Geophysical Research Abstracts, Vol. 8, 08007, 2006
SRef-ID: 1607-7962/gra/EGU06-A-08007

Stochastic resonance in North Atlantic Ocean circulation in a 3-dimensional fully coupled climate model

J. I. Jongma (1), M. Prange (2) and M. Schulz (2)

(1) Faculty of Earth and Life Sciences, Vrije Universiteit Amsterdam, The Netherlands, (2) DFG Research Center Ocean Margins (RCOM), Universität Bremen, Germany (jochem.jongma@falw.vu.nl)

Stochastic resonance can be regarded as a simple threshold mechanism that can amplify weak periodic signals with the assistance of noise. Superposition of the noise and the weak forcing results in a preferential threshold crossing when the forcing is near its maximum, which leads to a cyclical response at integer multiples of the forcing frequency. Stochastic resonance in the thermohaline circulation has been invoked as part of an explanation for glacial Dansgaard-Oeschger events, which show remarkable millennial-scale cyclicity in the absence of an obvious periodic forcing.

2-dimensional ocean models with externally added noise have been shown to exhibit stochastic resonance on such a time-scale but this has not yet been demonstrated in 3-dimensional climate models with internal noise mechanisms. We show that a fully coupled 3-dimensional atmosphere-ocean model (ECBilt-CLIO) can indeed exhibit stochastic resonance behavior in the North Atlantic circulation, providing support for the idea that it plays an important role in millennial-scale climate variability.

The model was forced with a small periodic (A=2.5 mSv; T=500yr) fresh water injection in the Labrador Sea, under pre-industrial boundary conditions. In a 12,000 year integration we observed 10 excursions to a weaker North Atlantic overturning state, which was characterized by non-convection in the Labrador Sea. Using a Rayleigh test we show ($p<0.05$) that both the state-shifts to and from this weaker state are correlated with the phase of the small periodic external forcing. Control-runs with constant forcing show that the system was in the bistable regime so it was the superposition of noise that induced these mode-transitions. Thus the weak periodic signal was ampli-

fied with the assistance of noise, which we interpret as a manifestation of stochastic resonance in the North Atlantic Ocean circulation in a 3-dimensional fully coupled climate model.