*****Reviewer's comments are in black*****

*****Answers to the reviewer's comment are in blue*****

Comments from reviewer for UV aerosol retrieval paper

The authors would like to thank the reviewer for you time and effort to help significantly improve the manuscript.

RC1: 'Comment on amt-2021-307', Anonymous Referee #1

Thank you for expressing your concerns; we have significantly revised the abstract and introduction to improve clarity of the approach. We believe this will help to prevent any further misunderstanding.

This work present and iterative method to obtain lidar ratio at 292 nm, which is later applied, to Langley Mobile Ozone Lidar (LMOL) backscattered signal. Once lidar ratio at 292 is estimated, authors use the classical Klett method to obtain independent aerosol extinction and backscattering. It is well-known in lidar literature that Klett method cannot provide accurate estimates of extinction profiles because of possible variations of lidar ratio with height.

Nevertheless, the authors try to address an important challenge and provide an estimation of lidar ratio at 292 nm. Typically, backscattered lidars use co-located measurements of sun-photometry AOD for estimating lidar ratios (see for example MPLNET or EARLINET/ACTRIS retrievals). Currently, there are not many radiometric measurements that provide aerosol AOD at 292.

Answer: We use Fernald method for aerosol extinction retrieval. Instead of using the sun-photometer AOD to constrain the aerosol retrieval, the analysis in this manuscript uses the co-located HALO measurement to constrain the retrieval. The HALO provides aerosol backscatter, extinction, and lidar ratio profiles at 532 nm with high vertical resolution which is a more reliable constraint for the aerosol retrieval. This is because the sun-photometer is a column-only measurement (no profile) and also does not provide data at 292 nm. As a result, we use the iterative method to determine both the lidar ratio at 292 nm and AE between 292nm and 532 nm.

However, I do not rely in the approach presented by the authors. It might need further explanations. But as I understand they propose iterative variations of lidar ratio in LMOL system and provide different aerosol extinction profiles. The range of variation of lidar ratios is not enough because absorbing aerosol can present lidar ratios larger than 90, and OMI satellite retrievals demonstrated the importance that aerosol absorption might have extinction. On the other hand, I understand that they vary Angström exponent iteratively in HALO system to obtain equivalent aerosol extinction at 292 nm. They are ignoring possible effects of variations of

Angström exponent with altitude. If so I would rely more on Angström exponent measurements using sun photometry. Finally, for the evaluation they are using the same data that for the computation in the iterative method, which is not appropriate.

Answer: There are two reasons that we believe the range of variation of lidar ratio from 10 to 90 making sense. The first one is according to previous publication (Sasano and Nakane, 1984). The second one is the result that we get from our calculation. Most 292 nm lidar ratio calculations converge to values between 20 to 70 sr. That is why we selected the current lidar ratio range (10 sr –90 sr) to save calculation time.

The sun photometer cannot provide the variation of aerosol Angström exponent with altitude. The sun photometer only provides the aerosol Angström exponent for the total column aerosol, while LMOL lidar measures aerosol of lower part of troposphere. Aerosol Angström exponent derived from our method using the LMOL data and HALO data at the same altitude range, provides a more reliable result. In addition, the sun photometer also cannot provide Angström exponent between 292nm and 532 nm since there is no sun-photometer data available at Westport site.

As stated in the paper, we are not proposing a new iterative variation based on some variation of the lidar ratio. We are here comparing the LMOL retrieval, using several lidar ratio, to the HALO data. HALO is an HSRL lidar, which means that it can retrieve the lidar ratio and Angström exponent in an independent and reliable way (see refs cited). As a result, this represents the state-of-the-art to provide aerosol parameters at each altitude. In the present paper, we consider the HALO value as the ground truth, and we compare it to the Fernald method applied to LMOL. We have added an additional figure (Figure 1) and description at the beginning of the manuscript to help clarify the analysis approach.

With all these points I propose to evaluate the method with CCNY lidar for 355 nm and make intercomparisons with extinction coefficient at that wavelength computed by Raman methodology.

Answer: The aerosol AE between 355 nm and 386.7 nm still need to be assumed when 355 nm aerosol extinction was retrieved using Raman Lidar. HALO can independently obtain aerosol extinction and backscatter using Rayleigh and Mie signal without any assumption. So, it is better choice to evaluate our method with HALO data. Furthermore, quantitative CNNY comparisons to LMOL retrievals, which may be interesting, are spatially too far away to be useful for this study.

Section 4.2 does not provide any relevant scientific results. It only shows coherence in the vertical structures of aerosols, and for that it is not necessary to retrieve extinction coefficients. Moreover, the study-case selected to demonstrate the novel methodology must be different than that used for the validation.

Answer: The comparison of aerosol profile in section 4.2 is very important because it will show the difference between LMOL and HALO aerosol profiles when you select the optimized lidar ratio and Angström exponent. This intercomparison is important because it illustrates the ability of the LMOL aerosol retrieval to capture a consistent aerosol feature when compared to HALO HSRL aerosol data. And thus, can produce relevant data for campaign analysis in the relationship of aerosols to ozone features. It is important also because is a first study in the development of a new data product for LMOL.

Finally, section 5 only shows that lidar ratio is the most important parameter in the retrieval of backscattering and extinction, which is widely known in lidar community. What is necessary in section 5 is sensitivity test of the new methodology proposed by the authors, which can be done using synthetic data.

Answer: This section not only shows the lidar ratio being important, but uncertainties in O_3 are comparable and change as a function of height. We agree lidar ratio is a key factor in the retrieval of backscattering and extinction. The sensitivity of both lidar ratio and angstrom exponent is illustrated in section 3.2 and therefore believe an additional sensitivity analysis is not needed.