

I have reviewed the paper “The retention of nitric acid, hydrochloric acid, and hydrogen peroxide” by N. von Blohn et al for the journal *Atmospheric Chemistry and Physics*. This article investigates the amount of retention of the trace gases, nitric acid, hydrochloric acid, and hydrogen peroxide, in rimed ice as a function of temperature. Water-soluble trace gases can get trapped in ice when liquid droplets freeze onto ice particles. This paper explores the riming process on ice particles (8 μm in diameter), dendritic ice crystals (6 μm ?), and snowflakes (for hydrogen peroxide only; 1-1.5 cm). Retention is approximately 100% for nitric acid and hydrochloric acid, consistent with these species dissociating fully in water. Retention of hydrogen peroxide is much lower than 100%, and does not match previous measurements. Groundwork is laid for future experiments on other trace gases.

The paper, tables, and figures are clear. I have minor comments on the science, and many minor comments to clarify the technical writing. I do not need to further review the document prior to publication.

Comments on Science:

Section 1, pg 17449, lines 1-6, especially lines 3-4: I think you are trying to say that when a liquid droplet with dissolved trace gases impacts onto an ice particle, some of the trace gas is transferred to the parent ice particle, some of it gets trapped as the liquid droplet freezes, and some of it evaporates back into the gas phase. This process depends on the freezing rate.

Section 2.4, pg 17455, lines 1-25: The wording is odd in this section. Desorption generally refers to molecules adsorbed onto a surface reentering the gas phase. Evaporation is the transfer of molecules from the solution phase to the gas phase. Hydrogen peroxide degrades in water to form water and oxygen.

Section 2.4: You expect the amount of hydrogen peroxide is less in the liquid droplets than the amount you initially added due to the degradation of hydrogen peroxide, but that just between the initial droplet and the freezing of the droplet to form rime on the ice particle, there is no more degradation, so that any difference observed is due to the evaporation of hydrogen peroxide (which leads to a retention below 100%). How much hydrogen peroxide concentration is lost over the sprayer? I would assume that the continual release of oxygen from the droplets would allow for continual degradation of hydrogen peroxide, even after the sprayer due to L’Chatelier’s Principle. Continued degradation of hydrogen peroxide could cause the lower observed retentions rather than evaporation. Could you address this point? Also, the free energy of the reaction will change as the droplet is cooled. How quickly do the droplets freeze? I do not think it is reasonable to assume that the equilibrium between hydrogen peroxide, water, and oxygen remains the same as the droplet is cooled.

How do you know that the presence of the salts used as tracers does not alter the equilibrium of the trace gases under study? You are almost always using these species in the same concentrations as the trace gases. Are you sure that the system is dilute enough that there will be no effect?

Sections 3.1 & 3.2: Henry's law says that the mass of a dissolved gas is equal to a constant times the partial pressure of the gas in equilibrium with the solution. Arguments about what the retention coefficients should be based solely on Henry's law constant are (I believe common), but odd. Could you also comment on the order of magnitude of the partial pressures involved?

Section 3.1: Why are Fig 2 and Fig 4 just for one temperature? Did you find similar results for other temperatures? On pg 17457, line 23, is the Gaussian error computation also what is shown in the figures?

Section 3.2: Could you provide more explanation on pg 17460 about why you think the previous measurements of hydrogen peroxide got such different results? Why did these field measurements get lower values?

Section 3.2& elsewhere: You mention "dry growth regime" several places. Could you define this term the first time it is used?

Comments on Writing:

The most common problem that is hindering the clarity of the writing is that prepositional phrases need commas placed after them.

pg 17448: line 11: change "ones" to "concentrations"

line 12: insert "one" or similar term to make "allow one to determine"

line 15+16: add commas around "nitric and hydrochloric acid"

line 20: follow prepositional phrase with comma, ie "content, riming"

pg 17449: line 17: change "leave again" to "exit"

line 20: change phrase to "does not dissociate and is only dissolved in water"

line 22: change "were leading" to "led"

line 27: change "even" to "observed"

pg 17450: line 5: change to "investigation"

line 9: put a comma after "melt water"

line 10: erase "with less uncertainty" (this means the same as more precise)

lines 14+15: place commas around "nitric acid and hydrochloric acid"

line 15: erase "at", end sentence after "first", delete "where", start new

sentence at "Retention"

pg 17451: line 4: place comma after "here"

line 9: place comma after "particles", erase "or" before "crystals"

line 24: add "that" to make "That means that"

line 25: add comma after "latent heat", change order of "stays" and "definitely"

pg 17452: line 9: alter sentence to read "As much as possible, the concentrations"

line 17: replace "at" with "on"

pg 17453: line 1+2: stop sentence after "analyses", the last clause is redundant

line 15: erase "in each case"

pg 17454: line 7: place comma after "droplets"

line 12: place comma after "There"

line 21: place comma after “analysis”
line 24: place comma after “dilution”
line 25: insert “the” to make “In the case”
pg 17455: line 3: change to “To summarize”
pg 17457: line 19: change “where” to “are” or “were”
line 20+21: erase “while” start new sentence “The device”, erase “only” at the
end of the sentence.
pg 17458: line 5: place comma after “120 ppmv”
line 15-17: break into 2 sentences
pg 17459: line 16: change to “techniques, which were”
line 25: erase “are”, change “lying” to “lie”
line 26: change to “independent”
pg 17460: line 18: put a comma after “content”
line 20: put a comma after “this is the case”
line 21: either erase “ing” or “of” in phrase “captively floating of graupels”
line 24: erase “to be”
pg 17461: line 6: place comma after “acid”
line 13: place comma after “content”
line 14: place comma after “slowly”, erase “to be”
line 18: erase “to be”
line 20: unclear what “The latter value inhibits a step forward” means
line 21-23: rephrase sentence