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An Analytical Wall Function for 2-D Shock Wave/Turbulent Boundary Layer Interactions

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Abstract : When handling the near-wall regions of turbulent flows, it is necessary to account for the viscous effects which are important over the thin near-wall layers. Low-Reynolds- number turbulence models do this by including explicit viscous and also damping terms which become active in the near-wall regions, and using very fine near-wall grids to properly resolve the steep gradients present. In order to overcome the cost associated with the low-Re turbulence models, a more advanced wall function approach has been implemented within OpenFoam and tested together with a standard log-law based wall function in the prediction of flows which involve 2-D shock wave/turbulent boundary layer interactions (SWTBLIs). On the whole, from the calculation of the impinging shock interaction, the three turbulence modelling strategies, the Lauder-Sharma k-ε model with Yap correction (LS), the high-Re k-ε model with standard wall function (SWF) and analytical wall function (AWF), display good predictions of wall-pressure. However, the SWF approach tends to underestimate the tendency of the flow to separate as a result of the SWTBLI. The analytical wall function, on the other hand, is able to reproduce the shock-induced flow separation and returns predictions similar to those of the low-Re model, using a much coarser mesh.

Keywords : SWTBLIs, skin-friction, turbulence modeling, wall function
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