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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The role of iron and black carbon in aerosol light absorption" *by* Y. Derimian et al.

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We appreciate the constructive and thoughtful comments made by the reviewer. Of course, sensitivity of single scattering albedo (SSA) to aerosol size is an important issue for our study and should be addressed. We looked for a way to test or include the effect of aerosol size on the derived empirical relationship. This brought us to the idea to modify the equation by including explicit dependence on Angstrom exponent — parameter used in common exponential approximation of spectral dependence of aerosol optical thickness. This parameter has high sensitivity to variability of aerosol sizes and it can be easily calculated from spectral measurements of aerosol optical thickness. The modification of the equation was based on the following considerations. SSA can be presented in terms of absorption and extinction optical thickness, which in turn can be presented as a multiplication product of specific absorption and

extinction by concentrations of the elements responsible for absorption and extinction. Since the spectral SSA can be expressed in terms of the spectral absorption and extinction, it is possible to include Angstrom exponent as a variable by using Angstrom approximation for spectral dependencies of absorption and extinction. The measured Fe and BC concentrations are the major elements that responsible for absorption. After some algebraic transformations we defined coefficients of the multivariate regression. The other elements of the equation (Fe, BC concentrations, spectral SSA and Angstrom exponent) are the known measured parameters. Thus the modified equation includes Angstrom exponent and therefore accounts for variability of SSA values and SSA spectral dependence caused by variability of aerosol size distribution. As a result, the modified equation is algebraically transparent and has suitable physical interpretation. The detailed derivation of this equation and the results obtained are discussed in the revised version of the manuscript.

As suggested by the reviewer, we have seriously considered a possibility of replacing the Angstrom exponent by the fine mode fraction. We agree that the fine mode fraction can often be more convenient than Angstrom exponent since it is more directly describes aerosol size distribution. We also followed the advice of the referee to analyze the possibility of replacing the Angstrom exponent by the fine mode fraction in some figures. These efforts showed that the fine fraction is slightly more variable, which means that it describes more precisely the variability in size distribution. At the same time, the obtained differences had no significant effect on the information presented in the figures. In addition, as suggested by the reviewer, we found high correlations (r is about 0.8-0.9) between fine and coarse mode fractions versus Angstrom exponent, and between coarse fraction and Fe concentration. This revealed a high coherency between employing Angstrom exponent and fine mode fraction for accounting size distribution variability.

Finally, we have concluded that using Angstrom exponent is more suitable for our analysis because it can be easily derived from measurements of spectral optical thickness,

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and then used as an input for the developed approximating relationship between chemical composition and light absorption properties.

Page 8161-2, regarding the term "equivalent" for BC: We are thankful for the information and the provided references. Since the term BC is carelessly used in various contexts, our intention was to emphasize an equivalent meaning of the measured BC in our study. However, we removed indexing "e" (equivalent) in BCe and added instead a clarification that the operational definition of BC includes already an optical equivalent. We also provided the relevant references.

Page 8162, regarding estimating BC by models: We modified this sentence and added references.

Page 8165, line 21: The sentence was corrected.

Page 8166, line 23, regarding the value of the fixed absorption efficiency: As we mentioned in the "Data sets and instrumentation" section, instead of assuming a mass absorption efficiency (MAE, in m2 g-1), the instrument was calibrated with secondary standards for BC determination. These secondary standards were produced by depositing soot from acetylene burning on filters. We added an estimation of the MAE that corresponds to the calibration factor obtained by reflectance measurements of the secondary standards. The estimated MAE is around 5 m2 g-1, references were also provided.

A discussion regarding further analysis of separation between Fe and BC signals was added.

Page 8168: Reference indicating that the SSA for pollution aerosols decreases with wavelength was added; it is (Dubovik et al, 2002).

Page 8168: We thank for this correction. It is more correct to say that for Angstrom exponent $>$ 1 the contribution of the fine mode is increased rather then dominant. We also added the corresponding references.

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Page 8172: Yes, in the case of a homogeneous aerosol distribution, the ratio tau_ext/sigma_scat0 could present an equivalent aerosol layer thickness, but in the case of a non-homogeneous distribution, it will indicate an equivalent aerosol layer height. We added "non-homogeneous" in the text, also there is a relevant discussion in the cited paper (Derimian et al, 2006).

Figure 5: Size scales are from 100 to 300 nm. We will check if it will be readable in the next printed version.

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