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Turbulent wall flows large-scale roughness heterogeneity: flow response to oblique alignment WILLIAM ANDERSON, YIRAN ZHENG, UT Dallas — The physics of wall turbulence – ducts, boundary layers, and pipes – affects the aero-/hydro-dynamic signature of an array of flows. Such flows often occur under the "fully rough", inertial-dominated limits for which viscous effects can be readily neglected and skin friction is driven by form drag (i.e., turbulent mixing). Rough surfaces composed of a complex height distribution are common in engineering and geophysical flows. Prognostic flow description is confounded by the presence of large-scale heterogeneity in surface geometry: that is, "patches" of differing roughness type, with spatial extent at least equal to the depth of the flow (i.e., duct half height, pipe radius, or boundary layer depth). When the prevailing transport direction is aligned orthogonal and parallel to such a heterogeneity, the flow responds with formation of an internal boundary layer or with counter-rotating rolls, respectively. These surface-driven secondary flows can completely disrupt outer layer dynamics, and thus have direct implications for wall modeled large-eddy simulation predicated upon outer-layer content. Moreover, realizations of precise orthogonal/parallel alignment are expected to be rare, and oblique alignment is likely the norm (for example, during vehicle maneuver). Results of wall turbulence response to such oblique arrangements are shown.

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