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Multiple Scenarios of Mid-Pleistocene Transition

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We replicate the mid-Pleistocene transition with a non-linear dynamical model of the global climate system which includes scaled equations of ice sheet thermodynamics combined with a linear equation of ocean temperature. In a previous study (Verbitsky et al. , 2018), we showed that this system is capable
of producing different modes of nonlinearity and consequently different periods of rhythmicity, depending on the values of the parameters. The crucial factor that defines a specific mode of system response to the astronomical forcing is the relative intensity of glaciation (negative) and climate temperature (positive) feedbacks, captured by an adimensional number called the V-number.

On this basis, we test different possible scenarios for the bifurcation from a 40-ka ice age cycle to cycles of 80 ka or more: decrease in the sensitivity of basal sliding temperature to ice sheet extent, changes in climate sensitivity to ice sheet extent, changes in mean climate conditions, changes of the sensitivity of ice sheets to the surface conditions, or finally as changes in ice sheet mass balance, i.e. ablation/precipitation versus basal friction.

The different scenarios correspond to different trajectories in the parameter space, resulting in qualitatively different transitions across the mid-Pleistocene. Inspection of the actual records then provides the empirical basis to establish the likelihood of these different scenarios.

Reference:

M. Y. Verbitsky, M. Crucifix, D. M. Volobuev (2018), A theory of Pleistocene glacial rhythmicity, Earth System Dynamics 9 1025–1043 doi:10.5194/esd-9-1025-2018