Variability of particle concentrations in a street canyon due to ambient meteorology

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Street canyons are known as hot-spots of particulate and gaseous pollutant concentrations within cities. This is due to large near-surface emissions from the traffic fleet together with limited dispersion within the built environment. While the flow regime within street canyons has been studied for a while, less is known about the dispersion and vertical variability of particles in street canyons and their relation to ambient meteorology.

During CAPAREX (Canyon Particle Experiment) meteorological and turbulent parameters as well as particle concentrations were studied for a one-month period in Essen, Germany. The site is characterised by a height (H) to width ratio of 0.8 and a considerable traffic intensity of 49,000 cars 24 h^{-1}. Measurements were performed in July/August 2005 and consisted of 5 levels of sonic anemometers and 3 levels of optical particle counters. Particles were measured as mass and number concentrations at the non-dimensional heights of z/H = 0.14, 0.24 (mass only) and 0.51 in the size range from $0.3 < D_P < 10$ μm.

During ambient flow directed perpendicular to the street canyon axis a vortex circulation inside the canyon develops. Depending on the measurement site being situated on the upwind or downwind position within the canyon, significant variations in canyon particle concentrations were observed. During downwind situations PM_1 concentrations were higher by a factor of 1.8 compared to upwind situations. Also a size-dependent dynamical behaviour within the canyon was found which was influenced by ambient meteorology, e.g. an increase of particles concentration of $D_p > 1\mu$m during enhanced turbulence.

The vertical distribution of particles with height in the canyon is quite homogeneous on average. However, in the upper part of the canyon concentrations decrease due to enhanced turbulence and mixing.

A future campaign to study the dynamics of ultrafine particles within the canyon is planned.