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comment**

Interactive comment on "How much information do extinction and backscattering measurements contain about the chemical composition of atmospheric aerosol?" *by* Michael Kahnert and Emma Andersson

Anonymous Referee #1

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The ACPD paper by Kahnert and Andersson deals with the assimilation of lidar observations into a chemical transport model. They investigate how much information about the chemical composition can be extracted from backscatter and extinction measurements and how this information is best assimilated into a chemical transport model.

Overall the paper is very well written and should be published as it is an interesting and important contribution to aerosol research. I only have a few minor comments which the authors may consider for their final paper. I have to say that my experience lies more on the lidar and aerosol optics side than on the information theory / mathematical

side, thus I was not really able to review all theory details described in the appendix.

Comments:

It may be beneficial to say a few words about the refractive index and the size bins of the individual species of MATCH. I suggest to add a table with the refractive index of these species at the lidar wavelengths.

Line 105-109: The description of the MATCH aerosol microphysics module could be shortend as it is not used in this paper.

Line 118: What about the emissions of the other species? Are they also from EMEP?

Line 134: "an" -> "and"

Line 147 "we constrain to better than observation error": It is not clear to me what this means.

Line 151: Remove "the".

Line 177: "To be specific" could be removed.

Line 177: Do the results (N_s and H) presented in this section depend on the order of the parameters? If yes, are the changes significant?

Line 185: "around 7.4 for a single wavelength to around 10-12 for two wavelengths" would be more precise.

Line 203: I was not aware about the difference between "observation error" and "measurement error". Is this generally accepted terminology? Maybe you can add a reference here so that the reader not familiar with this terminology can see that is used also elsewhere or was introduced by someone (maybe Rodgers?).

Fig. 1: The difference between the middle and the right subplot is hardly visible. Perhaps you find a better way to visualize it.

Line 229 (and at other places): You use beta_sca and beta_bak for the backscatter

coefficient. Please use only a single symbol throughout the paper.

Line 241 "the secondary inorganic aerosol (SIA) species are almost completely restored by the 3DVAR": Is it understandable why exactly SIA is restored? Because of the refractive index? Or does it have something to do with the order (index number) of the species in the model?

Line 274 "there appeared ...": This was not really shown in the paper, so you might remove this sentence or write it in a different way.

Fig. 3: In this figure the difference between "observations" and "analysis" is much smaller than 10 % (the assumed "observation error"). As this is somewhat unexpected (but understandable as an optimization is applied) you may add a brief discussion about the effect a "measurement error" (noise) would have. Because of the assumed linearity this probably is not very difficult to explain.

Fig. 4: Could it be of interest to see which aerosol species (size bins) the individual variables represent? What would be the effect of changing the order of the species?

Line 277: "to be sure" could be removed.

Line 314: I think some aerosol species exist for which assuming externally mixed spheres is not that wrong.