A STUDY OF A FLOW AROUND BACKWARD FACING STEP USING LARGE EDDY SIMULATION

Ivo Sládek, Czech Republic
Supervisors: C. Benocci & E. Simons

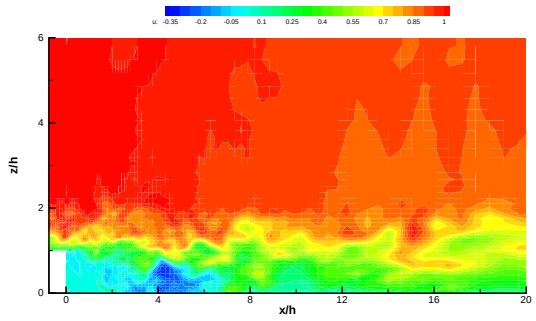
A parametric study of a backward facing step (BFS) flow has been performed using the Large Eddy Simulation approach and the multi domain technique as implemented in an in-house VKI developed code. The main purpose was to evaluate the effect of different approximate wall and inlet BFS boundary conditions as well as the sub-grid scale models. Effect of grid refinement was also studied. As a benchmark, two sets of reference data have been used, namely: numerical DNS for Re=5100 and experimental PIV for Re=5000, where Reynolds number is based on the mean free--stream inlet velocity and step height.

Totally 15 different backward facing step simulations have been carried out using only around 2~\% of grid points downstream of the step compared to DNS case.

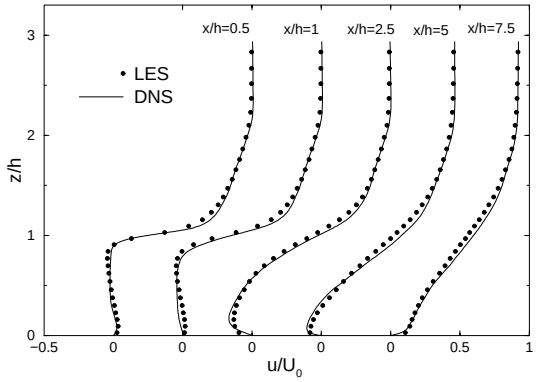
The most important parts of the BFS simulation are the generation of the inlet boundary conditions and the grid resolution. It was found that the refinement of discretization in the streamwise direction is very important to reproduce the DNS solution. Differences caused by different sub-grid scale or wall models are small and less important.

In general, very good agreement was found for velocity components between LES and DNS. However, the underestimations close to step and the overpredictions close to reattachment were found for turbulence intensities and Reynolds shear stress. The skin friction coefficient has shown a good agreement in the recirculation region, but it was overpredicted after the reattachment of the flow.

In the context of a dynamic study of the BFS flow, the vortical structures downstream of the step have been visualized by the application of Moin-Q criterion based on second invariant of the velocity gradient tensor.



Instantaneous contour map of streamwise velocity component



Profiles of mean streamwise velocity component at different positions downstream of the step