6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Scale-resolving modeling of convective heat transfer in impinging and separating flows accounting for near-wall turbulence

Benjamin Krumbein and Suad Jakirlic

Institute of Fluid Mechanics and Aerodynamics, Technische Universität Darmstadt, Alarich-Weiss-Str. 10, 64287 Darmstadt, Germany, krumbein@sla.tu-darmstadt.de

Keywords: *Turbulence modeling, Very Large Eddy Simulation, Heat transfer*

Accurate prediction of turbulent convective heat transfer is important in a wide variety of applications including internal combustions engines and exhaust systems among many other examples. Near-wall turbulence phenomena play a crucial role in many of these applications: not only since the turbulent fluctuations are mainly responsible for the mixing process, which affects heat transfer considerably, but also the global structure of the mean flow is distinctly affected by flow features affected by near-wall turbulence. These flow features include for example separation and reattachment, strong streamline curvature, shear layers and secondary flow. Scale-resolving modeling approaches based on LES (Large Eddy Simulation) have proved to be superior to the widely adopted RANS (Reynolds-Averaged Navier Stokes) models in predicting many of the aforementioned flow features, of course at the price of higher computational costs. In this work, a seamless hybrid LES/RANS model combining the advantages of both modeling approaches is employed to simulate several convective heat transfer configurations including channel flow, jet impingement onto a heated wall as well as the thermal mixing of crossing streams in a T-shaped junction. The hybrid model, derived nominally in line with the VLES (Very Large Eddy Simulation) concept of Speziale (1998), employs the advanced elliptic-relaxation-based eddy viscosity model of Hanjalić et al. (2004) as a background model. The RANS models contribution to the effective eddy viscosity is evaluated based on a resolution function formulation of Chang et al. (2014). In addition to the VLES simulations RANS computations employing the underlying eddy-viscosity model are performed, for the purpose of a comparative assessment. The computational results are analyzed along with available reference DNS (Direct Numerical Simulation) and experimental data bases.

REFERENCES

[1] Chang, C.-Y., Jakirlić, S., Dietrich, K., Basara, B. and Tropea, C. (2014), Swirling flow in a tube with variably-shaped outlet orifices: an LES and VLES study, *Int. J. Heat and Fluid Flow*, Vol. 49, pp. 28-42.

[2] Hanjalić, K., Popovac, M. and Hadžiabdić, M. (2004), A robust near-wall elliptic-relaxation eddy-viscosity turbulence model for CFD, *Int. J. Heat and Fluid Flow*, Vol. 25, pp. 1047-1051.

[3] Speziale, C.G. (1998), Turbulence modeling for time-dependent RANS and VLES: A review, *AIAA J.*, 36(2), pp. 173-184.