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Interactive comment

Interactive comment on "The 2018 fire season in North America as seen by TROPOMI: aerosol layer height validation and evaluation of model-derived plume heights" *by* Debora Griffin et al.

Anonymous Referee #2

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The paper presents the first analysis of TROPOMI ALH retrieval. OSSE is conducted to guide the analysis, which is excellent. This reviewer would recommend moderate revision of the paper to shed some light of surface albedo that may affect the ALH accuracy, and to provide somewhat closure between the past theoretical error analysis of ALH and the finding in the paper.

Datasets. What is the data resolution and range of TROPOMI ALH? In other words, in the retrieval, is ALH data continuous or in discrete values at different pressure level? Can ALH be 0.5 km or lower?

GEM-MATCH A few sentences describing how GEM-MACH estimate the injection

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Discussion paper

height can be insightful. Is the fire radiative power used in CFFEPS?

OSSE TROPOMI flume heights P8, L20. Using wavelength (instead of wavenumber) is suggested here. In addition, it is noted that TROPOMI uses the spectral fitting to derive ALH, not a simple ratio. In contrast, Xu et al. (2017, 2019, already cited in the manuscript) used the ratio.

Section 4.1. Some discussion about the reasons for MISR vs. modeled plume height difference can be helpful. Note, most satellite-based fire products provide only pixel-based FRP, where the plume rise model should use FRP over the fire area (not pixel area). This paper might be useful here to interpret the difference. Peterson et al., 2014, Quantifying the potential for high-altitude smoke injection in North American boreal forest using the standard MODIS fire products and sub-pixel-based methods, JGR.

Section 4.2 and results: There are multiple times, 'thin' layer is mentioned. How the thin layer is defined? By optical depth or geometric thickness? Past work has shown that O2-A type of ALH retrieval should be sensitive the high aerosol plumes provided a moderate value of AOD. The appendix in Xu et al. (2019) provides the ALH error estimates for different AOD and different ALH. It shows that retrieval is most sensitive to ALH at 2 km, and should be good to provide ALH from 1 – 8 km with retrieval error of less than .5km for AOD of 0.4 over dark surfaces. Anyhow, these past analyses should be helpful to interpret the physics behind the finding here. Afterall, past work have done several case studies to evaluate the ALH retrieved from O2 band (although not from TROPOMI). It is shown that the retrieval error can be affected not only AOD and ALH, but also by surface albedo. It might be interesting to stratify the ALH differences by surface albedo. As surface albedo increases, the ALH retrieval error can be large. Some comparison and contrasting of the results here with the results in the literature can be more revealing.

Summary L25-28, P15. Is your finding from the real data more or less consistent with the theoretical error analysis in Xu et al. (2019)?

L5-15, P16. Again, surface albedo is briefly mentioned and discussed here. It might be nice to sort the ALH evaluation by surface albedo. In addition, it is worth mentioning that for thick plumes at the surface, ALH retrieval is expected to have large errors. The analysis presented in the papers show the retrieved ALH is at least 1 km above the surface. There are also cases where TROPOMI ALH is consistent with CALIOP for high and think plumes (Fig. 4b). In other words, in both abstracts and conclusion, it is worth mentioning that the TROPOMI ALH has some success in retrieving high plumes up to 8 km (in addition to that the most accurate retrievals are for thickness plumes from 1-4.5 km).

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