Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Log-Law scaling of a convective boundary layer in an unstably stratified turbulent channel flow ANDREA SCAGLIARINI, Department of Physics, University of Rome "Tor Vergata", HALLDOR EINARSSON, ARMANN GYLFASON, School of Science and Engineering, Reykjavik University, FEDERICO TOSCHI, Department of Applied Physics, Eindhoven University of Technology — Turbulent convection is ubiquitous in a variety of natural and industrial flows. In particular, convective motions may play a role in sheared flows. In this work, we are concerned with the interplay of buoyancy and shear in the dynamical boundary layer structure. The lattice Boltzmann Method (LBM) is applied to study numerically an unstably-stratified, fully developed, turbulent channel flow, driven by a longitudinal pressure gradient and with an imposed transverse wall temperature difference along the direction of gravity. Spanning the friction Reynolds ($Re_{tau} \leq 205$) and Rayleigh numbers ($Ra \leq 1.3 \times 10^7$) we could systematically study the influence of the convection on the boundary layer structure and mean profiles of flow quantities in the channel. Our focus is on providing physical understanding of the deviations observed from the logarithmic law of the wall due to the buoyant motions as well as providing a model of this behavior, and link with fundamental quantities of heat transfer in the convective channel flow. Our findings show that the introduction of an unstably stratified thermal field results in an effective drag increase in the channel flow, quantified in the logarithmic region by a modified log-law, with model parameters dependent on Ra, Re_{tau}.

Andrea Scagliarini
Department of Physics, University of Rome "Tor Vergata"

Date submitted: 01 Aug 2014 Electronic form version 1.4