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Dr. Ansmann and Anonymous Reviewers,

we wish to thank the Reviewers for their feedback and careful consideration of this paper. We think the changes outlined below in response to their criticisms have certainly made this a better manuscript overall.

Thank you again for your consideration.

Yours Sincerely,

Giuseppe D'Amico, Aldo Amodeo, Holger Baars, Ioannis Binietoglou, Volker Freudenthaler, Ina Mattis, Ulla Wandinger, and Gelsomina Pappalardo

1 Anonymous Reviewer #1

All the recommendations provided by the Reviewer have been implemented in the manuscript. In particular, the following references have been added:

1. Johnson, F. A., Jones, R.,McLean, T. P., and Pike, E. R.: Dead-Time Corrections to Photon Counting Distributions, Phys. Rev. Lett., 16, 589–592, 1966.

2. Papayannis, A., Ancellet, G., Pelon, J., and Mégie, G.: Multiwavelength lidar for ozone measurements in the troposphere and the lower stratosphere, Appl. Opt., 29, 467–476, 1990.

3. Whiteman, D. N., Melfi, S. H., and Ferrare, R. A.: Raman lidar system for the measurement of water vapor and aerosols in the Earth's atmosphere, Appl. Opt., 31, 3068–3082, 1992.

4. Bösenberg, J., Hoff, R., Ansmann, A., Müller, D., Antuña, J. C., Whiteman, D., Sugimoto, N., Apituley, A., Hardesty, M., Welton, J., Eloranta, E., Arshinov, Y., Kinne, S., and Freudenthaler, V.: GAW Report No. 178: Plan for the implementation of the GAW Aerosol Lidar Observation Network GALION, Tech. rep., Geneva, World Meteorological Organization, ftp://ftp.wmo.int/Documents/PublicWeb/arep/gaw/gaw178-galion-27-Oct.pdf, 2008.

2 Anonymous Reviewer #2

1. *Main comments: Generally speaking, the current content is much too qualitative, not quantitative enough. I am anticipating that the other two manuscripts on SCC will focus on the specifics of the data processing, and will therefore not produce much of an over- all evaluation, which is the anticipated purpose of the present manuscript. We should therefore expect to see in the present manuscript a comprehensive review of the SCC performance with respect to the products of all relevant "manual" (as it is referred to in the manuscript) retrievals, or at least all of the retrievals currently producing publicly available profiles. The uncertainty budget must as well include quantitative information.*

   The whole manuscript has been revised according to the Reviewer suggestion. In particular, sections 4.1 and 4.2 have been extended providing one more table (currently Table 1 in the manuscript) and two more figures (currently Fig. 11 and 14). Moreover, the results of both these sections have been commented in more details providing a more quantitative overview of the SCC performance. More information about the uncertainty propagation have been given providing also references. For more details on the modifications please refer to the items 11 and 12.

2. *My second major comment is the lack of discussion on the actual purpose and use of the SCC. Who currently uses it, and for what purpose? Is there a long-term plan for centralized processing? Is it going to be an official product of EARLINET or ACTRIS? How many stations/instruments have indeed released e and b profiles produced by the SCC? What time period do these data cover? Etc. These questions need to be addressed in the SCC overview manuscript.*

   The following text has been added in the section "SCC description":

   "The SCC is an official EARLINET tool. It has been developed to accomplish the fundamental need of any coordinated lidar network to have an optimized and automatic tool providing high-quality aerosol properties. Currently, it has been used by 20 different EARLINET stations which have submitted about 2600 raw datafiles covering a quite large time period (2001–2015). Moreover, more than 5000 SCC optical products (about 3600 aerosol backscatter profiles and 1400 aerosol extinction profiles) have been calculated and used for different purposes like analysis of instrument intercomparisons (Wandinger et al., 2015), air-quality model assimilation experiment (Wang et al., 2014; Sicard et al., 2015), and ongoing long-term comparisons with manually retrieved products (Voudouri et al., 2015). The large usage and the long-term plan for the centralized processing system make the SCC the standard tool for the automatic analysis of EARLINET lidar data."

3. *Introduction: The introduction is often repetitive, but most importantly, is out of focus, i.e., it is used as a discussion rather than a simple introduction to the subject. Its content until P4975/L25 can be kept unchanged,*

however, most of the material included after that should be shortened into one or two paragraphs, and the more detailed content should be redistributed among the remaining sections, as appropriate.

The suggestion of the Reviewer has been taken into account. A new section "SCC description" has been added to the manuscript where the text indicated by the Reviewer has been moved in. Moreover, the authors tried to avoid repetitions.

4. *P49976/L6: Real-time and NRT lidar products are not needed for climate change models. A standard validated lidar product is typically enough.*

   The Reviewer is right: climate change models are not mentioned in the sentence anymore.

5. *Figure 1: The use of the term "user" is confusing here. It is not clear if the "user" is the end-user of the optical product or the raw data provider. I think "raw data provider" would be more appropriate in this case in order to distinguish from the data user (i.e., the end-user).*

   The Figure 1 has been changed according to the Reviewer suggestion.

6. *P4985/L6, use of standard models vs. radiosonde profiles: Some details should be given here and/or later in sections 4.1 and 4.2 (see comment on reference density profile). How and for which instrument is the choice of sonde vs. model made?*

   The authors would like to recall that the sections "3.2 Pre-processor module (ELPP: Earlinet Lidar Pre-Processor)" and "3.3 Optical processor module (ELDA: Earlinet Lidar Data Analyzer)" do not pretend to be exhaustive description of the respective calculus modules. They are just included in the manuscript (mainly for consistency and clarity reasons) as general overview of the capabilities of the ELPP and ELDA modules. All the details about these modules are described in the technical papers (D'Amico et al., 2015) (submission expected by the end of Jul 2015) and (Mattis et al., 2015) (submission expected by the end of Oct 2015) as mentioned in the text. For example, a subsection in D'Amico et. al., (2015) is entirely devoted to the Rayleigh atmosphere calculation with all details about formulas, configurations etc. For this reason the authors would prefer not to repeat here details already covered somewhere else. Moreover, if the authors provided further details for Rayleigh calculation they would provide (for consistency) further details also for all other corrections mentioned in the same section. In this case the section would become too much long and beyond the scope of the paper.

   Having said that, we provide here an answer to the specific Reviewer question. The choice of sonde vs. model is not made on the basis of instrument: for any instrument it can be decided if to use sonde or model. The raw data provider can select which method to use just setting a variable in the raw input data. Actually, the choice is made by the data submitter on the basis of the PTU data availabily. If there are correlative soundings, it is recommended to make use of them. In case no correlative sounding is available the data provider should use temperature and pressure profiles from atmospheric models (for example ECMWF, NASA, etc.). Only in rare conditions where it is not possible to go for any of these two options, the data provider should set the SCC to use standard model atmosphere (US 1976). Indeed, it is well known that US 1976 model typically produces less accurate temperature and pressure profiles with respect to the previous ones. In case soundings/model temperature and pressure profiles are intented to be used they need to be provided as input to the SCC using a specific (NetCDF) data format. In case the US 1976 model is selected there is no need to provide any additional input file as the temperature and pressure profiles are calculated by the model itself. It is also planned to implement directly in the SCC the option to provide model data profiles (e.g., GDAS, ECMWF, etc.) that would help the raw-data supplierers in the calculation of reference density profile.

7. *P4985/L8: Statistical uncertainty propagation is mentioned, but what about other sources of uncertainty? (e.g., associated with ancillary measurements, Rayleigh cross-section, iterative methods, etc.). At least a summary of how uncertainty is treated should be in the present manuscript. The Mattis et al., 2015, and D'Amico et al., 2015 articles should be referred if uncertainty is treated in details in those articles.*

   Also in this case the topic is partially covered in Mattis et al., (2015) and D'Amico et al., (2015). In both these papers there is a section about error propagation which gives some specific details on how the uncertainty is handled by ELPP and ELDA modules. Moreover it is planned to have in EARLINET AMT special issue another paper fully devoted to the error calculation on EARLINET products:

   Amodeo, A. and D'Amico, G. and Mattis, I. and Freudenthaler, V. and Pappalardo. G.: Error calculation for EARLINET products in the context of quality assurance and single calculus chain, Atmos. Meas. Tech. Discuss.

   The aim of this paper is to provide a comprehensive treatment about the uncertainty calculation on lidar products (both systematic and statistical). It is discussed how the statistical uncertainty affects lidar signals acquired in both analogue and photon-counting regime and how it is handled by the pre-processing and optical processing procedures implemented in the SCC. Moreover, concerning the other sources of uncertainty mentioned by the Reviewer, several systematic effects are presented in Amodeo et al., (2015) taking into account the instrumental characteristics of the lidar systems operating in EARLINET as well as the retrieval algorithms used in the data processing. In particular, systematic uncertainties in the determination of the atmospheric density profile are covered. The implications of the most common assumptions made to retrieve aerosol optical products are discussed (e.g., extinctio-to-backscatter ratio value in elastic only lidar retrievals, Rayleigh cross-section calculation, Ångstöm exponent, etc.). The paper also covers the estimation of the systematic uncertainties involved in procedures for the correction of instumental effects (e.g., dead time, trigger delay, etc.) as well as the uncertainties associated to different algorithms used in lidar data processing (e.g., gluing of low/high range signals, smoothing, etc.). At the same time, indications about possible way to minimize the systematic uncertainties are also provided. An explicit reference to the paper Amodeo et al., (2015) has been added in the manuscript. Unfortunatly also this paper is not yet available on AMTD as it is in preparation. It is expected to have it submitted by the end of Oct 2015.

The authors understand the concerns expressed by the Reviewer in having several relevant papers not yet available. At the same time, the authors believe that redundancy and overlapping with the companion papers should be avoided (the same concern was also expressed by the Reviewer #3).

8. *P4985/L24: There is no details on vertical resolution. Just like uncertainty, a summary of how vertical resolution is reported together with the SCC products should be in the present article. The Mattis et al. 2015, and D'Amico et al. 2015 articles should be referenced if vertical resolution is treated in details in those articles.*

   The vertical resolution of the SCC products is fully covered by Mattis et al., (2015) which has been cited in the text indicated by the Reviewer. As mentioned in the text, ELDA implements an automatic vertical-smoothing and time-averaging technique selecting the optical smoothing level as a function of altitude on the base of different thresholds on product uncertainties specified in the SCC database for each product. This means that the raw data provider should set (in the SCC database) the maximum error one would like to have on the product below and above 2km altitude. According to that, the automatic smoothing routine implemented in ELDA tries to find the optimal smoothing and time-avaraging level to meet the specified thresholds. The actual (altitude-dependent) vertical resolution of the profile is saved by ELDA in the output file using a dedicated NetCDF variable.

9. *P4991/L19-26: What reference density profiles were used for figure 3? Were they the same for all instruments, and were they the same for "manual" and "scc" retrievals? Differences observed on figures 3-7 need to be discussed more quantitatively, otherwise these figures lose their purpose. Considering that the scales are currently unreadable, a simple "good agreement" statement in the text is not sufficient.*

   The figures indicated by the Reviewer has been improved in terms of overall readability. For more details see item 10.

   Concerning the comment about the reference density profiles the following sentence has been added:

   "For all the profiles shown in Figs. 4–8, the molecular contribution to atmospheric extinction and transmissivity has been calculated using the atmospheric temperature and pressure profiles measured by a radiosounding correlative to the lidar measurement session."

Concerning the discussion about the differences between "manual" and "scc" profiles, the section 4.1 has been extended including more quantitative details as recommended by the Reviewer (see item 11).

10. *Most figures need major cosmetic revisions: 1- Scales and axis legends are much too small and unreadable 2- Which instrument is where? It should be mentioned on the figure, or in the caption 3- The x-axis scale of the difference plots should be stretched in order to identify more easily the numerical values of the calculated differences. 4-For a clearer picture of the differences vs. uncertainties, I would suggest to add +/- uncertainty curves for both products on the right plots (difference plots).*

    All the figures mentioned by the Reviewer have been re-generated according to his suggestions. In particular, the axis fontsize has been enlarged, systems identification has been added in all the captions and the x-axis scale of difference plots has been doubled (keeping the same minimun and maximum values) with respect to the previous version.

    Finally, the authors tried to add +/- uncertainty curves on the difference plots as suggested by the Reviewer (number 4). However, the resulting figures including this feature were a bit confusing. We would like to underline that the difference plots mentioned by the Reviewer show relative difference between SCC and manual profiles. The relative differences usually get unrealistically high values when the SNR is low (as it can be seen already from large oscillations visibile in some difference plots above 5-6km). As a consequence in such regions the +/- uncertainty curves appear to be outside the horizontal scale of the plots. It would be useful to provide relative errors only when there is aerosol significantly above background level. Moreover, the errorbars of both profiles are shown in the profile plots (on the left of each difference plot). So, the information the Reviewer would like to have in the difference plots is provided, in different way, in the corresponding profile plots. For these reasons, the authors would prefer to keep only relative difference curves in the difference plots.

11. *Section 4.1: The entire section lacks quantitative details, and considering that the scales of figures 3-7 are unreadable, it is very difficult to extract any objective assessment from these figures. I recommend a big "shake-up" with clearer demonstration that the "scc" and "man" retrievals "agree well", and clear interpretations of the observed discrepancies. Also, this critical assessment must point at the specific instrument/algorithm being tested. The authors should not use this section 4.1 to convey a general message, but instead should use it to point out quantitatively the elements of agreement and discrepancy. This is the type of information the end-user needs if he chooses to use the SCC.*

    The authors fully agree with the Reviewer suggestion and thank him to have pointed out this important point. The section has been extended including more quantitative elements to allow a better assessment of the SCC performance. In particular, the discrepancies are discussed in terms of mean absolute and relative deviations of SCC and manual profiles. A new table summarizing such parameters has been added to the manuscript (Table 1 in the manuscript). Finally, the values shown in this table are discussed and commented also taking into account the EARLINET quality requirements on aerosol backscatter and extinction coefficient retrievals (Matthias at al., 2004). Almost all the deviations meet clearly the EARLINET requirements. The cases showing largest deviations are discussed and interpretations of observed discrepancies are provided.

12. *Section 4.2: The benefits of a centralized automated processing software for a large number of instruments within the network are emphasized throughout the manuscript, yet the validation results from only two instruments/stations are shown. This is insufficient, and this is where the overview paper should provide a more comprehensive validation evidence that the SCC is a powerful tool. If currently more than two instruments provide publicly available SCC products, then the validation results of all these instruments/stations should be presented. If only two instruments provide publicly available SCC products, then the reasons for such a low number must be discussed (add a "discussion" section). This section once again lacks quantitative results. Numerical values are given in Tables 2 and 3. However, there is no quick access to the actual differences between "man" and "scc". In particular, the authors state early in section 4 that the comparisons of section 4.2 aim at identifying possible systematic differences, but there is almost no discussion of this here, and it is very difficult to characterize possible biases without showing plots of the differences.*

    Concerning the lack of quantitative results, the authors thank also in this case the Reviewer for the useful suggestion. Two figures (Figs. 11 and 14), reporting the relative defferences between mean SCC and manual retrieved profiles for Potenza and Leipzig stations, have been added to the manuscript. The relative differences have been calculated up to 4km which is also the maximum height considered to calculate the mean values reported in Tables 3 and 4. Moreover, above 4km the aerosol content is generally too low and close to the detection limit of the lidar. As a consequence, the relative deviations show large spread (mainly around zero) which makes the figures very confusing. For the same reason, in Leipzig daytime relative difference plot the relative differences for backscatter at 355 and 532nm have been cut at about 2 and 2.5km as most of the aerosol is trapped below 2km height. Moreover, in doing that we have realized that the procedure (external to the SCC) we have used to calculate mean profiles starting from SCC and manual products was affected by an error (the variable used to count the number of the sample to average was not initializated correctly in all the cycles). After having fixed it, all figures and tables referring to this session have been re-generated and now they show a slightly better agreement.

    Concerning the Reviewer suggestion to include more instruments/stations in this validation approach, the authors would like to stress that the only aim of this section is to show if there are evident biases in the SCC retrieval which cannot be detected by the comparisons discussed in the previous section. To make this test the authors considered only the two stations, for which the most manual analysis were available in the EARLINET database and, at the same time, the atmospheric conditions differ significantly. The biases we are interested in this section are not system-dependent. In this section we are mainly interested in investigating what happens when we fix the system and allow the atmospheric conditions to change. Example of such kind of biases could be problems in backscatter calibration in case or low (or high) aerosol loads. According to that, the choice of Potenza and Leipzig was also made taking into account the different characteristics of the two measurement sites. Potenza lidar station operates in a typical mountain weather. The site is also representative of the Mediterranean area and it is affected often by Saharan dust intrusions. Leipzig is a continental low-land site where air masses from polluted, highly industrialized and densely populated Central European regions as well as clean maritime air masses are frequently observed.

Moreover, system-dependent biases are investigated in the section 4.1 where lidars with different characteristics are taking into account under the same atmospheric conditions (a kind of "complementary" situations with respect the previous ones).

Finally, we would like also to underline that the SCC implements only quality-assured algorithms used within EARLINET community on a large number of lidar systems since many years.

Considering all the above points, the authors think that including other systems in the validation approach described in the section 4.2 would not add a relevant benefit.

On the other hand, we believe the Reviewer suggestion goes more in the direction of an EARLINET climatological study based on the SCC products which may be the main topic of another paper. Actually there are already other papers (Wang et. al, 2014, Wandinger et. al., 2015, Sicard et al., 2015) in which the topic is partially covered and the data of more instruments are analyzed using the SCC.

13. *P4995/L7 and caption of Tables 2 and 3): "standard errors" I am not sure what the authors mean by "standard errors". Are the authors referring to the standard deviation of the measurements, to the measurements" standard uncertainty, or to the standard deviation of the estimated mean? Please clarify. If it does not refer to the standard deviation of the estimated mean, it should not be called "standard error". If it does refer to the standard deviation of the estimated mean, the authors should explain how they estimate it. If it refers to the standard deviation of the measurements used to compute the mean, they should use "standard deviation".*

    According to the Reviewer suggestion, "standard errors" has been changed in "standard errors of the mean" (standard deviation divided by the square root of the samples) along the whole manuscript.

14. *Typos and language: - Please reformulate sentence P4975/L7*

According also to one of the Reviewer's #3 comment, the sentences P4975/L5-L11 have been reformulated to improve English (see also answers to Reviewer #3)

15. *Please reformulate sentence P4975/L28*

    The sentence has been reformulated:

    "At network level, the SCC ensures high-quality products by implementing quality checks on both raw lidar data and final optical products. Such quality checks are part of a rigorous quality assurance program developed within EARLINET."

16. *In general, there are several systematic English syntax errors appearing throughout the paper. I recommend that co-authors with the best knowledge of English language read through and correct them.*

    The Reviewer suggestion has been taken into account. The whole manuscript has been reviewed trying to improve readability and English syntax.

3 Anonymous Reviewer #3

All the suggestions provided by the Reviewer have been implemented in the manuscript. We report below a list of the main changes applied to the manuscript according to the Reviewer recommendations.

1 Introduction

- *P4975/L5-L11: Awkward use of English. Please rewrite.*

  The full sentence has been re-phrased to improve English:

  "The aerosols' high variability in terms of type, time and space makes it quite difficult to understand the atmospheric processes in which aerosols are involved (Diner et al., 2004). Therefore, there is a strong need from the scientific community to have access to comprehensive aerosol datasets in which vertically resolved aerosol optical parameters can be found. Lidar measurements, providing high-resolution profiles (in both space and time) of aerosol optical properties, meet this demand entirely as they allow the full characterization of each layer present in the atmosphere."

- *P4976/L17-P4978/L23: This is all somewhat repetitive......*
  Recommend streamlining this whole section. It is too verbose without really adding much information. Also check English crammer and spelling !

  According also to the suggestions of Reviewer #2, the "Introduction" has been re-arranged completely. Most of the text written there has been moved to a new section "SCC Description". The authors tried also to avoid repetitions and to improve English.

3.1 SCC database

- *P4983/L8-P4984/L10: Is there an existing technical note or report you can just refer to here? This text reads like a users manual or interface control document.*
  Please streamline this section.

  Unfortunatly, there is no available technical report about the SCC database structure that can be used here as reference. For this reason, the authors think it is important to devote a subsection of the manuscript to the SCC database. Without a description of the SCC database structure, hardly the reader can have a complete and consistent overview of the whole SCC. However, at the same time, the authors agree with the Reviewer opinion that this section contains too much technicalities. As a consequence the section indicated by the Reviewer has been shorted and a new figure (Figure 3), showing a simplified version of the SCC database structure, has been added to the manuscript. The corresponding text has been modified as it follows:

"In the SCC database, the experimental parameters are grouped in terms of stations, lidar configurations and lidar channels. Figure 2 shows a simplified version of the SCC database structure. Each station is linked to one or more lidar configurations which in turn are linked to one or more lidar channels. Moreover, each lidar configuration is associated also to a set of products that the SCC should calculate. Basically, the products are specified in terms of type (e.g., aerosol extinction, backscatter by Raman method, etc.) and usecase which, as it will be explained later, represents the way to calculate the product. Additionally, for a particular product, it is possible to fix a set of calculation options, e.g., the pre-processing vertical resolution, the backscatter calibration method, the maximum statistical error we would like to have on the final products and so on.

Finally, when lidar measurement sessions are submitted to the SCC they are linked to a specific lidar configuration. In this way, with specific SCC database queries, it is possible to get any detail needed for the analysis of the lidar measurements.

On one hand, a so structured database allows us to keep track of all information used to generate a particular SCC product assuring the full traceability; on the other hand, it guarantees the implementation of a reliable and rigorous quality assurance program at network level."

3.6 SCC daemon module

- *P4987/L21-P4988/L2: Is this text really necessary ? It reads like it has been extracted from a users manual.*

The authors agree with Reviewer comment. All the technicalities have been removed and only the multithread capabilities of the module are mentioned as:

"As the SCC is mainly designed to run on a single server where multiple users can perform different lidar analyses at the same time, the SCC daemon has been developed to act in a multithread environment. In this way, different processes can be started in parallel by the SCC daemon enhancing the efficiency of the whole SCC."

Figures 3,4,5,6,7

- *Fonts to small.*

These Figures has been re-edited, taking into account also the suggestions of Reviwer #2 (see item 10 above). Fontsize has been increased.