Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Direct Numerical Simulation of Air Layer Drag Reduction over a Backward-facing Step[1] DOKYUN KIM, PARVIZ MOIN, Stanford University — Direct Numerical Simulation (DNS) of two-phase flow is performed to investigate the air layer drag reduction (ALDR) phenomenon in turbulent flow over a backward-facing step. In their experimental study, Elbing et al. (JFM, 2008) have observed a stable air layer on an entire flat plate if air is injected beyond the critical air-flow rate. In the present study, air is injected at the step on the wall into turbulent water flow for ALDR. The Reynolds and Weber numbers based on the water properties and step height are 22,800 and 560, respectively. An inlet section length before the step is 3h and the post expansion length is 30h, where h is the step height. The total number of grid points is about 271 million for DNS. The level set method is used to track the phase interface and the structured-mesh finite volume solver is used with an efficient algorithm for two-phase DNS. Two cases with different air-flow rates are performed to investigate the mechanism and stability of air layer. For high air-flow rate, the stable air layer is formed on the plate and more than 90% drag reduction is obtained. In the case of low air-flow rate, the air layer breaks up and ALDR is not achieved. The parameters governing the stability of air layer from the numerical simulations is also consistent with the results of stability analysis.

[1]Supported by the Office of Naval Research

Dokyun Kim
Stanford University

Date submitted: 06 Aug 2010 Electronic form version 1.4