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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) an indication of continuous increase in n_s after depletion of superaturation, and 4) the method used to constrain n_s to >100% RH_{ice}.

<u>AIDA experimental profiles for INUIT campaigns</u>

Figure S1 shows the temporal profiles of AIDA experiments during INUIT campiagns, 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.

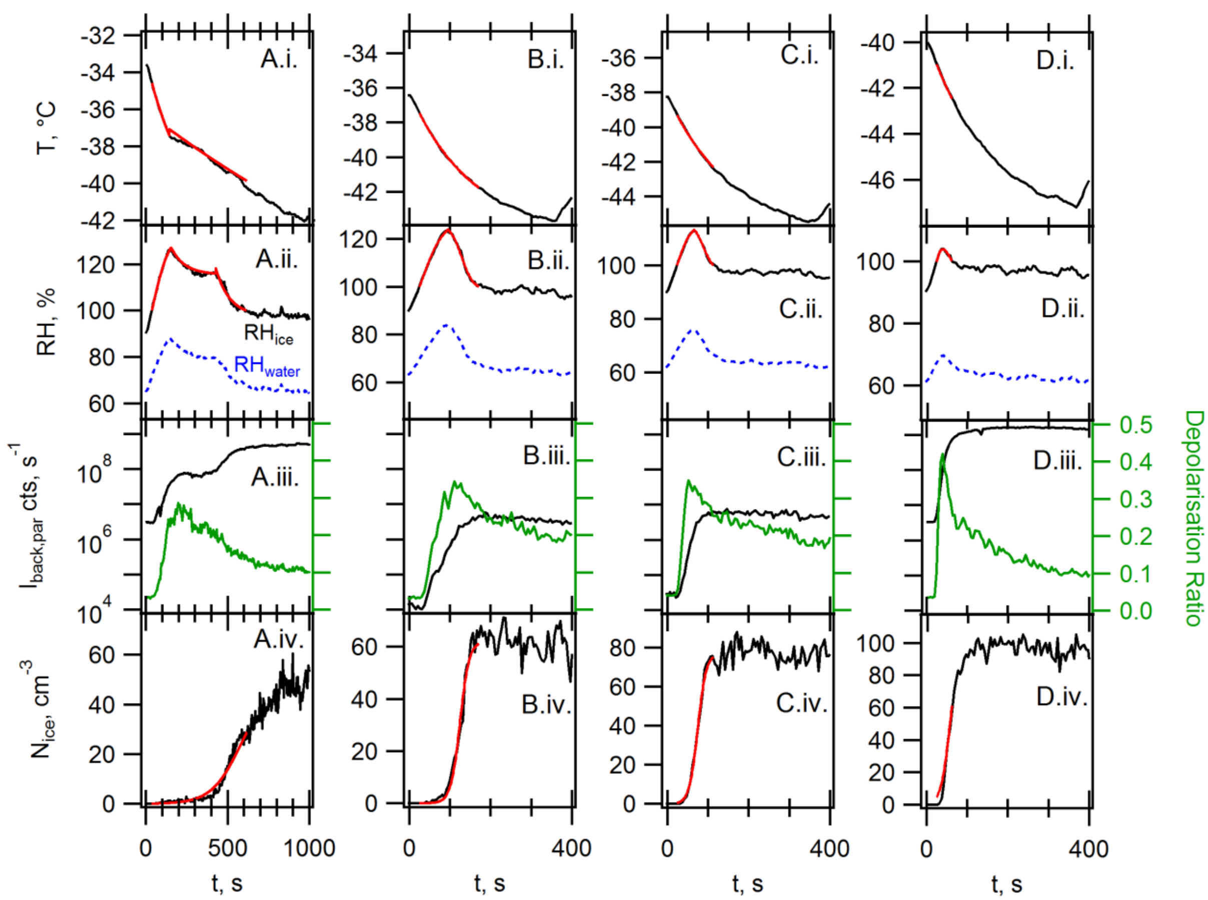

Figure S1. Temporal plots of the AIDA experiments of INUIT campaigns including A. INUIT01_30, B. INUIT04_10, C. INUIT04_08 and D. INUIT01_26. Panel-arrangements are identical to Fig. 1.

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_{ice} space (Fig. 2), isolines were initially fitted by assuming $RH_{ice,\,(ns)}$ to be a function of T. A bundle of n_s-isolines ($2.5x10^8$ $m^{-2} < n_s < 1.0x10^{12}$ m^{-2}) was derived from the following second degree polynomial fit equations:

$$
\begin{aligned}
&RH_{ice,(n_s)} = f(T)\\
&RH_{ice,(n_s = 1.0x10^{12})} = 305.62 + (6.8767 \text{ x } T) + (0.062894 \text{ x } T^2)\\
&RH_{ice,(\, n_s = 1.0x10^{11})} = 312.94 + (7.5808 \text{ x } T) + (0.067883 \text{ x } T^2)\\
&RH_{ice,(\, n_s = 1.0x10^{10})} = 334.74 + (8.2497 \text{ x } T) + (0.06897 \text{ x } T^2)\\
&RH_{ice,(\, n_s = 5.0x10^{9})} = 334.17 + (8.2704 \text{ x } T) + (0.068525 \text{ x } T^2)\\
&RH_{ice,(\, n_s = 1.0x10^{9})} = 355.52 + (9.2094 \text{ x } T) + (0.07642 \text{ x } T^2))\\
&RH_{ice,(\, n_s = 5.0x10^{8})} = 383.61 + (10.414 \text{ x } T) + (0.087181 \text{ x } T^2)\\
&RH_{ice,(\, n_s = 2.5x10^{8})} = 434.61 + (12.552 \text{ x } T) + (0.10605 \text{ x } T^2) \qquad \text{(S1)}
\end{aligned}
$$

Note that the number in RH_{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 continuous increase in n_s after depletion of superaturation and resulting max n_s after the peak RH_{ice} while continuous cooling at T > -50 ˚C, which is indicative of a predominant T influence. As opposed to the strong influence of RH_{ice} at T < -60 ˚C, observed strong temperature-dependency was routinely observed for other experiments for T > -50 ˚C (not shown).

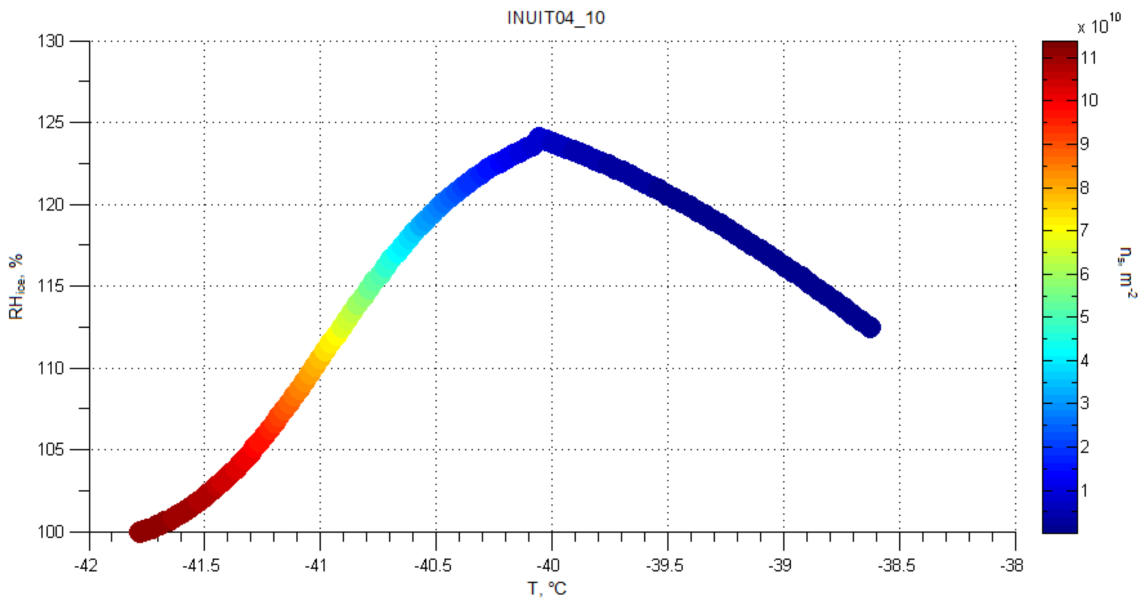

Figure S2. n_s for hematite particles as a function of temperature under water subsaturated conditions from INUIT04_10. While continuous cooling (from right to left) proceeds, concurrent increase in n_s after depletion of supersaturation at RH_{ice} = 123 % is observed. Color scale represents n_s in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

<u>Constraining n_s to >100% RH_{ice}</u>

The n_s-isolines governed by Eqn. S1 are not analogous to observed ice nucleation data because the fit is blind to the presence of ice saturation conditions and therefore prone to an artifact (i.e., nucleation under ice subsaturation conditions). Without any corrections, modelling 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 corrected RH_{ice} by the following procedures. First, an upper bound of the n_s (= 7.5×10^{10} m^{-2}) is assigned as the reference isoline hovering above 100% RH_{ice} at any T between -36 ˚C and -78 ˚C. Next, to relocate concealed isolines to RH_{ice} >100%, we introduced the constant, c, as:

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

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

$$RH_{ice,(n_s)} = \frac{RH_{ice,(n_s=7.5\times10^{10})} + c \cdot RH_{ice,(n_s)}}{c+1} \qquad \text{(S3)}$$

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 $RH_{ice,(ns)}$. An ensemble of $RH_{ice,(ns)}$-T is represented in Figure 4A.

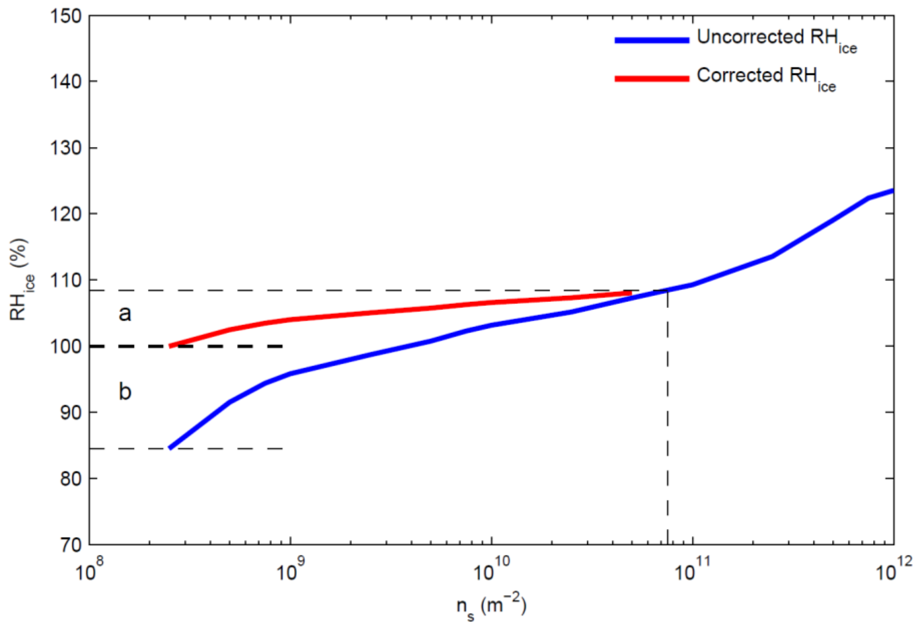

Figure S3. An example of visualizing the relationship between uncorrected- and corrected RH_{ice} as a function of n_s at -45 ˚C.