Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

High Resolution DNS of Turbulent Flows using an Adaptive, Finite Volume Method[1] DAVID TREBOTICH, Lawrence Berkeley National Laboratory — We present a new computational capability for high resolution simulation of incompressible viscous flows. Our approach is based on cut cell methods where an irregular geometry such as a bluff body is intersected with a rectangular Cartesian grid resulting in cut cells near the boundary. In the cut cells we use a conservative discretization based on a discrete form of the divergence theorem to approximate fluxes for elliptic and hyperbolic terms in the Navier-Stokes equations. Away from the boundary the method reduces to a finite difference method. The algorithm is implemented in the Chombo software framework which supports adaptive mesh refinement and massively parallel computations. The code is scalable to 200,000+ processor cores on DOE supercomputers, resulting in DNS studies at unprecedented scale and resolution. For flow past a cylinder in transition (Re=300) we observe a number of secondary structures in the far wake in 2D where the wake is over 120 cylinder diameters in length. These are compared with the more regularized wake structures in 3D at the same scale. For flow past a sphere (Re=600) we resolve an arrowhead structure in the velocity in the near wake. The effectiveness of AMR is further highlighted in a simulation of turbulent flow (Re=6000) in the contraction of an oil well blowout preventer.

[1]This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Advanced Scientific Computing Research, Applied Mathematics program under contract number DE-AC02-05-CH11231

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Date submitted: 01 Aug 2014 Electronic form version 1.4