Authors' response (in blue) to the Reviewer #3's comments:

The authors thank Reviewer #3 for their comments and suggestions. A general revision of the overall manuscript has been performed, including also Abstract, main text, Conclusions and References. Required changes and modifications have been introduced in the text of the current revised version of the manuscript by using the Word Track Changes tools.

Next, the authors respond to the particular comments of the reviewer #3.

- Reviewer 3

R3C1. This paper describes a comparison between data collected using the authors Micro Pulse Lidar (MPL) and another lidar from PollyNet. Although the MPL used in this study normally operates as part of the MPLNET, it was removed from its normal station and the data collected during this campaign were processed by the authors with their own processing, calibrations, and data collection techniques. The data collected here are not from MPLNET, nor did they utilize that projects established methodology (including existing calibration process for both polarization and overlap). Therefore the results of this study are not widely applicable, and definitely do not accurately represent the data produced by the MPLNET project. This limits the overall usefulness of this study.

Authors' response: We agree. The polarized Micro Pulse Lidar (P-MPL) data collected in this work are not part of MPLNET collection, as the experimental intercomparison campaign was performed in other different station from the usual MPLNET site of El Arenosillo station (Huelva, Spain) (https://mplnet.gsfc.nasa.gov/data.cgi?site=El_Arenosillo), managed by the Instituto Nacional de Tecnica Aeroespacial (INTA), where it usually operates within the network. This was already stated in the manuscript. Particular regular calibrations and signal processing were applied, which are the same as those described by Campbell et al. (2002) and Welton et al. (2002), being within the principal MPLNET publications, and also by Flynn et al. (2007), whose data processing techniques remain also applicable for polarized MPL systems, as indicated in Welton et al. (2018). To our knowledge, those existing MPLNET overlap and polarization calibrations are just available for a few sites, and not applied yet for El Arenosillo site. That is why one of the aims of this work was, indeed, to achieve a particular experimental overlap correction and a polarization assessment of this particular P-MPL system with the information delivered by its manufacturer (Sigma Space Corp.), that is no related to defined MPLNET calibrations. However, authors think the procedure described in this study can be useful to be applied to similar P-MPL systems that cannot account for those stablished MPLNET calibrations yet.

In order to clarify it, Section 2 has been modified (changes are highlighted using the Word Track Changes tools; see, in particular, page 5, lines 165-175 of the updated revised version of the manuscript).

R3C2. The authors also present a main conclusion of this paper as an accurate overlap calibration is needed to retrieve aerosol properties from an MPL. This is by no means a new conclusion, this has been known since the MPL was first used in the 1990s. It is also why the MPLNET project has long ago established methods to deal with this issue. The methods used by MPLNET were ignored in this study and not well referenced. The authors do cite Berkoff 2003 which describes the basis of the current MPLNET method to retrieve overlap, however they do not discuss the relevance to their process shown in the paper (which is very similar, involving retrieval of the overlap from the two lidar profiles).

Authors' response: Indeed, every lidar system has to be calibrated by overlap (MPL included). The MPLNET stablished methods for overlap calibration, as those described in Berkoff et al. (2003), were not ignored, but actually, they could not be applied in our particular case. The two procedures for overlap function determination shown in Berkoff et al. (2003) are different from that presented in our work. We presented an alternative experimental method based on the cross-comparison of the backscattered signal recorded by the uncorrected lidar system (our MPL) with respect to that collected by a reference (overlap-corrected) lidar (in this work, EARLINET lidars). A similar methodology has been also used for the overlap correction of other lidars and ceilometers (i.e., Guerrero-Rascado et al., 2010; Sicard et al., 2020; and references therein). We decided to apply this experimental procedure because we wanted to validate the overlap function delivered by the manufacturer and did not have yet the chance to apply the other two overlap calibration procedures described in Berkoff et al. (2003), which have their limitations as well: 1) performing measurements under atmospheric stable and homogeneous conditions with the MPL pointing in horizontal, or 2) making use of a secondary wide field-of-view receiver (WFR) telescope.

Therefore, the main goal was achieved, i.e., determining a well-characterized overlap function for this specific P-MPL system, allowing the retrieval of reliable profiles of aerosol properties.

For clarification, the Introduction has been improved (in particular, page 3, lines 90-98 in the updated revised version of the manuscript.

R3C3. In addition, there are a number of errors present in this work and the authors do not present a clear understanding of the polarized MPL. Instead, a very vague and generalized description of the polarization problems is given to describe the causes of bias, for instance the authors say "This offset represents a correction to account for any slight mismatch in the transmitter and detector polarization planes and any impurity of

the laser polarization state", and reference older work from non-MPL polarized lidars (that utilize an entirely different optical design) and an older polarized MPL using a different crystal polarizer. This statement is simply vague and inaccurate. The authors just apply an offset to make the polarized MPL data agree better with the Polly lidar, but appear to have no idea what is causing the bias (or how it might manifest in other ways). If the authors attempt to describe their work as an "experimental assessment of a Micro Pulse Lidar system" then they should have an expert level understanding of the instrument itself. None is presented in this paper. Again, the MPLNET project has established methods for calibrating polarized lidars that were not well referenced in this paper. The authors cite a Welton 2018 paper, but do not discuss the findings from it that bear directly on the polarization calibration of MPL instruments.

Authors' response: As stated before in **R3C2**, we presented an alternative experimental method based on the cross-comparison of the backscattered signal recorded by the uncorrected lidar system (our MPL) with respect to that collected by a reference (overlap-corrected) lidar (in this work, EARLINET lidars). In particular, this methodology has been also used for the overlap correction of other lidars and ceilometers (i.e., Guerrero-Rascado et al., 2010; Sicard et al., 2020; and references therein). This kind of calibration (overlap, polarization, …) procedures are usually performed in experimental intercomparison campaigns in order to evaluate different instruments in operation within diverse atmospheric networks (i.e., EARLINET, AERONET, NDACC, …). The experimental performance of the instrumentation involved in such campaigns is assessed this way. A similar concept has been applied in our case. Such a method could be applied in case the MPLNET stablished calibrations are not applicable for a certain instrument due to manifold reasons, but it does not mean that this procedure is aimed to become a standard for MPLNET.

It is out of scope to try to accurately describe the instrument itself in this work. Instead, a relatively brief description of the MPL system used is introduced in the manuscript, since the principal issue is focused on experimental corrections and aerosol properties retrieval. There are already several works presenting a more complete description and operation of the instrument, including MPLNET publications, and specific instrumental manuals as provided by the manufacturer (as indicated in the paper). The P-MPL system of our work corresponds to the MPL version 4B design (v. 4B), which uses a Ferroelectric Liquid Rotator (FLR) instead of a Liquid Crystal Retarder (LCR) (in a previous MPL v.4), with a faster switching time. The signal processing techniques that are described by Flynn et al. (2007) for the LCR version remain also applicable for the FLR one, as stated in Welton et al. (2018). Particular signal processing procedures are applied in our work, which are the same adapted from Flynn et al. (2007). We presented an experimental polarization correction based on real measurements as an alternative, due to the unavailability of the special and specific methods for polarization calibration within MPLNET at the time of the validation campaign. The presented alternative procedure is also used in other works (e.g., Córdoba-Jabonero et al., 2013, and references therein) and represents a fast and reliable method to be used and implemented in our P-MPL system in order to obtain good results on aerosol optical retrievals.

For clarification, Sections 2.2.1, 2.4 and 3.2 have been modified (changes are highlighted using the Word Track Changes tools) in the updated revised version of the manuscript.

R3C4. I do not understand why MPLNET is discussed in this paper, nor mentioned in the acknowledgements. Other than the fact that this lidar normally operates in the MPLNET in Spain, this particular study is from a redeployment of the MPL outside of MPLNET using the authors own processing and calibrations. It should be made very clear in this manuscript that the methods described here are not part of MPLNET, nor applicable to MPLNET as they have previously defined methodologies. If the intention is otherwise, then how that would be achieved is not discussed at all. There appear to be no NASA funded contributions to this work, so why is that included in the acknowledgements section? If this did occur it is not obvious in the paper, if not then this should be removed from the acknowledgements.

Authors' response: MPLNET is not discussed in this work. It is just mentioned that the P-MPL of this work is the usual operative system in the MPLNET site of El Arenosillo station (Huelva, Spain). As stated before, P-MPL data used in our work do not appear in the MPLNET database as they were obtained during a particular intercomparison campaign performed in other different place (Leipzig, Germany) from the operative MPLNET El Arenosillo site. The calibration/correction procedures described in our work are not MPLNET standards, but they are used by other lidar/ceilometer community to retrieve accurate results (e. g., Guerrero-Rascado et al., 2008; Sicard et al., 2020). In addition, as the MPL system of our work is the current lidar operating in the MPLNET El Arenosillo site, the following statement was already included in the Acknowledgements section of our work: "The MPLNET project is funded by the NASA Radiation Sciences Program and Earth Observing System.", as the MPLNET policy indicates in the website.

In general, changes are highlighted using the Word Track Changes tools in the updated revised version of the manuscript.

Authors would like again to highlight that the experimental assessment procedure shown in our work is not a MPLNET calibration procedure, because none of the reported MPLNET calibrations (Berkoff et al., 2003; Welton et al., 2018) have been applied yet to the El Arenosillo P-MPL instrument. In addition, data are not MPLNET data, because they were obtained at a different site from the MPLNET El Arenosillo site.

We are really aware of the hard work to implement the calibration procedures in an atmospheric observational network, likewise in MPLNET. Any lidar system needs to be calibrated, and mainly, by overlap and depolarization in order to correct the lidar measurements and obtain good-quality data to be used in research. That was one of the reasons to carry out the intercomparison campaign as described in this work for the experimental assessment of the El Arenosillo MPL system, as stated in the manuscript. As it has not been possible to use the MPLNET calibration procedures by now (we wish

that will be possible in a near future, of course), we used other alternative methods, as those shown in this work, which are based on the intercomparison with reference good-calibrated lidars (EARLINET lidars in this work) to independently check the performance of that P-MPL system. This is a usual methodology carried out in other intercomparison campaigns of different atmospheric networks (EARLINET, AERONET, NDACC, …), where the calibration of the instruments for performance testing is carried out in other different places from the regular operative site, as it is in our case. In addition, this is a common benefit, reinforcing the network. In fact, the overlap function as obtained in this work is the current one approved and used for correcting the El Arenosillo MPL data within MPLNET. In this point, we also want to highlight the help from MPLNET in keeping the MPL systems and the data analysis up-to-date, alerting about new problems detected in the measurements and/or monthly calibrations, data missing or any other doubts on the instrumentation. In this sense, we think that acknowledgements to MPLNET are justified. More of those efforts should be done on the way to combine all existing networks in Europe (EARLINET), Asia (AD-NET), Latina America (LALINET) and also MPLNET within the future vision of GAW (Global Atmospheric Watch) Aerosol LIdar Observations Network (GALION).

Authors seem to be convinced that the paper can really represent a meaningful contribution, despite it may not be relevant from the point of view of MPLNET. Our goal was to focus on general or basic problems when using lidar measurements for atmospheric profiling in the lower and middle troposphere. And we clearly think the lessons we obtained are very useful. We show and demonstrate how we can obtain the overlap profiles with upward looking lidars (in their exact measuring and monitoring configuration). Our paper is clearly a new and valuable contribution to the lidar literature.

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