Abstract Submitted
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Stable, high-order SBP-SAT finite difference operators to enable accurate simulation of compressible turbulent flows on curvilinear grids, with application to predicting turbulent jet noise JAESEUNG BYUN, DANIEL BODONY, CARLOS PANTANO, University of Illinois at Urbana-Champaign — Improved order-of-accuracy discretizations often require careful consideration of their numerical stability. We report on new high-order finite difference schemes using Summation-By-Parts (SBP) operators along with the Simultaneous-Approximation-Terms (SAT) boundary condition treatment for first and second-order spatial derivatives with variable coefficients. In particular, we present a highly accurate operator for SBP-SAT-based approximations of second-order derivatives with variable coefficients for Dirichlet and Neumann boundary conditions. These terms are responsible for approximating the physical dissipation of kinetic and thermal energy in a simulation, and contain grid metrics when the grid is curvilinear. Analysis using the Laplace transform method shows that strong stability is ensured with Dirichlet boundary conditions while weaker stability is obtained for Neumann boundary conditions. Furthermore, the benefits of the scheme is shown in the direct numerical simulation (DNS) of a Mach 1.5 compressible turbulent supersonic jet using curvilinear grids and skew-symmetric discretization. Particularly, we show that the improved methods allow minimization of the numerical filter often employed in these simulations and we discuss the qualities of the simulation.

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