

Title: Urban Ventilation Dependence on Geometric Configuration

Author: RNDr. Ing. Libor Kukačka

Department: Department of Atmospheric Physics

Supervisor: prof. RNDr. Zbyněk Jaňour, DrSc., Academy of Sciences of the Czech Republic, Institute of Thermomechanics, v. v. i.

Abstract: The main goal of the thesis is to investigate the impact of urban geometry on the urban ventilation using wind-tunnel modelling. To measure the pollutant transport, both advective and turbulent, within complex urban geometries with a high temporal resolution a special measurement method was developed. At first, the pollution of a simplified urban area was simulated by a ground-level point source and the ventilation of the intersection with respect to four wind directions was studied. Later, the pollution of other simplified and complex urban areas was simulated by a ground-level line source and the ventilation of three different street canyons with respect to wind direction perpendicular and oblique to their along-canyon axis was investigated. The clear impact of urban complexity and wind direction on street canyon ventilation is demonstrated at lateral and top openings of all investigated canyons and the intersection. Whilst the dominance of the pollutant advection is demonstrated at the eaves of pitched roofs, at the roof ridges the turbulent transport clearly dominates irrespective of the urban complexity and wind direction. For turbulent pollution fluxes, coherent structures were identified, and new nomenclature is introduced for assessment of the ventilation. A high correlation with analogical structures known in turbulent momentum flux is demonstrated for all investigated openings. The thesis improves the current knowledge about the characteristics of the flow and dispersion within real urban areas.

Keywords: Air pollution, Atmospheric boundary layer, Wind tunnel modelling, Urban area ventilation, Pollution fluxes, Street canyon, Street intersection