Reply to reviewers:

We would like to thank both reviewers for careful reading of paper and valuable comments. For convenience, the original comments by reviewers are indicated below in **bold blue font**. Our response to each comment is given in normal black font.

Comments for anonymous referee (RC1):

The authors have done a very good job in addressing my comments. Overall, I think the paper is now ready for publication. There are, however a few minor issues and typos which should be addressed in the final version:

l 56 ClO + NO2 → ClONO2 should read ClO + NO2 + M → ClONO2 + M

Reaction now includes a non-reactive molecule M.

l 69 ...reach THE upper stratosphere....

This is now corrected.

l 69 ...too short FOR any....

Corrected using "for".

l138 maybe clarify that the stronger SH vortex is less diffusive and hence O3 depleted vortex air remains better confined.

We added following: **"This can be explained by southern hemispheric polar vortex forming earlier and being more stable and less diffusive, which confines ozone depleted air more efficiently."**

l151 by THE indirect EPP effect

This is now corrected.

l190-201 This paragraph is now a bit confusing as it mixes up ClONO2 and HCl responses at different altitude ranges. I would here restrict to the discussion of responses of both species in the 3-10 hPa range, concluding that ClO is buffered mostly into HCl rather than ClONO2 in EXP, and leave the discussion of 10-20 hPa responses for the next paragraph. Also, from Fig 2 of the response letter, it becomes clear that the driving process for ClO->HCl conversion is the reaction of ClO+NO (ClO decrease in panels e and f correlates very well with the NO/NO2 ratio in panels a and b, indicating that ClO+NO rules both the ClO and the NO/NO2 response). This should be made clear.

We separated the discussion into two paragraphs. We also highlighted slightly more the explanation via reaction R9.

l204-205 I think that ClO is released by the heterogeneous reaction of ClONO2 and HCl. Since there is way more HCl compared to ClONO2 in the SH lower stratospheric polar vortex in the CFC era, this reaction stops when all ClONO2 is processed. However, under EPP there is a steady supply of ClONO2 via enhanced NOx which keeps this process running, resulting in less HCl, more ClONO2, und finally more ClO via processing on PSCs.

We modified the text as: **"ClO is mostly released by consuming HCl which recovers slowly to initial values, while ClONO2 levels can rebuild fairly quickly and to excess levels of its initial values (Molina et al., 1987; Webster et al., 1993), especially in the presence of additional NOx due to EPP. This means that EPP keeps the heterogeneous processing between HCl and ClONO2 running and results in less HCl, more ClONO2 and finally more ClO via processing on PSCs."**

l219 ...via THE ClO dimer cycle

Corrected with adding "the".

l240 increases THE NO/NO2 ratio

This is now corrected.

l241-242 maybe you can add that heteogeneous processing on PSCs is HCl-limited in the pre-CFC era while being ClONO2-limited afterwards (due to the O3 impact on the NOx partitioning), compare Fig 11 panels c and d.

l242-243 I think that the principal mechanism during the CFC era (ClONO2-limited heterogeneous processing) is that the NOx supply under EPP conditions keeps the ClONO2+HCl reaction running, resulting in ClO increase (see above).

We included following: **"One can see that the NO/NO2 ratio starting from June is notably higher during the CFC era (Figure 11b) than in the pre-CFC era (Figure 11a). Potential explanation for this is lower ozone amount which reduces reaction (R7) and increases the NO/NO2 ratio. There is generally more NOx available (due to EPP) to react with ClOx. In the pre-CFC era, low NO/NO2 ratio favors ClONO2 reformation (reaction R8) after heterogeneous reaction between HCl and ClONO2 (Figure 11c) resulting with less ClO and more ClONO2 due to EPP (Figure 11e). Thus, heterogeneous processing on PSCs is HCl-limited in the pre-CFC era (Figure 11c). In the CFC era, higher NO/NO2 ratio limits ClONO2 reformation and allows active chlorine (and ClO) to accumulate (Figure 11d). Heterogeneous processing is thus ClONO2-limited. While EPP related ClONO2 production in the CFC era is also slowed due to higher NO/NO2 ratio, it is still net positive over the whole winter (Figure 11f). This excess ClONO2 due to EPP is able to keep the heterogeneous processing running, resulting in ClO increase and considerable HCl decrease over the whole winter (Figure 11f).**

l281-282 see point above.

We modified the discussion as: **“We propose that during the pre-CFC era, heterogeneous processing on PSCs is HCl-limited and excess NOx due to EPP enhances ClONO2 reformation via reaction (R8) leading to lower ClO levels. However, during the CFC-era low ozone levels limit reaction (R7) between NO and ozone and leads to higher NO/NO2 ratio. This limits the ClONO2 reformation and makes heterogeneous processing ClONO2-limited. While EPP related production of ClONO2 is also slowed in the CFC era, it is still net positive over the whole winter. EPP is thus able to keep heterogeneous processing running and results in increase of ClO and substantial decrease of HCl. These results imply that EPP has significantly modulated chemical processes responsible for ozone hole formation.”**

Comments for anonymous referee (RC2):

Figures 7 b and e and following (Figs 8 b and e; 9 b and e; 10 a and c), response to reviewer 2: I still think showing the error bars makes sense, even if they are very small - they are visible mostly in the example shown, and clearly show the differences are significant.

Following the reviewer’s comment, we decided to include the error bars to Figures 7-10 (Subfigure b and e).

The link to the SOCOL-MPIOM3 data provided in the data availability section did not work for me (June 5, 2022) - please check.

We checked this and the doi link works for us (https://doi.org/10.5281/zenodo.6553494). Maybe it is some issue with the pdf reader. Alternative direct link to zenodo repository is https://zenodo.org/record/6553494.