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SHORT ABSTRACT

Abstract title: Refining Urban Wind and Pollutant Dispersion Modelling: From Raw Lidar Data to CFD Models

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Abstract text *(maximum 350 words.)*

Predicting both wind patterns and atmospheric dispersion of pollutants is challenging in urban areas because of the complex urban canopy. Firstly, obtaining a realistic urban geometry suitable for flow models is difficult. Secondly, the flow simulations require a computational grid fine enough to capture the details in individual buildings but also large enough to cover relevant atmospheric flow scales in urban areas. Thirdly, there is a common lack of validation data that matches the capacity of the models. In this work, we propose a workflow that quantifies the uncertainty of each of these challenges, which will help us understand the limitations of the modelling approach.

The approach is tested in a single-building experiment conducted on the Risø Campus, part of the Technical University of Denmark (DTU). Situated on gently sloping grassland with simple inflow conditions, the building is meticulously scanned using data from a national aerial-lidar campaign and a terrestrial-lidar using a Leica Total Station. This allows for two levels of detail in the building representation. Subsequently, these data are converted to a three-dimensional geometric surface model using the software City3D [1], with several pre- and post-processing steps. Concerning the second challenge above, we use a novel implementation of the immersed boundary method within the Reynolds Averaged Navier Stokes (RANS) solver EllipSys3D [2] to study the flow around the defined geometry. The dispersion is modelled by solving a transport equation for a passive tracer. A model grid study is conducted to verify the

implementation and quantify the numerical errors in the simulation. Finally, the model is validated using DTU Short Range WindScanners [3], providing detailed spatial resolution of the flow. In a comprehensive discussion, we thoroughly analyze and compare the differences between the simulation and the validation data.

In summary, this research demonstrates a systematic approach that spans the entire process of flow and dispersion modeling in an urban context—from lidar data integration to CFD modelling, including robust verification and validation. Moreover, it highlights the key elements needed for increasing the reliability of urban flow and dispersion simulations.

References

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