Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

A Multi-scale Approach for the Thermally Stratified Turbulent Boundary Layer[1] SAM NOTARO, Syracuse University, GUSTAVO RIVERA-ROSARIO, Rensselaer Polytechnic Institute, LUCIANO CASTILLO, Texas Tech University — The governing equations have been established for the inner and outer regions of the turbulent boundary layer for thermally stratified flows subject to external pressure gradient. It was shown that the pressure gradient across the boundary layers contains the wall-normal Reynolds stress and the buoyancy term. Therefore, the streamwise momentum equation includes the buoyancy terms and can be employed to obtain the scales of the velocity and thermal fields. Furthermore, it has been clearly identified that single scaling analysis cannot satisfy the equations of motion while satisfying the boundary layers simplifications. Moreover, using a multi-scale similarity approach of the equations of motion a buoyancy parameter, β_T has been derived and must be constant for an equilibrium flow to exist. From this new parameter a power law for the growth of the thermal boundary layer exists given as, $\delta_T \sim {\Delta T_w}^{1/\beta_T}$, in which the growth is controlled by the strength of the stratification. In addition, it was shown that the outer mean temperature scales with the temperature difference, ΔT_w, and the inverse of the Richardson number.

[1]NSF-CBET and ONR (R. Joslin)

Luciano Castillo
Texas Tech University

Date submitted: 10 Aug 2011 Electronic form version 1.4