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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Long-range transported bioaerosols captured in snow cover on Mount Tateyama, Japan: Impacts of Asian-dust events on airborne bacterial dynamics relating to ice-nucleation activities" *by* Teruya Maki et al.

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Dear Anonymous Referee 1,

I appreciate your kindly and useful comments for our manuscript. Moreover, we are very glad that our study has been valued. Furthermore, I am sorry for bothering you due to some mistake in the description of ice-nuclei experimental design. I would have revised our manuscript referring to your comments, and wish your review again. Your comments are indicated at sections (Q) and my responses are indicated at sections

(A). In sections (A), the revised parts in our manuscript were indicated using line.

Q1.) Samples were filtered (0.22 micron) and re-suspended for INP quantification. I wonder what proportion of INP may have passed through the filter. Did you do, for comparison, drop freezing assays with samples prior to filtration?

A1: After the particulate matters were removed from some of snow samples using 0.22 micron filters, the samples without >0.22 micron particulate matters showed mostly similar IN activities to nano-puresawater. Moreover, I have compared the melted snow samples without filtration and with re-suspension. There is no significant difference between them. Accordingly, I think that the soluble substrates in snow samples can be neglected in this study. I have added this explanation in the revised manuscript (P5 L6-L9).

Q2.) Equation at the end of page 4: What does "deltaMo" stand for? Does "V" stand for the volume of snow from which the particles were derived (e.g. is it corrected for the 200-fold concentration and dilution mentioned in the paragraph above the equation)?

A2: Sorry for occurring this confusion, because the explanation about the equation are insufficient. The factor "deltaMo" had meant the dilution rate in the previous version. I have revised the equation and inserted the dilution and concentration factor "C" instead of "deltaMo". The explanation about "C" has been added (P5 L5).

Q3.) Page 5, line 3: Quantitative statements about ice nucleating particles (INP) should be accompanied by the temperature at which the mentioned INP were active. Otherwise these numbers have little meaning. The numbers (1.74 to 49.7 IN per litre) are very small compared to other numbers of INP in precipitation (please see for comparison the summarising Figure 1 in Petters and Wright, 2015, http://dx.doi.org/10.1002/2015GL065733). Is the unit (IN per litre) correct? Another unit that makes me wonder is the "m-3" on the y-axes of Fig. 4. Should this be "cm-3"?

A3: I am sorry again for confusing you. The INP numbers have to be shown using "mL-

1". I have integrated the unit of INP concentration to "L-1" in the revised manuscript (P5 L6). Moreover, the previous Figure has not real INP numbers. I have calculated them again and inserted additional figure (Figures 5 and 7). I would like to appreciate your comments.

Q4.) Page 9, lines 28-29: "Dust mineral particles without organic matters, such as ATD, showed lower temperatures (less than -15 C) for the initial freezing of water drops than snow samples of the dirty layers." The onset of observed freezing or, as you call it: initial freezing, is a function of the particles' ice nucleation property and the total number of particles in the drop freezing assay. The same kind of particles will show a higher onset of observed freezing when a larger number (higher concentration) of them is tested in an assay (greater probability that it contains a rare INP active at warm temperature). Therefore, parameters like "initial freezing", "end-freezing" and "IN-T50C) are strictly relative numbers. They are meaningful when comparing samples that have all been processed exactly the same. In this context, it would be important to know exactly how the filtration, re-suspension and dilution (page 4, lines 21-24) was done and whether this procedure introduced differences between samples. You write: "Concentrated samples were diluted to the lowest particulate densities of approximately 5.0 10ËĘ4 particles mL-1 (from 1.0 g mL-1 to 2.0 g mL-1) using the nano-purewater, : : :" (page 4, lines 23-24). Does that mean you normalised samples to a particle density of 10ËĘ4 mlËĘ-1 for INP analysis?

A4: Thank you for your indication. We adjusted the particles concentrations in snow samples to same in dependence on DAPI-count densities. We would like to compare the IN activities under same particles concentrations 5.0 10ËĘ4 particles mL-1. The parameters such as "initial freezing", "end-freezing" and "IN-T50C) are show the relative abilities of IN in snow samples. The dilution and concentration procedures have been described in detail in the revised manuscript (P4 L24-L29)

Q5.) Similar to the previous comment about the onset of freezing depending on particle numbers in an assay, the ": : :higher diversity in the dirty snow layers than those of

other snow layers: : :" (page 10, lines 8-9) could also result from a greater probability of identifying a rare species in a sample where a larger number of its copies are present (more dirty snow). What is the lowest number of copies of a species that would have been necessary for a species to be detected in your analysis?

A5: I think MiSeq sequencing provided enough read numbers that almost bacterial categories (species) can be followed in this study. In fact, rarefaction curve showed that the bacterial OUT numbers are saturated at the numbers of analyzed sequences. In general, the lowest number of sequences in minor category (species) are single sequence and the almost saturation of OUT numbers is indicator for judging the follow of entire bacterial categories. I have added this explanation about the minor categories of OUT (P9 L10-L12).

Q6.) By looking at Figure 5a, I wonder why samples with high numbers of INP were not diluted and re-analysed to obtain INP values of all samples for at least one common reference temperature (e.g. -10 C).

A6: I have shown the IN numbers using other figure. Sorry. The Y axis did not show IN numbers and indicate the freezing well numbers (Figure). This graph is needed for the determination of IN-T50C and should be remained after revision (Figure 6a).

Q7. Figure 4: Is the unit on the y-axes indeed "m-3"?

A7: The Y-axes indicated the particle concentrations in melted snow samples (liquid). Accordingly, the unit is "mL-1". I have shown the concentrations using the unit "L-1" in the figures (Figures 5 and 7).

Q8. Table 1: Some headers and sentences are longer than the text boxes. What is "endfreezing temp."?

A8: Some headers and sentences have revised and all parts can be shown in the table in the revised manuscript (Table). The term "endfreezing temp." has been explained in this table (Table 1).

Q9. Table 2: Header: What do you mean with “Relatives of relative abundances : : :”? Footnotes, **: What do you mean with “: : :the 50% of concentrations of ice nucleic particles.”

A8: I have revised the header. Moreover, some explanations in table have been re-drafted (Table 2).

Q10. The manuscript would benefit from English language editing.

A8: English language has been checked by native speakers again (Entire section of the revised manuscript).

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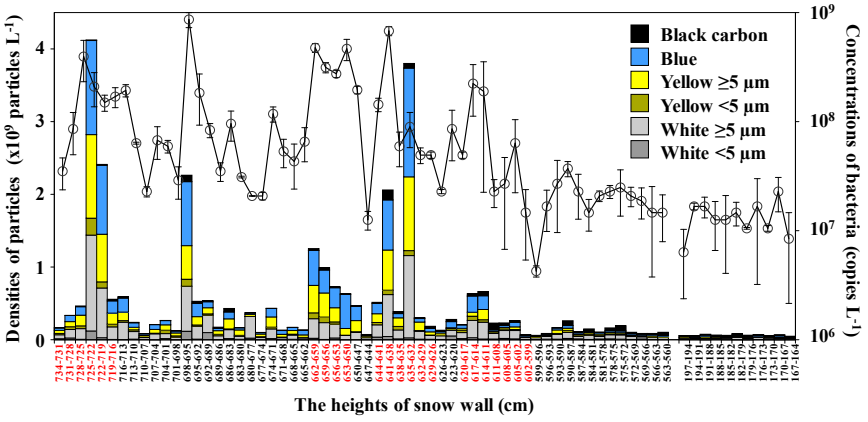

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Fig. 1. Figure 5: Vertical profiles for DAPI-stained particle densities (bars) and 16S rRNA genes copies determined by qRT-PCR (open circles), in snow samples collected from Murododaira, Mt. Tateyama, in Apri

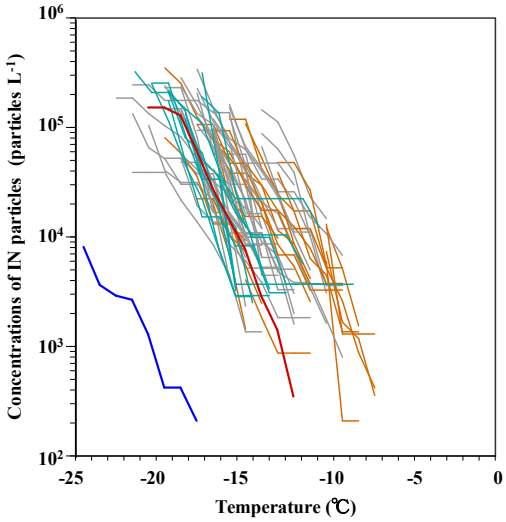

Fig. 7 T. Maki et al.

Fig. 2. Figure 7: Variations of ice-nuclei particles in the snow samples collected from the dirty layers (orange lines) and non-dirty layer (grey lines) in the upper parts and all the layers in lower parts (g