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Atmospheric Measurement Techniques Discussions

Interactive comment on "Optical properties of a heated aerosol in an urban atmosphere: a case study" *by* J. Backman et al.

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First of all we want to thank the Referee for the constructive feedback and knowledge to make this article scientifically more accurate and solidly founded.

Answers to the general comments:

Comment: Filter based absorption measurements are disturbed by light scattering constituents (page 1584, lines 5,6). Volatilization of scattering constituents reduces this cross sensitivity to scattering but also changes the mixing state of aerosols. Since absorption by internally and externally mixed particle constituents is different, volatilization can lead to a bias when measuring absorption coefficients of ambient air (page

1585 line 5).

Answer: This is true, volatilization will lead to bias, actually underestimation of absorption because the true absorption of light by particles is larger for internally mixed than for externally mixed particles, as can be shown by Mie modelling. By volatilizing the material surrounding an absorbing core the true absorption decreases. For externally mixed absorbing and scattering aerosol this would not happen. If there were ideal, artefact-free absorption measurements the absorption coefficients measured from heated and non-heated sample lines would tell whether the absorbing and scattering particles are internally or externally mixed.

Comment: The authors described the method and effects on optical properties, but it is somewhat not clear if this method improves a) measuring absorption coefficients of ambient air or b) estimation of EC concentrations using appropriate mass absorption cross sections (page 1599, line 15 to 23).

Answer: The goal of the work was to improve the measurement of light absorption by soot in ambient air. Filter-based absorption measurement methods have large uncertainties associated with the correction of the effect of light scattering particles and the influence of different mixing states. By volatilizing the scattering part of the aerosol this effect can be minimized and it is possible to measure the absorption and scattering by the absorbing core only – or by externally mixed soot particles – with a minimal effect of the scattering aerosol.

But since the state of mixing changes due to heating the method would be preferably accompanied with a volatility tandem-DMA that gives information on the state of mixing. Then, if also the size distributions of the absorbing core particles and the size distribution of the non-heated aerosol are measured these data can be used for modelling the true absorption in ambient air. Therefore it can be stated that the heated absorption measurement is a piece that may improve measurement of absorption in ambient conditions.

Determination of the mass-absorption coefficient of EC was not the main goal of the work. It was, however, calculated to see how the heating affects the obtained MAC.

Answers to the specific comments:

Comment: page 1584, abstract: First two sentences were repeated.

Answer: The two first sentences were removed.

Comment: page 1585, line 6. Are BC emissions highest in the tropics? Or does the author mean, that the radiative forcing is highest in the tropics?

Answer: BC emissions are highest in the tropics, according to Ramanathan and Carmichael (2008), as well as the incoming solar radiation. The sentence was changed to "The highest BC emissions are in the tropics where the incoming solar radiation is the strongest (Ramanathan and Carmichael, 2008)"

Comment: page 1589, line 4: Year in reference Heintzenberg et al. should be 2006

Answer: The year of publication was changed to 2006.

Comment: page 1589, line 7: plural "number size distributions"

Answer: The citation was changed to plural.

Comment: page 1592, line 14: what was the reason for choosing the algorithm published in Arnott et al.2005 ?

Answer: The method of Arnott et al., 2005 was used because the method is only semi-empirical with the calibration function derived from a basic two-layer model. This has been clarified in the text: "(8) which is a semi-empirical method with the calibration function derived from a basic two-layer model."

Comment: page 1593, line 16: Does the temperature at which 50% is evaporated depend on particles size. If there is a size dependence, does it have an effect on measurements at ambient conditions?

Answer: Yes is does. We showed that a residence time of 1.2 s was sufficient to evaporate the entire poly-disperse ammonium sulphate population at 220 °C (Fig. 2). The number of particles left after heating dropped faster than the volume fraction remaining. A very likely explanations to this is that the residence time of 1 second is not long enough to evaporate completely the largest partices. For example, if there were many 100 nm particles and a few 500 nm particles in the aerosol, all the smaller ones would have completely evaporated but the larger ones would have just shrunk in size but leaving some volume. This would lead just to what was observed in our laboratory experiment: number of particles decreased faster than the aerosol volume. Quantitative estimations would require modeling that was out of the scope of the present paper.

This has been clarified in the text: "This implies that as volatile species as ammonium sulphate are sufficiently evaporated in the oven at 280 °C. The fact that the volume fraction remaining dropped slower (Fig. 2) than the number of particles indicates that the remaining volume fraction is a function of the initial size of the particles. For semi-volatile species and lower temperatures we are more likely to measure the rate of evaporation rather than equilibrium conditions as is commonly the case for thermo denuder applications (Riipinen et al., 2010)."

Comment: page 1595, line 14: Colon after omega – typing error? The single scattering albedo is defined as ratio of two extensive properties, the extinction and scattering coefficients. What is the physical meaning of the difference between two single scattering albedos?

Answer: "ω_0:s" changed to "ω_0's". The physical interpretation of single-scattering albedo is the darkness of the aerosol. Two different single-scattering albedo's measured at the same wavelength have either different size distributions or different chemical compositions.

Comment: Figure 4: Which errors are indicated by the dotted lines, and why are the dotted lines crossing at about 0.6 gm^{-3} (left plot) and 0.5 gm^{-3} (right plot).

Answer: The errors indicate the calculated standard error for ordinary least square regressions. This specification was added to the text: "The errors were calculated using the standard error for ordinary least square regressions and the dotted lines corresponds to the estimated upper and lower uncertainties in the slopes". They cross at about 0.6 gm^{-3} because of an offset of the OC/EC analyzer. The 0.5 gm^{-3} offsets of the OC/EC analyzer were removed from Figure 4.

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 1583, 2010.