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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Mass concentrations of black carbon measured by four instruments in the middle of Central East China in June 2006" *by* Y. Kanaya et al.

Y. Kanaya et al.

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Reply to the Referee 1

We are grateful to valuable comments that the referee made on this manuscript. Detailed responses to the comments are given below.

Comment 1. What I find a bit difficult to understand is the concept of using different instruments with different protocols at different times. The PSAP had a heated and an unheated inlet - why not also the MAAP? This might have helped in investigating whether the lensing effect is indeed responsible for the high BC concentrations or whether other effects might have been the cause. Why was the MAAP switched between a PM1 and PM2.5 inlet during the whole campaign, and not the other instru-

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ments as well? Changing from the NIOSH to the IMPROVE protocol on the Sunset instrument takes time and would not have been feasible on a daily basis, but it would have been very interesting to compare these two protocols at least during the biomass burning episodes. As the field study is of course completed, nothing can be done about it now. The authors, however, did as much as was possible with these limitations in the data set.

Reply 1. We agree with the referee that the heated inlet with the MAAP would help investigating if the lensing effect is responsible. PM1 and PM2.5 switching for MAAP was made to obtain PM1 data even during the intensive campaign period which were acquired for a longer time period at the location, while enabling investigation of size distributions of BC (by comparing PM1 and PM2.5) and comparisons to other PM2.5 instruments during the campaign period. We suppose PM1 and 2.5 switching is enough for one instrument. It was not possible to try IMPROVE* protocol during the biomass burning period, because it was only after the field campaign that we came to know that the biomass burning affected the site only in the first half of the intensive campaign period. We will try the suggested measurements in the next opportunity.

Comment 2. No information about how opt_EC was determined is given. Please add info (especially also on the conversion factor optical signa to opt_EC)

Reply 2. The BC mass loading (in microgram cm-2) on the filter was empirically determined by 2.25ABS + 0.75(ABS)2, where ABS (absorbance) is determined from the temporal decrease in the laser transmittance during sample collection. The mass loading was then converted to concentration using the filter area and sample volume. We will add this information in the revised text.

Comment 3. The MAAP is reported to overestimate BC concentrations at all times, and especially severely under conditions of aged aerosol. This overestimation is attributed to the lensing effect of BC particles with organic (and other non-absorbing) coatings, although no quantitative argument is given. As the difference between meth-

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ods is most severe during the biomass burning episodes, other reasons for the large MAAP_BC (or low thermal EC) concentrations are possible. All optical methods overestimate BC when other absorbing substances are present. Biomass smoke contains also light absorbing organic material (brown carbon; see review by Andreae and Gelencser, 2006, ACP, 3131 - 3148), and the mention of the thermogram with the OC peak at relatively high temperatures is an indication that brown carbon was present also in this episode. In the study by Reisinger et al. (referenced in the MS) all methods deviated most strongly from one another when brown carbon was present, which is similar to the findings of this MS. Another reason might be that the Sunset instrument actually underestimates EC. The authors indeed mention this at one point in the MS, but as all the text is written in terms of overestimation of the other methods, one could get the impression that the Sunset instrument is, indeed, a standard, when it is not. I suggest to qualify the overestimation statements in this respect.

Reply 3. It is difficult to argue the lensing effect quantitatively on the basis of theory because detailed size distributions and shapes of the BC particles are not known for this field campaign. As mentioned in section 3.3, Bond et al. (2006) suggested from theoretical calculations that absorption by aged particles can be 1.5 times greater than that of fresh particles due to the coating. The degree of the lensing effect we argue is in a similar range. As indicated in Figure 9 and discussed in page 14969, the large difference between BC and EC does not correspond to the intense biomass burning event with high OC and EC concentrations; these maxima in the BC/EC ratios occurred several hours after the event. We agree with the referee that the brown carbon might be present, but it is only speculation from the thermogram. Even if the brown carbon was present, it is not very likely that the brown carbon particles contributed to the large enhancement of the absorbance in the wavelength region of 565-670 nm (used in the optical instruments), as mentioned by Andreae and Gelencser (2006). Therefore we do not mention the possibility that brown carbon enhanced the optical absorbance. We agree with the referee that there is a possibility that the Sunset instrument underestimated EC. We will make the revised manuscript more balanced by mentioning that

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none of the instruments are regarded as a standard.

Comment 4. The study is part of a larger field study focusing on aerosol and ozone chemistry. Is there already a reference to the other results of the study?

Reply 4. The references of relevant studies for this field campaign which can be mentioned now are Li et al. (2008) in the reference list and those in the footnotes (e.g., Akimoto et al., Kanaya et al., Yamaji et al., in preparation).

Comment 5. Explain acronym SUS

Reply 5. We will mention "stainless steel" instead.

References

Andreae, M. O. and Gelencser, A.: Black carbon or brown carbon? The nature of light-absorbing carbonaceous aerosols, Atmos. Chem. Phys., 6, 3131-3148, 2006.

Bond, T. C., Habib, G., Bergstrom, R. W.: Limitations in the enhancement of visible light absorption due to mixing state, J. Geophys. Res., 111, D20211, doi:10.1029/2006JD007315, 2006.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 14957, 2008.