

Dear referee,

We grateful you for reading and reviewing our paper as well as for your valuable suggestions and comments to improve our manuscript. Please find the detailed response to each comment below (in red)

The MS: "The future ozone trends in changing climate simulated with SOCOLv4" deals with ozone evolution in the "middle-of-the-road" (SSP2-4.5) and "fossil-fueled" (SSP5-8.5) scenarios in the troposphere and middle atmosphere. As the authors have already presented the results from their historical simulations and comparisons to measurements in another paper, this study concentrates only on the future changes.

As expected, ozone is increasing in the stratosphere and decreasing in the lower stratosphere and troposphere. However, the mesospheric part is interesting as there are not many analyses for this region. This is a well-written MS and I have only some minor comments on this.

Major:

I thought a comparison between the previous RCP scenarios with the latest SSP scenarios is needed in the discussion. There are some studies based on CMIP5 ozone results. This should be in the modelling point of view. You have mentioned some in Introduction, but a discussion of the ozone results from both CMIP5 and CMIP6 are needed.

Thank you for this comment. We agree that the comparison with results of future ozone trend analysis in CMIP6 simulations based on SSP2-4.5 and SSP5-8.5, which available in previous studies (i.e., Keeble et al., 2021, Shang et al., 2021) was not complete and should be extend in the discussion of our results. Therefore, we extended the discussion section with this comparison with results from these studies.

However, we should state that adding the direct comparison to previous studies based on CMIP5 RCP or other SSP scenarios in the discussion is not possible, because even in the corresponding scenarios, there is a discrepancy in climate forcings between RCP and SSP scenarios due to difference in GHG concentration pathways, which might cause quite different atmospheric and the ozone response (see Revell et al., 2022). Thus, the direct comparison requires performing additional model experiments with these RCP or others SSP scenarios, but this requires a large computer power budget extension since SOCOLv4 is high computing power-consuming model, but this is out of the scope of this study.

References:

Keeble, J., Hassler, B., Banerjee, A., Checa-Garcia, R., Chiodo, G., Davis, S., Eyring, V., Griffiths, P. T., Morgenstern, O., Nowack, P., Zeng, G., Zhang, J., Bodeker, G., Burrows, S., Cameron-Smith, P., Cugnet, D., Danek, C., Deushi, M., Horowitz, L. W., Kubin, A., Li, L., Lohmann, G., Michou, M., Mills, M. J., Nabat, P., Olivie, D., Park, S., Seland, Ø., Stoll, J., Wieners, K.-H., and Wu, T.: Evaluating stratospheric ozone and water vapour changes in CMIP6 models from 1850 to 2100, *Atmos. Chem. Phys.*, 21, 5015–5061, <https://doi.org/10.5194/acp-21-5015-2021>, 2021.

Shang, L., Luo, J., and Wang, C.: Ozone Variation Trends under Different CMIP6 Scenarios, *Atmosphere*, 12, 112, <https://doi.org/10.3390/atmos12010112>, 2021.

Revell, L. E., Robertson, F., Douglas, H., Morgenstern, O., and Frame, D.: Influence of Ozone Forcing on 21st Century Southern Hemisphere Surface Westerlies in CMIP6 Models, *Geophys. Res. Lett.*, 49, e98252, <https://doi.org/10.1029/2022GL098252>, 2022.

Minor:

L6: "and upper and middle"

Done

L9: speed up of BDC?

We rewrote it as follows:

Speed-up of the Brewer-Dobson circulation

L11-12: increase of UV in the tropics or mid latitudes?

Increase of UV level is expected in the tropics. We rewrote this part as follows:

... tropics, which causes a decrease in the mid-latitudes and increase in the tropics in surface level of UV radiation...

L20: element? You need a better word here

We rewrote this sentence as follows:

The stratospheric ozone layer plays an essential role in...

L31: The following studies should also be mentioned here

<https://doi.org/10.5194/acp-18-7557-2018>

<https://doi.org/10.1038/s41612-018-0052-6>

Done.

L38: GHG was first mentioned in L23

The abbreviation was moved to the line 23.

L84: space after full stop

Done.

L89: decrease (Keeble et al., 2021).

Done.

L102: what is "slightly" comparable;?

Slightly compatible means that simulated trends show some signs of agreements but generally far from the observations. We reformulated this as follows:

“..are not completely consistent...”

L115: Hue et al. (2016)

Done.

L119: CCMI campaigns? Sounds a field campaign, not modelling experiments

Agree. However, we excluded the paragraph with this line from the revised paper.

L168: respectively (Zhao et al., 2020)

Done.

L192: indices

Done.

L241, 245: delete content, use amount or concentration instead

Done. “Content” word was exchanged with “concentration”.

L248: signs of increase

Done.

L251-252: how NO_x produces ozone in the lower stratosphere?

The increased NO_x might still contribute to ozone production in the lower stratosphere via smog reactions (e.g., Wang et al., 1998). It was added to the paper’s text.

References:

Wang, Y., Jacob, D. J., and Logan, J. A.: Global simulation of tropospheric O₃-NO_x-hydrocarbon chemistry: 3. Origin of tropospheric ozone and effects of nonmethane hydrocarbons, , 103, 10,757–10,767, <https://doi.org/10.1029/98JD00156>, 1998.

L253: do not start a sent with AND

Agree. We have merged these two sentences.

L260: These increases of 0.13 and 0.27 DU are significant?

Yes, they are statistically significant.

L269: Can you please give another reference for this. It is known long before, not in 2021

Agree. We have exchanged the given citation with those below:

Thompson, B. A., P. Hartwick, and R. R. Reeves Jr. (1963), Ultraviolet absorption coefficients of CO₂, CO, O₂, H₂O, N₂O, NH₃, NO, SO₂, and CH₄ between 1850 and 4000 Å, *J. Geophys. Res.*, 68, 6431–6436.

Solomon, S., Garcia, R. R., Olivero, J. J., Bevilacqua, R. M., Schwartz, P. R., Clancy, R. T., and Muhleman, D. O.: Photochemistry and transport of carbon monoxide in the middle atmosphere, *Journal of Atmospheric Sciences*, 42, 1072–1083, [https://doi.org/10.1175/1520-0469\(1985\)042<1072:PATOCM>2.0.CO;2](https://doi.org/10.1175/1520-0469(1985)042<1072:PATOCM>2.0.CO;2), 1985.

L299: as expected

Done.

L369: delete the “expected”

Done.

L382: it barely changes? Then you write a change of -4DU/decade? Delete “barely”

Done.