Invitation à la soutenance publique de thèse

Pour l’obtention du grade de Docteur en sciences de l’ingénieur et technologie

Madame Ariane FRERE
Master ingénieur civil électronique et énergétique

Towards wall-modeled Large-Eddy Simulations of high Reynolds number airfoils using a discontinuous Galerkin method

Wind turbine and aircraft industries rely on global numerical optimization to reach high performances in ever shorter times to market. Computational Fluid Dynamics (CFD) boost the industrial competitiveness and this can be pushed further by developing more reliable methods. The two main methods are Large-Eddy Simulation (LES) and Reynolds-Averaged Navier-Stokes (RANS). LES resolves accurately a significant part of the unsteady flow, while RANS provides the averaged flow; it is thus dramatically cheaper than LES, and has been the established method in design for decades. Recent needs from the industry motivate the switch to the higher fidelity LES method. However, the computational requirements of wall-resolved LES (wrLES) remain unaffordable for flows at high Reynolds numbers, as in most of the relevant applications.

This work is dedicated to the implementation and validation of wall-modeled LES (wmLES) to drastically reduce the cost. WmLES alleviates the near-wall grid requirement by employing a model to reconstruct the wall shear stress. The developments are made in a Discontinuous Galerkin (DG) framework, chosen for its high accuracy and scalability. The DG wrLES approach is first validated on low Reynolds number airfoils. The DG wmLES approach is then developed and validated on a turbulent channel flow, also providing rules of good practice. It is then applied to the flow over a NACA 4412 airfoil at a high Reynolds number, where it is seen to successfully capture the global flow behavior; thereby inspiring confidence in its potential. Finally, a wrLES computation of the same airfoil allows to evaluate several wall models, and to identify paths for future wmLES developments.

Membres du jury:

Prof. Philippe Chatelain (UCL), supervisor
Prof. Grégoire Winckelmans (UCL), supervisor
Prof. Thomas Pardoen (UCL), chairperson
Prof. Jean-François Remacle (UCL), secretary
Dr. Koen Hielenwaert (Cenaero, Belgium)
Prof. Philipp Schlatter (KTH Royal Institute of Technology, Sweden)
Prof. Martin O.L. Hansen (DTU Wind, Denmark)