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Synchronization of the climate system to orbital eccentricity insolation and the 100ky problem

Jose A. Rial

Department of Geological Sciences, University of North Carolina, USA

Email: jar@email.unc.edu

Abstract

The '100ky problem' (1ky=1000 years) of the astronomical theory of the ice ages questions how the almost negligible ~100ky eccentricity forcing could power the ten massive glaciations of the last million years while the stronger ~400ky eccentricity forcing is nearly absent from the proxy records. Further, the astronomical theory does not explain how, without change in forcing, climatic oscillations switched from 41ky to 100ky at the mid-Pleistocene transition (MPT) 1.2 million years ago (1.2 Ma), or what caused the strong climatic response at the marine isotope stage (MIS) 11, the presence of power at frequencies absent in the external forcing, or the timing of glacial terminations. To resolve these inconsistencies many explanations have been put forward, from internal climatic oscillations without external forcing to external forcing other than the Milankovitch cycles, but the ultimate cause(s) remain elusive. I will introduce a unifying explanation that resolves all the above inconsistencies through a single process: nonlinear synchronization of the climate system's internal oscillations to the eccentricity forcing. Synchronization is a fundamental nonlinear phenomenon and one basic mechanism of self-organization in complex system. The evidence suggests that after at least four million years of slow evolution, the climate system first synchronized to eccentricity at ~1.2Ma and has remained synchronized ever since. Synchronization powered the late Pleistocene glaciations, forced the frequency switch at the MPT, and caused the strong short-lived response at the MIS11 (~400ka).

Biography

Jose A. Rial is Professor of geophysics and climatology in the University of North Carolina at Chapel Hill. He holds a Ph.D. in Geophysics from the California Institute of Technology. He is an elected fellow of the American Association for the Advancement of Science and the director of the Wave Propagation Laboratory at UNC's Department of Geological Sciences.