

# Reply to the reviewers

## **Anonymous Referee #1**

This is a useful technical paper describing an advancement in the way that simulations of ice crystal growth in the laboratory are performed. A lot of work has gone into this chamber, and I'm happy to see all the considerations & analysis published so others can use it and understand the strengths and weaknesses of the technique.

I recommend publication, following some minor corrections.

**Our Reply:** We thank the reviewer for their helpful suggestions. We point out here the changes made to the revised manuscript:

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Introduction "but each experiment seems to give different normal growth rates (i.e., rate of face advancement normal to itself), even under similar conditions and using similar techniques" - can you provide examples of this, and relevant citations here?

**Our reply:** We followed the reviewer's suggestion and have added citations to the data sets showing the large variations at -15C and -30C.

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I felt section 2 was a very long unbroken section. It would benefit from being broken up a bit - for example splitting into subsections and including more of a "road map" at the start of the section outlining the issues to be addressed

**Our reply.** We have added new subsection headings in bold to increase the readability of this section.

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Equation 1 - I'd say  $\rho$  is more conventional notation for density. . . The analysis that follows could be spelled out more clearly. Why is the numerator proportional to  $dT$ ?

**Our Reply:** Equation 1 is a standard definition of supersaturation.  $N$  is the common symbol for number density in the crystal-growth literature. We prefer the symbol  $N$  to avoid confusion as the symbol  $\rho$  is used for the mass density of the air and vapor. Also  $\rho$  is the usual symbol for the mass density of water and ice,  $\rho_w$  and  $\rho_i$ , respectively. The numerator is

equilibrium number density difference between the vapor source temperature and the surface temperature. We have rewritten this section of the paper to add clarification to the text.

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You do a “back of the envelope” calculation here, with the Hertz-Knudsen equation - what assumptions does this calc make? e.g. regarding crystal + growth kinetics.

**Our Reply:** The estimate was made with the assumption of  $\alpha = 1$ . We have added a reference to the Hertz-Knudsen equation to the text.

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"If we assume that the onset of convection occurs with a Rayleigh number of about 1500, . . ." more background needed. can you justify this threshold, and define Ra physically

**Our Reply:** We have estimated the Rayleigh number for the onset of natural convection. We have referenced an experimental and numerical study showing approximately this value for convective onset and have added a little more explanation to the text.

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Page 5, last paragraph. Up to this point the analysis seems to suggest that  $S_a$  can be estimated very precisely. But reading this last paragraph, I wasn't sure what to think. The author's conclusion needs to be more explicit here. You say the computed  $S_a$  in your “other experiments” was different to the real value (using droplet as a reference for the environmental saturation ratio). Can you be quantitative? How different? More than you would expect from the preceding estimates? If so, why might this be? And what is the implication for analysis of results from the chamber generally?

**Our Reply:** We have rewritten this section to explain more clearly the limits to  $S_a$  determination. The “gold standard” for crystal growth experiments is stable T and S conditions in a chamber along with direct measurements of S and T near the crystal surface simultaneous with the growth rate measurements. To date there have been no experiments with a direct measurement of S near the crystal surface simultaneous with the growth rate measurements. We have made droplet evaporation measurements simultaneous with crystal growth measurements to obtain a direct measurement of  $S_a$ . But precise determination of  $S_a$  is not required here as we are focusing on the differences in facet-normal growth rates for crystals growing simultaneously in the chamber under the same growth conditions. We have added the estimated value of  $S_a$  using Eq. 1 to the text. Unfortunately there isn't space here for describing in detail our new method for more precise  $S_a$  determination and this will be reported elsewhere.