SPALART ALLMARAS TURBULENCE MODEL IMPLEMENTATION IN THE COOLFLUID FRAMEWORK

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In order to describe turbulent flows, Reynolds suggested the decomposition of the flow variables into their mean value and fluctuations. Applying this decomposition to the Navier Stokes equations leads to the Reynolds Averaged Navier Stokes equations (RANS). This is at present one of the best practical ways to account for turbulence in CFD computations, as other methods (among which LES or DNS) are computationally too expensive.

This project aimed at implementing the Spalart Allmaras turbulence model in the VKI's object-oriented multi-physics framework COOLFluiD.

The turbulence model equation was implemented in a similar manner as the governing equations of the flow, using a cell-centered Finite Volume approach for spatial discretization combined with an implicit time integration method.

The model has been tested on the problem of the fully turbulent flow over a flat plate at zero angle of incidence. The boundary layer velocity profile obtained is shown in *Figure 1*. We can see that the computed velocity profile agrees with the analytical solution (given by $u^+ = y^+$) for the *viscous sublayer*. In the *Log-law* region the results deviate slightly from the analytical solution (given by $u^+ = \frac{1}{k}\ln\left(y^+\right) + B$). However, if we apply the *Coles law of the wake* ($u^+ = \frac{1}{k}\ln\left(y^+\right) + B + \frac{2\Pi}{k} f\left(\frac{y}{d}\right)$) with $\Pi = 0.45$ (typical value for a flat plate with zero pressure gradient), we observe that our results follow, very closely, the (corrected) analytical solution.

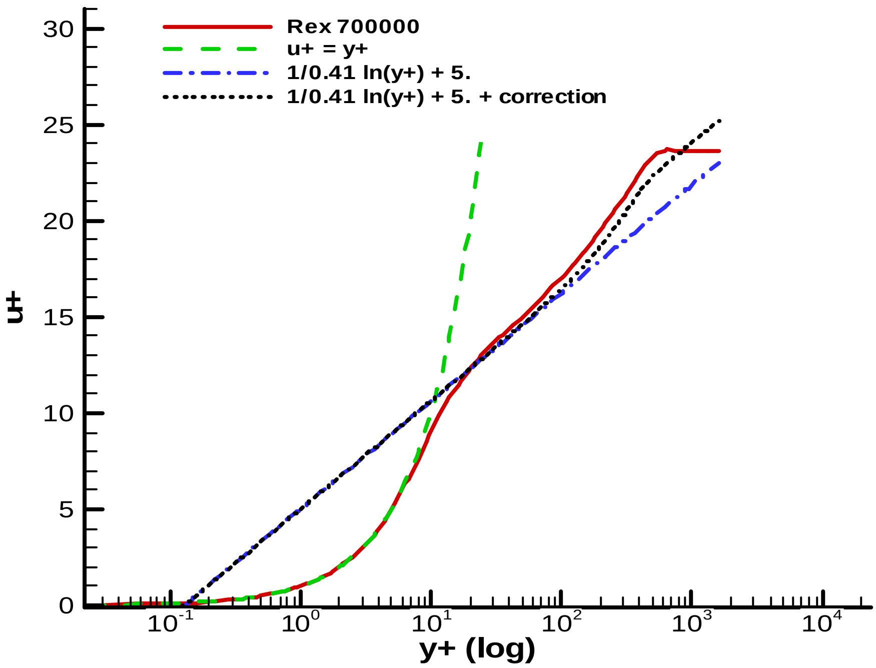

Figure 1: Comparison with analytical results of the turbulent velocity profile for a fully turbulent flow over a flat plate