Multi-year long investigation of atmospheric nucleation in urban environments

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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. Their health related aspects have been increasingly recognized even in large cities as well.

Multi-year measurement of particle number size distributions was performed by a Differential Mobility Particle Sizer (DMPS) in the diameter range of 6–1000 nm with a time resolution of ~10 min. The measurements were carried out for 3 years in the city centre of Budapest. The 1-year long measurement campaign was realized in the near-city background. The classification and dynamic parameters of the nucleation were determined according to Dal Maso et al. (2005) and Németh and Salma (2014).

The total particle number concentrations showed slightly decreasing tendency during the years in the city centre (Table 1.). The UF ratio had a similar pattern, resulted by the new particle formation frequency and the fluctuation of other anthropogenic sources. Some ordinary and substantial emission sources, such as boat traffic on rivers in cities or diesel-driven single heavy-duty tracks or buses, cause sudden and considerable changes in the concentration in an irregular or occasional manner. Number concentrations can be also modified very much or sometimes even in a determinative way by local meteorology and mixing as well.

Table 1. Yearly median total number concentration and median UF ratio to the total number concentration.

Year	$N_{6–1000}$ ×10^{-3} [cm^{-3}]	UF/$N_{6–1000}$
2008–2009	11.8	0.80
2013–2014	9.7	0.77
2014–2015	9.3	0.76

The annual nucleation frequencies were 24%, 20% and 24% for the 3 years in the city centre, respectively (Figure 1.). The median monthly nucleation frequency had seasonal variability with a minimum in winter and two local maxima, one in spring and the other in autumn caused by favourable meteorological conditions or biogenic cycling through emissions of volatile organic compounds (VOCs) from vegetation (Riipinen et al., 2011).

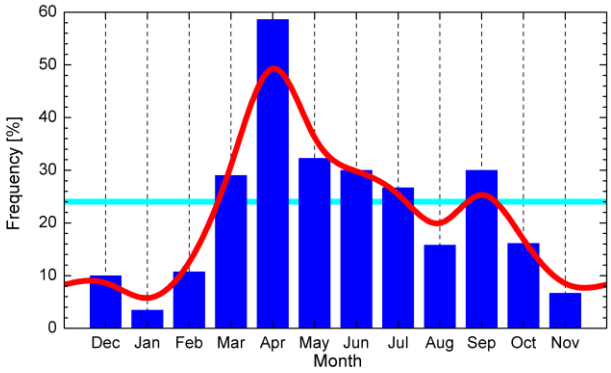

Figure 1. Median monthly nucleation frequency for 3 years in the city centre environment.

The mean earliest (t_1) and the latest (t_2) estimated time of the beginning of the nucleation were 10:39 and 13:37. The individual concentration of the nucleation mode particles between t_1 and t_2 varied from 1.1×10^3 cm^{-3} to 63×10^3 cm^{-3} and from 0.2×10^3 cm^{-3} to 49×10^3 cm^{-3} on nucleation and on non-nucleation days, respectively. Meteorological parameters assigned to the $N_{6–25}$ values showed that nucleation occurred at slightly higher wind speed and temperature values. Relative humidity were 36% and 53% at 25 and 75 percentiles on nucleation days, while 51% and 80% on non-nucleation days.

In the near-city background, the median total particle number concentration was 3.9×10^3 cm^{-3}, and the UF contribution to the total concentration was 66% due to the lower traffic and local emission sources. The nucleation frequency was 28% which showed higher contribution of new particle formation to the UF particles.

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