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On the astronomical forcing of simple conceptual ice age models

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Variations of the Earth's orbital parameters are known to pace the ice volume variations of the last million year [1], even if the precise mechanisms remain unknown.
Several conceptual models have been used to try to better understand the connection between ice-sheet changes and the astronomical forcing. An often overlooked question is to decide which astronomical forcing can best explain the observed cycles.

A rather traditional practice was to use the insolation at a some specific day of the year, for instance at mid-july [2] or at the june solstice [3].
But it was also suggested that the integrated forcing above some given threshold could be a better alternative [4]. In a more recent paper, Tzedakis et al. [5] have shown that simple rules, based on the original Milankovitch forcing or caloric seasons, could also be used to explain the timing of ice ages.
Here we adapt and simplify the conceptual model of Parrenin and Paillard 2003 [6], to first reduce the set of parameters.
Like in the original conceptual model from [6], this simplified conceptual model is based on climate oscillations between two states: glaciation and deglaciation. It switches to one another when crossing a defined threshold. While the triggering of glaciations is only triggered by orbital parameters, the triggering of deglaciations is triggered by a combination of orbital parameters and ice volume.
Then, we apply the different possible forcings listed above and we try to adapt the model parameters to reproduce the ice volume record, at least in a qualitative way. This allows us to discuss which kind of astronomical forcing better explains the Quaternary ice ages, in the context of such simple threshold-based models.

[1] Variations in the Earth's Orbit: Pacemaker of the Ice Ages, Hays et al., 1976, Science

[2] Modeling the Climatic Response to Orbital Variations, Imbrie and Imbrie, 1980, Science

[3] The timing of Pleistocene glaciations from a simple multiple-state climate model, Paillard, 1998, Nature

[4] Early Pleistocene Glacial Cycles and the Integrated Summer Insolation Forcing, Huybers et al., 2006, Science

[5] A simple rule to determine which insolation cycles lead to interglacials, Tzedakis et al., 2017, Nature

[6] Amplitude and phase of glacial cycles from a conceptual model, Parrenin Paillard, 2003, EPSL.