



EGUsphere, referee comment RC1
<https://doi.org/10.5194/egusphere-2022-544-RC1>, 2022
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.

Comment on egusphere-2022-544

Anonymous Referee #1

Referee comment on "Ice fog observed at cirrus temperatures at Dome C, Antarctic Plateau" by Étienne Vignon et al., EGU sphere,
<https://doi.org/10.5194/egusphere-2022-544-RC1>, 2022

The authors report on the observation of two cases of ice fogs formed at Dome C, Antarctica. Both ice fogs formed at very cold temperatures which are typical for cirrus clouds in the upper troposphere. In particular, these fogs formed in-situ, most likely due to the homogeneous nucleation of ice crystals, i.e. the freezing of pre-existing aerosol solution particles. This aspect makes this study particularly interesting since in contrast to aircraft based observations of natural (i.e. outside of the laboratory) cirrus clouds the authors are able to show timeseries of key parameters at a stationary location, hence within the forming cloud itself.

The manuscript is very well written and fits well into the scope of ACP. After addressing my comments and questions I have listed below, I recommend the acceptance of the manuscript.

Comments:

(1) I find it a pity that no data is presented that can shed some light on the nucleated ice crystals within the two fogs, such as their shape, mass, number density. If there is such data available, I strongly recommend to include that.

(2) Line 21-22: You state that the ice crystal properties "such as their size and their number concentration" are different for an ice fog or diamond dust. I suggest adding a sentence to clarify these differences.

(3) Line 30-32: To me it seems that the formation process you describe here is the freezing of supercooled liquid droplets which are already as large as cloud droplets. In other words it is the freezing of a pre-existing liquid cloud. I suggest to refer to this process as a liquid-origin cloud, since the term "homogeneous freezing" is usually understood as the freezing of much smaller solution aerosol particles (you describe this

process in line 41-44).

(4) Section 2.2: At very cold temperatures close to 200K, a new formulation of the saturation vapor pressure over liquid water was recently presented by Nachbar et al. This formulation differs from the formulation given in Murphy and Koop (2005), in particular at cold temperatures. What happens to your RHI-values if you use this new formulation? Although Nachbar et al state that their parameterization is only valid for temperatures above 200K, it seems that such a comparison is applicable for observed fog in the case 1. Of course, such a comparison might also affect the results in Appendix A.

Reference:

Nachbar, M., Duft, D., and Leisner, T.: The vapor pressure of liquid and solid water phases at conditions relevant to the atmosphere, *J. Chem. Phys.*, 151, 064504, <https://doi.org/10.1063/1.5100364>, 2019.

(5) Section 2.5: Does the Global Data Assimilation System employ a rotated grid to avoid a pole-singularity in the Antarctica area? If not, does this singularity affects data that is used to compute the backward trajectories?

(6) Figure 4 and 8: I suggest to indicate the two time periods which you describe in the following subsections with "Initiation" and "Growth+Decay" within the figures, e.g. by adding two vertical arrows below the panels. In addition, I suggest to indicate the time which corresponds to each of the vertical lines shown in the panels (e.g. by adding the times at the top of the first panel). What is the meaning of the solid black horizontal line?

(7) Line 151: Note that Baumgartner et al (2022) describe that the homogeneous freezing of the solution particles already starts at values of RH_i below the threshold given in Koop et al (2000). The rate of ice crystal nucleation increases as the values of RH_i approach that threshold, but the threshold is not to be understood as a switch. In essence, as long as RH_i comes close to the critical value (e.g. the threshold), the homogeneous nucleation starts and there might have been some homogeneous nucleation also at 3m height during your observation.

Minor and technical comments:

(1) Line 27: It should read "pre-conditioned"

(2) Line 59: "...data at Dome C, a site particularly..."

(3) Line 104: "droplets"

(4) Line 114: "to track the trajectories of the air masses probed above Dome C."

(5) Line 120: It should read "0600 LT" ?

(6) Line 149: It should read "0800 LT, 8 March (Fig. 4)." and "2230, 7 March, at the"

(7) Line 209-210: What is the maximum value of RHi?

(8) Line 213: "measurements"

(9) Line 247: "precipitation"

(10) Line 256: Delete "this"

(11) Appendix A: I found it quite hard to understand what exactly is shown in figure A1. Please state this more explicitly. It would also be helpful to add a sentence on how one should "read" these plots.

(12) Line 281: It should read "RHI and RHi"

(13) Equations A1, A2 and line 290: Please substitute the asterisk by a centered dot to indicate multiplication.

(14) Equation A2: The numbers of the regression coefficients should appear as an index.