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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The potential importance of frost flowers, recycling on snow, and open leads for Ozone Depletion Events" *by* M. Piot and R. von Glasow

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We want to thank all three reviewers for their thoughtful and thorough reading of our manuscript and for their comments. We are replying to these comments below and have included the comments for convenience. Our replies are preceeded by 'Reply:'.

*** Anonymous Referee - #2 ***

"In the description of the initial parameters of the model it is unclear to me as to the initial abundance, if any, of halogens in the snow pack".

Reply: The reviewer is right mentioning that the initial concentrations of halides in the snowpack are set to zero prior to the passage over Frost Flowers (FF). It is also right

that this configuration does not necessarily represent the typical composition of the snow in the Arctic. Nevertheless, it is possible to encounter a polar snow surface which contains negligigle amounts of halogen within this surface (e.g., multi-year sea ice). We intentionally avoided the presence of halides in the snowpack for the following reasons:

First, we intended to isolate the potential influence of only FF aerosols on ozone/bromine. Adding an additional source of halogens before the FF area would probably have an effect on the bromine explosion, depending on the strength of the source. However, this configuration would not allow a comprehensive understanding of the potential influence of the FFs only, on the ozone/bromine chemistry.

Second, the concentration of halides in snow varies drastically, depending on the meteorology, time, and geography. Adding some concentration of salt halides to the snow composition would simply mean another assumption, which we would rather avoid. As proposed by the reviewer this limitation in our runs has been noted in the model description.

"The dependence of reaction (14), and hence the release of gas phase bromine from ionic bromine, should probably be referenced to [Fickert et al.(1999)]."

Reply: [Fickert et al.(1999)] is cited for the release of gas phase bromine in the paragraph following Reaction (19), with a more general statement. We have now added it earlier in the text to better highlight this paper.

"However surface snow in the vicinity of frost flowers is sufficiently acidic to support reaction (14) suggesting acidification is rapid at high latitudes as well [Kalnajs and Avallone(2006)]. Section 3.4 would be strengthened by referencing observational evidence that supports your conclusion that bromine release and therefore ozone depletion events are not significantly affected by carbonate precipitation."

Reply: We have added the measurements made by [Kalnajs and Avallone(2006)] to the text (p. 4534, l. 20). In addition, a note has been added to mention the laboratory

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work from [Adams et al.(2002)] who found no significant influence of the pH on the release of reactive bromine from frozen halide-containing surfaces. The pH of snow is a very ill-defined property. What is measured, is the pH of melted snow, it does not give information as to whether this acidity is actually available for reactions important for the atmosphere.

“It may also be interesting to confirm that the modeled frost flowers are not acidified before release as aerosols, even with substantial carbonate precipitation”

Reply: We agree with the reviewer that a lot more experimental and modeling studies are needed. We will try to study this in future versions of MISTRA, coupled to a snow model.

“On a technical note, the figures included with the paper are difficult to understand, and in some cases not of a quality suitable for publication”

Reply: We agree with the reviewer and have improved the quality of the plots and have suppressed compression artefacts.

“The lack of legends on the individual plots makes comprehension difficult”

Reply: Legends are only missing for plots similar to Fig. 2k and 2l. We have added legends to these plots.

“Finally I question the need to have over 75 individual plots included in this paper”

Reply: The chemistry highlighted in this paper is complicated. We agree that it contains a large number of individual plots. However, we believe these plots are necessary to fully understand the text. Suppressing plots or moving them to a supplement to this paper would, in our opinion, only reduce the comprehension of the reader.

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