

Responses to Anonymous Referee # 1

First of all, we would like to thank the reviewer for the useful comments and suggestions.

Comments on Science:

1. Section 1, p. 17449: As the diffusion of trace gas molecules in ice is extremely low we do not assume that any species are moving into the parent ice particle during riming. This might happen in nature but in our experiments we do not account for. We concentrate on the processes of trapping solved trace gases in the ice phase during freezing and part of ice escaping back into the gas phase.
2. Section 2.4, p. 17455: The expression “desorption” is used to describe the process that adsorbed molecules leave a solid surface; however, it is commonly also used in literature to describe the process that solute molecules leave a liquid surface. Evaporation, on the other hand, means the process that solvent molecules leave the liquid surface. The process that hydrogen peroxide breaks up into water and oxygen seems to be named correctly by “decomposition” which has been used in the revised manuscript instead of “degenerate”.
3. Section 2.4: The temperature adaption times of droplets released from the sprayers into the wind tunnel have been in the order of one second. During this time period the droplets cool down from almost 0°C (definitely positive temperatures) to the experimental temperature (between -5 and -12°C). During this one second they desorb and decompose the most. After reaching the ambient air temperature in the tunnel we expect that all these loss processes slow down so that it is reasonable to neglect them until the droplets rime on ice. Generally, all reaction rates are decelerated in low ambient temperatures. A sentence has been added to the revised paper to mention this.

Measurements indicated that between 15% (with higher concentrations) and 25% (with lower concentrations) of H₂O₂ concentration has been lost over the sprayers. This statement has been included into the revised manuscript.

4. Tracers: The concentration of the tracers in the droplets has been in the micro-molar range and we assume that in such a diluted solution there will be no effects. The neutral salts used in the experiments did not change the pH value. The described technique has been used in earlier studies also.
5. Section 3.1 & 3.2: The effective Henry’s law constants give indications how much species is present in the droplets as it accounts for both solubility and dissociation; therefore, they have been referred to in the paper instead of the Henry’s law constants. Values of Henry’s law

constant at subzero temperatures are not well known but are expected to be larger than literature values measured at 20°C. With the literature value of 6.9×10^{-5} M/atm for H₂O₂ we calculated a partial pressure of 4×10^{-4} Pa for 1 ppm liquid phase concentration and 4×10^{-3} Pa for 10 ppm liquid phase concentration. For subzero temperatures it would be even lower.

6. Section 3.1: In Figs. 2 and 4, results are shown from experiments with ice crystals freely floated during riming. As described in the paper, those experiments are really difficult and time-consuming so that in the time period of a running project only a limited number of experiments could be performed. Therefore, it was not possible to successfully perform several experiments for several temperatures so that all experiments have been summarized in the temperature range of $10 \pm 2^\circ\text{C}$.
7. Page 17457: The error bars in the figures represent the measurement errors which were calculated by the Gaussian error computation. A sentence which is mentioning this has been added to the revised paper.
8. Section 3.2: A new section 4: Discussion and comparison to earlier results has been included into the revised paper where the reasons for the different retention coefficients in previous and our present studies have been discussed in detail.
9. The term “dry growth” is explained at the end of section 2.1.

Comments on Writing:

All replacements and changes suggested by the reviewer have been included into the revised manuscript.