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Internal Layer Hierarchy in Rough-Wall Turbulent Boundary[1]
FARAZ MEHDI, CALEB MORRILL-WINTER, RACHEL EBNER, JOSEPH KLEWICKI, University of New Hampshire — The existence of an internal layer hierarchy is centric to the characteristic properties of wall-bounded turbulent flows. Its presence, which is revealed through an analysis of the mean momentum balance (MMB), accounts for the dynamics undergoing a continuous self-similar variation over a length scale range spanning the viscous length scale to the outer scale, $\nu/u_\tau \leq \ell \leq \delta$. Surface roughness introduces multiple new length scales which are often reduced (for simplification and comparison) to a single "working" scale given by the equivalent sandgrain roughness k_s^+. We report on our continuing efforts to study how this imposition modifies the continuous hierarchy of scaling layers admitted by the MMB. The establishment of log-like behavior closer to the wall in rough-wall flows is one such effect. It is speculated to be the direct consequence of the roughness causing the vorticity field to three-dimensionalize more rapidly compared to a smooth-wall. Data sets comprising of experiments being performed at UNH and high quality data sets available in the literature are being used for this combined roughness–Reynolds number study. The current experiments are conducted in a 8m long boundary layer wind-tunnel. Roughness is introduced in the form of sandpaper attached to the entire lower wall and profiles are taken using hot-wires and two-dimensional laser velocimetry.

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