We appreciate referee #1 for the comments and suggestions. We have answered all questions and revised the manuscript. We also modified figures 4, 14, 15, 16, so that the AEL-PRO figures come first, then the SCA-mid or CALIPSO figures. In this document, the answers are given in blue text.

Review report egusphere-2024-731

The authors present an assessment study of the Aeolus' feature mask and vertical extinction profiles versus CALIPSO data. Aeolus products have been obtained via the implementation of the AEL-FM and AEL-PRO retrieval algorithms adapted from the A-FM and A-PRO algorithms, which have been developed for the EarthCARE HSRL ATLID. The analysis focuses on dust-rich scenes probed by the two spaceborne instruments across N. Africa in October 2018 and May 2019. The study is well-organized, and all the essential details are well presented and discussed. Therefore, I recommend that the manuscript be published after addressing the minor comments provided below.

1. **Lines 64-65:** To what extent your results will be affected by the consideration of L1B data generated with the most recent Baseline version (i.e., Baseline 16)?

We added some answers in Sect. 3.2 Aeolus data.
"The AEL-FM, AEL-PRO algorithms derive the attenuated Rayleigh and Mie backscatter signals from the L1B Mie measurement data (counts), the impacts from L1B and auxiliary data are mainly the hotpixel detection, dark current, background signal. We do not expect significant changes in these parameters between L1B baselines 14 and 16."

2. **Lines 91-92:** Is there any threshold on the number of counts?

I am not sure about the question. There is no threshold on the number of counts when separating the Mie and Rayleigh signals. The ACCD pixels from 6 to 11 are used to calculate Mie channel signal (not counting the leading 2 pixels).

3. **Line 177:** Which is the source of the a priori lidar ratios and the particle effective area radii?

We do not have a specific reference for the a priori lidar ratios and particle effective area radii but we try to choose some reasonable values as in the DeLiAn paper and in the simulated data for ATLID.

We added the follow sentence in the manuscript close to line 174. We also exchanged the order of two paragraphs starting at lines 171 and 179.
"In a configuration file, the a priori values of lidar ratio (S) and Ra are specified for water clouds, ice clouds, two kinds of stratospheric ice clouds, aerosols and stratospheric aerosols according to the values in the simulated data for ATLID (Donovan et al., 2023) and in Floutsi et al. (2023)."

Floutsi, A. A., Baars, H., Engelmann, R., Althausen, D., Ansmann, A., Bohlmann, S., Heese, B., Hofer, J., Kanitz, T., Haarig, M., Ohneiser, K., Radenz, M., Seifert, P., Skupin, A., Yin, Z., Abdullaev, S. F., Komppula, M., Filioglou, M., Giannakaki, E., Stachlewska, I. S., Janicka, L., Bortoli, D., Marinou, E., Amiridis, V., Gialitaki, A., Mamouri, R.-E., Barja, B., and Wandinger, U.: DeLiAn – a growing collection of depolarization ratio, lidar ratio and Ångström exponent for different aerosol types and mixtures from ground-based lidar observations, Atmos. Meas. Tech., 16, 2353–2379, https://doi.org/10.5194/amt-16-2353-2023, 2023.

4. **Lines 179-181:** Can you please explain better this sentence? What do you mean "… *otherwise the lidar-ratio supplied by the classification procedure is used.*"?

The sentence has been rewritten as, 'However, the Pass-I output is only valid for the weak features, for the strong features or invalid Pass-I output, Pass-II selects the a priori values from the configuration file. ' close to line 184.

5. **Lines 234-236:** In my opinion it would be quite interesting to show this comparison and briefly discuss the obtained outcomes. It is well known that when non-spherical particles (e.g., dust) are probed by ALADIN it is expected a "weak" performance in terms of reproducing the backscatter coefficient (for reasons already stated in the manuscript). Taking into account that there is a sufficient volume of Aeolus-CALIPSO collocated data, a better assessment can be given than those in Abril-Gago et al. (2022) and Gkikas et al. (2023), who presented single (few) dust cases.

Thank you for the suggestion and references. We prefer to keep the comparison focus on extinction coefficients in this paper.
If we compare the backscatter coefficients, we would need to assume/choose a depolarization ratio and do some simulations using different particles to understand our findings. This is out of scope for this current paper. We could write another paper about the evaluation of the backscatter coefficients.

6. **Line 286:** I would suggest to remove this sentence since CALIPSO assigns a lidar ratio for each aerosol type.

I cannot find the sentence related to CALIPSO close to Line 286. We removed the sentence, 'We do not compare the lidar ratio with CALIPSO data in this paper'.

7. **Lines 294-300:** I am confused with this part of the text. Why are you considering all aerosol subtypes across the scene in order to reproduce the frequency histogram of S values? Do you think that it would be better to reproduce the histograms for specific aerosol types (dust and smoke for this case)? I think that the dust lidar ratio given by Song et al. (2023) are substantially higher than those provided in the DeLiAn database (Floutsi et al., 2023).

The histogram was used to show the values in the AEL-PRO for all cases, including clouds and aerosols.
In the AEL-PRO product, we do not have aerosol subtypes, so I did not separate aerosol subtypes when making the histogram of S. I thought there would be a bi-mode distribution if there were different S for dust and smoke burning but it did not show up.

We have checked the distribution of S for dust (lat 15-30 N, below 5 km) and smoke (lat 10-25 S, below 5km). We can see the lidar ratio for the smoke case is on average larger than that for the dust case.
In AEL-PRO the a priori of aerosol lidar ratio is 60, depolarization 0.15.
In the figure we find the smoke lidar ratio has a peak close to 75 (72-78) sr but the distribution is rather broad from 25 to 120 sr.
The dust lidar ratio has a large peak close to 54 (48-60), a second peak close to 102. The lidar ratios are reasonable compared to the Sahara dust and smoke lidar ratio in the DeLiAn data set.

In the DeLiAn paper,
Saharan dust S = 53.5 +/- 7.7 sr depol = 0.244 +/- 0.025
Smoke S = 68.2 +/- 7.4 sr depol = 0.027 +/- 0.013

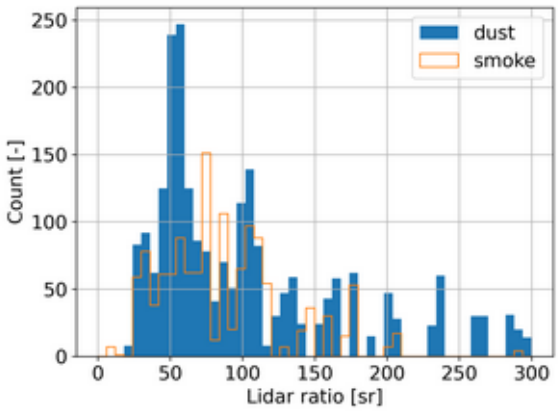

Fig 11

We replaced the S distribution figure with this new figure and add explanations in the revised manuscript between lines 323 – 333.
In lines 187 – 195 we now explain the effective lidar ratio (related to the fact that Aeolus uses circular depolarization and only measures the co-polar backscatter).

8. **Line 304:** What do you mean with the term “error” for the CALIPSO extinction coefficients?

The error for CALIPSO extincton coefficients is Extinction_Coefficient_Uncertainty_532 in CALIPSO L2 data. We have added the explanation and changed the error to uncertainty in the manuscript.

9. **Section 4.2:** Do you see any noticeable differences between daytime and nighttime conditions?

We did not look at the daytime and nighttime data separately because we did not have lots of collocated data to separate to two datasets.
Recently we looked at the AEL-PRO data for in June 2020 over Sahara desert and found the afternoon orbits have a slightly larger extinction coefficients than the morning orbits. However, this analysis is not relevant for this paper.

10. **Section 4.1:** Are you taking into account all the CALIPSO retrievals or are you processing only those tagged as "dust" in the classification scheme?

We used CALIPSO data for all cases, not only the cases tagged as "dust'. The dust aerosols are selected in the region of lat [0-30] °N, lon [-10 – 50] °E, where most aerosols were dust but there could be other aerosol types, like sea salt.

11. **Lines 335-336:** How much your results would be affected in the case of using more realistic aerosol speciated lidar ratios (see DeLiAn)?

The lidar ratio is a retrieved parameter, we have tried to use realistic a priori values for the lidar ratio. However, the retrieved lidar ratios are effective ones. They are appropriate to co-polar backscatter only (since ALADIN only has a co-polar channel and no cross-polar backscatter is detected). The difference between this effective S and the "normal" S depends on the particle circular depolarization ratio and smaller for particles having small depolarization ratios. The retrieval algorithm is not very sensitive to the a priori S value. We have discussed this issue close to lines 187-195..

Lines 364-365: It would be nice to provide further explanation regarding this assertion, highlighting the necessity of the deployment of a cross-polar channel on the Aeolus-2 satellite mission.

The cross-polar channel is needed to derive the depolarization ratio and lidar ratio appropriate for total backscatter. These two parameters are essential in separate clouds, aerosols and subtype aerosols. We have added some discussion in Sect. Conclusion and outlook.