Spectral responses of nucleation events and source related correction of Aethalometer data using multi-wavelength photoacoustic spectroscopy

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Atmospheric aerosol has severe impact on climate on human health and air quality. The light absorbing carbonaceous aerosol is responsible for the major fraction of uncertainty in climate forcing calculation and one of the most harmful atmospheric constituents too. Therefore, precise and accurate measurement of that is deemed essential. The researcher is in common platform in that the photoacoustic spectroscopy is one of the most powerful methodology for precise and accurate determination of light absorption of aerosol. In this study, we perform results of the field measurement campaign focussing on the correlation between the aerosol size distribution and photoacoustic responses of ambient.

The measurement was made under wintry urban meteorological conditions from late winter until early spring of 2015, in Budapest, the capital of Hungary. Optical absorption coefficient (OAC) by aerosol is generally measured by two different methodologies. One was the most commonly applied Aethalometer [1]. The other was the recently developed multi wavelength photoacoustic instrument (4-λ-PAS) [2]. The number concentration and size distribution of ambient aerosol was measured by a single mobility particle sizer (SMPS equipped with a Vienna-type DMA+CPC, Grimm Aerosol Technik GmbH & CO. Austria, with a size range of 10,1-1093 nm). The wavelength dependency of the measured OAC data quantified by the Aerosol Angstrom Exponent (AAE) was also deduced and analysed from the measured responses of the ambient at the operational wavelength of 4-λ-PAS.

Based on the data evaluation of size distribution, the measurement period can be classified into two categories such as normal and nucleation days. On 5 measurement days clear nucleation events were observed. At normal days three characteristic size modes were defined with count median diameters of circa 15, 25 and 110nm that association with nucleation, traffic and heating activities. We also identified diurnal variations of the strengths of those characteristic modes and AAE values. Investigating the correlations betwen the photoacoustic and size distribution data we revealed and quantified relationship between the mode structure and the AAE. During the campaign we also identified characteristic spectral responses of nucleation events first. Moreover, in daily regulation, we experimentally demonstrated so called uncompleted nucleation events with characteristic AAE values in normal days.

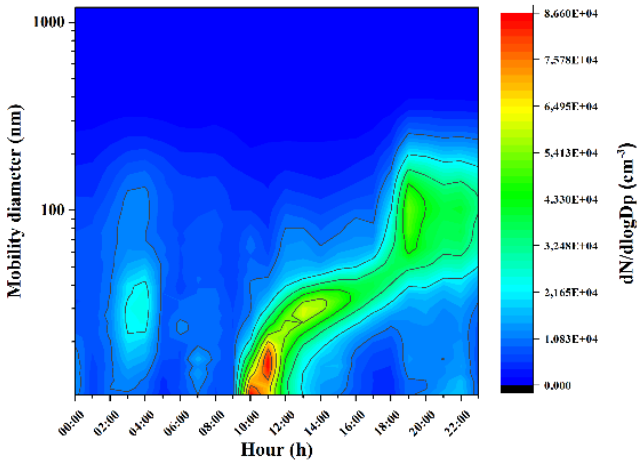

Fig.1. The banana curve demonstrating a nucleation event

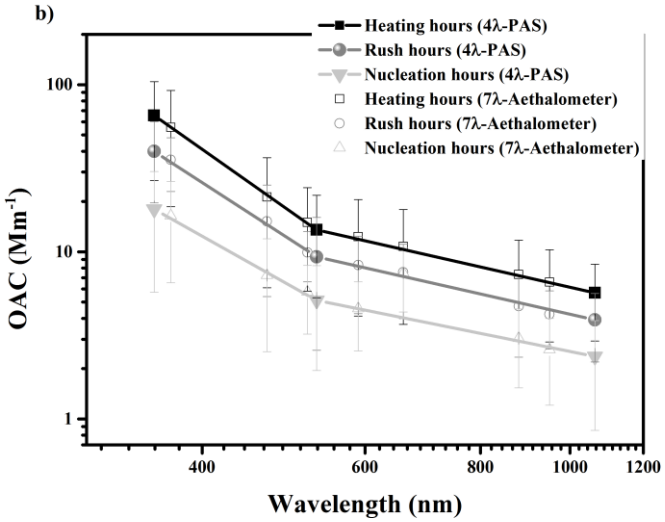

Fig.2. Absorption responses of ambient measured at different periods of the nucleation days using 4λ-PAS the 7λ-Aethalometer using C*ref* values

From the simultaneous measurement of OAC by the 7λ-Aethalometer and a 4λ-Photoacoustic Spectrometer as reference instrument, wavelength dependent correction factors (*f* and C) was defined in weingartner posterior correction schemes [3]. We found that the correction factor of C has source specific diurnal variations, while correction factor of f no clear trend could be observed during the measurement period.

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