**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 #1

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I. General comments: This study has for primary goal to determine a spatial resolution range and cloud mask for which a polar orbiting satellite sensor like MODIS or geostationary like GOES would have a sufficient aerosol availability. The aerosol availability is defined as the number of aerosol retrievals that could be made despite the clouds, divided by the total number of possible retrievals in that domain if this one was completely cloud free. The authors clearly show that a MODIS-like sensor and MODIS-like aerosol cloud mask with an 8 km-pixel resolution would be able to retrieve aerosol particles, at the most, over 3–5% of the Globe (P 644, L18). The authors also would have liked to demonstrate that a geostationary sensor (similar to the one proposed in GEO-CAPE) with a MODIS-like cloud mask and a 1 to 2km pixel resolution would provide

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"sufficient" aerosol availability.

While the study is generally well conducted concerning the aerosol availability from a MODIS-like polar orbiting satellite with different spatial resolutions (section 4), it seems to lack some depth and clarity concerning the aerosol availability from a GOES-like geostationary satellite (section 5). Both parts should be better balanced.

The reader seems to be left with these (sometimes partially) unanswered questions: 1) Does geostationary satellites like GOES resolve the diurnal aerosol signal? The authors write (P 643 L5) that "the answer to that question lies outside the scope of this study" but the conclusion states "(...) at 1 or 2 km resolution, GEO-CAPE will have sufficient aerosol availability even on a day-to-day basis for a local area, and will be able to resolve the diurnal aerosol signal." This last statement seems to rely, at the most, on one day of GOES data in August 2010 and can't, therefore, be said in a general sense.

2) Compared to polar orbiting satellite sensors, does enhanced temporal resolution offset coarser spatial resolution for geostationary sensors (in terms of aerosol avail-ability)? (P631, L8). It seems there is no sufficient information in this study to fully answer that question. Again, the GOES-R cloud mask is applied to the GOES data for only one day in 2010 and extra caution should be applied when drawing any conclusion out of one single day of data. 3) Which one between MODIS or GOES-R cloud mask should be used for "sufficient" aerosol retrieval availability? The authors state: "we con-clude that the GOES-R availabilities calculated here are overly optimistic for aerosol retrievals." and "The MODIS values, where the aerosol cloud mask is well-established, provide much better estimates of availability of different sensor resolutions for a variety of domains". There seems to be no demonstration, reference or either discussion in this study that shows that one cloud mask is more appropriate than the other in terms of aerosol retrieval.

II. Specific comments: . Although the language is comprehensible, the wording could

be sometimes improved (for example, "a cloud mask that protects the aerosol retrieval", "make a retrieval", "as before", "not seen by eye", etc. . .). There is often a lack of effort in finding synonyms for two identical words in a sentence and definite/ indefinite articles seem to be often missing.

. The aerosol "availability" is a key definition in this study and should be defined in the introduction. The authors also need to define what is called "sufficient" aerosol retrieval availaiblity for any sensor.

. It would benefit the reader to start with a short description of both MODIS and GOES instruments in the introduction or slightly afterwards. It should contain spatial and temporal resolution, brief aerosol retrieval description for both sensors and uncertainties (wrong surface reflectance, aerosol model etc. . .)

. A table listing the three MODIS cloud masks and the GOES-R cloud mask with corresponding references would be easy to point to at any moment in the manuscript, especially in the description and legend of Figure 2.

. The GOES-R cloud mask description is confusing and needs more references. It is unclear how the ABI and its resolution as well as the different AWG both relate to the study.

. Section 4.1 explains how the authors downgrade the spatial resolution of the data. First, it seems this section concerns both sensors as the authors point to section 4.1 in the GOES-R portion of the study (P641, L25). If so, it should not be contained under "Aerosol availability from a polar orbiting satellite . . .". Secondly, if the author i) downgrades directly the spatial resolution of the cloud mask and ii) determines each product box as "available" for a potential aerosol retrieval if more than 10% of the pixels in the product box is cloud free (P637, l10), they should also clearly state what was done (or not) about the various bright surfaces (snow, desert). In fact, the authors point out the snow cover as being a potential factor in the decrease of aerosol availability in Figure 6, casting doubt on whether they dealt with especially bright surfaces or not in

their processing of the MODIS data.

. Section 4.3 and 4.4: There seems to be no reason for separating both sections. Also, the following question should be clearly stated and answered in the analysis of Figure 7: does August 12 2010 seem representative of the entire summer season (Figure 6, upper right panel)? Note that for that purpose, Fig. 6 and 7 should present the exact same y-axis.

. MODIS cloud mask or GOES-R cloud mask? Figure 9 and 10 (and corresponding section 5) should focus on how well the GOES-R cloud mask compares to the MODIS cloud mask (through aerosol availability) for different pixel sizes; as well as which one to select for a "sufficient" aerosol availability. If one isn't "better" than the over, the authors should clearly state it and why. In the conclusion, the authors write: "we conclude that the GOES-R availabilities calculated here are overly optimistic for aerosol retrievals." and "The MODIS values, where the aerosol cloud mask is well-established, provide much better estimates of availability of different sensor resolutions for a variety of domains". Nowhere in this study is shown one cloud mask better than the other. Let us note that selecting one cloud mask over the other seems challenging in the current state of this study (that is using one day worth of GOES-R data). Comparing Figure 9-10 to Figure 7 is the first step in answering that question but it seems that we would need to also analyze GOES aerosol availability (i) at the same overpass time and (ii) on a daily average. Figure 11 attempts to do that. It is an important result and seems to resume Figure 7, 9 and 10. However, there is very limited description of the data behind Figure 11 and how the aerosol availabilities were computed. It says in the legend of Fig. 11 that "The availabilities for the local areas (VA, WY, NM, MX) are calculated for the same time as MODIS overpass and are not diurnal averages." This should be in the manuscript as well as how the availabilities were computed for regions like AO, NE NW etc... (daily averages or TERRA overpass time). In addition, some quantification of the cloudiness of each area along with the rest of the results would be very informative.

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. Finally, in the discussion, although a brief passage says "these results (..) should not be used for absolute availability", we can see further in the text: "These results can be used to learn about diurnal patterns". To avoid drawing any conclusions on a one-day worth of GOES-R data, we suggest looking into daily averages (or coincident TERRA overpass time) during the exact same time period as for MODIS (see Figure 6: three weeks of data, the first weeks of each of the three months that define each of the four seasons)

III. Technical corrections: P628, L9:"techniques" P628, L17: suggest adding "(August 12 2010)" P628, L19, "but not the diurnal aerosol properties due to cloud cover developed during the day": suggest better wording P628, L22: "better chance of returning the diurnal aerosol properties": in August 12 2010 (see specific comments) P629, L12: "six harmful pollutants": suggest citing all six pollutants or not informing on the number. P629, L18: "For climate, a global perspective is needed": suggest adding references P629, L26: "Satellites make a unique (. . .) air quality community": this sentence is redundant. It needs better wording. P630, L5: ". . . is challenging, and making aerosol retrievals in cloudy environments is especially challenging": suggest changing "challenging" into "difficult". P630, L7: ". . . separates cloud scenes from cloud-free": suggest "cloudy from cloud-free scenes". P630, L9: "Waquet et al., 2010": suggest adding their paper published in Journal of the atmospheric sciences together with their A-train symposium paper. P631, L8: "In doing so we attempt an answer to the question of whether enhanced temporal resolution from a geosynchronous satellite offsets the decreasing availability presented by decreased sensor spatial resolution, compared to the availability from a polar orbiting satellite": suggest ". . . offsets its lower aerosol availability due to its coarser sensor spatial resolution, compared to the aerosol availability of a polar orbiting satellite sensor" P632, L3: "In addition" P632, L9: "Figure 1 illustrates the criteria of positioning of potential thresholds": suggest deleting "criteria of" P632, L14: ". . . does not take a chance when the heavy dust aerosol overlays the cumulus field": suggest "does not attempt the retrieval of heavy dust aerosols overlaying . . ." P632, L20: "much choosier": suggest "more selective" P632, L26: suggest replacing

"make" by attempt"; this comes up numerous times in the text. P633, L2: " both more and less": suggest rephrasing P633, L25: when referring to Figure 3, suggest saying "left" or "right" P634, L12: "Bit 1, 15 and 18" : this is either too much information or it needs some more explanation, suggest referencing the MODIS cloud mask ATBD P635, L2: Give example of bright surfaces and add sun glint P635, L16 – P636, L14: This description needs some more work. Please see specific comment. P637, L3-6: Those two sentences seem to say the same thing. P637, L10: "The MODIS aerosol algorithm makes a retrieval if more than âĹij10% of the pixels in the product box are cloud-free"; this contradicts (P635 L7) where it seems that the land algorithm requires at least 12 pixels out of 400 (10 x 10 km) to perform an aerosol retrieval? P637, L17: the sentence "Availability is defined as the number of 8km product boxes available for aerosol retrieval divided by the total number of 8km boxes in the region or time period of interest"(P637, L22) should be written earlier and explain the example of 100% aerosol availability P638, L1: add "for" right after "level 1B MODIS reflectances" P638, L16: snow is detected and removed while the MODIS algorithm looks for the 50 % brightest pixels escaping the masking tests. It's not clear how the authors processed the data (see specific comment) P638, L17: "This would not produce adverse effects in the operational MODIS aerosol retrieval because snow pixels have to be eliminated from the retrieval also." Not clear; needs better wording/ explanation P638, L24: "Differences in cloud type and morphology from region to region explain how this happens." : suggest adding more explanation P639, L1: this sentence is right for the full domain. Not right for AO in Spring in Table 2 for example. P639, L17: "The actual MODIS algorithm must also consider surface brightness, causing there to be far fewer retrievals in the SW from the operational MODIS algorithm than is suggested by Fig. 7": suggest adding this explanation to section 4.1 P640, L2: "Calculations of aerosol retrieval availability over broad domains may be insufficient for applications that focus on a particular local area." Suggest giving example and/ or references P640, L16: "not seen by eye": suggest "visible" P640, title section 5: "Aerosol availability from a geosynchronous satellite" P640, L24: what about overlap at high latitudes? Suggest giving at

least overpass time at the equator somewhere in the text. P641, L1: the GEO-CAPE mission should be explained P641, L2: "can observe each location multiple times per day": give more specifics on temporal resolution P 641, L14: "As described above in Sect. 3.2": suggest deleting "above" P 641, L17: "In this way the GOES-R cloud mask is a cloud identification scheme, as illustrated in Fig. 1 and similar to the lower left panel of Fig. 2." Redundant; this was already said in section 3.2

P641, L23: ""available": suggest adding "for a potential aerosol retrieval" P641, L23: "if the number of cloud-free pixels exceeds the specific criterion for the resolution as defined in Sect. 4.1": which criteria? If 10% of the pixels in the product box are cloud-free? Suggest giving more info P641, L26: "number of retrieval squares available for retrieval": suggest better wording P642, L19: "afternoon" P642, L27: "With a geosynchronous satellite making aerosol retrievals, the local NM area would have access to aerosol retrievals on that day,…" suggest: "geosynchronous satellite would provide additional aerosol retrievals in the morning but not in the afternoon." P642, L24: "The most interesting diurnal pattern occurs in NM." : suggest explaining why these are the most interesting P643, L4: "to compensate" : suggest saying for what P643, L4: "Will those early and late retrievals properly represent aerosol conditions for that day when the scene was very cloudy for the majority of the day?: suggest better wording and adding "August 12 2010".

P643, L8: "With increasing of cloudiness": suggest changing into "with what seems to be increasing cloudiness during the day" P643, L9: "the two very cloudy regions": suggest changing into "the two most cloudy regions (at least at the TERRA overpass time, see Fig. 8)" P643, L15: Figure 11 needs more explanation (see specific comments) P643, L23: "Using cloud masks applied to MODIS and GOES radiances we explore the availability of an aerosol retrieval in a cloudy environment.": suggest saying which cloud mask applied to which dataset. P644, L4: "The cloud mask used for MODIS aerosol retrieval is designed to eliminate as many cloud problems as possible": suggest better wording P644, L7: "These different approaches create striking differences

in aerosol retrieval availability.": suggest adding "for one day in Summer 2010" P644, L9: "that avoids false positives for clouds". This was already written in one of the previous sentences. P644, L10: "one-size" P644, L14: "we conclude that the GOES-R availabilities calculated here are overly optimistic for aerosol retrievals." 1) this was not proven in this paper and 2) this statement can't be generalized as the study concerns one day only (see specific comments) P645, L1: "may open up to aerosol retrievals either early or late in the day": suggest better wording P645, L16: "will be able to resolve the diurnal aerosol signal" (see specific comment)

Table 1: Explain the last line of table 1 "8km product" in the legend: suggest "aerosol retrieval opportunity for 8km product if at least ∼10% etc. . ."

Figure 2: Would be more informative if each of the features (cloudy, sun glint, probably cloudy, clear etc. . .) were of the same color in the upper right, lower left and lower right panels; In the legend: "This panel shows only the cloud mask, not the pixels chosen by the retrieval." Suggest better wording; "Red oval identifies a region", "where the aerosol cloud mask finds more clouds than the standard cloud mask" and "The red arrow identifies an area that . . ."

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