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Atmospheric Measurement Techniques Discussions

Interactive comment on "EARLINET lidar quality assurance tools" *by* Volker Freudenthaler et al.

Anonymous Referee #3

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The paper entitled "EARLINET lidar quality assurance tools" by Volker Freudenthaler, Holger Linné, Anatoli Chaikovski, Dieter Rabus, and Silke Groß describes several tools and tests for the monitoring of lidar hardware setup and estimation of uncertainties of derived products.

——————————— general comments ———————————

The paper is of scientific significance, it provides a variety of valuable tools and methods for uncertainty estmimation for lidar scientists. The scientific approaches and applied methods are valid. Nevertheless, the presentation of the methods and results can be improved.

The first sentence of the introduction should be deleted or re-phrased. It is uncommon to say that the introduction to the actual paper is provided in chapter 3.1 of another paper. The authors could at least give a short summary of this section.

introduction: The text should be structured in several paragraphs

p1,l36 - p2, l14: The introduction should provide an outlook to the content of the following sections. There are too many technical details and results provided in this part of the manuscript.

All figures are too small. Legends are really hard to read.

The manuscript misses a summary and/or conclusion section.

——————————— Specific comments ———————————

introduction: p1, l18: why are the instruments not homogeneous?

p1, l24-25: The phrase "which was .. ozone research" is not needed here.

p2, l1: a too high signal-to-noise ratio - in near range?

fig1, caption: .. red curves are range corrections -> are range-corrected signals

section 2.1: Please consider to shorten this section. It should be sufficient to provide equations (1),(2), and (4) together with a reference to the extinction retrieval which is available, e.g., in lidar textbooks.

eq (1): the symbols β and C are not explained in the text.

p3, l19: provide few more words how the differentiation is related to the absolute error.

section 2.2: A list of the several discussed methods would be helpful as introduction.

eq(6)/fig2: how is the delta alpha of figure 2 related to equation(6)?Equation(6) cannot give negative values.

p5, l5-6: what does "decrease the signal height .. detectors" mean? Shall the aperture suppress signal saturation?

p5, l12-13: Which accuracy of the speed of light in the fibre is needed to measure the trigger delay with an accuracy of 7.5m?

p6, l8: "The main peaks are distributed between two range bins." -> Figure 7 shows that the peaks of the photon counting signal are distributed over 3-4 bins.

p6, l8-9: "The statistical properties... better than a range bin" -> Provide details / equations how this uncertainty can be derived or skip the sentence.

p6, l22: "The small correlation peak" -> which one? The peak at 0 is larger than the one at -11?

p7, l5: It could be emphasized that you now start the discussion of another (traditional, widely used) method. Otherwise the reader may not realize that figure 7 is about lab measurements and figure 10 about atmospheric measurements.

Figure 9 could be removed because its information is also provided in figure 10.

section 3: This section needs re-organization. It should start with a general description of the method (equations 7-9), followed by the discussion of measurement examples and a conclusion. This section mixes the discussion of the accuracy of the Rayleigh fit (resulting in calibration uncertainties) with the use of the Rayleigh signal as a tool for the quality check of signals (analog signal distortions). These two aspects of the Rayleigh fit should be discussed separately.

p9, l4-6: This sentence is difficult to read.

eq(8): β_p should be β_m

eq(10): $r^2P(r, r_0)$ should be $r^2P(r)$

eq(10): it should be mentioned that the term for particle transmission is completely neglected in equation (8) and the following.

eq(11) is wrong. β_m^{att} and β_m are not equal. They are different by the molecular transmission term.

eq (11): The interesting question is how the uncertainties of the normalization

(Rayleigh fit) propagates to the uncertainty of the retrieved backscatter profiles? Which uncertainties of the backscatter profiles are to be expected if the normalization range is not completely free of particles? It is not necessary to introduce new simulations here, but corresponding values from literature could be helpful to understand the importance of a good Rayleigh fit.

p9, l16-20: These approximations of the backscatter ratio and backscatter coefficient should be skipped because they are not used in the following parts of the manuscript.

fig11: You should show only one Rayleigh fit. It is confusing to show different options and not to discuss which fit range is optimum.

p8, l12: What is the glued signal? Skip this curve. Gluing is not the scope of this manuscript.

It should mentioned that the analog signals discussed in fig 11 and fig 12 are different. The one in fig 11 (Licel) is not optimized for the far-range in contrast to one in fig 12. It is worth to mention as a conclusion that those Licel analog signals should never be used without the corresponding photon-counting signal.

Why is the uncertainty of the analog signal in Fig 11 calculated with respect to the photon counting signal and in fig 12 with respect to the calculated Rayleigh signal? Which method is recommended?

fig 13: could be skipped because there is no additional information to figure 12.

fig16: The discussion of Licel curves is quite short. E.g., why do cyan lines have a stronger noise than black and magenta lines?

figures 16 and 17: The legends are too small and the numbers are difficult to understand. A legend in table form beside the plot could significantly improve readability.

fig24: would be easier to read if the nomenclature is plotted left. What is the viewing direction - towards the atmosphere or into the lidar?

fig24,caption: skip "Using the four .. octant test". These terms are explained in the text; "the pictures above.." -> pictures left

p17, l8: insert something like "The measurement sequence started with the north sector followed by ..."

p17, l13: "due o signal noise, except for .." -> due to signal nose and atmospheric ...

p18, l1 : Is there a threshold at which deviations the overlap is considered as full? It is really hard to see the curves below 100m. A break of the axis at 1-4km would enlarge the overlap range.

fig 26: The optical schematics are too small! Are they needed to understand the simulations? what are the green and blue areas in the left plot?

fig 27: legends are not readable.

figs 28-30: skip titles. If necessary explain in the caption. What are symbols and lines?

p19: Are there differences between the results of the paraxial and the ZEMAX simulation? If yes, discuss the pros and cons of the two simulation tools. If no, skip one method.

figs 31-32: skip titles. If necessary explain in the caption.

annex: The variable β is used as an angle in eq (15) and as backscatter coefficient.

——————————— technical corrections ———————————

p5, l11: "With this" -> with this setup

p6, l15: Figures 7 -> Figure 7

p8, l2: "calculated signals from air density" -> calculated pure molecular signals

fig11: skip the title of the plot

fig12: skip titles of the plots

p8, l21: without aerosols -> without aerosol particles

p8, l25: What does "too strong" mean? E.g. larger than 5

p11, l2-3: "..clearly visible in section 3 about .. above." -> "..clearly visible in section3."

p16, l2: "deviations of" -> deviations between

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