STEVENS
Institute of Technology

Seminar Series in Applied Mathematics

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Geometrical approach to fluid transport in realistic geophysical flows.

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3:15 pm
Pierce 116

Abstract: Many geophysical flows of interest are effectively two-dimensional due to the Earth's rotation and the stable stratification of the ocean. The geometrical approach to the fluid transport in such flows is based on identifying regions of the flow with distinct motion type (e.g. recirculating in a vortex) and following their evolution. The key objects, separating the phase space into regions with different types of dynamics, are the stable and unstable invariant manifolds (IM) of the saddle-type trajectories.

Recently this approach was extended to the much more general class of 2D flows, including numerically generated velocity fields with general time dependence, defined only on a finite time interval. As an example, I will present a study of the Lagrangian dynamics of the Loop Current and the adjacent mesoscale rings in the eastern Gulf of Mexico. The coherent structures are identified by means of the effective invariant manifolds (EIMs) - material lines that play the analogous role as IMs do in periodic case.

The extension of the EIM technique to realistic flows, modeling the ocean only with certain degree of accuracy, brings up the question of the reliability of the predictions about the Lagrangian dynamics based on such incomplete knowledge of the underlying velocity field. Indeed, the analytic models capture only the principal features of the actual flow, whereas the experimentally obtained velocity fields are gridded, and thus necessarily contain an interpolation error. I will formulate a method for the error analysis of the EIM computations, and analyze the robustness of the EIMs in a simple kinematic model of transport in Rossby-wave critical layers, and in a shallow-water model of a double gyre circulation.

Refreshments will be available starting at 3:00pm.

For additional information contact Yi Li (216-5433) or Patrick Miller (216-5452).