Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Large Eddies in the Flow over Two-Dinemsional Dunes MOHAMMAD OMIDYEGANEH, UGO PIOMELLI, Queen's University — We performed large-eddy simulation of the flow over two- dimensional large-scale river-bed irregularities called dunes at laboratory scale (the Reynolds number based on the average channel height and mean velocity is 18,900). The flow separates at the dune crest, generating a shear layer that plays a crucial role in the transport of momentum and energy, as well as the generation of coherent structures, and reattaches $5.2h$ downstream on the stoss side of the dune. Near-wall turbulence is strongly affected by the concave shape of the bed after the reattachment point cause streamwise Taylor-Gortler vortices to be generated. These vortices cause more coherent organized elongated streaks close to the wall in contrast to the streaks in turbulent boundary layer. The flow over dunes has unique characteristics among open channel flows because of the presence of spanwise vortices in the separated shear layer generated by the Kelvin- Helmholtz instability. Large eddies are formed when the spanwise vortices in the shear layer undergo lateral instabilities result into inclined horseshoe-like vortices. Between the legs of these vortices, strong ejections occur (with $u'v'$ over 40 times and turbulent kinetic energy over 15 times larger than the local mean). When these eddies reach the surface, the ejection causes a local stagnation point on the surface, with divergent streamlines, similar to those observed in the field when upwellings occur.

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Date submitted: 12 Jul 2011 Electronic form version 1.4