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Atmospheric Measurement Techniques Discussions

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Interactive Comment

Interactive comment on "MISR Dark Water aerosol retrievals: operational algorithm sensitivity to particle non-sphericity" *by* O. V. Kalashnikova et al.

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We thank Dr. Reid for his constructive ideas and thoughtful comments, and we have tried to respond to them as much as possible. Below we provide detailed responses to each of the comments, with the original comments in italic.

But in all the exhaustive theoretical analysis, they fail to provide the one thing I was wishing I could see throughout: A hand analysis! They have AOTs>0.4 in the southern oceans when they likely should not. How about showing some side by sides of RGBs and cases where you have erroneous retrievals?

As stated in the abstract, the focus of this paper was to consider the global performance of the MISR V22 Dark Water aerosol retrieval algorithm based on the actually observed viewing geometries and algorithm assumptions. Hopefully it is clear to the reader that this is a significant extension beyond the theoretical studies done for MISR previously reported in the literature. It is out intention to perform exactly the type of analysis suggested by the reviewer, but we feel that is outside the scope of the current paper.

So a conclusion of this is that MISR's cloud screening can't completely detect cirrus, even for high COTs. Instead they say that one should be cautious when cirrus are present. Well, how do we know????

To be clear, the real issue raised by the reviewer is the effectiveness of the cloud screening within the MISR aerosol retrieval algorithm, not the ability of the instrument to detect cirrus in general. The paper is an investigation of the seasonally varying non-spherical artifacts that appear in global analysis of the MISR V22 Dark Water aerosol retrievals. A number of hypotheses were raised regarding the cause of these artifacts, and these were systematically tested as described in the text. Potential cirrus contamination is a conclusion of the paper, rather than the primary focus of the research effort. Ongoing and future research will address the issues of cloud screening and the effect of thin cirrus on the MISR operational aerosol retrieval, but this again appears to us to be outside the scope of the current paper.

Bottom line is that this is important work that just needs to be framed better.

As noted in the first response to Reviewer $\#1$, the framing of the paper was chosen to represent what was, to us, a logical progression through the V22 operational MISR Dark Water aerosol retrieval algorithm. This involved introducing the different aspects of the algorithm and how they are important (or not) to our central investigation into the non-spherical artifacts observed in the MISR global aerosol climatology. We appreciate the reviewer's suggestion that, given the outcome of the investigation, it would be possible to reframe the entire investigation as a study of cirrus contamination in the MISR aerosol product. As mentioned above, we fully intend to pursue this line of research in the future.

Page 1596, line 25. You may want to point out Yingxi Shi's 2011 paper, where they are all mapped out.

We have added the reference to Shi et al. (2011) to the list.

Page 1596 line 27: I always wondered about the medium dust being the best fit, as this is clearly too small. But then, the MISR large is too big!

As mentioned in the paper, Schladitz et al. (2009) demonstrated from SAMUM field campaign data analysis that "monomodal size distribution with a number median diameter of 1μm and a geometric standard deviation of 1.5 represents the measured dust size distribution at the Tinfou ground station." This size distribution was adopted as MISR medium dust (Particle 19). MISR large dust mode (Particle 21) needs further evaluation, because, as discussed in the paper, MISR algorithm very rarely selects Particle 21 as a best fit.

Page 1597: This is an interesting point that we were unaware of-perhaps because we only looked at the non-spherical maps in places where we see dust. Your possibilities for the mid latitude bands sort of slightly brush aside some key points. When you say that (2) there is reduced sensitivity in the high mid-latitudes, really what the initial presentation of the data is that MISR has no sensitivity to spherical particles. These look like maps of coarse mode AOT. Not to add to a long paper, but maybe you should do that in the supplemental materials. Or, you don't have to show all 12 months. We like to do the winter/summer monsoon thing and break it up into Dec-May, June-November. You could have one plot that shows total AOT, fine, medium and coarse AOT and aspherical fraction. This would get us more information and less space.

As discussed in the response to Reviewer $\#1$, we will consider presenting seasonal mean maps, as opposed to monthly mean maps, as long as they retain the features of

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interest. Also, the issue with a plot of coarse mode AOD (or non-spherical fraction × AOD) is that the interesting features end up dominated by the overall AOD in particular regions at particular times. The AMTD format presentation allows readers to toggle back and forth between total AOD (Fig. 3) and non-spherical AOD fraction (Fig. 4) to see the relationship.

Page 1597-part 2. Another possibility here is lower boundary condition. There are pretty big waves in the mid-latitudes too.

Our list of hypothesis was not intended to exhaustive. However, if large waves were affecting the amount of sea foam on the ocean surface, for example, beyond what can be represented by the ocean surface model used in generating the MISR LUT, we would expect to see evidence of this in both the total AOD and the non-spherical fraction, not just the non-spherical fraction.

Page 1601 line 13-27: The thing is that we don't expect AOTs of 0.4 in the sea salt bands. In fact to my knowledge it has never been observed. This does not mean that it does not happen-sampling bias is likely part of this. This discussion is a bit inconsistent with that of Figure 5, where you say that the aspherical fraction is independent of AOT. Really what you want to say is that there are times when MISR has a strong positive AOT artifact (no surprise there). When that happens, it also shows up in the aspherical fraction. Just say it outright. The statement that "this is only for certain viewing geometries" is not really proven either. It could be that for the African Sahara belt there is an absence of artifact (certain type of clouds, lower boundary condition etc) or that you have a big coarse AOT, and that would then be flagged as aspherical too. Just say that too in the early discussion.

The point we were attempting to make with Fig. 9 is somewhat different than that inferred by the reviewer. An initial hypothesis was that the non-spherical artifacts would "disappear" when the analysis was restricted to larger AODs. This is fundamentally related to the point made by both reviewers that we do not necessarily care about

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non-spherical fraction when the AOD is low. In addition, the quality of MISR aerosol properties retrieved when the AOD is low is reduced, at least compared to AERONET (see Kahn et al., 2010). Only considering the non-spherical fraction for locations with retrieved AOD $>$ 0.4 was an attempt to address both these points. If the artifacts were simply due to reduced sensitivity at low AOD, then they should not be apparent at higher AOD – instead the artifacts remain, in a manner precisely consistent with Fig. 5. Figure 9 does not say anything about the sampling, so the question of the rarity of AOD $>$ 0.4 in the sea salt bands is not addressed. The point about "certain viewing geometries" is a segue into the next section where different optical models are tested.

Page 1604. Line 5. So are you saying that where you use dust non-spherical fraction the most (i.e., the Sahara) MISR really does not have sensitivity? I think one way to improve the presentation to make things more clear is that for figure 11 and 12, cut the angles down to where MISR sees. Next, you should normalize them to one key scattering angle. Perhaps 140 degrees. It is the wavelength dependency, not the actual phase function that you care about in the retrieval.

The reviewer seems to be over-interpreting Fig. 11 (as well as Figs. 12–15). Based on single scattering considerations alone, it appears that the MISR Dark Water algorithm would not be able to distinguish (non-spherical) dust from spherical particles in the Sahara region. This comes about due to details of how the viewing geometry happens to be sampled in the vicinity of the Sahara in the summertime, in particular. Once multiple scattering is included, as shown in Fig. 16, the sensitivity of the retrieval comparing non-spherical to spherical particles is very good everywhere. With regard to Figs. 11 and 12, the angles that MISR actually observes are indicated by the vertical lines. As explained in the caption, cameras potentially in glint and not used in the Dark Water retrieval are shown as thin lines and those used in the retrieval are shown as thick lines. As shown in a number of papers, it is MISR's sensitivity to the phase function, not the wavelength dependency, that is being utilized in the retrieval algorithm. MODIS, in contrast, is relying on the wavelength dependency.

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Page 1606 Section 5.1&5.2 can't this be supplemental material? I think the authors can make their point in much more straightforward fashion.

In our opinion, Section 5.1 on the distinguishability criteria and Section 5.2 on the radiometric floor are the key sections to the entire discussion. The distinguishability criteria are the core of the MISR Dark Water retrieval algorithm, while the effect of the radiometric floor in the χ^2_{abs} metric is a central finding of this work, in our opinion.

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