Geophysical Research Abstracts
Vol. 15, EGU2013-987, 2013
EGU General Assembly 2013

Development of a 1D canopy module to couple mesoscale meteorogical model with building energy model

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The actual global warming, highlighted by the scientific community, is due to the greenhouse gases emissions resulting from our energy consumption. This energy is mainly produced in cities (about 70% of the total energy use). Around 36% of this energy are used in buildings (residential/tertiary) and this accounts for about 20% of the greenhouse gases emissions. Moreover, the world population is more and more concentrated in urban areas, 50% of the actual world population already lives in cities and this ratio is expected to reach 70% by 2050. With the obviously increasing responsibility of cities in climate change in the future, it is of great importance to go toward more sustainable cities that would reduce the energy consumption in urban areas.

The energy use inside buildings is driven by two factors: (1) the level of comfort wished by the inhabitants and (2) the urban climate. On the other hand, the urban climate is influenced by the presence of buildings. Indeed, artificial surfaces of urban areas modify the energy budget of the Earth's surface and furthermore, heat is released into the atmosphere due to the energy used by buildings. Modifications at the building scale (micro-scale) can thus have an influence on the climate of the urban areas and surroundings (meso-scale), and vice and versa.

During the last decades, meso-scale models have been developed to simulate the atmospheric conditions for domain of 100-1000km wide with a resolution of few kilometers. Due to their low resolution, the effects of small obstacles (such as buildings, trees, ...) near the ground are not reproduced properly and parameterizations have been developed to represent such effects in meso-scale models. On the other side, micro-scale models have a higher resolution (around 1 meter) and consequently can better simulate the impact of obstacles on the atmospheric heat flux exchanges with the earth surface. However, only a smaller domain (less than 1km) can be simulated for the same computational time.

To simulate the processes at the micro-scale (building) as well as at the meso-scale (city and surroundings), it is necessary to connect these two types of models. It is proposed here to develop a canopy module able to act as an interface between these two scales. The meso-scale model provides the meteorological parameters to the micro-scale model via the canopy module. The micro-scale model then calculates the influence of the different type of surfaces on the variables and gives its back through the module to the meso-scale model. By simulating in a better way the interactions between the atmosphere and the urban surfaces, the model will enhance the estimation of the energy use by building. The tool produced by this research could be coupled in the future with an urban dynamics model to optimize urban planning in order to improve the sustainability of cities.