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Reply on RC1

Marco Di Paolantonio et al.

Author comment on "A semi-automated procedure for the emitter–receiver geometry characterization of motor-controlled lidars" by Marco Di Paolantonio et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-231-AC1, 2022

We thank the anonymous referee for the constructive comments that have been useful to improve the paper. Following the comments of the referee, corrections have been applied on the paper.

The paper presents a novel procedure to characterize the geometry, and its influence on receiving features, of a motor-controlled lidar. The aim of the paper is very interesting and I must thank the authors for this descriptive work, that is of practical interest for many lidar instruments.

I have some remarks:

1

The system analyzed is the multi-wavelength multi-telescope Rayleigh-Mie-Raman "9-eyes" lidar in Rome Tor Vergatta. The authors give a reference where the description of the lidar was included (Congeduti et al, 1999). Unfortunately this paper has little detail about the system, although the main innovations are pointed out. As a result, the present paper devotes section 2 to a further description of the system, in its present state. So this description is of great interest.

First of all, Congeduti et al, 1999 says very little about, for instance, the transmitted laser, and so Table 1 in the present paper includes some additional data. I am somehow puzzled about the energy distribution of the laser pulses (400 mJ @355 nm, 200 mJ @532 nm). Could the authors possibly confirm this data and elaborate a bit more? It would also be helpful knowing about the manufacturer and model of the laser, or knowing if it was developed by the Rome Tor Vergata team.

Manufacturer and model added to the description (line 91). The energy distribution is nominal and optimized for the UV output (line 92).

An additional issue is about the fibres that are used to bring the light collected in the different telescopes (after being separated in visible and UV bands near the telescope focal planes). The first mention (on line 113) does not say anything about the fibres, while later on we learn that they have 0.94 mm cores... which is not standard at all. Maybe some modified reference, as "large-core fibre" could be made from the first time. This would improve the reader's understanding.

“Large-core fibre” added to the text (line 112).

Table 8 depicts the correspondence of telescopes and received wavelengths. I presume that these are the actual implemented channels. To me it is not clear why, for instance, the smaller and widest field telescope is not used for the 355 channel... unless the "receiving block" depicted in figure 3(b) is not built for the small telescopes (3 and 4). If this is the case, it should be clearly stated. Any other details about the telescopes should be stated as well.

The smallest telescope does not have a dichroic beam splitter in the receiving block. The difference between this and the other receiving blocks is now also clarified in Fig. 3 caption. The lidar system was originally designed for the mid-upper atmosphere and the 355 nm capability was added in 2011. Table 4 was updated in order to clarify the definition of acquisition channels in terms of telescopes and received wavelengths.

Table 5 is somehow puzzling: according to table 4, some combinations of telescopes and received wavelength are not possible or are not implemented. Anyway, the different overlap parameters are computed for every channel and the two elastic wavelengths, with the only exception of R0 and R1 for 355 nm and telescope 4... so I would ask the authors to state clearly if table 4 counts for implemented interconnections or for the possible ones, and make it as coherent as possible with table 5.

The combinations are calculated for the two emitted wavelengths (now clarified in the table caption) for each telescope and consider the currently implemented interconnections. Please note that the 9 largest telescopes are not used for 355 nm acquisition but still receive Raman signals at 386 and 407 nm.

2

Section 3.1 is devoted to the description of the strategy for optimizing the mutual alignment of laser beams, telescope and the so-called “receiving blocks”, which couple the collected light into one or two fibres (depending on the specific channel). I have not been able to find a detailed description of these receiving blocks, other than a very simplified sketch in figure 3.b. and some vague description around line 110; I have found no citation of any other source describing these blocks.

Knowing the equivalent focal distance of the optics that couples the incoming light to the fibre(s) at the output of the block is necessary to understand the influence of a given displacement in any of the XYZ axes. A more detailed description of these receiving blocks is expected from the authors. This data would allow a more complete analytical model of the method.

Information on the lenses and schematics of the receiving blocks added in the new version (Fig. 3).

Even though it is stated that the optimizing criterium is maximizing the normalized signal, for me it is not clear enough what would be taken as “reference signal” or, more precisely, how it was obtained (somewhere in the text it is suggested that it is channel 2?). It should be stated if this reference signal and the normalized signal is measured at a given range from the lidar (what is suggested later on in figure 16), maybe considered as the most significant; or if this figure is obtained from some integration of the detected signal profile for each position. This should be stated in a non-ambiguous way.

Clarified in the new version. See lines 280-288.

It would be desirable that the authors present a model for the expected variations in the *signal for given deviations from the optimum position, that can be applied to the actual parameters of the receiver channels (focal distance of telescopes, receiving blocks, acceptance angle of the fibres, etc.).*

The study is aimed to implement a procedure for the characterization of the relative beam-telescope FOV alignment and assumes that the optical system downstream of the field stop diaphragm is well aligned (see line 236 and 115). A full description of all the components in the optical path is outside of the scope of the study. We instead focus on the development of a simple operative procedure to optimize the performance of the system. Nevertheless, the cumulative effect of deviations from the nominal position of all the optical elements can be qualitatively identified by the procedure. This was clarified in line 250.

3

Section 3.2 describes very shortly the laser mapping procedure. This procedure is devoted to determine the overlap profile of the laser-telescope-receiver block system. The authors must include a description of how this profile is computed from the signals obtained during the laser mapping procedure. Later on (section 4.3) a model for retrieving this overlap profile is cited (Stelmaszczyk et al, 2005). This citation must be made in section 3.2 as well, with details of its implementation.

The procedure for the overlap function estimation follows an original approach and is described from line 308 to 312 (now updated for better clarity). The cited model was used only for the validation.

4

Section 4.1 describes the telescope mapping and alignment process. While the graphical presentation makes this process very easy to understand, some question still arise:

First of all, two telescope mapping sessions are reported, but Table 6 includes information about a later laser mapping session, reported in section 4.3. This should be clearly stated, as nothing is said about this later session in the table title or, better, collected in an additional table located in section 4.3. I must remind here my comment #3.

The information on the three sessions was left in a single table. The table format and caption are now corrected for better clarity.

This process is devoted to optimally align of channel 1, which is normalized with respect to channel 2. This seems OK with the first lines of table 6. So, why channels 4 and 8 (386 and 355 nm) are acquired? Are they used in any way? According to table 4, they are collected with the 30-cm telescope which does not seem to be part of the process. Please clarify the content of this table.

They are acquired but not used in the mapping procedure. Table 6 caption was corrected for better clarity.

Figure 10 shows normalized signals, obtained in a "coarse" mapping session. This is how it had been announced by the authors. They start from a "manual" previous alignment and explore different positions. Even though this is a coarse alignment, do the authors consider that there is an optimum position as a result of this first session? It is somehow suggested that one of the positions in Fig 10.b should be the one. Please confirm that this is the, let us say, provisional choice.

As stated in line 321 the coarse mapping session is used to preliminary identify the subvolume of optimal alignment.The results of the first session are then used to center the second session movements around the presumed optimal position. To clarify the different steps of the procedure, the optimal position resulting from the coarse mapping has been added in line 344. This provisional choice differs slightly from the final choice.

Regarding the second session, the results are presented in absolute signal instead of normalized one. Even though this does not seem to me to be an issue, it is the only plot where such absolute signal intensity values are presented. In section 2 of my remarks I wrote that I was missing a definition of this signal, be it absolute or normalized.

The second channel was not used for normalization due to highly incomplete overlap in the low range. Clarified in the new version (line 358). For the definition of signal and normalized signal see line 212 and 280-288

Finally the variations for different z positions are depicted in figure 12, once again with normalized signal. Is there a plot like figure 12 available from session 1?

Both sessions are depicted in Fig. 12 (now Fig. 13). The figure was updated to better differentiate the two sessions.

I must emphasize that the definitions of "signal" and "normalized signal" must be stated.

The definition of signal and normalized signal are now in line 212 and 280-288.

5

No comments on section 4.2.

6

As I mentioned in comment #4, the details of the laser mapping should be detailed in a table included in this section.

As mentioned in a previous comment, the information on the three sessions was left in a single table. The table format and its caption were updated for better clarity.

For the first time in the article, it is somehow suggested that the signal values depicted are taken at a given range, here described by a delay value. If it is so, this must be stated here and in the previous sections.

Each mapping figure represent the signal (or normalized signal) at some selected range. All the captions were updated in order to clarify the range of each subplot.

Once again, absolute signal is used without any explanation.

The absolute signal was used only for the graphical representation in order to show both mapping signal and mapping in the reference position.

Line 426 states "…the experimental results are in agreements with the models". The authors must detail or cite these models clearly.

The models are detailed in line 436. An explicit citation of the Halldórsson and Langerholc (1978) model was added in the new version.