Reply on reviewer # 3 (lead editor)

Knibbe et al.

First we thank reviewer # 3 for the comments to improve this manuscript.

Separating this paper into two manuscripts could have been an option, as trough re-submissions and revisions the size and focus on particularly the trend analysis part has increased. However, a new separate paper on Antarctic ozone trend analysis and estimates by two of authors of this paper, just accepted for publication in ACPD, argues that important structural uncertainties exist in trend analyses based on multi-variate regressions that until now have been ignored. That paper is in part motivated by results presented in our paper, and we argue that for a separate paper with a focus on trend analysis the results of these two papers should be combined, something that we have not done (yet) and requires a considerable amount of time.

In addition, a large part of the methodology is applied in both the PHYS/STAT model and trend analysis. Hence we find that publishing these findings as a whole has its advantages as well. In the light of the results of this new paper – i.e. the need for additional analyses in case of trend analyses - we prefer to not rework our paper into two parts.

In this reply we respond to the questions and announce the adjustments we will process to improve the manuscript.

Major comments

- Reviewer: *"it would be very helpful to include an additional line in the PHYS results showing the term DAY+EP+PV+GEO so that may be compared directly to the "FOURIER" term in the stat model.", "Additionally, it would be useful to note in the appropriate figure captions that the units of "coefficient" in each plot are DU per unit change of the explanatory variable.".*

Figures 7, 8 and 9 have been improved by adding an DAY+EP+PV+GEO term in the PHYS regressions to be compared with the Fourier term in the STAT model. In addition, the captions of figures 4, 5, and 6 now state that the unit of the coefficients is DU per unit change in the normalized corresponding explanatory variable.

- Reviewer: "*In Figure 2, is it possible to plot the absolute value of the correlation. Whether it is positive or negative has no bearing, and the sharp discontinuities at the equator make it difficult to read."*

It would be possible to plot the absolute value of the correlation in figure 2, but we do not agree that the sign of correlation has no bearing. We have not addressed this issue because it is of minor importance, but in the interpretation of the regression results of corresponding explanatory variables the reader may want to combine the regression coefficients with information regarding the correlation and its sign. For example, the EP and DAY variable are negatively correlated in the Northern Hemisphere. Therefore, the large positive effect on ozone of both of these explanatory partly cancel our each other, taking the negative correlations into account. This is why we extensively addressed the issue of accounting for correlations in interpretations of these highly seasonal variables throughout the paper. The colorbar in figure 2 is similar to the colorbar in figures 4, 5 and 6. Therefore, we argue that these plots are similarly readable.

- Reviewer: *"do the authors have any reference to model results that would clarify what we expect to see in terms of transport vs. in situ production?"*

We have briefly extended the description/discussion of the DAY and EP flux regression results. We added a references to literature discussing the relative roles of transport vs chemistry, and argue that our results are consistent with the current understanding. In summary: DAY represents photochemical processes, EP flux transport from tropics to higher latitudes. We also note that some care has to be taken with interpreting results as DAY and EP flux do correlate.

- Reviewer: *"The stronger Brewer-Dobson circulation in winter leads to the build-up of ozone due to net transport not isolation of the vortex. I believe they are two separate concepts, but the EP flux represents both the stability of the vortex and the Brewer-Dobson circulation in the analysis. This should be clarified."*

With regard to the remark about the EP flux representing both transport from tropics to higher latitudes as well as polar vortex dynamics, this is now clarified in section 2.1 where the EP flux is introduced.

The referee also suggests that the 2011 Arctic "ozone hole" episode was a rather unique vortex event. However, Weber et al. (2003, 2011) has shown that the NH and SH polar vortex dynamics and seasonal variations are in essence similar. Differences arise due to vortex stability related to poleward transport of energy, but under similar conditions of poleward transport of energy, both the NH and SH polar vortex also show very similar behavior in terms of stability and seasonality. Hence, we argue there is no need to make adjustments with regard to the uniqueness of the 2011 Arctic "ozone hole" episode.

All technical corrections are applied accordingly.