Assessment of turbulence hybrid models with transition modeling for the simulation of massively separated flows

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ABSTRACT

In the proposed communication, several hybrid turbulence models, possibly equipped with transition modeling, are evaluated on the simulation of the flow around a circular cylinder in the supercritical regime and over an airfoil at incidence. The flow through the Caradonna-Tung rotor will complete the benchmarks considered in this study.

The first hybrid approach investigated in this work is the classical Delayed Detached Eddy Simulation (DDES) model. The two other hybrid models combine either a RANS model or the DDES approach with a dynamic variational multiscale large eddy simulation (DVMS) model. A smooth blending function, which is based on the value of a blending parameter, is used for switching from RANS to DVMS in the RANS/DVMS strategy [1]. In the DDES/DVMS approach [2], the DVMS model is preferentially activated in the wake in order to more accurately predict this region of the flow thanks to the low dissipation introduced by this model. With the aim of improving the prediction of the targeted flows, a new $k-\varepsilon-\gamma$ transition model based on the model of Akhter [3] is also developped and used in these hybrid approaches.

Results are compared to those of other RANS, LES and hybrid simulations in the literature and with experimental data, and highlight the overall good prediction capabilities of the proposed hybrid strategies for the simulation of such massively separated flows, with often a significant improvement when the transition model is activated.

REFERENCES

[1] C. Moussaed, M.V. Salvetti, S. Wornom, B. Koobus and A. Dervieux, Simulation of the flow past a circular cylinder in the supercritical regime by blending RANS and variational-multiscale LES models, Journal of Fluids and Structures, Volume 47, 2014, pages 114-123.

[2] E. Itam, S. Wornom, B. Koobus, and A. Dervieux, Combining a DDES model with a dynamic variational multiscale formulation, 12th International ERCOFTAC Symposium on Engineering Turbulence Modelling and Measurements (ETMM12), 2018.

[3] M.N. Akhter, M. Ali and K. Funazaki, Numerical Simulation of Heat Transfer Coefficient on Turbine Blade using Intermittency Factor Equation, 6th BSME International Conference on Thermal Engineering, Procedia Engineering, Vol. 105, pages 495-503, 2015.