Atmospheric
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Discussions

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Interactive comment on "First validation of GOME-2/MetOp Absorbing Aerosol Height using EARLINET lidar observations" *by* Konstantinos Michailidis et al.

Anonymous Referee #2

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General Comments:

In this study, the authors evaluate geometrical features of lofted aerosol layers derived by the Level 2 absorbing aerosol height product of Global Ozone Monitoring Experiment-2 (GOME-2) aboard the Meteorological Operational satellite programme (MetOp) platforms, using collocated ground-based lidar observations from 13 European Aerosol Research Lidar Network (EARLINET) stations. The research has scientific merit and therefore, it is worth being published under the special issue "EARLINET aerosol profiling: contributions to atmospheric and climate research" of the Atmospheric Chemistry and Physics journal. However, I would kindly suggest the authors

to take into account the following recommendations in order to improve the manuscript. I would advise the authors to reorder some parts of the manuscript, e.g results, in which the order of figures doesn't correspond to the order of their appearance in the text. For example, the authors discuss Figure 13 before introducing figures 10 to 12. This is quite confusing. Also, I would recommend to check and improve the language usage. There are a few places in the text where the combination of long sentences and language makes it hard to follow. From the scientific point of view, it wasn't clear to me whether GOME-2/MetOp should only be used to fill a gap compared to other space-based observations (active or passive) or if it is as reliable and under which occasions? Could the authors also comment regarding the performance of the different MetOp instruments? Do they perform equally? Another point that wasn't clearly mentioned is whether the findings apply to all aerosol types or a specific category (e.g absorbing ones)? This needs to be stated clearly in the manuscript. Furthermore, what is the advantage of using GOME-2/MetOp instead of other passive sensors or CALIPSO for the geometrical boundaries of aerosols? Do the results presented here have a difference with similar studies for other space-borne sensors? Should we use AAH product or not, under which conditions these retrievals are reliable? A bit more discussion should be included in the manuscript.

Specific comments:

1. Introduction: I suggest the authors to improve the reasoning for the need of accurate spatial distribution of aerosols. Where this information can be used and what would improve (e.g Xu et al., 2017; Sun et al., 2019)? Currently, this information is more or less there but it is missing a sentence which would bring together and combine all the separate reasons mentioned in the first paragraph.

Sun, J., Veefkind, P., Nanda, S., van Velthoven, P., and Levelt, P.: The role of aerosol layer height in quantifying aerosol absorption from ultraviolet satellite observations, Atmos. Meas. Tech., 12, 6319–6340, https://doi.org/10.5194/amt-12-6319-2019, 2019. Xu, X., J. Wang, Y. Wang, J. Zeng,O. Torres, Y. Yang, A. Marshak, J. Reid, and S.

Miller (2017), Passive remote sensing of altitude and optical depth of dust plumes using the oxygen A and B bands: First results from EPIC/DSCOVRat Lagrange-1 point, Geophys. Res. Lett., 44, 7544–7554, doi:10.1002/2017GL073939.

P4/L18: Referring to the description of the Absorbing Aerosol Height (AAH) paragraph (Sect 3.1.2): What is the uncertainty of the Level 2 absorbing aerosol height product? Is this study the first to evaluate the aforementioned product against ground-based lidar observations? This would raise the significance of the research and should be, more clearly, mentioned. Are there other studies evaluating the AAH product? The accuracy requirement for GOME-2 AAH product is only mentioned later on in the summary and conclusions section.

P4/L30: The authors mention "below 2.0 correspond to scenes with too low amount levels of aerosol to result in a reliable AAH retrieval. Also for AAI values larger than 2.0 but smaller than 4.0 the aerosol layer is not in all cases thick enough for a reliable retrieval. However, most of our aerosol cases correspond to AAI values below the 4.0 level". The authors have used values above 2 in their study. What is this basically translates to (e.g in terms of AOD)? This would give a broader understanding for future users of AAH product and also for this study regarding the aerosol layers included in the comparison.

P6/L1: It is not clear from this section that the authors have used the WCT for the retrieval of the geometrical boundaries of the aerosol layers. They do mention PBL and cloud geometrical boundaries with WCT method but they quickly refer to being used in a previous study to retrieve the aerosol layers too. Please, consider adding this information in a clearer manner. One more comment for this section is whether the authors have merged aerosol layers close to each other and in general, how the aerosol layer information was handled? A more detailed description is needed in order to understand better the discrepancies shown in the amount of aerosol layers between the ground-based lidars and the satellite (e.g Fig. 3 and Fig.8). How the selection of a dilation value of 500 m affects the amount of the detected aerosol layers in the lidar

signal?

P8/L30-35: This paragraph is a bit confusing. The authors have excluded aerosol layers close to ground due to the overlap limitation. This translates to aerosol layers above 1 km as indicated in Fig.8. To this direction, when lidar observations are not available at some upper height threshold then I would assume that the specific case is not included in the comparison as it would bias both the height of the observed aerosol layer between the lidar and the satellite. Correct? Also, it was made clear during this paragraph that dissimilar to the satellite product which assumes a single aerosol layer in the whole atmospheric column, the lidar observations can efficiently detect more layers. Could you include a better description of the comparison procedure and maybe specify this feature earlier in the manuscript? Were there any cases with single aerosol layer detected by the lidar for the while atmospheric column and how the comparison with the satellite looked then? I am not sure if there will be any cases, though.

Technical corrections:

P1/L16: PBL -> (PBL). There are a few places in the manuscript with the same feature, for example, P2/L32 and P11/L2. Please correct. P1/L17: Fourteen -> thirteen. The amount of EARLINET stations is 13 in total, correct? The same comment for P7/L12. P1/L18-21. I assume that the authors are referring to the height of the aerosol layers but this information is missing from these sentences. P1/L31: Consider adding the Ice nuclei (IN) to include ice crystal formation. P2/L1: "Moreover, the vertical…..their dynamic processes". Please rephrase the sentence. Where do the authors refer to with the "dynamic processes", the weather conditions or the aerosol particles? P2/L8: "Active lidar sensors… individual locations". Lidars are active remote sensors but as written it gives the impression that passive lidar sensors might be an option. Please rephrase. I would recommend also to change the word "belonging" to "part of" or something similar. P2/L14: "Therefore, combined studies….on a global scale". I assume that the authors are talking about improvements in temporal and spatial distribution regarding the aerosol particles but the word "aerosol" is missing from this sentence.

Please add it. P2/L20: The acronym AAH is not introduced before. P2/L33: Replace Global Ozone Monitoring Experiment-2 to GOME-2. The acronym is already defined in the beginning of this paragraph. P3/L20: Siomos etal., -> Siomos et al., P3/L27: multiwavelength -> multi-wavelength. A similar comment, ground based -> ground-based (e.g P7/L21). P3/L34: with multi-wavelength Raman -> with multi-wavelength Raman channels. P4/L7: elevated amounts absorbing -> elevated amounts of absorbing. P5/L23: vertical distribution backscatter and aerosol extinction -> vertical distribution of aerosol backscatter and extinction. P5/L32: remove the word "more" P5/L25: In this study we use -> In this study, we use P5/L27: Here we use -> Here, we use P5/L32: I assume the authors mean Table 2 not Table 1. I would also suggest to combine Tables 2 and 4. P6/L17: and -> to P7/L14: Do you mean Table 4 and not Table 1? Table 1 doesn't contribute to the argument in the same sentence. P7/L20: Consider changing the word "is enforced" to the word "necessary" or similar. P7/L22: in the comparison study -> for the comparison. P7/L24: "In addition, unconverging pixels with AAH set to be 15 km are also excluded". Could you elaborate a bit on this? P7/L24: Do you mean Table 3 here? P7/L31: due system overlap-> due to the system overlap P7/L33: 0-1km -> 0-1 km. The same feature can be found in a few places in the manuscript. Please correct. P8/L4: Correct Table 3 to Table 4. P8/L8: Bucharest is missing from the list. P8/L10: Have you excluded Regime C cases? If not, why? This should be mentioned. P8/L17-19: Consider rephrasing the sentence. As it is written it is difficult to read. P8/L21: Do you mean Table 5 here? P9/L8: aerosol type -> aerosol types P9/L12: The equipment includes -> the instrument features P9/L13: and a further (polarization) -> and a polarization P9/L15-17: Consider rephrasing this sentence. P9/L23: under intense Saharan dust air masses conditions -> under the intense Saharan dust outbreak. P10/L3: The unit is missing. P10/L6: Provide a reference for MODIS. P10/L9: The Absorbing Aerosol Height is expressed through the AAH acronym. Please, use the acronym since it has been introduced in earlier section. Same comment for P10/L12 for the AAI and AAH. P10/L17: As mentioned above both ground and satellite followed... -> Maybe, "As mentioned above, both ground-

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and satellite-based observations have followed..." P10/L19: Do you refer to Figure 14 instead of Figure 15? P10/L32-35: Very long sentence. P11/L12: geometrical features -> geometrical feature. Also, "make uses" -> makes use. P12/L7: Acronym and reference for TROPOMI? Table 6: You could add in the asterisk part at the bottom: "The station of Sofia has only one collocation, therefore it is not shown". Figure 2: Are the colors in the legend in the opposite way? The blue line seems to be the smoothed S-G signal and the yellow one the noisy signal. What are the horizontal and vertical lines in the panels? Please include a better description for the figure. Also, the different panels should be marked as (a), (b). Please correct all the figures featuring more than one panel. Figure 5: What are the individual dots? Please include a better description for the figure. Figure 6: Add the specification for Regime A, B and C in the caption.