Department of Mathematics and Statistics Colloquium

Methods for Prediction and Control of Complex Systems

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Abstract: In the first part of the talk I will discuss some of the basic theoretical and practical properties of a turbulence model known as Lagrangian-Averaged Navier-Stokes equations, also called Navier-Stokes-alpha model. In the process, I'll identify core issues that arise when one uses a PDE model to characterize a complex flow. Similarly, there are common issues that arise when one uses a purely data driven modeling strategy, with no governing equations, to characterize multi-scale highly nonlinear complex systems. This motivates the need to properly merge the model equations derived from physical laws with the available observational measurements. I will introduce a continuous data assimilation (downscaling) algorithm for the two-dimensional Navier-Stokes equations employing coarse mesh measurements of only one component of the velocity field. This algorithm can be implemented with a variety of finitely many observables: low Fourier modes, nodal values, finite volume averages, or finite elements. Using a similar type of data assimilation algorithm one can recover the exact full reference solution (i.e. velocity and temperature) of the 3D Planetary Geostrophic model, at an exponential rate in time, by employing coarse spatial mesh observations of the temperature alone. This provides a rigorous justification to an earlier conjecture of Charney which states that temperature history of the atmosphere, for certain simple atmospheric models, determines all other state variables of the system.

Monday, April 15 at 3:50 in Roop 103

Refreshments at 3:30