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Atmospheric Measurement Techniques Discussions

Interactive comment on "Mapping ice formation to mineral-surface topography using a micro mixing chamber with video and atomic-force microscopy" *by* Raymond W. Friddle and Konrad Thürmer

Anonymous Referee #1

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Review for Mapping ice formation to mineral-surface topography using a micro mixing chamber with video and atomic-force microscopy by Raymond W. Friddle and Konrad Thürmer

I would like to congratulate the authors on the development of a novel and useful instrument for linking topographic features on bulk systems to ice growth. The results are clearly presented and the manuscript is well written. Nevertheless, I have a few comments listed below.

General comments:

The paper initially describes the technique as an instrument for elucidating atmospheric

ice formation. However, the primary focus of the results are about ice growth and propagation on the feldspar mineral. Although this is an interesting observation and result, it is not very atmospherically relevant. As in the atmosphere, the aerosols acting as INPs are between approximately 50 and 10000 nm. Therefore, it is likely that individual droplets would not exist on the surface of the aerosol particle. Rather, the entire aerosol would be immersed in a cloud droplet above water saturation and the ice nucleation event would cause the entire droplet to freeze. This renders the step height analysis unnecessary for atmospheric ice formation. I think this should be more clearly presented in the manuscript.

Nevertheless, the step height analysis is potentially an interesting and important result for the material science, biomedical and food preservation fields. Perhaps the authors should present the step height analysis in reference to those fields.

Although it is discussed that certain sites repeatedly nucleated ice while others lost that ability, it would be nice to show some examples of the types of sites that retained or lost their ice nucleating ability. For example, do they differ in geometry, location on the mineral surface etc.

Do the crystals that emerge from pits below water saturation or protrusions above water saturation have the same orientation as discussed in the Kiselev et al., (2017) study?

Minor Comments What is the resolution of the AFM? What is the tip width and how does this affect the mapping of the topographic features?

What is the temperature uncertainty of the thermistor? Is there an impact of the temperature measurement occurring below the standoff stage rather than below the sample itself (see Fig. 1)?

What are the uncertainties in the iced step height analysis? Please add error bars to the Fig. 6. Is there a reason that the largest step heights have a lower iced fraction above 0.75 AHin or is this due to the uncertainty of calculating the iced fraction of a step. This result is in direct conflict with the statement that higher iced steps would retain ice longer than shorter steps (see discussion and outlook).

It is not stated how the humidity would be calibrated at other temperatures? Would the AHin be increased until water is observed and then this be used as 100 % RH in the cell?

I understand that once droplets are formed, the humidity would drop in the chamber, but at the highest AHin used in the study $\sim$200 % RH, do the droplets continue to grow/merge?

As mentioned in the general comments, the experiments conducted above water saturation are investigating ice growth. Please make this clearer on page 5 line 11.

Detailed comments Page 2 Line 5: Please add Pach and Verdaguer, (2019)

Page 2 line 16: Remove “however” as this confuses the sentence and move the citations to the end of the sentence.

Section 2.1.1 please reference Figure 1.

Section 2.1.1 on page 3 line 10 is not numbered correctly. Please change to 2.1.2

Page 3 line 16: Capitalize “figure”

Page 3 line 24-26: This sentence seems unnecessary here especially as it is not explored in this study. Ether reformulate to state that in theory this would be an additional advantage or remove.

Page 5 line 3: Please add appropriate references for ice formation from capillary condensation such as: Campbell et al., (2017); Campbell and Christenson, (2018); David et al., (2019); Marcolli, (2014); Pach and Verdaguer, (2019)

Page 6 line 5: numbering of section is off, change to 4.2.

Page 6 line 27: please change ice formation to ice growth

References:

Campbell, J. M. and Christenson, H. K.: Nucleation- and Emergence-Limited Growth of Ice from Pores, Phys. Rev. Lett., 120(16), 165701, doi:10.1103/PhysRevLett.120.165701, 2018.

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Marcolli, C.: Deposition nucleation viewed as homogeneous or immersion freezing in pores and cavities, Atmos Chem Phys, 14(4), 2071–2104, doi:10.5194/acp-14-2071-2014, 2014.

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