Reply to anonymous Referee #1

We thank the reviewer for the helpful comments and suggestions on the manuscript. Please find below our detailed reply and our changes to the manuscript.

As stated in the manuscript the new data set will be valuable for the community, but only if it will be made public. How can the community excess the data set? No information is provided in the paper.

This point was raised also by reviewer#2 and we added a paragraph at the end of the summary section on how we proceed with the publication of and access to the complete dataset.

Major points:

For the Bayesian classifier four different methods are used to distinguish between the different PSC types. The methods are properly explained in the manuscript. However, the use of different years in the examples (Figures 3, 5, 7, and 8) does not enable the reader to form his own opinion on the author's claim that one method is more reliable than the other to distinguish between the different PSC types. Please use the same year for all example cases.

We changed this accordingly for most of the MIPAS examples (using data from 2010), with exception of Fig. 8, where we like to highlight the variability from year to year by adding Aug 2009 and Aug 2011 to the Aug 2010 example.

When comparing CALIPSO and MIPAS, CALIPSO data should be smoothed in the vertical.
This would enable a more reasonable comparison not only because of the noise in the CALIPSO measurements but also regarding the differences between CALIPSO and MIPAS in terms of vertical resolution.

Our intention for the comparison of the CALIOP and MIAPS classification was to use a consolidated and accepted official CALIPSO PSC product. This is the fact with the CALIOP PSC mask product (used in various studies before the official release on the CALIPSO website). The product includes already a vertical and horizontal gridding of the physical level 1 parameters, which are necessary for improving the signal to noise for the classification procedure. However, the resulting cloud mask parameter (a lidar specific PSC classification flag of each PSC class just 0 or 1) is not a meaningful parameter for a horizontal or vertical smoothing/weighting procedure. For such an approach it would be necessary to reanalyze the CALIOP level 1 data and to apply the classification in the next step. This kind of 'optimised' procedure would imply a complete reprocessing of the CALIOP dataset, consolidation of this very specific new product, and would imply the download of the quite huge level 1 data. This is beyond the scope of this study.
However, we already considered to a certain extent the vertical and horizontal smoothing of MIPAS in the comparison with the CALIOP high resolution measurements. Like described in Sec. 4.3.2, we used for one MIPAS PSC measurements all pixel-like CALIOP coincidences (cloud and non-cloudy) in a MIPAS-like FOV box (200 km x 3 km, typically 300-600 coincident CALIOP pixel) to define the most likely MIPAS-like CALIOP PSC type for the specific coincidence event. This approach represents a kind of combined equally-weighted smoothing of the vertical and horizontal CALIOP information.

In the manuscript you need to state what CALIPSO level data were used for the comparison. Your mentioned V1_00 CALIPSO PSC MASK product, but this product does not seem not to be available for the general public when I checked with LaRC ASDC.

We checked the data availability on the ASDC website and found that after registration at ASDC, you should be able to download the data following the link at https://eosweb.larc.nasa.gov/project/calipso/cal_lid_l2_pscmask-prov-v1-00_table. In addition, we added also the data DOI provided on the website and are presenting the corresponding webpage in the references

CALIPSO Science Team: CALIPSO/CALIOP Level 2, Polar Stratospheric Cloud Data, version 1.00, Hampton, VA, USA: NASA Atmospheric Science Data Center (ASDC), accessed in July 2015, doi:10.5067/CALIOP/CALIPSO/CAL_LID_L2_PSCMask-Prov-V1-00_L2-001.00, at https://eosweb.larc.nasa.gov/project/calipso/cal_lid_l2_pscmask-prov-v1-00_table, 2015.

Minor Points:

The labels of the different PSC types in the figures do not agree with the acronyms given in Table 2. Please homogenise.

We followed the suggestion or reviewer#2 and labeled the areas now with *region (1) to (13)* and changed the corresponding sections in the manuscript. The acronyms are still in the manuscript (Tab. 3) but are now in line with the notation in the corresponding subsections.

Figure 3, STS mix: according to Table 2 it includes STS and large NAT particles. However on page 10, line 24, it is stated that STS mix can include optical thin clouds. Why is that not stated in Table 2?
The table includes acronyms for the regions defined in Figs. 3, 5, 7 and 8. Following another comment we labeled these areas with region (1) to (13) to make the description in the text as well the cross reference with Tab. 2 easier and to get rid of inconsistencies between Tab. 2 the labeling in the figures. The acronyms include usually the dominating particle type first, followed by the second likely contributor in this region. Only if 2^{nd} and 3^{rd} type have a similar probability then we added this in the acronym. The acronyms shall give some guidance to the reader concerning the most prominent particle types in a specific region.

Page 7, line 17 and 21: CALIPSO MIX 1 and 2 consist of liquid/NAT mixtures. What do you mean with liquid: STS droplets or background aerosol?

We mean STS droplets and replaced the term ‘liquid’ with ‘STS’.

Page 7, line 23: MIX 2 enhanced is described as containing NAT particles and the group is not masked by liquid particles. However, later on page 28, line 27 it is stated that MIX2 enhanced consist of NAT clouds and/or ice clouds. Please clarify.

We think this is not in contradiction: MIX 2 is containing NAT and no STS (and is not masked by liquid particles (STS)), but may have some overlap with ice, which is stated on page 28. For more clarity we added a comment on the probability of ice overlap at both places.

Page 15, line1/2: It is stated that only large NAT particles can overlap the area attributed to STS (Figure 6). However, in the upper left panel of Figure 6 Ice particles are overlapping with the STS area. That needs to be discussed in the text.

Correct, we missed to discuss this feature and added:

The two BTDs tend to shrink close to zero for optically thicker conditions (see colour coded volume density path for STS). However, ice clouds with high optical thickness show a significant overlap exactly in this region, even for small and large mean radii (Fig. 6, top left). Consequently, this single classifier is not sufficient for a definite separation of ice and STS, but can still deliver additional information for a combined classification approach.

Technical comments:

The figures need to be improved: there is too much unused space taken by redundant labels and axis descriptions as well as unnecessary figure titles.

We followed the reviewer comment an improved the figures (Figs. 3, 5, and 7 to 10).

New additional References:

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CALIPSO Science Team: CALIPSO/CALIOP Level 2, Polar Stratospheric Cloud Data, version 1.00, Hampton, VA, USA: NASA Atmospheric Science Data Center (ASDC), accessed in July 2015, doi:10.5067/CALIOP/CALIPSO/ CAL_LID_L2_PSCMask-Prov-V1-00_L2-001.00, at https://eosweb.larc.nasa.gov/project/calipso/cal_lid_l2_pscmask-prov-v1-00_table, 2015.

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Hollstein, A., Fischer, J., Carbajal Henken, C., and Preusker, R.: Bayesian cloud detection for MERIS, AATSR, and their combination, Atmos. Meas. Tech., 8, 1757-1771, doi:10.5194/amt-8-1757-2015, 2015.

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Wilks, D. S.: Statistical methods in the atmospheric sciences, Academic Press, International Geophysics Series Vol.100, 2nd edition, 2005.

Yang, P., Wei, H., Huang, H.-L. Baum, B. A., Hu, Y. X., Kattawar, G.W., Mishchenko, M. I., and Fu, Q.: Scattering and absorption property database for nonspherical ice particles in the near- through far-infrared spectral region, Appl. Opt. **44**, 5512-5523. 2005.

Zasetsky, A. Y., Gilbert, K., Galkina, I., McLeod, S., and Sloan, J. J.: Properties of polar stratospheric clouds obtained by combined ACE-FTS and ACE-Imager extinction measurements, Atmos. Chem. Phys. Discuss., 7, 13271-13290, doi:10.5194/acpd-7-13271-2007, 2007.