Dear reviewers and editor:

We would like to thank you for taking the time to review our manuscript and suggest such valuable information in order to improve its quality. Even the most trivial suggestion helped in the progress of the text's value.

Some main and relevant changes have been made to the manuscript, as summarized below:

- While submitting the first version of our manuscript, a relevant study related to Aeolus optical products were made. Thus, for the sake of completeness, the following published paper has been included now in the reviewed version of our work:

  Baars, H., Radenz, M., Floutsi, A. A., Engelmann, R., Althausen, D., Heese, B., Ansmann, A., Flament, T., Dabas, A., Trapon, D., Reitebuch, O., Bley, S., & Wandinger, U. (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(8), e2020GL092194. https://doi.org/10.1029/2020GL092194

- Furthermore, a reprocessing of Granada's ground-based dataset was made right after the manuscript submission, to increase the quality of the depolarization-related products. No relevant differences were found between the results obtained with the former and the reprocessed products. However, the charts included in the manuscript have been updated accordingly. These changes affect Figures 5, 12, 13, 14 and 15 (a new figure is included following the Reviewer#2 suggestion, so these figures correspond now to Figure 5, 13, 14, 15, and 16, respectively).

Apart from these main changes, a set of minor changes and typos has been corrected throughout the document. Following this introduction, you may find a detailed answer to every Reviewer#2's comment. All of the listed changes and the ones suggested by the reviewers can be seen in the new version of the manuscript, marked in red.

Reviewer 2

1) *Introduction*

   The introduction of the paper is lengthy and distracts from the actual content of the paper. I miss the point why of the descriptions of all the networks is there, while the paper is based on three ground based lidar stations on the Iberian peninsula. The fact that these stations are part of ACTRIS/EARLINET is relevant, especially for the quality control of the instruments as well as the central data processing that is harmonised in the network. I suggest that the introduction is substantially shortened and focuses on these main points. It is relevant to refer to the ground based intercomparisons/validation efforts of optical profiles from other active space borne sensors, as the applied methodology is largely taken from these previous efforts (e.g. colocation criteria and network design).

Similarly, the main purpose of the Aeolus mission is a technological demonstrator for active wind profile measurements from space, as well as a demonstrator for the impact of those data on operational numerical weather prediction of those space borne observations. The optical data are, from a point of view of the mission, a by-product. I suggest that the introduction is also shortened to help the reader.

Accordingly to the reviewer#2's comment the introduction section has been substantially shortened, with approximately a 30% reduction of the section's text with respect to the previous version (apart from removing the corresponding references). Concretely, the following text has been removed from the manuscript's introduction:

- Aerosols are unevenly distributed, both horizontally and vertically, with significant concentrations over landforms such as deserts (e.g. Laurent et al., 2010; Heinold et al., 2011; Ansmann et al., 2011) or large populated urban areas (e.g. Landulfo et al., 2003; Sun et al., 2004). Aerosol particles frequently travel through the troposphere (e.g. Guerrero-Rascado et al., 2009; Preißler et al., 2011; Sicard et al., 2012a, 2012b; Pereira et al., 2014; Granados-Muñoz et al., 2016) and exceptionally at the lower stratosphere (e.g. Ansmann et al., 1997, 2018; Sawamura et al., 2012; Baars et al., 2019).

- Nowadays, Global Observing Systems (GOS) allow the study of a great variety of atmospheric properties through ground-based instruments and satellites. Ground-based instruments for aerosol monitoring are set at local stations, which are unequally distributed in space, grouped in federated networks such as AERONET (Holben et al., 1998), EARLINET (Pappalardo et al., 2014), LALINET (Guerrero-Rascado et al., 2016; Antuña-Marrero et al, 2017) and MPLNET (Welton et al., 2006), and also unequally distributed in time, i.e. during intensive field campaigns, such as ACE (Bernath et al., 2005), SAMUM (Heintzenberg, 2009), SAMUM-2 (Knippertz et al., 2011) and CHARMEX (Mallet et al., 2016), among others.

- Nonetheless, until 2018, there was not a single satellite mission aimed to retrieve worldwide, continuous wind measurements from space.

- named after the Keeper of the Winds in Greek Mythology

- At that time, it became the fifth satellite in space of the ESA's Living Planet programme, the first European satellite with a lidar onboard and the first space-borne Doppler lidar ever able to measure vertical wind profiles on a global basis.

- During the 2020 pandemic of COVID-19, continuous near-real-time worldwide measurements from the Aeolus mission served as a prominent remedy to the lack of wind measurements, especially in the high troposphere and lower stratosphere, caused by air traffic reduction (Ingleby, 2020).

- ESA encourages the participation of organizations around the world, such as EARLINET, LALINET, NOAA (National Oceanic and Atmospheric Administration of the United States of America) and several other nation-wide organizations in Europe, Asia and North America.

2) *Section 2.1, Line 134-135 "Currently, L2A products access is still limited until a more confident version of the data products is achieved." This is a rather important statement. Here more explanation is needed. Perhaps the authors consider that the value of their manuscript may be devalued because of this since the conclusion will change after a new version of the Aeolus processor is released, but for the reader it is important to know a bit more about this.*

Recently, a new processor of the products was implemented, baseline 12. From May 26 2021, Aeolus products are processed under baseline 12 and these products are openly published. Thus, the quoted sentence is no longer accurate and will be restated and completed as:

Recently, L2A products began to be produced under a new processor version (baseline 12) and are openly published along L2B and L2C products.

3) *Section 2.2 A table with the station properties would be very helpful for a clear overview for the reader and gives the opportunity to shorten the lengthy descriptive text.*

This suggestion is particularly welcomed, as it will help to both reduce the manuscript length and also clarify some of the main aspects and differences of the ground stations. Thus, the following table has been included in the text:

Station		Granada (MULHACEN)	Évora (PAOLI)	Barcelona
Type		Raman, elastic and depolarization	Raman, elastic and depolarization	Raman, elastic and depolarization
Laser radiation source		Nd:YAG	Nd:YAG	Nd:YAG
Wavelengths (nm)	elastic	355, 532, 1064	355, 532, 1064	355, 532, 1064
	Raman	354 (N_2), 407 (H_2O), 530 (N_2)	387 (N_2), 607 (N_2)	354 (N_2), 407 (H_2O), 607 (N_2)
	depol.	532	532	355, 532
Repetition frequency (Hz)		10	20	20
Nominal vertical resolution (m)		7.5	30	3.75
Nominal temporal resolution (s)		60	30	60
Full overlap height (m agl)		~ 800	~ 800	~ 400
References		Guerrero-Rascado et al. (2010) Navas-Guzmán et al. (2011) Bravo-Aranda et al. (2013)	Preißler et al. (2011)	Kumar et al. (2011) Rodríguez-Gómez et al. (2017) Zenteno-Hernández et al. (2021)

Table 1. Overview of the lidar systems of Granada, Évora and Barcelona stations.

4) *Section 3.1, Line 235 and further "In the current study, only aerosol products (L2A) are considered, and in particular particle backscatter coefficients derived from the Standard Correct Algorithm (SCA) and Standard Correct Algorithm middle bin (SCAmb)." Here the authors should explain why they limit themselves to the backscatter profiles and do not take into account the ALADIN L2A extinction profiles. After all, this is a first for space borne observations (CATS was configured to provide HSRL extinction profiles, but the instrument failed partially on this point.)*

The exploration of Aeolus L2A extinction profiles would have been a valuable contribution to this study. However, whereas backscatter profiles can be retrieved with high quality both during day and night-time, the retrieval of extinction profiles, with enough SNR is limited before sunrise and after sunset, when the Raman channels are not saturated by solar radiation. Depending on the time of the year, Aeolus overpasses take place almost around sunrise or sunset, when the background signal is highly variable, preventing its use for 1-hour (or 1.5-hour) averaged retrievals. At other times of the year Aeolus overpasses take place way after sunrise or before sunset, so again no possible intercomparison of Aeolus extinction products can be assessed. Thus, the following information is now included in the manuscript:

The Raman derived extinction profiles retrieved at ground level could not be used in the study due to the time of the satellite overpass, when the signal-to-noise ratio is not good enough for these channels. Therefore, Aeolus extinction coefficients are not exploited in the study.

5) *Section 4.2.1, Line 365 A reference is made to profiles that are not shown. Please show the data.*

The following plot corresponds to the backscatter-related Ångström exponent profile calculated with the 355 and 532 nm channels of the measurements taken by the lidar system in Granada around the Aeolus overpass on 5th September 2019. We decided not to include this graphic in the manuscript in order to avoid extending the manuscript length. Furthermore, although the information of the graphic is relevant it is commented on the text with no need of including the plot, which might distract from the main objective of this section.

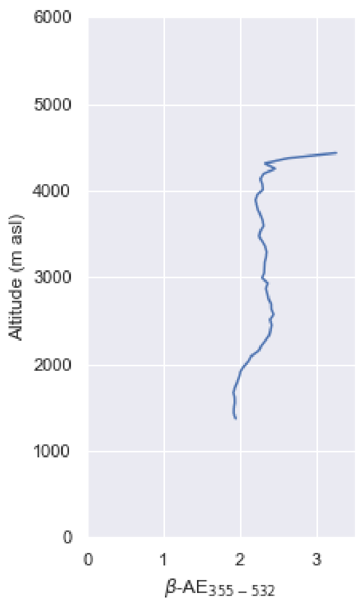

Figure. Backscatter-related Ångström exponent profile calculated at 355-532 nm (β-AE$_{355\text{-}532}$) derived by the lidar system in Granada around the Aeolus overpass of the 5th September 2019.

6) *Section 4.2.2, Line 391 A reference is made to sunphotometer measurements that are not shown. Please show the data.*

Following the reviewer#2's suggestion, the requested figure (Figure 8 in the text) is now included in the manuscript.

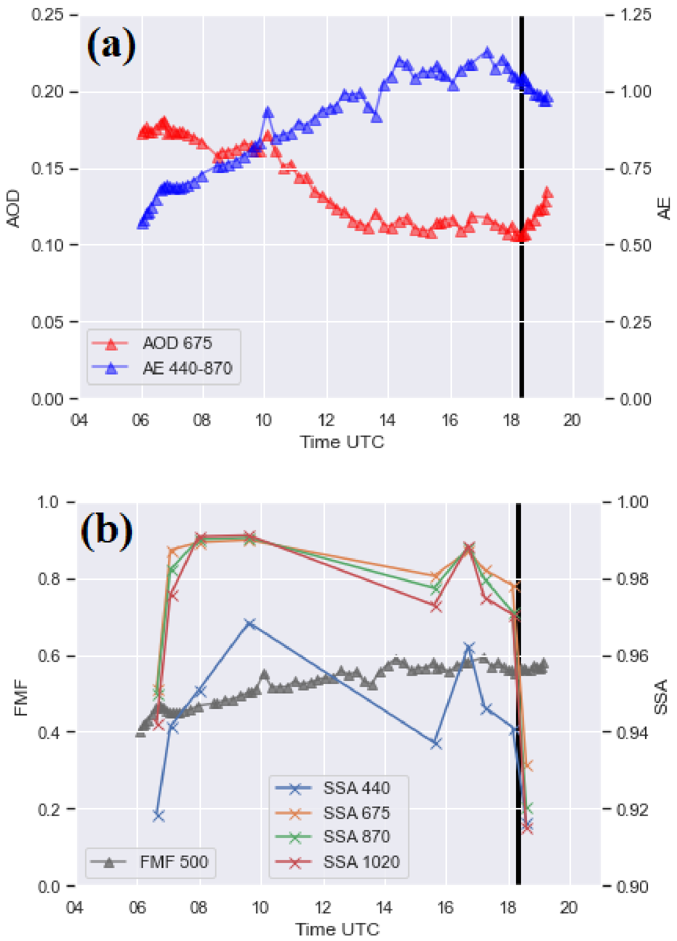

Figure 8. Sun-photometer data retrieved by AERONET at Évora on the 28th June 2019: (a) AOD_{675} and AOD-$AE_{440\text{-}870}$ and (b) fine mode fraction at 500 nm (FMF_{500}) and multiwavelength SSA daily series. The black vertical line indicates the Aeolus overpass.

7) *Section 4.2.1, Line 408 A reference is made to profiles that are not shown. Please show the data.*

The following plot corresponds to the backscatter-related Ångström exponent profile calculated with the 355 and 532 nm channels of the measurements taken by the lidar system in Évora around the Aeolus overpass of the 28th June 2019. We decided not to include this graphic in the manuscript in order to avoid extending the manuscript length. Furthermore, although the information of the graphic is relevant it can be commented on the text with no need of including the plot, which might distract from the main objective of this section.

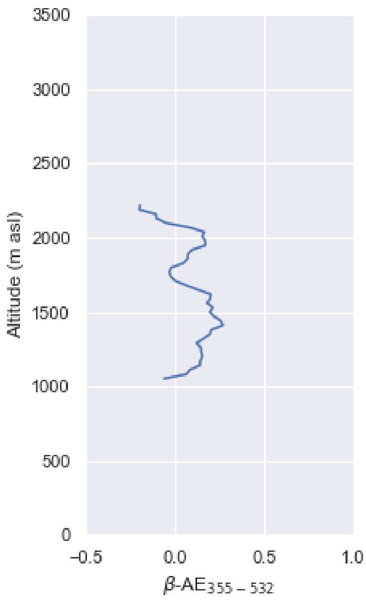

Figure. Backscatter-related Ångström exponent profile calculated at 355-532 nm (β-AE$_{355\text{-}532}$) derived by the lidar system in Évora around the Aeolus overpass of the 28th June 2019.

8) *Section 4.2.3 The case is presented as a smoke case, but proceeds to explain that there was a mixture of smoke and mineral dust. Please change the title of the section to remove the contradiction.*

We appreciate this suggestion. Thus, we will modify the title of Section 4.2.3 so that it reads:

4.2.3 Case study of smoke and mineral dust mixture: Barcelona, 2nd July 2019

9) *Section 5, Conclusions The first paragraph contains important information about the version of the data considered for the intercomparison. This should be mentioned either in the introduction or section 2.1 about Aeolus.*

The mentioned information appears in Section 3.1, where the processing of Aeolus products and baselines are mentioned and explained. The information regarding Aeolus included in the introduction or Section 2.1 is rather more general or more technical. However, a short introduction is now included in Section 2.1. Thus, the following information will be included in the text:

At the time of writing this article, the longest, fully homogeneous product dataset has been reprocessed in baseline 10 (B10). In this study, we evaluated Aeolus B10 optical products with a thorough analysis of Aeolus co-polar backscatter coefficients under the SCA and the SCAmb.