Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2017-340-AC2, 2017
© Author(s) 2017. This work is distributed under
the Creative Commons Attribution 4.0 License.

Atmospheric Measurement Techniques Discussions

Interactive comment on "Minimum Aerosol Layer Detection Sensitivities and their Subsequent Impacts on Aerosol Optical Thickness Retrievals in CALIPSO Level 2 Data Products" *by* Travis D. Toth et al.

Travis D. Toth et al.

travis.toth@und.edu

Received and published: 6 December 2017

Comment: This paper identifies the frequencies in which the CALIPSO L2 algorithms fail to detect tenuous aerosol layers (AOT < 0.05) and reports retrieval fill values (RFV) for extinction for the entire column. It also compares these profiles to collocated MODIS and AERONET data to determine AOT is being undetermined/underestimated by CALIPSO. Finally, a method to remedy these RFV profiles is presented. As noted in the conclusion, the main impact of the results shown in the paper, from a data product and lidar algorithm standpoint, is that the CALIPSO L2 aerosol products (AOT, extinc-

Printer-friendly version

Discussion paper

tion) are underestimated. The method presented for correcting these RFVs is a novel concept and valid method. The paper is well written, clear, and gives proper credit to related work. It deserves to be published with a few minor revisions.

Response: Thank you for your positive comments and encouraging review of the paper.

Comment: I have 2 main comments that I believe would strengthen the paper: 1) The "scientific" impact of the work presented in the paper is not well stated. The impacts on lidar data products and processing algorithms are well stated and important, but not everyone that reads the paper will be a "lidar expert". High aerosol loading critically impacts the Earth's radiation budget and air quality, but what is the influence of aerosols at AOTs less than 0.05? To put it bluntly, why should a non-lidar expert care about AOTs of less than 0.05? I think the answer is that, from a climate perspective, they are so frequent that they become important if we ever want to decrease the uncertainties in aerosol radiative effects. I suggest adding a figure that shows the MODIS detection frequencies of AOTs < 0.05 in cloud-free retrievals relative to all cloud-free retrievals (for a few months or even a year of data if possible). Then add a few sentences discussing the figure and point to the potential cumulative impact of these low aerosol loading profiles on global aerosol models (Koffi et al. 2012; http://onlinelibrary.wiley.com/doi/10.1029/2011JD016858/full) and the global/regional radiation budget (Use something like Figure 4 from Yang et al. 2009 to determine radiative impact; http://onlinelibrary.wiley.com/doi/10.1029/2009GL039801/full).

Response: We thank the reviewer for these suggestions. The recommended figure (similar to another reviewer's request) has already been published in a previous paper. Figure 14 of Levy et al. (2013) provides histograms of C6 MODIS AOT over oceans. While the 0.05 MODIS AOT bin exhibits the largest frequency, AOTs less than 0.05 comprise roughly 20-25% of the total sample (i.e., estimating from the figure). Another way of looking at this is through Maritime Aerosol Network (MAN) sun photometer derived AOT over oceans, the histograms of which are found in Fig. 4 of Smirnov et al. (2011). Most areas of the global ocean show occurrence frequencies of AOTs less

CC BY

than 0.05 between 10 and 20%. These are much larger for the Southern Ocean (>80%; cleaner aerosol conditions) and smaller (∼2%) for the Baltic, Black, and Mediterranean Seas (subject to more air pollution). Thus, we do not show similar histograms in this paper, but have added the following text to the manuscript (Conclusions section):

"Note that this conclusion hints that CALIOP may not detect very thin aerosol layers (i.e., AOTs < 0.05), which account for ∼10-20% of the AOT spectrum and are of climatological importance (e.g., Smirnov et al., 2011; Levy et al., 2013). Also, these CALIOP-undetected thin aerosol layers are important for various applications, ranging from data assimilation to aerosol indirect effects."

Comment: 2) The section discussing the anticipation of CALIPSO V4 data products is lacking some important details. The study uses V3 CALIPSO data and V6 MODIS data, but new releases have been made (CALIPSO) or will be made shortly (MODIS). Section 3.7 shows that the frequency of RFV profiles doesn't change dramatically with CALIPSO V4 data products, and points out the important improvements to the L1 calibration and impacts. However, do any of the improvements to L2 retrievals impact your study? Surely changes in cloud-aerosol discrimination or surface detection can also impact aerosol detection and likely play a role in some of the differences in all-RFV frequencies observed. Please add a few sentences in section 3.7 on this impact. Also, there is no discussion about how MODIS V6.1 may change the statistics of MODIS AOT for CALIPSO RFV profiles. Since that data hasn't been released yet, you can't do a re-analysis yet, but please add a few sentences on this topic. I'm not too familiar with what changes will be made for MODIS, so it is possible that none of the changes will impact your results. If that is the case, please let the reader know because that strengthens your paper.

Response: Thank you for the comment. As mentioned to Reviewer 1, checking the change log for over water Dark Target MODIS products (https://modis-atmosphere.gsfc.nasa.gov/sites/default/files/ModAtmo/C061_Aerosol_Dark_Target_v2.pdf), the only major change is the modification of the sedimentation mask, which is unlikely

CC BY

to make a significant change to the conclusions of the study. We did not add new comments to the paper as the MODIS Collection 6.1 data have been only partially released a month ago, after submission of this paper (https://modis-atmos.gsfc.nasa.gov/). For CALIOP data, we have revised the sentence in Section 3.7 to:

"Specifically, V4 data feature improved calibrations of Level 1 (L1) backscatter, as well as improved cloud-aerosol discrimination and surface detection, that may increase the detection sensitivity of diffuse aerosol layers that are reflected in L2 aerosol extinction retrievals."

Further, and as we describe to Reviewer 1, the purpose of the paper was never necessarily a quantitative evaluation of the current products on offer. Instead, we are really stressing a conceptualization of the problem, both for future missions and for science inquiries at high latitudes that rely on three-dimensional aerosol information (i.e., radiative forcing inquiries). We recognize the relative inconsistences. But, in that primary context, we still think that the consideration of Version 3 CALIPSO and approximation of the effect within Version 4 is reasonable. Thanks again.

Comment: Minor comments/suggestions:

Line 112: The phrase "believed likeliest" is awkward to read. I suggest rewording it.

Response: We have edited this phrase to "it is likely".

Comment: Line 445: The fixed lidar ratio of 29 sr is appropriate, but I would include the standard deviation computed in Kim et al. 2017 along with a few words about the fact that the value was derived from constrained lidar ratios over ocean and represents background aerosols within the entire tropospheric column. Otherwise, the reader has to look up the paper to find out that information. (Note: for the future, it would be interesting to see the values of 532 nm lidar ratios that are measured by the LaRC HSRL during NAAMES).

Response: Thank you for the comment. We have revised the sentence to:

CC BY

"The aerosol extinction profiles for all-RFVs are derived in two steps. First, using an assumed lidar ratio of 29 sr (standard deviation of 10 sr; derived from constrained lidar ratios over ocean and represents background aerosols for the entire atmospheric column; Kim et al., 2017), an unconstrained extinction solution is generated from 20 km to the top of the surface-attached layer (3.5 km)."

Comment: Table 2: I suggest adding columns for the standard deviation of the MODIS and AERONET distributions.

Response: The standard deviations of the MODIS and AERONET distributions were added to the table as suggested.

Comment: Tables 3: I suggest highlighting rows 2 and 3 because it is a key result of your work. I also suggest adding columns for the standard deviation of the MODIS and CALIPSO AOT distributions.

Response: Table 3 has been edited to account for both of these suggestions. We have also added the following sentence to the table caption.

"Key results are highlighted in yellow."

Papers cited:

Levy, R. C., Mattoo, S., Munchak, L. A., Remer, L. A., Sayer, A. M., Patadia, F., and Hsu, N. C.: The Collection 6 MODIS aerosol products over land and ocean, Atmos. Meas. Tech., 6, 29893034, doi:10.5194/amt-6-2989-2013, 2013.

Smirnov, A. and coauthors: Maritime aerosol network as a component of AERONET – first results and comparison with global aerosol models and satellite retrievals, Atmos. Meas. Tech., 4, 583-597, doi:10.5194/amt-4-583-2011, 2011.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-340, 2017.

CC BY