MMM SEMINAR SERIES

Turbulence and Temperature Fronts in Stable Boundary Layers

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Recently, we performed very high resolution large eddy simulations (LESs) of canonical stable boundary layers (SBL) over a range of stratification using a mesh of 1024^3 gridpoints (mesh spacing 0.39 m). The stratification h/L varied from 1.7 to 6 where h is the SBL height and L is the Monin-Obukhov length. For the highest stratification considered continuous turbulence is maintained, but the SBL appears to split vertically with different dynamics above and below the height of the low-level jet. One of the most intriguing features in these simulations is the presence of ubiquitous temperature fronts. Animations show that these sharp fronts are tilted in the downstream direction, exhibit spatial spanwise and vertical coherence and propagate in time as organized entities. The front tilt and vertical separation is determined by the balance between the background stratification and the amplitude of the turbulent fluctuations. The fronts are internally generated by the dynamical interaction between turbulence and a stably stratified temperature field--the surface boundary conditions in the LES are horizontally homogeneous. Based on conditional averaging, the flow fields near a temperature front appear to be controlled by pairs of upstream and downstream vortices. Guided by the LES findings, we are able to identify qualitatively similar patterns in temperature profiles collected during the CASES-99 field campaign.

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