RANS SIMULATIONS FOR AIRCRAFT CONFIGURATIONS USING UNIVERSAL WALL FUNCTIONS

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ABSTRACT

The present investigation explores the applicability of the DLR TAU-code's wall function method for RANS simulations of a 3D wing body configuration. The work emphasises specifically transonic flows under cruise conditions, not too far from the design point, involving shocks, shock induced flow separation and reattachment. The idea of using wall functions is to accelerate the simulations while maintaining a similar level of accuracy. Two-dimensional and three-dimensional well established benchmark flows are modelled and simulated by different RANS turbulence models. Several levels of grid refinement are employed in the wall function approach. Based on the performance observed, best practice settings are retained and novel solutions to observed deficiencies are proposed and implemented. The improvements are successfully applied to 2D flows and contribute to shed light on the complex nature of 3D flows, where a further research effort is required.

RESULTS

The current work is an attempt to continue the research presented in [1]. That paper is dedicated to the adaptive turbulence model specific wall functions and its implementation in TAU. Other aspects of wall functions like the turbulence model specific near wall treatment and aspects of numerical accuracy on wall function methods are described in [2].

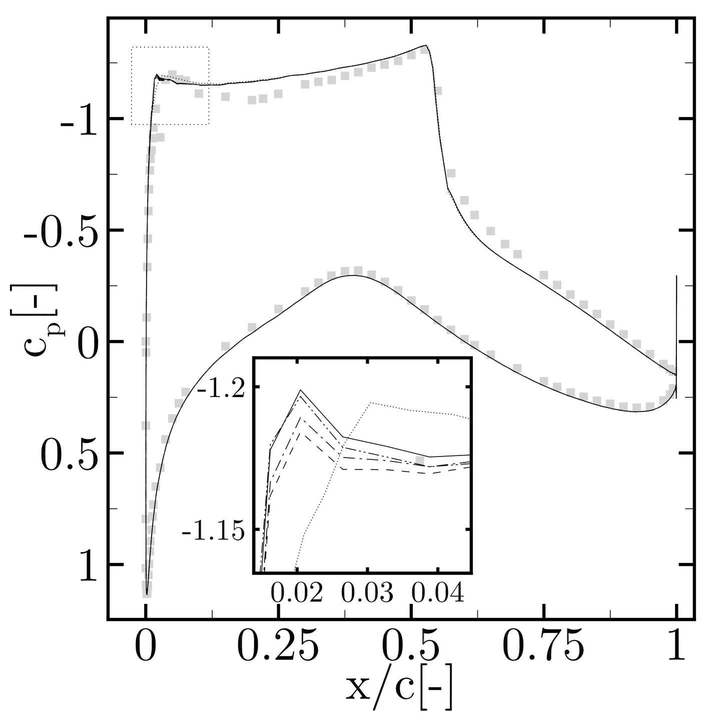

Fig. 1: RAE 2822: c_p distribution for wall function ($y^+ = 50$).

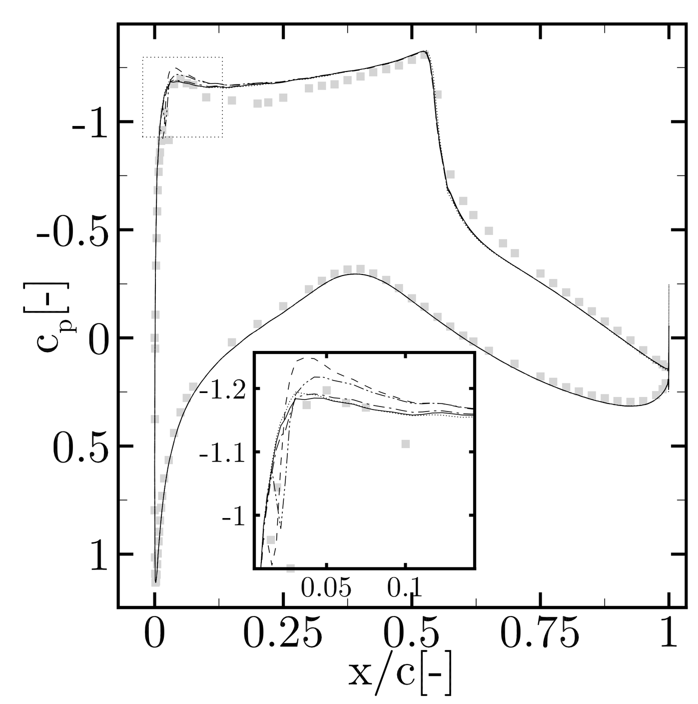

Fig. 2: RAE 2822: c_p distribution for wall function ($y^+ = 100$).

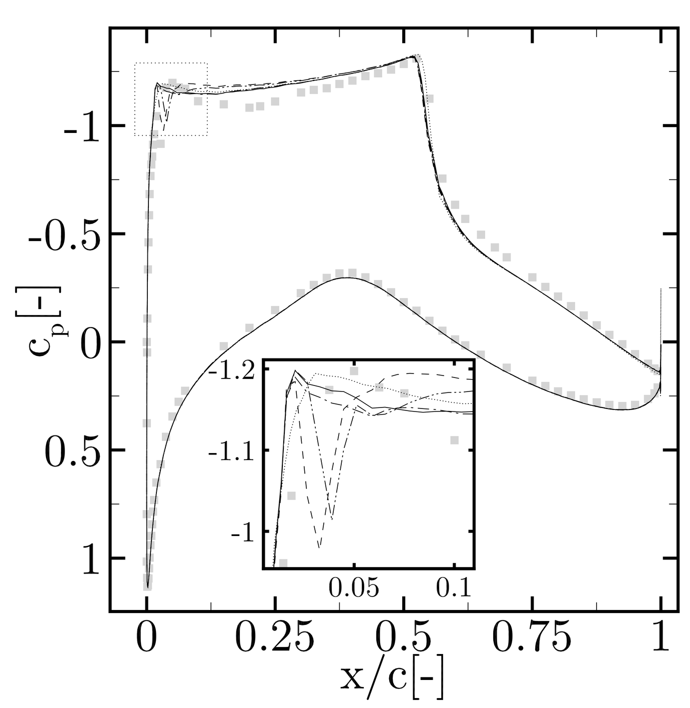

Fig. 3: RAE 2822: c_p distribution for wall function ($y^+ = 200$).

Critical flow regions for the application of wall functions are identified. In the leading edge region the wall function profile is adjusted for low local Reynolds numbers. The generation of turbulence on coarse wall function meshes is fostered by triggering. The proposed modifications are successfully applied in 2D (airfoil RAE2822) and 3D flows (NASA CRM).

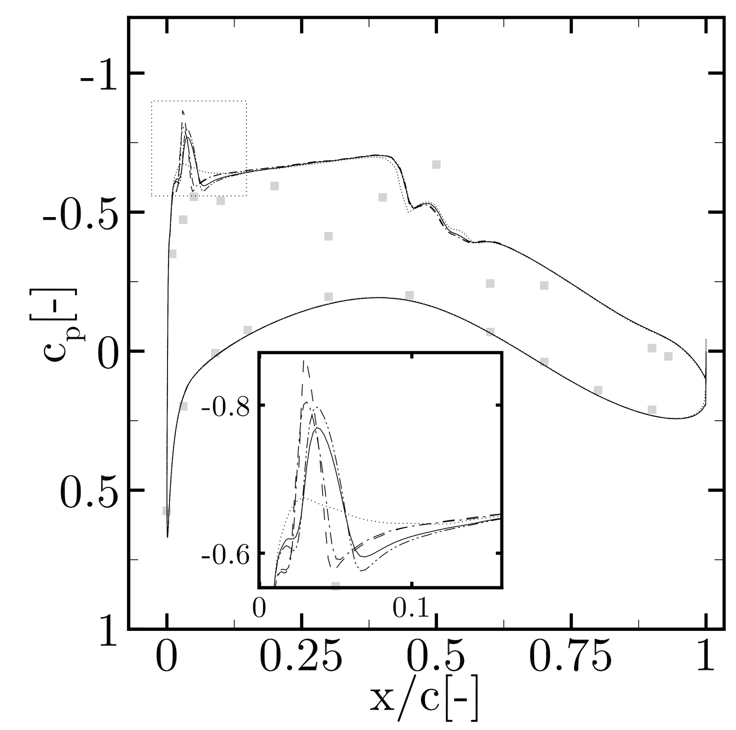

Fig. 4: CRM: c_p plot for & wall function ($y^+ = 50$). End of wing section.

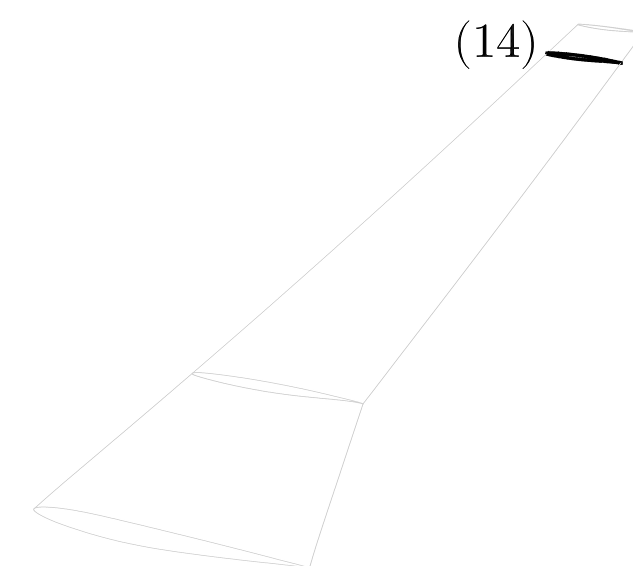

Fig. 5: CRM: Location of the wing section closer to wingtip.

Legend in Figures: reference (······); *original* (−−); *local Re* (-·-·-); *triggering* (-··-); *local Re & triggering* (—). Experimental data (▪).

REFERENCES

[1] T. Knopp. On grid independence of RANS predictions for aerodynamics flows using model-consistent universal wall-functions. *ECCM-ECFD*, 2006.

[2] G. Medic, G. Kalitzin, G. Iaccarino, and E. van der Weide. Adaptive wall functions with applications. *36th AIAA Fluid Dynamics Conference and Exhibit*, 2006.

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