Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Effects of surface roughness on an adverse-pressure-gradient separating turbulent boundary layer[1] WEN WU, UGO PIOMELLI, Queen's University, TURBULENCE SIMULATION AND MODELLING LABORATORY TEAM — Separating turbulent boundary layers over smooth and rough flat plates are investigated by large-eddy simulations. A suction-blowing velocity distribution is imposed at the top boundary to produce an adverse-to-favourable pressure gradient and a closed separation bubble. Sandgrain roughness in the fully-rough regime is modelled by an immersed boundary method. In the rough-wall case, streamline detachment occurs earlier and the separation region is substantially larger due to the momentum deficit caused by the roughness. The adverse pressure gradient decreases the form drag and causes a thin reversed-flow region below the roughness crest, so that $C_f = 0$ does not coincide with the detachment of the flow from the surface. The wake regions behind roughness elements affect the intermittency of the near-wall flow, so that upstream of the detachment point the flow can be reversed half of the time, but its average is positive. The separated shear layer exhibits higher turbulent kinetic energy (TKE); the growth of the TKE there begins earlier relative to the separation point, and the peak TKE occurs close to the separation point. The momentum deficit caused by the roughness, again, plays a critical role in these changes.

[1]The authors acknowledge the support from Hydro-Québec and the NSERC Collaborative Research Development program (CRDPJ 418786-11). The simulations were performed at CAC Queen't site. UP also thanks the support of Canada Research Chair Program

Wen Wu
Queen's University

Date submitted: 25 Jul 2017 Electronic form version 1.4