Department of Mathematics
College of Science

Applied Mathematics Seminar

"Evolution of the energy spectrum among a large number of internal waves in the deep ocean"

Friday November 9, 2:30 pm
Pickard Hall, Room 304

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Abstract:

Internal waves are generally accepted to be responsible for a large fraction of mixing in the deep ocean. Internal waves can interact with one another and exchange energy among themselves. This is possible because of the nonlinear advective terms in the governing equations of motion for a stratified medium in a rotating coordinate system. The nonlinear interactions between the waves lead to a nonlinear coupling and energy transfer from large to small vertical scales, end eventually to dissipation. Away from direct forcing, the oceanic internal wave-field appears to be remarkably uniform and described by the Garrett-Munk (GM) spectrum which quantifies the observed distribution of wave energy in wave number and frequency space.

While empirical knowledge of internal wave processes and their spectra is now reasonably complete, the dynamical underpinnings are still uncertain. A convincing approach to deriving the internal wave spectrum is still elusive. So far the energy distribution is well understood for the case of a single resonant triad only. At present there are still no any detailed enough theoretical studies of this process for two resonant triads.

This work represents a novel way to describe the internal wave spectrum and its evolution. We propose a mathematical model consisting of arbitrarily large number of waves to investigate the evolution of the energy spectrum and energy transfer in the internal wave field. The results are based on physics of internal waves and do not depend on "black-box" modeling.

As an illustration to the model, we consider 100000 resonant triads and we initialize the energy spectrum with the GM spectrum. We solve the system of 200000 evolution equations to determine the temporal evolution of the energy distribution among the various possible wave numbers and frequencies. The model involves internal waves with frequencies spanning the range of possible frequencies, i.e., between a maximum of the buoyancy frequency N for horizontal wave vectors (vertical motion) to a minimum of the inertial frequency f for vertical wave vectors (horizontal motion) [two limiting cases]. Because of the inclusion of high-frequency waves we don't make the hydrostatic approximation.

The goal of this model is to investigate the evolution of the wave's amplitudes to predict the evolution of the internal wave energy spectrum.

The Math Department will provide refreshments 30 min. prior to the presentation.

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