TECHNICAL UPDATE

AUGUST 2017

http://www.telegraph.co.uk/sponsored/china-watch/culture/12212269/G20-summit-in-Hangzhou.html
Photo: provided to China Daily

AUTOMATIC GENERATION OF A 3-D UNSTRUCTURED MESH OF AN URBAN ENVIRONMENT

Work generated for the MAGIC and LoHCool Projects by
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CONTEXT

Numerical simulations are widely used as a predictive tool to understand the three-dimensional complex air flows and pollution concentrations at the building, block, borough and city scales. Results from CFD can assist planning emergency responses and assessment of potential impacts. In such context, the need to generate more realistic computational domains for urban atmospheric flow is crucial to have more accurate CFD results and to enforce proper boundary conditions in the flow solution.

Computational meshes for urban flow simulations require an idealised geometrical description to answer the need of numerical strategies. The geometric model must preserve the main features influencing the flow while removing smaller features that cannot be physically modeled. The main task is to generate an appropriate - but accurate - mesh of an urban environment, suitable for CFD simulations.

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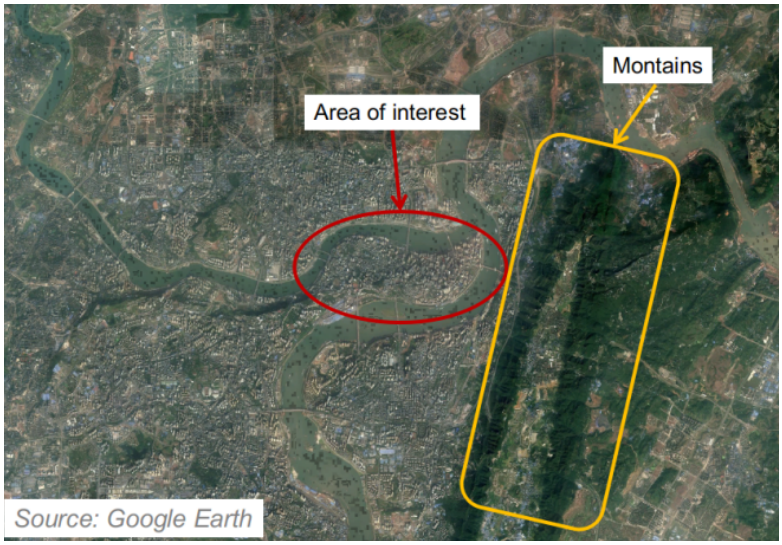

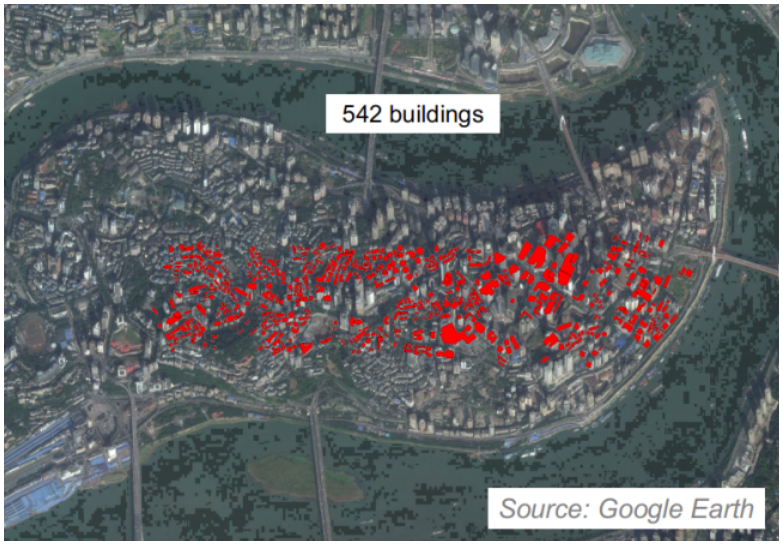

Figure 1: Top- The area of interest in Chongqing, China: Yuzhong district. Bottom- 542 buildings are modelled.

Data was collected during a field survey made by Chongqing University and the final model of buildings was gratefully given by the University of Reading in the context of LoHCool project.

AUTOMATIC MESH GENERATION WITH ELEVATION FOR CFD SIMULATIONS

An automatic tool to generate three-dimensional unstructured mesh of an urban environment, including the elevation of the terrain, has been developed. This tool is based on existing geographical data. The elevation model data are extracted from Google Earth (WSG84 coordinate system). Buildings are stored in a shapefile format. A shapefile consists of a 2D representation of buildings footprints where each footprint is associated with its height.

CASE STUDY AREA IN CHINA (LOHCOOL PROJECT)

The automatic tool developed to generate the mesh was successfully applied for two areas in China. The first area is the Yuzhong district in Chongqing (Figure 1). The area of interest - with the elevation of the terrain - was successfully modelled as shown in Figure 2. The second area is the Zhejiang university in Hangzhou (Figure 3). The CFD software FLUIDITY (http://fluidityproject.github.io/) is used to predict the turbulent air flows (Large Eddy Simulation (LES) method), pollution concentrations and temperature distributions. Figure 4 shows the velocity field on a slice at 10m height from the ground and the pressure field along the facade of buildings. Figure 4 highlights that the generated mesh can be used for CFD simulations.

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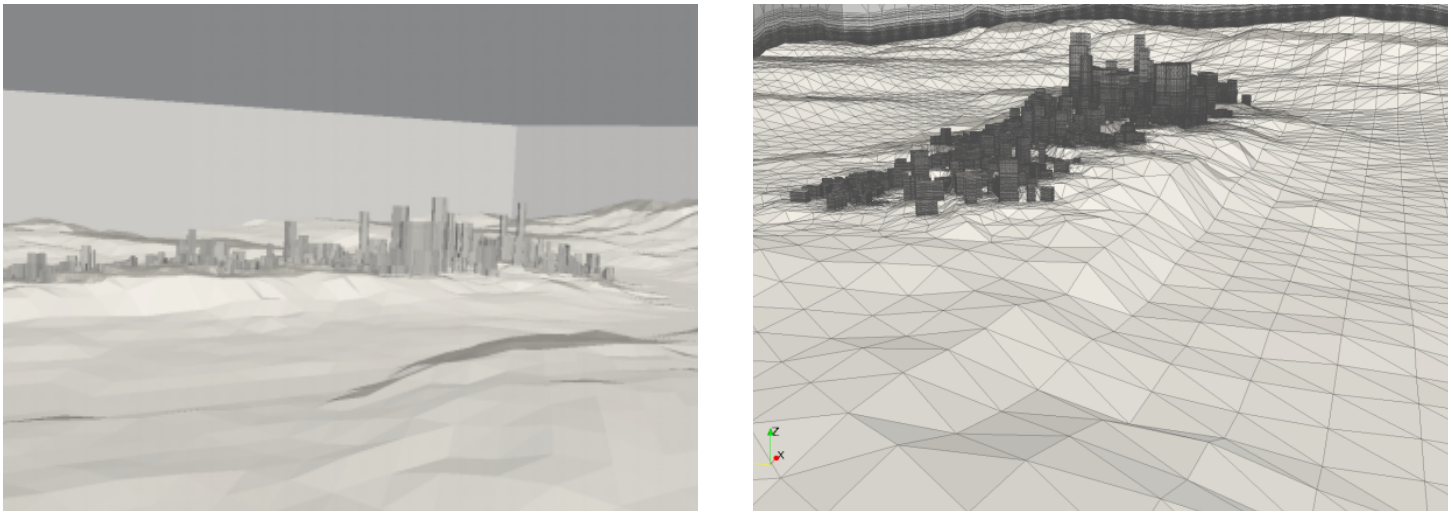

Figure 2: 3-D geometry with the elevation of the terrain for 542 buildings in Yuzhong district (Chongqing, China).

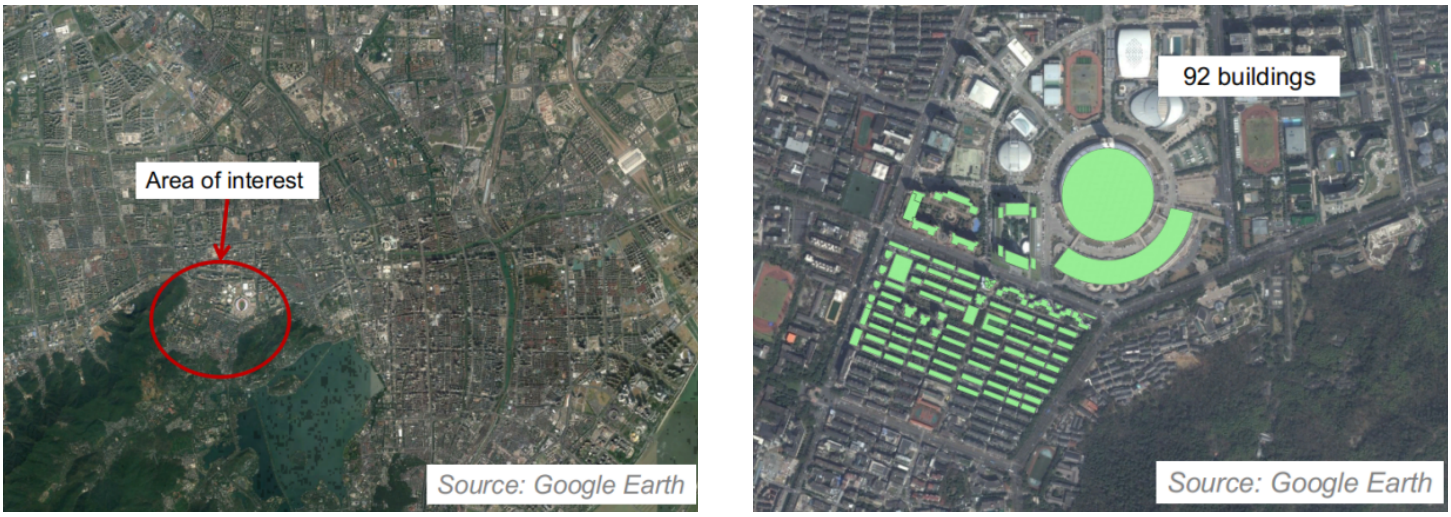

Figure 3 - Left: The area of interest in Hangzhou, China: Zhejiang University. Right: 92 buildings are modelled. Data provided by Zhejiang University in Hangzhou in the context of LoHCool project.

THE LOHCOOL PROJECT

The Low Carbon Climate-Responsive Heating and Cooling Cities (LoHCool) project concentrates on recovering value from the existing urban building stock in the challenging hot summer and cold winter zone of China (Chongqing and Hangzhou).

The main objectives of the project are: 1 - Increase understanding and knowledge of the variety existing in the built environment, the fundamental building types, their urban settings, their microclimates, their energy systems, their occupants' thermal comfort aspirations; 2 - Diagnose and analyse fundamental issues of current performance and 3 - Invent and catalogue climate-responsive, performance-improving re-engineering and refurbishment solutions for heating and cooling.

The LoHCool project is a collaboration between the University of Cambridge, the University of Reading and Loughborough University from the UK, and Chongqing University and Zhejiang University from China.

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