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APPLICATION OF HYBRID RANS/LES APPROACHES TO ATTACHED AND MILDLY SEPARATED FLOWS

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ABSTRACT

More than one and a half decade have passed since Spalart et al. [1] proposed the Detached Eddy Simulation based on the Spalart-Allmaras RANS model. Following this, the approach was applied to other RANS models, e.g. based on the k-ω-SST proposed by Travin et al. [2]. Since then Hybrid RANS/LES methods (HRLM) have found an ever increasing interest, which resulted in elimination of some problems found in the early applications of these methods through appropriate improvements, e.g. the Delayed or Improved Delayed DES (DDES, IDDES) and inspired a large variety of methods not restricted to DES-like approaches, but including also other, “seamless” and zonal, methods.

HRLM have generally led to dramatic improvements in the simulation quality of massively separated flows at practically meaningful high Reynolds numbers or made them feasible at all.

While this has made HRLM equally important for many both fundamental and industrial applications with a potential to become a dominant practical CFD approach for the prediction of complex turbulent flows in the foreseeable future, at least one major problem inherent to these methods still remains unresolved. This is the issue known as the “Grey Area” which is that part of the flow domain where the transition between RANS and LES takes place and where despite being in LES mode the flow field does not contain enough resolved turbulence as none is provided by the RANS part. This is only a minor problem in configurations with massive separation and intensive recirculation of separated flow (leading to a strong secondary instability and “feed-back” of turbulent content). Severe consequences arise,

however, in attached flows and those with shallow separation, when HRLM act as Wall Modelled LES (WMLES). Then, an overall turbulence deficit arises, as there is neither sufficient modelled nor sufficient resolved turbulence due to its slow development in LES mode, which in turn can compromise the whole simulation.

A related problem appears at the RANS-to-LES interface in Embedded LES approaches, which can also be considered as a kind of HRLM. In this case it is accompanied by the opposite problem at the LES-to-RANS interface when resolved structures enter the RANS area, where excessive turbulence can result.

Considering the importance of these two problems for the future of HRLM as applied to attached and mildly separated flows, this **Minisymposium** is dedicated to papers on the application of existing approaches and the development of enhanced ones aimed at elimination or at least weakening of the issues outlined above.

REFERENCES

[1] Spalart, P.R., Jou, W.-H., Strelets, M., Allmaras, S.R. (1997) Comments on the feasibility of LES for wings and on a hybrid, RANS/LES approach. In Liu, C. and Liu, Z. (eds) Advances in DNS/LES, Proceedings of 1st AFOSR International Conf. on DNS/LES, Ruston, LA, August, 4-8, Greyden Press, Columbus, OH, 1997, pp. 137-147

[2] Travin, A., Shur, M., Strelets, M., Spalart, P.R. (2002) Physical and numerical upgrades in the detached-eddy simulation of complex turbulent flows. In: Friederich, R., Rodi, W. (Eds.), Fluid Mechanics and its Applications. Advances in LES of Complex Flows, Proc. of EUROMECH Colloquium 412, vol. 65. Kluwer, pp. 239–254.