

## RESPONSE to Reviewer #2

On behalf of all co-authors of this paper, I would like to thank you a lot for your time to evaluate our manuscript and for your valuable feedback. Below you may find our replies to your comments written with blue colour. New or changed sentences/paragraphs in our manuscript are also provided (in black colour/italics).

1. L 56. In this sentence, I suggest replacing "anthropogenic" with "anthropic"

**Response:** Thank you, it has been corrected.

2. L62-63, "is comprised by" -> consists of

**Response:** Thank you, it has been corrected.

3. L83, remove "the" before "lidars"

**Response:** Thank you, it has been corrected.

4. L91. "This is though" -> "However, this is"

**Response:** Based on Reviewer's #1 comment lines 91-92 have been changed as follows: *“Although fine dust presents lower depolarization values (Järvinen et al., 2016; Sakai et al., 2010; Szczepanik et al. 2021), they are still higher than the depolarization values of anthropogenic particles.”*

5. L161. What is the difference between "volume" and "particle" linear depolarization ratio? Can you define these quantities somewhere in the text?

**Response:** The volume linear depolarization ratio is the linear depolarization ratio taking into account both molecules and aerosol particles in the atmosphere, whereas the particle linear depolarization ratio takes into account only the aerosol particles in the atmosphere. We have included this clarification in line 162: *“(VLDR takes into account both molecules and aerosol particles in the atmosphere, whereas PLDR takes into account only the aerosol particles.)”*

6. Figures 5 and 6. Consider inverting the order of the figures, and describe them more precisely in the text (e.g., "Fig. 5 show retrieved size distributions and concentration profiles for the case study etc...., and Fig. 6 shows the agreement between observed values of total optical depth, sky radiance and lidar signals, and the values fitted with GARRLic/GRASP).

**Response:** We prefer not to change the order of the figures since we think that it follows better the order of the retrieval process, i.e. first the fitting of the measurements and then the provision of the results. Following the reviewer's suggestion we describe more the figures in the text, changing the lines 298-299 as following: *“Figure 5 shows an example of the fitting with GRASP/GARRLiC of the lidar and sun-photometer observations (i.e., the total optical depth, sky radiance and lidar signals) for one of the acceptable solutions (size distributions and concentration profiles), which is shown in Fig. 6.”*

7. Does Fig. 7 add any new information to Fig. 6? If not, you may consider removing it (isn't the optimal solution already highlighted in Fig. 6?)

**Response:** Thank you for the suggestion. We have removed Fig. 7.

8. L306-307. "This indicates... part of the retrieval uncertainty of the solution". Is this a general statement or does it just hold for the example you are showing?

**Response:** Thank you for the comment. It is a general statement for the case studies investigated within our work. We added the following in line 307 to make this clearer: *"This conclusion holds for all the case studies investigated herein."*

9. L330. "the information content... size distribution" -> "the information content of lidar measurements on the aerosol size distribution"

**Response:** Thank you, it has been corrected.

10. L339. Some references are missing here. Are you maybe referring to Fig. 10?

**Response:** Thank you, it has been corrected.

11. L340, eq. 1-2, Appendix B. Why do you indicate concentration with VD? Could you use a more intuitive symbol? For example, in eq. 3 you use c...

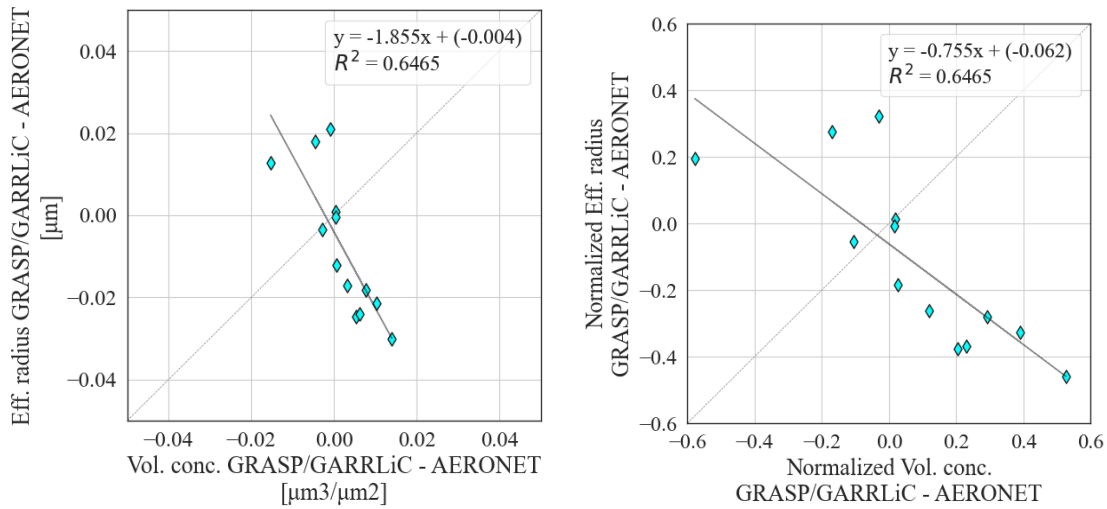
**Response:** Thank you, we have changed it to "VC".

12. L369-372. "h<sub>a</sub> (pink)... full overlap height". What do you mean by "taking into account"? How do you actually take those values into account?

13. **Response:** Thank you, we have changed lines 369-372 as follows: *"... "h<sub>a</sub>" (pink) is the concentration profile comprised by the maximum values above the full overlap height and the minimum values below the full overlap height. "h<sub>b</sub>" (dark blue) is the concentration profile comprised by the minimum values above the full overlap height and the maximum values below the full overlap height."*

14. Figs. 14.-15. How do the variables that appear in the plot correlate? Scatter plots may be useful in addition to histograms.

**Response:** We provide here the scatterplots of the differences (GRASP/GARRLiC – AERONET) for the effective radius vs the volume concentration (left), along with the corresponding normalized differences (right):



We see an anti-correlation between the differences in the retrieved effective radius and the differences in the retrieved volume concentration. Thus, the smaller effective radii retrieved by GRASP/GARRLiC is associated with higher values for the volume concentration. This anti-correlation is not easy to interpret.

We included these scatter plots in the manuscript as Fig. 15 and we added the following in line 388: “*Figure 15 shows the scatterplots of the differences (GRASP/GARRLiC – AERONET) of the retrieved effective radius vs the retrieved volume concentration, along with the corresponding normalized differences. The plots show that the differences are anti-correlated, with the lower values of the effective radius retrieved from GRASP/GARRLiC to be associated to higher values of retrieved volume concentrations. This anti-correlation is not easy to interpret.*”

15. L426. "depends also" -> "also depends"

**Response:** Thank you, it has been corrected.

16. L460. "of the simulated signals against the input ones" -> "between simulated and measured signals"

**Response:** Thank you, it has been corrected.

17. L462, "to obtain a quantitative metric" -> "to obtain such a metric", "input" -> "measured"?

**Response:** Thank you, it has been corrected.