Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Numerical experiments of thermal convection with shear CURTIS HAMMAN, PARVIZ MOIN, Center for Turbulence Research, Stanford University — Inspired by Sayadi, Hamman and Moin's (2013, J. Fluid Mech.) finding that late-stage boundary layer transition shares the same structure and scaling behaviour of high Reynolds number wall turbulence, we explore whether facets of the related ultimate state of Rayleigh-Bénard convection (RBC) can develop at moderate Rayleigh numbers ($10^5 < Ra < 10^{10}$) with amplified wall shear. In shear-free RBC, turbulence in the bulk produces a large-scale circulation or mean wind too weak to prompt boundary layer transition by shear instability, except possibly at extreme Rayleigh numbers where the largest eddies organize the local wall shear flow above a critical friction Reynolds number. We propose a numerical experiment to produce turbulent, three-dimensional, thermal and kinetic boundary layers near the walls while maintaining shear-free, buoyant turbulence production in the bulk as in unperturbed RBC. We speculate that this flow structure may correlate with the ultimate state of thermal convection, given that most of the near-wall turbulent energy production by shear is due to the effects of a mean wind-induced turbulent wall layer. Simulation results are presented to test this connection between the boundary layer structure of RBC and canonical wall-bounded turbulent shear flows.

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Date submitted: 03 Aug 2013 Electronic form version 1.4