Response to Referee 2

The authors present the combination of CALIOP and ALADIN measurements of a dust plume over the Atlantic ocean. They show that ALADIN measurements align well with CALIOP observations as long as proper data filtering as applied. They also re-iterate known limitations of the analysis of CALIOP observations of mineral dust by using ALADIN measurements of the dust lidar ratio to show that the dust lidar ratio in the CALIOP data retrieval is still set too low. The paper would benefit from re-organisation and shortening. Hence, minor revisions are needed.

We greatly appreciate the review and detailed comments provided by the referee. While the limitations of CALIOP in analysing mineral dust are well-established, our study demonstrates the potential of the new ALADIN lidar to address these issues. This aspect of ALADIN, contributing to a more accurate dust lidar ratio from space measurements, represents a novel approach not previously explored in depth. Our responses to the specific comments are as follows.

- I suggest to organise the work in a more conventional way with fewer sections. Please put methods and results into the corresponding sections rather then mixing them up as in the case study. The introduction is also bit lengthy and could be sharpened towards what's relevant for the presented work.

We have restructured the sections of this manuscript. Specifically, the discussion on converting ALADIN co-polar to total backscatter coefficients has been relocated to a new subsection, 2.1 Aeolus ALADIN Aerosol Products. Consequently, Section 2 now includes the following subsections: 2.1 Aeolus ALADIN Aerosol Products; 2.2 CALIPSO CALIOP Aerosol Products; 2.3 Collocation of Aeolus and CALIPSO; and 2.4 Aerosol and Cloud Discrimination. Moreover, the sections comparing ALADIN and CALIOP have been grouped into Section 3, titled 'Case Studies: June 2020 Saharan Dust Event', which includes 3.1 Statistics between ALADIN and CALIOP Retrievals and 3.2 Experiments over Collocated Orbits.

We deleted the last paragraph of the Introduction Section.

- The text includes plenty of figure descriptions that should be covered solely in the figure captions (e.g. lines 193-196, 233-234, 270-275, 306-309, 3043-346). Please omit from the main text.

Following your suggestion, we have carefully reviewed the mentioned sections and omitted repetitive descriptions from the main text.

- Please unify the colour axes in Figs. 1 and 2. The inversion is not very intuitive. Figure 2 might be expanded by a panel that shows all latitudes.

We have unified the colourbars in these figures to avoid any confusion and ensure consistency. However, a panel showing all latitudes was found to be difficult to interpret.

- Why are the authors discussion cloud masks that are not being used for this work? I suggest to stick to what has been used (the MSG-SEVIRI dust mask) and to provide a statement that other cloud masks have either not yet been available or less useful for your purpose. Figure 3 would need to be revised accordingly.

We appreciate your concern about the discussion of cloud masks in our manuscript. The primary reason for discussing these cloud masks, despite not utilising them in our final analysis, is to justify our methodology. Cloud masks are commonly used to distinguish between cloud and aerosol observations. However, our study deviates from this standard method by employing a specific aerosol type (dust) flag. By presenting the cloud masks and their limitations, we aim to justify and clarify the rationale behind our chosen approach. To clarify which mask is used in our study, the following sentences have been added at the end of subsection Aerosol and cloud discrimination: "In the case studies presented here, the SEVIRI dust mask is used to identify dust-dominated profiles within ALADIN observations. As CALIOP Level-2 APro products already discriminate between aerosol and cloud features, they do not require additional cloud masking".

- Figures 4, 5, and 10 could be improved by adding the number of profiles that contribute at the different height bins. Also, colour scales for the gradients in Figs. 4 and 5 are missing.

We have added colourbars for Fig.4(a) & (b), Fig.5(a) & (b). Profile showing number of valid retrievals at all altitudes have been added to the right margin of each subplot.

- The discussion of Figure 4 - particularly of the particle depolarisation ratio - would benefit from comparisons to findings of SAMUM-2 at Cape Verde.

We have incorporated the findings of SAMUM-2 at Cape Verde from *Ansmann et al., (2011)* into the discussion of the particle depolarisation ratio.

- line 251: shouldn't it be feature type identification?

Yes. We have corrected the sentence.

- I suggest to add lidar curtain plots to Figs. 6 and 7 as those would clearly demonstrate the effect of signal attenuation. It would also be nice if the comparison of extinction coefficients had some quantitative element, such as a correlation plot.

We have now added curtain plots to Fig. 6 and 7. Regarding the comparison of extinction coefficients, we considered incorporating a correlation analysis. A meaningful correlation coefficient requires at least 30 data points. However, we have less than 20 collocated data points available at each altitude layer because of ALADIN's 87 km horizontal resolution. So we removed mention of the correlation coefficients in order to avoid misleading readers. Consequently, we chose a more feasible approach by comparing the extinction coefficients between ALADIN and CALIOP across different altitude layers.

- I don't think that Figure 8 is needed.

We have retained this Fig.8 in our manuscript for two reasons: Firstly, it depicts the horizontal coverage of the dust plume as observed by MODIS, providing a spatial context for our study area. Secondly, the figure includes CALIOP's curtain plots which captured the dust plume. The curtain plot (b) reveals profiles with a significantly higher number of fully attenuated bins than seen in Fig.6(g) and Fig.7(g), a factor that significantly influences the AOD analysis.

- It is not clear to my what the investigation related to Fig. 11 and Tab. 2 is supposed to tell the readers. Okay, the mean profile shape is different for cases with AOD below or above an arbitrary threshold. But can this be used somehow? If anything, I would expect that type (b) with the higher extinction peak would correspond to the attenuated lower AOD profiles - but it doesn't. This part of the paper left me puzzled and I suggest to omit it.

Fig.11 and Tab.2 were included to address the discussion *"As depicted in Fig. 9, a subset of CALIOP AOD values better align with the MODIS AOD following the correction. However, there remain CALIOP values that are significantly lower than the MODIS AOD values".* Fig.11 and Tab.2 are important for investigating why certain CALIOP AOD values remain significantly lower than those from MODIS even after the lidar ratio correction. Our analysis reveals that for layers between 2.4 and 7 km, both sets of measurements exhibit similar corrected layer-AOD values. However, for the subset with notably lower AOD values, we observed that the layer-AOD between 0 and 2.4 km is substantially lower than the other group. This demonstrates that the lower AOD values are not a result of inadequate lidar ratio correction, but rather due to the inherent limitations of lidar measurements in terms of signal attenuation. Including this analysis in the manuscript underscores the effectiveness of lidar ratio correction in most cases, thereby addressing the initial concern raised in the manuscript.

- I don't think that Section 7 provides any information about the vertical transport of dust aerosol. Fig. 12 is certainly a nice plot that combines the observations of the two platforms. However, it would me more informative if it was to provide information on the longitudinal and height distribution as well. It seems to me that a similar plot could already be produced using much more data from MODIS observations.

We agree that including longitudinal and height distribution in Fig.12 would provide a more comprehensive depiction of dust transport. However, due to the narrow swath and the limited overpasses in the studied area over the 7-day period, it is challenging to expand the plot longitudinally, leading us to limit the longitude between 40° W and 20° W. In terms of height distribution, we faced the issue of low SNR with ALADIN at lower altitudes due to attenuation, and this his can affect the representation of dust transport. Consequently, we focused on the 4.5 to 6.5 km height range to ensure reliability. This plot aims to show that utilising more high-quality lidar profiles in the future can significantly improve our understanding of dust vertical transport. Although our current plot has limitations, it highlights the potential benefits of integrating multiple lidar datasets in such studies.