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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Spatial distribution of enhanced BrO and its relation to meteorological parameters in Arctic and Antarctic sea ice regions" *by* Sora Seo et al.

Anonymous Referee #3

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General comments:

The manuscript by Seo et al. presents an interesting statistical research work using long-term satellite-based BrO column measurements. The analysis process is comprehensive. The findings, especially the wind-direction based analysis, in this work are important for the atmospheric bromine research community. The only major concern I have is why the author did not use tropospheric BrO column products. I am sure with such valuable 10-yrs observations, the author can provide more important and meaningful results to the research community, if both total and tropospheric BrO columns are used. Otherwise, the manuscript is well written and should be published

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Discussion paper

after addressing the following comments.

Specific comments:

P5 L158: I think the author wants to say all BrO DSCDs (or from which ones?) are fitted by a Gaussian function, and the mode of the function is used in the correction. Anyway, the sentence is not very clear. Please revise it.

P8 L236-237: No information about cloud filtering are provided. BrO enhancement/hotspots induced by large scale low-pressure systems (e.g., the case in Blechschmidt et al., 2016) may accompany with large cloud covers and even precipitations (e.g., Zhao et al., 2017). How these cloudy pixels were treated? What are their impacts (to sensitivities of stratospheric and tropospheric BrO)? I understand some cloudy pixels should be kept for the purpose of this study. But, can you provide statistical analysis with/without cloudy pixels (e.g., with any threshold like cloud fraction < 0.3 or any reasonable one)?

P8 L240-242. It is a very interesting and important figure (Fig. 2). It shows the Canadian archipelagoes are the BrO swamp. But, I am not sure it is misleading or not. I think the author only used the pixels over the sea with sea ice fraction > 5 % (Section 3.1). So, is this selection make any impact over Canadian archipelagoes (i.e., where the land-sea ratio was determined by what?)? Anyway, from Fig. 2, I think this is the region that has larger land to sea ratio, compare to all other studied regions. Please provide more comments and explanations for this important result.

P10 L301-306: The positive surface temperature anomalies coincident within the regions that have low-pressure anomalies. I don't think it is a surprise, but a good indication that these analyses are strongly correlated (warmer surface temperature in the low-pressure system). The factors analyzed in this work (e.g., temperature, wind

speed, and tropopause) are not truly independent in contributing to the enhanced total column BrO. Without separation of the source of bromine enhancement, i.e., enhancement due to dynamic process (low tropopause, more stratospheric bromine) or chemical process (surface bromine explosion) or both, the results presented here are a bit vague and complex. The mechanism of enhanced BrO columns discussed in this and the previous section (Sects. 4.2.1 and 4.2.2) are mostly for surface bromine enhancement (except low tropopause). So, why not performing all the above analyses with satellite tropospheric BrO data? To me, this will provides more insights from this valuable 10-yrs satellite observations.

P10 L294-299: Comparing to the frequency distribution of pressure (i.e., Fig. 3), the results (Fig. 6) here show a significant difference between Arctic and Antarctic. Can the author provide some comments on why we observed such differences? Is this indicate some major differences in the driven factors in total BrO at these two regions? Anyway, similar to my previous comments, the Canadian archipelagos have unique conditions in these analyses (i.e., larger land-sea ratio, thus colder than pure sea ice region in general). With/without this region may affect the frequency distributions.

P10 L317: Well, I thought the community already found the base assumptions supporting frost flower as the direct-source of bromine explosion is over (Abbatt et al., 2012). The surface area of the frost flower is not as large as expected (e.g., Obbard et al., 2009; Roscoe et al., 2011). There are still some hypotheses that frost flower could play some indirect roles in bromine explosion, but please do not say frost flower is a "primary source of bromine explosion events". Otherwise, this will be misleading, and an overlook of all previous research works.

P11 L334-335: I cannot agree with this. The wind speed anomalies in the Canadian archipelagoes are weaker than the other regions mention by the author (e.g., the eastern coast of Greenland). In fact, the wind speed in the Canadian archipelagoes

is lower compare to most of other regions. This is topography determined. The conclusion here is not valid (enhancement of BrO columns related to positive wind anomalies), unless one excludes the Canadian archipelagoes in the frequency analysis (which I would suggest to). Also, even for the high wind regions (the eastern coast of Greenland or centre Arctic sea), I did not see the high frequency of BrO enhancement in Fig. 2. The cause of this might be the high surface wind (10 m wind) is only one of the driven factors for blowing snow induced surface BrO enhancement. But, the author had a discussion of total column frequency (not tropospheric column), which has other major driven factors should be considered. Anyway, perfect separation of all these strongly correlated factors is not possible. But, at least, one can separate the stratospheric signal.

P11-12 L355-363: Fig. 12 is the high wind speeds frequency, which shows that we have more high wind conditions at locations such as Greenland or centre Arctic sea. I agree with this. But, how this can prove high wind speed frequency is consistent with a high frequency of BrO enhancement? I am very confused about this paragraph. For example, if we compare Figs. 2 and 12, we can easily find the eastern coast of Greenland has a low frequency in BrO enhancement but a high frequency in high wind speed. Same for the Canadian archipelagoes, where the high wind is less common but has a very high chance of enhanced BrO columns. I am not challenging the blowing snow scheme, but one should be clear that the transported bromine explosion events may have a different spatial distribution pattern compare to stable shallow boundary layer events. In other words, shallow ones are confined at local, which one might find easy correlation as “low-wind and high BrO” in one place. But, the transported events may be originated or triggered in this 12 m/s wind speed conditions, but transported in relative mild condition (e.g., $<$ 6 m/s). Anyway, the analysis done in the next paragraphs is decent and important (L364-416). Wind speed analysis should be done together with wind direction.

P14 L445-447: Since the Canadian archipelago usually has low tropopause, then how this contribute to the BrO hotspot frequency map (i.e., Fig. 2)?
P16 L503-504: As the author already found out, use only wind speed is not sufficient (need to include wind-direction at least). Do you have correlation analysis for different wind directions too? Do we have a better (higher) correlation when we have preferred wind-directions?

P 18: L562-566: These are significant factors that should be addressed before the analysis. I fully understand the limits and difficulties in performing this large scale study (both time and spatial). The paper is well written and meaningful. But, I would suggest the author provide these limits before the beginning of the analysis. The author can inform the reader why the stratospheric correction is not applied (i.e., why not using BrO tropospheric columns).

Technical corrections:

P5 L139: Use proper multiple signs in here and thereafter, not letter "x".

P5 L160: Define DSCD.

P28. Fig 1: Use consistent y limits for all four panels (e.g., 1e5). The current selections for each panel are a bit arbitrary.

Figs. 2 and 4: The 0-degree Longitude sign and the 70-degree Latitude sign are jammed.

P13 L421: Please provide the definition of DU (Dobson unit).

P20 L 627: Capitalize each word; change "Geophysical research letters" to "Geophys-

ical Research Letters."

P23 L736: Remove "n/a-n/a".

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