SIZE DISTRIBUTION AND SPECTRAL RESPONSES OF ATMOSPHERIC AEROSOL MEASURED BY SINGLE MOBILITY PARTICLE SIZER (SMPS) AND MULTI WAVELENGTH PHOTOACOUSTIC SPECTROMETER (4λ-PAS)

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Abstract
This campaign 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) is generally measured by two different methodologies. One was the most commonly used Aethalometer [1]. The other was the recently developed multi wavelength photoacoustic instrument (4-λ-PAS) [2]. The size distribution and number concentration of ambient aerosol was measured by a single mobility particle sizer (SMPS). The measurement period could be classified normal days and nucleation days. The correction factor of filter based transmission measurement was experimentally determined using photoacoustic instrument as reference. Both the correction factor and the spectral responses were found to be characteristic for normal and nucleation days.

Introduction
Nowadays you can hear a lot about atmospheric aerosol and it‘s effects on the environment (climate and air quality) and health. In urban air, aerosol has many health effects. May be mild respiratory disease, allergies, impaired respiratory function, lung cancer, etc. The effect of aerosol on climate is very complex; it has direct and indirect parts as soon as cooling and warming climatic impact. The light absorbing carbonaceous aerosol is responsible for the major fraction of uncertainty in climate forcing calculation and one of the most adverse atmospheric component too. It also shows that a precise definition of this is essential. The photoacoustic spectreoscopy is one of the most powerful methodology for precise and exact determination of light absortption of aerosol.

Experimental
The measurements were between 15 February 2015-12 March 2015 at the György Marcell Observatory of the Hungarian Meteorological Service in Budapest, the capital of Hungary (47,430009° N, 19,181225° E).
Optical Absorption Coefficient (OAC) was parallel measured by a 7-wavelength Aethalometer (AE42-7, Magee Scientific, Berkley USA) at 370, 470, 520, 590, 660, 880, 950 nm and by our self-developed multi-wavelength photoacoustic spectrometer (4λ-PAS) at 1064, 532, 355, 266 nm.
Size distribution was determined by a Scanning 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) combined with Portable Aerosol Spectrometer (Model 1.109, Grimm Aerosol Technik GmbH & CO. Austria with a size range of 0,25-32 μm).

Results and discussion

We analysed the measured size distribution by using lognormal multi peak fitting algorithm. 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. So there are 2 categories, one for nucleation days (days with particle growth) and the other for normal days (days without particle growth) (Fig.1.).

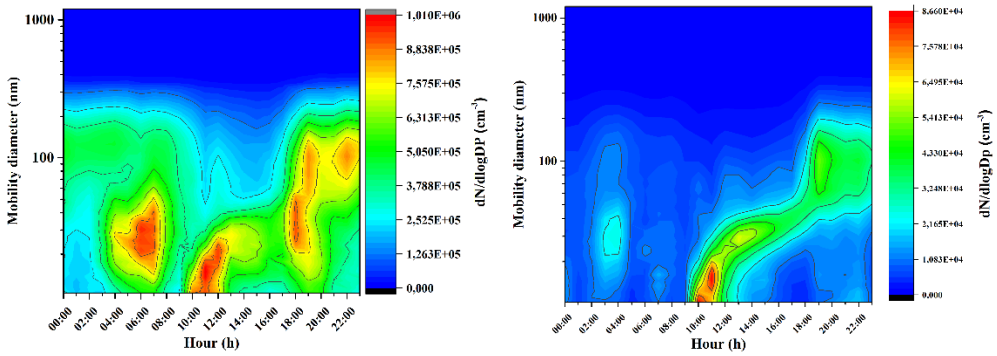

Figure 1.: a) size distribution in normal days b) the banana curve demonstrating a nucleation event

We identified three characteristic size modes both normal and nucleation days, which were Mode 0 (average count median diameter (CMD): 14.89 ± 3.97 on normal and 14.81±3.79on nucleation days), Mode 1 (average CMD: 25.80 ± 1.60 on normal and 24.23±0.67 on nucleation days) and Mode 2 (average CMD: 115.76 ± 19.17 on normal and 115.60±24.14on nucleation days). Further these mode structure we found that we can divide the days into 3 parts: namely heating, traffic and nucleation hours. (Table 1)

Part of day	**Time period**	
	Normal days	Nucleation days
Heating hours	21:00-04:00 12:00-15:00	22:00-03:00
Traffic hours	04:00-10:00 15:00-21:00	03:00-10:00 19:00-21:00
Nucleation hours	10:00-12:00	10:00-19:00

Table 1.: Parts of the day

The diurnal variation of OAC were measured by the 4λ-PAS and the 7λ-Aethalometer. The highest OACs were measured from late afternoon to early morning, while lower values were measured during the morning and the afternoon and the lowest OACs were between the middle of the day and the very early afternoon. We measured Absorption Angström Exponent (AAE) by two instruments (4λ-PAS and the 7λ-Aethalometer) respectively and OAC and AAE data's trends were found to be similar. The highest AAE values were measured during the late afternoon and during the night, lower values during the morning and the early afternoon, while AAE had its diurnal minimum during the midday.

Conclusion

This study discusses the results of a 1-month field measurement campaign during the late winter and the early spring of 2015, in Budapest, the capital of Hungary.

Based on the data evaluation of size distribution, in the measurement period we can characterised two categories. These two class are normal and nucleation days. Both normal and nucleation days could be further categorized to three parts of day, namely heating, traffic and nucleation hours in time series.

Highest OAC and AAE values were measured during heating hours, lower during traffic hours and the lowest values in the nucleation period.

Examining the correlations between the photoacoustic and size distribution data we quantified relationship between the mode structure and the AAE. With this measurement we also identified characteristic spectral responses of nucleation events first and we experimentally demonstrated, uncompleted nucleation events with characteristic AAE values in normal days (which measured by photoacoustic spectroscopy).

We measured parallel 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] The result shows 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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