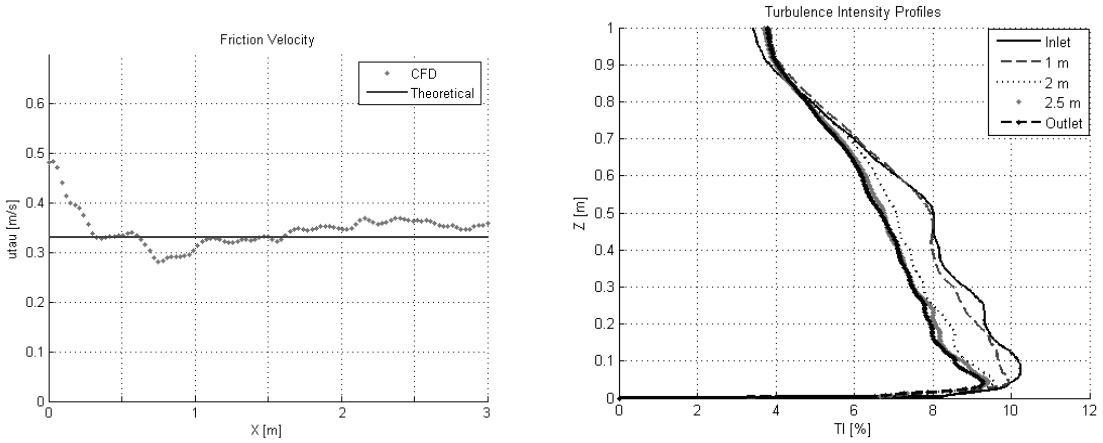
LARGE EDDY SIMULATION OF THE ATMOSPHERIC BOUNDARY LAYER USING OPENFOAM

Lorenzo Lignarolo, Italy
Supervisors: Prof. C. Benocci, A. Parente, C. Gorlé

The present project is part of the effort of the EA department to apply and validate the open source code OpenFOAM for atmospheric flows. The purpose of this specific project is to assess and validate the LES option. This investigation is motivated by the fact that LES represents the most accurate option for the simulation of complex atmospheric flow fields (around a single building, a cluster of buildings, industrial plants etc.). The present project is based on the assessment of two main issues which are of paramount importance for the LES simulation of turbulent flows and, in particular, for the simulation of atmospheric boundary layer (ABL) flows with and without obstacles: the wall function problem and the test of the inflow conditions.

Four different new wall functions have been implemented in OpenFOAM and tested in order to find the best performing one. Performances have been evaluated in terms of horizontal homogeneity of velocity profiles and of value of wall shear stress, which has to be as similar as possible to the theoretical one (the one characterising the logarithmic inlet velocity profile). Once chosen the best wall function, new inlet boundary conditions for ABL flows have been applied and tested in depth; the sensitivity to turbulence length scales and to the turbulence intensity profile shape introduced as inlet condition has been assessed. In each case, numerical and experimental data were available for the validation. The first set of tested inflow conditions was based on data retrieved in the CEDVAL database (measurements in the Blasius Wind Tunnel of Hamburg University of Technology). The second set was based on VKI L1-B measurements of an equilibrium ABL. Some anomalous behaviour of CEDVAL data has been found out, whereas a good horizontal homogeneity of properties has been achieved when using VKI L1-B data.



(a) Friction velocity *(b) Turbulence intensity*

Figure 1: Horizontal homogeneity of properties along the computational domain