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Atmospheric Measurement Techniques Discussions

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.

Anonymous Referee #2

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The paper by Remer and co-authors presents an analysis of the frequency of potential aerosol retrievals (so-called "aerosol availability") in a cloudy environment as a function of spatial and temporal resolution. These analysis are conducted based on MODIS and GOES observations to evaluate respectively the impact of spatial and temporal resolution on aerosol availability.

These are interesting and important questions, especially in the context of defining future sensors and missions, but I found several major shortcoming in the analysis and discussion which in my view make the paper conclusions very limited and specific. The only new result provided is that MODIS aerosol availability is currently estimated to be

close to 15% on a global basis but would decrease to 3% to 5% if a perfect cloud mask was to be applied on similar observation at 8km resolution. However, even these numbers are not clearly well established. They seem to be derived (but I can only guess) from the 15% estimate by Kahn et al (2009) on which has been applied the loss percentages of 70-85% estimated in this study over the Northern American domain. It seems to be a rather crude estimate since one could expect the aerosol availability to depend strongly on regional cloudiness. There are regions with very limited cloud cover/fraction in which the use of a 0.5km or 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 even at 0.5km and therefore would not suffer any loss with a sensor at 8km. If this is incorrect, then the authors should really explain how they came up with these global numbers, OR restrict the conclusion to what was actually evaluated over the region of interest. Other than this I don't consider that "Clearly, a 'one-sized' cloud mask cannot fit all" is a significant new scientific result, and the temporal analysis based on GOES observation is too limited to allow drawing general conclusions.

Regarding the evaluation of spatial resolution impact on aerosol availability, I have two major concerns which relate to (i) the definition of "spatial resolution" and (ii) to the complete lack of discussion about the possibility or relevance of making aerosol retrievals within vicinity of clouds. Regarding the definition of spatial resolution, I would have liked the authors to discuss (at the very least) the impact of varying pixel size with view angle in MODIS observations. What is called 0.5km resolution observation is strictly relevant at MODIS nadir and the study seems to ignore completely this (although I am sure the authors do not). If one aims at studying the impact of sensor resolution, shouldn't we restrict the analysis to MODIS pixels where the resolution is indeed close to 0.5 km and reject observation at large view angles ? It may even be worth comparing the aerosol availability at 4km resolution derived from 0.5km observation close to nadir, with real 4km resolution availability derived from 1km or 2km observation at the

edge of MODIS swath (though I realise, viewing geometry also has an impact on cloud detection and could make the analysis a little tedious). Second, I am concerned that a study which focuses on determining the "aerosol availability" as a function of resolution does not address or at least discuss the lower bound of the problem. In other word, it is not discussed whether it makes sense or not to derive aerosol properties within broken cloud field when only about 3% out of 400 pixels remain available for retrieval. For instance, it would be interesting to evaluate whether a retrieval at 0.5km resolution using 5% of 400 initial individual radiances is better than a retrieval performed at 8km with 1% out of the 400 original radiances which are actually cloud contaminated.

I believe these two points at least should be addressed before this paper could be further considered for publication. I would probably advise the authors to consider focusing on the spatial resolution issue on one hand and for a different paper produce a more thorough and extended study using GOES to deal with the temporal aspect of that question.

I am including below a few specific comments in addition to those identified by the first reviewer : * General : when assumption is made of a "perfect cloud mask", it would be worth evaluating the use of a really perfect cloud mask such as one given by a lidar (ex : CALIOP).

p 634 - l 5 : Over land, the 0.47 micrometer channel is used. It is said that this is because the land is darker and more homogeneous. I can see why the land is darker but don't see why it should be more homogeneous. Isn't it that the TOA reflectances are more homogeneous because of increased Rayleigh scattering and not because of the land itself ?

p 635 - l 7 : the algorithm requires 10 pixels (12 over land) out of 400 to do a retrieval. This is 2.5% of the area only. This is inconsistent with the statement p 637 - l 10 where it is said the MODIS algorithm makes a retrieval if more than 10% of the pixels in the product box are cloud free. Even assuming that the brightest and darkest 25%

radiances are being rejected, it would correspond to at least 5% as a threshold, not 2.5%. Can you clarify ?

p 643 - l 4 : The authors wonder whether aerosol retrievals from GOES made early or late during the day when it is clear sky would actually correctly represent correctly the aerosol condition for that day when the scene is very cloudy. This is indeed a very interesting question but it should be extended to the fact that MODIS also actually retrieves aerosol properties in sometimes very cloudy environment.

p 645 - l 16 : I don't think the paper has demonstrated that GEO-CAPE would be able to resolve the diurnal aerosol signal. In fact one can even find contradicting statement in the paper that the "answer to that question lies outside the scope of this study" (p 643 - l 6).

Remarks for figures : Fig 8 : would be useful to order the different subpanels in the same way for other Fig 10.

Fig 9 : Instead of UTC time, I believe local solar time would make a lot more sense and also restrict the presentation of data for those condition where sun is high enough to allow aerosol retrievals. Including nighttime conditions does not help at all here.

p 645 - l 21 : The authors adequately question the impact of varying footprint size with view angle for APS. It would have been great to ask that question much earlier in the study and consider the impact of the very same problem for MODIS.

p 643 - l 20 : The authors discuss the fact that some cloud mask should not be used to work with aerosol retrieval and yet they use a "cloud" oriented cloud mask to perform the temporal resolution analysis. Though I can understand than some main features would be capture by doing this, I think it is hard to evaluate the full gain of high temporal resolution observation when the cloud mask is not designed to actually account for and benefit from those temporal information. Again, I would suggest to separate the two studies as the question of evaluating the gain in aerosol availability from geosyn-

chronous sensors would take a lot more to address than what is currently presented here.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 627, 2012.