Stable and Scalable Spectral Element Methods

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Abstract

This talk will cover several critical developments that make it possible to use spectral element methods for large-scale convection-dominated incompressible flow simulations on tens of thousands of processors. Discretization advances that have made the SEM viable for these problems include stabilizing filters and spectral element dealiasing. Solver advances include spectral element multigrid methods that employ robust Schwarz-based smoothers and scalable parallel coarse-grid solvers. In addition to these fundamental elements, we touch upon a few technical details that were required to exceed processor counts in excess of 10,000. We present the results of several spectral element simulations, including comparisons of turbulent vascular flows with experiments, isotropic turbulent flow vs. Fourier based results, flow in reactor core subchannels, and recent MHD results computed using $>$ 100 million gridpoints on 32000 processors of IBM's Blue Gene Watson platform.