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Comparative Mesh Sensitivity Study of Different Reynolds Averaged Navier Stokes Turbulence Models in OpenFOAM

Authors : Zhuoneng Li, Zeeshan A. Rana, Karl W. Jenkins

Abstract : In industry, to validate a case, often a multitude of simulation are required and in order to demonstrate confidence in the process where users tend to use a coarser mesh. Therefore, it is imperative to establish the coarsest mesh that could be used while keeping reasonable simulation accuracy. To date, the two most reliable, affordable and broadly used advanced simulations are the hybrid RANS (Reynolds Averaged Navier Stokes)/LES (Large Eddy Simulation) and wall modelled LES. The potentials in these two simulations will still be developed in the next decades mainly because the unaffordable computational cost of a DNS (Direct Numerical Simulation). In the wall modelled LES, the turbulence model is applied as a sub-grid scale model in the most inner layer near the wall. The RANS turbulence models cover the entire boundary layer region in a hybrid RANS/LES (Detached Eddy Simulation) and its variants, therefore, the RANS still has a very important role in the state of art simulations. This research focuses on the turbulence model mesh sensitivity analysis where various turbulence models such as the S-A (Spalart-Allmaras), SSG (Speziale-Sarkar-Gatski), K-Omega transitional SST (Shear Stress Transport), K-kl-Omega, γ-Reθ transitional model, v2f are evaluated within the OpenFOAM. The simulations are conducted on a fully developed turbulent flow over a flat plate where the skin friction coefficient as well as velocity profiles are obtained to compare against experimental values and DNS results. A concrete conclusion is made to clarify the mesh sensitivity for different turbulence models.

Keywords : mesh sensitivity, turbulence models, OpenFOAM, RANS
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