Review of the manuscript amt-2018-335

The scope of the submitted work is to investigate the potential exploitation of CALIOP extinction profiles in order to derive near-surface concentrations of particles with aerodynamic diameter less than 2.5 μm ($PM_{2.5}$). The assessment of the applied methodology is made through the evaluation of the CALIOP derived PM concentrations against corresponding daily ground-based measurements obtained at numerous EPA stations, over the period 2008-2009, distributed across CONUS, which is the area of interest. A powerful element of using vertically resolved retrievals is that the altitude range can be constrained (i.e., near surface where the PM concentrations are measured from the ground) in contrast to passive sensors which are representative for the whole atmospheric column. To my opinion, the issues addressed by the authors fit well to the scientific objectives of AMT and therefore I recommend the submitted manuscript to be published. Nevertheless, I believe that several points must be modified making the text acceptable for publication. My major and minor comments are listed below.

Major comments:

1. The authors have used only 2-year satellite data thus making the robustness of the obtained outcomes questionable taking into account CALIOP's low sampling frequency and narrow footprint. In order to overcome this drawback, you have to repeat the analysis for the full dataset.
2. According to the applied methodology, all the aerosol extinctions assigned as dust in the CALIOP retrieval algorithm are masked out since focus is given on the small size particles (Lines 198-200). However, which is the treatment for the other aerosol subtypes consisting of coarse particles (i.e., marine, dusty marine)? Moreover, what is happening when the aerosol subtype is clean continental? I would suggest to repeat the aerosol type analysis (Section 3.2.8) but considering only the CALIOP aerosol subtypes which are not associated with large size particles (i.e., dust, marine, marine dust) and are relevant to pollution. Keep in mind that appropriate modifications, depending on aerosol types, may be needed in equations 1, 2 and 3 (i.e., mass scattering and absorption efficiencies, hygroscopic growth factor).
3. Could you please comment why the quality assurance criteria applied here are different than those suggested by Tacket et al. (2018; https://www.atmos-meas-tech.net/11/4129/2018/)?
4. **Page 7 – Lines 157-160:** The inclusion of different PM measurements techniques (filter-based or averages from hourly samples) how can affect the intercomparison results?
5. **Page 4 – Lines 97-102:** How much reliable are the scatterplot metrics when MODIS provides daylight AODs while PM concentrations are daily averages? Have you noticed any variation both in spatial and temporal terms?
6. **Page 9 – Line 202:** A couple of citations are needed here in order to support this argument.
7. **Page 10 – Lines 236-238:** It will be useful to provide a map with the number of days participating for the calculation of the average maps illustrated in Figure 3. Moreover, it is required a geographical distribution providing the average number of profiles considered for the derivation of 1° x 1° grid cells (i.e. an indicator of spatial representativeness within the 1deg grid cell).
8. **Page 12 – Lines 270-279:** I don't agree with the collocation criteria applied here. The horizontal distance (100 km) between CALIOP and PM station probably is too long since the analysis focuses on $PM_{2.5}$ originating from pollution. Under these cases it is expected that the horizontal variability will be very strong and the concentrations will decrease rapidly for increasing distance from the source. As it concerns the temporal collocation, the optimum solution would be to use PM measurements available at the finest temporal resolution thus making feasible an appropriate matching with the CALIOP near-surface profiles. On the contrary, if the ground-based data are provided only as daily averages then you cannot consider that a satellite overpass and a daily average are temporally collocated. In the former

data you have an instantaneous observation while in the latter one the diurnal variation is included. In case where the EPA data are given only on a daily basis, then it is more convenient to compare "daily" CALIOP profiles (considering dates where both the daytime and nighttime satellite retrievals are available) against the corresponding surface PM_{10} concentrations. For this reason, I believe that Figures 3-e and 3-f as well as the relevant parts of the text must be removed. Please consider this comment throughout your analysis.

9. **Section 3.2.1:** Considering my previous comment, the analysis should be presented only for the "daily" CALIOP – PM pairs and not separately for daytime and nighttime. Likewise, the CALIOP derived $PM_{2.5}$ ranges (x axis in Figure 5) should be equally sampled and not grouped based on user-defined bins of PM concentrations. In addition, the authors are stating in Lines 314-316 that the computations have not been done for PM concentrations ≥ 25 μg m^{-3} due to the limited number of concurrent annual means. However, according to Figure 5, the number of samples for the lowest bin (< 5 μg m^{-3}) during daytime is almost zero (the same is valid for the highest bins, particularly for the nighttime retrievals). Is that correct? Can we trust the calculated RMSEs resulting from a very small number of samples?
10. **Section 3.2.2:** To my opinion this sensitivity study should be the first step of the analysis in order to define the most "representative" altitude range. According to the summary statistics presented in Table 2, it seems that it is better to restrict the upper bound at 600 – 700m.
11. **Section 3.2.4:** Which is the impact on the r^2 values?
12. **Section 3.2.5:** Instead of presenting daytime and nighttime CALIOP derived PM concentrations it is better to consider only the daily (computed from the concurrent daytime and nighttime profiles) ones (see comment 6).
13. **Page 19 – Lines 448-450:** This means that the CALIOP derived PM concentrations are not reliable in coastal (contamination by sea-salt particles) or dust affected regions?
14. **Section 3.2.9:** In this section it would be also useful to provide a map with the distances where the 1/e value is found at each station.

Minor comments:

1. **Page 3 – Lines 81-84:** Could you please explain better this sentence?
2. **Page 4 – Lines 91-94:** It is not clear what the authors want to say here.
3. **Page 10 – Line 244:** What do you mean exactly here? ("*…, as surface layer heights may change seasonally and diurnally.*")
4. **Page 19 – Line 431:** Sulfate & organic or just sulfate?
5. **Page 20 – Lines 456-458:** Please rephrase this sentence.