

Interactive comment on “How much of the global aerosol optical depth is found in the boundary layer and free troposphere?” by Quentin Bourgeois et al.

Anonymous Referee #1

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Review of : How much of the global aerosol optical depth is found in the boundary layer and free troposphere

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The authors describe a large set of CALIPSO data used to better estimate the aerosol concentration within the free troposphere (away from sources) and within the boundary layer. This manuscript is of interest for the scientific community but need major revisions before submission to ACP.

We would like to thank the referee for these positive words as well as the careful review. We very much appreciated the suggestions and comments that helped us significantly improve the manuscript.

MAJOR COMMENTS :

1. The large set of data is always express by years i.e. from 2007-2015. However, it would be useful for the reader to have the numbers of profiles used for each season and each location (Land vs Ocean) and also for each type of particles retrieved by the CALIPSO algorithm. It would increase the confidence for each percentage and value given within this paper.

Overall, more than 1.1M CALIOP vertical profiles are used per month. 55% (45%) of them are retrieved during daytime (nighttime) and 40% (60%) of them are retrieved over land (ocean). This is now mentioned in the “Data and method / CALIOP observations” section.

2. The authors state page 7 that AOD correspond to aerosol mass concentration. From my point of view this statement should be made earlier in the paper to avoid any misunderstanding. As an example, the mass concentration of polluted aerosol is not important while their number concentrations are tremendous.

We agree with the reviewer that the particle number concentration is a primordial parameter for air pollution. However, the focus of the paper is not air pollution but the BL and FT contribution to AOD. Particles need to be optically active (larger than the wavelength of the incident light) to scatter light and thus, to retrieve an AOD. Therefore, the radius - and not the number - of the particles is important and AOD roughly corresponds to the aerosol mass concentration. This is now mentioned in the introduction as well.

3. The authors are claiming to compare the CALIPSO data set with airborne in-situ measurements (LOAC). However, the coincident measurements correspond to 1 flight (corresponding to 10 lines in the paper) and therefore are not really relevant for this paper. The CALIPSO data could be compared to ground-based LIDAR measurements all over the world and to in-situ measurements from all the airborne campaigns (such as DISCOVER-AQ, HIPPO, AMMA, etc: : :). This comparison would provide much more information than what one flight with one instrument could provide.

Since there is indeed a single coincident measurement between CALIOP and LOAC, we compare LOAC measurements for 23 flights over Aire sur l'Adour for the 2014-2015 period with CALIOP vertical profiles collected in a 2x2 degree grid box centered on Aire sur l'Adour for the closest day (before or after) of each LOAC flight. Note also that particles found in Aire sur l'Adour are representative of a rural aerosol background because the closest mountain (Pyrenees), big city

(Toulouse) and ocean (Atlantic Ocean) are located at about 100 km away. So, the comparison between LOAC in-situ measurements and a large 2x2 degree grid box a few days before or after the LOAC flight is relevant. The new Figure 6 shows that the mean vertical profiles of aerosol extinction for LOAC and CALIOP are indeed in agreement, even though CALIOP underestimates low aerosol extinction values in the FT. The underestimate of low aerosol extinction values by CALIOP has also been reported in several other studies that are now mentioned in the LOAC result section. Following the recommendation of another referee, we also repeated the calculations of Sheridan et al. [2012] with CALIOP v4.10 data and 28 collocated flights over Illinois (USA). We arrived at the same conclusion with regards to extinction at the limits of CALIOP detection (i.e. an underestimate of the lowest aerosol extinction values). We expanded the discussion about this matter but we did not add any new figure because it would probably be redundant with Sheridan et al. [2012] results.

MINOR COMMENTS :

Page 4 – L 12 : What does “clear air” refers to ? I didn’t understand why you choose the 2.46km threshold.

“Clear air” refers to air without aerosols. This is now mentioned in the manuscript. We did not “choose” the 2.46km threshold but we used the recommendation of Winker et al. [2013] in order to screen the data properly.

Page 5 L 5 : not well said : the influence of the accuracy of the estimated BL height

The sentence has been changed for: “Sensitivity tests have been performed on the BL height to evaluate its influence on the AOD partitioning between the BL and FT.”.

Page 6 L16 AOD over instead of AOD pver.

Done.