Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2017-299-AC3, 2017

Atmospheric Measurement Techniques Discussions

Interactive comment on "The Ozone Mapping and Profiler Suite (OMPS) Limb Profiler (LP) Version 1 Aerosol Extinction Retrieval Algorithm: Theoretical Basis" *by* Robert Loughman et al.

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Received and published: 25 December 2017

We appreciate the thoughtful comments presented, and have responded to as many of them as possible (significantly improving the presentation, in our opinion). For the cases in which we do not respond as requested, our motivation arises from the following viewpoint:

As its title states, the primary purpose of this paper is to document the theoretical basis for the Version 1 OMPS LP aerosol extinction retrieval algorithm. The algorithm described in the text was used to create the Version 1 dataset, which was released many months ago, and should be accompanied by a clear explanation. So we have

used the reviewers' comments to improve that explanation as much as possible, but requests to try new analysis approaches, etc. are beyond the scope of this document.

However, we are pleased to continue the general discussion about the various ways that limb scattering measurements might be used to characterize stratospheric aerosol properties. We definitely do not claim that we have "perfected" the best approach to this problem in the Version 1 algorithm. Like the other groups engaged in this effort, we continue to experiment with the algorithm, and look forward to publishing the resulting analysis in future papers (alluding to a few ongoing research efforts in this text).

Point-by-point responses are numbered in the same order as they were given in the review, beginning with the major comments:

1. (Horizontal variation question.) We agree that we have not proven that line of sight variation in aerosol extinction is a major error source. Therefore we have reworded the abstract to present this as an area of concern that warrants further study, rather than a clearly-quantified error source.

2. (Bi-modal size distribution question.) As noted in Sect. 3.3.2, our main motivation for using a bi-modal size distribution arose from the existing OPC dataset, which generally features a bi-modal size distribution at the altitudes where the stratospheric aerosol extinction is greatest. But the problem of how to specify this more complex distribution is a serious concern. Our initial hope was that requiring the resulting Angstrom exponent to = 2 would minimize the importance of the 5 size parameter settings, but that is unfortunately not true in all cases. Given that the sparse OPC dataset (for example) shows clear variation of aerosol properties with time and all 3 spatial dimensions, we suspect that a general consensus on the "best" static size distribution to use for the limb scattering aerosol extinction retrieval application will never be reached.

(Angstrom exponent question) We agree that we chose a poor example from the SAGE II data record to support the claim that the Angstrom exponent should = 2. We therefore replaced Fig. 9 with a sample at a lower altitude (20 km, rather than 30 km), which lies much closer to the typical peak of the stratospheric aerosol layer, and which shows Angstrom exponent = 2 for the post-Pinatubo period.

3. (SNR question) The SNR at 40.5 km is typically between 550-800, which justifies its exclusion as a significant error source (see the early paragraphs describing an “error floor" that were added to Sect. 5).

4. (Phase function ratio question) The word “correlation" was not well-chosen, and this section has been re-worded to refer to similar functional forms of the phase function ratio and the ANR as they vary with scattering angle.

5. (Choice of 675 nm wavelength question) At the time that 675 nm was chosen, the quality of the stray light correction for OMPS LP wavelengths beyond that point was uncertain (since those wavelengths played no role in the ozone retrieval). We plan to use longer wavelengths in future work.

(Sensitivity of ASD at longer wavelengths question) We have added aerosol phase function figures for the most promising longer wavelengths that OMPS LP can measure (guided by the SAGE III aerosol channels) at 756, 869 and 1020 nm, as Figs. 12-14. The main effect of using longer wavelengths for that set of ASDs is that the agreement for scattering angle = 30 - 90 deg degrades.

6. (Spectral resolution question) OMPS LP resolution at 675 nm is 15 nm, which has now been added to the text.

7. (Convergence question) Allowing the algorithm to do additional iterations rarely causes the residuals to shrink significantly (i.e., the changes are generally below the $1-2\%$ “noise floor" discussed in Sect. 5).

8. (Stray light question) As also now noted in Sect. 5, our analysis indicates that the residual stray light error at 675 nm generally is at the 1% level or below.

Minor comments:

All of these have been accepted. Some detailed responses appear below:

1. (Acronym question) We appreciate the suggestion to reduce the number of abbreviations used in the text (made by both reviewers). We have removed some uses of abbreviations (particularly in the figure captions). But our main response hopefully makes the text easier to read without introducing repetitive use of long phrases (aerosol extinction, aerosol phase function, etc.), by replacing acronyms and abbreviations with mathematical symbols. These include the following:

β_a for "aerosol extinction" (AE)

Θ for "solar scattering angle" (SSA)

P_a for "aerosol phase function" (APF)

P_R for "Rayleigh phase function" (RPF)

ρ for "altitude normalized radiance" (ANR)

y for "aerosol scattering index" (ASI)

5. (Time of day question) This statement was meant to reference dependence on scattering angle, so the reference now refers to “solar zenith angle" instead of time of day.

8. (Phase function figure question) We have added Fig. 6, which shows how the aerosol phase function varies during the year for several latitude bands.

9. (Fig. 11 reference question) This now refers to Fig. 16 - we have changed the reference so it refers to Sect. 3.4 rather than a particular future figure.

10. (Tangent altitude question) As now noted in the text, Fig. 11 (now Fig. 16) refers to h = 25.5 km and h_n = 40.5 km.

11. (Figs. 13-14 question) We have rearranged the text and these figures (formerly Figs. 13-15, now Figs. 18-20) to hopefully make the presentation clearer.

12. (Averaging kernel question) We have now (hopefully) addressed this point in the text.

13. (Fig. 19 question) This figure has been moved to its more logical place in the text (Sect. 3.3.2, now Fig. 15), and discussed at that point.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-299, 2017.