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Comment on acp-2022-412

Anonymous Referee #2

Referee comment on "Validation of the TROPOMI/S5P aerosol layer height using EARLINET lidars" by Konstantinos Michailidis et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-412-RC1, 2022

The authors present a quantitative evaluation of the accuracy of the aerosol layer height (ALH) product derived from the satellite-based Sentinel 5P-TROPOspheric Monitoring Instrument (TROPOMI-SP5) using ground-based lidar observations submitted to the European Aerosol Research Lidar Network (EARLINET) database. The study is focused on the Mediterranean Basin in which observations from 7 EARLINET stations are selected, taking into consideration their proximity to the sea and the presence of absorbing aerosols. Within a 3-year time frame the authors have found 34 suitable cases for the comparison which shows the challenge in satellite validation attempts but also marks the importance of networks such that of the EARLINET. Given the importance of the ALH information in radiative forcing calculations, UV aerosol index, aviation safety etc. the study has scientific interest and therefore it is worth publishing. The work is overall sound, and I have only a few points to raise.

The manuscript is well structured, but I miss a thorough discussion on the findings. Why the comparison is worse over the land/ocean dataset compared to the ocean? Mention previous studies which have already found this known feature of TROPOMI retrievals and make comprehensive conclusions. What is missing from this comparison which would be beneficial in the community?

In this study, the geometrical features from ground-based lidars were compared against the ALH product from TROPOMI. I was wondering since most of the ground-based lidars used in this study have a lower detection limit at around 700-800m, if not higher, how was this taken into consideration when calculating the ALH? How did the authors tackle the overlap issue in the ground-based lidar observations and what is the error from ground-based lidar overlap limitation to the calculated ALH? For example, in the smoke episode the lidar signal is cut below 1km (Figure 11 and Figure 14). I assume that the bias is not big (equation 1) but given that the attempt is to validate a satellite product this effect should be discussed.

During daytime, the Klett method was used for the retrieval of the particle optical properties. I was wondering how the selection of a single lidar ratio (LR) for the whole profile can skew the ALH calculation in the presence of multiple aerosol layers in which the aerosol type is not the same since it affects the particle backscatter coefficient value and therefore the ALH calculation? How many of the 34 cases were Raman cases? Was there any difference in the bias between the Raman cases and the Klett cases?

Technical corrections:

In general, the writing of a scientific article should be impersonal, therefore, I would recommend rechecking these places in the manuscript were the word 'we' has been used. To this direction, there are a few typos and misuse of English language in several places in the manuscript. A careful review is required.

L38: Repentance of the text 'over the Mediterranean basin'. Please, correct.

L43: '…illustrates that TROPOMI ALH is consistent with EARLINET'. A satellite product (ALH) cannot be consistent with a network (EARLINET). Rephrase the sentence.

L54: 'Aerosol properties are one…' à 'Aerosol properties present one…'

L77: Nada et al., (2020) presented a comparison between TROPOMI ALH and CALIOP observations therefore not relevant in the context of this sentence.

L80: The EARLINET acronym is already defined in P2/L63. Similarly, in P4/L33.

L139. 'EARLINET measurements…' - > '. Observations submitted to EARLINET database follow….'

L149: 'On the other, during nighttime' -> 'During nighttime,…'

L166-L175: I suggest removing this paragraph as its context is not relevant to EARLINET.

Section 2.2 or/and the discussion are more relevant candidates.

L203: Please, provide the acronym for TOA.

L208: Provide a reference for OMI/Aura and their corresponding acronyms.

L220: 'To construct…TROPOMI observations. Please, rephrase the sentence.

L251: 'In addition, $ALH_{ext\ldots\ldots}$'. Do the authors refer to the weighted-extinction height? Please, specify.

L270: The acronym Z_{COM} is already defined in L246. Please, go through the manuscript and carefully correct the usage of the acronyms. Define an acronym once and then use in the rest of the manuscript. Also give the acronyms that are missing e.g TOA, OMI etc.

L278: 'In the case where more than one layers with a significant contribution to the optical thickness of the profile, an average value.….retrievals' à 'In case more than one layers with significant contribution to the optical thickness of the profile are present,……..'

L286: 'two selected' à Two or three? In some places it is mentioned 2 in some others 3. I assume three is the correct answer.

L388: Add UTC next to the time and the corresponding Fig. 4a.

L559: 'All the input datasets considered in the study have been previously pre-processed at high resolution'. What is high resolution referring to?