Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Methods and issues for highly-scalable simulation of isotropic homogeneous turbulence ORLANDO AYALA, CHARLES ANDERSEN, HOSSEIN PARISHANI, LIAN-PING WANG, University of Delaware — Direct numerical simulations (DNS) of homogeneous isotropic turbulence have served as a reliable quantitative research tool for studying the physics and dynamics of small-scale turbulence. It is desirable to extend the range of scales or equivalently the flow Reynolds number so a more complete understanding of related physical processes can be obtained. While the pseudo-spectral method is known to be the most accurate DNS approach, it has the challenge of performing global data communication (i.e., Fast Fourier Transform) which may not scale well on the state-of-the-art PetaScale computers with O(100,000) processors. Alternative approaches, such as high-order finite difference, finite-volume, and lattice Boltzmann equation, have been proposed to replace the pseudo-spectral method. The question we wish to address in this talk is: how do different approaches compare in terms of accuracy and parallel efficiency? Complexity analyses of several approaches will be discussed and be used to understand scalability data obtained from several parallel computers. The simulated flows will also be compared to examine the resolution requirements for various approaches to achieve a comparable accuracy. Detailed implementation issues related to multi-dimensional domain decompositions and large-scale forcing scheme will be discussed.

Lian-Ping Wang
University of Delaware

Date submitted: 12 Aug 2011

Electronic form version 1.4