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Effect of trees on street canyon ventilation

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Due to the overall growth of the world population and to the progressive shift from rural to urban centres, 70% of the world population is expected to live in urban areas in 2050. This trend is alarming when related to the constant decline of urban air quality at the global level. To cope with this rapid urbanization, solutions for sustainable cities are extensively sought. In this framework, the mitigation of air pollution in street canyons plays a crucial role. The street canyon (a street flanked by high buildings on both sides) is the fundamental unit of the urban tissue, as well as a vital public and residential space. Street canyons are particularly vulnerable to air pollution due to traffic emissions, low ventilation conditions, and the number of citizens exposed. Tree planting in street canyons is often used as a pollution mitigation strategy, due to the filtering effect of vegetation on airborne pollutants. However, from the aerodynamic point of view, trees can obstruct the wind flow thus reducing canyon ventilation and leading to higher pollutant concentrations. In this framework, we present the results of an experimental study aimed at evaluating how tree planting influences the flow and concentration fields within a street canyon. The study was carried out in a recirculating wind tunnel. An idealised urban district was simulated by an array of square blocks, whose orientation with respect to the incident wind was varied. Within this urban geometry, two rows of model trees were arranged at the sides of a street canyon. Three configurations with different spacing between the trees were considered. A passive scalar was injected from a line source placed at ground level to simulate traffic emissions. Concentration and flow field measurements were performed in several cross-sections of the street canyon. Results showed the effect of trees on the spatial distribution of pollutants. Moreover, a characteristic exchange velocity between the street canyon and the overlying atmosphere was estimated to quantify the overall canyon ventilation under several wind directions and different planting densities. These preliminary results provide city planners with first recommendations for the sustainable design of urban environments. Moreover, the experimental dataset is valuable in validating numerical simulations of air pollution in cities accounting for urban vegetation.