Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Experiments in Environmental Flows: Flow over Large-Scale Topography ALI M. HAMED, LEONARDO P. CHAMORRO, University of Illinois at Urbana-Champaign — In order to provide a better understanding of the flow over large-scale topography relevant to environmental applications, particle image velocimetry (PIV) was used in a refractive-index-matching (RIM) channel to study the flow over 2D and 3D walls defined by the same length scale and occupying roughly 10% of the boundary layer. A series of experiments were performed to investigate the impact of roughness three-dimensionality on the flow field in developed turbulent flow, developing turbulent flow, and the transition to turbulence regime. The results show that 3D topographies (in contrast to 2D ones) have characteristic spanwise flows within the topography that relatively reduce spanwise vorticity leading to reduced drag and turbulent activity. Furthermore, turbulent boundary layers exhibit a distinctive response to an abrupt large-scale topographic change depending on whether the topography is 2D or 3D. For example, the integral parameters (e.g., displacement and momentum thicknesses) are significantly more modulated by the topography in the 2D case due to large pressure variations in the streamwise direction. The three-dimensionality of the topography also impacts the nature by which the boundary layer transitions to turbulence. The transition over the 2D topography occurs due to an inflection point in the velocity profile resulting from flow separation within the roughness troughs. In the 3D case, the transition is significantly delayed due to the lack of such instability.

Ali M. Hamed
University of Illinois at Urbana-Champaign

Date submitted: 07 Nov 2016 Electronic form version 1.4