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WALL-MODELLED LES OF BOUNDARY LAYER SEPARATION FROM A SMOOTH RAMP

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Wall models allow reducing the computational cost of LES of wall-bounded flows and are therefore necessary for simulation of industrial flows at high Reynolds numbers. However, it is known that the performance of wall-modelled LES (WMLES) for flows separating from smooth surfaces is generally unsatisfactory. We are still far from complete understanding of what modifications to the simulation setup and modelling techniques would be necessary to overcome this.

Here, we will present results from WMLES of a turbulent boundary layer separating from a smooth ramp. The simulations contribute to an international effort in advancing the accuracy of WMLES in the framework of a workshop organized by AIAA Fluid Dynamics Technical Committee's LES Discussion Group [2]. The Reynolds number of the separating boundary layer is $Re_\delta = 32\,000$, and the corresponding Reynolds number based on the length of the ramp is $Re_L = 10^6$. The geometry of the ramp is defined by a fifth-order polynomial and follows previous experimental work of Simons et al. [3]

The simulations are performed using OpenFOAM, on a set of five grids ranging in size from ≈ 12 to ≈ 450 million cells. Additionally, the numerical scheme for the convective term is varied, as well as the wall modelling approach. Preliminary results show very strong sensitivity of the size of the separation bubble with respect to the resolution of the grid. With simulations on the two finest grids still in progress, we currently do not see a trend towards grid convergence. This may indicate that the resolution requirements for WMLES of such flows are more stringent than what has been anticipated by the scientific community. In this context, using high-order methods for WMLES is relevant, and we are currently driving associated developments in the spectral-element code Nek5000.

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