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Supplement of

A comprehensive parameterization of heterogeneous ice nucleation of dust surrogate: laboratory study with hematite particles and its application to atmospheric models

N. Hiranuma et al.

Correspondence to: N. Hiranuma (seong.moon@kit.edu)

This supplementary information provides additional details for 1) temporal plots of the AIDA experiments during INUIT campaigns, 2) the n_s interpolation to draw initial n_s-isolines in the T-RH$_{ice}$ space, 3) the continuous increase in n_s after depletion of superaturation, and 4) the method used to constrain n_s to >100% RH$_{ice}$.

AIDA experimental profiles for INUIT campaigns

Figure S1 shows the temporal profiles of AIDA experiments during INUIT campaigns, including mean gas T, RH measured by TDL, depolarisation measured by SIMONE and N_{ice} measured by welas. The temporal n_s profiles were formulated based on these data.

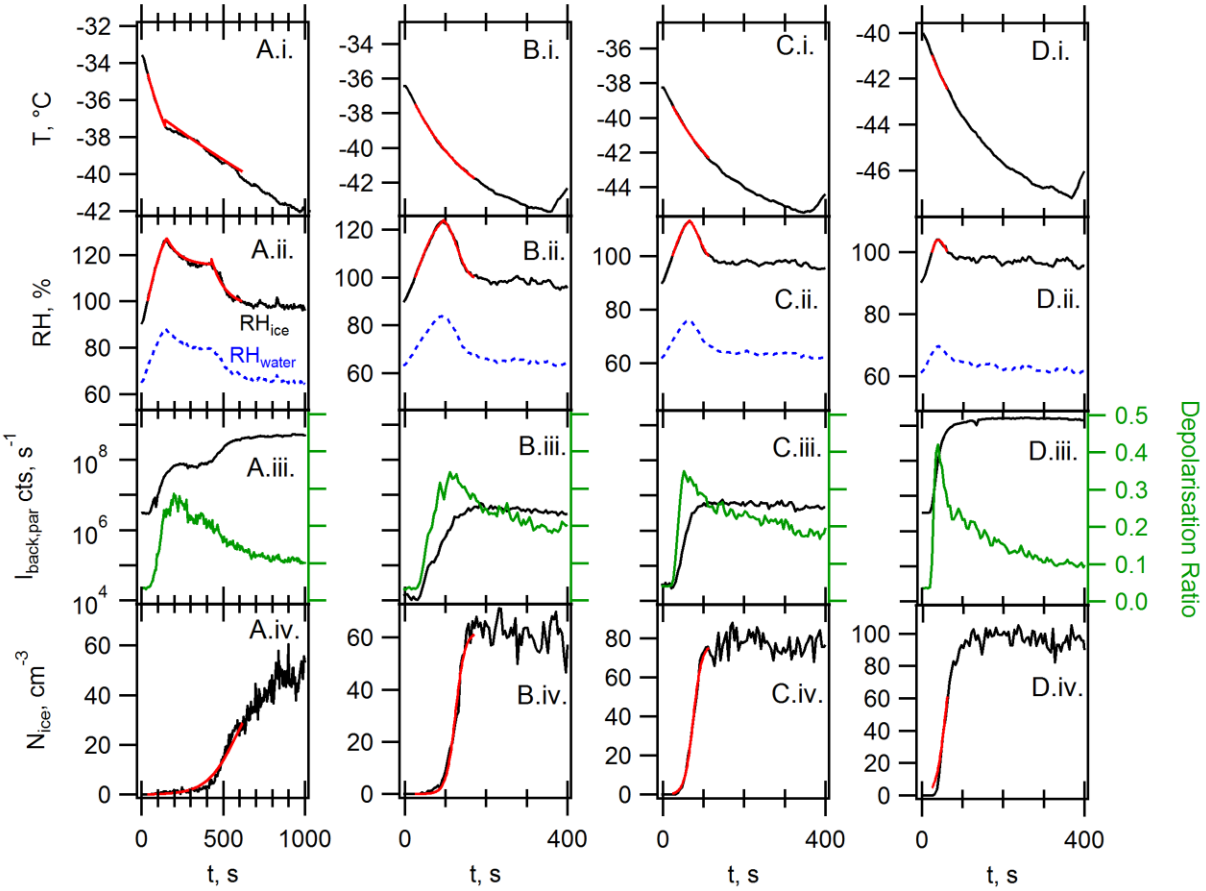

Figure S1. Temporal plots of the AIDA experiments of INUIT campaigns including A. INUIT01_30, B. INUIT04_10, C. INUIT04_08 and D. INUIT01_26. Panel-arrangements are identical to Fig. 1.

Fitting procedure to generate initial n_s-isolines

In order to connect discrete constant n_s values derived from AIDA experiments, plotted in the T-RH$_{\mathrm{ice}}$ space (Fig. 2), isolines were initially fitted by assuming RH$_{\mathrm{ice,\,(ns)}}$ to be a function of T. A bundle of n_s-isolines ($2.5\mathrm{x}10^{8}\ \mathrm{m}^{-2} < n_s < 1.0\mathrm{x}10^{12}\ \mathrm{m}^{-2}$) was derived from the following second degree polynomial fit equations:

$$
\begin{aligned}
&\mathrm{RH}_{\mathrm{ice},(n_s)} = \mathrm{f}(T)\\
&\mathrm{RH}_{\mathrm{ice},(n_s = 1.0\mathrm{x}10^{12})} = 305.62 + (6.8767 \mathrm{~x~} T) + (0.062894 \mathrm{~x~} T^2)\\
&\mathrm{RH}_{\mathrm{ice},(\ n_s = 1.0\mathrm{x}10^{11})} = 312.94 + (7.5808 \mathrm{~x~} T) + (0.067883 \mathrm{~x~} T^2)\\
&\mathrm{RH}_{\mathrm{ice},(\ n_s = 1.0\mathrm{x}10^{10})} = 334.74 + (8.2497 \mathrm{~x~} T) + (0.06897 \mathrm{~x~} T^2)\\
&\mathrm{RH}_{\mathrm{ice},(\ n_s = 5.0\mathrm{x}10^{9})} = 334.17 + (8.2704 \mathrm{~x~} T) + (0.068525 \mathrm{~x~} T^2)\\
&\mathrm{RH}_{\mathrm{ice},(\ n_s = 1.0\mathrm{x}10^{9})} = 355.52 + (9.2094 \mathrm{~x~} T) + (0.07642 \mathrm{~x~} T^2))\\
&\mathrm{RH}_{\mathrm{ice},(\ n_s = 5.0\mathrm{x}10^{8})} = 383.61 + (10.414 \mathrm{~x~} T) + (0.087181 \mathrm{~x~} T^2)\\
&\mathrm{RH}_{\mathrm{ice},(\ n_s = 2.5\mathrm{x}10^{8})} = 434.61 + (12.552 \mathrm{~x~} T) + (0.10605 \mathrm{~x~} T^2) \qquad \text{(S1)}
\end{aligned}
$$

Note that the number in the RH$_{\mathrm{ice}}$-bracket represents n_s values in m^{-2}.

Evidence of n_s increase after saturation depletion due to further cooling

Figure S2 shows an example of the continuous increase in n_s after depletion of superaturation and the resulting max n_s after the RH$_{\mathrm{ice}}$ peak while continuous cooling at $T > -50$ ˚C, which is indicative of a predominant T influence. As opposed to the strong influence of RH$_{\mathrm{ice}}$ at $T < -60$ ˚C, a strong temperature-dependence was routinely observed for other experiments at $T > -50$ ˚C (not shown).

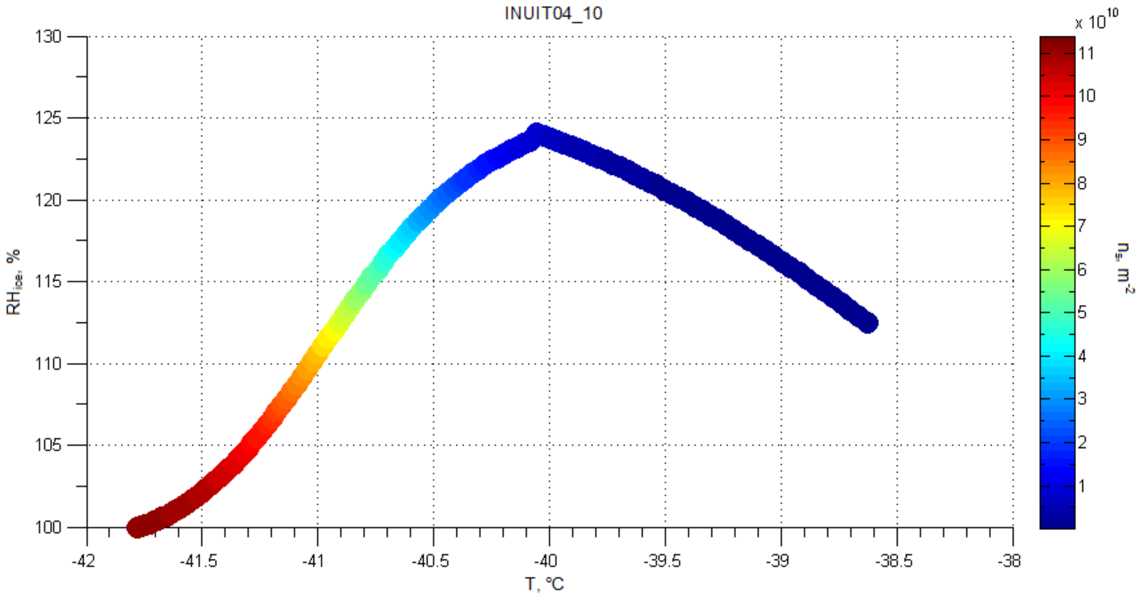

Figure S2. The n_s values for hematite particles as a function of temperature under water subsaturated conditions from INUIT04_10. While continuous cooling (from right to left) proceeds, concurrent increase in n_s after depletion of supersaturation at RH$_{ice}$ = 123 % is observed. The color scale represents n_s in m^{-2}.

Constraining n_s to >100% RH$_{ice}$

The n_s-isolines governed by Eqn. S1 are not analogous to the observed ice nucleation data because the fit is blind to the presence of ice saturation conditions and is therefore prone to an artifact (i.e., nucleation under ice subsaturation conditions). Without any corrections, modeling studies can be biased and mislead by concealed n_s values. Hence, we invariably confine the n_s-isolines (2.5×10^8 m^{-2} < n_s < 7.5×10^{10} m^{-2}) to RH$_{ice}$ >100% (Fig. 4A) and correct RH$_{ice}$ by the following procedures. First, an upper boundary of the n_s (= 7.5×10^{10} m^{-2}) is defined as the reference isoline hovering above 100% RH$_{ice}$ at any T between -36 and -78 ˚C. Next, we introduce the constant, c, to relocate concealed isolines to RH$_{ice}$ >100%:

$$c = \frac{\mathrm{RH}_{\mathrm{ice},(n_s=7.5\times10^{10})} - 100}{100 - \mathrm{RH}_{\mathrm{ice}(n_s=2.5\times10^{8})}} \equiv \frac{\mathrm{a}}{\mathrm{b}} \qquad \text{(S2)}$$

in which, a/b is evaluated at each temperature step (every 0.1 ˚C for -36 to -78 ˚C). Accordingly, the scaled RH$_{ice}$ for a given n_s, RH$_{\mathrm{ice},(n_s)}$, is estimated as:

$$\mathrm{RH}_{\mathrm{ice},(n_s)} = \frac{\mathrm{RH}_{\mathrm{ice},(n_s=7.5\times10^{10})} + \mathrm{c}\cdot\mathrm{RH}_{\mathrm{ice},(n_s)}}{\mathrm{c}+1} \tag{S3}$$

As can be seen in Figure S3, the ratio of a and b (at -45 ˚C as an example) is set to be a constant in order to scale the $\mathrm{RH}_{\mathrm{ice},(n_s)}$. An ensemble of $\mathrm{RH}_{\mathrm{ice},(n_s)}$-$T$ is represented in Figure 4A.

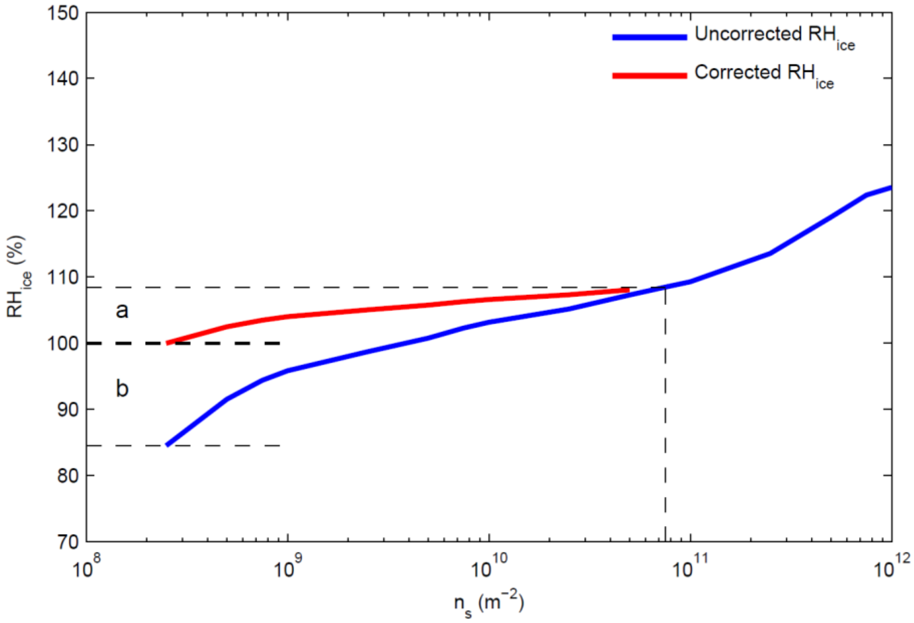

Figure S3. An example of the relationship between uncorrected- and corrected $\mathrm{RH}_{\mathrm{ice}}$ as a function of n_s at -45 ˚C.