Modelling flows through canopies with immersed boundary methods

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ABSTRACT

Since the early nineties of the last century, large-eddy simulations of the flow through canopies usually treat the vegetation as a horizontally uniform body with a constant drag coefficient, e.g. [1-3]. As a result, these studies concentrate on the mean impact of the canopy on the flow structure above and behind it. Only recently, attempts were made to simulate canopies using a plant-scale representation [4]. Here, we describe an alternative computational approach for simulating canopy flow with, in principle, arbitrary geometrical distribution of trees. Recent advances in active remote-sensing to map the detailed forest structure (crown height, stem distribution etc) [5] might open a new avenue to deliver a realistic 3D-forest topology as input fields for numerical simulations.

In this paper, we apply the multiscale geophysical flow solver EULAG [6] using the immersed boundary method [7] to simulate flow through and above a canopy in the neutrally stratified boundary layer. For simplicity, the canopy is treated a porous media where the stems and branches are modelled as randomly distributed solid obstacles for the flow. Within the solid, the repelling forces attenuate the flow to stagnation in a short time compared to the characteristic time scale of the flow through the forest. Results of the flow structure above and behind as well as inside the canopy are presented for forests of different density, height and horizontal extension.

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