



EGUsphere, referee comment RC2  
<https://doi.org/10.5194/egusphere-2022-218-RC2>, 2022  
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## **Comment on egusphere-2022-218**

Anonymous Referee #2

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Referee comment on "The ozone–climate penalty over South America and Africa by 2100" by Flossie Brown et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-218-RC2>, 2022

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This manuscript presents an interesting work focusing on the climate change effect on near surface ozone over South America and Africa using three ESMs.

It is generally well structured and presented. However I have a number of points that have to be addressed before acceptance. See my analytical comments below:

### **Comments**

line 51: It can be also produced from the oxidation of CO in the presence of adequate levels of NO<sub>x</sub> so that net ozone production (P-L) is positive. Please modify accordingly.

line 68: Apart from chemical and biological processes there are also complex dynamical processes such as transport from the stratosphere to troposphere. See for example Morgenstern et al. 2018, Akritidis et al., 2019.

line 84: There also soil NO<sub>x</sub> emissions which are not mentioned (e.g. Romer et al., 2018).

line 84: What do the authors mean with severely NO<sub>x</sub>-limited regions? Please clarify.

line 86-87: Do the authors imply the NO+O<sub>3</sub> titration process acting as an ozone sink close to NO emission sources which is common in highly polluted areas being in the VOC limited regime?

line 102: Concerning the isoprene chemistry in models, maybe the authors could also refer here more explicitly the uncertainty due to the different model assumptions on the yields of isoprene nitrates and their subsequent NO<sub>x</sub>-recycling ratios.

line 223: The authors mention that the simulations are fully coupled but the ocean is not coupled since SSTs are prescribed.

line 230: Apart from the cited reference, this approach has been also applied in Chapter 6 of IPCC AR6 (Szopa et al, 2021).

line 240: The authors mention that tropics as lying between 40 N and 40 S. The tropics are commonly defined as the area between the Tropic of Cancer (roughly 23.5-degrees North latitude) and the Tropic of Capricorn (roughly 23.5 degrees-South Latitude). In the domain of Figure 1, the subtropics of Northern and Southern Hemisphere are also included. This is a comment to be considered as in several places throughout the manuscript the authors refer to the tropics but the analysis includes also subtropics.

line 272: Maybe you can also discuss this result in relation to the results of Turnock et al. (2020).

line 316: Do you have some explanation why NO<sub>x</sub> surface concentration decreases in UKESM and slightly increase in MRI and GISS in Fig 2b? A discussion with possible reasons is missing.

line 316: There is no discussion of OH changes in Fig. 2c. Could you discuss why MRI and UKESM show an increase while GISS shows a decrease? Theoretically, increases in methane, CO and NMVOCs reduce OH while increases in water vapour and temperature, incoming solar radiation, NO<sub>x</sub> and tropospheric ozone enhance OH.

line 331: Please discuss also how the models deal with the soil NO<sub>x</sub> emissions in the simulations.

lines 387-389: It is rather confusing when discussing megacities and urban scale in model results with much coarser resolution. The current datasets produced for CMIP6 were produced at 0.5° (historical anthropogenic and future) (Feng et al., 2020). Capturing the distinctions between urban and rural emissions, and the finer distinctions in between, is an ongoing challenge for emission inventories for global datasets. I think that the discussion should rather point that areas with ozone penalty identified in this study include

a number of highly populated regions and megacities.

line 390: The authors introduce in Section 3.4, chemical production and loss terms but they have to describe how these terms are calculated (simply discuss the model diagnostics for these terms).

lines 397-398: There is missing discussion on the reasons for the decrease of dry deposition of ozone due to climate change. Is this a robust signal? There are different physical and biophysical processes affecting dry deposition of ozone on which climate change may induce opposite sign of change. To what level these processes are parameterized in the model simulations is crucial for the understanding.

lines 412-413: This is a comment linked to my previous comment on dry deposition of ozone. Please check to what level biosphere-atmosphere interactions are taken into account in the current simulations (negative and positive feedbacks on ozone through stomatal upatake and deposition velocity reduction). Mind also the links of dry deposition velocity with the boundary layer changes under a warmer climate.

lines 437-438: Could you comment on the possible reasons that determine the net ozone production increase for UKESM? Despite NO<sub>x</sub> decrease in many regions due to natural emission changes and chemistry under climate change, net ozone production is positive. So it is essential the high NO<sub>x</sub> levels at polluted regions (NO<sub>x</sub> regional levels) which play a key role for an increase in net ozone production rate in a warmer and more humid environment. On top of that there also isoprene emission increases which may have an impact on ozone and it could useful to discuss their contribution on net ozone production rates (in which regions have a positive or negative impact and if this is related to the regions NO<sub>x</sub> levels).

line 502: It is rather misleading when the authors state that "climate change could lead to an ozone-climate penalty in areas which already have a high background O<sub>3</sub> concentration". The ozone climate penalty is linked to the regional NO<sub>x</sub> levels in a highly polluted region where net ozone production rates increase in warmer and more humid environment (even if natural NO<sub>x</sub> levels are slightly reduced due to climate change).

Figure 6: A letter should be assigned in each one of the 12 sub-figures of the panel.

### **Minor technical comments**

lines 26-27: The whole sentence needs rephrasing as it does not read well.

line 30: Please add a "comma" after "on average".

lines 211-212: The sentence needs rephrasing as it does not read well.

line 226: Please replace "are" with "and".

line 271 : Please replace "the" with "that".

line 291: I would suggest "range between" instead of "fall within".

line 376: It is Fig. 4c instead of Fig.4d.

line 377: It is Fig. 4d instead of Fig.4c.

line 382: I would suggest "larger" than "much more extreme".