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Atmospheric Measurement Techniques Discussions

Interactive comment on "Issues related to the retrieval of stratospheric aerosol particle size information based on optical measurements" *by* Christian von Savigny and Christoph Hoffmann

Anonymous Referee #2

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1 General Points

This paper investigates the bias in retrieved particle size properties between occultation and lidar measurements due to differing sensitivity. In particular, errors due to the assumption of a unimodal lognormal distribution are investigated when the true distribution is bimodal. Error in retrieved distribution parameters as well as integral properties are explored. This paper represents a useful addition to the understanding of bias in retrieved stratospheric aerosol properties, and is clearly and concisely written. I think the discussions and conclusions are at times too broad given the analysis (discussed below) but would recommend publication after minor edits.

In general, the choice of assumed bimodal distribution parameters seems reasonable, however I think some further discussion or analysis of the sensitivity to the choice of these parameters and retrieval algorithm is needed with regards to Figs. 3-6. Without that it is difficult to say exactly how broadly this analysis can be applied. For example, in SAD the increase in error as CMF grows seems reasonable, but then it decreases as CMF grows further. Presumably this is due to the fixed width, and the retrieved median radius of the distribution shifting smoothly between the two modes. But this seems dependent on the retrieval assuming a fixed width and the choice of a priori values and bimodal state. Similarly, do other, commonly retrieved quantities such as effective radius show this effect? How large is the error in the retrieved Lidar extinction?

2 Specific Points

L203: It is to be expected that the systematic differences in retrieved aerosol sizes for lidar and occultation retrievals will increase during periods of enhanced volcanic activity, because then the second particle mode at radii of several hundred nm will be enhanced (e.g., Deshler, 2008).

- By "size" do the authors mean median radius? It is not discussed how other size metrics such as effective radius may react, and SAD and volume are not necessarily worse.
- Is this error not dependent on the assumed properties of the retrieval? If the a priori width was too small, could the error not decrease after volcanic activity?
- It is not clear that volcanic activity necessarily leads to an increase in particle size. While true for large eruptions such as Pinatubo, smaller, more recent eruptions have a more ambiguous signal, at least in terms of the wavelength dependence.

L215-219: It is also important to note that the correct particle size parameters can in principle be retrieved from measurements in any observation geometry (neglecting here issues related to potential non-uniqueness of the solutions), if the assumption of a mono-modal log-normal particle size distribution is correct. . .

Is this meant to apply to the 2-wavelength retrievals investigated here? If so, I think it should be noted that not only must the unimodal assumption be satisfied, but one size parameter must also be known a priori. If more general, I think non-uniqueness is not an issue that can be neglected.

L220: The results presented here are also of importance for model simulations of stratospheric aerosols, some of which model aerosol growth processes more or less explicitly

Is this a recommendation to not compare with derived quantities, but more direct measurements of extinction/back-scatter?

L83/L201: The effects studied here should, however, also be investigated for aerosol size retrievals from limb-scatter measurements in future studies.

Some aspects of these effects, and the sensitivity of limb scattering measurements to particle size have been previously investigated by Malinina et al., (2018) and Rieger et al., (2015).

There's a few orphan sentences that should probably be incorporated into surrounding paragraphs or reorganized/expanded (L95, L203, L114, L220).

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