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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modelling the potential impacts of the recent, unexpected increase in CFC-11 emissions on total column ozone recovery" *by* James Keeble et al.

Anonymous Referee #2

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The manuscript presents a modelling investigation of the impact of recent increase in the emission of one of the major ozone depleting substance banned by the Montreal Protocol, the CFC-11. From the recently published evidence of recent emission increase, authors elaborate several scenarios for future emissions of CFC-11, with consequences on future levels of total inorganic chlorine and total ozone column throughout the 21st century. One interest of the study is that scenario independent metrics are explored to evaluate the relationship between ODS emissions and the timing of total ozone column recovery. The paper is well written and reference to previous work is adequate. It is suitable for publication in ACP provided that following comments and recommendations are considered in the revised version.

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Discussion paper

Major comments

1. Description of the model is limited and relates mainly on references. Very little information is provided on main features of tropospheric and stratospheric chemistry schemes. Are VSLS included? Since the model simulation output show a well-defined solar cycle effect, a brief description of the scheme used to integrate solar cycle variation would be valuable. Also, what is the lower boundary of the model?

2. The CFC-11 and CFC-12 emission scenarios are lacking explanation on the particular industrial activities they are based on. For example, what activities lead to emissive use of CFC-11? How realistic are the scenarios regarding industrial use of CFC-11? What is the reference for assuming equal emission of CFC-12 and CFC-11 in SCEN3 scenarios? A table summarizing the various scenarios would also be useful.

3. In Figure 3, the spread of return dates of inorganic chlorine Cly at 40 km is smaller than that of CFC-11 return dates in Figure 2. It would help to show total tropospheric emitted chlorine in order to understand this difference.

4. Figure 4: Comparison of baseline scenario with Bodeker dataset: it would be also interesting to compare with one of the datasets used in the last WMO Ozone Assessment (WMO, 2018), e.g. the GOME-SCIAMACHY-GOME-2 (GSG) product from the University of Bremen (Weber et al., 2011). I am not sure that the solar cycle is that pronounced in other data sets.

5. Figure 5: In order to evaluate the significance of the difference in return dates of the various scenarios, indication of uncertainty as indicated in page 7, l20-25 should be indicated in the figure. The largest spread in return dates is observed for Antarctica, the tropics and in the Arctic. Could the authors elaborate on the processes in the model simulation that explain this difference in spread of return dates? Is the simulated Brewer-Dobson circulation different in the various scenarios? Could that explain the difference?

6. Figure 6: the timing of Cly recovery is chosen from the date at which Cly at 40km averaged in the 10°N-10°S latitude range return to 1980 value. Is there a reason for choosing the 10°N-10°S latitude range?

7. Figure 7: the added value of additional results from TOMCAT simulations is not clear to me. Also in which time frame the additional TCO depletion is computed in the figure?

8. In Figure 8, and other correlation figures, the goodness of the fit is heavily influenced by the SCEN3-30 scenario, which contradicts in some way the statement on the scenario independent metrics. I would assume that for the results ranged in latitude bins, even larger error bars would be expected from the regression in the absence of that extreme scenario. Could the authors comment on that and on the significance of the delay in TCO recovery in some latitude bins in that case?

Specific comments

P3 l9-12: The text is somewhat confusing. It is not clear whether the increase in CFC-11 emissions is 35 Gg.y-1or 13 Gg.y-1 greater than expected from the Montreal Protocol.

P5 l19-20: explain relation between 1Gg CFC-11 and Gg Cl.

P13 l20-22: It is not clear why 200 Gg of CFC-11 emitted in 2020 would not have the same effect on ozone recovery as the same emitted in 2080.

In the text, some exponents are not well written, e.g. r2 values for the goodness of the fits.

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