Adaptive High-Order Finite-Volume Methods for Partial Differential Equations

Official Title of Funded Project: "High-Resolution and Adaptive Numerical Algorithms for Partial Differential Equations"

Phillip Colella, Peter McCorquodale
Lawrence Berkeley National Laboratory
1 Cyclotron Road
Berkeley, CA 94720

Stephen Guzik
Lawrence Livermore National Laboratory
7000 East Ave.
Livermore, CA 94720

Christiane Jablonowski, Paul Ullrich
Uinersity of Michigan, Department of Atmospheric, Ocean, and Space Sciences
2455 Hayward St.
Ann Arbor, MI 48109-2143

Abstract

In this presentation, we highlight recent developments in higher-order (fourth-order accuracy or better) adaptive finite volume methods for classical PDE written in conservation form. Our approach is based on computing the average of the divergence operator applied to a vector field over logically rectangular control volumes using the divergence theorem, and then using high-order accurate quadratures to compute the integrals of fluxes over faces. For time-dependent problems, this is combined with a method-of-lines discretization in time. We will discuss the issues arising in extending the method to block-structured locally-refined meshes, including explicit methods for hyperbolic conservation laws; semi-implicit methods for advection-diffusion problems; the extension of the method for locally-refined grids to the case where the underlying logically-rectangular coordinatization of space comes from a smooth mapping; and the combination of the adaptive mapped grid approach with the use of a cubed-sphere coordinate system to compute solutions to PDE on a sphere, with applications to atmospheric modeling.