Time trends of particle number concentrations in a Central European city between 2008 and 2018

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Introduction

Research activity dedicated to urban new particle formation (NPF) and growth events in Budapest have been going on since November 2008. Measurements for 6 full years were realised in the city centre at a constant and fixed location. Semi-continuous data sets containing particle number concentrations in various size ranges, concentrations of criteria pollutants and meteorological data are available by now and were utilised to determine time trends for particle number concentrations from 2008 to 2018, thus for a decennial interval. The main objectives of this study are to present and discuss the statistical model developed specifically for the time trend analysis of particle number concentrations, to interpret its results for diurnal variability and time trends, and to relate the temporal tendencies to different atmospheric sources, processes and environmental circumstances.

Methods

The experimental data dealt with in the present study are related to the Budapest platform for Aerosol Research and Training (BpART) facility. The site represents a well-mixed, average atmospheric environment for the city centre due to its geographical, physical and meteorological conditions (Salma et al., 2016). A time interval from 03–11–2008 to 02–11–2018 was considered for the purposes of the present study. The data consists of particle number concentrations measured with differential mobility particle sizer (DMPS), meteorological data and concentrations of key pollutants: SO_2, CO, NO, NO_x, O_3, and PM_{10} mass.

The data were analysed in two phases. First, the trends for concentrations for particles and main pollutants were estimated with dynamic linear model (DLM), method described in Mikkonen et al. (2015). Secondly, the factors affecting the changes in particle concentration were detected with linear mixed model (LMM) in similar manner as in Mikkonen et al. (2011).

Results

We found that the particle number concentrations have been decreasing within the decennial period covered by our measurements. The deepest decrease in particle number has been in the smallest particle size class of 6-100 nm in diameter. The data suggests that the annual mean relative occurrence frequency of new particle formation (NPF) events stayed almost constant over the time interval considered and formation rate of new particles has not decreased. Thus the decrease in the number of nucleation mode particles is possibly due to decrease in direct emissions from traffic or industry. This is yet to be confirmed. Fig. 1 shows the diurnal pattern of nucleation mode particle number concentration on event- and non-event days on weekdays and weekends. It shows that traffic is significant contributor on the particle number, as on weekdays a notable peak on morning rush hour can be seen.

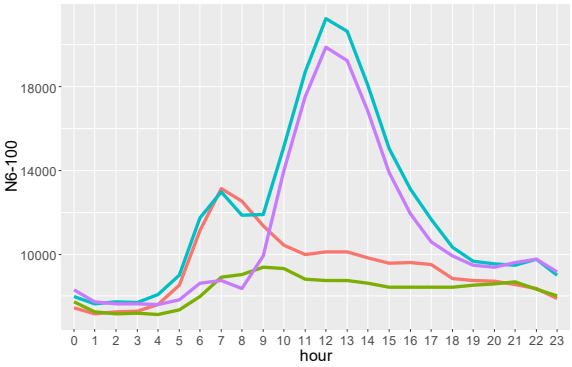

Figure 1. Diurnal pattern of 6-100 nm particle concentration in cm^{-3} units. Red=nonevent on weekday, cyan=event on weekday, purple=event on weekend, green=nonevent on weekend

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