

## ***Interactive comment on “OMI total bromine monoxide (OMBRO) data product: Algorithm, retrieval and measurement comparisons” by Raid M. Suleiman et al.***

**Raid M. Suleiman et al.**

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We thank referee's helpful and constructive comments and review. Our responses are in **bold** starting with “**Response:**”

**Figures have been moved around:  
Old manuscript Updated manuscript  
Figure 1 still Figure 1  
Figure 2 still Figure 2  
Figure 3 still Figure 3  
Figure 4 moved now Figure 10**

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**Figure 5 moved now Figure 4  
Figure 6 moved now Figure 5  
Figure 7 moved now Figure 6  
Figure 8 moved now Figure 7  
Figure 9 moved now Figure 8  
Figure 10 moved now Figure 9  
Figure 11 still Figure 11**

**Please note: all mention of figure 's below corresponds to the updated numbering in the updated manuscript.**

**Please note that many figures have been changed based on another referee's suggestions.**

- Figure 1 plotted as a function of optical thickness**
- Figure 4 was redone without averaging OMI BrO data and a new orthogonal regression was performed (Figure 5)**
- Section 3.6 was moved to 4.4**
- Figure 9. We increased the covered area, used a full-color scale, and added the lake line.**
- Added another panel to Figure 9 to show BrO over the Dead Sea Valley for September 2007.**
- Figure 10 was extended to cover the full wavelength window**

Anonymous Referee 2 General Comments The manuscript gives an overview of the retrieval of BrO VCDs from OMI observations in the OMBRO data product. They then present a comparison of the retrieved VCDs to GOME-2 and ground-based observations at Harestua, Norway, showing general agreement with other BrO observations. Case studies of salt lake observations and volcanic eruptions are also presented, and uncertainties arising from the choice of SO<sub>2</sub> cross section are discussed. The

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topic is appropriate for AMT and the broader community would likely benefit from this publication. However, the presentation of the figures is quite sloppy and some aspects of the main text should be improved prior to publication. Specific comments are provided below to assist in this process.

**Specific Comments**

**Introduction Referencing**

I find the choice of references throughout the introduction a bit odd and in some cases not appropriate.

Page 2, line 6: The knowledge of BrO in the polar troposphere predates both those references by a pretty fair margin. I'd suggest citing some of the earlier observations (e.g. Hausmann and Platt, 1994) or review papers on the topic (e.g. Simpson et al., 2007; Abbatt et al., 2012).

**Response:**

**Added the suggested references.**

Page 2, line 7: Hebestreit et al. (1999) should really be cited here. Response: Added "Hebestreit, et al., 1999"

Page 2, Line 15: Again, this is a widely studied phenomenon that there are more appropriate references for. See suggested citations in my first comment.

**Response:**

**More references were added.**

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**(Hausmann and Platt, 1994; von Glasow et al., 2004; Salawitch et al., 2005; Simpson et al., 2007; Salawitch et al., 2010; Abbatt, et al., 2012).**

Page 2, Line 24: If this list is intended to be comprehensive, one should include observations at Alert (e.g. Zhao et al., 2015), Summit, Greenland (Stutz et al., 2011), and throughout the Arctic Ocean (e.g. Burd et al., 2017).

**Response:**

**Added the suggested references.**

**The manuscript changed to: and Barrow, Alaska (Liao et al., 2012a,b; Frieß et al., 2011; Sihler et al., 2012; Peterson et al., 2016), Eureka, Canada (Zhao et al., 2015), Summit, Greenland (Stutz et al., 2011) and the Arctic Ocean (Burd et al., 2017).**

Page 2, line 26: While many papers have been published on BrO observations at Barrow, Simpson et al. (2005), detailing studies of snowpack chemical composition, is not one of them. Please find a more appropriate reference for this location.

**Response:**

**Removed Simpson et al. (2005) and added two appropriate references. The new text "and Barrow, Alaska (Frieß et al., 2011; Liao et al., 2012a,b; Sihler et al., 2012; Peterson et al., 2016),"**

Page 5, Line 8

Remove XtrackQualityFlags and other references to specific data field names throughout the manuscript. In a manuscript it makes more sense to say information is there without referring to a specific field in the data product.

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**Response:**  
**Removed XtrackQualityFlags**

Page 7, Line 16  
Specify that the cross sections used can also be found in Table 1

**Response:**  
**Modified the sentence to be “The operational parameters and the cross sections used are provided in Table 1.”**

Section 3.6 and 4.4  
In my view, the discussion in section 3.6 fits better integrated into section 4.4 since it discusses an application of the data product, not the algorithm itself. Since measurements of halogens in volcanic plumes is a potential use of these data, I think a specific recommendation here would be helpful rather than just advising caution. Would it be an appropriate use of these data to examine BrO production in volcanic plumes?

**Response:**  
**Section 3.6 has been moved and incorporated into section 4.4.**

Page 11, line 21  
Since you are comparing 2 sets of satellite observations, orthogonal distance regression would be more appropriate than linear regression here. Linear regression assumes the uncertainty in the GOME2 VCD is much less than that of the OMI VCD, which isn't a valid assumption in this context.

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**Response:**  
**We corrected Figure 5 using orthogonal distance regression.**

Page 12, line 17  
Some context for this correlation would be helpful. How does this correlation compare with other ground-based vs satellite comparisons (e.g. Sihler et al., 2012)?

**Response:**  
**Added to the manuscript:**  
**Sihler et al. (2012) compared GOME-2 BrO to ground-based observations at Barrow finding the correlation to be weaker ( $r = 0.3$ ), likely due to both elevated and shallow surface layers of BrO. However, their correlation between GOME-2 BrO and ground-based measurements at Amundsen, U.S. ( $r = 0.4$ ) is closer to our correlation here.**

Page 13, line 28  
Provide a reminder of what background values are here.

**Response:**  
**In the manuscript we replaced:**  
**BrO enhancement of  $5\text{-}10 \times 10^{12}$  molecules  $\text{cm}^{-2}$  over background values is clearly shown right over this salt lake.**  
**with:**  
**Over the Great Salt Lake, BrO enhancement occurs predominantly over the lake bed with enhancements of  $5\text{-}10 \times 10^{12}$  molecules  $\text{cm}^{-2}$  over background values ( $4\text{-}4.7 \times 10^{13}$  molecules  $\text{cm}^{-2}$ ).**  
**Please note that we have included discussion and a plot of BrO enhancement**

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over the Dead Sea Valley from 09/2007.

Suggested Figure Corrections

I'm aware some of these suggestions may seem pedantic, but I found the figure presentation really distracting. The suggested modifications would go a long way toward improving the quality of the manuscript.

Figure 4: Fix y axis label BRO→BrO. Add reference to Operational SO<sub>2</sub> and BrO cross section, remove 1st SO<sub>2</sub> from Vandaele cross section label. For the sake of consistency, the convoluted Vandaele cross section be shown here rather than the raw laboratory cross section.

Added to the end of Figure 10 caption:

Cross sections have been convolved with OMI slit function (which is assumed to be a Gaussian with 0.42nm full width at half maximum). **Response:**

**Old Figure 4 (now Figure 10) was updated to include the entire fitting window, the references for the cross sections. Additionally, the updated Figure 10 now shows the cross sections after they have been convolved with OMI slit function (which is assumed to be a Gaussian with 0.42nm).**

Added to the end of Figure 10 caption:

Cross sections have been convolved with OMI slit function (which is assumed to be a Gaussian with 0.42nm full width at half maximum).

Figure 5: Plot against the actual date and explain the large gap in OMI data in the middle of the plot.

C7

**Response:**

We updated old Figure 5 (now Figure 4) so the x-axis is now the actual date. The gap in OMI data is due to the filtering of retrievals with bad quality flags. We also did not average OMI data anymore by using individual OMI pixels and we relaxed the quality flag selection which eliminated the gap.

Figure 6, 8: These plots are really hard to read. Please consider an alternate font.

**Response:**

Figure 5 and 7 have been updated to use orthogonal regression and used a more suitable font.

Changed caption of Figure 5:

Correlation and orthogonal regression of OMI and GOME-2 BrO for the data in Fig. 4 when both data are available. The legends show the mean biases and standard deviations of the differences, correlation, and the orthogonal regression.

Changed the caption of Figure 7:

Correlation and orthogonal regression of OMI and Harestua BrO for the data in Fig. 6. The legends show the mean biases and standard deviations of the differences, correlation, and the orthogonal regression.

Figure 7: Since you are only comparing the total BrO VCD in this work, showing just the time series of the total VCD from Harestua would be more useful than showing three different timeseries from Harestua. You don't really discuss the other two time series in any meaningful way in the text. Axis labels should also be added.

**Response:**

Figure 6 have been updated to include total BrO only at Harestua. We also added the axis labels.

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**Figure 10:** This should be shown in tandem with a zoomed out map so the reader can orient themselves on the globe and also to show the magnitude of the enhancement relative to the background. The color scale as it currently stands spans a much larger range than that of the data, making it unusable. The map underneath the data is also barely legible.

**Response:**

Updated Figure 9 as suggested and added another panel to show BrO over the Dead Sea Valley.

**Technical Corrections**

Page 1, Line 27 Change "US Great Salt Lake" to the U.S. Great Salt Lake to be consistent with the rest of the manuscript.

**Response:**

Changed US to U.S.

Page 3, Line 17 30 pixels?

**Response:**

Added the word "pixels" after 30

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-1, 2018.