Atmospheric Measurement Techniques Discussions

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Comment on amt-2021-268

Ronny Engelmann (Referee)

Referee comment on "The eVe reference polarisation lidar system for the calibration and validation of the Aeolus L2A product" by Peristera Paschou et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-268-RC2, 2021

The manuscript "The eVe reference polarization lidar system for Cal/Val of Aeolus L2A product" by Peristera Paschou, et al. describes a new Raman Polarization lidar system that is capable of measuring atmospheric linear and circular depolarization, as well as backscatter and extinction at 355 nm wavelength.
The system was constructed by Raymetrics in cooperation with the University of Munich and the National Observatory of Athens.
The manuscript is well written, the outline is appropriate for such a technical description, the content is clear, the figures are of good quality, and the English language is of high quality except for a few minor points.
I recommend considering this manuscript for publication in ACP after some minor revisions have been considered. Most comments are given in the supplement pdf. However, the most important points that should be addressed are given next:

1.) As this is a descriptive paper for a new lidar system, it would be good to specify the most important optical elements as well as possible. If the policy of Raymetrics allows, it would be good to mention a bit more in detail manufacturers, and specs of e.g., telescope manufacturer & type, the collimation lens focal length, polarizing beam splitter types, sheet polarizer types, as well as interference filter manufacturer and specs, eyepieces, and so on. It has been seen from other papers in the past, that such a publication is the first point to look for such details during future work with the system.
2.) In Fig.5 a lot of optical elements are described by Müller matrices. This is nicely done and quite clear. But it should be mentioned, why those matrices are given and what they are used for. Do you know the values of these matrices? Can you specify them in the Appendix for future reference? Otherwise, it is not clear, why those matrices are given here.
3.) If possible, also give real values of the GH parameters for future reference.
4.) It should be mentioned, why a new algorithm for the retrievals is needed. After all, many algorithms already exist. But nevertheless, it is good to compare to a standard example like the EARLINET case. However, this case shows extremely high AOD and large extinction values. In most real-life cases the extinction can be smaller by as much as a factor of 10. Such cases would be really more challenging for a comparison. My suggestion is to at least mention this fact about the EARLINET case. Furthermore, I would suggest

combining the graphs and tables to shorten this part of the Algorithm development, as this is scientifically speaking nothing new.

5.) Error estimates: In the case study the error of the VLDR is below 0.0005. That seems to be very small, considering that signal noise plays a role, calibration uncertainties, and uncertainties of G&H are always present. I would suggest revising these calculations. Also, the PLDR has a very small uncertainty in regions with almost no backscatter. Please recheck, from experience, the errors should be much larger in Fig 10, right, above 5km height.

Furthermore, the uncertainties of the extinction coefficient seem to be very small as well. How is the extinction calculated? Usually, the derivative is calculated by a linear fit over a certain height range. Was the error of this fit propagated towards the extinction coefficient? Please denote the fit(smoothing) length. Can you also present the corresponding lidar ratio profile? Calculating the lidar ratio by eye leads to very small values between 10 and 20 in lower altitudes. Is this reasonable?

6.) Can you compare the measured Rayleigh volume depolarization (in particle-free air) to the theoretically determined depolarization (according to the filter bandwidth)?

7.) As the first case study shows a measurement with very low depolarization I would suspect the second case presents quite the opposite. While the second case has a slightly higher depolarization I wonder: is it not possible to find a real dust-dominated case? Then you could show the real performance of the system and how the Aeolus-like backscatter significantly differs from the "total" backscatter. I think such a case (instead of case #2) would improve the manuscript quite a lot.

8.) Did you perform any of the EARLINET QA tests? Telecover, Rayleigh-fit, etc. Is it possible to include any of these results?

Please also note the supplement to this comment:
https://amt.copernicus.org/preprints/amt-2021-268/amt-2021-268-RC2-supplement.pdf