

Interactive comment on “Long-term Time-series of Arctic Tropospheric BrO derived from UV-VIS Satellite Remote Sensing and its Relation to First Year Sea Ice” by Ilias Bougoudis et al.

Anonymous Referee #2

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Review of ‘Long-term Time-series of Arctic Tropospheric BrO derived from UV-VIS Satellite Remote Sensing and its Relation to First Year Sea Ice’ Bougoudis et al.,

The paper is well written overall. However, there lacks clear take home messages, i.e. how does this work significantly advance our knowledge. I would like to come away with more than the relationship is ‘complex’. I would like quantification of the first year sea-ice extent and Arctic amplification on BrO explosion events as these have been nicely explored in this paper, but the clarity of conclusions drawn reduces the potential significance and usefulness of this work. Below I detail edits throughout the paper with my major concern being around the significance of this work, and how it could be used

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to advance model, observation comparisons going forward, so that predictions of the implications for the oxidative capacity of the Arctic (and therefore also the Antarctic) can be explored in climate simulations.

Page 1, line 12: Sentence needs revising: Every polar spring BrO explosions occur, which are a series of chemical reactions that release bromine molecules to the troposphere over sea ice covered regions.

Page 1, line 16 Name the four satellite experiments

Page 1, line 20 and elsewhere: 1.5% per year – since there is a focus in the abstract on Arctic Amplification – could this response be expressed also per degree of warming experienced?

Page 1, line 22 Specify how linked (stating that it is complex is very general)

Page 1, line 24 Arctic temperature please qualify as surface air or sea-surface temperature?

Page 2, line 6 here and elsewhere please remove hyphen in ecosystem

Page 2, line 11 1990 and 1997 don’t represent 3 decades worth of studies, a 2010s review paper reference more appropriate here

Page 2, line 14 insert but ... OH are reduced, but the reactions of...

Page 2, line 17 the “Bromine explosion” closing speech mark needs format correction

Page 2, line 20 citing a 2009 paper when discussing controversy is problematic, as modelling efforts recently have integrated simple and effective parameterisations, based on both frost flower and blowing snow mechanisms i.e. (Falk & Sinnhuber, 2018) or some other more recent reference would be appropriate here to discuss exactly what controversy still exists.

R1 – hv should be $h\nu$ the should be defined in the text)

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Page 3 line 7 bromine atoms rapidly remove (switch from remove rapidly)
Page 3 line 20 it's = its
Page 3, line 23 favor bromine explosion conditions. Again, there is more recent (and quantitative) modelling efforts.
Page 3, line 17 remove second comma
Page 5, line 16
Page 5, line 23 on – was the data from Metop-C useable in theory, if so why wasn't it used in your study?
Table 1 in GOME-2A line 40 x 40 (remove capitalisation from X)
Page 6, line 9 and elsewhere – Sun should be capitalised throughout
Page 9, line 5 insert comma: autumn, when the solar...
Page 11, line 2 (whole paragraph needs reworking): For the NO₂ and O₃ column satellite retrievals, the tropopause height ... is used....
Page 11 Line 4: reflectivity, which is required...
Page 13, line 11 change the degree sign from a zero to a circle
Figure 5 – please show 1 sigma errors in the VCD retrievals as well as interannual variability with error bars on these plots in order for us to be able to determine agreement significance.
Section 4.2, by selecting only for high BrO over sea-ice areas you are only capturing the genesis and not necessarily determining the implications of the combined oxidative capacity and changes in cyclonic activity. Much of the interesting implications of warming and BrO will happen outside of areas which are over sea-ice. I'm unclear why the only BrO over sea-ice was a necessary criteria?

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Figure 9 – please try to get onto one page, use horizontal colorbars perhaps?

Page 22, line 16. And Figure 11 Stating that the relationship between sea-ice area and BrO explosion is complex is unsubstantiated by a useful plot. I would like to see the first year sea-ice area versus average BrO column plot (or BrO explosion area). Figure 11d goes some of the way to providing this but I suggest that an annual number be provided i.e. those produced in 11 a and b (with variability range errorbars for both axes) could be more useful than using every data point above the threshold as is done currently. Figure 11d trend line is arbitrary and should be removed (unless the annual number provides support for a linear relationship). Some metric representation of annual cyclonic activity or amplification amplitude would be valuable too on this plot – i.e. providing an annual cyclonic index in color and some index for Arctic amplification temperature with size may help to disentangle the story for us. This way we would be able to determine whether a parameterization that would be useful to test models could be derived for this 'complex' relationship.

Page 25, line 4 VD -> VCD

Figure 11 a-d labels missing

Page 27, figure 12. How can trends over 1 year be considered significant or reliable with only a few points? I assume the annual cycle is removed for this plot (otherwise like a sine curve, you would get a trend just due to that). I'm really unclear about what figure 12 is showing, given it only is discussed briefly and doesn't add to the papers aims/conclusions. As the minimum time to detect a trend is not provided, I think this plot and the discussion can be removed.

Figure 13, over what time period is the trend calculated? Provide this in the caption.

Page 29 line 5 the BrO explosion -> Bro explosion events.

Page 29 when discussing trends state over what period they are determined.

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