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Atmospheric Measurement Techniques Discussions

Interactive comment on "MODIS Collection 6 MAIAC Algorithm" *by* Alexei Lyapustin et al.

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- We truly appreciate a very careful and detailed analysis of the Reviewer. The response to the comments is provided below. We accepted all edits and suggestions except one minor case where we feel the information is already provided and repetition would be redundant.

Dear Authors, First, thank you for a well-written detailed manuscript. The MAIAC product you describe is a very significant addition to the Earth system monitoring capability enabled by the MODIS instruments. I have only a few clarifying areas and this manuscript can be ready for publication. I have numerous smaller suggested edits below, and then several typographic edits at the bottom.

1) You should be congratulated for the "Known Issues and Limitations" section, this is very valuable information to compile and include. No one knows this product better than the authors, and this information is very valuable to end users even though it is not fully digested (if it were fully digested it would probably be solved!)

- Thank you for your comment. This section should help users, especially the new ones, in their application or science analysis based on MAIAC dataset.

2) The assumed background AOD seems very important. If the assumed background is too low by 0.01, what is the resulting error in the retrieved AOD?

- In general, at low AOD it will translate into a similar low retrieval bias of $\sim$0.01. At higher AOD, the uncertainty in aerosol model will play a much larger role than this source of uncertainty.

3) If the "reference SRC" is updated before retrieval of AOD, this means it is impossible for MAIAC to retrieve an AOD lower than the assumed background.

- It is updated after, but in general you are correct. For instance, assuming background AOD$\sim$0.05 works well for the North America in summer, but creates a significant bias in late fall-winter when the background value is closer to $\sim$0.02. That's why the background AOD in some regions is seasonally-dependent, and it was carefully selected by "calibrating to" the AERONET measurements for each region. However, the retrieved AOD can be lower than the background value due to different sources of errors in MAIAC, some of which can be considered as random (e.g., uncertainties of gridding) or systematic (relatively wide angular bins of SRC which creates albeit small but detectable geometry-dependent bias. For instance, analysis of Superczinsky et al., or the current results of Mhawish et al., indicate the need to add 2 more bins at high VZAs).

Does the two-stream method described for correcting the "reference SRC" upward mitigate the upward trend in AOD that would be expected from downward updates to the "reference SRC"?

- MAIAC SRC-retrieval procedure was worked out well, and it is quite resistant to noise and errors (e.g., from residual clouds). The major impact on SRC comes from undetected shadows which can reduce the value significantly if undetected. That's why I've put a large effort into a good shadow detection so it won't interfere with SRC retrieval. All other factors (e.g., high AOD or un-detected clouds) tend to increase SRC and don't affect our minimum reflectance method. From this prospective, the main issue is not to go "down" for SRC, but instead is to find the cloud-free day with minimum aerosol for regions with persistent haze like southern China which may require from half a year to a whole year to initialize the SRC.

MINOR notes and edits: Page-Line 19-20 How are cloud shadows flagged in the output product?

- It's in the first 3 bits (0-2) of QA (see Table 2b), value (101 — Cloud Shadow)

4-15 "with optimal combination of different cloud tests and smoke detection:" Please clarify if you mean A) MAIAC automatically determines the optimal combination of cloud tests and smoke detection; B) The authors have empirically determine the optimal combination and implemented this in MAIAC; C) Within the MAIAC framework, selection of an optimal combination is possible (similar to how the MISR research retrieval can be hand-tuned to obtain the best answer for a given scene)

- The answer is B). We changed the relevant sentence as follows: "With optimal combination of different cloud tests and smoke detection, which was found experimentally based on large-scale MODIS data processing, . . ."

13-26 "The land surface is considerably brighter at 2.13um compared to the Blue wavelength. This results in spectral dependence of the BRDF shape and in SRC dependence on the view geometry." This demands an additional sentence of explanation.

- The relevant text was changed as follows: "This results in spectral dependence of the BRDF shape: when the surface is dark, the BRDF is well defined by the first order of

scattering whereas in case of bright surface, the photon can experience several scatterings on microfacets of the surface "roughness" before escaping into the atmosphere which results in relative flattening of the BRDF shape. For this reason, SRC depends on the view geometry."

6-17 This could be clearer. If I understand correctly, LUTs are generated for P=1 for all wavelengths. For wavelengths shorter than 660nm, a second calculation is done for P=0.7. Is this because the pressure correction is largely the signal of the molecular atmosphere, and thus diminishes at longer wavelengths?

- That is correct. To make it more clear, the sentence was changed as follows: "Because Rayleigh optical depth rapidly decreases with wavelength, computations with P=0.7 are done for wavelengths shorter than 0.66um."

5-11 Either here or at the beginning of Section 2, please enumerate the static data used by MAIAC, so that the reader clearly understands that all other values are dynamically updated by the MAIAC processing.

- The following phrase was added at the end of Sec. 2: "As ancillary data, MAIAC uses static DEM, 1km land-water mask for deep and static water, and 6-hour NCEP ozone and wind speed."

26-9 "seasonal variation in aerosol properties: " Do you mean like the variation diagnosed in Eck et al. 2013 (https://doi.org/10.1002/jgrd.50500)?

- Yes – and thank you, I provided a wrong reference which has now been corrected.

7-5 It would be nice to have a table tabulating the dimensions of the LUT. If you can do it in a sentence, that is also OK.

- Implicitly, the dimensions are stated in the second sentence on p. 7: "Finally, LUTs are computed for a relatively sparse angular grid (delta_u=0.05 for the range u=0.4 – 1 (0o - 66.42o), ïĄ■u0=0.15–1 (0o - 81.37o) and delta_AZ= 9o) and 12 AOD values, {0.05, 0.1, 0.2, 0.3, 0.4, 0.55, 0.75, 1., 1.4, 2.0, 2.8, 4.0} giving the size of 45.7MB per

a regional aerosol model."

Translating into specific numbers gives: 16 Bands x 12 AOD (+ Rayleigh) x 13 (VZA) x 18 (SZA) x 21 (relative AZ), and 2 pressure levels. Because this information is redundant, it is not currently provided. However, if the Reviewer thinks it's important I can easily add it.

24-21 Give yourself some credit! "The QA structure may be updated in future releases to better accommodate the needs of end users."

- I appreciate your comment. I meant to say that we didn't spend much time on QA design, and current structure is not optimal.

23-23 "Following the Sun-View Geometry suite at 5km: : :" I don't know what you are referring to. Is this another MODIS product?

- Thank you for noticing this omission. To explain, the following sentence was added at the end of sec. 10.2.1: "Along with the retrieval results, we also provide the "Sun-View geometry" at 5km resolution which includes cosines of solar and view zenith angle, relative azimuth, and scattering and glint angles which may be required for analysis or applications."

22-24 Is it the first 16 orbits, or is it the 16 orbits with the largest coverage of the tile?

- The second. The relevant sentence was corrected as follows: "At high latitudes, only 16 orbits with largest coverage are reported per day in order to limit the file size."

- Below, we accepted all suggested edits – thank you!

TYPOS and very minor edits: Page-Line 26-23 Devadiga 25-22 Taklamakan 24-10 most pixels 14-7 Uses the LER surface model 13-31 linear interpolation: : : is used within 0.01 of bin boundaries 9-1 The test uses the shortest wavelength MODIS channel 9-24 Please be specific about what "neighboring" means here - The sentence was modified as follows: "This second iteration is applied to pixels which are direct neigh-

bors of the detected clouds."

8-6 This is a good place for a call-forward "See Section 6.2 and 6.3"

- Added.

4-3 This is a good place for a call-forward (see Test C.4, Section 4.1)

- Added (and thank you again - you really delved into the details of the algorithm!!!)

4-15 for most smoke plumes 3-24 For every observation 2-13 we have significantly changed 1-9 "adapt to global processing" or "adopt global processing"

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