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Conceptual Model of Global Ice Volume during the Quaternary for the Mid-Pleistocene Transition

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During the Quaternary, the dominant periodicity and amplitude of glacial-interglacial cycles underwent a transition from low-amplitude cycles of 41 kyr to high-amplitude 100 kyr cycles around 1.2-0.8 Myr ago. This transition is known as the Mid-Pleistocene Transition (MPT). The cause of the MPT is still unclear, as there was no change in the external orbital forcing during this time. Various hypotheses have been proposed to explain this phenomenon. Proposed hypotheses include scenarios of gradual and abrupt changes in the climate system over the Pleistocene, with ongoing debate about whether the MPT was triggered by an abrupt or gradual change.

Here, we utilize a conceptual model, which is a zero-dimensional representation of the climate system that simulates the global ice volume over the past 2 Myr. While the standard model is solely driven by orbital forcing namely obliquity and precession, it can be extended to take internal forcing into account, either caused by an abrupt or gradual change during the Pleistocene. Since the gradual setup has been shown to yield the best results, we focus on improving this model configuration by investigating different parameterizations and their influence on the model output. The model is fitted onto reconstructed global sea levels of the past 2 Myr, using a Monte Carlo random walk for tuning the parameters. Once properly tuned, the model can be used to simulate future glacial-interglacial cycles. The objective is to gain further insights into the underlying mechanisms that initiated the MPT and which mathematical features in this model are the most relevant. In future work, this conceptual model could be extended to include other paleoclimatic records like atmospheric CO2 or methane.