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Interactive Comment

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.

magee@tcnj.edu

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Thank you very much for your helpful insights and suggestions regarding this manuscript. We look forward to incorporating your suggestions into a final manuscript. We will be glad to include the suggested references and a brief discussion of the potential for these results to inform interpretation of polarimetric measurements. Our specific responses to questions are below:

Q. 1 – What percentage of ice particles demonstrate roughening? Were the transported crystals (section 3.3) the primary source of smooth faceted particles?

Every crystal we observed demonstrated some evidence of roughening at the microscale or sub-microscale. The main differences were in scale, degree, and morphology of the roughness. In a qualitative sense, the actively sublimating crystals (i.e. Fig.) showed the largest scale and most extensive roughness while the transported crystals at equilibrium showed the largest facets with small-scale or barely perceptible roughness. Actively growing crystals tended to show intermediate roughness, but the scale and morphology of roughness was highly varied. Some crystal facets clearly showed roughness features with heights >5 μm, while other growing facets appeared to be smooth until examination at high magnification revealed roughness on a scale below 100 nm.

Q. 2 – Is there a way to discriminate conditions that lead to smoother versus more roughened particles? The reason for this question is that one often observes cirrus haloes and other optical phenomena, but more generally when updraft velocities are low. It would be useful if the authors could relate their observations to natural cirrus if possible.

We agree that discriminating among conditions that lead to the various degrees and scales of roughness observed would be highly desirable. Unfortunately, in the experiments described here, we could not detect systematic variation in roughness scale, degree, or morphology beyond the description in the response to question 1. Resolving the causes of varied roughness will be a primary goal of our continuing work. We have also been intentionally reluctant to draw direct comparisons between natural cirrus and the crystals observed here because the lack of air pressure and the presence of the growth substrate could render such comparisons misleading (see Reviewer Comment C4758 and reply). The surface character of the transported crystals should be more directly relatable to natural cirrus; however, in this set of experiments we were not able to explore a range of growth conditions for the transported crystals – all observed transported crystals were grown at low supersaturation (rhi ∼105% or less) and at a temperature near -50 C. The observation of larger facets with less roughness on

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the slowly grown transported crystals may be consistent with the observations of optical phenomena primarily in gentle-updraft, low supersaturation environments. Future experiments will focus on testing for systematic variability in the surface roughness of diffusion-chamber grown crystals across the natural range of temperature, pressure, and saturation ratio.

Q3. page 8401, paragraph beginning on line 13: we find that ice particles in environments of high updraft velocities (e.g., convection) tend to demonstrate characteristics consistent with the most roughening (e.g., Cole et al. 2013; 2014) in passive remote sensing using polarization data. Perhaps the severe roughening is caused by the formation mechanism for aggregates (i.e., crystals colliding with ridges radiating outwards from point of impact). Please comment.

This is an interesting idea that we had not considered, and would be worth mentioning in the revised manuscript. One event that clearly does enhance roughness during active growth (e.g .Fig. 1, panel b.) is the disruption of the growing surface by another crystal. In natural environments with high ice particle collision rates and aggregating crystals, it does seem plausible that this could be a significant influence on the total roughness of the particles.

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