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Regime Dynamics of the Stably Stratified Atmospheric Boundary Layer

Flow, stratification, and turbulence in the atmospheric boundary layer are dynamically coupled: turbulent intensity and fluxes are influenced by the character of the eddy-averaged state, which in turn is itself influenced by the turbulent fluxes. This interplay is of particular interest in the stably stratified atmospheric boundary layer, which is observationally found to exist in distinct regimes. The first, the weakly stable boundary layer (wSBL), is characterized by weak bulk shear, a modest inversion, and sustained turbulence. The second, the very stable boundary layer (vSBL), has strong bulk shear, a strong inversion, and turbulence which is weak and intermittent.

This talk will present recent observational and idealized modelling results regarding these regimes and the transitions between them. First, the regimes will be separated in data using a Hidden Markov Model (HMM) analysis of long time series of tower observations. Idealized physical models will then be used to elucidate the physical mechanism resulting in these regimes. Equilibrium and linear stability analyses will be presented and compared with time-dependent model behaviour. Finally, these ideas will be combined in a stochastic model of the bulk boundary layer momentum budget which provides a physically-based, if idealized, model for the probability distribution of near-surface winds.