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Multi-year long measurement of urban new aerosol particle formation and its relation to local meteorology

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Aerosol particles play an important role in the radiation balance of the Earth. Ultrafine aerosol particles (UF, d <100 nm) have a significant contribution to the global aerosol budget. Atmospheric nucleation is one of the main sources of these particles.

Particle number size distributions were measured by a Differential Mobility Particle Sizer (DMPS) in the diameter range of 6–1000 nm with a time resolution of ca. 10 min for several years. The measurements were carried out in the city centre for 5 years, and in the near-city background of Budapest for 1 year. Classification of the new aerosol particle formation (NPF) and consecutive growth events, and their dynamic parameters were determined. The median total particle number concentrations were 11.5×10^3 cm^{-3}, 9.7×10^3 cm^{-3}, 9.3×10^3 cm^{-3}, 7.3×10^3 cm^{-3}, 10.6×10^3 cm^{-3} in the city centre for 5 years, respectively. They showed slightly decreasing tendency during the years except the last year. The UF ratio had a similar, decreasing tendency pattern, resulted by the alteration of new particle formation frequency and the fluctuation of other anthropogenic sources

The annual mean nucleation frequencies were 24%, 20%, 23%, 13%, and 23% for the 5 years in the city centre, and 27% in the near-city background. This indicates significant nucleation source of UF particles in cities. We showed that NPF produces about 25% of UF particles in the city centre, and about 34% in the near city background on a longer (yearly) time scale. The mean occurrence of NPF was the highest in spring and high in autumn, which is in line with previous measurements in urban environments. It was caused by favourable meteorological conditions as well. The annual global maximum of NPF occurrence coincided with the lowest monthly mean RH values during 3 out of the 5 years. The temperature also showed correlation with the nucleation frequencies. The spring peak was associated with the first month in the year which had higher mean temperature than the annual mean temperature.

Formation rate at a particle diameter of 6 nm varied from 0.81 to 24 cm^{-3} s^{-1} with a mean and standard deviation (SD) of 5.6$\pm$3.8 cm^{-3} s^{-1} in the city centre, while the same properties for the near-city background were 0.48–5.6 cm^{-3} s^{-1}, and 2.2$\pm$1.3 cm^{-3} s^{-1}, respectively. The mean particle growth rate with SDs for 10 nm particles were 7.6$\pm$2.9 nm h^{-1} in the city centre, and 5.2$\pm$1.4 nm h^{-1} in the near city background. These data revealed some similarities and differences in the NPF process itself between the city centre and near-city background atmospheric environments.

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