Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2016-569-RC1, 2016

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Development and Assessment of a High Spatial Resolution (4.4 km) MISR Aerosol Product Using AERONET-DRAGON Data" *by* Michael J. Garay et al.

A. M. Sayer (Referee)

andrew.sayer@nasa.gov

Received and published: 16 August 2016

This paper illustrates how the MISR standard aerosol retrieval algorithm's performance improves, compared to AERONET DRAGON deployments (Sun photometers deployed in distributed networks for field campaigns), when the output horizontal pixel size of the algorithm is reduced from 17.6 km to 4.4 km. This increased spatial resolution is one of the changes which will be featured in the next version of the MISR standard aerosol product.

I was initially surprised that this manuscript was in ACPD rather than AMTD, since it is related to remote sensing algorithm updates. However, since the paper is mainly an illustration of results rather than an algorithm description or theoretical analysis,

Printer-friendly version

Discussion paper

I think it can fit in ACPD as well. The quality of language is good and I don't have any major issues with the manuscript. There are however some topics which aren't discussed within the manuscript, which I think shouldn't be too difficult to add, and would increase the interest/usefulness without making the manuscript overly long. I therefore favour minor revisions, and would be willing to review the revised manuscript if necessary.

General comments:

1. As the authors note, the MODIS 3 km aerosol product was found to have poorer performance than the nominal 10 km product when compared to AERONET, which is the converse of the authors' experience with MISR, where the higher resolution improves things. My understanding is that with MODIS this is mostly an algorithmic issue whereby finer resolution means more potential for noise/bias in the assumed surface reflectance relationship. What is the reason that going to a higher resolution makes things better for MISR? Is it a consequence of the way the land surface reflectance is modelled in the MISR standard algorithm, or does it suggest that 17.6 km was perhaps too coarse a resolution to use initially? The conclusion (page 13 lines 8-13) suggests the latter is the case, but I did not see direct evidence; it is definitely plausible, but I don't see why scene variability should lead to a persistent low AOD bias (as opposed to random noise) unless it's nonlinearity in the radiative transfer, or something in the way the algorithm partitions surface vs. atmospheric contributions to the satellite signal.

2. Throughout, the MISR/AERONET comparisons show AOD at 558 nm. AERONET provides spectral AOD and related quantities such as Ångström exponent, and in some cases retrievals of e.g. aerosol fine and coarse mode AOD. MISR retrieves AOD at 558 nm and a set of aerosol mixtures which fit the observations. These MISR aerosol mixtures have defined aerosol optical properties and so can be used to compute Ångström exponent or spectral AOD (and are often used to provide a categorical indication of aerosol 'type', which is one of MISR's selling points). The main focus of the aerosol data user community has been on midvisible AOD since this has been the main quan-

tity observed/retrieved by different techniques but it would be good to show similar types of plot for Ångström exponent and/or AOD at MISR's other wavelengths. If these also improve then it provides an indication that, for example, the set of aerosol mixtures chosen by the retrieval is also improving, which is important for those interested in the 'aerosol type' applications of MISR data. This could be accomplished by adding analogues of Figure 4 for other wavelengths/ Ångström exponent.

3. The examples in this paper are drawn from AERONET DRAGON deployments. As the authors note, these are limited in geographical and temporal extent. There are a number of other areas where I think that the increase in spatial resolution might make a difference due to spatial heterogeneity on scales of a few km. For example, broken cloud fields (such as found in the Amazon) and near-source smoke or dust plumes (in many places of the world). It would be interesting to see a few examples of heterogeneous scenes like this (which don't necessarily have to be matched with AERONET sites) to see what the retrieval decides to do, both in terms of statistics of retrieved AOD, as well as whether a valid retrieval is obtained or not. This could have implications for aggregated statistics in level 3 products in some regions. If the authors would like some suggestions, I can provide some example MODIS Terra granules with interesting features (since MISR observes down the middle of MODIS Terra's swath).

4. A generalised danger in going to higher resolution is that artefacts can start appearing in a data set, due to contextual biases (e.g. related to surface cover) in the assumptions in the retrieval algorithm, leading to artificial structure in retrieved data fields which is taken to be real. This has been an issue for several other algorithms which operate at a higher resolution than the $\sim$10 km scale common to most operational/heritage data products. In this case the DRAGON data suggest that, over these scenes at least, the bulk of the new finer-detail structure appearing in the MISR data is plausible. I would suggest adding a cautionary note to this effect to remind the reader of this possibility, perhaps around the end of the first paragraph in the conclusions where the 10 km/3km MODIS products are discussed, since this effect is not limited to

the MODIS DT product.

Specific comments:

It is a little tangential to the main point of the article, but the MODIS aerosol products' horizontal pixel sizes for the nominal 3 km and 10 km products are only valid near the centre of the MODIS swath. The broad swath and scan geometry mean that pixels get distorted in shape and size as the view zenith angle increases (often called the 'bow tie effect'), which makes them a lot larger than these nominal sizes and causes them to overlap, and in turn affects the characteristics of the level 2 data. See e.g. Wolfe et al (1998) and Sayer et al (2015b) for details. In contrast the MISR pixel size is, to my understanding, much less variable across-track.

Figures 2, 4: It would be good to add in plot titles or captions which data are being plotted here (i.e. California case for figure 2, all DRAGONs in Table 2 for figure 4.)

Figure 4: There are about a dozen points with AERONET AOD of 0.8 or higher, which are quite low-biased in the 17.6 km data set, but much closer to 1:1 in the 4.4 km data set. Are these from the same location or date, or more randomly distributed throughout the data set? This is relevant since, if they're from the same place or time, it could indicate that the higher resolution is particularly helpful for that specific circumstance, and it is interesting to know where you see a benefit vs. where it doesn't make much difference. From Table 2 I infer they may be from the Seoul deployment but it isn't clear whether they're the same date or from sites around Seoul itself (urban) or elsewhere in Korea. Same question for the outliers in more moderate-AOD cases (AERONET about 0.35, 0.4, 0.7; MISR about 0.15-0.2) which also jump more in-family when the retrieval is done at 4.4 km. This comment relates to my general comment 1 about figuring out why the higher resolution is helping.

Page 9, line 10: Can you expand a bit more on what 'complex terrain' means here? I guess it means variable-altitude scenes or similar, but a brief mention of what is tested for/how it is done (e.g. spectral/spatial tests, ancillary data base, etc) would be useful.

Figures 5, 6, 7: these are all on the same AOD colour scale, from 0-1.4. Figure 5 however is a much lower-AOD scene than the others, so it's hard to make out the patterns and values. Perhaps this could be redrawn on the same scale as Figure 1, i.e. 0-0.3? Also, for all these maps, it would be good if a different colour could be used for 'zero AOD' and 'no retrieval'; at the moment both are white. The colour bar font would benefit from being a little larger on all the maps (not legible on the pdf unless zoomed in).

Figure 6, 7 captions: delete 'the' in 'the Korea', or change to 'the Korean peninsula'.

Page 13, lines 14-19: I know that us data providers hate to hear the question, but if the authors are able to comment on whether there's a tentative schedule for the release of the new data set version, incorporating the higher resolution as well as the other updates mentioned in the referenced paragraph, that would be helpful. If it is up in the air then no need to include this.

References:

Sayer, A. M., Hsu, N. C., and Bettenhausen, C.: Implications of MODIS bow-tie distortion on aerosol optical depth retrievals, and techniques for mitigation, Atmos. Meas. Tech., 8, 5277-5288, doi:10.5194/amt-8-5277-2015, 2015b.

Wolfe, R. E., Roy, D., P., and Vermote, E.: MODIS Land Data Storage, Gridding, and Compositing Methodology: Level 2 Grid, IEEE Trans. Geosci. Remote Sens., 36, doi:10.1109/36.701082, 1998.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-569, 2016.