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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Location controls the findings of ground-based PSC observations" *by* Matthias Tesche et al.

Anonymous Referee #1

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Referee report on "Location controls the findings of ground-based PSC observations", authored by Tesche, Achtert and Pitts.

The paper addresses the representativeness of ground-based lidar measurements in the Polar regions with respect to CALIOP (and MIPAS) observations of polar stratospheric clouds. The main conclusion of the paper is the identification of the best sites for PSC observation. To my opinion, the title is not adequately describing the main goal of this work. I would suggest something like "How to find the best locations for ground-based PSC observations", which better expresses the conclusions and recommendations of the authors. The comparison of the two CALIOP datasets (troposphere and PSC v2) and the ground-based lidar observations might produce many interesting results. The paper does not fully explore the potential of this method and also is not

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considering possible biases due to the different measurement protocols of CALIOP and ground-based lidars. It would be useful to specify the different categories of ground-based lidars; those measuring in a continuous mode, others “randomly” and still others in a CALIOP-synchronous mode”. The authors should also explain that CALIOP is NOT a continuous mode lidar at a certain location, but has overpass frequencies in the order of days at specific local times. This might cause a bias in the statistics. Having at disposition both data sets the authors might also explore the possible correlation between tropospheric cloudiness and PSC occurrence (as they mention in lines 240-247) . They also might quantify the bias introduced by prohibitive meteorologic conditions, such as cloud cover in the ground-based dataset, by comparing the PSC occurrence, as observed by CALIOP, with and without cloud cover. I suppose that this could be easily done. An important flaw of the paper is that they apparently are not aware of the fact that a lidar observatory is active at Concordia station since 2014 (see e.g Snels, ACPD 2020 and https://tmf.jpl.nasa.gov/testLidar/NDACC_LWG/sites/dome_c.html).

This is particularly relevant, since the authors recommend Concordia as one of the best sites to perform PSC observations. The authors consider the CALIOP observations as a reference system for the ground-based lidar. When they speak about representativeness they refer to the agreement of the statistics of the ground-based lidar measurements with respect to the CALIOP observations. This is generally speaking an acceptable concept, but there are some caveats. CALIPSO is performing 14-15 orbits per day, which means that the orbits have a separation in longitude of about 180/15 = 12 degrees (we have ascending and descending overpasses). At a latitude of 70(80) degrees. 12 degrees of longitude means 450 (225) km of distance between successive overpasses. The authors use boxes of 2 x 2 degrees lat-lon boxes to do their statistics, this means that several days are needed to “fill the boxes”. Experience shows that tropospheric clouds and PSCs are not constant over days, often they change during the day. The CALIOP overpasses in a box occur at fixed local times and thus are biased wrt to the random ground-based observations. Synchronized ground-based observations eliminate this bias. If one considers only average statistics, one should take into

account the biases present in the comparison of ground-based lidar observations wrt to CALIOP, due to the different measurement times.

Some stations (McMurdo in the past, Concordia in the present, maybe also Belgrano) synchronize their observations with CALIOP overpasses, and this makes the comparison more reliable. I would suggest that the authors comment on the opportunity to perform synchronized measurements with CALIOP overpasses. The synchronized measurements do not improve the occurrence statistics necessarily, but they make comparison with CALIOP more reliable.

Snels, ACPD, 2020: Snels, M., Colao, F., Shuli, I., Scoccione, A., De Muro, M., Pitts, M., Poole, L., and di Liberto, L.: Quasi-coincident Observations of Polar Stratospheric Clouds by Ground-based Lidar and CALIOP at Concordia (Dome C, Antarctica) from 2014 to 2018, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-972, in review, 2020. Other comments:

Abstract. Line 8. What do the authors mean by representativeness ? Is it wrt to the CALIOP observations in a lat-lon box or wrt to the overall occurrence statistics in the Northern or Southern Hemisphere ?

Line 12. These findings are rarely in agreement with polar-wide results. . .... Why would one expect an agreement with polar-wide results? Each location is different. It would be more interesting to have an agreement with a “box-region” observed by CALIOP

Line 15. Concordia is already a NDACC lidar observatory since 2014. Data are available on the NDACC web-site.

Line 33 “calculations with” should read “calculations considering. . .”

Line 43: representativeness see comment on line 8

Line 47 : I would prefer “ground stations” instead of “ground sites”, “site” already implies “ground”..

Lines 81-83, This line is not very clear for readers that are not familiar with CALIOP data and should be written in a more “reader friendly” way. The 4 digits in the height are not significant and mentioning the bin number is irrelevant.

Line 92 ..if this type. . ..

Line 101 . the 2x2 degrees boxes correspond with 220 x 76 km at 70 degrees of latitude and 220x38 km at 80 degrees latitude. This implies that the box dimensions change with the locations. Does this create a bias on the statistics ?

Line 108: I would add (iii) ground-based observations synchronized with CALIPSO overpasses.

Line 108-113. The authors want to estimate potential biases due to the mode of operation of the ground based stations. The answer is apparently in the small numbers in Figure 7. To my opinion these numbers do not address adequately the question they posed in the introduction, since the difficulties encountered while recording ground-based measurements cannot be simply translated in doing random measurements.(implicating that non random measurements would give different results..). “(ii) a manually operated system for which one third of the cases of the ground-based view was randomly selected.” What does this mean and how it works? In most cases the number in the third column is about 1/3 of the second column, except for Tiksi. Why is that? What is the rationale between taking a random 1/3 or just divide by three ?

Line 201. It is not clear what the 1:1 line means, and also the other grey lines like 1.0:1.6 are not clear. The authers write “the grey lines mark the ratios. . ...” But which ratios ?

Line 202 add Concordia Line229 understanding of processes.

Figure 2 . The longitudes in fig b are wrong !

Figure 4 shows the occurrence rate of the different PSC classes as seen by CALIOP, by the ground-based lidar (continuously operating) in clear sky conditions and for manually

operated ground-based stations. This figure is not clear for what concerns the small numbers written in the coloured columns. It would be better to have a Table with these numbers. Then the number of continuously operating lidars is very small.

Figure 5 the longitudes are wrong in fig a

Figure 6 the longitudes are wrong

Table 1. mark Concordia with existing datasets (see NDACC) The authors might indicate in Table 1 (or in a new Table limited to PSC observing stations) which lidars are continuously operated, which are randomly operated (whenever it suits the operator) and which are synchronized with CALIOP overpasses.

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