Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Numerical Simulation of Turbulence-Induced Bedform Initiation

YI-JU CHOU, OLIVER FRINGER, Environmental Fluid Mechanics Laboratory, Stanford University — Bedform initiation induced by near-wall turbulence structures on a sand bed is studied using large-eddy simulation. Due to the dilute sediment concentration during the simulation, transport of sediment is modeled with the Eulerian method. A second-order accurate arbitrary Lagrangian-Eulerian scheme is implemented that allows flow simulation over evolving bedforms. With a bed elevation model based on conservation of sediment mass to calculate changes in bed elevation, the present numerical model enables detailed observation of bedform instability caused by near-wall turbulence. It is found that the streak structure on the bed surface appears as the initial bed perturbation due to sediment erosion by turbulent sweeps, which in turn induce small pile-up at the downstream end of the inrush zone where the sweep diminishes. The continuous growth of the small sediment pile-up leads to the formation of bed defects, which alter the flow condition and the spatial distribution of near-bed sediment erosion. As a consequence, merging of multiple bed defects leads to the formation of ripple marks, which are a common bedform pattern in the subaqueous environment. The simulation results reveal interactions between turbulent structures and the sand bed and demonstrate the importance of the resolved turbulence in the simulation of bedform initiation.

Yi-Ju Chou
Stanford University

Date submitted: 06 Aug 2009 Electronic form version 1.4