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Atmospheric Chemistry and Physics Discussions

Interactive comment on "An exemplary case of a bromine explosion event linked to cyclone development in the Arctic" *by* A.-M. Blechschmidt et al.

Anonymous Referee #2

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Blechschmidt et al. analyze an enhanced tropospheric BrO plume (also known as "bromine explosion", or "BrO explosion") coincided with a polar cyclone during Mar 31-Apr 3 2011 in the Arctic by utilizing a comprehensive set of meteorological data from a mesoscale model WRF and various satellite observations. They investigate the observed BrO explosion event over the course of frontal activities in the associated low pressure system, as well as examine the possible effects of first-year sea ice and blowing snow as inorganic bromine sources. The important conclusions of this study include (1) the frontal high wind speeds and BrO uplifts at the onset and mature stages of BrO explosion inferred from WRF simulations, (2) possible contributions of first-year

sea ice and blowing snow as sources of inorganic bromine supported by SMOS and MODIS measurements, and (3) the suggested BrO injection heights of 0-3 km from FLEXPART simulations while ruling out the stratospheric origin from GOME-2 total ozone, MODIS cloud, and WRF tropopause height images.

This is a meaningful study for it is the first attempt to analyze a BrO explosion event in context of the frontal activities of a polar cyclone, as well as it utilizes an unprecedentedly comprehensive set of meteorological data. While it was widely reported that BrO explosion events accompanied with polar cyclones, no single study has utilized all the data sets used in this study so far; only parts of data sets used in this study have been utilized in previous studies. Moreover, interpretations of the various data sets nicely converge to its main idea, the BrO explosion of tropospheric origin contributed by frontal activities, the first-year sea ice, and blowing snow throughout the progress of a polar cyclone.

Overall, this study makes a high quality analysis and I recommend publications of this article in ACP provided that the following concerns are addressed.

1) In the manuscript, the authors use the term "bromine explosion" to indicate the observed event of the enhanced BrO plume. However, "bromine" in this context can be bromine species other than BrO, including Br, Br2, HOBr, and BrCl. Since we do not have the capability to observe these species over a wide spatial range, the extent of other bromine species is just unknown. I would like to ask the authors to justify their calling the enhanced BrO plume as "bromine explosion", or specify the term for the observed BrO plume other than "bromine explosion". Otherwise, it may give an impression that BrO would be the only species involved in "bromine explosion" to readers.

2) p24962 l21: please include Vasilkov et al. (2009) regarding the reduced cloud shielding over bright surfaces.

Vasilkov, A. P., Joiner, J., Haffner, D., Bhartia, P. K., and Spurr, R. J. D.: What do satellite

backscatter ultraviolet and visible spectrometers see over snow and ice? A study of clouds and ozone using the A-train, Atmos. Meas. Tech., 3, 619-629, doi:10.5194/amt-3-619-2010, 2010.

3) p24969 l5: The suggested correlation between the BrO plume and the low temperature at 350 gpm in 1-2 April 2011 is not apparent to me, in the second and third rows of Fig. 3(a) and Fig. 4(d). For example, tropospheric BrO column in April 1 looks like a comma in normal orientation while the temperature at 350 gpm looks like a comma turned 90 degree clockwisely. Can the correlation be revealed by modifying the color scale? Or does it mean correlation in terms of broad locations?

4) p24971 l16: 3 km is the suggested maximum height of vertical injection. What is the planetary boundary layer height from the WRF model for this case? I guess it would be lower than 3 km.

5) p24972 l18-20: “The higher elevation runs do not show a comma shaped plume and simulated tropospheric VCDs are on the order of observed ones.” I think this is not only unnecessary, but may be also confusing since the authors already ruled out the higher elevation of BrO scenarios in the previous paragraph.

6) p24972 l21-24: "Overall, the simulations from FS1 for the dissolving stage of the BCTE show that other emission sources as the ones included in FS1 ... after the evening of 1 April.” I think the observed BrO column shapes may reflect the continuous change of the BrO source locations (frontal areas) over the course of the polar cyclone, while the source of the FS1 simulation is fixed as the BrO plume of 00 UTC of April 1.

7) p24975 l1-4: “Results presented in this paper ... fronts with polar cyclones are favorable not only for development of BEEs, but also sustain high values of tropospheric BrO, thereby extending plume lifetime substantially.” I personally do not think extension of BrO lifetime by fronts is the only explanation of behaviors of the observed BrO plume. It might be reflecting the continuous BrO release from frontal regions that lasted 2-3 days over the course of the low pressure system.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 24955, 2015.