3D Modeling of Urban Areas for Built Environment Applications Using Comsol

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Abstract

Building physics aims to study the built environment on several scales: (1) mm-scale: material physics; (2) the m-scale: indoor climate and energy physics; (3) the km-scale: urban physics. Figure 1 provides an overview of these scales. Looking at current use of COMSOL, the most applications seem to be at the material physics scale, some applications at the m-scale, and only very few applications at the km scale. For the latter we refer for example to the Geomechanics Module and the Subsurface Flow Module that are designed for geophysical and environmental phenomena studies. In this paper we present a methodology to build 3D urban area models based on random placed buildings for Built Environment Applications: Step 1, creating 3D urban area geometries using COMSOL with MATLAB® script. Several types of urban areas ranging from low to high building densities can be build on scale of order ~1 km^3. Figure 2 shows a typical result. Step 2, Application of these geometry models. In this case our aim is to simulate the wind velocities in the urban area. The model of step 1 is loaded into COMSOL. The necessary physics is added to simulate wind velocities. The Spalert-Allmaras (SA) turbulent flow model turned out to be suitable for this kind of application. Furthermore, the inlet conditions were taking from a standard atmospheric boundary layer and a CFD controlled standard (coarse) meshing was used. With these quite simple settings we were able to get stable simulation results. Figure 3 shows the simulated velocity field. The full paper will include more detailed results of the above mentioned methodology. Furthermore it will include practical results of the method, i.e. the maximum scale, the maximum amount of buildings, accuracy of the turbulent models, etc. We conclude that the presented methodology is promising for 3D Modeling of Urban Areas for Built Environment Applications.

Reference

1. HAMLab (2012), http://archbps1.campus.tue.nl/bpswiki/index.php/Hamlab.
2. CFD-online (2012) http://www.cfd-online.com/Wiki/Main_Page.

Figures used in the abstract

Figure 1: Relevant scale levels for Building Physics.

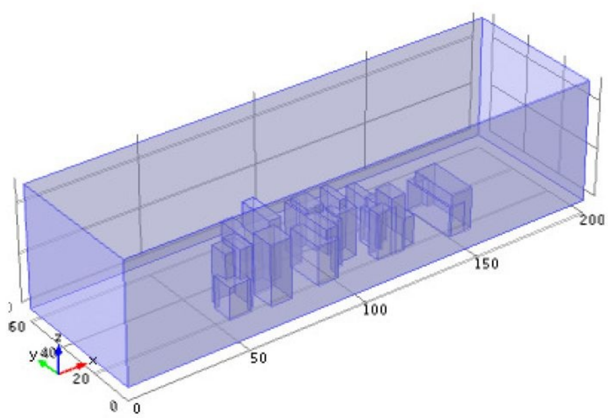

Figure 2: Geometry model of urban area with random placed buildings.

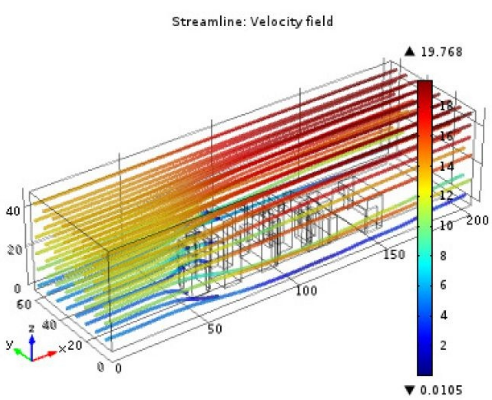

Figure 3: The simulated wind velocity field.