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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Estimates of Ozone Return Dates from Chemistry-Climate Model Initiative Simulations" *by* Sandip Dhomse et al.

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We thank the reviewer#3 for his/her useful comments. These are repeated below in italics, followed by our responses after the '»'.

The manuscript uses the latest CCMI simulations to derive new estimates of the ozone layer return dates. The study is an important update of the existing CCMVal2 evaluations and will provide valuable input for the next WMO ozone assessment. The paper is clearly written and well-structured and I recommend publication after the following comments have been addressed.

1) The authors adjust the model results to avoid biases when comparing to historical data and to reduce the spread in the predictions of the ozone column. However,

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Discussion paper

this method can introduce new errors if the bias is not constant over time but process related and time dependent. The manuscript misses a discussion of possible shortcomings of this method. What do the return dates look like before the adjustment? Is the mean return date the same and only the spread is reduced or are the models on average over/underestimating the atmospheric ozone abundance? In this context it is not clear what the difference between Figure 1a and 1b is. From the text and the captions it sounds like, the only difference is the adjustment to the 1980-1984 values, but the lines look like the models have been smoothed as well. Furthermore, it is also not clear what the impact of excluding models outside the 1 sigma uncertainty range is. Is this only reducing the uncertainty or also changing the mean values?

» Figure 1 shows the impact of the adjustment on the return dates (compare panels a and b) and this is discussed in Section 4.1. The aim of the adjustment is to improve the visualisation of the different models on the same plots will not impact the return date for any single model; it is a case of just displacing the ozone curve on the y axis so the return to the 1980 value will still occur at the same time. The impact of excluding the models outside the 1-sigma uncertainty is shown by comparison of the MMM and MMM1S results (e.g. Figure 1 and Table 3). Overall there is a small impact of the return date but a decrease in the uncertainty. Yes, the reviewer is correct that there also additional smoothing between Fig 1a and Fig 1b (and Fig 2a and 2b). This is the application of the10-point boxcar smoothing. Text had been added to clarify this.

2) The comparison of the modeled lower and upper stratospheric ozone columns with the BSVertOzone data set gives large differences for some regions (even after the bias adjustment). I miss a discussion of possible reasons for the over- and underestimation of ozone loss and possible implications for the projected return dates.

» We have updated the BSVertOzone dataset,which was revised before the submission of Hassler et al. (2018). The lower stratospheric comparisons are improved. We have added some sentences to point out the remaining upper stratospheric difference and to say that we do not think differences in this region will greatly affect column ozone

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return dates.

3) In parallel with the CCMI activities, the stratospheric ozone community has undergone large efforts to provide updates of the ozone profile trends from observational data sets (e.g. Steinbrecht et al., 2017). How do the models compare to these new results? Do they agree on the upper stratosphere ozone recovery quantified for the 2000-2016 time period?

» Results from CCMI models have been included in the LOTUS report. That report is not finalised (and so we cannot cite it yet) but there will be information in there. A separate analysis in this current paper is beyond the scope of our current work.

4) How different are the chlorine comparisons if HCl+ClO instead of Cly is used in order to have a consistent comparison between models and measurements? How does the amount of stratospheric bromine differ from model to model and how do such differences impact the return dates? Why not use the EESC instead of Cly?

» The MLS ClO + HCl is a good surrogate for total Cly for the regions that we compare. The differences between the observed sum and true Cly will be small compared to the model-model spread that we wish to illustrate. Also, we do not have the CCMs sampled as the MLS local time for a true comparison of ClO. We now present the modelled Bry loadings in the Supplementary Material. As more models provided Cly output compared to Bry it is simpler to use Cly than EESC, and avoids the complication of selecting an alpha value for the models.

Page 8, line 41: Do you mean 2046?

» Yes, corrected.

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