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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Investigating biomass burning aerosol morphology using a laser imaging nephelometer" *by* Katherine M. Manfred et al.

Anonymous Referee #1

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This paper presents very interesting data on the scattering phase function of aerosol emitted from biomass burning. There is a strong need for a better quantification of the scattering properties of non-spherical particles. I, therefore, fully agree with the authors' sentence on page 12 that "It would be useful to collect more information about how the morphology of fresh emissions evolves with aging in the atmosphere". The data obtained here are very encouraging regarding the ability of this new instrument to provide this kind of data that can aid radiative forcing calculations as well as remote sensing retrievals. I, therefore, strongly support the publication of this paper.

General comments:

The paper is very well written and the experiments have been mostly well described, and for the most part, well justified. I think the paper can be published almost as is,

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Discussion paper

with just a few minor clarifications and additions that I will discuss next.

Specific comments:

- Introduction

* Page 2, lines 19- 29: An interesting recent approach for determining the shape of coarse particles is provided by Berg et al., Solving the inverse problem for coarse-mode aerosol particle morphology with digital holography. Scientific Reports, 2017. 7(1): p. 9400.

* Page 2 bottom, and 3 top. There are also commercial nephelometers that measure the backscattering at different angles by adjusting the backscattering arm angle. Maybe this could be mentioned here. See, for example, Chamberlain-Ward et al., Advances in Nephelometry through the Ecotech Aurora Nephelometer" TheScientificWorldJOURNAL, vol. 11, Article ID 310769, 6 pages, 2011.

- Experimental

* At the beginning of the section: It would be nice to mention the reasons for the choice of the specific wavelengths. Why these and why so close to each other?

* Why is the polarization converted to circular? It would be useful to explain the reason. Could one switch the polarization periodically from vertical to horizontal to collect images at different polarizations and possibly further gain insights on the shape of the particles? If not why? Or is just a practical choice?

* Also, it would be good to provide some details about the beam quality, the noise and the stability of the lasers and provide some information on the set of apertures.

* On page 5 at the top: The Rayleigh scattering contribution is calculated based on pressure and temperature. What composition is assumed here? Is there any potential for biases due to gases specific to the air in which the aerosol are transported? For example, NO2 (although that was probably removed by the scrubber)? In other words,

was there any attempt to compare this with measurements of just aerosol-free air using a filter?

* On page 6, line 27: 5 nm coating is quite thick when compared with ∼50 nm soot monomers (see below on the monomer diameter, as well). That might also affect how coated the particles might appear vs. be “naturally”.

* Page 7, line 10: the fractal-like structure depends also on the presence of co-emitted components that might condense on the soot and restructure it.

* Page 7, line 16: It might be good to cite Sorensen’s review paper here as well (it is cited a few sentences later on, but it seems to fit here too).

* Page 8, lines 14-17: Some more details here would be useful. How did you get the total scattering from the LAS? How was the match performed? What algorithm was used? etc.

* Page 8, line 17: Monomers diameter might change quite a bit depending on the specific combustion conditions (for example, even for the specific of biomass burning, in the paper by China et al. (2003) cited earlier on in the manuscript, the monomers had diameters from 37 to 56 nm). Did the author estimate the diameter from their SEM images? Would the exact diameter value make a large difference in the comparison when using RDG? Similar comments apply to the effect of k0 and Df. Although some of these aspects are touched upon later in the paper.

- Results and discussion

* At the beginning of the section, while discussing the performance of the instrument: It might be useful, for the purpose of comparing the performance of this instrument to the other more widely used techniques, to also calculate Allan-Werle variances for the TSI and the CRD-PAS instruments.

* Page 9, line 24: a work that might be worth mentioning here is also that by Liu et al. , Aerosol single scattering albedo dependence on biomass combustion effi-

ciency: Laboratory and field studies. Geophysical Research Letters, 2014. 41(2): p. 2013GL058392.

* Page 10, lines 17-19: Is there any guess on the reasons for the disagreement?

* Page 10: While discussing figure 4, it would be good to provide some more details (here or earlier on would be fine too) on the details of the RDG calculations.

* Page 11, lines 4 and 5: “Given the value of the fractal dimension (ðİŘůðİŚŞ = 1.85). . .” maybe I misunderstood, but I thought the Df was assumed from other work, not measured somehow in this work, so I am not sure how this conclusion can be reached here.

* Page 11, line 10: in the paper, cited earlier on in the manuscript, by China et al. 2003, an analysis of the changes of tar balls by the thermal denuder is also discussed.

* Page 11 at the bottom: a discussion of the effect of thermodenuding on fractal aggregates from different fuels is also provided in a recent paper by Bhandari et al., Effect of Thermodenuding on the Structure of Nascent Flame Soot Aggregates. Atmosphere, 2017. 8(9): p. 166.

- Figure 2. Caption: “The laser axis is curved due to the alignment with respect 5 to the wide-angle lens.” Please clarify.

- Figures 6 and 8 How are the different curves normalized?

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