



Complex Climate Response to Astronomical Forcing: The MPT as a Change in Frequency Locking

Peter Ditlevsen (1) and Peter Ashwin (2)

(1) University of Copenhagen, Niels Bohr Institute, Centre for Ice and Climate, Copenhagen O, Denmark, (2) Department of Mathematics, Centre for Systems, Dynamics and Control, University of Exeter, Exeter, United Kingdom

Through the past few million years large ice sheets have repeatedly grown and disappeared on the Northern hemisphere. These are the Pleistocene glaciations. They are related to the changing solar heating of the Earth due to changes in Earth's orbit and axis of rotation. The climate response to these changes is highly non-trivial and non-linear, expressing the complex nature of the climate system. Many aspects of glacial cycles still need a convincing explanation, one particular mystery being the change from approximately 40 kyr (kilo year) glacial cycles to approximately 100 kyr cycles around 1 million years ago. This transition is called the middle Pleistocene transition (MPT). Here we review some conceptual models to explain the dynamics of glacial cycles and possible dynamical causes of the MPT. We especially focus on the well studied van del Pol oscillator as a conceptual model for the glacial cycles and propose that the MPT is a result of changes in frequency locking of the climate system to the astronomical forcing. This is compared to a recently presented model that relates the MPT to a transcritical bifurcation in the structure of a generic critical/slow manifold for a fast-slow dynamical system.