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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.

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Comment: The paper presents and discusses the CALIOP detectability problem of tenuous aerosol layers with backscatter below the algorithm noise floor. This technical issue is critical since it propagates into CALIOP climatological AOT studies and based on the selected approach introduces artificial underestimations or overestimations to detected AOT features. The paper is not only limited to addressing the issue. The paper quantifies the related AOT of retrieval fill values (RFV) over ocean (daytime), through comparison with MODIS Aqua DT AOD and AERONET coastal sites, performs

a proof- of-concept exercise to correct the artificial effect of RFV values, introduces the nighttime problem and refers to the CALIPSO improved V4.

The study falls within the scope of AMT. The authors have done a thorough job and have a rigorous approach. The manuscript is well-written/structured, the presentation clear, the language fluent and the quality of the figures high. Furthermore, the authors give credit to related work and the results support the conclusions. I recommend publication following minor revisions.

Response: We thank the reviewer for his/her comments and warm encouragement.

Comment: 1) CALIOP methodology: The description of the methodology is not sufficient. In the Datasets section the authors state that "prior to analysis, advanced QA procedures are performed on the L2_05kmAProf product. This QA scheme is similar to that employed in Campbell et al. (2012) and Winker et al. (2013), detailed descriptions of which are also outlined in our most recent CALIOP-based study (Toth et al., 2016)". This section is of high importance since the scientific methods, assumptions, the validity of the conclusions are based on the preprocessing of the CALIOP data. Although proper reference is given, a short summary of the methodology would help the reader to follow.

Response: This is a nice suggestion. We have revised the sentence to:

"This QA scheme is similar to that employed in Campbell et al. (2012) and Winker et al. (2013), and involves several parameters included in the L2_05kmAProf product: Extinction_Coefficient_532 (0 and $\leq$ 1.25 km-1), Extinction_QC_532 (= 0, 1, 2, 16, or 18), CAD_Score (-100 and $\leq$ -20), and Extinction_Coefficient_Uncertainty_532 ($\leq$ 10 km-1). The Integrated_Attenuated_Backscatter_532 ($\leq$ 0.01 sr-1) parameter from the L2 5 km Aerosol Layer (L2_05kmALay) product is also used as a QA metric."

Comment: 2) In page 11, lines 256-258 and for Figure 2c the authors state that "... L2 CALIOP profiles collocated with MODIS AOT between 0.03 and 0.07." The reason of

the selected boundaries 0.03/0.07 is not clear.

Response: These boundaries were arbitrarily selected to represent low aerosol loading scenarios in order to limit the influence of retrieval failures during high AOT cases. The following sentence appears in the text: “This restriction is meant to limit the influence of layer misclassifications and occasional QA failures, and in particular relatively high AOT cases where unusually high TAB could influence the mean profile.” To be clearer, the following was added to the first occurrence of the 0.03-0.07 MODIS AOT restriction: “(i.e., arbitrarily selected for low aerosol loading scenarios)”.

Comment: 3) I would suggest the authors to provide similar histograms of all over ocean Aqua MODIS AOT (#) for the same domains (used in figure 4) and of AERONET-number of AOT (presented in figure 8), in order for a reader to be able to visualize the differences between the different sensors, apart from just MODIS and AERONET statistical values (mean/median-table 2). This would strengthen the scientific question through the simple visual comparison of the different histograms. The figures could be added either in comparison with the already existing figures or as supplementary files in the end of the paper.

Response: Thank you for this suggestion. The histograms of MODIS and AERONET AOT the reviewer is referring to have been published in other papers. For example, C6 MODIS AOT histograms are shown in Fig. 14 in Levy et al. (2013). Also, histograms of Maritime Aerosol Network (MAN; a component of AERONET) sun photometer derived over-ocean AOT are shown in Fig. 4 of Smirnov et al. (2011). Thus, we do not include similar histograms in this paper. However, we have added the following to make the reader aware of these plots:

In Section 3.3: “We also note, for the reference of the reader, that histograms of C6 MODIS AOT (not collocated with CALIOP) are provided in Levy et al. (2013).”

In Section 3.4: “We note that histograms of sun photometer derived AOT from Maritime Aerosol Network (MAN) observations (i.e., over-ocean component of AERONET; not

collocated with CALIOP data) are shown in Smirnov et al. (2011).”

Comment: 4) Figure 4. The exhibited distributions between the three domains are not similar in terms of the first MODIS AOT bin, between 0 and 0.01. Figures 4a and 4c are characterized by large number of CALIOP profiles, both all-RFV and all, larger than the following bin between 0.01 and 0.02. This characteristic reverses for the 30S to 30N domain. This feature is interesting and may deserve some justification.

Response: Thank you for bringing this to our attention. We have checked on the MODIS AOT distribution in the first bin (0 to 0.01). The vast majority (>99%) of these points are MODIS AOTs = 0. Thus, this feature in the histograms indicates that MODIS AOTs = 0 are more frequent in the 30N to 60N and 60S to 30S domains compared to the 30S to 30N region, likely because the 30S to 30N region is more aerosol polluted (as indicated by Fig. 5b).

Comment: 5) Figure 6. The exhibited distributions between the three domains are not similar in terms of the last AOT Aqua MODIS bins in the 60S-30S domain. Figures 6a and 6b are characterized by a decreasing percentage with increasing Aqua MODIS AOT values (0.2-0.3). This characteristic reverses in Figure 6c. This feature is interesting and may deserve more attention.

Response: Thank you for the comment. We suspect this is due to the relatively “clean” aerosol environment in the Southern Hemisphere (SH) compared to that of the Northern Hemisphere (NH). Thus, MODIS AOTs greater than 0.2 are less frequent in the SH than NH (see the histograms in Fig. 4), resulting in an increasing percentage of CALIOP all-RFV profiles due to the limited number of data points at this higher AOT range.

Comment: 6) Although the paper’s purpose is the description of the RFV problem, the quantification of the RFV problem in CALIPSO V4 may be more interesting than for the outdated CALIPSO V3.

Response: Thank you for the comment. As mentioned in the responses to the other reviewers, when the analysis was originally performed, the V4 products were in initial release. We have completed a case study using the V4 products and included the results in Section 3.7. Minor differences in the results were found between V3 and V4, and the overall conclusions of the study do not change.

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.

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