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Turbulent Secondary Flows in Boundary Layer Flows over Regular and Random Roughness[1] KRISTOFER WOMACK, Johns Hopkins University, RALPH VOLINO, MICHAEL SCHULTZ, United States Naval Academy, CHARLES MENEVEAU, Johns Hopkins University — An experimental study was conducted on rough-wall, turbulent boundary layer flow with regular and random roughness element arrangements. Varying planform densities of truncated cone roughness elements in a square staggered pattern were investigated. The same planform densities were also investigated in random arrangements. Velocity statistics were measured via two-component laser Doppler velocimetry and stereo particle image velocimetry. A novel technique was used to determine friction velocity, u_τ, from only the wall-normal profiles of mean streamwise velocity and Reynolds shear stress at a single streamwise location with accuracy comparable to force-balance measurements. Additionally, evidence is presented showing that the observed differences between regular and random surface flow parameters are due to the presence of low momentum pathways (LMPs) and high momentum pathways (HMPs) over the random surfaces which are not present over the regular surfaces. Previously identified spanwise heterogeneities thought to generate and sustain LMPs and HMPs in other studies do not seem to be present which suggests that these mechanisms are not necessary for LMP and HMP sustainment. Possible mechanisms for LMP and HMP self-sustainment are discussed.

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