Reviewer #2

Comment [2-1]: This study explores the sensitivity of summertime ozone pollution in the United States to changes in temperature, focusing in particular on changes in that sensitivity across three recent decades. Manuscript text is generally clear and cohesive and accompanying figures are well constructed and easy to interpret. On the whole I find this an interesting and useful expansion of previous ozone-temperature studies and a worthwhile addition to the literature. I do have a few suggestions for strengthening the paper before publication:

Response [2-1]: We thank the reviewer for the positive and valuable comments. All of them have been implemented in the revised manuscript. Please see our itemized responses below.

Comment [2-2]: The CEDS inventory has some known biases in terms of agreement with observations. Of particular relevance for this study, previous work has found regional patterns in NOx biases, pointing overall to overestimates in the US (e.g. Christiansen et al., 2024 https://doi.org/10.5194/acp-24-4569-2024). Considering its importance to this study, it would be worth exploring previous work evaluating the CEDS inventory with respect to ozone precursors and commenting on how any biases or uncertainties may be influencing results shown here.

Response [2-2]: Thank you pointing it out. The overestimation of anthropogenic emissions in the post-2010 emission inventories may be a key reason for the underestimation of the ozone-temperature sensitivity trends. We have added discussions on the uncertainties in anthropogenic NO_x emissions from the CEDS inventory and their potential impacts on the ozone-temperature sensitivity.

In Section 3.2: "<u>The simulated ozone-temperature sensitivity for 2013–2017 shows an overestimation, particularly in the SEUS and Midwest regions (Figure S8). Christiansen et al. (2024) suggested that the CEDS inventory overestimates post-2010 anthropogenic NO_x emissions, especially in the eastern United States, which may lead to overestimation of ozone-temperature sensitivity in these regions.</u>"

In section 4: "<u>Our study demonstrates that ozone-temperature sensitivity is highly responsive to</u>

<u>changes in emissions, emphasizing the importance of more accurate anthropogenic emissions inventory for interpreting the ozone-temperature relationship.</u>"

Reference:

Christiansen, A., Mickley, L. J., and Hu, L.: Constraining long-term NOx emissions over the United States and Europe using nitrate wet deposition monitoring networks, Atmospheric Chemistry and Physics, 24, 4569–4589, https://doi.org/10.5194/acp-24-4569-2024, 2024.

Comment [2-3]: The naming scheme for normalized cases confused me somewhat. For most cases it appears to identify the effect being normalized or removed (FTEMP normalizes temperature fields), but for FTRANS this appears to be the opposite, as all meteorology is normalized except for transport. Some clarification and consistency here would help for parsing later results.

Response [2-3]: Thank you for your suggestion. We have renamed the BASE-FTRANS and 1995E-FTRANS simulations to BASE-TRANS and 1995E-TRANS (all meteorology is normalized except for transport).

Comment [2-4]: On a related note, it appears that a number of simulations listed in Table 1 are not explicitly mentioned or discussed in the manuscript text. If these simulations turned out to be used in developing manuscript figures and conclusions, it should be clearer how and where they were incorporated, with explicit case names cited for easier reference back to the table.

Response [2-4]: Thank you for your suggestion. Our results are primarily presented by comparing the differences between various simulations, but the large number of simulations may cause some confusion for readers. To address this, we have added a summary of the differences between the simulations used for quantifying the drivers of $m_{\Delta O3\text{-}\Delta Tmax}$ trends in Table S2.

Table S2 The contribution for each mechanism

Term	Calculation method

All effect contribution	the difference in $m_{\Delta O3-\Delta Tmax}$ between the BASE and 1995E simulation
Temperature-indirect effect contribution	the difference of $m_{\Delta O3-\Delta Tmax}$ between BASE-FTEMP and 1995E-FTEMP
Temperature-direct effect contribution	the difference of $m_{\Delta O3-\Delta Tmax}$ between BASE and 1995E minus the difference between BASE-FTEMP and 1995E-FTEMP
Transport contribution	the difference of $m_{\Delta O3-\Delta Tmax}$ between BASE-TRANS and 1995E-TRANS
Other-indirect effect contribution	difference of $m_{\Delta O3-\Delta Tmax}$ between BASE-FTEMP and 1995E-FTEMP minus the difference between BASE-TRANS and 1995E- TRANS
Combined contribution from four temperature-direct effects	the difference of $m_{\Delta O3-\Delta Tmax}$ between BASE and 1995E minus the difference between BASE-F4PATHS and 1995E-F4PATHS
BVOCs contribution	the difference of $m_{\Delta O3-\Delta Tmax}$ between BASE and 1995E minus the difference between BASE-FBVOC and 1995E-FBVOC
Soil NO_x contribution	the difference of $m_{\Delta O3-\Delta Tmax}$ between BASE and 1995E minus the difference between BASE-$FSNO_x$ and 1995E-$FSNO_x$
PAN decomposition contribution	the difference of $m_{\Delta O3-\Delta Tmax}$ between BASE and 1995E minus the difference between BASE-FPAN and 1995E- FPAN
Dry deposition contribution	the difference of $m_{\Delta O3-\Delta Tmax}$ between BASE and 1995E minus the difference between BASE-FDEP and 1995E- FDEP

Comment [2-5]: While the details of transport effects are not a focal point of this paper, I found the description of transport impacts (lines 365-376) to be a bit thin and muddled relative to other sections, especially considering their apparent importance. Do BASE-TRANS and 1995E-TRANS refer to BASE-FTRANS and 1995E-FTRANS from Table 1? Why would solar radiation and BVOC emissions in the SE be relevant to the patterns shown in 7a, since (if I understand these cases correctly) all meteorology other than transport has been normalized out in the simulations being subtracted here? A bit more attention to these results, identification of possible mechanisms at play, and discussion within the context of the broader literature would be appreciated.

Response [2-5]: Thank you pointing it out. The impact of transport on ozone-temperature sensitivity largely depends on the transport patterns that has significant temporal variation. Discussing transport effects based on simulation over just one month (July 2017) may not provide sufficiently robust information. Thus, we have only provided a brief discussion. We apologize for the confusion regarding Figure 7, where the descriptions were incorrect: BASE-TRANS and 1995E-TRANS should refer to BASE-FTRANS and 1995E-FTRANS from Table 1. We have separated the indirect effects contributing to the reduction in ozone-temperature sensitivity due to anthropogenic emission reductions into transport and other indirect effects. The influence of solar radiation on BVOC emissions in the southeastern United States is related to the contribution from other indirect effects (Figure 7b, not Figure 7a). This is because the radiation received by vegetation is highly correlated with temperature, and radiation plays a crucial role in BVOC emission calculations in the model (Guenther et al., 2012). This strong collinearity likely explains the significant contribution of other indirect effects in the southeastern United States. We have added further discussion in the main text to highlight this point in Section 3.3: "The temperature-indirect effect excluding transport (Figure 7b) on $m_{\Delta O3\text{-}\Delta tmax}$ shows a more uniform decline with reduced emissions in most regions across the CONUS, with a larger decrease in Southeast US. The radiation received by vegetation in the southeastern United States is highly collinear with temperature and also plays an important role in BVOC emissions (Guenther et al., 2012), which may reflect its potential for ozone formation reduces with the decline in anthropogenic NO_x emissions. In comparison, the transport effect has larger impacts on the $m_{\Delta O3\text{-}\Delta Tmax}$ trend (Figure 7a) with reduced NO_x emissions in the northeastern US, where transport has the largest contribution to the mean $m_{\Delta O3\text{-}\Delta Tmax}$ values (Figure S10) as also reported in Kerr et al. (2019). Some studies have

demonstrated that changes in mid-latitude weather systems can significantly influence the ozone-temperature sensitivity by affecting pollutant transport (Barnes and Fiore, 2013; Kerr et al., 2020), which could be the underlying mechanism explaining the role of transport in contributing to the decrease of ozone-temperature sensitivity with emission reductions."

Reference:

Guenther, A. B., Jiang, X., Heald, C. L., Sakulyanontvittaya, T., Duhl, T., Emmons, L. K., and Wang, X.: The Model of Emissions of Gases and Aerosols from Nature version 2.1 (MEGAN2.1): an extended and updated framework for modeling biogenic emissions, Geoscientific Model Development, 5, 1471–1492, https://doi.org/10.5194/gmd-5-1471-2012, 2012.

Barnes, E. A. and Polvani, L.: Response of the Midlatitude Jets, and of Their Variability, to Increased Greenhouse Gases in the CMIP5 Models, https://doi.org/10.1175/JCLI-D-12-00536.1, 2013.

Kerr, G. H., Waugh, D. W., Strode, S. A., Steenrod, S. D., Oman, L. D., and Strahan, S. E.: Disentangling the Drivers of the Summertime Ozone-Temperature Relationship Over the United States, J. Geophys. Res. Atmos., 124, 10503–10524, https://doi.org/10.1029/2019JD030572, 2019.

Kerr, G. H., Waugh, D. W., Steenrod, S. D., Strode, S. A., and Strahan, S. E.: Surface Ozone-Meteorology Relationships: Spatial Variations and the Role of the Jet Stream, Journal of Geophysical Research: Atmospheres, 125, e2020JD032735, https://doi.org/10.1029/2020JD032735, 2020.