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The influence of regular and random roughness on outer-layer similarity[1] MICHAEL SCHULTZ, United States Naval Academy, KRISTOFER WOMACK, Johns Hopkins University, RALPH VOLINO, United States Naval Academy, CHARLES MENEVEAU, Johns Hopkins University — An experimental investigation was carried out on rough-wall, turbulent boundary layers with regular and random roughness element arrangements. Varying planform densities of truncated cone roughness elements in square staggered patterns and random arrangements were investigated. Velocity statistics were measured via two-component laser Doppler velocimetry and stereo particle image velocimetry. Differences in the mean streamwise velocity profiles recorded over the regular arrangements were confined to within one roughness height above the roughness crests whereas the random cases exhibited significant variation across the span that persisted into the outer layer. Evidence is shown that the differences result from low momentum pathways (LMPs) and high momentum pathways (HMPs) over the random surfaces which are not observed over the regular surfaces. The LMPs and HMPs were marked by elevated and depressed Reynolds shear stress as seen by previous investigators. However, previous studies had systematic or regular surface topography which they linked to the secondary flows. The present results indicate that secondary flows may develop even in the absence of these surface characteristics.

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