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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modelling the optical properties of fresh biomass burning aerosol produced in a smoke chamber: results from the EFEU campaign" *by* K. Hungershöfer et al.

K. Hungershöfer et al.

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We thank the reviewer for the comments. Changes have been made to address these comments. Text changes compared to the ACPD version are also indicated.

Comment 1: The scientific name for musasa (Brachystegia spiciformis) should also be given. Furthermore, it should be indicated that the tree is also named msasa.

Response: A more detailed description of the fuels, including their scientific names was added. See also response to referee #1 (Comment 1).

Comment 2: Page 12658, lines 14-15, and Page 12671, lines 12-13: Reference is made here to changes in particle size. However, nowhere in the article is it indicated

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how the particle size distribution changes in the course of the burning experiment. Only average size distributions are presented (i.e., in Fig. 1).

Reponse: A figure that shows the range in the number size distribution as well as the size distribution at two selected times during the combustion of savanna grass was added to Figure 1 (which is Figure 2 in the revised version).

Comment 3: Page 12664, lines 8-9: The presumptions made here are clearly not justified. Later in the paper, the authors invoke changes in chemical composition in the course of the experiment to explain some of their results. Furthermore, it appears from the authors' reference Iinuma et al. (2007) that the average chemical composition (average over the course of the experiment), as deduced from the 5-stage Berner impactor samples, is not the same for the 5 size bins. Some clarification and explanation is needed here.

Response:

(i) time-resolved ECa data Since no time-resolved ECa data were available, we have to interpret our data based on the initial assumption that the average ECa value can be used for this analysis. On the other hand, we realize that this introduces an uncertainty into our analysis if the burning conditions and hence the chemical composition deviate significantly from the mean state, as acknowledged on p.12668 L2-8 and L-11-13.

(ii) size resolved ECa data The assumption of a size-independent refractive index (and hence constant chemical composition) may be invalid, but the descriptive power of an 'effective' mean chemical composition does not depend on it. For both experiments, both the optical and ECa data are dominated by two impactor size bins (0.14-0.42 um (stage 2) and 0.42-1.2 um (Stage 3)). In case of the SAVA20a experiment, the ECa mass fractions in both stages (15.5% (stage 2) and 16.5% (stage 3)) was about equal to the average over all five impactor stages of 15.5%, while for the MUSA23a experiment, the average ECa mass of 8.6% differed significantly from the 4.4% and 10.5% observed for stage 2 and stage 3, respectively. In spite of this fundamentally differ-

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ent situation, using a constant effective refractive index and hence constant effective chemical composition provided good agreement between the measured and modelled optical properties for both experiments. This indicates that the size-resolved, in contrast to the time-resolved, chemical information is only of minor importance.

Comment 4: Page 12665, lines 10-14: The size distribution data from the smoke chamber experiments are compared here with those from the SMOCC campaign. The latter campaign took place in the Amazon basin and the biomass burnt there is quite different from that in the African savanna or in the authors' smoke chamber experiments. Are there no better (and also more complete) size distribution data sets available for comparison?

Response: Following this suggestion we replaced the size distribution from the SMOCC campaign (Brazil) by the size distribution of fresh biomass burning aerosol sampled during the Southern African Regional Science Initiative (SAFARI2000) in a plume over a large biomass burning fire in agricultural land near Otavi (Northern Namibia). This has three advantages:

1.Otavi is very close to the Etosha region, where the savanna grass samples used for the EFEU experiment came from. 2.The age of the particles from the Otavi plume is less than a few minutes (Haywood et al., 2003) and therefore comparable to the ones from the lab experiments. 3.Information on the coarse mode particles are available for the Otavi size distribution.

The updated text version of this paragraph reads as follows:

new text version: For comparison, the size distribution of fresh biomass burning aerosol (less than one minute old) sampled during the Southern African Regional Science Initiative (SAFARI2000) in a plume over a biomass burning fire near Otavi (Northern Namibia) is also shown in Fig. 1 (Haywood et al., 2003). The distributions were normalized to their peak values to facilitate visual comparison. The Otavi fire consisted of both flaming and smouldering combustion and the area is close to Etosha, the origin

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of the savanna grass that was used for the EFEU experiment. The tri-modal Otavi size distribution is similar to the EFEU data showing an accumulation and a coarse mode at diameters of about 0.2 and 2 um, respectively, with relative contributions to the total particle concentration that are comparable to the EFEU data. However, in contrast to our results the coarse mode is likely to contain a significant amount of dust (Haywood et al., 2003). In case of SAVA20a and MUSA23a there is an elevated abundance of large accumulation mode particles (D $>$ 0.2um) compared to the Otavi measurements which is possibly due to reduced coagulation in the Otavi data as a result of plume dilution.

Comment 5: Page 12666, line 7: It is unclear what size range is meant by "bulk fine". I would think that the mass data were obtained from the TEOM and that this instrument collected the total aerosol, as no inlet is specified in section 2.1.1.

Response: The TEOM did measure total aerosol mass, but the calculation of the mass emission factors is based on the mass from the 5-stage impactor using all five stages (particle aerodynamic diameter from 0.05 to 10um), which agreed with the TEOM within experimental uncertainties. Since over 95% of the mass was found below 1.2 micrometers (impactor stage 1-3) the term 'bulk fine' was used. But since this was not clearly stated in the text, we removed the term 'fine' from the text.

Comment 6: Page 12666, lines 21-22 and line 27: Presumably, the mean mass scattering and absorption efficiencies and the associated standard deviations of the mean were obtained from the about 30 data points displayed in Figs. 2b, 2c, 3b, and 3c. This should be made clearer, i.e., the number of data points used (N) should be indicated.

Response: We added the sentence: These averages were calculated from the 30 (SAVA20a) and 29 (MUSA23a) data points shown in Figure 2b and 3b.

Additionally, we added the number of data points in the caption of Table 1.

Comment 7: Page 12670, lines 20-21: If I understand it correctly, the authors seem

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to imply that the semi-volatile (condensed) organics have a larger mass scattering efficiency than the primary organics of the biomass burning smoke. Is there any evidence (e.g., a literature reference) to substantiate this?

Response:

This is a misunderstanding and the sentence was removed.

Comment 8: Page 12670, lines 27-29, continuing on page 12671, lines 1-2: Since the aerosol produced from the EFEU lab experiments is substantially different from that in biomass burning field experiments, the refractive index of the EFEU experiments will also differ from that in the field. Stating that the current study gives insights in "the refractive index of biomass burning aerosol" seems too general.

Response: This is certainly true and we changed the text accordingly.

Technical corrections: p. 12674, l. 4: replace "using a capillary" by "using capillary".

p. 12684, Figs. 2b and 2c, and p. 12685, Figs. 3b and 3c: "coefficient" in the ordinate should be replaced by "efficiency".

p. 12685, Fig. 3d: "SSA" should be replaced by "Single scattering albedo". Incidently, the acronym SSA is not defined in the text and there is no need to do so as it is not used there.

Response: We changed the revised version of the manuscript accordingly.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 12657, 2007.