

Interactive comment on “Improved inversion of aerosol components in the atmospheric column from remote sensing data” by Ying Zhang et al.

Anonymous Referee #3

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General comments:

Article is well in the scope of the ACP journal and discusses a method for retrieval of aerosol chemical composition from remote sensing. Aerosol chemical composition is in a grand demand by a scientific society providing data to evaluate global atmospheric modelling and climatic models. Presented method introduced some of the novelties and meanwhile is based on a well-established and proven techniques. Paper is well referenced at least to my knowledge, although I've found some inaccuracies (see in notes below).

At the same time, I have a feeling that paper doesn't reflect fully the potential of the method and the complexity of the work performed by authors, and definitely doesn't provide enough explication to reproduce the described method. Article is very brief and

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dry, to the extent it sometimes hard to read and what is more important to understand concepts of the study performed. Also, I've found out quite a number (for a short paper of 10 pages) of typos, please, consider general grammar revision, some of them I've listed below.

I would recommend this article for publication after major revision, which in my opinion should increase the impact and significance of the presented results.

Below I've highlighted some points where there is a room for improvement.

Major comments:

Formula 12: Possible typo, square is missing in numerator. Either it is missing either it is no chi-squared function. Please, clarify. If no square formula was actually used for the study, I'm not sure the method is legit as opposite sign errors in refractive indices at different wavelengths can compensate each other. Minimisation procedure of chi² function is not described at all, at least mention how it is done. What is “iterative kernel function”, is it LUT or a version of Newtonian method? is it the same that was used in previous studies? Please clarify or refer.

Whole section 3 is rather confusing, despite of illustrations and formulas it doesn't give a clear understanding of a methodology, just some of its pieces. Also, if this method is an improvement of an existing one, it should be clearly referred and changes introduced highlighted. Please, consider re-formulating this part to make it clearer.

Figure 3 and Aerosol classification in section 3.1, it is hard to understand at which part of the retrieval this classification is used. And what parameters it used to classify aerosol in groups? Is it part of forward modelling? Does it use PVD provided by SONET, other part of paper claims only refractive index is used... And section 3.3 refers to refractive index of fine and coarse mode...

Also “combined” aerosol types such as BC, OM, IS and AW are used only in figure 3 and not referenced anywhere else in the paper. Why then there are presented?

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Personally, I would prefer here a flowchart of the retrieval algorithm in general, i.e. where it would be easy to understand what parameters enter it, how refractive index is modelled and fitted and what parameters are coming out.

Error analysis: I would like to be convinced that method works, by showing a retrieval without any noise added, proving that it retrieves the exact pre-defined composition, i.e. calculating CRI using the forward model and retrieving it back again. Errors are analysed only from the point of view of data uncertainties, although some of them can emerge from the retrieval itself (i.e. inaccuracy of the forward model) and an obvious fitting bias in figure 6 can be an indication of that.

Data analysis: Again, very dry, some additional analysis (for e.g. splitting sites into several groups and analysing the seasonal averages for the groups) would be appreciated. For instance, there was a statement that higher BC in winter is because of heating in north region, splitting sites into heated/not heated regions and analysing seasonal trend would make this statement much more trustworthy and results obtained more significant. Also, a comparison to a previous method could be presented, if, of course, such comparison could be done. For e.g. comparison with OM from Zhang 2018 could be performed to illustrate improvements (if any), or discuss the similarities/differences observed.

There is a misfit error available as a result of the retrieval, why not use it to clean up the data a bit? This will provide more trustworthy results. Besides, as I understood estimations of the SONET retrieval errors for complex refractive index are available, why not get rid of the results whose fits are below the error bars? Authors themselves claim that ~40% of the retrieval are above the average error, i.e. these results have questionable quality and could significantly influence the statistics provided.

Minor comments:

Line 70: I would suggest replacing “much information” to “sufficient information”

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Lines 87-89: "Using the sub-modal characteristics data set thus obtained, an aerosol sub-modal model was established for China by Li et al. (2019), but the sub-modal aerosol components have not been given." I'm not sure what authors mean by this sentence, please, consider rephrasing.

Line 94: "...the linear interpolation method is used to match the SONET observations...", please clarify if interpolation in time or alt/lat/lon or all together were used.

Line 210. It is claimed that error of 50% in AWf is “acceptable”. No references or desired thresholds were provided to jump to such conclusion. Consider providing them, or rephrasing the sentence to a milder comparison.

Line 308: "...improved a component inversion algorithm...", please refer to a baseline method. And what improvements authors refer to? No comparison to previous methods shown, is it complexity of the composition? Please clarify.

Line 353: I presume that another Dubovik 2000 paper, “Dubovik, O., and M. D. King, 2000: A flexible inversion algorithm for retrieval of aerosol optical properties from sun and sky radiance measurements. J. Geophys. Res., 105, 20 673–20 696.” will be more suitable in the context it is referenced in the article.

Figure 5. I would appreciate to have numbers on pie charts too like figure 4, or an additional table with percentage of the components for each site.

Figure 6. Why only imaginary for fine and only 670? Fitting statistics is a necessary (but not sufficient) metric to justify that the method works. Please consider showing at least a real part at 670 too, but I would be more convinced to see all of them, all wl and fine/coarse. At least show minimal set, following the structure of Table s2 fine/coarse real/imaginary and 440 too, since they all referenced to have different level of uncertainty. Also, please, mention that it is fine mode in figure caption.

Figure 7. Is it possible to re-plot or at least re-paint so the color scheme will be the

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same as in figs 5 and 6?

Table 2. Please specify what “No” in the head of the table means. If this is a number of observations, then why for quite different observation periods the numbers are so close? Was observation data filtered? Please, clarify.

Table s2 and s1. They are not a part of a publication provided (.pdf) and I don't see much reason why. I mean they are rather small and multiply referenced from the text, what is the reason to have one external half-page containing them?

Technical comments:

Figure 3. Size distribution axis. I believe it is $\mu\text{m}^3 \cdot \mu\text{m}^{-2}$

Line 27-28: “. . .retrieval of the chemical composition. . .”

Line 49: “. . .simultaneously retrieved. . .”

Line 56: “. . .to solve for the refractive index in a multicomponent liquid system”

Line 57: “. . .in the algorithm. . .”

Line 70: “. . .radiation to determine the columnar water vapor”

Line 93-94: Probably author meant “To avoid observation uncertainties, only data from manned weather stations that are maintained regularly were used.”

Line 185: “. . . by the different aerosol size distribution. . .”

Line 246: “On the one hand”

Line 247: “. . . than for the other components. . .”

Line 252: “. . . data points are below. . .”

Line 260: “. . . high in spring. . .”

Line 260: “. . . to the dust transport from the northwest China. . .”

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Line 261: “. . .seasons indicates that the aerosol at some sites”

Line 262: “. . .due to the observational errors. . .”

Line 304: “. . .changes in the meteorological conditions. . .”

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2019-1062>, 2020.

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