Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2019-348-RC2, 2020


Atmospheric Measurement Techniques Discussions



# *Interactive comment on* "Validating TROPOMI aerosol layer height retrievals with CALIOP data" *by* Swadhin Nanda et al.

**Anonymous Referee #2**

Received and published: 11 January 2020

The paper presents the first attempt to validate the TROPOMI ALH data product and therefore, bears lots of research interest from the community. The work overall is sound. However, given the unprecedented observation from TROPOMI and its potential for the wide use of ALH, the paper should be revised to provide an uncertainty estimate to the community. In fact, from what is presented in the paper, the ALH at the pixel level appears to have large uncertainties. Perhaps changing 'validating' to 'first evaluating" is more appropriate for this paper – this is a suggestion though. Major recommendations are provided below.

1) While the introduction part mentioned several papers regarding ALH retrieval, it didn't go in depth to the method themselves. A few notes are highlighted below; more details can be found in Xu et al. (2017).



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a. MSIR offers stereo height information; this is simply done by geometric optics, and providing top height of the aerosol layer

b. Xu et al., 2017: used primarily O2 A band (I think) for ocean, while Xu et al. 2019 used O2 B band primarily over land. In both cases, these two papers demonstrate for the first time in the literature that diurnal variation of ALH can be retrieved. They are also the first to define the method to evaluate ALH from such retrievals. Somewhere, it is worthy mentioning these, for example, in the method part for equation 2, and in the analysis and discussion part regarding surface reflectance.

c. MAIA by Davis et al. This is really a theoretical work as MAIA is not launched yet. This work should be separated from the work that uses the real data, and should be lumped with other theoretical work (such as Ding et al., 2017).

Reference: Xu et al., (2018), Passive remote sensing of aerosol height, in Remote Sensing of Aerosols, Clouds, and Precipitation, edited by T. Islam, Y. Hu, A. Kokhanovsky, and J. Wang, pp.1-22, Elsevier, Cambridge, MA.

Ding et al. (2016), Polarimetric remote sensing in O2 A and B bands: Sensitivity study and information content analysis for vertical profile of aerosols, AMT

2) The analysis part is really short in this paper. A few questions are suggested here with a hope to improve the analysis and add more 'meat' to the paper.

a. It is worth mentioning that aerosols, unlike cloud droplets, are ubiquitous in the atmosphere. So, a single layer representation is rather a crude approximation. The algorithm by Xu et al. assumes a continuous profile (and so are some others in the theoretic work). within 1M collocated pairs, will ALH comparison be different or be the same regardless one single layer or multiple layer aerosols? Can CALIPSO be helpful to identify or illustrate some cases of multiple layer of aerosols?

b. The ALH retrieval co-vary with AOD and UVAI. Xu et al. (2020) show some analysis on that. It might be interesting to plot ALH vs. UVAI for different AOD value ranges (as

Xu et al.) and see if the finding is consistent with Xu's finding.

c. It remains puzzling while 1M collocation pairs only give less 800 data points in the Figure 7. Why? Can we show all the collocated data points and find out how many percentage of TROPOMI ALH lies in +/- one sigma of the CALIOP ALH? This information is needed, and will the similar as MODIS AOD validation (which says, 76% or more data points are in +/- STD and have uncertainty of 0.05+/- 0.10AOD over land). Can such uncertainty envelope be derived?

d. The illustration case is almost exclusively for Saharan dust layer over ocean. A suggestion is to change the title of this paper to say validation or evaluation over the ocean? For this reviewer, it is bit difficulty to comprehend how well TROPOMI ALH over land, unless one case can be demonstrated.

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-348, 2019.



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