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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Observations of Bromine Monoxide Transport In the Arctic Sustained on Aerosol Particles" *by* Peter K. Peterson et al.

Anonymous Referee #1

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This paper presents a detailed analysis of a bromine activation event that took place over Barrow in March 2012. This event was probed by BrO and supporting measurements at the surface (in situ and MAX-DOAS), from aircraft (MAX-DOAS), and from satellite. A spectacular finding is the observation of a BrO plume aloft at 0.5-1 km altitude, implying that BrO can be sustained through reservoir recycling reactions within the atmosphere presumably through aerosols. This is a major new finding not only for understanding elevated BrO in Arctic spring but also for explaining the BrO tropospheric background. This paper certainly deserves publication in ACP.

The paper can be published pretty much as is in my opinion (I do think the abstract needs some tweaking, see below). However, I found it a struggle to go through because of all the complicated plots of near-raw data forcing me through (I thought) unnecessary details. In my view, Figure 11 makes the paper. The authors might consider cutting

back on the figures or simplifying them. This is just a suggestion, however, because the authors might feel that the detail is necessary. Readers like me will be discouraged by the detail and go straight to the abstract, and that's OK.

I do think that the authors can (and should) broaden the impact of their paper by linking their results to background tropospheric BrO. As they know, there is a lot of current interest in understanding the ∼1ppt BrO observed in the troposphere with implications for ozone, OH, and Hg. Heterogeneous recycling in aerosols similar to the springtime Arctic (but at a slower pace) has been proposed to explain the sustained background tropospheric BrO levels but without direct evidence (Parrella et al., ACP 12, 6723-6740, 2012; Schmidt et al., JGR 121, 11819-11835, 2016; sorry to be pushing my own literature). The present paper offer strong support for this heterogeneous recycling. It would be a neat way to connect the Arctic spring chemistry to the global picture. Brief statements in the Abstract, intro, and conclusions is all that would take.

Specific comments: (page, line) 1. Abstract, line 9: "disconnected from the surface" is vague, I would point out that the plume is at 0.5-1 km altitude.

2. Abstract, lines 10-11: I don't think that the authors can claim as fact that the recycling took place on the co-located supermicron aerosol particles. They can claim evidence that it did. It's too bad that the aircraft didn't carry in situ instrumentation that would provide more correlative information including BrO reservoirs and ozone as well as aerosols. Maybe for the next campaign?

3. Abstract, line 12: "increases the spatial extent of bromine chemistry" This is vague. We already know that BrO events extend for great distances horizontally. Maybe the authors mean vertical extent? That would definitely be an appropriate statement.

4. Abstract, line 14: "...must be considered in the interpretation of satellite observations..." Vague, how is that? I didn't see reference to this in the text.

5. Page 7, line 7: give the source of the tropospheric BrO satellite data (a website can

be a useful reference). How was the stratosphere removed?

6. Page 11: a spectacular observation from this paper is that BrO is “killed” by ozone depletion at the surface but apparently not at 0.5-1 km. This led me to search through the paper for any indication of ozone data aloft but I didn’t find any. Presumably there were no ozone measurements from the aircraft? That would be worth stating. No ozonesondes? Does the general ozonesonde climatology in the Arctic have information on the vertical structure of ozone depletion in the lowest 2 km?

7. As an example of making figures more user-friendly, it would help if the LT-VCD data and the fraction below 200 m were expressed in units of ppb BrO. More generally, anything you can do to cut back on the number of figures (or panels within figures) or simplify them would (I think) be appreciated by the reader.

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