Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

An LES Study of Transition in Atmospheric Boundary Layer Turbulence Structure from Neutral to Convective Stability States BALAJI JAYARAMAN, JAMES BRASSEUR, Department of Mechanical Engineering, The Pennsylvania State University — The scales, strengths and detailed structure of atmospheric boundary layer (ABL) turbulence that affect wind turbine performance and reliability are strongly dependent on the relative contributions of buoyancy-driven vertical motions from surface heating and shear driven motions from geostrophic winds at the mesoscale, as characterized by the global stability state parameter $-z_i/L$. In the shear-dominant neutral limit, the ABL is characterized by streamwise-elongated coherent eddies of negative fluctuating horizontal velocity As surface heat flux is increased, buoyancy drives vertical fluctuations strongly correlated with shear-driven motions that eventually organize to generate streamwise rolls that couple upper with lower boundary layer. We use large-eddy simulation (LES) to study this transition between "near neutral" and "moderately convective" by quantifying correlations and integral scales as a function of -z_i/L.The interactions between outer and the surface layer eddies generate surprising turbulence dynamics that includes a special transitional stability state with unusually enhanced streamwise coherence. The transitional process includes a critical phenomenon with sudden dramatic change in ABL structure, and high sensitivity in horizontal fluctuations to surface heating at a low $-z_i/L$. *Supported by DOE.*

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Date submitted: 03 Aug 2013 Electronic form version 1.4