

## ***Interactive comment on “CALIPSO lidar level 3 aerosol profile product: version 3 algorithm design” by Jason L. Tackett et al.***

**Anonymous Referee #3**

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The authors describe the Level 3 CALIOP monthly mean AOD and extinction profile products, their quality screening and averaging methods. This paper is of excellent quality and worthy of publication. It is very well written and very well structured.

Major comments: Any reference for these statements and assumptions would help the reader: . “The underlying assumption is that all aerosol layers below 250 m are in reality attached to the surface” . “. . . rarity of tropospheric aerosol detection above 12 km” . “. . . altitudes where shallow convective clouds are expected: above 8 km at the equator and lower towards the poles” . “. . . lidar ratio of a dust/marine mixture, which would fall in the range 20sr-40sr”

Please consider adding a Table in section 5 that summarizes all the quality filters that were applied to the level 2 data (i.e., iso80km, CAD, cirrusFringe, extQC, extUnc, NSA

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filter).

It is not clear why the NSA filter is not part of Fig. 8 and 9

Fig. 18 b is not explained in the text. What is its purpose? Similar comment for Fig. 20b.

Consider giving two different names for variable “Agr” in Eq. A1 and Eq. A3.

Detailed comments:

P4 L23: “The 12 km upper limit was selected due to the rarity of tropospheric aerosol detection above 12 km in the level 2 product”. Would it be possible to quantify that statement? CALIOP Level 3 would then be missing any aerosol event above 12km?

P5 L2: consider adding “at night” to “Figure 2 depicts these sky conditions for an individual level 2 granule” if that is the case (and consider adding that info in the legend of Fig. 2)

P6 L3: MODIS needs to be defined

P6 L13: consider adding “clouds” to “desert and snow”

P7 L16: this is if you consider well-mixed aerosols in an atmospheric column of 1km. Is that, right? If so, you might want to add this information.

P8 L10: “The underlying assumption is that all aerosol layers below 250 m are in reality attached to the surface”. Is this assumption based on any observation? Any reference here, even case studies, would be helpful.

P8 L14: “Consequently, global mean level 3 AOD is increased by a small amount, roughly 1 %.” This applies to this one case over the Arabian sea. Do you have more global statistics?

P11 L2: “sky” is repeated twice.

P11 L28-29: “Corresponding seasonal totals and averages, defined as December–

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February (DJF), March–May (MAM), June–August (JJA) and September–November (SON), are also reported in supplementary material.” Which figure(s) does this refer to?

Fig. 6 and 7: Are these gridded maps?  $2^\circ \times 5^\circ$ ? Consider adding this information in the legend.

Fig. 8: Do “All filters” include the “NSA” filter as well (not shown in Fig. 8 but in Fig. 19 instead)?

Fig. 8: consider adding the total percentage of aerosol samples rejected by each filter in the title of each of the 6 graphs

P15 L4: “altitudes where shallow convective clouds are expected: above 8 km at the equator and lower towards the poles”. Any reference here?

P15 L5: delete “at”

P15 L6: Fig. S4b instead of Fig. S4a

P15 L30: “because there is no confidence in”

P16 L1-3: “Low CAD scores also indicate a high probability of layer detection artifacts where noise spikes cause the feature finder to detect layers that do not actually exist.” However, the authors select data with CAD scores between -100 and -20. These are “low” CAD scores. Consider rephrasing.

Fig. 10: Is this figure global? If not, you might want to provide the latitude/ longitude range

P17 L22: “causing aerosol subtyping misclassifications”. Is this the case for the aerosols near the surface in Fig.12? If so, are those corrected? It’s not clear from the text.

P19 L3: “and having a cloud top temperature less than  $0^\circ\text{C}$ ”

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P19 L11: consider adding “in this case” to “The reduction in full column dust AOD...”

P19 L13: consider adding the dust AOD reduction in % in the text (i.e., values on Fig. 14)

P21 L3: “These are the least frequent of all solutions for aerosol layers, however” Can this be quantified?

P21 L28: “... lidar ratio of a dust/marine mixture, which would fall in the range ...” Consider adding references for typical lidar ratios.

P23 L17: consider rephrasing this way: “... profile shape the least while still rejecting solutions that are untrustworthy.

P23 L24: “while having only a small impact on mean AOD” Consider quantifying this statement

P24 L12: “or” is repeated twice

P24 L14: What do the authors mean by “this” example? Fig 18a?

Fig 18a is missing its color scale

Fig. 18b is not explained in the text (and Profile #1-3 are not described). What is its purpose?

Fig 19b: Consider adding AOD in the title.

P25 L6: “AOD increases by 5–10 % in regions affected by the NSA”. The red box in 19b seems to show values between  $\sim 0.8$  and  $\sim 1.2$ ? The authors might refer to the pixels that show only a certain percentage of NSA frequency on 19a. if so, this needs to be specified. “AOD decreases by 5 % in unaffected regions” but it looks like it varies on 19b. More explanation here would be appreciated.

P26 L16: instead of “more aggressive at changing”, consider “more impact than others”

Fig 20b: The description of this graph is not clear. It does not seem to be used in the

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text either.

P27 L5: “dominate the aerosol sample rejection”

P27 L11: four instead of three metrics

P27 L12:  $\Delta z_{63}$  needs to be defined in the appendix, right after  $z_{63}$  (eq. A2).

P27 L13: consider two different names for “Agr” in Eq. A1 and Eq. A3.

P27 L22: “For the remaining filters,  $\Delta z_{63}$  is either zero or decreases by 60 m because these filters act upon layers at higher altitudes”. This is over ocean according to Table 2. You might want to describe what happens over land as well. Legend of Table 2: “and with no filters against all filters and with each filter applied independently”. Consider rephrasing. Also, what is the reasoning behind the ocean and land separation in the Table?

Fig. 22: It is not clear why the authors show the surface elevation in this figure (not discussed in the text).

Fig. 23: Consider adding a mean AOD histogram as a fourth plot (instead of values on Fig 23a)

P30 L6: “greater geometric depth”. Am I not understanding this correctly? Doesn't this mean  $z_{63\_filtered} > z_{63\_non\_filtered}$ ? Which would mean a higher altitude under which 63 % of the aerosols reside (instead of a geometric depth)?

P30 L16-18: “When aerosol loading is low, rejecting just a small number of aerosol samples may have a larger impact on sigma than in regions where aerosol loading is high since there are not many aerosol samples to begin with” This is not clear. Consider rephrasing.

P31 L16: similar levels of uncertainty

P31 L24: in order to reduce

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Appendix: Table B1 comes sooner in the text than appendix A: consider switching Appendix A and B.

Fig. S1-S2 consider “quality screening” instead of “data filtering” to match the legend of Fig. 6-7

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