Atmos. Chem. Phys. Discuss., 11, C8059–C8062, 2011
www.atmos-chem-phys-discuss.net/11/C8059/2011/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Wind tunnel experiments on the retention of trace gases during riming: nitric acid, hydrochloric acid, and hydrogen peroxide" *by* N. von Blohn et al.

F. Domine (Referee)

florent@lgge.obs.ujf-grenoble.fr

Received and published: 22 August 2011

The purpose of this paper is to determine the retention coefficient of three atmospherically important trace gases during riming. One of the applications indicated is to use the values obtained in models of cloud chemistry. The authors use a wind tunnel and clever ice making procedures to reproduce cloud conditions and obtain values of retention coefficients that they believe should be applicable to cloud conditions.

This paper is doubtless of interest to atmospheric chemistry. It has one very strong point and a major weakness, which, if remedied, can lead to an excellent paper. The very strong point is the experimental aspect. The method used to fabricate ice crystals

of several kinds and suspend them in air makes an excellent use of the outstanding facility of the University of Mainz. In general, the data appear quite reliable and instill confidence, even though, as detailed below, the description could be improved. However, the discussion and use of the data are disappointing and must definitely show more in-depth interpretation.

First of all, there is no real discussion in this paper. It looks more like a purely technical report than a true scientific paper. There is not even an individualized discussion section, just a couple of paragraphs at the end of the H2O2 results, and a quick comparison to previous data does not make a discussion. I am lead to wonder whether all authors, some of them pretty senior, actually read the paper. What I retain from this paper is that, in the conditions used, the retention of H2O2 is 64%, while in other conditions, it is 100% or 5%. The only explanations given for this discrepancy are of the kind "We think 100% is an overestimation" without the slightest justification. Now, if I am a cloud modeler and I want to use a value for H2O2 retention, what do I make of this paper? When do I use 100%, 64%, or 5%?

I truly think that this excellent experimental work must be complemented by an adequate theoretical interpretation. As such, the paper adds little to what we already know and its publication in ACP is probably not justified. I very strongly recommend either (1) that the authors develop a kinetic model of ice crystal growth that takes into account heat transfer aspects and the propagation of the solidification front, uses an effective incorporation coefficient at the ice/water interface, takes into account liquid phase diffusion and liquid/gas transfer, or (2) use an existing model to develop a theoretical basis to quantitatively interpret their data. All the pieces already exist in the literature for both options. For example, the model of Stuart and Jacobson (2004), which the authors cite, does a fine job at predicting species retention and I just do not understand why the authors did not use it to discuss their data. If they think that this model is not adequate, they should explain why and develop a better one. I recommend that the authors read the last sentence of S & J (2004) and say how their work fits into that sentence, which

I feel is a reasonable statement.

In conclusion, over the past decades, scientists have produced experimental data on retention during riming that yielded different values. There is now little sense in producing additional values without a thorough theroretical interpretation. If this is not done, then this paper will be just another one that reproduces existing data (for HCl and HNO3) and adds a tiny bit of novelty for H2O2, which has already been studied many times.

Minor comments

p. 17451, l. 5 ff. How about a schematic of the experimental apparatus? Or has that been published elsewhere? But please remember that a paper must be understandable without having to look up references.

p. 17451, l. 14. How do we know the droplets were in thermal equilibrium?

p. 17452, l. 17. of the order, rather than at the order.

p. 17544, l. 15. diameter, or length?

p. 17455, l. 19. 1997

p. 17455, last few lines. I am not sure I fully understand how the amount of reduction was determined.

p. 17456, l. 1, Mention R in text.

p. 17458, l. 7. Than, rather than as.

p. 17458, l. 21. Please give the error bars of I & P (1990), for a meaningful comparison.

p. 17459, l. 29. is R(HCl) really significantly different from R(HNO3)? Although it would fit the authors' idea nicely, I think all R values for these species are 1 within experimental error, and there does not appear to be an objective basis to say one is greater than the other.

p. 17459, l. 1 ff. So what determines the R value? The fact that a trace gas dissociates or that it has a high Henry's law constant? I think the reader will expect a stronger theoretical background here, and the integration of the new data presented here within this background.

p. 17460, l. 2. Why would this 100% value be an overestimation?

p. 17460, l.8. Why does the method of Snider and Huang underestimate retention?

p. 17460, l. 10. What were the specific conditions of Snider and Huang, and how did they influence the results and in which way? Note: This section really illustrates the weakness of this paper: other authors have found different values, but the reader is unable to select the most appropriate value for his/her problem. The authors hint that their results are better, and while this may be possible, they need to qualify that.

p. 17460, l. 23. All of a sudden, we learn that some rimed ice had a smoother surface, from which deductions are made here! Should not this be explained in the appropriate part of the results?

p. 17461, l. 16. Here we learn that under wet growth, retention should be lower. Sure, but some theory would nicely confirm/infirm this.

p. 17461, l. 20. What do you mean, inhibit?

Table 1 and 2. Do we expect the presence of H2SO4 to have an effect on the retention of acids, through an effect on their dissociation ?

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 17447, 2011.