Study of ultrafine aerosol particles in different urban environments

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Ultrafine aerosol (particles with a mobility diameter <100 nm) plays an important role in urban environments due to the increased environmental and health risks related to these particles. Our objective was to study the fundamental properties of these particles such as formation and growth processes, including health effects. For the determination of spatial variability, measurements were performed at different sites in Budapest, including an urban (city centre), a special vehicular microenvironment (tunnel), a street canyon and an urban background site. For acquiring particle concentrations in the mobility diameter range from 6–1000 nm, a flow-switching type differential mobility particle sizer was utilised [1]. It collects data in 30 channels, with a time resolution of ca. 10 min. Meteorological parameters such as temperature, global radiation, relative humidity, wind speed and direction were gained from the meteorological station operated at the university campus in the city centre.

From the number size distribution data, various quantities were derived such as total particle number concentration, ultrafine concentration (N_{6-100}) and "accumulation mode" ($N_{100-1000}$) concentration. Number mean median diameters (NMMDs) were determined by fitting two or three lognormal functions on the inverted distributions. The days were classified with regard to the time evolution of number size distributions, particularly considering new particle formation.

Daily median number concentration of particles was 4.3×10^3 cm^{-3} in the urban background, 11.8×10^3 cm^{-3} near the city centre [1], 23×10^3 cm^{-3} in the street canyon and 143×10^3 cm^{-3} for the tunnel site [2], where the largest concentration recorded was 465×10^3 cm^{-3}. Variability is related to micrometeorological conditions and to formation and sink processes, particularly vehicular emissions. The concentration of the particles increased dramatically with the level of anthropogenic impact. Mean contribution of ultrafine particles to the total particle number was (77±9)% in the urban background, (79±6)% near the city centre, (85±3)% in the street canyon and (85±2)% for the tunnel site, which is slightly larger than for the urban ambient air. Overall mean for the NMMD of the Aitken and accumulation modes were 26 and 93 nm, and 33 and 86 nm for the central and the tunnel site, respectively. All these values are substantially smaller than for rural or background environments. The reason is that the smallest particles are affected by coagulation and wall losses more extensively than the larger ones, and these effects can shift the modes to larger median diameters. New particle formation was observed at all the sites except for the tunnel. Its frequency varied with the rate of sources and with the level of pollution (concentration of pre-existing particles, sinks) due to the differences in coagulational scavenging. The most frequent and clearest nucleation events occurred at the urban background site, where practically was no anthropogenic impact. The frequency of new particle formation showed a marked seasonal dependency, with a maximum in spring and a minimum in winter. The frequency significantly depended on the site location as well. The diurnal pattern of ultrafine particle concentration also had a notable variation from site to site, with almost a perfect bell shape in the urban background site to a rather constant level from morning to late evening at the street canyon, while the central site was a special mixture of the previous two locations mentioned.

[1] I. Salma, T. Borsós, T. Weidinger, P. Aalto, T. Hussein, M. Dal Maso, M. Kulmala, *Atmos. Chem. Phys.* **2011**, *11*, 1339–1353.
[2] I. Salma, T., Borsós, P. P. Aalto, M. Kulmala, *Boreal Env. Res.* **2011**, *16,* 262–272.