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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Mesoscopic surface roughness of ice crystals pervasive across a wide range of ice crystal conditions" *by* N. B. Magee et al.

**N. B. Magee et al.**

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The authors would like to offer our sincere thanks to Dr. Murray for his constructive comments and corrections. We look forward to incorporating all suggestions into a final manuscript. Our specific responses are found below each numbered question/comment:

1. Section 3.3. It is stated that the transported crystals may have changed during transport, if so, how useful are these results. They don't seem to add anything greatly to the paper. Either justify their inclusion and make the conclusion clear or remove the

section.

The primary motivation for including the discussion and images of the transported crystals lies in showing the nature of roughness on ice crystals grown in a cirrus-analog environment and without full substrate contact. Pointing to the absence of ambient air pressure in the actively growing and sublimating crystals, other readers and reviewers of this manuscript and other recent ESEM studies have questioned whether the observed mesoscopic roughness may be entirely absent for crystals grown in natural cirrus conditions. We acknowledge that precise measurements of the growth and transport environment of the transported crystals has not been yet accomplished, but the images still convey valuable information – they demonstrate that crystals grown in cirrus-analog environments (not just in the pure vapor ESEM environment) do still show mesoscopic roughness. We will try to clarify this conclusion in the manuscript and add more careful discussion around the significance of the images in figure 5. Our next experimental goals are to 1) ensure and demonstrate maintenance of equilibrium conditions during transport and 2) to make careful roughness measurements on crystals subject to conditions spanning the range of natural cirrus environment. These goals will require significant additional engineering of the experiment design, but should be feasible.

2. Section 3.3, 8405 'Tabular'. Is this the correct name. Do you mean shorter columns. The name tabular refers to a special class of crystal. There is an illustration on p 42 of Tape (1994, Atmospheric Halos, vol 64, Antarctic research series). A tabular crystal is one in which a hexagonal column has two prismatic faces much wider than the other two.

Yes, thank your for the correction. We intended to describe short columns, with dimensions along the a-axis and c-axis nearly isometric. The improper usage of 'tabular' will be removed.

3. P8404. The section on 'ice Ic/ice Ih combinations' not quite correct. The references



ACPD
14, C6152–C6156, 2014

are fully relevant, but are rather technical in nature. Revise this section to something closer to: 'Several recent studies have also suggested that ice up to 243 K does not have a well ordered hexagonal crystal structure. Instead ice can contain a mixture of cubic and hexagonal sequences which can give rise to roughness on the prismatic faces (Malkin et al., 2012; Kuhs et al. 2012). It has also been shown that the proportion of cubic sequences decreases as ice is heated and the ice tends towards perfect hexagonal ice (Murray and Bertram, 2006; Kuhs et al., 2012). Both of these. . .. . .'

Thank you for the suggested rewording, we will adopt your suggestion.

4. & 5. Fig 1-6. I encourage ACP to print these images as large as possible – i.e. full two column width. The details are central to the paper. The scale bar and conditions is hard to read in many cases. Either include this information clearly in the figures or put in a table. Put scale bars on figures

Thank you for this suggestion – we agree that the images are of central importance to value of the manuscript and anything that can be done by ACP to maximize image size would be greatly appreciated. The scale bar conditions are hard to read without viewing the images at full size. Since trying to write this data directly into the figure could interfere with maximum space for the images themselves, we will include this information in a table.

6. & 7. Fig 5 caption: Add more detail of what this image is. Figure 6 caption. More detail. What magnification. Are we looking at the prismatic or basal face. What does this look like on a lower magnification (include second inset image?)

For figure 5., we agree that more information should be provided in the caption. The images show portions of 4 different crystals grown slowly at -50 °C in a static diffusion chamber between 100 and 105% rhi. The crystals were maintained in cryogenic equilibrium during transport into the ESEM for imaging under matched equilibrium conditions. We acknowledge that figure 6. also needs more context – this is a close-up of a portion of a prismatic face near the location where the basal face of an adjacent



ACPD
14, C6152–C6156, 2014

crystal had intersected an adjacent prism face of this crystal. An inset image at lower magnification is a good idea – we've uploaded a lower magnification (1903x) image and highlighted the region of close-up. This frame was taken 115 s prior to the image in fig. 6.

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Interactive comment on Atmos. Chem. Phys. Discuss., 14, 8393, 2014.





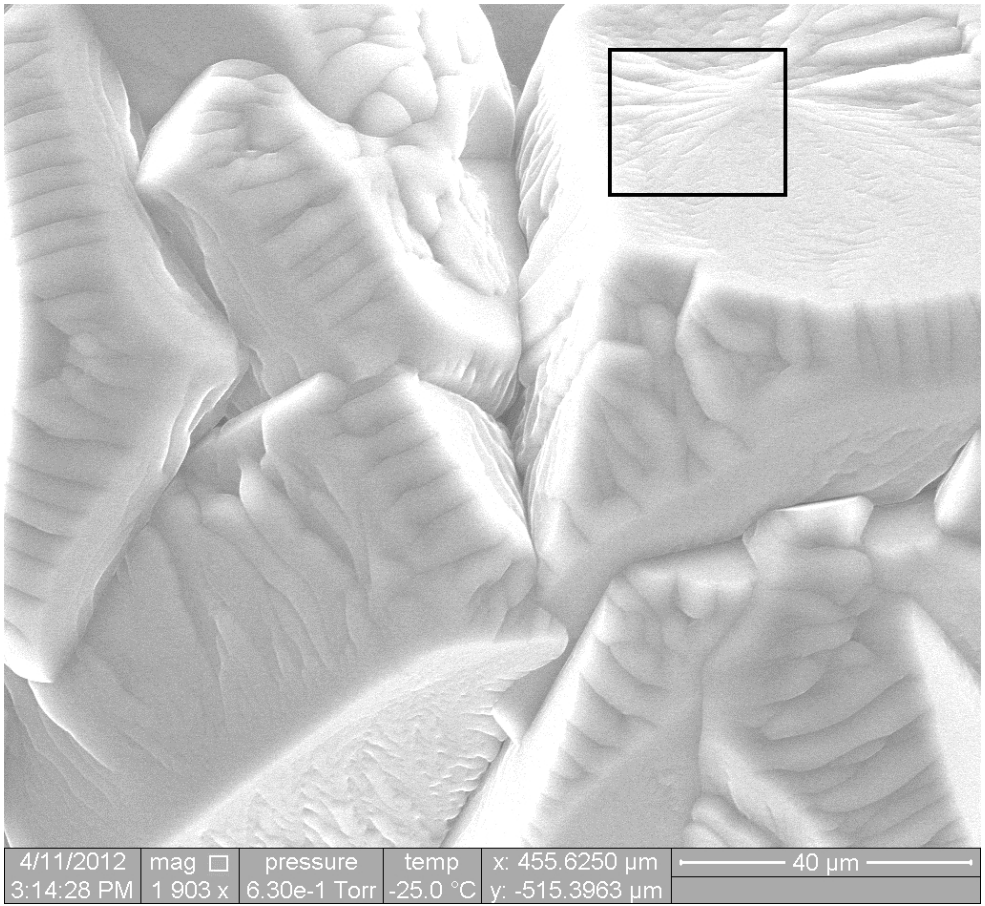


**Fig. 1.** Lower magnification inset to be included in Figure 6.



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14, C6152–C6156, 2014