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The Impact of Favorable-Pressure-Gradient Conditions on Large-Scale Motions in Smooth- and Rough-Wall Turbulence D. MIN, K.T. CHRISTENSEN, MechSE Dept., Univ. of Illinois — The combined impact of irregular surface roughness and moderate favorable-pressure-gradient (FPG) conditions ($K \approx 4.0 - 4.4(10^{-7})$) on large-scale motions in a turbulent boundary layer was assessed using stereo PIV measurements in the wall- normal–spanwise plane. The roughness under consideration was replicated from a turbine blade damaged by deposition of foreign materials and contains a broad range of topographical scales. These measurements were compared to measurements of smooth-wall flow under identical FPG conditions to reveal the combined impact of roughness and FPG conditions on the larger-scale motions. Instantaneous smooth- and rough- wall velocity fields embodied spanwise-alternating patterns of low- and high-momentum regions (LMRs and HMRs). While these motions in the smooth-wall case were found to penetrate less deep into the boundary layer compared to similar motions in zero-pressure-gradient flow, they often extended much further away from the wall in the presence of roughness. Two-point correlations of low-pass- filtered velocity fields embodying only the larger-scale motions of smooth-wall flow revealed a remarkable spanwise- alternating nature of low- and high-momentum regions well beyond that reflected in correlations of unfiltered velocity. Roughness was found to reduce this spanwise coherence.

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