DFD14-2014-001573
Abstract for an Invited Paper
for the DFD14 Meeting of
the American Physical Society

DNS/LES of Complex Turbulent Flows beyond Petascale[1]

PAUL FISCHER, University of Illinois

Petascale computing platforms currently feature million-way parallelism and it is anticipated that exascale computers with billion-way concurrency will be deployed by 2020. In this talk, we explore the potential of computing at these scales with a focus on turbulent fluid flow and heat transfer in a variety of applications including nuclear energy, combustion, oceanography, vascular flows, and astrophysics. Following Kreiss and Oliger '72, we argue that high-order methods are essential for scalable simulation of transport phenomena. We demonstrate that these methods can be realized at costs equivalent to those of low-order methods having the same number of gridpoints. We further show that, with care, efficient multilevel solvers having bounded iteration counts will scale to billion-way concurrency. Using data from leading-edge platforms over the past 25 years, we analyze the scalability of state-of-the-art solvers to predict parallel performance on exascale architectures. The analysis sheds light on the expected scope of exascale physics simulations and provides insight to design requirements for future algorithms, codes, and architectures.

[1]Supported by DOE Applied Mathematics Research Program