Statistical validation of Aeolus L2A particle backscatter coefficient retrievals over ACTRIS/EARLINET stations in the Iberian Peninsula

Jesús Abril-Gago, Juan Luis Guerrero-Rascado, Maria João Costa, Juan Antonio Bravo-Aranda, Michaël Sicard, Diego Bermejo-Pantaleón, Daniele Bortoli, María José Granados-Muñoz, Alejandro Rodríguez-Gómez, Constantino Muñoz-Porcar, Adolfo Comerón, Pablo Ortiz-Amezcua, Vanda Salgueiro, Marta María Jiménez-Martín, and Lucas Alados-Arboledas

Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-388, 2021

Comments on Preprint acp-2021-388

In this manuscript the authors provide a good introduction to the uncertainties regarding the measurements of aerosols present in the atmosphere and the interaction between aerosols and clouds, mentioning the importance of lidar networks and measurement campaigns to reduce the aerosol optical properties uncertainties and improve data quality for satellite data calibration. The authors present a highly valuable data set based on lidar measurements for three different EARLINET lidar station to assess the Aeolus satellite reprocessed data (baseline 10). Since the Aeolus satellite receiver detects the co-polar component of circular polarized backscattered radiation at 355 nm, the authors applied a technique to extract the co-polar component of the ground-based observations at 355 nm from the total particle backscatter coefficient. In the manuscript the authors present three different case studies and a statistical analysis of the baseline 10 co-polar backscatter coefficients from the standard correct algorithm middle bin (SCAmb) and the standard correct algorithm (SCA). The manuscript is well written and the results are very important to validate the aerosol detection of Aeolus mission. I recommend the article for publication following correction and clarification of a few minor issues described below.

In the section 3.1-Database and intercomparison methodology (page 7) the authors describe the measurement protocol for each station - For Granada, a 1.5 hour interval for the morning overpass time and a 1-hour interval for the evening overpass time (i.e.17:30 - 18:30 UTC) were chosen. For Barcelona, a 1-hour range centered at the overpass time was considered. For Évora, a 1.5-hour interval containing the overpass time was considered to take into account the larger distance between the Aeolus ground track and the lidar site. I recommend the authors discuss in more details the uncertainties or issues that 1 or 1.5-hour time differences can cause in the comparative analyzes between the ground-based lidar and the Aeolus satellite.

In section 3.2-Aeolus-like conversion of ground-based lidar particle backscatter coefficients - The authors proposed a method to estimate the linear particle depolarization ratio at 355 nm ($\delta^{part}_{linear,355}$) from the linear particle depolarization ratio at 532 nm. However, it is stated the third lidar station in Barcelona, does measure both depolarization ratios but for the sake of consistency of the data processing, calculated the same way than the other two stations. In figure 2c (page 39 and discussion on page 10) the autors presented a scatter plot of dust and non-dust aerosol particles obtained from dual-polarization measurements in Barcelona, together with spectral conversion factor Kδ=0,76±0,01 and the spectral conversion factor from literature results for dust and non-dust types, equals to 0.82 ± 0.02. It is not very

clear why the authors prefer to use the literature values instead of spectral conversion factor retrieved from measurements.

In section 3.3 Statistical parameters, the authors stated *"The resolution of these bins depends on the altitude range: 500 m between 0 and 2 km asl, 1 km between 2 and 16 km asl and 2 km between 16 and 30 km asl. Because the ground-based lidars present a much finer resolution, of the order of a few meters, the resolution of each ground -based profile has been degraded to the Aeolus vertical resolution."*
The authors' choice to downgrade the data quality of the groundbased handles to perform a bin-to-bin comparison is understandable, however, the decrease in signal quality doesn't seem to make much sense when comparing the Aeolus and the groundbased lidar, especially when taking into account the different nuances of the atmosphere in the region closest to the surface. How do the authors understand that this loss of quality, or the lack of a finer resolution in the Aeolus data, can affect the application of the data to the study of optical properties of aerosols?

In section 4.3 Case studies, the authors stated *"Sun -photometer measurements are taken into account for the sake of completeness aerosol typing, through the study of the aerosol optical depth at 675 nm (AOD 675)"*. Why was the 657 nm wavelength chosen? Why not choose the AOD values in the UV region as 340 or 380 nm, instead?

"The location of the stations is highly interesting due to their proximity to the Sahara Desert and mainland Europe, so frequent events of mineral dust and anthropogenic particles could be detected by the satellite. In addition, Barcelona lies just in the coastline, and both Barcelona and Granada present high concentrations of anthropogenic aerosol, while Évora aerosol concentrations could be classified as rural. Thus, Aeolus operation can be tested under a complete set of atmospheric scenarios."
How was the difficulty of comparing the layers closest to the surface taken into account that Barcelona station is located just in the coastline and is influenced by the mixture of anthropogenic aerosol and/or dust and marine aerosol? How might this difficulty in comparing the layers closest to the surfacehave influenced the statistical results?

In Page 13-lines 385-386 - *"The HYSPLIT model indicates that the 12:00 UTC air masses over Évora at 1.7 and 2.7 km agl (equivalent to 2 and 3 km asl) are coming directly from lower altitudes in Northern Africa (Figure 7a)."*
This sentence is slightly confused, please, rewrite the sentence.

Page 15 - Lines 455 and 456 - *"First, the satellite presents a satisfactory agreement with the ground-based lidar in the whole available profile under both SCA and SCAmb (Figure 11c)."*
For the first atmospheric layers up to 2,5 km asl it seems there is an underestimation of Aeolus particle backscatter signal, and for the layers from 2.5 to 6 km asl, it seems to have an overestimation of Aeolus particle backscatter signal. Considering that Barcelona is the station with the most complex scenario, with several layers coming from different sources and containing different optical properties, the comparison analysis seems to be much more sensitive, I believe the authors could explore more this aspects in order to improve the manuscript discussion.

Page 15 - lines 467-469 - *"101 B10-overpasses for Granada, 51 for Évora and 52 for Barcelona, and after applying the set of requirements, the intercomparison has been performed with 24 cases for Granada, 15 cases for Évora and 16 cases for Barcelona, leading to enough statistical significance."*
What criteria were considered by the authors to reach the conclusion that this number of cases is statistically significant?

Page 15 - lines 474-475 - *"With the implementation of the quality flags (Figure 12c and 12 d), all of the sets range from 0 $Mm^{-1}sr^{-1}$."*.
Please, consider correct this sentence. All the sets range from 0 to which value?

Page 16 - lines 490-491 - *"Aeolus backscatter coefficient uncertainties (known as Aeolus error estimates) are addressed through the biases between satellite and ground-based measurements. Figure 14 reveals that the larger the Aeolus uncertainties, the larger the bias."*
Just for improve the understanding, is the bias mentioned in this sentence and presented in axis Y in figure 14 the same values calculated in equation presented in page 9-line 286? If yes, I would recomment the authors rewrite the sentence.

Page 23 - line 710 - Please, consider correct the reference *"Córdoba-Jabonero, C., Sicard, M., López-Cayuela, M.-A., Ansmann, A., Comerón, A., Zorzano, M.-P., Rodríguez-Gómez, A., and Muñoz-Porcar, C.: Aerosol radiative effect during the summer 2019 heatwave produced partly by an intercontinental Saharan dust outbreak. 1. Shortwave dust-induced direct impact, Atmospheric Chemistry and Physics, 21, 1–25, https://doi.org/10.5194/acp-2020-1013, 2021."* since the DOI is leading to the pre-printed version of the article.