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Large Eddy Simulation of Urban Flows in an idealized fractal Model City

Velocity, Turbulence, Darcy's Law

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Abstract

The majority of human activities and their impacts (e.g. pollution emission) takes place in the lowermost part of the atmosphere, especially in the extensively growing cities. Knowledge about the flow field and its modification through urban areas is essential for numerical weather and air quality predictions. The questions, how to describe an urban area, and how to parameterise its impact on the atmosphere in numerical prediction models must be considered.

In our work, we treated a city as a porous medium with a fractal geometry. We created an idealised model city (cf. Fig. 1) out of the Sierpinski triangle, a self-similar fractal with a fractal dimension of ≈1.585, and implemented it in EULAG using the immersed boundary method.

In analogy to Darcy's law, which describes the flow through a porous medium at low Reynolds numbers, we seek the relationship between the mean horizontal flow and the horizontal pressure gradient [1] for our high Reynolds number (turbulent) flow.
A series of numerical simulations of the turbulent flow through the Sierpinski city was conducted for different flow speeds and different building heights.
They indicate, that the modified Darcy's law is valid for the turbulent flow through the fractal model city.

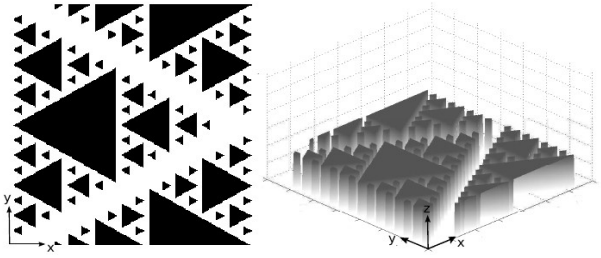

Figure 1: Idealised model city, which was created from the fractal Sierpinski triangle. Domain size is 12.75 m x 12.75 m x 3.2 m.