Date: **April 11**

Time: **11:00 AM**

Location: **Ames 234**

Speaker: **Dr. Gregory Eyink**
Department of Mathematical Sciences
Johns Hopkins University

Title: **"Statistical Mechanics of the Thermohaline Circulation"**

Abstract

Both simple box models and GCM's 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 iceage. This talk will elaborate upon a simple conceptual model of the Atlantic THC introduced by Thual and McWilliams, corresponding to the zonally-averaged Boussinesq equations forced by prescribed surface temperatures and salinity fluxes. Unlike those authors, we include also a stochastic component to the salinity flux (which could represent rainfall, glacial outburst flooding, etc.) We take the limit of a thin ocean, previously considered by Cessi and Young for the deterministic system, with a Gaussian space-time 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 that are caricatures of either present or ice age conditions. Because of an exact nonlinear Fluctuation-Dissipation relation, the invariant measure or statistical climate state is known exactly. 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, sub threshold periodic forcing. This phenomenon has recently been hypothesized to explain the DO events at approximate 1450yr intervals during the last ice age. In the model the stochastic resonant frequency can be analytically calculated and related to other system parameters.

This model has been investigated as part of a larger project to develop statistical-mechanics methods for making forecasts and hindcasts of climate histories. If time permits, we'll discuss briefly some aspects of that work.