General Comments

The manuscript describes a formalism to calibrate the polarization channels of a lidar instrument by considering several sources of systematic uncertainties. This is a really important work since not many publications are dealing with the three signal calibration approach. Even if the method is commonly used by several lidar stations, a complete theoretical support with experimental results was somehow lacking. Under these considerations I consider the manuscript of scientific relevance and suggest to be published in AMT after some revisions. In order to be improved I would kindly suggest the authors to consider several comments stated in the following section:

Specific comments:

1. Abstract: "A comparison with another polarization lidar" replaced by "A comparison with a second polarization lidar"

2. Page 2, Line22-25: Please use the same notation for the sections. Currently we can find "section", "Section", "Sect."

3. Section 3.1 starts with the statement that the manuscript follows the "notation and explanations of Freudenthaler (2016)" from AMT. Still in the following description, the authors define the misalignment between the polarization axis of the transmitted light and the co-polarized receiver channel as θ - Page 5, Line 25-26: "The misalignment between the polarization axis of the transmitted light and the co-polarized receiver channel (defined by the respective polarization filter in front of the PMT) is characterized by angle θ ...."

   The corresponding parameter in Freudenthaler (2016) should be the "Rotation of the plane of horizontal linear polarisation of the laser around the z axis (laser rotation)" which is relative to the receiving unit reference plane. Since the manuscript refers to a similar study performed by a lidar station from the same research network EARLINET-ACTRIS, I would suggest the authors to use the same notation used in the previous work (α). Keeping the same variable names and notations as used in previous studies will help a reader familiar with similar studies and encourage the use of standardized variables and parameters.

4. Same comment as above applies for Page 6, Line 17: "The rotated polarization axis is represented in Fig. 3c, and after" and Figure 3 (also Page 8, Line 18).

5. Page 7, Line 13: "A commonly used method for the calibration is ~~the~~ to insert"

6. Page 7, Line 27: "$P0$ is the ~~emitted~~ number of emitted laser photons"

7. Page 9, Line 25: This section should be described in more detail and the reasoning behind the use of two altitude heights should be clearly mentioned. Please consider extending this section since it is an important part of the theoretical background required to use the calibration technique used in this study.

8. Page 10, Line 3: "we obtained a mean value for X_{p}". Is this really "p" or is this "δ"?

9. Page 10, Line 3-9: "Similarly, evaluation of many values of ..... are used to simultaneously determine the volume depolarization ratio in three different ways.". This section should be described in much more detail. Even if most of the readers are experts in lidar techniques, they are not familiar with the theoretical description and formalism presented in the manuscript. The theory behind this calibration technique is really valuable since this is one of the few manuscripts dealing with the three channel calibration topic and it is important to provide a complete set of information on the theory. This section must be reconsidered before the manuscript is send for publication.

10. Page 10, Line 14: "To derive ~~now~~ the linear depolarization"

11. Page 10, Line 28: "In the first step, the inter-channel constant X_δ has to be measured." More detail must be provided by the authors. The experimental technique on how to perform the assessment of X_δ must be provided since this is one of the key parameters for the calibration of the depolarization channels.

12. Eq. 42: please give more details on the missing variable "C".

13. Page 13, Line 8: "By using constant and Eq. (42), a mean value of ..." Please provide more information on this topic.

14. Page 14, Line 10-15: Since the comparison between the volume linear depolarization ratio measured by MARTHA and BERTHA is designed to validate the calibration technique used in this study, I would advise to also use a second case for this comparison. A strong depolarizing layer (e.g mineral) would help validate the results for highly depolarizing layers.

15. Page 17, Line 22-25: I do not see the necessity of this section. A link with further studies was already included in the introduction of the study and since this section is not connected to the conclusions I would advice to remove it for the final version of the manuscript.

16. Since the manuscript has an important theoretical section containing many variables and equations, I would suggest adding an additional list of variables containing a comprehensive description for each element. Please consider following the same terminology used by Freudenthaler (2016)