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Roughness Signature in the Outer Layer of a Turbulent Boundary Layer[1] JIARONG HONG, JOSEPH KATZ, Johns Hopkins University, MICHAEL SCHULTZ, United States Naval Academy — Roughness signature, consisting of bumps (slope flattening) in energy spectra at roughness scale wavenumbers, have been observed in the outer-layer high resolution PIV data obtained in a turbulent channel flow over 3D rough surfaces. The measurements cover the entire well-characterized channel flow with δ/k=50 (k is roughness height) and k_s^+=90-150. For the present Reynolds numbers, Re_τ=3520-5360, these spectral bumps fall in 10-30 times the local Kolmogorov scale. Instantaneous realizations, swirling strength based linear stochastic estimation, and bandpass-filtered velocity maps indicate that this phenomenon is a result of rapid entrainment of eddies generated near the wall by large scale, outer-layer structures. This process floods the boundary layers with eddies of 1-3 times the roughness height, in addition to those generated by local production. Consequently, the energy and shear spectra show an excessive amount roughness-scale energy in the outer-layer. On going time-resolved measurement focus in this interaction between inner and outer layer structures. Thus, although the means flow and second order moment statistics satisfy Townsend's hypothesis, the small scale turbulence maintains the roughness signature.

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