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Interactive comment on “Arctic stratospheric dehydration – Part 2: Microphysical modeling” by I. Engel et al.

Anonymous Referee #2

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The authors investigate the formation of ice PSCs and subsequent water vapor redistribution in the Arctic stratosphere using balloon instruments and the CALIPSO and Aura MLS satellite instruments. A microphysical box model is adapted to simulate various nucleation mechanisms and sedimentation processes within a vertical column along trajectories determined the CLaMS and driven by the ERA-Interim reanalysis fields. It has long been known that temperature fluctuations promote the formation of ice PSCs. However, in this paper the authors show that in the Arctic 2009/2010 winter an unusual episode of synoptic-scale ice formation requires additionally a heterogeneous nucleation mechanism in order to reproduce observations of backscatter/depolarization and accompanying signatures of dehydration/rehydration.

I recommend publication of the manuscript with the following suggested corrections.

C9637

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/xxx/ means remove xxx [xxx] means add xxx

27168:27 Add reference to Pitts et al (2009) since this introduced the perpendicular backscatter into the PSC detection algorithm and the composition classification scheme.

Pitts, M. C., Poole, L. R., and Thomason, L. W.: CALIPSO polar stratospheric cloud observations: second-generation detection algorithm and composition discrimination, *Atmos. Chem. Phys.*, 9, 7577-7589, doi:10.5194/acp-9-7577-2009, 2009.

27169:22 "overall uncertainty" includes accuracy and precision?

27172:9 It seems you mean "increasing time" rather than distance.

27172:16 Ear/y/[ier]

27172:21 "nucleate" as in homogeneously freeze?

27173:5 remove +/- since amplitude is a positive quantity. also do you mean root mean square amplitude?

27174:14 "unmistakably suggests" seems a rather weak statement with which to assert that an "observational impasse has been overcome".

27174:26 How is this a Eulerian scheme? No 3D lat,lon,height seems to be involved. You simply allow vertical redistribution by sedimentation of particles to lower altitudes within the same vertical column. The column advects synchronously and there is no horizontal displacement other than along the streamline.

27175:5 What criteria? Over what time-period? As given in 27171:3-10?

27176:7 essentially [ice] cloud free

27176:24 Are the temperature fluctuations the same amplitude discussed previously?

27176:13 Quote some backscatter values for COBALD and CALIOP depolarization. Also COBALD has no depolarization measurement and so cannot differentiate a solid

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NAT within STS composition.

27177:16 /far/ [away]

27178:16 Although COBALD cannot discriminate between PSC types, the large fluctuations in BSR suggest underlying changes in composition.

27178:17 There is a profound anti-correlation (but obviously not "perfect").

27178:20 "suggesting clear layers" meaning distinct layers?

27179:9 What are the BSR values?

27179:16 This is stated as a reduction so remove the negative sign.

27181:12 gray [shaded] area[s]

27182:22 Add reference to Pommereau et al (2013) Pommereau, J.-P., Goutail, F., Lefèvre, F., Pazmino, A., Adams, C., Dorokhov, V., Eriksen, P., Kivi, R., Stebel, K., Zhao, X., and van Roozendaal, M.: Why unprecedented ozone loss in the Arctic in 2011? Is it related to climate change?, Atmos. Chem. Phys., 13, 5299-5308, doi:10.5194/acp-13-5299-2013, 2013.

27183:16 long enough [to grow]

27184:19 /6/ [six]

27185:3 This is stated as a reduction so remove the negative sign.

27185:16 /not indispensable/ [not required]

27186:1 27171:3-10 indicates this is not a problem over first 12 hrs of modeled sedimentation. Indicate that you are referring to a longer continuing time period here.

Fig 2 Add a line for the frost point temperature.

Figs 3 and 6 What is the cause of the substantial BSR values at 400-440K in the COBALD data? Could you comment the effects on BSR and depolarization values

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of different assumed optical properties of the simulated PSCs (27175:7-11) i.e. only spheroids have been assumed with a single aspect ratio.

Fig 4 [Blue] dashed line in lower

Fig 5 Column 2 ... heterogeneous nucleation [of ice and NAT]

with both [heterogeneous nucleation and temperature fluctuations]

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 27163, 2013.

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