Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2017-395-RC2, 2018

Atmospheric Measurement Techniques Discussions

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

Anonymous Referee #2

Received and published: 28 March 2018

The manuscript "EARLINET lidar quality assurance tools" by V. Freudenthaler et al. summarizes the tools that have been developed approximately over the last decade to harmonize EARLINET lidar systems and their data products. The paper mainly focusses on checks according to hardware issues (and not on the quality of the data analysis algorithms). That fact should probably already be addressed in the title.

I believe the manuscript is an important contribution to the lidar community and hence it should be published.

However, up to know this manuscript is sometimes a bit confusing. I would suggest several points to consider before publication:

-The introduction reads a bit unmotivated. Maybe it does not need to be long but the general idea to introduce into the topic, to cite work that has been done before, to show the significance and relevance, and to outline the manuscript should be taken into

Printer-friendly version

Discussion paper

account. It should also be a bit more structured, e.g., suddenly at p1l36 the common issues like trigger delay are mentioned, these technical details should be introduced and explained, at least in a way, that they will be treated in this manuscript further below.

-Maybe there should also be a short overview chapter on the known lidar hardware issues (if it cannot be given in the introduction) and on the quality tests. Right now, the start with section "2 Trigger delay" is abrupt.

-All figures need attendance. The labeling and often also the line width is too small by at least a factor of 3 to 5. Some figures contain cryptic (at least for the common reader) abbreviations. Also, the quality is quite poor on some graphics. It should be checked if vector graphics could be used.

-Some statements maybe lack citations, I will try to mention a few of those below.

-The manuscript text should be true BLACK, on my printer it was just an RBG mixture and thus all letters had a colorful shade around.

-There are quite a few sentences which need some language rephrasing. Please consider rechecking the manuscript carefully with respect to that. Specific comments:

Sect. 1:

-P1L30. I think the sentence should be rephrased, also "wherefore"(several times used in the manuscript) seems to be an antique word nowadays, e.g.: Nonetheless, a direct lidar intercomparison with a reference system is considered to be the ultimate test because it can often reveal problems that have been missed even after the tests described in this manuscript have been performed.

-P2L3. Photon-counting saturation is mentioned here as a possible problem but never mentioned in the manuscript. Please try to make clear which problems will be addressed in the paper and which not. Also, include a citation on the photon-counting saturation. And maybe also on the other effects. Sect. 2:

-P2L17. "Large errors up to 1 km" What means large and why up to 1 km. Maybe the conditions should be put first. "Assuming the zero bin error to be of 15 m errors on the order of ... can be as large as ..% in the lowest 1 km. Furthermore, the error of the extinction can be as large as 1 km-1 at a height of 100 m."

-Fig1-4. In general, I think the whole story could be better presented in a 4-panel graph from one single measurement case. As of now, Fig. 1 is just some independent, arbitrary data case. My suggestion: Left top and bottom: Signal and RC-Signals with different trigger delays (like Fig 1 but with data from Fig. 3). Right top: Absolute Extinction error (Fig. 2), Right bottom: Extinction coefficients (Fig. 4).

-For Fig 1 it is not mentioned, when and where the measurement was taken, therefore I suggest to skip this case as mentioned above.

-Fig1. I would suggest marking the "0" on the x scale, maybe with a vertical bar. The legend m532xcg can be removed. It is just confusing.

-Eq.1,3,4,5 {[()]} the bracket order not kept

-Eq 2, is there a citation?

-Eq 3 and 4 seem to have different fonts.

-Fig2, caption: @355/387, please write properly, e.g., ...from (N_2 vibration-rotation) Raman measurements at 355 nm.

-P3L3. beta_IR should be beta(I,r) in the text, also later the notation should be consistent

-P3L16. A variation/error ... please decide for one or replace "/" with "or an"

-P4L5. Please give some reference to the used lidar systems if possible

-P5L13. Can you mention the exact fiber type and the refractive index? How exact has n to be known? Couldn't the refractive index (speed of light within the fiber) also be

derived by combining two exactly same length fibers and measure the time delay? Or with a photodiode/oscilloscope measurement? Would that maybe more precise?

-P6L2: What could you do, if the range resolution is 30 or even 60m? Is it possible to adjust the fiber length until the peak jumps from one bin to the next?

-Fig 5 and Fig 6 could be combined, as they are directly linked.

-Fig 7 has LSB written on the left scale, but the caption says it is on the right scale P6L22, can you a bit more specify the terms signal noise and background noise here? Does it mean the signal needs to be larger than the background? And how can the peak at 0 in C be explained?

-Fig 8, as the range bins start at 0, is plot A already corrected for the different trigger delays? Please mention in the text.

-I would skip Fig 9 because it is not clear from the text why it is presented. And Fig 7 and 10 can be combined in a two-panel graph. Again, they present the same topic, where first the focus is on shot-to-shot trigger jitter and the second is on inter-channel jitter or delay (cross-channel vs parallel and 607) and on the error made when using the scattered light from the laboratory. Probably even Figure 10 should be presented first (top/left) and Fig 7 should be second (bottom/right) because the near-range peak is a well-known feature to a lidar operator. Can you comment on the size of your lab and if it indeed can explain the 37 m (10 bins) difference between those peaks?

Sect. 3:

-In general, I would place the Rayleigh-fit section after the telecover section. This is an atmospheric test with real measurements, whereas the other tests are for signal conditioning or of laboratory character.

-P8L2, Please explain why the Rayleigh fit is the only "absolute" calibration? Either give some citations or rephrase.

-P8L4, what is a high dynamic range, and doesn't that depend on the wavelength and aerosol conditions?

-Fig 11, the 7 different lines and colors are not visible

-P8L9, dead-time corrected. How was this done?

-P8L9-12, the log plotting info could go into the figure caption, not to distract from the topic. Also, this part is more about gluing than about the Rayleigh fit. Actually, after Fig 11 the text should continue with P8L20.

-P8L10, the term 19 Least Significant Bits should be explained? Isn't the LSB usually the one or the two which are considered to be the noise of the signal?

-Fig 12 or corresponding text, citation for MULIS missing. Why is the Rayleigh fit performed on an A/D signal, when later in the manuscript it is shown that A/D signals can be highly distorted in the weak-signal regime?

-Eq. 7, please mention that this is the elastic lidar equation in contrast to Eq. 1.

-Fig 13. There is not mentioned, why Fig 13 is in the manuscript? What can be seen here that presents some new facts? Could be skipped or combined with Fig 12. However, to demonstrate the effect of analog and p.c. in the far range one graph is enough.

-P10L11-14. Again, many error sources are mentioned but not discussed or analyzed or referenced.

Sect. 4:

-P10L16. This subsection consists of just one sentence. Please elaborate/cite more about sources of analog distortions and introduce in Sect. 4, e.g., that there are electronic and optical test methods. In general, this entire chapter needs some more attention.

-Fig 15 is not mentioned in the text.

-Fig 16+17: I would suggest combining them (one graph, two panels). Also for Fig 16, not all transients have to be shown. After all, this paper shall present the test ideas, not the results of one individual system. Therefore, it would be enough to show one curve each for LICEL and the two SPECTRUM cards. The inter-channel variations are not discussed in the text anyways.

-P13L18. What is the analog output of an A/D converter? Do these modules deliver an analog signal as well or do you mean the digitized output? Please also specify the manufacturer of these modules and the later mentioned detectors.

-Subsect 4.3: This subsection needs much more explanation. What is measured, why are there two pulses (8:1), what does the background LED do? What are F-in levels? What is Vout/Vin, when it is an optical test? Also, these graphs differ in style from the rest of the manuscript.

-Can there anything be said about the EM-distortions in those modules? It is stated that everything (detector, amplifier, A/D converter) is in one box to avoid such distortions. But can this fact be shown as well?

-The end of section 4 should introduce/motivate into the next section of dark measurements.

Sect. 5:

-P15L3-4: Please split such long sentences, because these are two independent effects.

Sect. 6:

-P16L2-4: This is just one sentence in the paragraph

-Fig 22. Please mention that the simulations are for a biaxial lidar setup. What are the top and bottom parts of the telescope? Do you refer here to North and South section

as stated later?

-P16L23. "In a first attempt" ...to do what? Better formulate in a way that in the following paragraph a method is shown to test the effects mentioned above.

-Fig 24, right. Somehow mention the viewing direction. Is the laser coming towards the reader or is it a view from behind the lidar?

-Fig 25. This graph is unnecessarily crowded. I think it is not needed to show the raw signals. In my opinion, the normalized telecover signals and deviations of one channel would be enough. It would be even more informative if next to the good example of POLIS-6 a failed-test example would be shown and the reasons would be explained later in the text.

-P18L2. What means "well-designed eyepieces"? Please give more insight or write well-designed receiver optic.

-P18L6. Since there are two different blue colors in the figure the sentence should also mention "(right)" somewhere.

-Fig 26. left: The blue part should probably also be green. It is not clear why the bar to the left is blueish and the bar to the right is greenish. It is also unclear, why all the laser and receiver optics are named, and what those notations mean. This lower part could be easily skipped, to explain the telescopes overlap effect.

-Fig 27 is very hard to read and understand. First of all, this figure shall explain the effect of telescope defocus. But the section is about the Telecover Test. So it could be argued, why is this off-topic presented here? This must be explained in the text. Secondly, it is not explained, what the new orange and purple colors in the paraxial simulations mean. Where do they come from suddenly? If this graph is really needed, maybe it can be condensed into 3 field-stop positions and just one range from 0-2 km?

-P19L8-12. "Loss of full overlap of the S-signal in the far range." Where can this be seen in Fig 28? This is not obvious.

-Fig 28. Can there be more rays used for the simulation to decrease the noise? Can you describe in the caption what is seen right and left? Why is there mentioned that polarization was considered? How is this relevant to this figure and the statements made?

-P20L4. Please write firstly what is seen in Fig 29, before mentioning disadvantages of the telecover test. It reads so negatively. And what exactly means S-N/S tilt?

-P20L14-18. This sentence is very hard to understand. Can you please explain the arguments a bit more in detail for a reader who is not performing optical simulations on a daily basis? Where is the collimator lens?

-Fig 29. What means coating IFF2C5555...? What is appendix "r"? If there are so many curves in a graph, they need some kind of annotation.

-P21L6FF. It is really hard to follow in this part of the text. Why suddenly the formula Eq. 14 of a transmission shift vs. angle of an interference filter is presented?

-Can Fig 31 and 32 be combined, as they deal with the topic of PMT inhomogeneity?

-Fig 32. What means eyepiece? Can you reference or explain in the text?

-General remarks: Can the telecover tests be used to estimate systematic errors? Let's assume you use different sectors of the telescope to derive backscatter, extinction, depolarization. Can the variability between these products be linked to the systematic error of those products? If such conclusions could be drawn from this test, this would be a real advancement. Like presented now, the telecover test can only discriminate into good alignment or problematic alignment. But what are the consequences? Stop measurements at all until all systems are perfect or adjust error bars?

Sect. 7:

-Fig 34. Vplus_mean and Vminus_mean are not visible.

After Sect 7. I agree with Reviewer #3 that at least a conclusion/summary section is

missing. This would be the ideal place to summarize the recommendations and standardizations requirements given by EARLINET and future ACTRIS for the necessary check-up routines to comply with the quality assurance.

Appendix 9.1: This part could be skipped if the signals in the few graphs would be annotated in a more readable form. If it is kept, it should be mentioned in the text, why this naming convention is used throughout the manuscript.

9.2: It is important that within EARLINET the Rayleigh scattering algorithms are harmonized. However, does this information belong to the context of this -mainly hardware related- manuscript? Then it could also be argued, why different algorithmic solution approaches of the lidar equations are not summarized here, too? I would suggest to skip this part and publish it elsewhere. If not, then again, it should be mentioned in the text, why this Appendix is needed here.

Literature: There are quite some typos, I guess this will be fixed later.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-395, 2018.