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Interactive comment on "Evaluation of a Method for Converting SAGE Extinction Coefficients to Backscatter Coefficient for Intercomparison with LIDAR Observations" *by* Travis N. Knepp et al.

Anonymous Referee #2

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Review for "Evaluation of a Method for Converting SAGE Extinction Coefficients to Backscatter Coefficient for Intercomparison with LIDAR Observations" by T. Knepp et al.

The authors present a calculation of Aerosol backscatter coefficients using multi-wavelength aerosol extinction products from the SAGE II and SAGE III/ISS instruments. The conversion methodology is presented followed by an evaluation of the conversion algorithm's robustness. I've tried to offer suggestions below that will improve methodology and overall clarity of the manuscript.

General comments: P1L14: Write out abbreviations for the first case use (e.g. SO2

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(sulfur dioxide)).

P2L36: The discussion on Lidar Ratio, S, needs improvement and more adequate literature referencing. For instance, there is no discussion of spectral differences between SAGE/lidars and how that may impact the lidar ratio. The value of S greatly depends on the wavelength of laser used. There is also no description on how you will interpolate/extrapolate an altitude varying S.

P4L80: I agree this effort is likely more important to do with the three selected ground based lidars. However, it woud be useful to have a follow on study utilizing additional data sets from NASA's MPLNet or the European EARLINet. An ideal case (perhaps there is a case study already) would be to use an event where two lidar sites could provide the vertical distribution of aerosols coincident with a SAGE occultation observation.

P6L125: How can you parse out the vertical distribution of aerosols vs. the horizontal inhomogeneity? There needs to at least be a description of the uncertainty associated with the measurement EBC assumptions. Will water vapor contamination in the longer wavelength bands become a source of further uncertainty?

I'm hesitant that a single value will be able to account for these. For a paper that leans so heavily on the assumption of sphericity in particles, I was surprised to not see a single mention of aerosol polarization/depolarization measurements from either ground-based of spaceborne (CALIPSO, CATS) instruments. These have long been known to provide context for optical and microphysical properties of aerosols. This manuscript could benefit from a short case study in which the authors show a proof of concept with a known event, rather than just grab bulk aggregate statistics that have no physical meaning.

There is recent work describing non-sphericity of Volcanic ash in the stratosphere. In particular, Noh et al., 2017 describe the settling of non-spherical particles after volcanic eruptions as well as a time dependence on the sphericity since eruption.

See (among others):

Michael I. Mishchenko, Janna M. Dlugach, Andrew A. Lacis, Larry D. Travis, and Brian Cairns, "Retrieval of volcanic and man-made stratospheric aerosols from orbital polarimetric measurements," Opt. Express 27, A158-A170 (2019)

Noh, Young Min, Dong Ho Shin, and Detlef Müller. "Variation of the vertical distribution of Nabro volcano aerosol layers in the stratosphere observed by LIDAR." Atmospheric environment 154 (2017): 1-8

Figure 3: Does this suggest that there are geophysical differences in the aerosol loading during the SAGE II/III time periods? Should the width be the same in A/C in non-Pinatubo times?

Figure 6: Is the SAGE data noisier towards the end of the record? Are results any different if you remove the last year? In general, is there something geophysical occurring that is decreasing the spread of the S value over time or that simply lack of signal? Also, the legend is obscuring the data.

Figure 8: Is there an explanation for the discrepancy in MLO BC after ∼2000? Is this cloud contamination? It looks to be consistent – was there some calibration that was changed? The S value at 15km at MLO is much lower after 2000 than other site, which does not seem reasonable for stratospheric aerosol which would largely be well mixed. I'm sure this was verified but are the altitude layers for SAGE and lidar both in ASL?

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