

Influence of trees in urban street canyons on the dispersion of vehicle exhausts

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The effective dilution and removal of traffic released pollutants is of extreme significance for the health of people living in cities. Pollutant dispersion processes in narrow urban street canyons are dominated by vortex structures, generated by the interaction of buildings with the atmospheric wind and are well understood for empty, obstacle-free street canyons. However, to what extent the natural ventilation is modified or limited by an avenue-like tree planting inside the canyon has not been investigated so far and is the topic of the present study.

In boundary layer wind tunnel studies, pollutant dispersion processes have been investigated inside an isolated urban street canyon model with various avenue-like tree planting configurations. The model setup consists of two parallel rows of houses forming the canyon and one row of model trees placed at the canyon center axis. A tracer gas emitting line source at street level was used to simulate vehicle exhaust emissions. Additionally, the influence of traffic-induced turbulence on the exhaust dispersion was simulated by means of small plates mounted on belts rotating along the street axis.

Flow and concentration measurements have been performed in the presence of a simulated atmospheric boundary layer wind approaching perpendicular to the street axis. Significant impacts of tree plantings on the pollutant dispersion inside the urban street canyon were found. Vortex structures typical for empty street canyons were inhibited to develop or considerably reduced in strength. High rises in pollutant concentration were observed in the canyon middle part at the leeward wall and at the street ends towards the neighboring intersections. However, paying attention to some design rules concerning the planting, like providing sufficient large tree spacing and limiting the crown size, the problem of pollutant concentration increases can be essentially mitigated. Examples and guidelines for planting configurations allowing for sufficient natural ventilation and adequate pollutant dispersion will be presented.

Keywords: urban trees, pollutant dispersion, urban street canyon, urban air quality, traffic exhausts, suppression of canyon vortex