Abstract Submitted
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Numerical subgrid-scale modeling of supersonic spatially-developing turbulent boundary layers[1] GUILLERMO ARAYA, HPCVLab, U. of Puerto Rico-Mayaguez, ANDRES TEJADA-MARTINEZ, U. of South Florida, KENNETH JANSEN, U. of Colorado-Boulder — We investigate the performance of numerically implicit subgrid-scale modeling provided by the well-known streamline upwind/Petrov-Galerkin stabilization for finite element discretization of advection-diffusion problems. While its original purpose was to provide sufficient algorithmic dissipation for a stable and convergent numerical method, more recently it has been utilized as subgrid-scale (SGS) model to account for the effect of small scales, unresolvable by the discretization. In addition, here we consider a physics-based SGS model, namely the popular dynamic Smagorinsky model. These two LES modelling efforts are evaluated by direct comparison with a DNS database of adiabatic supersonic spatially-turbulent turbulent boundary layers at high Reynolds numbers ($\mathrm{Re}_{\delta 2} \approx 3{,}000$) based on the freestream velocity, momentum thickness and wall viscosity. The freestream Mach number is 2.5. In all cases, turbulent inflow conditions are generated via the dynamic rescaling-recycling approach (JFM, 670, pp. 581-605, 2011) extended to compressible flows. Focus is given to the assessment of the resolved Reynolds stresses, turbulent heat fluxes and turbulent Prandtl number. Also, the influence of coherent structures on the thermal transport phenomena is scrutinized.

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