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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Retrieval of aerosol composition directly from satellite and ground-based measurements" *by* Lei Li et al.

Anonymous Referee #1

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This paper presents an interesting strategy for using polarized/multiangular satellite measurements to infer aerosol composition. The method uses the Generalized Retrieval of Aerosol and Surface Properties (GRASP) along with assuming that aerosols are mixtures of non-soluable particles embedded within a soluable host. GRASP then derives size distribution, loading and light absorption characteristics based on determining the fractions of each aerosol type. The algorithm is applied first on synthetic data, then on ground-based AERONET, then on historic POLDER data.

Although quite long, I find this paper to be well-organized, well-written and worthy of publication. I really like the idea that the GRASP retrieval can combine specific aerosol types (size + shape + absorption) to retrieve the aggregate. This makes it possible to compare directly with models (that also assume these types). I think the authors should

highlight this even more than they have already. Finally, this is probably well beyond the scope of the paper, But I would like to see some sort of graphic (even for a single panels from Figs 15-19), to compare how your global maps (of species type) compare with other maps, such as from AeroCom models, and/or MISR size/shape/absorption climatology. Right now, they look reasonable, but I would be curious whether they might "change" our way of thinking about aerosol types distribution.

I have some small suggestions for improving the paper. They are as follows

1) Specifically, what are the aerosol type/model components? I feel as if a table could be used to describe each component, its size/shape and refractive index components.

2) Around line 290, the terms Fraci(i) and dV/dlnr appear without definition. I guess they are in the table 1, but since table 1 (in the PDF) wasn't near the text, one might want to define first time in the text.

3) The stars on equation (1) are confusing. Do the stars represent apriori or solutions?
4) In line 355, Csph appears (see comment #2).

5) How are the intrinsic aerosol parameters allowed to vary in time and space?

6) For Eq (7), there appear to be a lot of zeros in the matrix. We can assume there is no covariance? For example, I can't see avc (volume size distribution) and av (total volume) as being independent

7) Line 396-397: I guess I am curious, what do you mean by: "choice of mixing rule.. significantly affects the results". Can you show something about this?

8) It appears that Eq (11) and Eq (12) have the same RHS?

9) Line 448 looks like a formula (11 minus 12) not 11 and 12.

10) Lines 455-484: See my comment #1.

11) I have a few comments regarding figure 5 and paper text. Could Fig 5a be split into

two? There is a huge range of real refractive indices for CAI, but not for BrC and NAI. I cannot tell if the differences in assumptions for BrC and NAI around 1.5 are significant.

12) Line 532-540. These range of values could also be added to a table (e.g. #1)

13) Line 545-546: “Elevated” meaning larger loadings or higher altitudes?

14) Lines 547-550: Are the fractions of BC and CAI somehow constrained so they can’t be “large”? I note that they never approach 0.5 and barely approach 0.1

15) For the plots of Figure 6, I am wondering what the “uncertainty” is. Should I read this as Uncertainty is fraction (%) of fraction? What if these were presented in same units as x-axis (fraction)? Of course estimates of tiny fractions should have large % uncertainties, (but then that also means that the estimates of the fraction of the other elements will have lower % uncertainties).

16) Line 581. I don’t understand: “The non-absorbing insoluble can stand also for the insoluble organic carbon”

17) Some of the figures have panels with cut-off axes (e.g. Fig 3)

18) Are the units Fig 15-19 correct? (mm3/m2)?

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