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SEMINAR

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304 Whitehead Hall
Refreshments: 3:30 p.m.
Seminar: 4:00 p.m.

STATISTICAL MECHANICS OF THE OCEAN CIRCULATION

ABSTRACT

This talk will discuss a simple stochastic PDE model of the general ocean circulation, a generalization of a deterministic model introduced by Thual and McWilliams, corresponding to the zonally-averaged Boussinesq equations forced by prescribed surface temperatures and salinity fluxes. We include also a stochastic component to the salinity flux (to represent rainfall, continental runoff, etc.) We take the limit of a thin ocean, previously considered by Cessi and Young for the deterministic system, with a Gaussian spacetime white-noise model for the random salinity fluxes. We'll present both exact analytic and numerical results for this system. First, we'll show how the systematic (nonrandom) salinity fluxes can be chosen in the model to create multiple equilibrium states. Both simple toy ODE models and more complex general circulation models (GCMs) have shown that the ocean thermohaline circulation (THC) has multiple stable equilibrium states. These multiple equilibria are believed to have played an important role in past climate change, e.g., in rapid warming or Dansgaard-Oeschger (DO) events during the last ice age. Because of an exact nonlinear Fluctuation-Dissipation Relation, the invariant measure (or statistical climate state) is known exactly for our model. It is multimodal, with peaks at the multiple stable equilibria. Furthermore, the model exhibits the phenomenon of "stochastic resonance" in which noise-induced transitions are synchronized to a weak, subthreshold periodic forcing (cf. Mark Freidlin's department seminar of February 24, 2004!) Originally proposed to explain 100K glacial cycles, this phenomenon has more recently been invoked to explain the DO events at approximate 1450-year intervals during the last ice age. In our model the stochastic resonant frequency can be calculated semi-analytically and related to other system parameters.