

Author's response to Anonymous Referee #1 (2025-08-09)

Thank you for your comments helping to improve the overall presentation of our research results. We will address the points in our revised manuscript as follows:

Line 67: there is an “e.g.” that isn’t followed by anything.

Has been removed

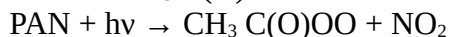
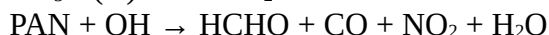
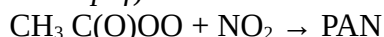
Line 104: In the supplement files I downloaded, I did not see anything labelled “Supplement B”.

“Supplement B” refers to the file `switch.nml` in Supplement A. This FORTRAN namelist file contains a list of all EMAC submodels. A boolean value (TRUE/FALSE) therein indicates whether they were used in our experiments. We will adapt the sentence accordingly:

→ *For a complete list of submodels used in this study, please consult the file `switch.nml` in Supplement A (`EMAC_namelists.zip`). The boolean values therein indicate whether the submodels were used.*

Fig 1 and Section 2.1: Peroxyacetyl nitrate (PAN) is a source of NO_x in the Arctic from long-range transport -- Does your model contain PAN and its decomposition to NO_x?

The following PAN reactions are included in our chemical mechanism – see Supplement A (*mecchanism.pdf*) for the full list of reactions including MPAN (methacryloyl peroxyxynitrite).



Line 239-241 and 243-245: To support the text comparing modelled and satellite-measured BrO, can you please either add the TROPOMI VCD of BrO to Figure 6 so that we can see how it compares side by side? Or at the least, you should reference Fig 3(b) in the text here, so that the reader is pointed to where to look to compare.

We refer to Fig. 3(b) in the text, because Fig. 6 is already quite busy.

Line 261: showed a better what?

The word *agreement* seemingly has disappeared during the final manuscript editing before submission. We add it accordingly.

Fig 6: text font is too small in the panels.

We adapted the font size for better readability.

Sec 4, first paragraph: Section 4.3 is referenced before Section 4.2. Text should be re-ordered to the flow of the paper.

We have reordered the sentence.

Line 268-269: This sentence seems very similar to that at line 260-261. Does it really need repeating here?

We have removed the repetition in line 268-269.

Line 280: Should “In 2000,” be “In 2020,” here?

Indeed. This is a typo and has been corrected.

Line 286: “raging within the Arctic cycle in 1919” should that be Arctic *circle*?

Indeed, another typo. It has been corrected.

Fig 7 and Fig B1: “The periods March–May are highlighted in linen” & linen is the light yellow colour? As ‘linen’ isn’t typically a word used for a colour (in my experience), maybe better to say ‘light yellow’ here.

Thank you for pointing this out. We changed the name accordingly.

Line 294-297: As you mention 2007 as the transition period, how come you chose 2000 as the cut off for the before and after time periods? Wouldn’t the results after 2000 still have the pre-2007 conditions included in the average?

Thank you for pointing this out!

We had chose the cut off after 2000 to make the two subsets for all stations as equal in terms of size as possible for statistical reasons. The relatively short data set from Alert is very susceptible to a cut off around 2007±1 as only a couple of years remain after the cut off, while the longer datasets from Utqiagvik and Zeppelin are less affected. As the results in principle remain the same when choosing 2007 as the cut off year – except for an expected larger standard deviation in the second subset of Alert (Fig. 1) – we would adapt our manuscript accordingly for consistency.

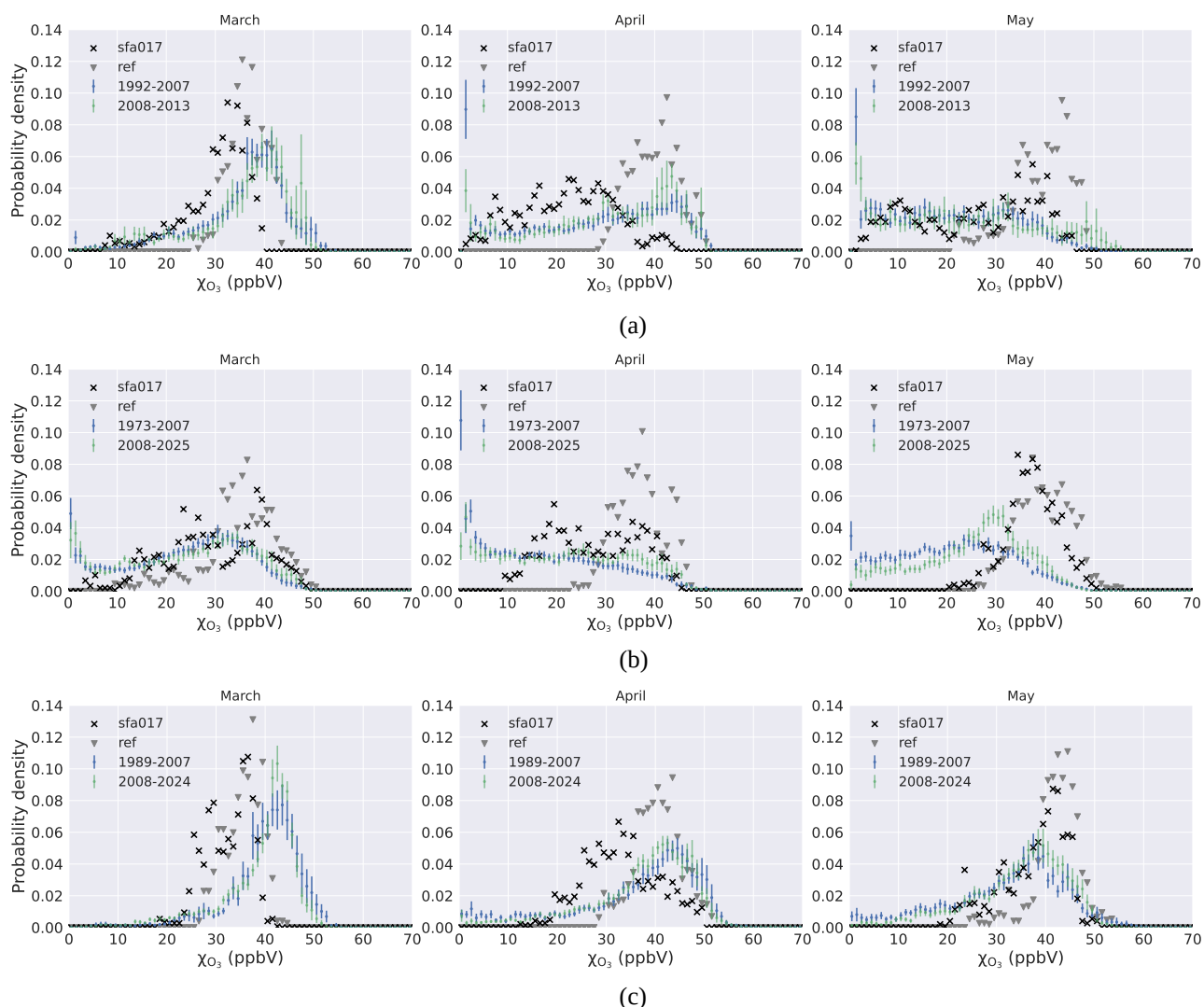


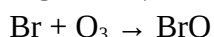
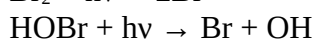
Fig. 1: Profile histograms for Alert (a) and Utqiagvik (b), Zeppelin (c) for a cutoff year 2007.

Line 301: “The tails become larger throughout April and March” – do you mean *April and May* since you already mentioned March in the prior sentence?

Indeed, we meant May.

Fig 9b: The MOSAIC dots look like they fall into vertical lines (e.g. on May 15 the dots span about 2-10 pptv. Is this because the uncertainty on those measurements is quite high or because it has a large diurnal cycle? What would the error bar be for each dot?

BrO is produced in the catalytic destruction of ozone which is driven by the photolysis of Br₂ (or other like HOBr):



This rapid increase in BrO following the diurnal cycle is, hence, expected.

The BrO observational data including uncertainties is described in Benavent et al. (2022) and has been published by Mahajan (2022). The average uncertain is 0.6 pptV ranging between 0.3 and 1.0 pptV (Benavent et al. (2022), Fig. 1(c)).

Line 373: might not *be* the solution

Corrected.

Sec 5: The Summary and Conclusion section is currently a little light on what you did in this study, and quite heavy on what others have done in the context of your future work. To shorten the latter and reduce duplication with what was already discussed in Section 4, you could simply list the future work items (snow, iodine chemistry, dry deposition). And for the former, for example, you could summarize the steps you took to improve the simulations of ODEs (e.g. sea ice and critical temperature).

We will follow your suggestion and revise the Section accordingly in our next revision.

Fig A1: Instead of “middle”, “right” and “left”, can you please include labels for each panel? (e.g. “(i) for upper left, (ii) for upper middle, etc). It is somewhat difficult to determine what is what from the current caption. Please also increase font size of the panel titles.

We improve the readability of the figure accordingly.

Fig A3: Similarly, It is not clear here that Br₂ is the left and BrCl is the right, since it's not mentioned except in extremely small font on the colour scale label. Please add additional panel labels, and increase the font size in this figure.

We increase the label size for improved readability by adding additional labels.

Fig A4: the text in this figure is unreadably small.

The figure is meant as a supplement to Appendix Table A1 in which the respective RMSE and R² are listed. We increase the font size better readability.

Bibliography

Benavent, N., Mahajan, A. S., Li, Q., Cuevas, C. A., Schmale, J., Angot, H., Jokinen, T., Quéléver, L. L. J., Blechschmidt, A.-M., Zilker, B., Richter, A., Serna, J. A., Garcia-Nieto, D., Fernandez, R. P., Skov, H., Dumitrascu, A., Simões Pereira, P., Abrahamsson, K., Bucci, S., Duetsch, M., Stohl, A., Beck, I., Laurila, T., Blomquist, B., Howard, D., Archer, S. D., Bariteau, L., Helmig, D., Hueber, J., Jacobi, H.-W., Posman, K., Dada, L., Daellenbach, K. R., and Saiz-Lopez, A.: Substantial contribution of iodine to Arctic ozone destruction, *Nat. Geosci.*, 15, 770–773, <https://doi.org/10.1038/s41561-022-01018-w>, 2022.

Mahajan, A.: Substantial contribution of iodine to Arctic ozone destruction - data, <https://doi.org/10.17632/BN7YTZ4MFZ.1>, 2022.