IMPLEMENTATION OF THE ONE-EQUATION TURBULENCE MODEL OF SPALART & ALLMARAS IN THE CFD PROGRAMME Traf2d

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With growing computational power, the importance of computational fluid dynamics in turbomachinery component design has been increasing over the last years. According to Wilcox (1997) turbulence modelling is - in the field of CFD- one of the three key elements next to grid generation and algorithm development. The need for turbulence modelling arises from the use of the Reynolds-averaged Navier-Stokes equations (RANS), which are until now the only practicable way to describe a turbulent flow field in a complex geometry. Usually algebraic, one- or two-equation or Reynolds stress turbulence models are used for modelling these high frequency fluctuations.

The Traf2d code of Arnone (1988) is used at the von Kármán institute to simulate steady two dimensional flows through turbomachinery cascades. To extent the code's applicability and to improve accuracy of predictions, the one-equation turbulence model of Spalart & Allmaras (1994) is implemented in addition to the existing algebraic Baldwin & Lomax turbulence model. The turbulence model equation is treated in the same way as the governing equations of the flow solver. A finite volume and an explicit time marching integration method is applied. The implementation of the turbulence model is validated on the flow over a flat plate.

The results are in a good agreement with the theoretical predictions. In this case the Spalart & Allmaras model gives slightly better results than the Baldwin & Lomax model, considering the comparison with the classical logarithmic velocity profile (Figure 1). For a more complex geometry the Spalart & Allmaras model reveals convergence problems. The results however show a more physical behaviour especially in the wake of the turbine profile LS89.

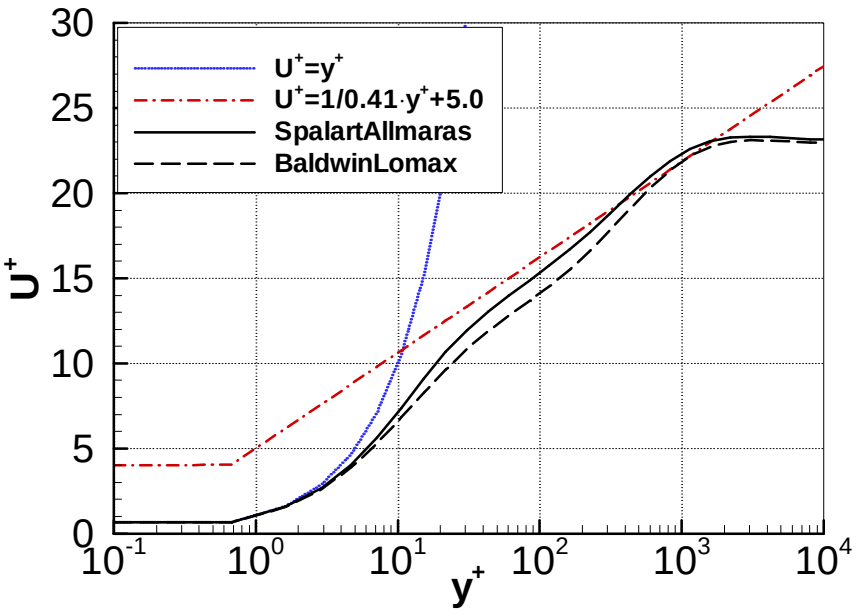

Figure 1: Logarithmic velocity profile in a turbulent flat plate boundary layer; comparison between Spalart & Allmaras model and Baldwin & Lomax model

Arnone, A., Swanson, R. C., "Navier-Stokes solver for cascade flows", ICASE R 88-32, July 1988, 27pgs.
Spalart, P. R., Allmaras S. R., "A one-equation model for aerodynamic flows", La Recherche Aerospitale, Nr. 1, pp. 5-21, 1994.
Wilcox, D. C., *Turbulence Modelling for CFD*, DCW Industries Inc., La Canada, Ca. USA, 1993.