Interactive comment on "Depolarization ratio ofPolar Stratospheric Clouds in coastal Antarctica: profiling comparison analysis between a ground-based Micro Pulse Lidar and the space-borne CALIOP" by C. Córdoba-Jabonero et al.

Anonymous Referee #2

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Authors strongly appreciate the helpful comments of the referee #2 with valuable suggestions and useful remarks, patently improving this work.

We will try to answer and explain, in any case, all the questions. In particular, the previous lidar datasets and new data have been processed and re-analysed in order to respond the questions of all the referees. Indeed, negative depolarization values as proposed by the referee #3, within given restriction limits (see response to the referee #3's comments), as well as new data profiles corresponding to higher CALIPSO overpass distances from Belgrano II station than those already considered, as requested by both the referees #1 and #3, have been also processed and included in the comparison analyses between lidar datasets. In particular, several changes (three Figures have been added: the new Figures 2, 3 and 6; old Figures 2 and 3 have been modified; old Figure 4 replaced; old Figure 5 splitted into 4 separated figures with other particular cases selected: the new Figures 8, 9, 10 and 11; Table 2 removed, and Tables 3 and 4 have been modified and joined together in one Table, the new Table 2) have been included in the manuscript as a consequence of responding to all the referees' comments. Then, Sections, Figures and Tables have been renumbered. As a result the text has been accordingly modified to contain these changes, including new required calculations, analyses and results. In general, a revised manuscript containing all the necessary modifications is also available.

This paper compares data from two distinct platforms (ground based and satellite) for the study of PSC I and PSC II types of clouds in the Argentinean station: Belgrano II. The overall presentation is very well structured and written. The idea of comparing the volume depolarization δ^V between CALIOP and MPL-4 is new and the statistical methods to compare both of them were fairly good. In the text despite its fluency there are many references to numbers in different cases which became a little confusing for the reader to follow which even though they are also shown in tables and some plots, I wonder if more plots were given or if those shown in the paper were split into different plots.

There are some issues and comments I would like to add:

C1)
Introduction - Lines 20 through 25
I would explicitly add the temperature ranges these clouds occur.

<u>Authors</u>*: Temperature thresholds for PSC formation has been mentioned in Lines 12-15. Antarctic temperatures usually observed at altitudes of 10-30 km height (Parrondo et al., 2007) are lower than those thresholds.*

<u>References</u>*:*

Parrondo, M.C., Yela, M., Gil, M., Von der Gateen, P., and Ochoa, H.: Mid-winter lower stratosphere temperatures in the Antarctic vortex: comparison between observations and ECMWF operational model, Atmos. Chem. Phys., 7, 1-7, 2007.

C2)

Section 2.1.2

Was the vertical averaging applied to all height range in CALIOP dataset?

<u>Authors</u>: The CALIOP level 1B data used in this work present a vertical resolution of 30 m, 60 m and 180 m at altitudes lower than 8.2 m, between 8.2 and 20.2 km and 20.2 and 30 km, respectively. This change in averaging scales is performed in order to reduce the noise level of the profiles. As mentioned in the manuscript, a vertical 7-point adjacent averaging is applied in order to reduce the noise level of the profiles (a horizontal averaging over 5 km CALIPSO ground-track is also performed for that purpose). I.e., a data smoothing is achieved by using a sliding window of 7 points for averaging through the entire profile. As a result of this procedure, the final resolution of the CALIOP data keeps unchanged.

That change in averaging scales across both the 8.2-km height and 20.2-km height boundaries would produce unpredictable results depending on the particular atmospheric situation. However, in general, this smoothing process doesn't significantly impact our following '0.5-km averaged' δ^V profiles from CALIOP because the 0.5-km averaged height-range, where an inhomogeneous smoothing is applied (in terms of vertical resolution but maintaining the number of points), cover the small atmospheric regions between 8.08 and 8.56 km and 20.08 and 20.56 km in each boundary case. Note that negative δ^V values are not disregarded during the smoothing process of CALIOP data profiles (see Sect. 2.1.2). Only δ^V values falling outside the (-0.1, 0.8) interval are ignored for the following 0.5-km vertical averaging of both lidar profiles (see response to the referee #3's General Comment 1).

The manuscript has been modified accordingly by including a more complete explanation of the smoothing and averaging procedures applied.

General Comment

There is a fairly amount of discussion on the comparison analysis between CALIPSO and MPL-4. However the discrepancies found could be more deeply discussed since the authors simply discarded the differences due spatial inhomogeneity. I suggest to exchange or add besides Table 2 by an histogram (number of occurrences) to show the cases due the CALIOP tracking distance, when that occurred seems to me irrelevant.

<u>Authors</u>: Tables 2, 3 and 4 have been modified and joined together, and replaced by the new Table 2 instead, also reflecting the number of occurrences respect to the CALIPSO ground-track distance and other kind of information.

Section 3.2 has been modified, once the new calculations and re-analysis of the profile comparison, following the suggestions of the referees #1 and #3 (see response to the referees #1 and #3' comments), have been performed. In particular, one more analysis of the comparison between both lidar datasets has been introduced, including the consequent discussion of the new results. The following text is shown next as an example of the corresponding Sect. 3.2 modified in the revised manuscript:

"Three different approaches are considered for the comparison between both lidar δ^{V} datasets in order to test the degree of agreement as a function of the CALIPSO ground-track separation from Belgrano II station:

1) the correlation coefficient (CC), as a measure of the relationship between both PSC vertical layering structures;
2) the mean differences, $\Delta(z) = \delta^{MPL}(z) - \delta^{CAL}(z)$, between both MPL-4 and CALIOP δ^{V} profiles, together with their root mean square (RMS) values; and
3) the percentage difference, $BIAS(z)$, since this parameter is also used in profiling comparisons between CALIOP and other ground-based lidar systems (Mamouri et al., 2009; Mona et al., 2009), and defined as:

$$BIAS(z) = \frac{100 \times \left[\delta^{MPL}(z) - \delta^{CAL}(z)\right]}{\delta^{CAL}(z)} \qquad (7)$$

For all these three approaches, $\delta^{MPL}(z)$ and $\delta^{CAL}(z)$ are the 0.5-km averaged volume linear depolarization ratio δ^{V} profiles for MPL-4 and CALIOP, respectively."

<u>References</u>:
Mamouri, R.E., Amiridis, V., Papayannis, A., Giannakaki, E., Tsaknakis, G., and Balis, D.S.: Validation of CALIPSO space-borne-derived attenuated backscatter coefficient profiles using a ground-based lidar in Athens, Greece, Atmos. Meas. Tech., 2, 513–522, 2009.

Mona, L., Pappalardo, G., Amodeo, A., D'Amico, G., Madonna, F., Boselli, A., Giunta, A., Russo, F., and Cuomo. V.: One year of CNR-IMAA multi-wavelength Raman lidar measurements in coincidence with CALIPSO overpasses: Level 1 products comparison, Atmos. Chem. Phys., 9, 7213–7228, 2009.

Figure 2
Please increase the inset fonts. Some of them are almost invisible, for instance χ
Also in the caption "CALIPSO ground-track distance was (instead of is)

<u>Authors</u>: Figure 2 and its caption have been accordingly modified.

Figure 5
I think these panels could be split into more plots. Here they are too small to read and are too "piled up".

<u>Authors</u>: Old Figure 5 (from top to bottom panels) has been replaced by four separated figures with other particular cases selected: the new Figures 8, 9, 10 and 11. As a consequence, all the Figures have been renumbered. Corresponding changes have been accordingly introduced in the text (Sect. 3.2.4).