

## Responses to Referee #1

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 manuscript egusphere-2026-596

### **Characterization of a huge transatlantic smoke transport event by constructing an Aeolus smoke dataset in synergy with multi-platform data**

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February 26, 2026

#### **General Remarks**

The manuscript describes a detailed study of intercontinental aerosol transport. Although there have been numerous transport studies including satellite data, the use of HSRL data from the ALADIN lidar extends such work by the capability of providing information on the modification of optical properties during the transport. The manuscript is well written and should be published after considering suggestions in the comments listed below.

#### **Specific Comments**

A lot of work was invested by the ALADIN team to make possible these observations, which deserves a few more words. “Data are available” is not a good attitude. The authors should either offer a co-authorship or add a statement in the Acknowledgements such as “We appreciate the enormous effort of .....”.

AR: Thanks for reminding. We have added the statement “We appreciate the enormous effort of Aeolus team under the frame of Aeolus DISC (Data, Innovation, and Science Cluster), who are still working on the validation and refinement of ALADIN data.” in the Acknowledgements.

Line 16: “The backscatter coefficient .... was corrected”: An abstract should be devoted to results. Either drop this purely technical statement here or tell the reader what you learnt from it (e.g., combine with the sentence in lines 22-23).

AR: Thanks for the suggestion. We have removed this and supplemented more results in abstract. The revised abstract is shown below:

“During the wildfire season on the West Coast of the US in September 2020, biomass burning smoke aerosols were continually generated, resulting in several transatlantic transport events. As a high spectral resolution lidar (HSRL), ALADIN could directly retrieve the aerosol extinction and backscatter coefficient. Targeting a large-scale tropospheric smoke transport event originating from the western US on 14 September and arriving over Europe on 21 September, a method for constructing an Aeolus smoke dataset was developed based on ALADIN observations, in synergy with multi-source data. Utilizing selected cross-sections from this dataset, the vertical structure of the smoke layers at different transport stages are presented. HYSPLIT simulations support the representativeness of these layers across the

transport. Statistical analyses of the complete Aeolus smoke dataset from 14 to 21 September reveal the evolution of the smoke plume throughout its transatlantic pathway. The dense smoke plume across the transport is characterized by mean extinction coefficients of approximately  $200 \text{ Mm}^{-1}$  of across all the selected cross-sections and a decline in AOD from 0.54 to 0.33 along the transport path. The smoke layers ascended from approximately 4.4 km above the US to over 6 km above the Europe and appeared above clouds upon reaching Europe. The initially decreasing and then increasing lidar ratios indicate the aging process and hygroscopic growth of smoke particles. Plume separation was observed over the mid-Atlantic, and the two resulting branches were investigated individually. To our knowledge, this paper presents the first use of a spaceborne HSRL for observations and analyses of a large-scale tropospheric smoke transport. The comprehensive characterization presented herein provides valuable information for advancing global aerosol research.”

Line 32: Twohy et al. is missing in the list of references.

AR: Added.

Line 50: Please, add a reference or web site for EARLINET.

AR: The reference “*Pappalardo, G., Amodeo, A., Apituley, A., Comeron, A., Freudenthaler, V., Linné, H., Ansmann, A., Bösenberg, J., D’Amico, G., Mattis, I., Mona, L., Wandinger, U., Amiridis, V., Alados-Arboledas, L., Nicolae, D., and Wiegner, M.: EARLINET: towards an advanced sustainable European aerosol lidar network, Atmos. Meas. Tech., 7, 2389–2409, <https://doi.org/10.5194/amt-7-2389-2014>, 2014.*” has been added.

Line 60: The references in the following are just a few examples in the existing literature. I suggest to add a statement like “Numerous transport studies exist based on satellite data. For example, ....”

AR: Thanks. Revised as “Numerous transport studies exist based on CALIOP observation. For example,...”.

Line 68: Are you sure that Ohneiser et al. clearly proved exclusive absorption-driven lifting (e.g., by comparing the altitudes with those from trajectories)? Otherwise, you could include “to a major extent”.

AR: Revised as “showing plumes lofted from 12 to 13 km to around 20 km partly contributed by absorbing solar radiation”.

Line 68: Please, replace “were in” by (e.g.) “took place”.

AR: Revised.

Lines 90-93: Please, add references or web sites for these platforms.

AR: Added.

Lines 96-97: Here, you need a clear justification for/explanation of the correction, not in the Abstract. Or refer to Sect. 4.2.

AR: The last sentence of Section 1 has been revised as “During the derivation of the Aeolus smoke profiles dataset, the backscatter coefficient was corrected using a linear depolarization ratio of 0.15, since ALADIN detected only co-polarized backscattered signals and the averaged smoke depolarization ratio remained relatively stable throughout the transport.”.

Line 117: Please, specify SCA.

AR: Specified.

Line 120: “extinction coefficient”.

AR: Revised.

Line 171: Please, add information of the meteorological model data used.

AR: The sentence has been revised as “The simulations were calculated with the model vertical velocity from the global data assimilation system developed by NOAA (<https://www.ncei.noaa.gov/products/weather-climate-models/global-data-assimilation>, last access: 27 March 2026).”

Line 179: “process” looks weird. You describe different phases of the transport.

AR: “process” has been replaced by “event”. We also checked and revised throughout the manuscript.

Lines 217-219: “In summary of this section ....”. I miss here some purpose, in view of the following sections.

AR: This paragraph summarizes the background information on the transport event presented in Section 3 and highlights the potential for deriving smoke properties from Aeolus L2A products for this event. This paragraph was revised as “In summary of this section, the specific period and pathway of the smoke transport were identified and the transport region was found dominated by the smoke-related aerosols. The results indicate the potential for deriving smoke properties from Aeolus L2A products for this smoke event, as the transport exhibited a large spatial and temporal scale with limited influence from other aerosol types.”

Line 241: Please, specify RH.

AR: Specified.

Line 244 and elsewhere: In many cases throughout the manuscript you use Aeolus instead of ALADIN. Please, change where necessary.

AR: As ALADIN is the only payload aboard the Aeolus satellite, these two terms have occasionally been used interchangeably. We have reviewed the manuscript and revised the terminology according to the following principles: “Aeolus” is used when referring to the concepts of the satellite and its data, datasets, or products; whereas “ALADIN” is used when referring to the concepts of the lidar instrument and its observations or measurements, particularly in Section 4.3, to ensure consistency with the “MODIS” instrument.

Line 249: Confusing! Better: “Since Aeolus missed ...”

AR: Thanks, revised.

Line 252-252: It would be helpful for the reader if you could start that paragraph with this information.

AR: Revised as “(4) Backscatter correction. Since ALADIN missed the cross-polar component of the particle backscattered signals, the original backscatter coefficients from Aeolus L2A products were underestimated. Thus, the correction is supposed to be performed in order to obtain the total backscatter

coefficient. Additionally, as ALADIN was a circular polarization lidar system, the smoke circular depolarization ratio ( $\delta_{smo, cir}$ ) converted from  $\delta_{smo, lin}$  should be used for the correction.”

Line 258: “should” looks misleading. Do you mean “elsewhere”, or do you mean “is discussed in the following”?

AR: Revised as “is discussed in the following”.

Line 322: “extinction coefficients”

AR: Revised.

Lines 380, 382, 388: : Please, rephrase “extensive” and “intensive” for more clearness.

Fig. 8: Is it possible to add one or more lines to separate the air masses?

Line 495: “The smoke was mainly transported in the free troposphere.”

AR: Thanks, revised.

Line 507: Decreasing trend: What about Fig. 10?

Line 509: What explains the rise afterwards?

Line 510: “characteristic aerosol properties during a long-range smoke transport event”.

AR: Thanks, revised.

Line 514: Please, add references or web sites.

AR: Two papers has been added to references:

*Dai, G., Wu, S., Long, W., Liu, J., Xie, Y., Sun, K., Meng, F., Song, X., Huang, Z., and Chen, W.: Aerosol and cloud data processing and optical property retrieval algorithms for the spaceborne ACDL/DQ-1, Atmos. Meas. Tech., 17, 1879–1890, <https://doi.org/10.5194/amt-17-1879-2024>, 2024.*

*Donovan, D. P., van Zadelhoff, G.-J., and Wang, P.: The EarthCARE lidar cloud and aerosol profile processor (A-PRO): the A-AER, A-EBD, A-TC, and A-ICE products, Atmos. Meas. Tech., 17, 5301–5340, <https://doi.org/10.5194/amt-17-5301-2024>, 2024.*

Style

Line 31: Using the tilde here is not good style. I think you mean “about”. Also, the tilde is the mathematical symbol for “proportional”.

AR: Revised.

Line 76: Perhaps “profiles of ....” (the expression is rather long).

AR: Revised.

Lines 77, 418 (and possibly elsewhere): “but” must be preceded by a comma if two full sentences are separated.

AR: Revised.

Line 109: Flamant!

AR: Here, the citation should be “Flament et al. (2021)”. It is a different author from “Flamant et al. (2008)”.

Line 173: The header looks much like a figure caption. It would be helpful if you could shift the figure to a position behind the beginning of this section.

AR: Thanks, revised.

Line 236: “Selection of bins”.

AR: Revised.

Line 322: “do not”. “are reliable”: in general???? I think you mean just 550 nm case.

AR: The statement has been revised as “[These results indicate better agreement and suggest that the Aeolus smoke dataset can provide reliable AOD and extinction coefficient.](#)”

Lines 337-338: “propagated to”.

AR: Thanks, revised.

Line 367: “To characterize better” (split infinitive!)

AR: Revised.

Table 1. left column: Mm-1 should be replaced by Mm-1.

AR: Revised.

Line 402: “during the transport”.

AR: Revised.

Line 406: “ALADIN”

AR: Revised.

Line 413: Circumstantial! I suggest: “Firstly, panel (a) is divided ...”

AR: Revised.

Line 435: “To characterize the features ..... more quantitatively ...” (split infinitive!).

AR: Revised.

Line 460: Do you mean “weakened”? Please, rephrase “abnormal”.

AR: Yes, revised as “weakened”.

Line 481: “transport event”.

AR: Revised.

Line 488: for deriving smoke data”.

AR: Revised.

Line 496: “during the transport”.

AR: Revised.

Line 493: “preliminarily”: Do you mean “as the first case”?

AR: Yes, revised.

Line 506: “during the transport”.

AR: Revised.