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MMM SEMINAR *NCAR*

A Comparison of Heterogeneously Heated Convective Boundary Layers with Fixed Flux and Fixed Temperature Boundary Conditions

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The heterogeneously heated free Convective Boundary Layer (CBL) is investigated by means of dimensional analysis and results from Large-Eddy Simulations (LES) and Direct Numerical Simulations (DNS).The investigated physical model is a CBL that forms in a linearly stratified atmosphere heated from the surface. We present results from two different experiments: a CBL that is heated from patches with afixed surface heat flux, and a CBL that is heated from stripes with a fixed surface temperature.

For the first experiment, we show that each simulation, if run long enough, contains first the formation of a peak in kinetic energy, corresponding to the "optimal" heterogeneity size with strong secondary circulations, and subsequently the transition into a horizontally homogeneous CBL. We have developed scaling laws for the time of the optimal state and transition that show that the optimal state and transition do not occur at a fixed ratio of the heterogeneity size to the CBL thickness. Instead, these occur at a higher ratio for simulations with increasing heterogeneity sizes, due to the development of structures in the downward moving air that grow faster than the CBL thickness.

For the second experiment, we show that imposing a fixed surface temperature changes the physics dramatically. In contrast to the first experiment, the system develops towards a steady state where the release of heat from the warm stripes equals the amount of heat taken up from the cold stripes. In this development, the system can go into transition to a horizontally homogeneous CBL and subsequently change back to a state with strong secondary circulations. Furthermore, large stripe sizes lead to oscillations in the kinetic energy and asymmetry in the plume circulations.

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Friday, 5 December 2014, 10:30 AM
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NCAR-Foothills Laboratory
3450 Mitchell Lane
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