The added value of UFP monitoring in urban environments: number concentration and size distribution assessments in Amsterdam (NL), Antwerp (BE), Leicester (UK) and London (UK)

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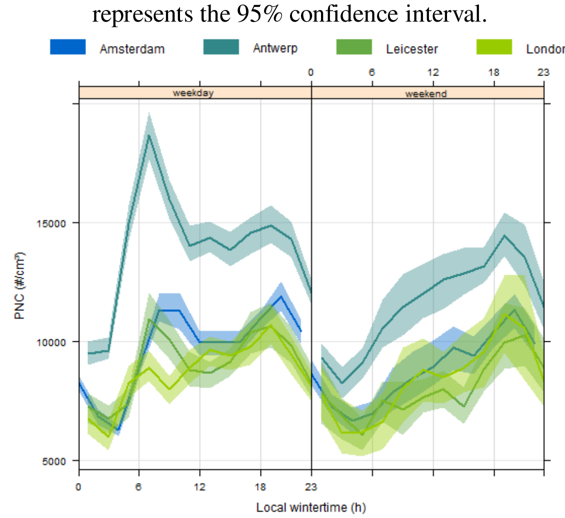
Current European air quality legislation is centred on monitoring, limiting and reducing mass concentrations of airborne particles. However, recent toxicological and epidemiological research argues that new particle metrics may constitute better links to health endpoints than mass concentration. For instance, the potential of inhaled ultrafine particles (UFP), which are able to penetrate deeply into the respiratory system and cause inflammation, is believed to contribute significantly in causing illness. So far, information on the number concentration and size distribution of UFP is limited and air quality experts and health professionals are unable to identify the most contributing UFP sources, adapt their current policies and re-define appropriate mitigation measures to protect citizens' health.

The Joaquin-project (www.joaquin.eu) aims to enhance our understanding of UFP in urban environments and tries to evaluate the added value of continuous UFP measurements. To do so, the temporal variation in number concentration and size distribution of UFP in four NW-European cities (Amsterdam, Antwerp, Leicester and London) was investigated. Moreover, relations of UFP with more commonly monitored pollutants such as nitrogen oxides (NO_x), particulate matter (PM_{10}, $PM_{2.5}$) and black carbon (BC) were evaluated.

The total particle number concentration (PNC) was measured with a condensation particle counter (TSI EPC-3783, water based, particles > 7 nm) and BC with a MAAP (Thermo-5012). The particle size distribution between 10 - 1000 nm was obtained by a scanning mobility particle sizer (Grimm-5420/L-DMA) in Amsterdam and Antwerp. In Leicester and London spectra between 20 and 200 nm were gathered with a differential mobility analyser with corona discharger and electrometer (TSI UFP-3031). To assess instrument comparability, there was an initial measurement campaign in Antwerp and follow-up comparisons at the four sites using a mobile trailer with the same instruments aboard as at the fixed stations.

UFP measurements were performed for two consecutive years, from April 2013 to March 2015. Results showed a traffic-related diurnal variation of UFP, NO_2 and BC with distinct morning and evening rush hour peaks on weekdays. In the weekends, only an evening peak could be observed (Figure 1). The relative UFP size distribution was quite similar for all cities with highest particle numbers in the 30-50 nm size class. The monitoring site of Antwerp showed highest NO_2, BC and UFP concentrations which can be explained by the proximity of a traffic-intensive thoroughfare of Antwerp.

Figure 1. Daily variation in hourly-averaged total particle number concentration (PNC) on weekdays and weekend days at urban background sites in Amsterdam, Antwerp, Leicester and London. Coloured zone represents the 95% confidence interval.



Based on the experienced wind fields, the contribution of site-dependent local and urban UFP sources could be identified which pleads for thoughtful consideration when positioning urban background stations in typical heterogeneous urban environments.

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