

STOCHASTIC RESONANCE AND GLOBAL SYNCHRONIZATION IN THE CLIMATE SYSTEM

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Paleoclimate data present strong evidences that during glacial age the climate system unlike recent 10,000 yr was characterized by strong variability on millennial time scale. Moreover, two the most pronounced types of variability, Dansgaard-Oeshger (D/O) oscillations and Heinrich events, were closely locked in time and the latter reveal clear 1500 years pacing. The goal of this paper is to demonstrate that peculiar timing and synchronism of different types of abrupt climate events during glacial age is a consequence of internal instability of the components of the climate system. In Ganopolski and Rahmstorf (2001) we proposed an explanation of D/O oscillations as a temporary state transitions triggered by a small-amplitude freshwater forcing in the high latitude North Atlantic, which causes rapid jumps of the thermohaline ocean circulation from the stable (cold) mode to the unstable (warm) mode. Such an excitable system is prone to stochastic resonance. In Ganopolski and Rahmstorf (2002) we have shown that when the climate system is driven by random noise of realistic amplitude, combined with a very weak climate cycle of 1500 yr, D/O oscillations result which are similar in time evolution and spatial patterns to those recorded in the Greenland ice core. In particular, simulated warm events have preferred interspike intervals of 1500, 3000 and 4500 yr. Ice sheets alike thermohaline ocean circulation can be described as an excitable system. In Calov et al. (2002), using coupled climate-ice sheet mode, we simulated large-scale oscillations of the Laurentide Ice Sheet resembling Heinrich events in geographical pattern, amplitude and temporal evolution. Although, a typical period of simulated Heinrich events is controlled by climate forcing and internal ice sheet dynamics, the precise timing of individual Heinrich events is locked to small-scale instabilities in the area of Hudson Strait. We speculate that in the real climate system such perturbations can be readily synchronized with the same external 1500 yr cycle.