

Interactive comment on “Remote sensing of soot carbon – Part 1: Distinguishing different absorbing aerosol species” by G. L. Schuster et al.

Anonymous Referee #3

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This paper presents an approach to separate several types of absorbing aerosols from AERONET products of size distribution and refractive index. The main advantage of the proposed method is that its outcome is consistent with the size distribution and refractive index from AERONET and thus also with the radiation fields measured by the sun photometers. The paper is well written and the method is well explained. The main issue is that the uncertainties of the complete procedure (AERONET + proposed method) are not well discussed. I favor publication of this paper in ACP considering the remarks below.

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1 General remarks

The proposed approach separates the different components such that the size distributions and refractive indices are not changed compared to those given by AERONET. This results in consistency with the AERONET model and the radiation field. Though this approach is reasonable given the available AERONET products, questions remain about the uncertainties of the results and how well AERONET retrievals themselves perform when complex aerosol mixtures with size-dependent refractive indices are measured.

For example, what happens if there is a strongly absorbing fine mode and a very-weakly-absorbing coarse mode? One could expect that AERONET reports some "average" refractive index, with the consequence that the absorption by the fine mode is underestimated and the absorption by the coarse mode is overestimated (which however might be (over-)compensated by branch D in Fig. 6 if there is a sufficiently large fraction of fine mode absorption).

The reader is left alone with the task to estimate the uncertainties of the final results. The sensitivity study in Section 4 is good, providing an estimate of the uncertainties due to the assumptions on the component's refractive index. Uncertainties due to the decision tree (Fig. 6) are partly covered by the statistical analysis, but should be discussed more quantitatively in the final paper. The following uncertainties are not discussed or quantified:

- (a) Uncertainties due to uncertainties of the AERONET-derived refractive index
- (b) Uncertainties due to limitations of the model (here the size-independent refractive index is most relevant)

To cover a), I suggest that the authors add a sensitivity study on the effect of the uncertain AERONET refractive index on the type separation (by varying the AERONET-derived refractive index within the expected uncertainty) to give an estimate of this

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uncertainty on the type separation.

As the quantification of the uncertainties due to the size-independent refractive index assumption (b) is certainly too complex to be added to this paper, I suggest the authors at least mention that this AERONET model assumption has effects on the final result. This model assumption is critical for this study. Extending the AERONET model by considering individual refractive indices for fine and coarse mode might also be worth a discussion, as that would be the most consistent way to separate absorption by fine and coarse mode aerosol.

2 About Section 5 (Critique on Bond report)

I agree with the authors of the discussion paper that their approach is more consistent with the AERONET model and the measured radiance fields, and this has to be (and is already) stressed in the paper. A consistent approach like the one proposed is preferable to an inconsistent approach. However, I'm not sure about the importance of this consistency, as already the AERONET model applies a very strong (often unrealistic) assumption on the size-independence of the refractive index.

My feeling is that "misconception" in the section title is too strong as the proposed methodology makes some assumptions (e.g. the scheme in Figure 6) that might also be called "misconceptions" from a strict physical point of view. As I'm not really convinced that the Bond approach is so much worse at the end, I would suggest to call this section "Discussion of AAOD approach in Bond report" (or similar).

3 Specific remarks

* p13610 l3: 53% -> 50%

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* p13612 l14 and l19: 0.700 μm -> 0.7 μm

* p13612 l19: insert absorption after hematite

* p13613 l1: it is unclear here which retrieval is meant, probably "our retrieval"

* p13613 l25: "... which implies that all particles are internally mixed." is the wrong conclusion, I think. I suggest "... have the same homogeneous refractive index. This implies that the refractive index from AERONET is some kind of effective refractive index."

* p13623 l3: "of carbon..."

* p13628 l15: If errors of size distribution and errors of refractive index compensate each other, the errors of derived parameters (AAOD, AAE, or SSA) could be smaller (I don't know if this is actually the case here). If the authors can not exclude that size and refractive index errors compensate each other or have further evidence, I suggest to remove the sentence in brackets.

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