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Forced Non-autonomous Empirical Model of the Mid-Pleistocene Transition

Evgeny Loskutov, Dmitry Mukhin, Andrey Gavrilov, Alexey Seleznev, and Alexander Feigin
Institute of Applied Physics of RAS, Nizhny Novgorod, Russian Federation (loskutov@appl.sci-nnov.ru)

The mid-Pleistocene transition (MPT), the shift from 41 Kyr to 100 Kyr glacial-interglacial cycles that occurred approximately one million years ago, is a bright example of a critical transition in paleoclimatology datasets. There exist many assumptions about the physical reason of that transition but the mechanism of the MPT is still under investigation. In this work we use an empirical (data-driven) stochastic model with external forcing for studying the MPT. As a forcing signal for the model we use insolation time series at four different latitudes [1] containing information about variation of the orbital parameters affecting the Earth's climate: eccentricity, obliquity, and climatic precession.
In contradistinction to real data, the empirical model allows us to investigate wider spectrum of paleoclimate cycles up to long-term (400 Kyr) ones. As a result, we obtain that after the MPT, the dominant periodicity of the climate cycles changed from 41 Kyr to 100 and 400 Kyr. We demonstrate good performance of our dynamical model in analysis of the paleoclimate variability. In particular, we show that the MPT can be explained as a response of a slowly changing dynamical system to the quasi-periodic insolation signal. The dynamical mechanism underlying such a transition is investigated and discussed in the report.

1. Berger A. and Loutre M.F. (1991), Insolation values for the climate of the last 10 million years. Quaternary Sciences Review, Vol. 10, No. 4, pp. 297-317