcing parameters.
For the first time, our conceptual model is able to simulate qualitatively the Mid-Pleistocene Transition with only changes in the orbital forcing parameters, reproducing the change in frequency and amplitude of the transition. Moreover, the hypothesis of a coupled influence of orbital forcing and a decreasing deglaciation threshold parameter is by far a better hypothesis than considering an abrupt change regarding our model results. In fact, the "gradual" model contains less parameters and a smaller data-model standard deviation of residuals than the "abrupt" model. Orbital forcing could thus have enabled the Mid-Pleistocene Transition. A combined influence with a decreasing parameter, such atmospheric CO2 concentration, would have triggered this transition.

References
Parrenin, F., & Paillard, D. (2012). Terminations VI and VIII (□ 530 and□ 720 kyr BP) tell us the importance of obliquity and precession in the triggering of deglaciations. Climate of the Past, 8(6), 2031-2037.