Review of "Comparison of diurnal aerosol products retrieved from combinations of micro-pulse lidar and sun-photometer over KAUST observation site" by Lopatin et al.

The manuscript *"Comparison of diurnal aerosol products retrieved from combinations of micro-pulse lidar and sun-photometer over KAUST observation site"* presents and discusses an almost 4-year comparison between retrievals of columnar aerosol optical depth (AOD), lidar ratio (LR) and particle backscatter (b_p) and extinction (a_p) coefficient profiles at 532nm, using the MPLNET and GRASP retrieval approaches over a coastal, desert dust dominated site in the Arabian Peninsula (KAUST). Both MPLNET and GRASP utilize collocated AERONET and lidar data, however different approaches in handling of these data. Specifically, MPLNET operational retrieval uses AERONET AOD linearly interpolated at 532nm as a constrain to apply the Klett-Fernald inversion to derive a_p and b_p, while GRASP uses spectral AERONET AOD as an input to the retrieval together with spectral solar almucantar data and lidar signals at 532nm (from MPLNET) thus inverting the sun-photometer and lidar datasets together. Both algorithms are in need of specific assumptions regarding either the temporal changes in AOD (in case of MPLNET) or temporal changes in particles microphysical properties (in case of GRASP) during night-time due to the absence of sun-photometer data. As such, the comparisons are separately performed during daytime and night-time. Further, two scenarios are demonstrated where the volume linear depolarization ratio (VLDR) at 532nm provided by MPLNET is included in the GRASP retrieval (scenario 2) or not (scenario 1). The paper also demonstrates the seasonal diurnal variability of the complex refractive index, concentration vertical distribution and relative contribution of fine, coarse spherical and coarse non-spherical aerosols to the atmospheric column over KAUST site for the overall period of the comparisons, offering an in-sight to the aerosol patterns in the area but also possibly to relation with meteorological conditions (i.e. wind direction).

I believe the study falls well within the scope of AMT. The manuscript is well-written and structured, the presentation of the methodology is thorough and the quality of the figures high. Furthermore, the authors give credit to related work and the results support the conclusions.

However, in order to help improving the manuscript, I would kindly suggest the authors to take into account the following specific comments.

1. Throughout the manuscript the authors refer to the use of the "AERONET data", however it is never mentioned which level or version of AERONET datasets is utilized. Although for MPLNET retrievals it is implied that Level 2 AERONET data are used (since it is stated that Level 2 MPLNET retrievals are produced after Level 2 AERONET data are available), this is not obvious for GRASP. I believe it would be helpful for the reader if the authors provide a few more details on the Level of data used in GRASP but also specific files names, list of parameters, units (if applicable) etc.
2. It is mentioned in several cases in the manuscript that the use of VLDR data in GRASP results in worse comparison with MPLNET predominantly during daytime observations when AERONET data are also included in the retrieval. The authors argue that this could be a result of several reasons including the assumption of a single aerosol mode in the atmospheric column when VLDR data are not utilized. Is it possible that this result for daytime retrievals, could also be related with the non-spherical particles treatment in GRASP? More specifically, could the fact that VLDR is used as an input, highlight the shortcomings of the spheroid assumption for dust particles shape in this case when the algorithm tries to balance the fitting of both AOD and VLDR?
3. Assuming an operational use of GRASP for long-term lidar/sun-photometer measurements' processing (i.e. for any MPLNET site), could there be a threshold for the VLDR values to differentiate between cases when it is useful for this parameter to be included in the retrieval or not? The results for the specific site mostly refer to desert dust dominated cases and indeed the use of VLDR seems to 'push' the retrieval of LR at 532nm closer to the values expected form

the literature. However, when the amount of depolarizing aerosols in the atmospheric column is very low, would the use of VLDR still be beneficial?

4. **Line 324:** "lidar" instead of "liar"
5. **Line 360:** It I not clear to me here and in other places in the manuscript what you mean with *'a bigger, and therefore, more flexible set of parameters during the retrievals, allowing to perform them more accurately'*. Wouldn't scenario 2 predominately benefit the retrieval of the coarse mode non-spherical fraction? However, the comparisons shown are between total LR, AOD, a_p and b_p values.
6. **Line 385:** '*LR at ~40±10 Sr which is within the ranges typical for desert dust*'. I believe here you mean at 532nm.
7. **Line 533:** *'scenario 2 for the case on 21 September demonstrates better accordance with MPLNET provided profile'.* I believe it seems from figures 7, 8 and 9 that this is mostly true for a_p and not b_p. In relation to question 2, do you think that this could be also related with the spheroidal assumption which would mostly affect the b_p?