Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-972-RC1, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Quasi-coincident Observations of Polar Stratospheric Clouds by Ground-based Lidar and CALIOP at Concordia (Dome C, Antarctica) from 2014 to 2018" *by* Marcel Snels et al.

Anonymous Referee #1

Received and published: 3 November 2020

Snels et al. use lidar observations made from Concordia for the time period 2014-2018 and provide a quasi-coincident data set to the space-borne measurements by CALIOP on CALIPSO. They show that this lidar dataset is complementary and congruent to the CALIPSO data and can thus be used to study the seasonal and inter-annual variation of PSCs at Concordia.

This study is definitely useful for the scientific community and does deserve to be published. However, I have some major points of criticism that should be consid-

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ered before publication.

General comments:
1) What is the goal of this study? To provide the coincident data set or studying the seasonal and inter-annual variations of the PSCs? The former has been definitely done, but not the latter. This has only been scratched at the surface. The differences should be discussed in more detail. This leads me directly to my second point.

2) The present version of this manuscript is quite technical and would have made a better fit in AMT or ESSD. To adjust the manuscript to the ACP standards the scientific content of this study should be elaborated in more detail.

3) The method applied in this study is not entirely clear, e.g. how has the extension of the PSCs determined? How has it been determined that lidar and CALIOP measured the same air mass? The time and distance criteria is here to my opinion not enough; one would need an additional criteria. Where has it been shown or documented that Concordia is well within the polar vortex during most of the winter?

4) The differences in the analyses and lessons learned between Snels et al. (2019) and the present study should be pointed out more clearly.

5) In my opinion the structure of the paper would be more logical if first the agreement in occurrence and extension of the PSCs would be discussed before discussing the measured PSC types. Additionally, a comparison as presented in Figure 4 in Snels et al. (2019) would also be for Concordia quite valuable.

Specific comments:
P1, L6: It may be correct that your study is the first study reporting an extensive comparison between ground-based and space-borne lidars. However, there have

been other studies before e.g. for the Arctic by Achtert et al., (2011). This should be considered and discussed. Of course not in the abstract, but in the main text of the manuscript. See my comments below.

P2, Figure 1: It would be quite helpful if the location of Concordia could be emphasized in the figure. You could e.g. add a colored box around Concordia.

P3, L21: What is the advantage of having quasi-coincident measurements? What is the difference between the data set derived for McMurdo in Snels et al. (2019) and the one derived for Concordia. Are both data sets equally valuable for the scientific community? This also should be discussed in more detail.

P3, L31: How has this been studied? How has the extension of the PSCs been determined?

P3, L33: Add a discussion on the different schemes. Achtert and Tesche (2014) provide such a comparison. Although this comparison was made for the Arctic, the derived results are also valid for the Antarctic. I remember that Pitts et al. improved their scheme based on the discrepancies found in the Achtert and Tesche (2014) study and that should be discussed here.

P5, L9: Also here, though on the Arctic, Achtert et al. (2011) is a good example.

P5, L15: To have the profiles within in 100 km distance and 30 min time difference is no guarantee for being in the same air mass. An additional criteria is needed, as e.g. PV or temperature.

P6, Figure 2: This is the same figure as in Snels et al. (2019). This should be

at least mentioned in the caption. However, it would also be enough to skip this figure and just refer to Snels et al. (2019). For the threshold values anyway a table would be much more helpful. Especially, the differences between CALIOP and the Concordia lidar thresholds should become clearer.

P6, L2: This should help to overcome the problems found in Achtert and Tesche (2014). Has a comparison been made to check if the results (for single profiles) between CALIOP and lidar really agree?

P6, L3-P8, L16: Isn't that a standard procedure for processing lidar data. Thus, isn't the whole section obsolete since this is documented elsewhere? This part could be put in an appendix or a supplement.

P9, L3: It is not entirely clear what value is used here. Wouldn't it be easier to show the agreement between CALIOP and lidar on one example PSC?

P9, Table 1: Why is still such a high amount of PSC detected by only one of the instruments?

P10, L7: Not clear if here all CALIPSO overpasses have been used or only the ones where a PSC was detected.

P10, L8ff: Not clear what has been done.

P10, L20: I cannot follow this line of reasoning. These paragraphs need definitely to be improved to understand what actually has been done.

P10, L20: How can you be sure that this is the same PSC and not another PSC?

P10. L27: Also here I have difficulties to follow. Please improve the text so that it becomes clearer what you have done.

P11, Figure 3: How does this figure look for the other years?

P11, Table 2: How does this table look for the lidar data?

P12, L1: Differences between the characterization schemes could be pointed out more clearly.

P12, Figure 4: Please add a legend. Not clear what is shown. Should not the left panels show the data and the right panels the coincident data?

P12, L13: The uncertainties and disagreements between the data sets should be discussed in more detail. Why does CALIOP or the ground-based lidar detect PSCs that the other instruments does not detect?

P13, Figure 5: Same as for Figure 4, please add a legend and check if the orders of panels agree with what is written in the caption.

P13, Figure 6: Same here as for Figure 4 and Figure 5.

P13: To my opinion it would be easier and more logical to first compare the PSC occurrence and extension before comparing the PSC composition.

P14, L10: This shift between ground-based lidar and CALIOP is nothing new. This has already been documented in Achtert et al. (2011).

P15, L1: Also here the Achtert and Tesche (2014) paper could be helpful for the discussion.

P16, Figure 8: The caption could be clearer on what is actually shown in which panel. For example that the always two panels are for one year and then all year from 2015-2018 are shown could be more clearly stated. Also here a legend to the figures would be more helpful then listing the color coding up in the caption.

P17, L9: The differences between the PSC seasons of the different years should be discussed in more detail.

P17, L19: Tested by what? What was the criteria?

P18, L9: Couldn't also here the results of the Achtert and Tesche (2014) paper be helpful for the discussion?

P18, L10ff: The recent study by Tesche et al. (2020) in ACPD could also be of interest for the discussion of the results in this study.

Technical corrections:
P4, L3: ice point → ice frost point

P4, L4: frost point → ice frost point

P4, L6: Here we compare → Here, we compare

P4, L25: I know what you mean, but I think "science winter-overs" is not the correct expression.

P4, L33: Citation should be embedded in the text, thus “(Hunt et al., 2009, Winker et al., 2009)” should be changed to “Hunt et al. (2009) and Winker et al. (2009)”.

P5, L26: Same here with the citation of Pitts and Snels.

P8, L11: deriving → derived

P8, L11: from photo counting → from the photo counting

P15, L15: The ice frost → The ice frost point

P16, L8: means f PSC → means of PSC

P22, L14: montly → monthly

P22, L16: Models → models

P22, L21: 0, null → obsolete ?

References:

Achtert, P., and M. Tesche (2014), Assessing lidar-based classification schemes for polar stratospheric clouds based on 16 years of measurements at Esrange, Sweden, J. Geophys. Res. Atmos., 119, doi:10.1002/2013JD020355.

Achtert, P., F. Khosrawi, U. Blum, and K. H. Fricke (2011), Investigation of polar stratospheric clouds in January 2008 by means of ground-based and spaceborne lidar measurements and microphysical box model simulations, J. Geophys. Res., 116, D07201, doi:10.1029/2010JD014803.

Tesche, M., Achtert, P., and Pitts, M. C. (2020): Location controls the findings of ground-based PSC observations, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-930, in review.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-972, 2020.

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