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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Snow heterogeneous reactivity of bromide with ozone lost during snow metamorphism" *by* Jacinta Edebeli et al.

Anonymous Referee #3

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The manuscript reports on a small series of six experiments quantifying the ozone loss on bromide-doped artificial snow samples. The effect of subjecting the samples to temperature gradients for extended periods of time (days) is studied.

This is an interesting and important study possibly allowing conclusions on the availability of bromide and the processes at the ice-air interface in (aged) snow. It is, therefore, in principle relevant for understanding and modelling bromine release events observed in polar regions.

The manuscript contains important information relevant to the readers of ACP and should be published. However it contains a number of deficiencies and significant improvements are possible and should be made.

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Discussion paper

1) Frequently release of volatile bromine is mentioned, however the experiments really determine loss of ozone, this fact should be stated more explicitly.

2) The data given in some parts are incomplete and are given in different units, so reading the manuscript requires a pocket calculator. For instance on page 5, lines 125-131 the air flow through the samples is given in ml/minute, the ozone mixing ratio in ppb, while later (page 9) the number of ozone molecules per second is required. Although the manuscript mentions release of bromine 'in light and in the dark' one assumes that the experiments were performed in the dark, but this is not said in the manuscript. Volumes are sometimes given in ml, sometimes in cm3.

3) A table is missing, which summarizes the pertinent data of the experiments: Volume of the reaction chamber, flow rate, snow density, snow surface area, number of ozone molecules lost per second, etc..

4) Fig. 1: The figure summarizes all experimental findings of the manuscript, therefore it should be as informative and clear as possible. However, it is actually quite hard to read since most of the data are huddled in the lowest 20% or so of the plot. It would be helpful if the plot could be split in two, one ranging to 8E12 molec/s or even higher (what are actually the highest measured ozone loss rates?), one showing the data up to e.g. 3E12. Also additional lines indicating the ratio of losses at treated snow vs. losses at untreated snow could be helpful. What is the significance of the symbols (e.g. circles), do they just indicate the lines or are they measurement points?

5) The discussion of the assumed reaction system is unclear: Why should be only 0.5 ozone molecules consumed per bromine molecule (Br2)? Reaction equations 1 through 3 suggest that it is at least 2 ozone molecules. The disproportionation reaction (BrO2- + BrO- ?) is missing from the scheme. What is the meaning of 'assuming a net loss of 1 ozone molecule per bromide molecule'? And how is the number of 1E16 available bromide ions calculated?

6) The discussion of available bromide vs. observed ozone loss (page 9, lines 227 ff)

states that the latter is much smaller than the former. Actually one could say that the observed ozone loss is three orders of magnitude larger than the calculated bromide flux. But what is the conclusion from this calculation?

7) Table 1 gives the bromide content of the samples in ppbw, while in most of the remaining manuscript bromide is given in micro M. It would be helpful to include both numbers. Also, the SSA is given per gram, which is fine, but the total snow surface area would also be good to know (difficult to calculate since the snow density is not given).

8) The conclusion section basically states that there is experimental evidence that aged snow (subjected to a temperature gradient) may essentially not release volatile bromine. This is an interesting finding, but it appears difficult to draw quantitative conclusions from this result. The speculations about switching off other reaction pathways (page 13, lines 347 ff) do not appear to follow from the reported findings.

9) In fact it would be interesting to know how long it actually takes to remove the reactivity of doped snow towards ozone. From the data given here it only follows that the reactivity is large at age zero and essentially zero at age 12 days. It would be interesting to know how large the reactivity is after e.g. 1, 4, 8 days. Likewise it would be interesting whether bromine is actually released to the gas phase. This could be found out by determining the bromide contents of the snow after the experiment.

In summary, this is an interesting paper, but for the rather small amount of data it is way too long, and not many conclusions can be drawn yet. The presentation could be made more clear and easier to read (see above) and in a number of places the text could be considerably shortened.

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