Abstract. We present a robust and automatic method to generate an idealized surface geometry of a city landscape ready to be meshed for non-viscous flow simulations. The city geometry is idealized and reproduces the topography and the city blocks. Our method needs three main steps. First, a 2D mesh of the cadastre is generated. Second, 2D mesh is deformed to reproduce the topography according to a least-squares criterion. Third, we extrude the city blocks according to the height of the corresponding buildings. Finally, we illustrate the main application of our method by obtaining a surface representation and a tetrahedral mesh for the city of Barcelona in Spain.

Problem statement

City streets and blocks: Barcelona cadastre

City topography: Barcelona
Digital Elevation Model (DEM)

City details: Barcelona Light Detection And Ranging (LiDAR)

Requirements

- **Detail removal.** City surface models may contain features such as cars, trees and other elements that have to be ignored by the final mesh.
- **Streets and buildings.** The fluid flow will be determined by the distribution of the city streets, which are defined by the surrounding buildings.
- **Topography.** The slope of the city underlying terrain influences the flow results and therefore, has to be captured by the simulation geometry.
- **Automation.** Reduce tedious, time-consuming and error-prone human intervention.
- **Element count.** Critical in daily operational frameworks, such as air quality forecasts, to deliver simulation results timely.
- **Surface marks.** Features such as urban surface, buildings or pollutant emission inventories have to be marked on simulation geometry.

References


Methodology and results: Barcelona area

1. **Incorporate city block limits (planar mesh):**
   - Set the desired sizes for the 1D, 2D and 3D mesh entities.
   - 1D mesh of the cadastre of desired size.
   - 2D planar triangular mesh [1] constrained to the 1D mesh.

2. **Incorporate underlying topography (surface mesh):**
   - Deform the previous 2D mesh to accommodate the topography (DEM) under a least-squares criterion.
   - This mesh is conformal with the cadastre blocks.

3. **Generate the geometry representation of the urban area (surface mesh):**
   - We duplicate the block boundary nodes to insert city block facades and roofs.
   - Roof heights computed as the average block heights from the LiDAR data.
   - The output is a surface mesh representation of the urban area geometry.
   - Number of nodes: 1M. Number of elements: 2M. Computational time: 113 sec.

4. **Generate the tetrahedral mesh for non-viscous flow simulation (volume mesh):**
   - We generate a tetrahedral mesh [2] bounded by our geometry representation of the urban area.
   - We check and optimize [3] the quality of the obtained meshes.
   - Number of nodes: 10M. Number of elements: 60 M. Computational time: 104 min.