Large eddy simulation of turbulent compressible flows using the characteristic-based split scheme and synthetic inflow boundary conditions

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ABSTRACT

The simulation of high-speed turbulent compressible flows using a numerical method of large eddy simulation (LES) combined with the characteristic-based split scheme (CBS) and inlet conditions generated through a synthetic turbulence method is proposed. The CBS scheme is a unified approach for Computational Fluid Dynamics (CFD) with capability of covering a wide range of flow speeds and types with good stability and accuracy compared with other numerical schemes of the same order. Although LES of incompressible flows combined with the CBS scheme has already been successfully addressed, the compressible extension is not yet covered, been the main contribution of this work. The CBS scheme is employed in a Finite Element Method (FEM) context for space and time discretization using unstructured meshes, allowing the representation of complex geometries. A compressible dynamic Smagorinsky model with anisotropic mesh capabilities and a van Driest damping for near wall eddy viscosity correction is employed in the present work for the compressible LES model. Synthesized isotropic turbulent fluctuations are generated at the inlet plane with prescribed energy spectrum and time correlation is enforced with an asymmetric time filter for unsteady turbulent inflow conditions. Numerical examples are evaluated and compared with results obtained by other authors in order to validate the present methodology capabilities.