Response to Referee #2

This study focuses on attributing the increase in surface ozone concentrations in China using different datasets and methods. Specifically, it compares discrepancies in attribution results derived from multiple reanalysis datasets and approaches—including data-driven statistical models, machine learning models, and process-driven atmospheric chemistry transport models (GEOS-Chem). The work holds significant value for more accurately quantifying ozone attribution in China and elucidating inconsistencies among existing studies. Overall, the manuscript is clearly written, and the conclusions are well-supported. I recommend publication after minor revision.

Response:

We sincerely thank the referee for the decision and constructive comments. The manuscript has been revised accordingly, and our point-by-point responses are provided below. The referee's comments are shown in black, and our replies are highlighted in blue. A tracked-changes version of the revised manuscript is also clearly showing the changes made.

While the results present variations in attribution outcomes across datasets/methods, the discussion regarding the underlying causes of these differences can be sharper. One recent study from the Tropospheric Ozone Assessment Report (TOAR, https://egusphere.copernicus.org/preprints/2024/egusphere-2024-3702/) has similarly addressed methodological disparities in ozone trend attribution in China. It would be helpful if the authors could incorporate a comparative evaluation between the two studies to enrich the discussion of result discrepancies.

Response:

We sincerely appreciate your valuable suggestions to improve our manuscript. We have incorporated a comprehensive comparative evaluation as follows:

1) "Lu et al. (2024) compared meteorology-driven O_3 trends derived from ERA5- and MERRA2-driven MLR models during the summer of 2013–2019. Their findings revealed that ERA5-derived trends were lower than those from MERRA2 in YRD and PRD, whereas trends derived from ERA5 were comparable to those from MERRA2 in BTH. This inter-study consensus further validates the robustness of our methodological framework." *[Lines 271–274 in the tracked-changes version of the revised manuscript]*
2) "Lu et al. (2024) also demonstrated a high degree of consistency among the MLR, ML, and GC models in PRD during summer. Specifically, all three

models indicated that meteorology contributed approximately 25% of O_3 variability over the period 2013–2019." *[Lines 353–355 in the tracked-changes version of the revised manuscript]*

3) "The GC's systematic overestimation of O_3 concentrations, as well as underestimation of O_3 increases, were also reported by Lu et al. (2024), in which the GC captured 13.6 ~ 81.1% of the observed O_3 increases in China during the summer of 2000–2019." *[Lines 370–372 in the tracked-changes version of the revised manuscript]*

Specific Comments:

Line 14: Clarify the specific ozone metric (e.g., MDA8, annual mean).

Response:

We have clarified the ozone metric as the "maximum daily 8-hour average O_3". *[Line 14 in the tracked-changes version of the revised manuscript]*

Sections 2.2.2–2.2.4: The temporal scale of statistical analyses (daily, monthly, or seasonal) is unclear. Please specify.

Response:

Thanks for your suggestion. We have revised the following statements to make it clear:

"In the decomposition process, $(X(t))$ represents the original daily time series" *[Line 122 in the tracked-changes version of the revised manuscript]*

"In this study, all statistical analyses were performed at the seasonal scale (spring: March-April-May; summer: June-July-August; autumn: September-October-November; winter: December-January-February)." *[Lines 132–133 in the tracked-changes version of the revised manuscript]*

"After establishing MLR models for the short-term and baseline components in each season", and "The constructed MLR models driven by meteorological variables from ERA5, MERRA2, or FNL in each season will allow a comprehensive analysis of multi-dataset uncertainties." *[Lines 146, 151–152 in the tracked-changes version of the revised manuscript]*

"quantify the meteorological influence on O_3 variations in four seasons" *[Line 214 in the tracked-changes version of the revised manuscript]*

"For each season, when examining the uncertainties arising from different datasets" *[Lines 231–232 in the tracked-changes version of the revised manuscript]*

Figure 6: The GEOS-Chem model suggests a smaller meteorology-driven ozone trend compared to data-driven methods. To what extent might this stem from GEOS-Chem underestimating observed ozone trends? While Figure S3 indicates the model captures overall temporal variability, please provide a quantitative evaluation of trend performance.

Response:

Thank you for your suggestion. Quantitative trend evaluation has now been provided in Table S4. During 2013–2022, GEOS-Chem simulated substantially lower O_3 trends than observations in China and BTH, but captured observed O_3 increases in YRD and PRD. Compared with 2013–2017, trend performance notably improved in BTH during 2018–2022. These quantitative comparisons confirm that the smaller meteorology-driven trends from GEOS-Chem partially stem from its underestimation of observed O_3 trends, especially during 2013–2017.

Following the Reviewer's suggestion, we have added newly Table S4 to provide a quantitative evaluation of trend performance and updated the discussion about multi-method uncertainty as follows: "As shown in Fig. S3 and Table S4, this difference could partly be attributed to the higher O_3 levels and lower O_3 increases simulated by the GC model before 2018." *[Lines 368–370 in the tracked-changes version of the revised manuscript]*

Table S4. Trends in GEOS-Chem-simulated (Sim) and observed (Obs) monthly mean MDA8 O_3 concentrations (ppb yr^{-1}) during 2013–2022, 2013–2017, and 2018–2022.

Region / Time period	China		BTH		YRD		PRD	
	Sim	Obs	Sim	Obs	Sim	Obs	Sim	Obs
2013–2022	–0.05	+0.84	–0.11	+0.89	+0.40	+0.97	+0.39	+1.07
2013–2017	–0.84	+0.27	–0.82	+0.22	–0.40	+0.29	+0.22	+0.31
2018–2022	–1.78	–0.86	–2.86	–2.49	–2.00	–0.96	–1.38	+0.17

References:

Lu, X., Liu, Y., Su, J., Weng, X., Ansari, T., Zhang, Y., He, G., Zhu, Y., Wang, H., Zeng, G., Li, J., He, C., Li, S., Amnuaylojaroen, T., Butler, T., Fan, Q., Fan, S., Forster, G. L., Gao, M., Hu, J., Kanaya, Y., Latif, M. T., Lu, K., Nédélec, P., Nowack, P., Sauvage, B., Xu, X., Zhang, L., Li, K., Koo, J.-H., and Nagashima, T.: Tropospheric ozone trends and attributions over east and southeast Asia in 1995–2019: an integrated assessment using statistical methods, machine learning models, and multiple chemical transport models, https://doi.org/10.5194/egusphere-2024-3702, 17 December 2024.