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A narrow-stencil formulation of subgrid-scale models in large-eddy simulation: application to the stretched vortex model for compressible flows RAMJI KAMAKOTI, CARLOS PANTANO, University of Illinois — Finite-difference approximations of second-order derivatives involving variable coefficients, as those discretizing subgrid-scale models of large-eddy simulation, are investigated. It is observed that use of the first-order derivative operators successively result in poor resolution and negligible contribution of the subgrid-scale models at the highest wavenumber supported by the mesh. This affects the stability of these simulations negatively. Low and high-order, narrow stencil, numerical discretizations are developed and applied to large-eddy simulation of compressible turbulent flows using the stretched-vortex subgrid scale model. These discretizations are based on a narrow-stencil formulation, which is constructed by requiring that the ellipticity property of the operators, when the variable coefficients are positive, is preserved. Such an approach is found to be discretely conservative, stable, resolves the subgrid model contribution at the smallest wavenumber supported by the mesh better and enables energy transfer from the resolved to the subgrid scales at all discrete modes of the mesh. We investigate the new discretizations in homogeneous decaying turbulence and temporally evolving shear layers.

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