

Interactive comment on “Retrieving aerosol in a cloudy environment: aerosol availability as a function of spatial and temporal resolution” by L. A. Remer et al.

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Response to reviewer_2

We want to thank this reviewer for identifying several important issues that required re-examining and at least one opportunity for expanding the analysis.

1. The first important issue was the extrapolation to global conclusions when all of the analysis was done regionally. The reviewer points out that globally,

“there are regions with very limited cloud cover/fraction in which the use of a 0.5km or

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8km resolution sensor would hardly make any difference and those regions probably contribute a lot to the general and global “aerosol availability” from MODIS. Similarly, regions with very high cloud fractions will not allow any retrievals at 0.5 km and therefore would not suffer any loss with a sensor at 8km.”

We agree. We also find this distribution of cloud cover/fraction within the domain that we examined. We even divide our domain into subdomains in which the reviewer-described situations occur at different frequencies. The southwest subdomain (SW) has a high frequency of very limited cloud cover fraction, and the Atlantic Ocean (AO) and northeast subdomain (NE) have high frequencies of high cloud fractions. We felt that the variety of situations found in our full domain and the relative narrow range of availabilities calculated for the different subdomains, despite the differences in their cloud cover enabled us to make the extrapolation to global conditions. We can’t prove it.

At least we cannot easily defend it quantitatively, and the amount of work to create a quantitative defense is simply not worth the effort. The results that we show for continental United States and surrounding oceans are still highly significant and pertinent to the design of Geo-CAPE, which will only view the western hemisphere and be focused specifically on the domain used in our study. We would still like to point out that the availabilities calculated in our domain for the 0.5 km resolution are much higher than the Kahn et al., global value of 15%. Thus, while we cannot prove it, there is a suggestion that moving to coarser resolution will down grade that 15% to a much smaller number percentage.

2. The reviewer comments that “a one-sized cloud mask cannot fit all” is not a significant new scientific result.

This conclusion is not surprising to the reviewer, nor to the authors of the paper. However, we have not found this conclusion appearing in the published literature. If there is another side-by-side comparison of two different cloud masks in an aerosol context

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that reach the same conclusion, we would be very grateful to be directed to that paper.

We feel strongly that such a statement needs to be made, with the analysis to support it, because not everybody in the remote sensing community is aware that cloud masks are designed for specific purposes and cannot be interchanged or shared. The MODIS Atmospheres science team has spent over a decade trying to educate our users about the differences in cloud masks, having no published paper to reference. Furthermore, if this conclusion was so obvious to the remote sensing community, why has the VIIRS algorithm developers created a processing path in which all downstream algorithms (aerosols, clouds, land surface, ocean color and SST) rely on a single universal one-size-fits-all cloud mask?

3. The reviewer criticizes that the temporal analysis based on GOES observation is too limited to allow drawing general conclusions.

The other reviewer made the same statement and we agree. We are now removing “temporal” from the title and down-grading the GOES analysis to a supplemental position. We still want to use the one day of data to have a glimpse on what a geo-stationary satellite might provide in terms of availability at different spatial scales, but now we are more careful to state the limitations on these conclusions. They are only a glimpse.

4. The reviewer discusses that MODIS nominal pixel size is only true at nadir, and at oblique angles the pixel size is actually much larger. The reviewer suggests 4 km at scan edge. It is actually 4x the nadir value or 2km at edge. The reviewer is correct and we became curious if there would be a difference in conclusions if we divided the analysis into near-nadir and oblique view angles. This opened up a new section of the paper with a new figure. We thank the reviewer for giving us this idea to expand the analysis.

The other change we made in response is to change the terminology throughout and explicitly let the reader know that the resolution designations are nominal for nadir.

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5. Another point that the reviewer questions is the logic in setting a threshold for the number of cloud-free pixels necessary before making an aerosol retrieval. The reviewer writes, “it would be interesting to evaluate whether a retrieval at 0.5 km resolution using 5% of 400 initial individual radiances is better than a retrieval performed at 8 km with 1% out of the 400 original radiances which are actually cloud contaminated.”

It would be interesting, but to determine which scenario was “better” we would need to make aerosol retrievals with a means to validate those retrievals. In this paper we never actually make an aerosol retrieval, only evaluate whether a retrieval could be made given a “perfect” cloud mask. Because this paper uses only cloud masks, not aerosol retrievals, the above suggestion is beyond the scope of the paper.

We did play around with alternate thresholds besides the 10%, but the added information using alternative thresholds did not seem to justify the added complexity to the paper in describing the various thresholds and presenting the results. Yes, the availabilities could be vastly different, but the change in availability as a function of spatial resolution, was about the same.

6. The reviewer suggests analyzing CALIOP because it is a perfect cloud mask. We are of strong opinion that there is no perfect cloud mask. Although lidar will separate clouds and aerosols much more cleanly than an imager, there is physically a continuum between aerosols and clouds using any means of measurement (Koren et al., 2007 using AERONET; Charlson et al., 2007 using lidar).

It might have been interesting to compare several different cloud masks, including CALIOP's, but that was not the initial direction of this research. It may be interesting to try such a study for future work, perhaps not worrying about spatial resolution and just asking the question of how do these different cloud masks affect the availability of the aerosol retrieval at the inherent spatial resolution of the sensor. But that would be another study.

P 634 L 5. Agreed. Removed “homogeneous”

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P 635 L 7. We added sentences explaining how we decided on the 10% threshold.

P 643 L 4. We are unclear on the reviewer's comment. Yes, MODIS some times retrieves in very cloudy environments. The 0.5 km resolution (nominal) allows it. The hope is that MODIS is able to sample some of the aerosol in close proximity to clouds, which is expected to have different properties than aerosol far from clouds. The very cloudy environments, may also create cloud contamination in the retrieval, but let's assume there is no cloud contamination. Then the average of AOD from MODIS at 0.5 km will be different from the average AOD from a geosynchronous sensor that only retrieves in the morning, because the aerosol is different in less cloudy conditions. We don't understand the reviewer's comment.

P 645 L 16. Agreed. Statements concerning Geo-CAPE's ability to resolve the diurnal signal have been removed.

Fig. 8. (now figure 9) Rearrangement done.

Fig. 9. For technical reasons it is difficult at this point to replot the figures with Local Time, besides the subdomains span multiple time zones making the east and west edges of the domains an hour apart.

P 645 L 21. The difference between MODIS and APS is that MODIS is not trying to register the different footprint sizes, one on top of each other for a multiangle retrieval. But, the question of whether there is a difference in the MODIS analysis for nadir and oblique angles is interesting. The reviewer's question prompted us to do that analysis, which is reported in the revised paper in Section 5.3

P 643 L 20. We wish we had had an aerosol-oriented cloud mask to apply to the GOES data, but we did not. The authors did discuss the option of removing the GOES analysis sections of this paper. In the end we decided to proceed by reducing the emphasis, rather than deleting the sections. Seeing the diurnal change of availability and the effect of changing spatial resolution is interesting in the context of planning for

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future geosynchronous missions. Obviously, it is not the right cloud mask for the job, but it gives a glimpse, and the authors felt this glimpse was better than nothing. The limitations of the analysis are stated clearly.

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