EGUsphere, referee comment RC1
https://doi.org/10.5194/egusphere-2022-218-RC1, 2022

Comment on egusphere-2022-218

William Collins (Referee)

Referee comment on "The ozone–climate penalty over South America and Africa by 2100" by Flossie Brown et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-218-RC1, 2022

This study nicely illustrates the impact of NOx levels in determining whether regions within South America and Africa are likely to incur an ozone-climate penalty. This is useful work and should be suitable for publication after accounting for the suggestions below. There is a robust correlation between isoprene emission changes and ozone production. A signal of correlation of increased ozone production with increased NOx change is found, and in one model there is a correlation with absolute NOx levels.

Reasons for the NOx changes are not explored, these could be due to changes in wet/dry deposition, changes in emission (lightning is mentioned, but not explored) or changes in organic nitrate and PAN formation. The latter are mentioned in the introduction, but not followed up in the discussion. In figure 6 (particularly UKESM1, but also GISS) the NOx and Isoprene emission changes seem anticorrelated over S. America, and possibly also over Africa. This would support the increased sequestration of NOx in organic nitrates and PANs.

It would be useful to look at P-L to determine whether the isoprene emissions have a net positive or negative impact on ozone. The introduction implies that the sign of the net effect depends on the NOx background whereas in figure 6 for UKESM1 the areas of increased isoprene emission all seem to have increase ozone production. Would the balance become more obvious when looking at P-L?

Using monthly values in figure 7 might lead to spurious correlations. There will be strongly seasonal variations in isoprene and NOx, and also strong seasonal variations in meteorology (wet vs dry). Some of the correlations in figure 7 might be due to the meteorology -i.e. isoprene emission changes might be stronger in the dry season where the meteorological impacts on ozone might also be more positive if dry gets drier.

Line 58-60: This sentence starts with the effect of ozone on climate, but the references are all to the effect of climate on ozone. Ozone doesn't lead to a positive forcing through increases in anthropogenic precursors, it is through its absorption and emission of longwave radiation.

Line 82: "Biogenic isoprene is the major O3-forming NMVOC …" This seems to imply that more ozone is formed from isoprene than from other NMVOCs. Is this true? Is this globally or just over forests? Does this mean gross formation i.e. ISOPOO +NO dominates the sum of RO2+NO, and ignoring the sinks. Elsewhere it is not clear even whether isoprene is a net producer of ozone.

Line 86: It is mostly OH+NO2->HNO3 that causes NOx-saturation.

Line 115: This could be described better by explicitly saying that O1D+H2O is the major ozone loss.

Section 2.1: Are the Price and Rind parameterisations in UKESM1 and MRI the same? Thornhill et al. 2021 found different climate responses from schemes that were all supposed to be Price and Rind. Soil NOx is mentioned, do these models include climate-dependent soil NOx emissions?

Line 234: It might be clearer to state that fixing CO2 in pd means that the difference compared to the baseline includes the effect of CO2 inhibition.

Line 241: Are the model levels really "above the canopy" or are they above the orography?

Line 386: Might be clearer to say that Emissions from cities create positive sensitivities to climate change in all months.

Line 414: The plot of loss frequency is very useful. It would also be useful to show dry deposition as a velocity in the supplement i.e. dividing by ozone concentration in kg/m3.

Line 414: In UKESM1 CO2 will also affect the stomatal closure, I don't know about the other models.

Figure 7: The correlation patterns here don't look to be quite the same as judging the correlations by eye from figure 6. This might be because this uses month as another variable. Is the isoprene coefficient really 0.00 for UKESM1? It looks as if higher isoprene leads to higher ozone production, both in figure 7 and in 6.

Line 512: Should say which reactions happen faster at higher temperatures.

Conclusions: This doesn't discuss why there is an ozone-climate penalty.

Line 572: Strictly you have shown that the ozone-climate penalty is in areas of high NOx rather than ozone.