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On the turbulent boundary layer over geophysical-like topographies. LEONARDO P. CHAMORRO, ALI M. HAMED, University of Illinois at Urbana-Champaign, LUCIANO CASTILLO, Texas Tech University — The developing and developed flows over 2D and 3D large-scale wavy walls were experimentally studied with high-resolution planar PIV in a refractive-index-matching channel. The 2D wall is described by a sinusoidal wave in the streamwise direction with amplitude to wavelength ratio a/λx = 0.05, while the 3D wall has an additional wave in the spanwise direction with a/λy = 0.1. The flow was characterized at Re= 4000 and 40000, based on the bulk velocity and the channel half height. The walls have amplitude to boundary layer thickness ratio $a/\delta_{99} \approx 0.1$ and resemble large-scale and geophysical-like roughnesses found in rivers and natural terrain. Instantaneous velocity fields and time-averaged turbulence quantities reveal strong coupling between large-scale topography and the turbulence dynamics near the wall, and the presence of a well-structured shear layer that enhances the turbulence for both walls. However, the 3D wall exhibits spanwise flow that is thought to be responsible for distinctive flow features, including comparatively reduced spanwise vorticity and decreased turbulence levels. Further insight is drawn in the developed and developing regions through proper orthogonal decomposition and quadrant analysis.

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