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Atmospheric Chemistry and Physics Discussions

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Interactive Comment

Interactive comment on "The NO_x dependence of bromine chemistry in the Arctic atmospheric boundary layer" *by* K. D. Custard et al.

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In this manuscript the authors present an analysis of gas-phase chemistry in the Arctic troposphere. The focus is on the impact of elevated NOx levels on bromine chemistry. They demonstrate using a simple 0-D model, constrained by ambient observations, that elevated NOx can lead to decreased BrO levels by tying Br and other radical species up in nitrogen-containing reservoir species. The study is well-designed and provides insight into Arctic atmospheric chemistry. I have a few technical questions or comments which should be addressed before publication.

- Snow chemistry may have a major impact on photochemistry in the Arctic (and specifically Br and NOx chemistry), but the representation of mass transfer to snow and snow

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chemistry is very simplified in the model used in this study. While many simplifications could be pointed out, for one thing, there appear to be no snowpack photolysis reactions, and these may have a significant impact on gas phase photochemistry. The authors should justify in the revised manuscript the use of such a simplified model and comment on the possible contributions of snowpack processes to discrepancies observed between modeled and measured data, e.g. Fig 5 and Fig 7.

âĂć As discussed on page 8 of the revision, and in response to Reviewers 1 and 2 above, constraining to observations for Cl2 and Br2 reflects the impact of snowpack photochemistry, reflected in these molecular halogen concentrations, and thus we are assured of accurately simulating the ensuing radical chemistry. However, that relevant snowpack chemistry and physics is not quantitatively understood well enough to enable accurate simulation of those processes and the upward fluxes.

- I agree with Reviewer 1 that the apparent lack of impact of NOx levels on the Br chain length demands more discussion.

âĂć This is now discussed on page 10 of the revision, in reference to the impact of NOx on HO2, HO2 being an important BrOx sink.

- Figure 7 is too small to be legible.

âĂć Each panel of Figure 7 is a separate Figure and can be appropriately sized for readability by the Journal. We will request this.

- Some explanation is needed for the values in Table S4. How have the authors arrived at the different aqueous rate constants? I assume "actual" means the measured aqueous reaction rate constant, but how are the different values for "particle" and "snow" obtained?

âĂć We have expanded the explanation for the numbers in Table S4 in the Table caption in the revision.

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Interactive comment on Atmos. Chem. Phys. Discuss., 15, 8329, 2015.

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