

Weekly Seminar: Spring 2009

Date: Friday March 13

Time: 11:00 AM

Location: Maryland Hall 110

Speaker: Lian Shen, Civil Engineering, Johns Hopkins University

Title: "Numerical Study of Free-Surface Turbulence"

Abstract

In this talk I will first give a brief introduction of our on-going research on free-surface turbulence with applications in wave-turbulence interaction, radiative transfer in upper ocean, interfacial scalar transfer, and wave-mud interaction. I will then focus on the problem of wind-wave interaction. In our study, we perform direct simulation of wind turbulence in the vicinity of water waves in order to obtain an understanding of the detailed flow structure. Mechanistic study is conducted through systematic simulations with different wave conditions. Examination of mean and fluctuation velocity field, Reynolds stress, turbulent kinetic energy and its budget, and enstrophy shows large variation with wave phase; and further analysis shows the variation is highly dependent on wave age and wave steepness/nonlinearity. Considerable intermittent air flow separations are detected over young waves with large amplitude. Coherent vortical structures are studied in terms of instantaneous flow field and statistics with conditional averaging, based on which we propose a model with quasi-streamwise vortices and reversed horseshoe vortices for young waves and a model with bent quasi-streamwise vortices for intermediate and mature waves. These conceptual vortex models agree with quadrants analysis of Reynolds stress and help the explanation of momentum transport. With the numerical result of surface pressure distribution, parameters of wave growth and their dependence on wave age and wave steepness are quantified, which are useful for the wind input modeling for large-scale phase-resolved wavefield prediction.