Replies to Referee #3

Thank you for reading the manuscript and providing very useful comments and suggestions to improve the paper. The referee comments are in black, while our replies are in blue. The modifications in the revised manuscript can be found in the track change version of manuscript.

Review of "Characterization of a huge transatlantic smoke transport event by constructing an Aeolus smoke dataset in synergy with multi-platform data" by Kangwen Sun et al.

Submitted to ACP (egusphere-2026-596)

This manuscript analyses an event of transatlantic smoke transport occurred in September 2020 using Aeolus/ALADIN together with CALIOP, MODIS, VIIRS, MERRA-2, and HYSPLIT. The topic is relevant and the use of Aeolus (a spaceborne HSRL) is potentially valuable as it provides vertically resolved extinction information. The manuscript's central contribution is the construction of a smoke dataset based on Aeolus and its use to characterize plume evolution from North America to Europe. The atmospheric transport interpretation remains more descriptive than dynamical. In addition, the core methodology depends on several filtering choices and assumptions that could be better justified, and the uncertainty and validation are not strong enough for some of the conclusions. The paper is well written and potentially interesting for the readership of ACP, but substantial revision is needed before publication.

AR: Many thanks for your detailed review and your keen insights of our study. We greatly benefited from working through your comments and found much inspiration while revising the manuscript. In light of your suggestions, we have made substantial revisions. We carefully considered all your advice and have incorporated almost all of it into the revised version.

Inspired by your and Referee #2's concerns, major modifications on the structure has been made: 1) the title has been revised as "Characterization of aerosol properties during a huge transatlantic smoke transport event using Aeolus observations in synergy with multi-platform data";

2) A new Section 4.3 "Caveats and uncertainties" has been added to be dedicated for the discussion for the caveats and potential uncertainties associated with deriving the smoke dataset;

3) more sub-sections were set in Section 5 for result analysis and discussion:

- 5.1 Cross-sections of the smoke aerosol layers at different transport stages
    - 5.1.1 General transport pathway analysis by the cross-sections
    - 5.1.2 Characteristics of the smoke layers at different transport stages
- 5.2 Characteristics of the smoke aerosol plume across its entire transport
    - 5.2.1 Variation of smoke aerosol optical depth and altitude along the longitude
    - 5.2.2 Investigation of the two branches following plume separation
- 5.2.3 Variation of lidar ratio along the longitude

Please find below our point-by-point responses to your comments. We sincerely look forward to your further evaluation and favorable consideration.

Major comments

1. My main concern is the atmospheric transport interpretation, which I find interesting but still too

qualitative. The manuscript describes northeastward transport, apparent plume separation over the mid-Atlantic, and later ascent over Europe, but these features are interpreted mainly from cross-sections, AOD/CMC maps, and a very limited HYSPLIT calculation. The discussion would be much stronger if these patterns were connected more explicitly to the governing meteorology, for example by referring to the synoptic-scale flow, isentropic or non-isentropic transport, or other dynamical structures that could explain the branching and altitude evolution. The manuscript suggests that Aeolus could help describing the dynamics of smoke transport, but that potential is somewhat missing in the present version.

AR: Thanks for the keen insight on this issue. We also agree that exploring more details about the dynamics of the smoke transport would be interesting, and we recognize that further evidence and discussion would be needed to thoroughly investigate this topic. However, we feel that such an exploration lies somewhat beyond the scope of the present manuscript. In this study, we intend to maintain our focus on the aerosol itself, describing the aerosol properties derived from ALADIN observations during the transport event. AOD/CMC maps are used to capture the movement of the smoke plume, while HYSPLIT calculations are employed to suggest the transport pathways across the cross-sections. To better clarify the scope of this manuscript, we have revised the title to "**Characterization of aerosol properties during a huge transatlantic smoke transport event using Aeolus observations in synergy with multi-platform data**", in order to avoid potential misunderstanding and to provide a more focused impression. In the revised manuscript, we have also been more cautious in describing the transport process, avoiding speculative language about dynamics (e.g., "the smoke plumes appeared to rise above the cloud layers", "the layer was lifted above clouds") and ensuring statements are more firmly grounded in observed facts.

Following your advice, we plan to conduct a more detailed investigation of the synoptic-scale flow and the isentropic or non-isentropic transport processes associated with this event, with the aim of explaining the observed branching and altitude evolution. However, this work will be pursued in a future dedicated paper, where Aeolus wind observations will be incorporated to better describe the dynamics of smoke transport. In the present manuscript, we only hint at this topic in the outlook section.

2. The representativeness of the seven selected cross-sections should be stated more cautiously. They are useful and illustrative, but the manuscript goes somewhat far in treating them as representative phases of the same plume. The HYSPLIT trajectories are initialized from only a few points at 10:00 UTC on 18 September 2020, and the forward trajectories are also noted to underestimate plume height compared to the Aeolus observations. The transport interpretation and the analysis of the later evolution of the plume need stronger support. Another reviewer suggested that the conclusions about transport patterns would benefit from comparison with similar transatlantic smoke events and asked what explains the later rise along the pathway. I agree with those concerns. Also, in line 403 the authors state that HYSPLIT trajectory simulations "confirmed" that the measurements represent dicerent transport phases of the same plume. A handful of single Lagrangian trajectories can be useful for preliminary exploration of a dataset, but it is well known that more robust Lagrangian transport modelling strategies can and should be used for a proper interpretation of this kind of observations. Otherwise, a more prudent statement should be used (e.g. "suggested" instead of "confirmed").

AR: Thanks for the comments. As stated in our response to your previous comment, we prefer to keep the focus on the aerosol properties throughout the transport process. The HYSPLIT simulation, widely used for tracking aerosol transport, was employed here only as a reference for a general check of the transport pathway, rather than for a dedicated qualitative analysis. Therefore, we decided to retain the current HYSPLIT trajectories and revise the associated statements on the dynamics of smoke transport. In the revised manuscript, we are more cautious on the statement of the representativeness of the seven selected cross-sections and the transport interpretation, and revised them, including replace "confirmed" with "suggested". Under this concern, the changes in Section 5.1 are shown below:

1) "representing different transport phases of the smoke transport process" to "analyzing the smoke layers at different transport stages".

2) "The cross-sections capturing the smoke layers and the trajectories match well with each other, demonstrating the three-dimensional pathway of smoke transport. It can also be inferred that the smoke layers in the seven cross-sections are capable to represent the different transport phases." to "All seven cross-sections captured the smoke layers, and these layers show good agreement with the HYSPLIT trajectories. Considering that the seven Aeolus orbits crossed the smoke plumes indicated by the CMC maps (as presented in Fig. 5), it can be inferred from the above facts that the smoke layers observed in the seven cross-sections originated from the same smoke plume but at different transport stages."

3) "On 20 and 21 September, the smoke plumes appeared to rise above the cloud layers according to Aeolus observations. However, the forward trajectory simulations underestimated the height of the smoke layer compared to the Aeolus observations." to "On 20 and 21 September, the smoke plumes were observed above the cloud layers according to ALADIN data. However, the limited forward trajectory simulations may not adequately represent the ascending motion of the smoke layer compared to what was observed by ALADIN."

4) "However, 7.19 km on 20 September and 6.89 on 21 September **illustrate** (~~suggest~~) that these layers were **at higher altitudes** (~~lifted~~) after being transported to above the Europe."

5) "After being separated as the northern portion and **appeared** (~~lifted~~) above the clouds,"

6) "These measurements are considered representative for different transport phases of the same plume, as **suggested** (~~confirmed~~) by HYSPLIT trajectory simulations."

The comparisons of the findings in this study with those of similar transatlantic smoke events are discussed, added in Section 5 of the revised manuscript, which are also shown as below:

About **extinction and backscatter coefficient**: "On 20 and 21 September, the mean extinction coefficients are 199 Mm-1 and 208 Mm-1, and the mean backscatter coefficients are 3.59 Mm-1·sr-1 and 3.87 Mm-1·sr-1, which are considered quite high over Europe. In a study targeting a very similar smoke transport event, Hu et al. (2022) reported that a smoke layer transported from the western US was observed by a ground-based lidar over Lille, France, between 22:00 UTC on September 11 and 03:00 UTC on September 12, 2020, with extinction and backscatter coefficients at 355 nm of approximately 180 Mm-1 and 5 Mm-1·sr-1, respectively. Similarly, Baars et al. (2021) used a ground-based lidar to detect a smoke layer transported from the western US over Leipzig, Germany, on September 11, 2020, reporting extinction and backscatter coefficients at 355 nm of around 160 Mm-1 and 3.3 Mm-1·sr-1. In both cases, the smoke layers were found in the troposphere (5-7 km), which is comparable to the layer heights observed on September 20 and 21 in this study (7.19 km and 6.89 km, respectively). Although these two cases do not describe transport events identical to the one in the present study, they exhibit extinction and backscatter coefficients similar to those observed here, thereby providing some validation for the ALADIN measurements over Europe. Taken together, these findings suggest that dense smoke plumes originating from the western United States covered Europe on September 11, 12, 20, and 21, 2020."

About **lidar ratio**: "As for the variations in the lidar ratio, one of the intensive properties that is independent of aerosol concentrations, it presents the properties of smoke particles at different transport stages. The mean lidar ratios ranged from 44 sr to 62 sr, consistent with the broad range of tropospheric smoke lidar ratios (30-110 sr), summarized in Ansmann et al. (2021). A general declining trend from 62 sr on 14 September to 44 sr on 19 September was observed as the smoke transported from the west US to the mid-Atlantic. This decline is considered attributed to the aging process of smoke aerosols, aligning with the findings and the statements in Nicolae et al. (2013), Haarig et al. (2018), Nicolae et al. (2026) and Haarig et al. (2026). Taking 44±2.9 sr on 19 September 2020 as the lidar ratio for aged smoke, this value agrees well with the 40-50 sr reported in Baars et al. (2021) and the 40 ± 6 sr reported in Hu et al. (2022) for aged smoke layers from the similar transport event mentioned above. Subsequently, after being transported to Europe and appearing above cloud layers, the mean lidar ratios turned to increase to around 60 sr on 20 and 21 September, a change that may be explained by hygroscopic growth. During the initial stages of the transport event (14-18 September), the smoke layers gradually became drier, with mean relative humidity from 43 % to 39 %. However, on 20 and 21 September, after the smoke had been transported over Europe and appeared above clouds, the relative humidity of the smoke layers increased to approximately 60%. The lidar ratio and relative humidity exhibited consistent increasing trends on 20 and 21 September. Regarding the extinction coefficient, it increased from 155 Mm-1 to around 200 Mm-1, while the backscatter coefficient remained relatively stable. This suggests that the increase in relative humidity enhanced the smoke lidar ratio, given that the lidar ratio is calculated as the extinction coefficient divided by the backscatter coefficient. A similar phenomenon has been observed and discussed for continental aerosols in Haarig et al. (2025)."

About **AOD**: "In general, the total AOD exhibits a decline tendency, dropping from around 0.54 to below 0.33 in the main transport region between 100°W and 20°E. Combining the declining trend in AOD from the Copernicus Atmosphere Monitoring Service model-from 0.5 over the western United States to 0.2 over Europe-during a similar smoke transport event in September 2020 reported by Ceamanos et al. (2023), and comparing both this event and the current study with a tropospheric transatlantic smoke transport event in 2019 from Canada to Europe, where AOD declined from 0.25 to 0.013 as reported by Shang et al. (2024), it can be inferred that the September 2020 smoke transport event was fairly severe."

3. The interpretation of the plume separation and ascent remains somewhat speculative. The manuscript attributes abnormal tendencies of AODU and layer altitude in the 40°W–20°W sector to plume separation and interprets the changes of lidar ratios over Europe as evidence that the plume was lifted during transport (in connection with changes in relative humidity). These are plausible explanations, but the mechanisms are not clearly demonstrated. In particular, the manuscript should distinguish more clearly between true ascent, sampling of dicerent transport branches, and other possible causes of the observed longitudinal evolution. Here a more detailed transport simulation could help. Otherwise, if the focus of the article is solely on the technical aspects of the lidar methodology, publication in AMT could be an option.

AR: Thanks for the comment on the plume separation. We have added a dedicated Section 5.2.2 "Investigation of the two branches following plume separation" to try to illustrate it, shown as below:

"**5.2.2 Investigation of the two branches following plume separation**

Integrating the ALADIN smoke observations within the purple and pink dotted boxes in Fig.8(a), representing the two branches following the plume separation, the smoke AOD and layer altitudes of both branches are investigated by statistical analyses.

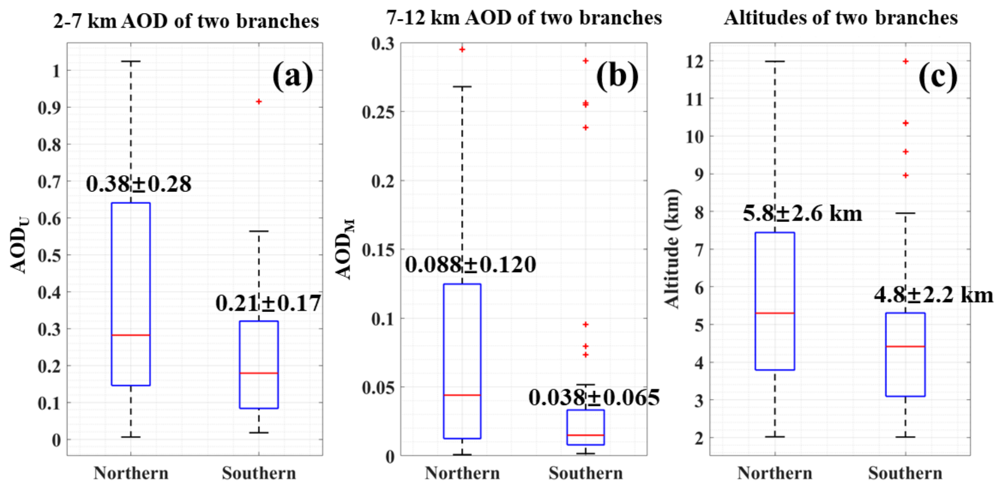

Figure 11 Statistical results of the two branches following the plume separation calculated from ALADIN smoke observations within the purple dotted box (latitude 45°N-70°N, longitude 40°W-20°W) and the pink dotted box (latitude 20°N-45°N, longitude 40°W-20°W) in Fig.8(a), labelled "Northern" and "Southern". (a) 2-7 km AOD (AOD_U) of two branches; (b) 7-12 km AOD (AOD_M) of two branches; (c) Layer altitudes of two branches.

Figure 11 presents the statistical results (boxplots, mean values, and corresponding standard deviations) of the two branches following the plume separation calculated from ALADIN smoke observations within the purple dotted box (latitude 45°N-70°N, longitude 40°W-20°W) and the pink dotted box (latitude 20°N-45°N, longitude 40°W-20°W) in Fig.8(a), labelled "Northern" and "Southern," respectively. AOD_U, AOD_M, and layer altitudes are presented in panel (a), (b) and (c), respectively. Overall, the smoke aerosol load in the northern branch was higher than that in the southern branch. The notably low AOD_M of the southern branch, with a mean value of 0.038 and a median of 0.015, contributed to the distinctly low AOD_M observed in the region between 40°W to 20°W, as shown in Fig.9(a). Regarding layer altitudes, the northern branch was situated higher than the southern one. The southern branch, with a mean altitude of 4.8 km and a median of 4.4 km, is considered be responsible for the low altitude in the same (40°W to 20°W) depicted in Fig.9(a). The information from Fig.11 provides insights into the behaviour of the two branches following the plume separation: the stronger and higher northern branch was subsequently transported toward Europe, while the southern branch was weaker and became lower in altitude."

4. It could be useful to add a dedicated section that identifies and discusses the uncertainties in the derivation of the Aeolus smoke dataset. This should include more justification of the chosen parameters, a sensitivity analysis, and a more robust treatment of error bars. In particular, the manuscript should assess how strongly the results depend on the choices made in bin selection, cloud screening, smoke-profile selection, backscatter correction, and lidar-ratio calculation. Examples include the outlier thresholds for extinction (600 Mm-1) and backscatter (30 Mm-1sr-1), the cloud screening thresholds based on Rb and RH, the MERRA-2 smoke CMC and smoke proportion thresholds used for smoke profile selection, and the assumed depolarization ratio of 0.15 used for backscatter correction. It would also be useful to distinguish more clearly between variability in the selected smoke samples and

methodological uncertainty introduced by the processing chain, and to show how much the reported longitudinal changes remain robust when these uncertainties are considered. Given that the smoke dataset is constructed through several sequential filtering and correction steps, and that the collocated MODIS and MERRA-2 data are not perfectly matched in time with Aeolus, a dedicated uncertainty section would substantially strengthen the paper.

AR: Thanks for the advice. We have added a new dedicated section, "4.3 Caveats and uncertainties," to clarify the limitations and uncertainties in the derivation of the smoke dataset, shown as below:

"4.3 Caveats and uncertainties

This section outlines the caveats and potential uncertainties associated with the five steps used to derive the smoke dataset, as introduced in Section 4.2. Steps (1) through (3) are limited to data bin selection and thus do not introduce uncertainties beyond those inherent in the Aeolus observational data. Step (4), "backscatter correction," adopts an assumed depolarization ratio for both backscatter coefficient and lidar ratio correction. This step could introduce additional uncertainties, which will be discussed in detail below.

In step (1), "quality control," preliminary quality control was conducted using the Aeolus flag and outlier elimination based on thresholds. The principle for threshold setting is that values exceeding than the thresholds are unlikely to originate from typical aerosol cases; they could represent outliers or be contaminated by clouds. After processing the selected Aeolus data (spatial domain: 140°W-40°E, 20°N-70°N; period: 11-21 September 2020) by step (1), 95% of extinction coefficients (174819 out of 183997 data bins) and 95% of backscatter coefficients (175002 out of 183997 data bins) were retained as valid data bins. Step (2), "cloud screening," applies thresholds of R_b and RH, as cloud layers are characterized by stronger backscattering and higher RH. After step (2), 87% of extinction coefficients (151922 out of 174819 data bins) and 86% of backscatter coefficients (150210 out of 175002 data bins) were retained as aerosol data bins. The risk here is that even a few weak clouds with particularly low R_b and RH could contaminate the smoke dataset. In step (3), "smoke profiles selection," hourly data from the MERRA-2 reanalysis dataset are used. The time gaps between colocated Aeolus and MERRA-2 data are less than one hour, during which the smoke layers are considered stable. Thus, the "smoke profiles" can be selected with the assistance of MERRA-2 dataset. After applying the smoke proportion threshold of 60%, a mean smoke proportion of 79% was computed from the selected smoke profiles. This indicates that the smoke dataset may contain a small amount of dust aerosol contamination.

With respect to step (4), the assumption of a constant linear depolarization ratio for backscatter coefficient and lidar ratio correction was based on the observations reported by Hu et al. (2022) and corresponding CALIOP measurements. It should be noted that this constant may vary depending on the characteristics of distinct smoke events. The assumption could introduce additional uncertainties. Regarding the calculation of uncertainties in the total backscatter coefficient and lidar ratio resulting from the depolarization ratio correction, the relevant formulas can be derived using equations (1) and (2), as shown below:

$$\sigma_{\beta_{smo}} = \frac{2\beta_{Aeolus}}{1-\delta_{smo,lin}} \cdot \sigma_{\delta_{smo,lin}} \qquad (3)$$

$$\sigma_{L_{smo}} = \frac{2\frac{\alpha_{Aeolus}}{\beta_{Aeolus}}}{(1+\delta_{smo,lin})^2} \cdot \sigma_{\delta_{smo,lin}} \qquad (4)$$

Among them, α_{Aeolus} and β_{Aeolus} are the extinction and backscatter coefficients observed by Aeolus, while $\delta_{smo,lin}$ and $\sigma_{\delta_{smo,lin}}$ represent the smoke linear depolarization ratio and its corresponding uncertainty, respectively. Using these two formulas, the uncertainties of the total backscatter coefficient ($\sigma_{\beta_{smo}}$) and the lidar ratio ($\sigma_{L_{smo}}$) can be obtained.

Utilizing these formulas, the uncertainties within a single smoke layer captured by one Aeolus cross-section as well as those across different transport phases, will be discussed as follows. First, to investigate the uncertainties introduced by depolarization ratio, assuming α_{Aeolus} of 200 Mm^{-1} and β_{Aeolus} of 3 $Mm^{-1}sr^{-1}$ as constants, under both circumstances. $\delta_{smo,lin}$ is set to the assuming constant of 0.15. For the uncertainty within a single cross-section, $\sigma_{\delta_{smo,lin}}$ of 0.085 is adopted, derived from the standard deviations of sub-regions presented in Table 1. Applying formulas (3) and (4), $\sigma_{\beta_{smo}}$ and $\sigma_{L_{smo}}$ are computed as 0.6 $Mm^{-1}sr^{-1}$ and 8.6 sr, respectively. Although this estimation is contingent upon specific assumptions and the use of CALIOP-derived $\sigma_{\delta_{smo,lin}}$, this approximate uncertainty quantification demonstrates that $\sigma_{\beta_{smo}}$ and $\sigma_{L_{smo}}$ per data bins attributable to $\sigma_{\delta_{smo,lin}}$ may exceed the uncertainties within a single cross-section (as indicated by the standard errors of the mean listed in Table 1). It should be illustrated that the standard errors of the mean in Table 2 do not incorporate the uncertainty estimation described above, as no accurate depolarization information was available for the Aeolus observations. As for the uncertainties introduced by depolarization ratio across different transport phases, the $\sigma_{\delta_{smo,lin}}$ is set to 0.009, which is the largest deviation from the mean depolarization ratio values presented in Table 1. This procedure tests whether the longitudinal changes in the backscatter coefficient and lidar ratio discussed in Section 5 remain robust when the variation in the linear depolarization ratio is considered. Under this assumption, $\sigma_{\beta_{smo}}$ and $\sigma_{L_{smo}}$ can be calculated as 0.06 $Mm^{-1}sr^{-1}$ and 0.9 sr, respectively, using formulas (3) and (4). Considering the mean lidar ratio values of the different cross-sections shown in Table 2, the maximum variation is around 20 sr. Therefore, under the assumption that $\delta_{smo,lin}$ is 0.15, $\sigma_{\beta_{smo}}$ and $\sigma_{L_{smo}}$ are negligible and will not affect the trends of the mean values across different longitudinal transport phases. In conclusion, while correcting the smoke backscatter coefficient and lidar ratio using $\delta_{smo,lin}$ of 0.15 may introduce additional uncertainties for each data bin (0.6 $Mm^{-1}sr^{-1}$ for backscatter coefficient and 8.6 sr for lidar ratio), the corrected results are used for only the mean value analyses of a single measurement cross-section or a specific sub-region in the following discussion."

5. It could also be beneficial, especially for readers interested in applying the methodology beyond this specific event, if the authors provided a more practical and transferable guide to the workflow used to construct the Aeolus smoke dataset. In its current form, the paper is written in a way that is readily accessible to lidar specialists and assumes a substantial level of technical familiarity with lidar retrieval concepts, filtering choices, and optical quantities. I think the manuscript would gain in broader usefulness if it included a short section or schematic "recipe" for reproducibility, summarizing the main processing steps, required inputs, threshold choices, correction assumptions, and expected limitations in a way that could be followed for other case studies. Such an addition would make the work more accessible to non-specialist users, including application-oriented readers and modelers, and would also facilitate subsequent reuse of the dataset and methodology for model diagnostics, transport analysis, and dynamical studies.

AR: Thanks for the advice. We have added a brief flowchart of the methodology (new Figure 3) in the revised manuscript, to summarize the main processing steps, required inputs, threshold choices, correction assumptions. The workflow guide is presented in Sections 4.1 and 4.2, while the associated expected limitations are discussed in detail in the new Section 4.3 ("Caveats and uncertainties," shown above). The new Figure 3 and relevant description are shown as below:

The brief flowchart of the methodology introduced in this section is summarized in Figure 3.

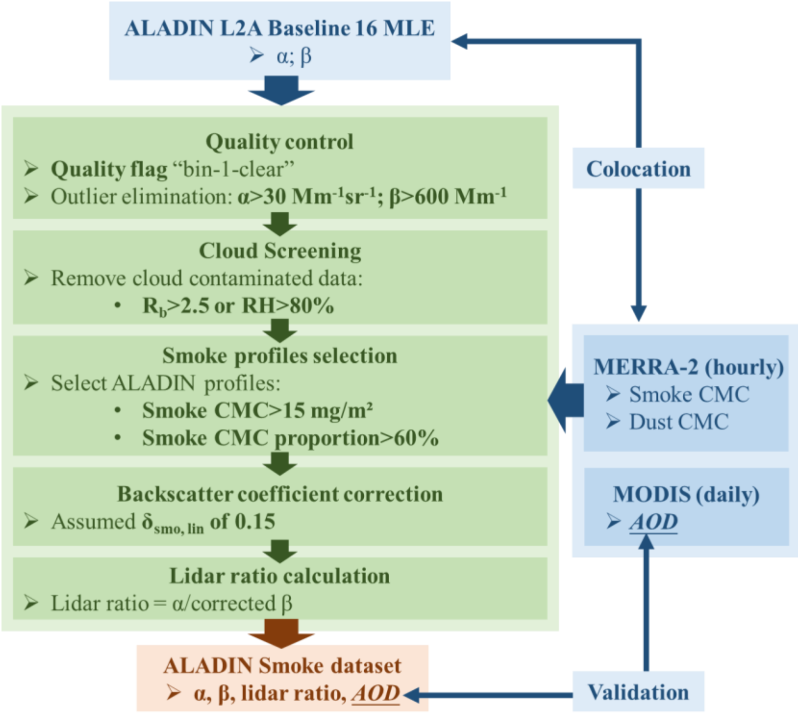

Figure 3. Methodology flowchart for development and validation of the Aeolus-based smoke dataset. α and β represent ALADIN observed extinction and backscatter coefficients. Rb and RH represent backscattering ratio and relative humidity. CMC is column mass concentration and δsmo, lin is smoke linear depolarization ratio.

Minor comments:

1. Please state the novelty more clearly relative to earlier Aeolus smoke studies.

AR: Only Baars et al. (2021) conducted validation of Aeolus L2A products with a ground-based lidar measurements, targeting a smoke layer transported from North America in September 2020. To our knowledge, the current study is the first one applying Aeolus L2A product for the characterization of the entire smoke transport event.

Reference:

Baars, H., Radenz, M., Floutsi, A. A., Engelmann, R., Althausen, D., Heese, B., et al. (2021). Californian wildfire smoke over Europe: A first example of the aerosol observing capabilities of Aeolus compared to ground-based lidar. Geophysical Research Letters, 48, e2020GL092194. https://doi. org/10.1029/2020GL092194.

2. Please justify more clearly why the MLE 90 km product was chosen over the higher resolution MLEsub.

AR: The MLE product (90 km horizontal resolution) was chosen because it integrates five times as many profiles as the MLEsub product (18 km horizontal resolution), resulting in a higher signal-to-noise ratio and thus better data quality (Flamant et al., 2022). The statement has also been added to Section 2.1 "ALADIN".

Reference:

Flamant, P., Dabas, A., Martinet, P., Lever, V., Flament, T., Trapon, D., Olivier, M., Cuesta, J., and Huber, D.: Aeolus L2A Algorithm Theoretical Baseline Document, Particle optical properties product, Tech. rep., ESA, version 6.0, https://earth.esa.int/eogateway/documents/20142/37627/Aeolus-L2A-Algorithm-Theoretical-Baseline-Document.pdf (last access: 28 May 2026), 2022.

3. The Ångström exponent assumed fixed value of 0.2 along the transport pathway may deserve a caveat.

AR: According to reviewer#2, we change the assumed Ångström exponent (355 nm to 532 nm) to 0.5, reported by Hu et al. (2022) for the same smoke event. The relevant descriptions are shown as below:

"Considering that ALADIN (355 nm) and MODIS (550 nm) AOD are in different wavelength and only smoke AOD is compared, the wavelength conversion was conducted. The Ångström exponent of 0.5 was applied to the conversion from 355 nm to 532 nm ($ÅE_{355-532}$), as reported by Hu et al. (2022) for the same smoke event. The low $ÅE_{355-532}$ suggests that the smoke plumes could be dominated by the coarse mode aerosols. We also consider it acceptable to use $ÅE_{355-532}$ for a similar wavelength range (355 nm to 550 nm), assuming the Ångström exponent is constant within the range of 355 nm to 550 nm."

4. The claim that Aeolus can identify smoke in the presence of thin clouds should be phrased more cautiously unless stronger evidence is shown.

AR: Thanks for the suggestion. The relevant statements have been revised:

"We believe that Aeolus smoke dataset acquired in this paper is capable of observing a smoke layer even if clouds are present below the smoke layers in a given profile.

We highlight the capability of the Aeolus smoke dataset (derived from ALADIN with the assistance of multi-source data) to observe aerosol layers above clouds, thereby providing more information than passive instruments such as MODIS, which are susceptible to cloud contamination."

5. Figure 9 captioning appears inconsistent, since the caption refers to "lidar ratio and altitude" in panel (b), while only one line (altitude?) appears to be shown.

AR: Thanks, revised.

6. The appendix longitude ranges appear malformed in Table A1.

AR: Thanks, revised.

7. The manuscript requires English editing. There are many typographical and grammatical issues, for example "enitre", "from there figures", "ALAIN", "synergic", and "capable to identify".

AR: Thanks, checked and revised.

8. Please check the data-access dates for consistency, especially the VIIRS date (1 February 2025).

AR: Thanks, checked and revised.