Reply to Reviewer 3

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We appreciate the comments offered. Our replies to the Reviewer 3 major comments are given below.

Page 3 L10: *Why are ER-2 measurements in August 1991 was used while there were many other ER-2 measurements/balloon measurements during moderate/background periods were available which will be more realistic in terms of OMPS period of measurements?*

Reply: Reviewer 2 also noted this. We agree that there are many other ER-2 measurements/balloon measurements available. We add text 'Our main motivation for using this Pueschel bimodal size distribution arose from the existing OPC dataset, which generally features a bimodal 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'.

Page 4 L10: *I am not an expert in running models but I am not sure how the simulations were done here? The sentence reads as "no explosive eruptions were used for the precursor emission but then in line 19 it reads as the simulation was done for the period 1990-1993 which includes Mount Pinatubo time period. I think it would be helpful for readers if you could explain this a little bit more in detail. As from the model simulations, I believe the simulations were made using prescribed SSTs for the period 1990-1993. My concern here is that a highly volcanically influenced ASDs are used here as this may not be a correct way of representing ASDs for the stratosphere for the OMPS measurement time period which includes many moderate eruptions. May be, it is more realistic if the simulation was done with same prescribed SSTs for the post-Pinatubo period (post 2005) to represent more of moderate volcanic eruptions.*

Reply: We agree that the simulations from modern period that include moderate volcanic eruptions can allay concerns over SST issues, but we think this is minor point. In fact, we are leveraging some CARMA simulations that were performed as part of a Pinatubo-focused study, so all simulations are for the period 1990 - 1993, as indicated. In the subset of simulations used in our paper we used model results that included *only* anthropogenic and non-volcanic natural sources of sulfate and precursors (the volcanoes were turned off, the natural source is from oxidation of OCS only).

Page 5 L 4-10: *How does OPC's compare to these distributions? I would like to see a comparison here. Although, gamma distribution in this case may be a better representation, I still believe that lognormal distribution is the best possible representation of stratospheric aerosols which I think would fit very well to the observations. I would like to see a sensitive analysis to Gamma distribution and* *lognormal distribution and compare them with actual measurements available on an altitude basis. I would like to see how these distributions differ particularly near tropopause region and higher up. Probably showing a comparison at different altitudes may help understand the observations better. The other possible way to compare your results is to compare CARMA ASDs with OPC measurements from Deshler et al., 2003 as balloon measurements have higher vertical resolution than aircraft measurements which will give us an idea how CARMA compares with the observed size distribution. I believe this is an important point to make as authors are testing a new ASD from a model in this study and this point should be addressed.*

Reply: Reviewer 1 made similar suggestions. We agree with you that lognormal distribution would fit very well to the observations. In our case, however, a Gamma size distribution (GD) represents a significantly better fit to the CARMA data than a unimodal normal distribution (UD) or a bimodal lognormal size distribution (BD), and our comparison results between the calculated and the observed ASIs suggest that Gamma-CARMA ASD is suitable for OMPS/LP measurements. The following two figures show the fitting results.

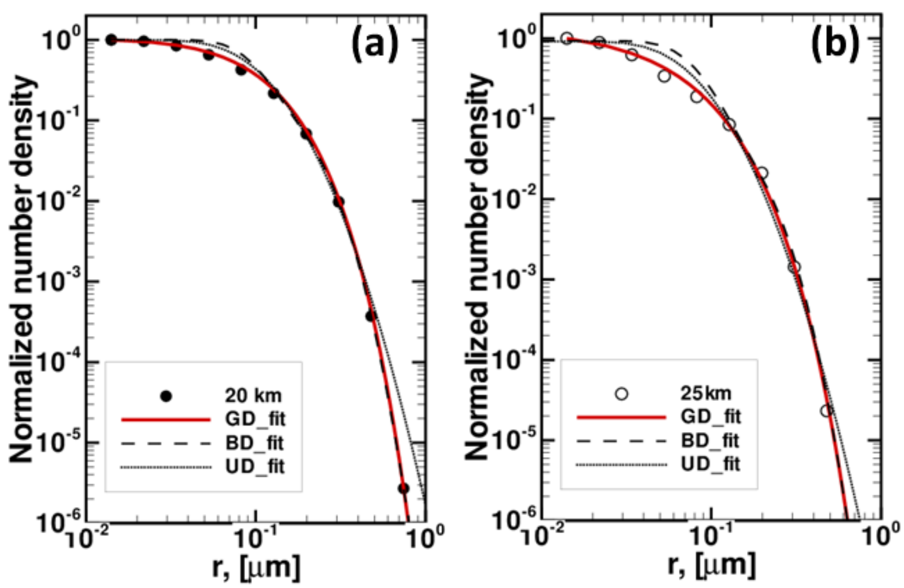


Figure R1. Gamma size distribution (GD), unimodal normal distribution (UD) and bimodal lognormal size distribution (BD) fits to the cumulative number density (N>r) for 20 km (a) and 25km (b). For the purpose of comparison, the cumulative CARMA data between 0.02 - 0.1 µm are also shown.

Regarding OPC data, in most cases, a bimodal lognormal size distribution is used to fit OPC data if there are enough sizes measured (Deshler et al., 2003). However, the same approach may be not suitable for remote sensing instruments working in the limb geometry (Malinina et al., 2017). It is know that almost all OPC measurements have limitations below 0.1 µm such that the aerosol size distribution from 0.01 - 0.1 µm is poorly measured. The lack of information in the OPC data gap region would result in large uncertainty in calculating phase function. We have added an appendix, and Figs. A1-A2 in it speak to the point of this comment. In fact, the Wyoming in situ data just updated and the minimum size measured is now claimed to be 0.094 µm (Deshler, private communication, 2018). We plan to use the new OPC data in future work.

Page 7 L10: I am not sure what this means? "We find that the key difference between the two ASDs is that the Pueschel distribution has larger dN/dlogr values at 0.1 micron, which causes the derived aerosol scattering phase function P(Θ), shown in Figure 4, to be more "Rayleigh-like" at large single scattering angle , i.e., closer to the Rayleigh P(Θ)

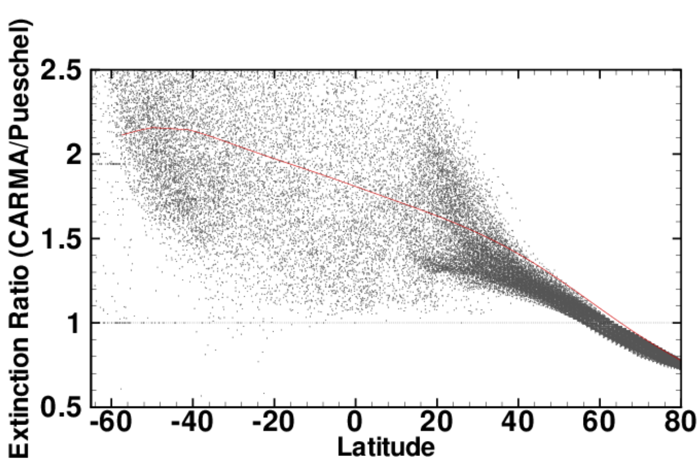
Reply: Reviewer 2 also noted this. More 'Rayleigh-like' means that comparing with CARMA phase function, Pueschel phase function is closer to Rayleigh phase function at larger Θ, i.e., closer to the Rayleigh P(Θ).

Page 10: It may help the reader if authors could explain as how the extinction is computed and at what wavelengths the extinctions are calculated.

Reply: Reviewer 2 made the same suggestion. The following explanatory text was now added: 'We retrieve aerosol extinction profiles at 675 nm from OMPS/LP radiance measurements. We first calculate the cross-section and phase function from the resulting Gamma aerosol size distribution using Mie theory, then run the radiative transfer model (RTM) within the aerosol retrieval code with the new cross-section and phase function to determine how the OMPS/LP aerosol retrieval changes with this new ASD relative to Pueschel ASD in the V1 (Loughman et al., 2018).'

Page 11 Figure 9: How does it look like in the lower stratosphere. This is where the main issue of all limb scatter measurements lies. I would like to see a similar plot for lower altitudes say 18, 16, or 13 km. If you could use a tropopause height climatology and use the above altitudes to do a similar plot, I expect to see some data showing up at 13 km for higher latitudes where I think limb scatter measurements have issues. What wavelength is extinction in Figure 9 calculated at?

Reply: Agreed. We made the following figure showing that the ratio of extinctions (black dots) has a very large variability at 15.5km.



Page 13 Figure 11: The figure says ASI's are computed at three different wavelengths. Are these wavelengths just used for ASI's or are these used for computing extinction as well (for example in Figure 9)?

Reply: Figure 11 shows that ASI's are computed at six (we now changed 'three' to 'six') different wavelengths. These wavelengths just used for ASI's, not for computing extinction. All extinctions are computed at 675nm.

Page 15 L15-20: The OSIRIS data are in reasonably good agreement with SAGEII (Rieger et al., 2015) except in the lower stratosphere at higher latitudes. I would like to see how CARMA ASD's derived extinction compare to OSIRIS. I understand it may be out of the scope of this paper but it would definitely help the stratospheric aerosol community as I believe OMPS measurements are valuable which may help fill the gap between SAGEII and SAGEIII-ISS in addition to OSIRIS/SCIAMACHY/CALIPSO.

Reply: We have compared OMPS/LP and SAGEIII/ISS retrieved extinction profiles. The CARMA ASD's derived extinctions are in good agreement with SAGE III/ISS data. We have also compared OMPS/LP data to OSIRIS. We plan to publish the resulting analysis in the next paper.