Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-441-RC3, 2020

Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Sensitivity of the southern hemisphere tropospheric jet response to Antarctic ozone depletion: prescribed versus interactive chemistry" *by* Sabine Haase et al.

Anonymous Referee #3

Received and published: 30 June 2020

This paper reported simulations of the climate responses to ozone depletion by WACCM, and compared the ones with interactive chemistry schemes with those prescribing zonal and 3d daily ozone. Each experiment consists of 9 ensembles with fully coupled ocean. It is found that interactive chemistry produces stronger stratospheric cooling, stronger strengthening of the polar night jet, and stronger poleward shift of the tropospheric jet, despite of the identical changes in ozone and shortwave heating rates. The authors attribute the difference to a chemistry-dynamics feedback that is absent when ozone is prescribed. This work highlights the importance to include the interactive chemistry into the climate simulations, and sheds light on understanding the complex coupling between the stratospheric ozone and the climate system. The paper

is logically organized and well written. I am not fully convinced by the mechanisms the authors provided to explain the "chemistry-dynamics feedback", but I do think the results deserve publication. Below is my detailed comments:

1. The authors suggested that there is both positive and negative feedbacks between ozone changes and dynamics, which occurs at different seasons and levels, which involves the background zonal wind condition and wave-mean flow interaction. However, it is not clear why interactive chemistry and specified chemistry would behave different based on this mechanism. Both of them have the same changes in ozone and SW heating rates, then the initial changes in the zonal winds should also be similar since that simply follows the thermal wind balance. Wave-mean flow interaction would also work in a similar fashion in the two experiments.

2. The mechanism for the "positive feedback" over the lower stratosphere in Nov/Dec is especially unclear, which is a key component to explain the stronger cooling seen in the interactive chemistry simulations. If the authors are referring to the positive correlations in Fig. 3a, these positive correlations are very weak and not statistically significant.

3. The climatology is calculated as the averaged over 1955-2013. But because of the strong trend related to ozone depletion, a large portion of the difference in the climatology may be a reflection of the difference in trends. It might be more meaningful to compare climatology over the pre-depletion era, such as 1955-1970.

4. Changes in the tropospheric jet. As shown in Fig. 9, the difference between Chem on and off is mainly between 20S-40S, which is more equator-ward than the equator flank of the tropospheric jet. I doubt the wind anomalies there can affect the location of the jet. Can the authors calculate the latitudes of the surface jets and verify if the latitude actually differ between the two? It is also not clear how the ozone anomalies in the polar regions affect the tropospheric jets in the subtropics.

4. Line 301-303: The first sentence here seems to suggest both the model used here and WACCM4 have stronger trends than WACCM-CCMI. But the second sentence

suggests the opposite.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-441, 2020.