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Abstract:

Currently most of the high-speed complex turbulent flows are studied through the mean of the Reynolds Averaged Navier-Stokes (RANS) method. For what concerns the turbulence closure, eddy viscosity models are widely employed since they are easy to implement and computationally convenient. In these models a linear dependence of the Reynolds stress tensor on the strain rate tensor is assumed. However, for wall dominated flows with thick boundary-layers, strong shock/boundary-layer interaction and with separation, the assumtion of a linear dependence is not always valid. Therefore, differential Reynolds stress models are important. Unfortunately, the use of second order closure models for the study of such flows has not been widely investigated both because of the numerical stifness and the decreased robustness [1].

For these reasons a Reynolds Stress Model (RSM) [2] has been implemented in the in-house code QUADFLOW. The code solves the Naviest Stokes equation using a finite volume method, the simulations are performed using an AUSMDV Riemann solver for the convective fluxes, the divergence theorem for viscous fluxes and both a fourth order Runge Kutta and first order implicit Euler for time integration. The RSM has been tested in different configurations like two dimensional double wedge flows and three dimensional inlet flows. The results obtained from these simulations [3] show that for transitional flow the prediction provided by the RSM is comparable to that of the SST model and both compare well with the experimental results provided along the center line of the models.

In order to deeper investigate the prediction capabilities of the RSM an experimental campaign has been conducted to collect data from a 15 degrees and a 40 degrees compression corner at Mach number of 6.68 providing attached and separated fully turbulent flow. In addition to measurements along the center line heat fluxes gauges have been placed closer to the edge in the separation region, where three dimensional effects are more likely to occur. The experimental results will be compared with the numerical solution provided by the newly implemented RSM and eddy viscosity models such as the Menter SST k-ω model and the LRR k-ω model.

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