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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

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The paper contains some useful information. But overall content of the paper is weak and would be of limited interest to the researchers in the field. Hence I do not recommend the paper for publication in its present form. In the following I highlight my main concerns. If these concerns are adequately addressed the paper may become suitable for publication.

The paper discusses errors in the retrieval of aerosol particle "size" from optical measurements. This is justified in the abstract by saying that the "size" AND "size distribution" are fundamental properties of the aerosol, implying that they are two distinct quantities. Obviously, they are not. The word "size" is an ambiguous term for aerosols

whose radii can vary by orders of magnitude. It is not until later in the paper one finds that by size they mean "median radius". But why chose this quantity instead of the effective radius, a commonly used parameter in the aerosol community, defined as the area-weighted radius.

This is not just a matter of personal preference. Many investigators have found that effective radius is a robust measure of aerosol size, since it is less sensitive to the assumed particle size distribution than other parameters, such median or modal radius. Indeed there is no scientific consensus on the median radius of aerosol particles, since microphysical models of aerosols indicate that bulk of the aerosols particles in the stratosphere (possibly more than 90%) are of radii less than 100 nm, to which optical instruments, including in situ optical particle counters, are insensitive. Though these particle are important for the formation of larger particles their effect on solar radiation, and hence on climate is minimal. So, it is not clear in what sense the median radius is a "fundamental" property of aerosols.

The choice of the median radius to define aerosol "size" then leads to the paper's key conclusion that the spectral dependence of aerosol extinction cannot be used to retrieve it with high accuracy. But I am not aware of anyone who has claimed otherwise. While the spectral dependence of aerosol extinction, often condensed into Angstrom Exponent (AE), is a useful size parameter in its one right, using this information one can estimate one of the two parameters of a unimodal lognormal distribution, the modal radius (same as median radius for this distribution) or the width, by prescribing the other parameter a priori. However, it is absurd to claim any scientific validity to either parameter. The primary purpose of doing this is to estimate the effective radius under the assumption that it can be estimated robustly in spite of the inherent ambiguity in the retrieval process. The paper would have been a decent paper if the authors had chosen to focus on this issue.

The authors, however, do discuss errors in the retrieval of other size related parameters that are commonly used by the aerosol community, such as surface area density

(SAD). So this part of the paper is more relevant. But not adequate attention has been paid in discussing the message of the figures 4-6. For example all these figures show a monotonic relationship between particle coarse mode fraction (CMF) and the size related parameters retrieved from extinction AE. Though quantitatively they do not agree with a similar parameter estimated from another distribution, whose parameters are somewhat arbitrarily chosen, it is hard to put lot of significance to this disagreement. One doesn't know, for example what the results would have looked like had they kept the modal radius fixed and had retrieved the width, as is commonly done by the SAGE group. Also the assumption that the modal radius and width of coarse mode particle distribution doesn't vary as the CMF changes is very likely inaccurate. Finally, it would have been very useful if the authors had plotted their calculated relationship between CMF and AE. Since there is a very long history of AE measurements from SAGE, it would have provided some perspective on how often CMF greater than 1%, where errors in the retrieval of various size parameters increase rapidly, may have happened during this record. My guess is that it is quite rare.

Finally, what is most notable from plots 4-6 is the lack of monotonic relationship between CMF and size parameters retrieved from Lidar color ratio. This indicates that LIDAR color ratio doesn't contain useful information about aerosols size, irrespective of how it is defined. This should have been quite apparent had they plotted the relationship between CMF and Lidar color ratio, so there would be no need to do actual retrieval to make the point. Though this wouldn't be a surprise to the various LIDAR groups, this conclusion is important enough to other readers to be highlighted in the abstract.

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