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Atmospheric Measurement Techniques Discussions

Interactive comment on "Stratospheric aerosol particle size information in Odin-OSIRIS limb scatter spectra" *by* L. A. Rieger et al.

Anonymous Referee #1

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Stratospheric aerosol particle size information in Odin-OSIRIS limb scatter spectra L. A. Rieger, A. E. Bourassa, and D. A. Degenstein

Problem: retrieve particle size informatiom from Limb Scatter data

Importance of work: stratospheric aerosols play an important role in Earth energy balance. However, with the demise of the SAGE sensors, there appears to be a lack of global stratospheric aerosol measurement. The Limb scatter sensors have recently been shown to yield extremely valuable information on aerosol vertical distribution (both extinction vertical profiles and vertically resolved particle size). The work presented in this paper deals with one of the three LS sensors which are either presently operating (OSIRIS and OMPS) or have just terminated their decade long mission (SCIAMACHY).

Difficulty: OSIRIS spectral range is relatively narrow (500-800nm), and there is only a very limited number of spectral channels outside of the gas absorbing region. Hence the retrieval of particle size distribution from OSIRIS spectral data alone is not attempted. Instead the authors are relying on two alternate methods, namely (1) using data from a separate sensor mounted on same space platform (InfraRed Imager, or IRI) or (2) using OSIRIS unique capability to make sequential measurements over same air mass at different viewing angles.

General comment: The two methods described in the paper are shown to be flawed, The first method is hampered by (a) difficulties to match the two measurements made by two different sensors and (b) the IRI low SNR. The second method is limited by the relatively small difference between the Single Scattering Angles (SSA) of the two sequential measurements (SSA is 90 degrees +/- 30 degrees). The authors abandonned the latter and seem to be relying on the former for their future data release. The paper seems to be a description of failed attempts with no clear path forward. Is it a necessary paper for the science community, with definite description of working methods? Would it not be better at this point to continue investigating other methods and only report when success has been achieved? A third alternative method would be to try to retrieve aerosol extinction at separate wavelengths (as is done with SAGE), even using the wavelengths within Chappuis band, but performing aerosol retrieval after the ozone retrieval (and iterate as need be). Angstrom coefficient can then readily be retrieved directly from the spectral shape of the extinction coefficient, and consequently one moment of the particle size distribution (such as the mean radius of an assumed logNormal distribution with constant width). At least, that method or others should be tried and reported since the authors seem to leave the readers with no definite answers

Specific comments: 1. A statement is made that "Figure 3 shows that the measurement vectors below approximately 800nm provide almost no discrimination between particle sizes, and thus little to no additional information that could be used for particle size retrieval". The authors make the assessment by comparing the model results for

3 cases: (a) bi-modal (parameters unknown), (b) fine mode (I guess Rmean=0.08 microns, width = 1.6) and (c) single mode (with same effective radius as bimodal, again parameters unknown). Have they tried a wide range of Rmean (from 0.05 to 0.2 for example)? The fact that the Angstrom coefficient vary with Rmean and sigma (over the visible / near InfraRed) can be checked (a) with Mie and (b) from SAGE data. The spectral range 470-800nm is quite narrow and adding 1000nm or 1500nm would indeed be preferable. However, if the Angstrom coefficient is 2 (corresponding to Rmean=0.1micron and sigma = 1.6), then the extinction ratio (800/470) would be 2.89. If the Angstrom number was 3 (corresponding to Rmean=0.05micron and sigma = 1.6), the extinction ratio (800/470) would be 4.9. If the Angstrom number was 1 (corresponding to Rmean=0.2micron and sigma = 1.6), the extinction ratio (800/470) would be 1.7. These are rather large changes. Something is basically wrong in the authors' model or analysis.

2. The description of the scattering angle method is unnecessarily complex. It would be sufficient to show that the phase function in the range 90+-30 degrees is rather mostly flat. The fact that you see SSA effect on your retrieved aerosol extinctions is due to fact that the phase function is not completely flat. The fact that you cannot use that method is that the variation of phase function in the range 90+-30 degrees is not large enough to beat noise and bias errors (Rayleigh).

3. The second method is likewise too complex: Why not using the extinction values at 770 and 1530 nm directly to evaluate the Angstrom coefficient? The mean radius can then be evaluated directly (since you assume LogNormal distribution with width = 1.6) from Mie. Instead, the authors refer to "At each iteration the mode radius and extinction are updated at each tangent altitude using the Levenberg–Marquardt algorithm (Marquardt, 1963)", With a rather complex formulation. Your Section 4.5 shows that the angstrom coefficient retrieval is rather insensitive to Rmean or assumption of uni/bimodal distribution. Basically, that would meam that in Limb Scatter, the information contained in the radiance data can give you fairly good results for Angstrom but

is insufficient to retrieve additional data on Rmean, width, uni/bimodal... So, why attempting to retrieve Rmean as your first step? That should be your last step. What is important (and robust) is the Angstrom coefficient. The Angstrom coefficient has a direct effect on the phase function (0th order), and that is basically all you can get from Limb Scatter radiances. That is rather a bold statement, but I believe that is borne out from your Section 4.5.

4. When comparing Versions 5, 6 to SAGE, it looks like Version 6 is not doing as well as Version 5: Larger bias and larger variances. Again, it appears that the work presented in this paper is unfinished

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