Atmos. Chem. Phys. Discuss., 13, C12205–C12211, 2014
www.atmos-chem-phys-discuss.net/13/C12205/2014/

Atmospheric Chemistry and Physics
Discussions

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

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Received and published: 14 February 2014

Reply to Anonymous Referee #2

We would like to thank the anonymous reviewer for reading this manuscript and offering suggestions for improvements. In the following, we respond to his/her comments.

P27168/L27 *Add reference to Pitts et al. (2009) since this introduced the perpendicular backscatter into the PSC detection algorithm and the composition classification scheme.*

We added the reference of Pitts et al. (2009).

P27169/L22 *"overall uncertainty" includes accuracy and precision?*

Yes, the overall uncertainty includes precision and accuracy. We clarified this in the text.

P27172/L9 *It seems you mean "increasing time" rather than distance.*

We changed this.

P27172/L16 *Earl/y/[ier]*

We changed this.

P27172/L21 *"nucleate" as in homogeneously freeze?*

We rephrased this passage to clarify this.

P27173/L5 *remove +/- since amplitude is a positive quantity. also do you mean root mean square amplitude?*

We changed this to typical peak-to-peak amplitudes of 1 K. Additionally, we calculated the FWHM defined in Gary (2006).

P27174/L14 *"unmistakably suggests" seems a rather weak statement with which to assert that an "observational impasse has been overcome".*

We changed this to "unmistakably reveals"

P27174/L26 *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.*

We agree that "Eulerian scheme" might be misleading and changed the wording in the manuscript to "Sedimentation of ice and NAT particles is realized by allowing particles to sediment within the advected column from one box to the next lower one. For the present study the column consists of a stack of 100 m thick boxes and the timestep for sedimentation is 15 min. Once ice or NAT particles grow to sizes large enough to sediment, the appropriate fraction of particles is removed from its current box and, according to its size-dependent sedimentation speed, injected into the next lower box. Sedimented particles are distributed equally over the entire box. Number and mass of the particles are conserved."

P27175/L5 *What criteria? Over what time-period? As given in P27171/L3-10?*

We reformulated the sentence to clarify the criteria and specified the time period as suggested.

P27176/L7 *essentially [ice] cloud free*

We added this.

P27176/L24 *Are the temperature fluctuations the same amplitude discussed previously?*

Yes. We clarified this.

P27176/L13 *Quote some backscatter values for COBALD and CALIOP depolarization. Also COBALD has no depolarization measurement and so cannot differentiate a solid NAT within STS composition.*

COBALD backscatter values are quoted on P27176/L12. However, we rewrote the sentence to clarify that the existence of NAT particles were concluded from the CALIOP data and added backscatter and depolarization values from CALIOP.

P27177/L16 */far/ [away]*

We changed this.

P27178/L16 *Although COBALD cannot discriminate between PSC types, the large fluctuations in BSR suggest underlying changes in composition.*

We adopted the text.

P27178/L17 *There is a profound anti-correlation (but obviously not "perfect").*

We changed this.

P27178/L20 *"suggesting clear layers" meaning distinct layers?*

Yes, we mean "distinct" layers and changed this.

P27179/L9 *What are the BSR values?*

We added the BSR values.

P27179/L16 *This is stated as a reduction so remove the negative sign.*

We removed the negative sign.

P27181/L12 *gray [shaded] area[s]*

We changed this.

P27182/L22 *Add reference to Pommereau et al. (2013).*

We added the reference.

P27183/L16 *long enough [to grow]*

We changed this.

P27184/L19 */6/ [six]*

We changed this.

P27185/L3 *This is stated as a reduction so remove the negative sign.*

We removed the negative sign.

P27185/L16 */not indispensable/ [not required]*

We changed this.

P27186/L1 *P27171/L3-10 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.*

We added this information on P27171/L10.

Figure 2 *Add a line for the frost point temperature.*

We added the frost point temperature to the figure.

Figures 3 and 6 *What is the cause of the substantial BSR values at 400 - 440 K in the COBALD data? Could you comment the effects on BSR and depolarization values of different assumed optical properties of the simulated PSCs (P27175/L7-11) i.e. only spheroids have been assumed with a single aspect ratio.*

An enhancement in BSR (from the Tropopause upwards) is clearly visible at 870 nm. The stratospheric aerosol or Junge layer causes this increase, for which CALIOP's sensitivity might be too low. We added this information to the manuscript (P27175/L26). Moreover, we extended the paragraph about the optical properties of simulated PSCs (P27175/L7-11), which reads now as follows:

"The optical properties of the simulated PSCs are calculated using Mie and T-Matrix scattering codes (Mishchenko et al., 2010) to compute optical parameters for size-resolved number densities of STS, NAT and ice. The refractive index for STS is assumed to be 1.44 (Krieger et al., 2000). For NAT, a refractive index of 1.48 was chosen, as used in several earlier studies (e.g. Carslaw et al., 1998; Luo et al., 2003; Fueglistaler et al., 2003). The refractive index for water ice is 1.31 (Warren, 1984). Following Engel et al. (2013), both crystals are treated as prolate spheroids with aspect ratios of 0.9 (diameter-to-length ratio). T-matrix calculations for spheroidal NAT particles and the effect of changing aspect ratios

on BSR and aerosol depolarization values are illustrated in Fig. 7 of Flentje et al. (2002). Increasing asphericity results in lower values of aerosol depolarization, which worsen the agreement between the simulations and the COBALD/CALIOP measurements."

Figure 4 *[Blue] dashed line in lower*

The word "blue" is already in the text.

Figure 5 *Column 2 ... heterogeneous nucleation [of ice and NAT] with both [heterogeneous nucleation and temperature fluctuations]*

We corrected a typing error ("Column 3: only homogeneous nucleation...") and added the second suggested addition. Exact information on the meaning of homogeneous and heterogeneous nucleation is already given in the caption.

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