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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Comparison of Antarctic polar stratospheric cloud observations by ground-based and spaceborne lidars and relevance for Chemistry Climate Models" *by* Marcel Snels et al.

Anonymous Referee #1

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A Review of "Comparison of Antarctic polar stratospheric cloud observations by ground-based and spaceborne lidars and relevance for Chemistry Climate Models" by M. Snels et al.

<General Comments>

This paper describes the comparison between PSC measurements at Antarctic McMurdo Station from ground based lidar and CALIOP satellite measurements. Furthermore, the paper tries to extend the comparison of PSC statistics from CALIOP with

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several CCM model results from CCMVal-2 and CCMI. Although scientific value of this study might be significant, the method of comparison especially with CCM models is not well organized to derive scientifically useful conclusions, as is pointed out below. Also, there are too many typos and careful mistakes in the draft. A major revision is required before this paper will be published in ACP. I recommend that authors should check the draft carefully, including the native check, before submitting the revised draft.

<Major Comments>

(M1) In Section 3.2, the authors try to compare the PSC statistics from 5 years (2006-2010) measurements by CALIOP, with the result of 4 CCM models from CCMVal-2, and one CCM model from CCMI. However, the model run type they chose for CCMVal-2 models are REF-B2, which are targeted to be used for future predictions until 2100. The major problem for this comparison is that the result of REF-B2 run contains both inaccuracy in modeled temperatures and imperfectness in PSC schemes which are different in each model. The combination of inaccuracies both in modeled temperature and PSC schemes makes it extremely difficult to understand the nature of PSC in each model. Rather than comparison with CCMVal-2 REF-B2 runs, it is strongly preferred to compare with CCMI outputs with refC1SD runs (which is available from http://badc.nerc.ac.uk/browse/badc/wcrp-ccmi/data/CCMI-1/output), which use nudging with more realistic temperature and wind field, just to test the PSC scheme in each model. Even if the authors stick to the comparison with CCMVal-2 model results, they should at least use the REF-B1 model run results, which are targeted to reproduce the past. In this case, the comparison with CALIOP could be made only for 2006, because REF-B1 run was made only for 1960-2006. Since CCMI refC1SD runs cover until 2010, I strongly recommend making comparisons with CCMI model outputs with CALIPSO measurements.

(M2) In Section 3.1, the authors mention about more sophisticated WACCM4.0/SD/CARMA model and EMAC/MSBM model, which use more realistic parameterizations for PSCs. It would gain the value of this paper significantly if

they could include the comparison of CALIOP PSC statistics with the result of these models.

(M3) In each model, denitrification and dehydration are included as is shown in Table 3. This would change the vertical distribution of HNO_3 and H_2O, which would affect the threshold temperature of NAT and ice PSCs, i.e., T_NAT and T_ice. However, this effect is never mentioned or discussed in the manuscript. Moreover, in many places in the text (especially in Sections 2.6 and 3.4), it is not clearly stated which temperature (MERRA-2, NCEP, or derived T in CCM) is used, and how T_NAT and T_ice are calculated (using HNO_3 and H_2O value from MLS data, modeled value in CCM, or fixed values like 6 ppbv HNO_3 and 4.5 ppmv H_2O). The effect of denitrification/dehydration in modeled PSC should be discussed in the manuscript.

(M4) For a PSC classes comparison described in Table 1, although the percentage of each PSC class is similar, this does not prove that each one to one PSC is simultaneously observed both by ground-based lidar and by CALIOP. I would recommend authors to add the statistics showing one to one correspondence of comparison of PSC classes observed by tables like the attached tables. Table A shows the statistics when CALIOP measured specific class of PSC, what PSC was observed by McMurdo ground-based lidar, or no PSC was observed. Table B shows the statistics when ground-based lidar measured specific class of PSC, what PSC was observed by CALIOP, or no PSC was observed.

(M5) In Section 3.4, they discuss about the cold pole bias in most CCMVal-2 CCM models. However, when I read the SPARC report No.5 Chapter 4 “Section 4.3.5 Polar stratospheric cloud threshold temperatures” in page 128, there is an explanation that CCM models have warm bias and A_NAT and A_ice show low value compared with ERA-40 temperature. This description totally contradicts with the discussion described in Section 3.4. Please explain why such contradiction occurs.

<Specific Comments>

(S1) The numbers in author list are not ordered correctly, i.e., 1, 5, 2, 3, 4. It should be 1, 2, 3, 4, 5.

(S2) P1, L3: The abbreviation of CALIOP should be shown also in the abstract.

(S3) P1, L9: The meaning of "... and a selection simulations obtained ..." is unclear.

(S4) P1, L4: In Pitts et al. (2018, ACP), they use "v2" instead of "V2". Please check if V2 should be changed to v2 throughout the manuscript or not.

(S5) P1, L18: The abbreviation of WACCM-CCMI should be shown.

(S6) P2, L7: The abbreviation of CALIOP should be shown here, not at P2, L20.

(S7) P2, L18: Chemistry Climate Models –> Chemistry Climate Models (CCMs)

(S8) P2, L20: clouds and aerosol –> clouds and aerosols

(S9) P2, L26: Chemistry Climate Models –> CCMs

(S10) P2, L29: The SPARC Report No5 (2010) cannot be found in the reference list.

(S11) P2, L30: Chemistry Climate Models –> CCMs

(S12) P3, L1: Chemistry Climate Models (CCM) –> CCMs

(S13) P3, L14: CALIOP (Cloud Aerosol Lidar with Orthogonal Polarization) –> CALIOP

(S14) P3, L14: Details on CALIOP –> Details of CALIOP

(S15) P4, L16: Reference (Cairo et al., 1999) should appear at the end of Line 18.

(S16) P5, L14: CALIPSO V2.0 data –> CALIPSO v2 data

(S17) P5, L15: V2.0 –> v2

(S18) P5, L17: V1.0 and V2.0 –> v1 and v2

(S19) P5, L26: Version 1.0 –> v1

(S20) P6, L22: “We used monthly averages” for what? Explain.

(S21) P6, L24-25: The English meaning of the following sentence is unclear: “This procedure approaches the V2 algorithm applied to the CALIOP data as good as possible”

(S22) P7, L1: close to the edge –> close to the polar vortex edge

(S23) P7, L10: lidar observes from distances –> lidar observed at distances

(S24) P10, L9: What is “lower altitudes wrt”?

(S25) P11, L1: Change paragraph before “Another way ...”

(S26) P11, L21-22: I cannot understand the explanation of the last sentence why the distribution of ice is different between ground-based lidar and CALIPSO.

(S27) P12, L6: Chemistry-Climate Models (CCMs) –> CCMs

(S28) P12, L6: [Eyring et al., 2008] –> (Eyring et al., 2008); this reference cannot be found in the reference list.

(S29) P12, L19-22: Please show references of each CCMs here as well as in Table 2.

(S30) P12, L22: The abbreviation of IPSL should be shown.

(S31) P13, Table 2: I assume that model run years for CCMs in CCMVal-2 for REF-B1 is 1960-2006, and for REF-B2 is 1960-2100. What do the years in this table mean?

(S32) P13, L1: nitric-acid-trihydrate (NAT) –> NAT

(S33) P13, L2: supercooled ternary solutions of sulfuric acid, water and nitric acid (STS) –> STS

(S34) P13, Table 3: I think themodynamics of CAM3.5 is NAT:HY; ice:EQ, not EQ. Please confirm.

(S35) P13, Table 3: I think sedimentation of CAM3.5 is dep. On mode radius? Please confirm.

(S36) P13, Table 3: What is the sedimentation of LMDZrepro? Please show.

(S37) P13, Table 3 caption: SAD does not appear in the table, so this is obsolete.

(S38) P14, L8: The abbreviation of CESM1 should be shown.

(S39) P14, L12: The abbreviation of MSBM should be shown.

(S40) P14, L14-16: A reference for the last sentence should be shown.

(S41) P15, L8: The abbreviation of COSMIC GPS-RO should be shown.

(S42) P15, L9: McMurdo site: please show where is the McMurdo Station in Figure 5.

(S43) P18, L3: CCMVal report (2010) –> CCMVal-2 report (2010): This reference is missing in the reference list.

(S44) P18, L3: maximum often occurring in June –> maximum often occurring in July (?)

(S45) P18, L7: surface area density (SAD) –> SAD

(S46) P19, Figure 7 caption: Surface Area Densities –> SADs

(S47) P21, 14: What is the meaning of “overall skills f the”?

<Technical Corrections>

(T1) P1, L10: Period after “Models” is obsolete.

(T2) P2, L7-8: McMurdo station –> McMurdo Station

(T3) P3, L17: in (Hunt et al., 2009; Winker et al., 2009). –> in Hunt et al. (2009) and Winker et al. (2009).

(T4) P13, Table 3: WACCM-CMMI –> WACCM-CCMI

(T5) P13, Table 3: HNO_3 / H_2SO_4 / H_2O (subscript)

(T6) P14, L7: by (Solomon et al., 2015). –> by Solomon et al. (2015).

(T7) P14, L8: (Zhu et al., 2017b, a, 2015) –> (Zhu et al., 2015, 2017a, b)

(T8) P14, L12: PSCS –> PSCs

(T9) P14, L17: CCM1 –> CCMI

(T10) P15, L5: 90° – 0° –> 90° W - 0°

(T11) P16, L2: 0° 90° –> 0°- 90°E

(T12) P17, L6: CMMI –> CCMI

(T13) P17, L7: WACCM-CMMI –> WACCM-CCMI

(T14) P18, L3: LMDZ –> LMDZrepro

(T15) P18, L11: CCMVAl-2 –> CCMVal-2

(T16) P18, L14: reported in (Adriani et al., 1995). –> reported in Adriani et al. (1995).

(T17) P19, Figure 7 caption: taken from (Adriani et al., 1995). –> taken from Adriani et al. (1995).

(T18) P19, L7: CCMVAl-2 –> CCMVal-2

(T19) P21, L1: WACCM-cmmi –> WACCM-CCMI

(T20) P21, L11: the for other –> the four other

(T21) P21, L13: notwithstanding –> not withstanding

(T22) P21, L31: CCMVal2 –> CCMVal-2

(T23) P23-26: Title of each word in the following references should be spelled in lower case letters: Eyring et al. 2010; Garcia et al., 2017; Hunt et al., 2009; Winker et al., 2009.

(T24) Reference list: The order of the following reference should be re-ordered to follow the order of published years: Pitts et al., 2013; 2018; 2009; 2011: Stephens et al., 2017; 2002.

(T25) P25, L8: Pitts et al. (2018) is now in ACP, not in ACPD.

(T26) P25, L23: Title of Stephens et al., 2002 should not be spelled in all capital letters.

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2018-589/acp-2018-589-RC1-supplement.pdf

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Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-589, 2018.

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Table A.

	McMurdo ground-based lidar					
CALIOP		STS	NAT mixtures	Enhanced NAT	Ice	No PSC
	STS	** %	** %	** %	** %	** %
	NAT mixtures	** %	** %	** %	** %	** %
	Enhanced NAT	** %	** %	** %	** %	** %
	Ice	** %	** %	** %	** %	** %

Table B.

	CALIOP					
McMurdo Ground-based lidar		STS	NAT mixtures	Enhanced NAT	Ice	No PSC
	STS	** %	** %	** %	** %	** %
	NAT mixtures	** %	** %	** %	** %	** %
	Enhanced NAT	** %	** %	** %	** %	** %
	Ice	** %	** %	** %	** %	** %

Table A shows the statistics when CALIOP measured specific class of PSC, what PSC was observed by McMurdo ground-based lidar, or no PSC was observed. Table B shows the statistics when ground-based lidar measured specific class of PSC, what PSC was observed by CALIOP, or no PSC was observed.

Fig. 1.

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