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A Three-Dimensional (3D) Numerical Study of Roofs Shape Impact on Air Quality in Urban Street Canyons with Tree Planting

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Abstract : The objective of this study is to investigate numerically the effect of roof shaped on wind flow and pollutant dispersion in a street canyon with one row of trees of pore volume, Pvol = 96%. A three-dimensional computational fluid dynamics (CFD) model for evaluating air flow and pollutant dispersion within an urban street canyon using Reynolds-averaged Navier–Stokes (RANS) equations and the k-Epsilon EARSM turbulence model as close of the equation system. The numerical model is performed with ANSYS-CFX code. Vehicle emissions were simulated as double line sources along the street. The numerical model was validated against the wind tunnel experiment. Having established this, the wind flow and pollutant dispersion in urban street canyons of six roof shapes are simulated. The numerical simulation agrees reasonably with the wind tunnel data. The results obtained in this work, indicate that the flow in 3D domain is more complicated, this complexity is increased with presence of tree and variability of the roof shapes. The results also indicated that the largest pollutant concentration level for two walls (leeward and windward wall) is observed with the upwind wedge-shaped roof. But the smallest pollutant concentration level is observed with the dome roof-shaped. The results also indicated that the corners eddies provide additional ventilation and lead to lower traffic pollutant concentrations at the street canyon ends.

Keywords : street canyon, pollutant dispersion, trees, building configuration, numerical simulation, k-Epsilon EARSM
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