Atmospheric Chemistry and Physics Discussions

Interactive comment on "Numerical simulations of homogeneous freezing processes in the aerosol chamber AIDA" *by* W. Haag et al.

W. Haag et al.

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Main issue

The reviewer makes agood point about the OPC detecting limit for ice particles. We will discuss this issue in the revised manuscript, as proposed below.

In the experimental paper, it will be noted more clearly that the sampling efficiency of the OPC below $D \simeq 10\,\mu$m is near 100%. Only particles with $D > 1.5\,\mu$m are counted as ice particles in order to avoid counting large aerosol particles. This has not been considered in the model paper.

We believe that the delayed increase of n_i seen in the experimental curve in our Fig.7 (right panel) is not linked to the $1.5\,\mu$m counting limit. It is rather caused by the partial evaporation of ice particles in the measuring device, a point which will be addressed also in the revision of the experimental paper.

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In the early stages of ice particle growth, the smallest ice particles detected by the instrument experience a heating and will evaporate and shrink to sizes below $1.5\,\mu$m, where they cannot be distinguished from aerosol particles. As the ice particles in the chamber grow, this effect becomes less and less important, and it is unlikely that the measurements underestimate the peak number of ice crystals.

This effect of sampling on n_i has not been considered in the model and therefore, n_i rises faster and takes its maximum earlier. Now, if we only count ice particles above $1.5\,\mu$m in diameter, the curve in Fig.7 (left panel) is very close to the curve already drawn showing the total number of calculated ice particles. We will make a corresponding note in the discussion of Fig.7.

As the reviewer notes, it is nevertheless important to consider the lower counting limit in the sensitivity study, where we vary the deposition coefficient α. As α is lowered, more ice particles nucleate, and their mean size decreases.

We will provide two additions that clarify this issue: first, we will add a row in Table 2, listing the number of ice particles $n_i(D > 1.5\,\mu$m), in addition to the total number n_i. The results are (in units of cm^{-3}): 482 ($\alpha = 0.05$); 264 ($\alpha = 0.1$); 168 ($\alpha = 0.2$); 93 ($\alpha = 0.5$); and 61 ($\alpha = 1$). Second, we will add a Figure 14, showing the mean number diameters of ice particles as a function of time t between $\sim$ 350 sec and 900 sec, for various values of α. The figure shows that for $\alpha \le 0.2$, the mean diameter rises above $1.5\,\mu$m at $t \le 365$ sec. In the cases $\alpha = 0.1$ and $\alpha = 0.05$, this occurs at $t = 400$ sec and $t = 490$ sec, respectively.

The conclusions of section 6.3 still hold.

Technical corrections

p.1472, moving size structure

We think that it is an advantage of performing the calculations with a nondiffusive size structure. Introducing numerical diffusion in aerosol and ice particle growth will yield

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an artificially broadened spectrum of the pristine ice particles.

The reviewer is correct when it comes to a proper representation of the ice particle size distribution. Our curves shown in Fig.8 (bottom panel) are not unique because the increment dlog(D_p) is not a uniquely defined quantity, as the diameter of ice particles varies within the prescribed low and high bin edges. In contrast, in a stationary size structure, all particles in a given bin have the same (mean bin) diameter, leading to dlog(D_p) = const.

For this reason, we plot $n_i(D_p)$ rather than dn_i/dlog(D_p) in the revised paper. The difference is just that the $n_i(D_p)$ values are about a factor 10 smaller than those shown now, the size dependence, of course, does not change.

p.1475, l.17

"... probability increases with the liquid aerosol volume ..."

p.1476, l.8

replace "number density" by "vapor pressure"

p.1479, l.5

"... are seen at ~ 330 s with ..."

p.1480, l.1

"... stay at relatively low mass fractions."

p.1481, l.6/7 and 22

"... is the effective mean free path for diffusion of H_2O molecules in air ..." and "To obtain parameters for lognormal aerosol size spectra ..."

p.1489, l.5

We meant limited influence of spectral parameters and α above ~ 0.2 in comparison

to the influence of T and total H$_2$O.

The sentence l.3 to l.5 clearly holds for the aerosol spectral changes; we remove "and of the water vapor deposition coefficient". Instead, we add: "The use of values significantly below 0.2 for the water vapor deposition coefficient is not supported by this analysis."

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Interactive comment on Atmos. Chem. Phys. Discuss., 2, 1467, 2002.