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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ozone sensitivity to varying greenhouse gases and ozone-depleting substances in CCMI simulations" *by* Olaf Morgenstern et al.

Anonymous Referee #2

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This paper outlines a series of CCMI simulations carried out by several chemistry-climate models. The effects of CH4, N2O, equivalent Cl, and equivalent CO2 on O3 are presented in the profile, total column, and at the surface. The paper is clearly written but the repetitive organization and lack of new insights make it a slow read. More significantly, there is little attempt to explain the underlying causes of model differences presented. It is hypothesized in several places that different stratospheric transport and dynamical responses between the models is the cause of most of the differences. However, this is not diagnosed and the reader is left wondering what to conclude from this study (see below). An evaluation of the dynamical feedbacks between the models would help immensely. Some detailed exploration of the cause of peculiar behavior

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Discussion paper

for some of the largest model outliers would also greatly help the paper. Even some speculative remarks about the causes of specific outliers would add value to the paper. I cannot recommend publication of this paper without at least some attempt to explain the differences between the models.

General Comments

As stated above the lack of an attempt to explain the discrepancies between the models diminishes this paper. Given that representatives of all the modeling groups are co-authors of the paper, they should diagnose some select outliers in the simulations. As the paper presently stands, one must conclude one (or more?) of the following possibilities:

-Our chemical/dynamical understanding is incomplete (except in the middle stratosphere)

-These models include significant differences in their treatment of the chemistry, which induce different responses on ozone from the source gases

-There are errors in some of the models

-Dynamical variability is larger than the chemical effect of the source gas changes on ozone

-Differences in dynamical feedbacks are larger than the chemical signal on ozone

A more complete discussion of this is needed in the paper. The paper only mentions the last possibility with no analysis to support it. The relatively small regions that are eliminated by being outside the 95% confidence interval suggest that pure dynamical variability is not the cause of the differences (or at least that such dynamical variability is auto correlated on the timescale of a few years or longer and thus is included in the forced response). This is a bit surprising and so I'm curious how you computed the significance regions. Including an assessment of the dynamical feedbacks between the models is needed to support the assertion that these feedbacks are the likely cause of

the model differences. The differences in the chemistry could be isolated by comparing results of simulations nudged to reanalysis output but this is likely beyond the scope of this paper unless such calculations exist in the CCMI archive.

Other Comments

1. It would be useful to include the profile plots in density units in the supplement (i.e., convert to DU/km per source gas change or another similar unit). Then one could clearly see where the column changes are coming from.

2. Include somewhere the formulas used to compute the significance values used on the figures. This should include the assumptions made in arriving at the formulas. This could be in a methods section, appendix, or supplement.

3. Section 3.4: I wonder if it would be better to use CO2 directly instead of equivalent CO2 since CO2 dominates the radiative effects of these gases in the stratosphere (as you note in lines 94-107).

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