PLEASE POST

NCAR
MMM JOINT SEMINAR *GTP*

A new spectral theory of turbulent flows with stable stratification

Semion Sukoriansky
Department of Mechanical Engineering
Ben-Gurion University of the Negev
Beer-Sheva, Israel

Vertical-horizontal anisotropy and turbulence-internal waves interaction are among the most fundamental problems one encounters in modeling of turbulent flows with stable stratification. Governed by strong nonlinearity, these two phenomena have been beyond reach for analytical theories. Here, we present an attempt to develop a self-consistent theory capable of dealing with host of complicated factors introduced by nonlinearity and stable stratification within a framework of a second-moment spectral closure. This theory is based upon a mapping of the actual velocity field to a quasi-Gaussian field whose modes are governed by the Langevin equation. The parameters of the mapping are calculated using a systematic process of successive averaging over small shells of velocity and temperature modes that eliminates them from the equations of motion. This procedure does not differentiate between turbulence and internal waves and accounts for their combined effect. This approach offers a powerful mathematical tool that allows tackling problems that have been nearly intractable; among them are the threshold criterion for generation of internal waves and the modification of their dispersion relation by turbulence. The process of successive small scales elimination results in a model describing the largest scales of a flow. Partial scale elimination gives sub-grid-scale viscosities and diffusivities that can be used in large eddy simulations. The elimination of all fluctuating scales results in RANS models. The model predicts various important characteristics of stably stratified flows, such as the dependence of the vertical turbulent Prandtl number on Froude and Richardson numbers, anisotropization of the flow filed, and decay of vertical diffusivity under strong stratification in good agreement with computational and observational data. The model's results are suitable for immediate use in practical applications. Here we present tests of the model as applied to atmospheric boundary layer with strong stable stratification.

Monday, 16 October 2006, 3:30 PM
Refreshments 3:15 PM
NCAR-Foothills Laboratory
3450 Mitchell Lane
Bldg 2 Auditorium (Rm.1022)