Abstract Submitted for the DFD15 Meeting of The American Physical Society

Turbulent boundary layer over 2D and 3D large-scale wavy walls LEONARDO P. CHAMORRO, ALI M. HAMED, University of Illinois at Urbana-Champaign, LUCIANO CASTILLO, Texas Tech University — In this work, an experimental investigation of the developing and developed flow over two- and threedimensional large-scale wavy walls was performed using high-resolution planar particle image velocimetry in a refractive-index-matching flume. The 2D wall is described by a sinusoidal wave in the streamwise direction with amplitude to wavelength ratio $a/\lambda x = 0.05$. The 3D wall is defined with an additional wave superimposed on the 2D wall in the spanwise direction with $a/\lambda y = 0.1$. The flow was characterized at Reynolds numbers of 4000 and 40000, based on the bulk velocity and the flume half height. Instantaneous velocity fields and time-averaged turbulence quantities reveal strong coupling between large-scale topography and the turbulence dynamics near the wall. Turbulence statistics show the presence of a well-structured shear layer that enhances the turbulence for the 2D wavy wall, whereas the 3D wall exhibits different flow dynamics and significantly lower turbulence levels, particularly for <u'v'>which shows about 30% reduction. The likelihood of recirculation bubbles, levels and spatial distribution of turbulence, and the rate of the turbulent kinetic energy production are shown to be severely affected when a single spanwise mode is superimposed on the 2D wall. POD analysis was also performed to further understand distinctive features of the flow structures due to surface topography.

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Date submitted: 31 Jul 2015

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