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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluating stratospheric ozone and water vapor changes in CMIP6 models from 1850–2100" *by* James Keeble et al.

Anonymous Referee #2

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The paper presents a comparison of ozone and H2O fields between different CMIP6 models. It also includes their evaluation against observations. It provides a lot of information that is necessary for the analysis of the climate simulations, notably the contributions of stratospheric ozone and H2O to radiative forcing in CMIP6 coupled climate simulations. I recommend publication after addressing several points. I think the difference between models that calculate interactively ozone and those that specify it should be even clearer in the analysis. The spread among models with specified ozone reflects how important the implementation process of a given ozone climatology into a model can be whereas the spread in the interactive models is of a different nature. I would suggest to add the ""Mean (specified)" in the Tables and add where possible "CMIP6 MMM (specified)" And 'CMIP6 MMM (interactive)" plots (e.g. Figure

4, 6). Here are below more minor comments.

341-343: "Notable differences between the models occur in the uppermost stratosphere, and around the tropopause (Figure A1). The BCC-ESM1, CESM2, FGOALS-g3 and SAM0-UNICON models all simulate much higher ozone mixing ratios in the upper stratosphere."

L75: "which, while consistent with the IPCC-AR5 estimate, represents an increase of $\sim$80% compared to the CMIP5 ozone forcing dataset". Why would a difference of almost a factor 2 indicate consistency between these 2 estimates?

L77: "The relative uncertainties in radiative forcing estimates for both stratospheric ozone and water vapor are large due to the challenges in constraining the concentrations of both during the pre-satellite era". That's not the only problem. If 2 modelling groups are provided with the same preindustrial and present-day fields for ozone and H2O, the radiative forcings calculated by the 2 groups would differ substantially, depending on their radiative schemes, on how the forcing is implemented (notably with respect to the tropopause adjustment), etc. . .(see literature about model intercomparisons including literature from some of the authors)

L80-86: I am not sure that this short history of stratospheric chemistry in the middle of the introduction is necessary.

L100:" However, recent research (Polvani et al., 2018, 2019) has shown that stratospheric ozone depletion caused by increasing ODSs has accounted for around half of the acceleration of the BDC in recent decades." It is an estimation based on model simulations. However, there is no clear agreement or at least quantitative agreement between BDC changes in model simulations and observations (BDC tracer proxies). The authors should be more cautious: recent model simulations indicate. . .ODS may have accounted.

L110: "followed by a sudden decrease of $\sim$10% after 2000 (e.g. Solomon et al., 2010)."

Can models reproduce it? If not, again, one should be cautious with model results regarding H2O evolution.

L159-163: Some caveats should be added here. The fields are “unique, consistent” but it is just 2 models! In view of the inter-model differences and differences with observations (see Figures in the paper), there are biases in those recommended fields, large uncertainties, notably in the projections. Again more caution is required.

L446: “. . .CMIP6 models to simulation (simulating) pre-industrial TCO”.

L446-447: Add a comment. The large differences for preindustrial are not totally surprising. Models are tuned to reproduce the observed ozone evolution (during the satellite era), not the preindustrial era when no observations are available.

L449: “Surprisingly, there is a $\sim$20 DU range in pre-industrial TCO values between those models prescribing the CMIP6 ozone dataset.” Add: suggesting that the TCO is not conserved after model implementation.

L615: The conclusions do not differentiate between ozone interactive and specified models. The spread among models with specified ozone reflects how important the implementation process of a given ozone climatology into a model can be whereas the spread in the interactive models is of a different nature driven by differences between model schemes. The analysis provides important information on both approaches. I think the conclusion should also summarise the conclusions for each approach.

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