Comments by Owen R. Cooper (TOAR Scientific Coordinator of the Community Special Issue) on:

The contribution of transport emissions to ozone mixing ratios and methane lifetime in 2015 and 2050 in the Shared Socioeconomic Pathways (SSPs)

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This review is by Owen Cooper, TOAR Scientific Coordinator of the TOAR-II Community Special Issue. I, or a member of the TOAR-II Steering Committee, will post comments on all papers submitted to the TOAR-II Community Special Issue, which is an inter-journal special issue accommodating submissions to six Copernicus journals: ACP (lead journal), AMT, GMD, ESSD, ASCMO and BG. The primary purpose of these reviews is to identify any discrepancies across the TOAR-II submissions, and to allow the author teams time to address the discrepancies. Additional comments may be included with the reviews. While O. Cooper and members of the TOAR Steering Committee may post open comments on papers submitted to the TOAR-II Community Special Issue, they are not involved with the decision to accept or reject a paper for publication, which is entirely handled by the journal's editorial team.

General Comments:

TOAR-II has produced two guidance documents to help authors develop their manuscripts so that results can be consistently compared across the wide range of studies that will be written for the TOAR-II Community Special Issue. Both guidance documents can be found on the TOAR-II webpage: https://igacproject.org/activities/TOAR/TOAR-II

The TOAR-II Community Special Issue Guidelines: In the spirit of collaboration and to allow TOAR-II findings to be directly comparable across publications, the TOAR-II Steering Committee has issued this set of guidelines regarding style, units, plotting scales, regional and tropospheric column comparisons, tropopause definitions and best statistical practices.

Guidance note on best statistical for TOAR analyses: The aim of this guidance note is to provide recommendations on best statistical practices and to ensure consistent communication of statistical analysis and associated uncertainty across TOAR publications. The scope includes approaches for reporting trends, a discussion of strengths and weaknesses of commonly used techniques, and calibrated language for the communication of uncertainty. Table 3 of the TOAR-II statistical guidelines provides calibrated language for describing trends and uncertainty, similar to the approach of IPCC, which allows trends to be discussed without having to use the problematic expression, "statistically significant".

Major Comments:

This paper provides a thorough analysis of the impact of transport emissions on present-day and future (2050) ozone based on three different SSPs. This is a complex endeavor requiring a wide range of tagged tracer runs and sensitivity tests, and it's not possible to consider every situation and account for every competing process (e.g. emissions, climate change, non-linearity). The authors are of course aware of this challenge and provide some extensive discussion in Section 7. I think this section would benefit from some further discussion regarding SSP3-7.0 and the expected impacts of climate change and increasing methane concentrations, as assessed in Chapter 6 of IPCC AR6 WG-I (Szopa et al., 2021).

Figure 6.4 in Szopa et al. shows an increase of the tropospheric ozone burden of roughly 10% from 2014 to 2050, based on SSP3-7.0, and much of this increase is due to projected increases in methane. Figure 6.20 in Szopa et al. indicated average ozone increases across South Asia of 8-10 ppb by 2050, under SSP3-7.0. These ozone increases seem to be much larger than your projected increases, as shown in your Figure 2. Part of this discrepancy could be due to differences in methane concentrations, as you discussed in Section 7. But another likely explanation is the ozone climate penalty that impacts boundary layer ozone, as discussed by Zanis et al. 2022. Your paper does not mention the climate penalty and I think that it deserves some discussion. Another important finding of IPCC AR6 and Zanis et al. (2022) is that a warmer climate will be more humid, especially in the boundary layer, which will lead to a reduction of ozone lifetime in remote regions, such as over the oceans. Your Figure 2 does not show a consistent reduction of ozone across the oceans under SSP3-7.0, probably because you use the same meteorology in 2015 and 2050; some discussion of this phenomenon would also be helpful.

Figure 5. Given that SSP1-1.9 has strongly decreasing transport emissions in all regions, I am surprised that none of the regional reductions produces ozone reductions in downwind regions. Why are there no ozone reductions in the receptor regions?

Figure 7. If the future scenarios included climate change, with more humidity in the boundary layer and therefore a shorter ozone lifetime, would the ozone reductions due to shipping emissions reductions be even more pronounced?

Section 4.4
A recent paper by Wang et al. (2022) indicates that the impact of aviation on the global tropospheric ozone burden is greater than suggested by previous studies. How does your analysis compare to that of Wang et al.?

Minor Comments:

Figure S4. There is hardly any difference in surface ozone between PD and SSP3-7, which is surprising. SSP3-7 is projected to have an increase in the tropospheric ozone burden, especially in the free troposphere. This should mean that ozone at high elevations sites (Greenland, the western USA, Tibetan Plateau, the Andes, Antarctica) should be higher under SSP3-7, but they appear to be almost the same. Is this due to your 2015 and 2050 simulations having the same methane concentrations, instead of higher methane in 2050?

Line 622
When considering the impact of climate change on ozone, a relevant study is Lin et al. 2020, who show that drought and heat waves can limit ozone deposition to vegetation.

Line 410
When discussing ozone non-linearity, two relevant studies are Wu et al. (2009) and Wild et al. (2012). Similarly, when discussing differences in ozone production efficiency among regions, the study by Zhang et al. (2016) is very important as it demonstrated that ozone production efficiency is much greater in tropical regions than at northern mid-latitudes.

References:

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Zhang, Y., et al. (2016), Tropospheric ozone change from 1980 to 2010 dominated by equatorward redistribution of emissions, *Nature Geoscience*, 9(12), p.875, doi: 10.1038/NGEO2827