Spatial - temporal variability of particle number concentrations between a busy street canyon and the urban background

V. Dos Santos-Juusela[1], T. Petäjä[1], A. Kousa[2], and K. Hämeri[1,3]

[1] Department of Physics, University of Helsinki, P.O. Box 64, FI-00014 Helsinki, Finland
[2] Helsinki Region Environmental Services Authority HSY, P.O. Box 100, FI-00066 HSY, Helsinki, Finland
[3] Finnish Institute of Occupational Health, Topeliuksenkatu 41 A, FI-00250 Helsinki, Finland
Keywords: Ultrafine particles, Helsinki, street canyon, spatial variations.
Presenting author email: vanessa.dossantos-juusela@helsinki.fi

Road traffic is a major source of airborne ultrafine particles (UFP, diameter < 100 nm) in urban areas. As these particles concentrate close to the sources, their number can vary considerably from site to site (Seinfeld and Pandis, 2006). Since exposure to UFP is suspected to cause serious adverse health effects (Franck et al., 2011, Oberdörster et al., 2004), understanding the spatial-temporal variations of UFP in urban areas is of great importance, especially for epidemiological studies. We evaluated the spatial-temporal variations of UFP by measuring particle total number concentrations (PNC) continuously in a busy street canyon and an urban background site of Helsinki, from 20.01 to 10.06.2010, using condensation particle counters. In addition, we evaluated the influence of roof-top wind speed, wind direction and temperature on PNC inside the street canyon, as well as the correlation between PNC and PM_{10}, $PM_{2.5}$ and black carbon (BC).

We found that the median PNC in the street canyon (16 500 cm^{-3}) was 3 times higher than in the urban background (5 300 cm^{-3}) for 1-min time series, and were moderately correlated (R^2 = 0.50, for 1-hour medians time series). The peak median number concentration in the street canyon during the morning rush hours was 40 200 cm^{-3} while in the urban background it was nearly 5 times lower, 8 400 cm^{-3}. The analysis of meteorological conditions showed that PNC in the street canyon were inversely proportional to wind speed and temperature, and highly dependent on wind direction. The highest concentrations were during northeastern winds and the lowest during southwestern winds. As both directions are perpendicular to the street axes, we speculate that the higher PNC during northeastern winds may result from wind vortex formation inside the canyon, as suggested by previous studies. The PNC in the street canyon were best correlated with black carbon (R^2 = 0.78) than with $PM_{2.5}$ (R^2 = 0.34) or PM_{10} (R^2 = 0.05) for 1-hour medians of weekdays. The result was expected since $PM_{2.5}$ and PM_{10} are also affected by sources other than traffic, such as long range transport and street dust.

The results confirm that the combination of high traffic intensity and slow dispersion rates in the street canyon yield in PNC considerably higher than the urban background levels. This indicates that people spending time in the street canyon are exposed to considerably higher UFP concentrations than people spending time in the urban background. Thus, air pollution hotspots should be considered in epidemiological evaluations.

The aerosol data was partly produced in the MMEA Programme (Measurement, Monitoring and Environmental Assessment). MMEA is supported by TEKES (the Finnish Funding Agency for Technology and Innovation) and coordinated by the Finnish energy and environment cluster – CLEEN Ltd. We would like to thank the Helsinki City Planning Department for providing the traffic data and Pasi Aalto for providing the technical support.

Franck, U., Herbarth, O., Röder, S., Schlink, U., Borte, M., Diez, U., Krämer, U. & Lehmann, I. 2011. Respiratory effects of indoor particles in young children are size dependent. *Science of the Total Environment,* 409**,** 1621-1631.

Oberdörster, G., Sharp, Z., Atudorei, V., Elder, A., Gelein, R., Kreyling, W. & Cox, C. 2004. Translocation of inhaled ultrafine particles to the brain. *Inhal Toxicol,* 16**,** 437-45.

Seinfeld, J. H. & Pandis, S. N. 2006. *Atmospheric chemistry and physics : from air pollution to climate change,* Hoboken, Wiley