LES OpenFOAM and ELMM model simulations of a scalar transport and dispersion within the 3D street canyon structure

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In this study, we present the results obtained from a series of high-resolution Large Eddy Simulations (LES) carried out on a 3D street canyon structure depicting a small part of a larger 3D urban array domain. Our work consists of wind-tunnel experiments, large eddy simulations, and subsequent analysis of turbulent flow and scalar transport within the street canyon. This work is associated with the scientific project named "The role of coherent structure's dynamics on scalar transport and dispersion in the urban canopy layer".

The complete set of high-resolution LES simulations is performed by the two different open-source computational fluid dynamics (CFD) models, namely, OpenFOAM and ELMM. Moreover, the domain geometry and configuration are based on the work previously published by Nosek et al., 2018[1], and Kluková et al., 2021[2]. The domain configuration is identical for most of the simulations, and encompasses a single street canyon, thus allowing us to explore the dispersion and transport of the scalar quantity in large detail.

As a first result of our work, we present the qualitative and quantitative comparison of the conducted LES models simulations against the experimental data obtained in the wind tunnel measurements. Secondly, we investigated the differences in performance and capabilities of the used CFD models to capture the turbulent flow within the utilized street canyon. In addition, to detect and analyze the relationship between the coherent structures' dynamics and the scalar within the simulated 3D street-canyon structure we apply the Proper Orthogonal Decomposition (POD) and Dynamic Mode Decomposition (DMD) and present the results from the mentioned analysis as well.

The results acquired in this experiment serve to a better understanding of the scalar transport and dispersion within the complex geometries, i.e., urban areas, and more importantly, show the influence of the urban flow coherent structures on the scalar transport. Moreover, the results display the model's competence to capture and resolve the turbulent flows when applied and used for investigation of this, and similar scientific problems.

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[1] Nosek et al., *Build. Environ.* **138**, 221 (2018).

[2] Kluková et al., *J. Wind Eng. Ind. Aerodyn.* **280**, 104468 (2021).