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# A high-resolution large-eddy simulation of turbulent flow within and above urban-like canopies

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The urban microclimate is a result of the interactions between regional climatology, morphology of urban fabric and thermo-radiative and hydric properties of the materials constituting the urban surfaces. Modern urban planning tries to compact cities for avoiding spreading of the town area in order to reduce the need of transports. The climatic effects of this politic are not well known yet.

This work is the first step of a study whose main purpose is to propose an urban planning politic which considers the urban heat island within the context of the climate change. Therefore it aims to understand the effects of building configuration on the momentum, heat and humidity turbulent transfers. Urban structures are quite heterogeneous and complex. To analyse the interactions between urban canopies and the atmosphere, the resolution has to be high enough that mean flow characteristics between the buildings can be observed as well as turbulent structures that develop above roof level.

For that purpose, the Large-Eddy Simulation atmospheric model ARPS (Advanced Regional Prediction System) is employed. The subgrid scales are modelled by means of the resolution of an equation for the subgrid-scale turbulent kinetic energy. The version used is this study is based on the developments of Dupont & Brunet (2008) who introduced a drag force approach to simulate the influence of the vegetal covers on the low atmosphere. The application of this model on urban canopies requires adjusting the drag coefficient (Cd) in function of the frontal density (Af) and of the building arrangement. Its dependency on configuration (staggered or aligned arrays) and on frontal density is investigated.

In order to put in light the main characteristics of the flow field and to validate the model in urban configurations, the turbulent flow above arrays of obstacles is investigated here for different arrangements and packing densities. The grid spacing is set to a few tens of meters in both horizontal directions and one meter in vertical direction, within the canopy. Above the canopy, grids are stretched vertically to reach four meters in average. The surface density Af is calculated in function of the geometry of the obstacles present in a grid cell. The effect of Cd values on the turbulent statistics is compared with results from wind tunnel experiments or building resolving simulations. The ability of the model to reproduce the major turbulent organized structures above the canopy and the influence of the building configuration is also studied, in terms of intensity, size and orientation of the structures.

Further research will be done to investigate the effect of configuration of buildings with more complex geometries, like variable building height, on turbulent flow characteristics. To understand the climatologic features of a real city this approach will be completed by the introduction of a parametrization for heat and humidity exchanges inside the canopy.