Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Wind Tunnel Simulation of the Atmospheric Boundary Layer[1]
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We aim to generate an artificially thickened boundary layer in the wind tunnel with properties similar to the neutral atmospheric boundary layer (ABL). We implement a variant of Counihan's technique which uses a combination of a castellated barrier, elliptical vortex generators, and floor roughness elements to create a thick boundary layer in a relatively short wind tunnel. We demonstrate an improved spanwise uniformity than in Counihan's original design by using a tighter vortex generator spacing with a smaller wedge angle to keep frontal area approximately constant. This is achieved while keeping the turbulence intensity and power spectral density unchanged. It was found possible to generate a boundary layer at $Re_\theta \sim 10^6$, displaying logarithmic mean velocity behavior, a constant stress region, and turbulence intensities that compare favorably with full scale ABL measurements and laboratory rough-wall boundary layers. In addition, the longitudinal power spectral density agrees well with von Kármán's model spectrum and the integral length scale agrees well with data from ABL measurements.

[1]Supported by Princeton University Grand Challenges

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Date submitted: 01 Aug 2014 Electronic form version 1.4