McGill Computational Science and Engineering Seminar

Friday March 17th at 14:00 in Burnside Hall room 1205

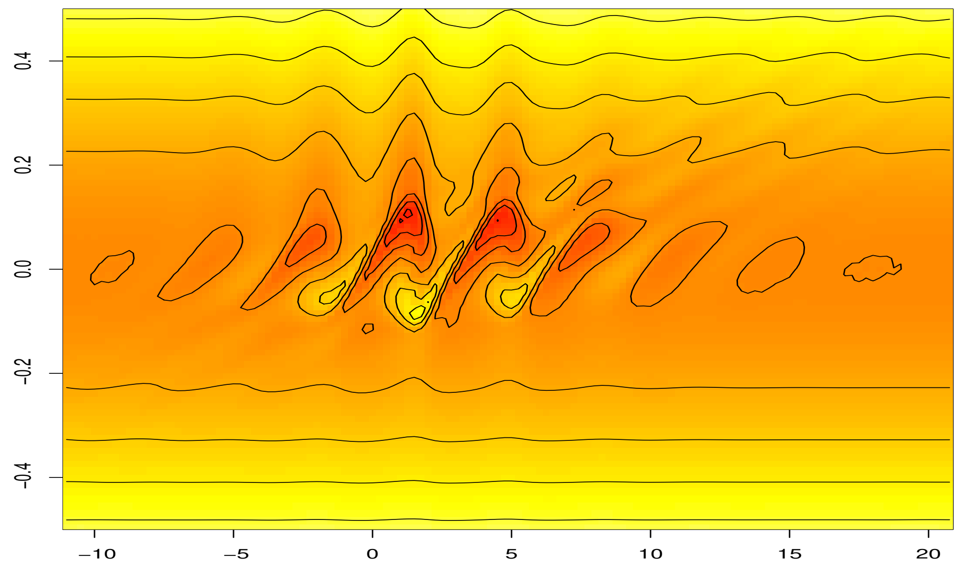
Numerical Simulations of Wave Packet Critical Layers in Geophysical Shear Flows

Lucy Campbell, Department of Mathematics and Statistics, McGill University

In this talk, I'll describe numerical simulations of the nonlinear evolution of a forced wave packet in the presence of a critical layer in a shear flow. The critical layer is the region surrounding the point where the flow velocity is equal to the phase speed of the waves; this corresponds to a singularity in the governing equations according to the linearized, inviscid theory of shear flows. I have been looking at two different geophysical flows: vertically propagating internal gravity wave packets in a stratified shear flow and Rossby wave packets propagating toward the equator in a zonal flow.

Most previous critical layer analyses have dealt with spatially periodic, monochromatic waves. These studies observed that, in the initial linear stages, the disturbance is absorbed at the critical layer, but subsequently, the linear theory breaks down and nonlinear phenomena such as wave breaking and reflection result. In my research, I used a forcing in the form of a spatially localized wave packet, rather than a monochromatic wave. This is a more realistic representation of wave activities in the atmosphere. The nonlinear equations were solved numerically using a pseudo-spectral Fourier approximation and a high order compact finite difference scheme on a non-uniform mesh.

The numerical solutions show that the spatial localization delays the onset of the nonlinear breakdown in the critical layer, the absorption of the disturbance continues for large time and there is an outward flux of momentum in the zonal or horizontal direction. I will present some of the results of the simulations and talk a bit about the numerical method used.



Coffee and desserts are served after the seminar at 15:00 in the lounge, Burnside Hall 1024