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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Polar stratospheric cloud climatology based on CALIPSO spaceborne lidar measurements from 2006–2017" *by* Michael C. Pitts et al.

Anonymous Referee #1

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The authors present a comprehensive analysis of 11 years of PSC observation based on spaceborne CALIPSO lidar measurements. The authors introduce and apply the new version 2 algorithm (v2) and compare its findings to those of the previous v1 used in earlier studies. The paper is important for the community and should be published in ACP after the fowling comments have been addressed.

Major comments:

- The paper lacks a comparison/validation of the CALIPSO-derived PSC occurrence statistics to long-term PSC statistic from ground-based measurements in the Antarctic and Arctic.

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- The authors compare their v1 and v2 composition schemes only for theoretical calculations. The paper would benefit from an example case for both the v1 and v2 classification, i.e. plots such as Figures 3 and 4 with real data, for instance the PSC observation presented in Figure 2.

- Page 11: There is an abundance of balloon-borne in-situ measurements of particle size distributions in PSCs, e.g. Schreiner et al. (2003), Voigt et al. (2003), Deshler et al. (2003). A discussion of these measurements should be provided. Also, why have those data not been considered in the estimation of SAD and VD?

- Where does the information on the height of the tropopause used in the retrieval come from? How reliable are the values? It seems excessive to dismiss any data within 4 km of the tropopause height.

- Figure 15c shows the highest occurrence rate of ice PSCs below 15 km height. I would expect to see those higher up, particularly as Figure 16 shows that the frost point temperature is only reached above 15 km height. Can cirrus still be misclassified as ice PSC?

- Please add a figure on the occurrence rate of different PSC types with altitude for the Arctic.

Minor comments:

- Please be precise in the naming of your parameter to avoid misunderstandings as in my initial comment.

- What is the explanation for the change of the crosstalk value in the 2008 Antarctic and 2008-09 Arctic winters, and then again in 2015?

- Please provide the equation used to calculate the particle linear depolarisation ratio.

- What is a typical total backscatter ratio for the stratospheric background aerosol layer from CALIPSO? Is it comparable to ground-based measurements?

- Page 8, line 7: Spheroids with aspect ratios smaller than 1 should be oblates. Why not use a mixture of prolates and oblates as done by Reichardt et al. (2002, 2014)?

- Page 8, line 8: What is the maximum value of the particle linear depolarisation ratio and how often have they been observed? I would like to know that these values are not outliers.

- Page 10, line 21: Note that there is literature of lidar ratios in PSCs from ground-based observations, e.g. Reichardt et al. (2004).

- Page 13, line 24: Are you referring to millions of PSC profiles or indeed millions of PSC observations (i.e. individual clouds)? Please note that your profiles in the same don't provide independent measurements and that a single cloud might be present over several orbits. This means that your statistics are biased towards oversampled clouds. Please comment.

- Page 19, line 7: Again, are you referring to profiles or individual clouds? Please carefully revise your use of numbers of observations/profiles.

- Page 20: Why has the comparison to SAM II not been performed for Arctic PSCs?

- Figure 2: There is no gap between tropospheric and stratospheric clouds. Are they separated, e.g. through the feature classification or the height of the tropopause? If it's the height of the tropopause, please add the respective data to the figure. If it's through the feature mask, please add a subplot with the feature mask.

- Figure 9: please provide information on the height of the tropopause.

- Figure 13: please remove all data points below the tropopause

- Figure 19: This figure reveals the same effect as shown in Figure 12 and described on page 14, line 27, though not for all years. This should be discussed. Note that it has been reported previously by Fromm et al. (2003) and Achtert et al. (2012).

- Figure 22: I would have expected a larger fraction of wave ice in the Arctic due to the

stronger wave activity, e.g. triggered by Greenland and the Scandinavian mountains. With generally lower temperatures in the Arctic, does the threshold for wave ice require adjustment?

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