

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

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Thank you for the comments. While we are happy to address the specific points listed in your reply, we think we have some central disagreements on the problem being tackled and results of the paper that are best addressed first. Hopefully the reply below covers your main concerns.

- This isn't an ideal scenario and we are indeed information poor to the extent that the aerosol size distribution cannot be fully characterized by OSIRIS measurements. However, we fundamentally disagree that this is a failed attempt. This work has improved both the understanding of the OSIRIS aerosol measurements as well as the extinction product. The decreased precision due to the infrared im-

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ager is unfortunate, but is more than offset by the improved accuracy as well as additional particle size information in the form of the Angstrom coefficient. Figure 1 below helps to show the improvement due to this work. Similar to Figure 9 in the paper, this shows the retrieved extinction between 25 and 28 km in the tropics, however expanded to highlight the years 2002 to 2005. Agreement between measurement geometries is substantially improved with little to no dependence on scattering angle.

- While the work presented here cannot be used to fully quantify the true aerosol state, no definite methods exist to retrieve particle size from limb scatter measurements, and few are even published. This work was instigated not by a comparison to accepted limb scatter particle size retrieval techniques or data products, but by the fact these do not yet exist. This work seeks to address that as well as highlight the ramifications of particle size assumptions in current limb scatter aerosol datasets.
- This paper makes two conclusions that we believe are valuable additions to the current state of knowledge and will be of value to all interested in accurately retrieving aerosol extinction from spectrally dispersed limb scattered sunlight. First, OSIRIS measurements taken at scattering angles of 60 to 120 degrees do not add sufficient information to aid in particle size retrievals when the 1.53 micron channel is available. This is an important statement on the dependence of spectral and geometric measurements, and how despite seeming to be different, can actually contain nearly identical information. Second, the addition of limb scattered sunlight profiles at 1.53 microns does indeed add enough information to improve the retrieved extinctions when compared to inversions done using only visible wavelengths. The fact that the OSIRIS 1.53 micron information is noisy and difficult to work with doesn't change this fact. Therefore, we would answer the question, 'Is it a necessary paper for the science community' posed by Anonymous Referee #1 with an 'absolutely!'. It is our opinion that this is exactly the type

Specific Comments

1. Figure 3 of our paper illustrates the fundamental difference between limb scatter and occultation measurements. The measurement vectors shown here are not direct measurements of extinction, but a complex result of extinction, phase functions, and multiple scattering. This is why even though the extinction ratio may change with particle size, the measurement vector does not. While only 3 cases were tested (parameters used are shown in Table 1 below), this was not meant to be a complete sensitivity study, but to show that for a robust retrieval infrared wavelengths must be included.
2. The phase function between 60 and 120 is not flat and can vary substantially. Changes by a factor of 5 across OSIRIS scattering angles would not be uncommon, nor would a factor of 2 across particle size. The SSA effect (change in retrieved extinction with solar scattering angle) is not due to this variability, but due to uncertainty in the phase function. The fact that this SSA effect is substantially reduced in version 6 is a major improvement to the data product.
3. In regards to the complexity of the method presented, it is simply a different, more complex problem than occultation retrievals such as those used by SAGE. Limb scatter measurements are a product of extinction as well as the particle phase functions, and both must be known to accurately model the measurements. This inherently couples the retrieval of particle size and extinction and makes direct retrieval of the Angstrom coefficient from multiple wavelength extinction retrievals inaccurate when the a priori particle size is used. Additionally, the phase function is not uniquely defined by an Angstrom coefficient, which is why mode radius and mode width must be set and/or altered in the model.

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4. The reviewer's idea of iteratively computing the Angstrom coefficient based on spectral extinction retrievals, then searching for a mode radius and mode width to match, then using those parameters in the next iteration is an interesting one, and worthy of study. However, this technique is not substantially simpler than the method presented here, which combines the steps of [multi-wavelength extinction retrieval] → [Angstrom determination] → [mode radius/mode width search] into a single step determined by the Levenberg-Marquardt search. Therefore, we feel that this additional work is best considered outside the scope of this paper.
5. SAGE III measured mid-to-high latitudes during volcanically quiescent periods (particle sizes likely very close to the assumed values), and as such version 5 comparisons were expected to be excellent. The results show that even when version 5 was expected to be at its best, version 6 provides similar results, despite the noisier IR channel.

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Table 1. Lognormal size distributions used to create Figure 3 in our paper

	Fine mode	Representative	Bimodal	
			Fine mode	Course mode
Number density (cm ⁻³)	4.0	3.0	3.2	0.012
Mode radius (μm)	0.080	0.077	0.080	0.400
Mode width	1.60	1.75	1.6	1.2

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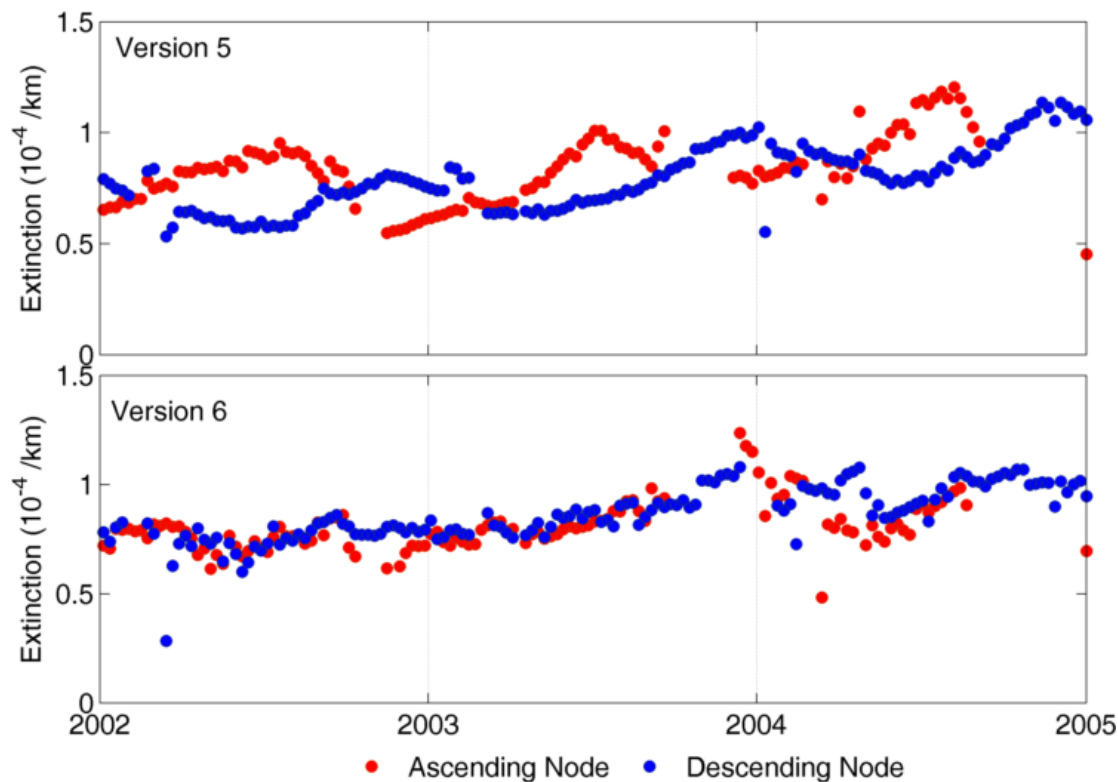
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Fig. 1. Comparison of weekly averaged ascending (red) and descending node (blue) 750 nm extinction measurements between 25 and 28 km and between 20°N and 20°S.

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