



Toward an understanding of the Middle Pleistocene Transition as a structural change in climate stability

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The Middle Pleistocene transition signifies a change approximately 1 Myr ago from a period with 40 kyr glacial cycles to a period of approximately 100 kyr cycles in response to the orbital forcing. This change from the "40 kyr world" to the "100 kyr world" is not reflected in noticeable changes in the forcing. To explain this we present a low order conceptual model for the oscillatory dynamics of the ice sheets in terms of a relaxation oscillator with multiple levels subject to the Milankovitch forcing. The model exhibits smooth transitions between three different climate states; an interglacial (i), a mild glacial (g) and a deep glacial (G) as proposed by Paillard (1998). The model suggests a dynamical explanation in terms of the structure of a slow manifold for the observed allowed and "forbidden" transitions between the three climate states. With the model, the pacing of the climate oscillations by the astronomical forcing is through the mechanism of phase-resetting of relaxation oscillations in which the internal phase of the oscillation is affected by the forcing.