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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Horizontal and vertical structure of reactive bromine events probed by bromine monoxide MAX-DOAS spectroscopy" *by* William R. Simpson et al.

Anonymous Referee #1

Received and published: 3 April 2017

This paper presents data from 3 MAX-DOAS instruments deployed in 2012 as part of the BROMEX experiment. The paper comprises an important contribution to our knowledge of halogen activation and ozone depletion in the Arctic and should be accepted after some minor comments are addressed.

Minor comments:

Abstract, L32 – Please define more clearly sharp edge.

Figure 1 caption – Please define "cloud streets"

Figure 2 – This is the only figure that I cannot fully understand. In the 3rd panel, what are the flat red and blue lines? Were wind directions so consistent or is this

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an instrument problem? Were their wind direction measurements on the IL1 and IL2 buoys? This is not clear for me.

L312, Section 5.2 – This section is titled “Snowpack-Based BrO events. . .” Does this refer to snow on sea-ice based events?

L337 – It would be nice to reference some additional work on bromine activation, including studies on aerosols at warmer temperatures. There is some evidence that there are interfacial/dark reactions that are also important. Two examples include:

- Hunt, S. W., et al. "Formation of molecular bromine from the reaction of ozone with deliquesced NaBr aerosol: evidence for interface chemistry." The Journal of Physical Chemistry A 108.52 (2004): 11559-11572.

- Oum, K. W., M. J. Lakin, and B. J. Finlayson-Pitts. "Bromine activation in the troposphere by the dark reaction of O3 with seawater ice." Geophysical Research Letters 25.21 (1998): 3923-3926.

L376 – There is a relevant study on HOBr uptake that should be mentioned here:

Roberts, Tjarda J., et al. "Re-evaluating the reactive uptake of HOBr in the troposphere with implications for the marine boundary layer and volcanic plumes." Atmospheric Chemistry and Physics 14.20 (2014): 11185-11199.

L393 – Sentence that starts with “As discussed by. . .” Please consider rephrasing as this sentence reads a bit strange.

L423 – I have two comments on this paragraph.

1. Can’t other aerosols besides sea-salt also be formed/released from open leads? Is sea-salt the only potentially important aerosol surface that can be contributing here?

2. Aerosol extinction is lower at IL2 than the other sites. Can’t this just be a limitation of the ability of the MAX-DOAS to measure aerosols aloft (higher than 1.5 km or so)? Given that the lead results in increased mixing, is it really there are less aerosols or are

aerosols just diluted and mixed out of the region where they can be measured reliably?

L452 – What does it mean to “deepen the BrO”?

L458 – Please rephrase the sentence that begins “Thus, in-situ. . .” to be more specific

L461 – The paper from Yang et al. (2010) and Theys et al. (2011) show good agreement with satellite observations in the Antarctic, but the model/satellite measurement comparison is less good in the Arctic. In addition, the study from Jones et al. (2009) primarily focuses on the Antarctic. Therefore, I think it’s important to point out that the conclusion that “high winds” increase tropospheric BrO may be somewhat Antarctic specific. There may be different mechanisms that dominate in the Arctic because it’s in general less stormy and more stable. I would add a reference to Theys et al. (2011) here as well:

Theys, N., et al. "Global observations of tropospheric BrO columns using GOME-2 satellite data." Atmospheric Chemistry and Physics 11.4 (2011): 1791.

Conclusions – I find it necessary to add a paragraph on what this means for future model studies/developments. Some examples of past work to mention include:

- Toyota, K., et al. "Air–snowpack exchange of bromine, ozone and mercury in the springtime Arctic simulated by the 1-D model PHANTAS–Part 1: In-snow bromine activation and its impact on ozone." Atmospheric Chemistry and Physics 14.8 (2014): 4101-4133.

- Toyota, K., et al. "Analysis of reactive bromine production and ozone depletion in the Arctic boundary layer using 3-D simulations with GEM-AQ: inference from synoptic-scale patterns." Atmospheric Chemistry and Physics 11.8 (2011): 3949.

- Holmes, Christopher D., Daniel J. Jacob, and Xin Yang. "Global lifetime of elemental mercury against oxidation by atomic bromine in the free troposphere." Geophysical Research Letters 33.20 (2006).

L506 – Missing period at the end of the paragraph.

Figures 4-6 – Consider using a different color than green so that it's easier to distinguish the green and blue curves. The dots are a bit big to see small differences in the measurements.

Figures 7 & 8 – Consider combining into one large paneled figure so that the BrO and aerosol profiles can be viewed together.

Figure 7 – Please comment in the text on the lower panel Mar 23 – What do the measurements mean above the black region? Are these real aerosol measurements or is everything above the black portion unreliable?

Figure 9 – Please mark on figure the upwind and downwind measurements for ease of understanding.

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