Mesh and order (h/p) adaptation methods for scale-resolving simulations of turbulent flows

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ABSTRACT

The rise in data-driven techniques and the industrial need for fast and reliable CFD simulations of realistic turbulent flows has accelerated the quest toward robust numerical methods for scale-resolving simulations of turbulent flows. A tremendous effort and progress has been observed for Reynolds-Averaged Navier-Stokes (RANS) modeling and simulation, some involving robust mesh adaptation techniques (see for example [2]) either using adjoints or feature-based sensors to drive adaptivity. However, for the complexity of realistic turbulent flows where massively separated flows might occur, potentially coupled with shock interaction, RANS modeling alone is unlikely to produce good results. The use of Large Eddy Simulation (LES) models or combinations with RANS offers a good prospect for overcoming this obstacle, as suggested in [1]. Although significant modeling issues remain to be addressed here as well, the progress in HPC hardware makes these scale-resolution techniques more and more realistic. Due to the complexity of the flows, meshing is a major challenge, which favors adaptive techniques such as mesh (*h*) adaptivity ([3,4]) or numerical scheme order *p*-adaptivity ([5,6]). We think such adaptive techniques offer great potential but have not yet seen widespread use due to complex geometries, inadequate error estimation (either in *h* or in *p* or in the *h-p* coupling techniques), high sensitivity of hybrid models to mesh sizes, etc.

The purpose of this mini-symposium is to discuss the challenges and recent developments on automatic mesh (*h*) and *p* or *h-p* adaptation methods for LES and hybrid RANS/LES simulations of complex turbulent flows. We welcome contributors from compressible or incompressible flows simulations communities, hoping for a fruitful exchange between these disciplines. Mesh adaptation techniques, error estimation, and turbulence modeling suitable for adapted meshes are of interest. Possible meshing techniques include AMR and/or unstructured anisotropic mesh refinement methods, while numerical discretization approaches encompass any spatial resolution method: finite volumes, discontinuous Galerkin and related techniques or other relevant schemes.

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