Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

On Closure Model for Accurate Reduced-Order Modeling in 3-D Flows IMRAN AKHTAR, JEFF BORGGAARD, TRAIAN ILIESCU, ZHU WANG, Virginia Tech — Reduced-order models based on the proper orthogonal decomposition (POD) can be used to represent and understand complex dynamical systems such as the Navier-Stokes equations. These models give insight to the flow physics, reproduce the data, and may be used for control purposes. However, most successful applications of this approach involve low Reynolds number, 2-D flows. For most 3-D flows, a large number of POD modes are required to accurately represent the flow field. The large dimension of the resulting model contradicts the essence of model reduction. Furthermore, the resulting reduced-order model is usually numerically unstable. In this study, we suggest an LES-type closure model within the POD-based reduced-order modeling framework. We simulate the flow past a 3-D cylinder at Re=1000 and collect a large set of snapshots to capture turbulent structures in the wake. We develop a reduced-order model using a small number of POD modes and introduce an additional term within the model to capture the effects of high frequencies (e.g. discarded modes) in the system. We compare the results of the model with the DNS data to establish accuracy of the modified reduced-order model.

Imran Akhtar
Virginia Tech

Date submitted: 11 Aug 2009 Electronic form version 1.4