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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 #2

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[Summary]

In this study, Peterson et al. analyzed the spatial and temporal evolution of gaseous reactive bromine species (especially BrO) around Utqiagvik (Barrow) measured from a suite of platforms between March 11 and 13 in 2012 during the BROMEX campaign.

Three MAX-DOAS instruments deployed at the ground/sea levels, one on the land (BARC site) and the other two on the sea ice to the west and east of the BARC site, provided the continuous time series of vertical column densities in the lowest 200 m (VCD200) and lower tropospheric vertical column densities (LT-VCDs) for BrO during the daytime. GOME-2 satellite retrievals provided pan-Arctic distributions of BrO LT-VCDs once per day and, because of swath overlaps, a few times per day over the small area of interest in this study around Utqiagvik. Airborne DOAS measurements

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on March 13 gave aerial surveys for a few hours along (and beyond) the line of the three MAX-DOAS surface deployments, probing much finer horizontal structures of the BrO LT-VCDs than can be seen from GOME-2 by nadir view during the cruise flight as well as the vertical profiles of BrO and aerosol extinction during the ascent and decent of the aircraft by limb view. The aircraft also measured the size resolved aerosol number concentrations in-situ, complementing the vertical aerosol extinction profiles retrieved by DOAS. Also used for the present analysis are the ground based measurements of Br2, BrO and HOBr by CIMS at a location several kilometers inland from Utqiagvik, surface ozone and wind measurements at the NOAA/GMD site and once-per-day meteorological soundings from Barrow Airport. Supplemented by the ASAR sea ice imagery and backward trajectories, the authors documented, at the "unprecedented" spatial resolution, three-dimensional structures and their time evolutions of air masses enriched in reactive bromine presumably released from the surface snowpack including the synoptic-scale lofting of reactive bromine to the height detached from the surface.

This case study is an important contribution to the field and hence I support its publication subject to minor revisions.

[Specific comments]

1. Section 3.1: I am not too impressed to the presentation order of Figure 4-7. The story telling in Section 3.1 begins with referral to Figures 5 and 7, followed by Figures 7 and 6 and then Figure 4. I felt uneasy while flipping pages back and forth many times until I understood the basic story. I suggest the authors to reorganize either the figure presentation order or the sentence order in Section 3.1 if at all possible.

2. Section 3.2, second paragraph: The description of the atmospheric stability on March 11 and 12 and its link to the mixing of BrO could be more specific. From the vertical gradient of potential temperatures, I can see that the lowest 200 meters of air was well mixed on March 11 and the lowest 300 meters on March 12. On March 11,

however, there was a second layer between 300 and 800 meters where the air appears to have been mixed relatively well. If the authors believe that this second layer carried a significant amount of surface-sourced reactive bromine, they should say so explicitly.

3. Section 3.3: You can make more sense of the vertical profile of BrO mixing ratios during the aircraft takeoff shown in Figure 11 by integrating over 0-2km altitudes and then comparing with the values of BrO LT-VCDs shown in Figure 9.

4. Section 3.4: It is not always clear to me what the authors mean by “heterogeneous recycling”, especially when they refer to the Hara et al. (2002) study at the end of the second paragraph. I normally use the term “recycling” when referring to conversion of gaseous halogen species into a more photolabile one, e.g., HOBr + HBr -> Br2 + H2O. If you refer to the reaction HOBr + Br- + H+ -> Br2 + H2O where the bromide anion is directly provided from sea salt, I would call it a “bromine explosion”. I would like the authors to state this difference a little more clearly in Section 3.4. The abundance of the super-micron aerosols measured in-situ at 700-1000 meters aloft (Fig. 11) does seem to imply these particles are relatively “fresh” having been emitted either from open leads or snow-covered surfaces, even though I understand the reservations by the authors as discussed in detail.

[Technical suggestions]

P2, L13 & L16: “e.g” -> “e.g.”

P2, L28-29: Add a comma between “that” and “during”.

P4, L12: “Sihler et al. (2012)” -> “(Sihler et al., 2012)”

P10, Figure 8 caption: Add the arrival date (March 13th) and time (either in UT or AKST) of the trajectories over Utqiagvik. Also, add the height (750 m) of central trajectory arrival.

P10, L19: “daily soundings” -> “daily meteorological soundings”

P12, Figure 10b (x-axis title): “West Wind” -> “Westward Wind”

P12, L17: “Fig. 11” -> “Fig. 11a”

P12, L17: “show” -> “shows”

P12, L18: “Fig. 11” -> “Fig. 11b”

P12, L21: “Fig. 11” -> “Fig. 11c”

P13, Figure 11: Change the x-axis title “BrO Molar Ratio” -> “BrO Mixing Ratio”.

P13, L12: “an initial” -> “a primary”

P13, L14: Remove the comma after “particles”.

P15, the top line: “or” -> “and”

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