

Response to Referee #1

We thank the reviewer for their time and for these helpful comments. We carefully considered all your comments and made every effort to address them in this revised manuscript. In this response letter, we have repeated each of the reviewers' comments and provided our responses individually. Our responses are marked in blue. We also used "R1" to indicate the reviewer#1's comments and "A1" for our responses

Reviewer 1

Review of Ryoo et al. (2026) "Origin of Low Ozone above Western North America: An Investigation of Sources and Trends"

R1-1: Summary:

The authors use observations, model simulations, and reanalyses to diagnose increasing low-end (< 33rd percentile) ozone amounts over Western North America (WNA) from 1994-2021, even though regional emissions over WNA have decreased. Source Receptor Relationships (SRR) derived from FLEXPART and ERA5 backwards trajectories indicate a strong influence of the tropical Pacific and SE Asia for WNA lower-tropospheric low ozone amounts. Trends in SRR were fairly weak except for the UTLS which demonstrates a growing impact of aircraft emissions and lightning NO_x on "background" ozone increases over WNA. Furthermore, large positive trends in ozone production from the GMI model simulation over SE Asia are identified as contributing to low ozone amount increases over WNA. The authors are able to leverage their datasets and analyses to describe both dynamical/transport and chemical changes and their effects on WNA ozone amounts.

General Comments and Recommendation:

This is a well-motivated and executed analysis, the writing quality is excellent, and this will end up being one of the shortest reviews I have ever submitted. I recommend publication after just a few technical items and suggestions listed below.

A1-1: We sincerely appreciate your encouraging remarks. We are addressing all of the reviewers' comments, including your constructive suggestions, and are committed to successfully finalizing the manuscript.

Line-by-line/Technical Comments:

R1-2: Figure 1c: The two different vertical axes are confusing, so I suggest just using one.

A1-2: Thank you for the suggestion. We have updated the vertical axis of Figure 1c as suggested in the revised manuscript.

R1-3: Line 98: Delete “particle dispersion model”

A1-3: We deleted that.

R1-4: Check the reference list. I found at least one in the text that does not appear in the references

A1-4: Thank you for bringing this to our attention. We have carefully double-checked the text and updated these items throughout the revised manuscript.

R1-5: All relevant figures: I suggest instead using dots to denote p-values above 0.5, so you are not obscuring the values for your high confidence results.

A1-5: Thank you for this constructive suggestion to enhance the visualization of our results. We have updated the plots across the manuscript, using dots to denote low-confidence results ($p \geq 0.05$) accordingly.

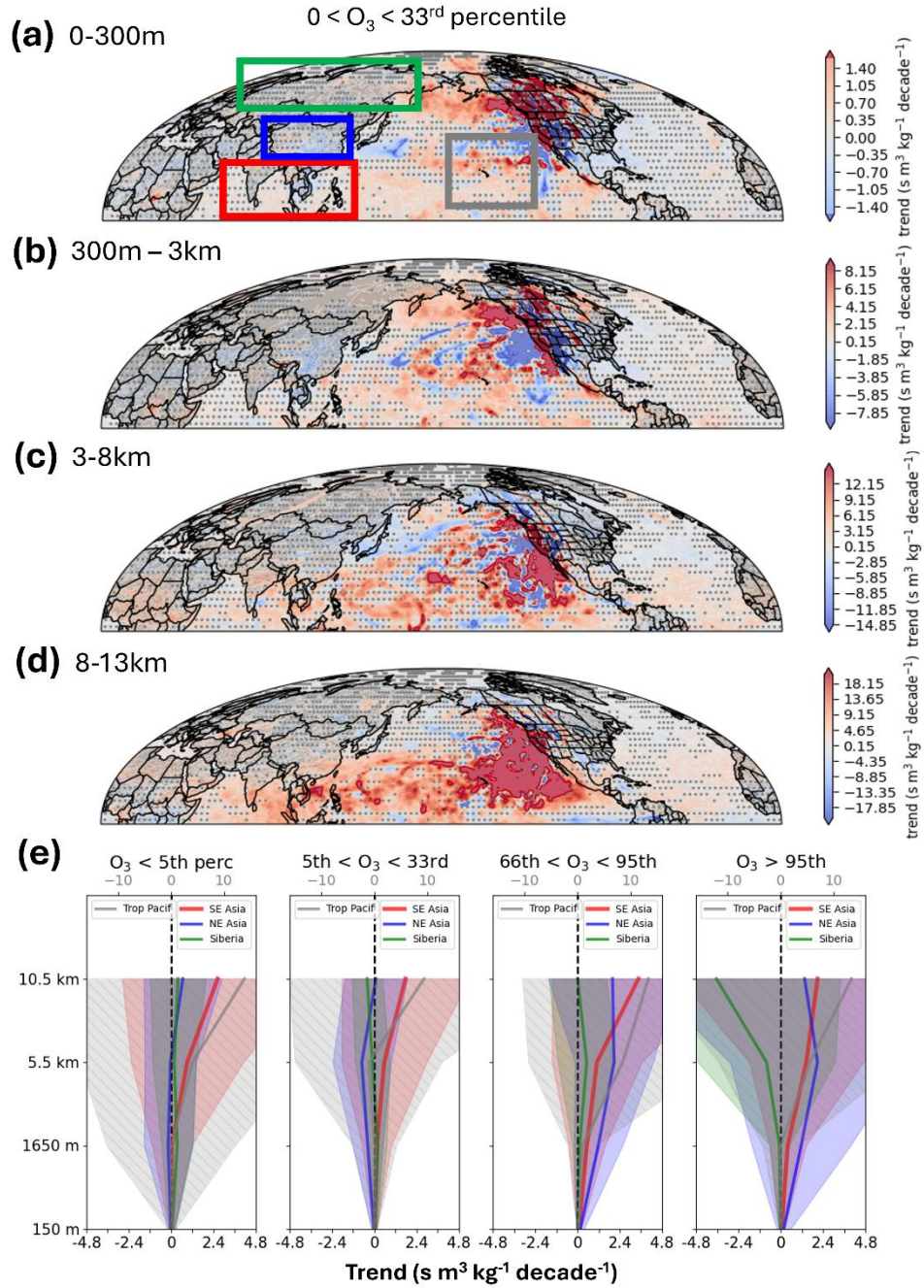


Figure 3. Trends in SRR over the interval 1994 – 2021. Panels (a) - (d) show SRR trends for low O_3 (5th to 33rd percentile range) over WNA for air parcels originating from four different layers: (a) 0–300 m, (b) 300 m–3 km, (c) 3–8 km, and (d) 8–13 km. Red colors identify regions of increasing influence. **The dots on the maps represent the grid cells with a lower confidence value (p -value ≥ 0.05).** The red, blue, green, and gray boxes in (a) represent SE Asia, NE Asia, Siberia, and Tropical Pacific, respectively. Panel (e) shows the vertical distribution of SRR trends for four regions

(SE Asia, NE Asia, Siberia, and Tropical Pacific) and four categories of ozone amount: $O_3 < 5^{\text{th}}$ percentile, $5^{\text{th}} < O_3 < 33^{\text{rd}}$ percentiles, $66^{\text{th}} < O_3 < 95^{\text{th}}$, and $O_3 > 95^{\text{th}}$ percentile. The trend values for the tropical Pacific are shown on the upper x-axis (gray), while those for the other regions are shown on the lower x-axis (black). The shaded region in (e) represents the ± 2 standard deviation (2σ) of each trend value at the given level for the region. For ease of visualization, the mid-level height of each layer is shown on the y-axis in panel (e).

R1-6: Line 460: Did I miss something or am I correct that MLS data do not appear anywhere in this paper?

A1-6: We apologize for the confusion. You did not miss anything; we had not included the MLS data plot in the original manuscript. Initially, we analyzed the OMI/MLS O_3 and OMI NO_2 data and calculated their trends (see below).

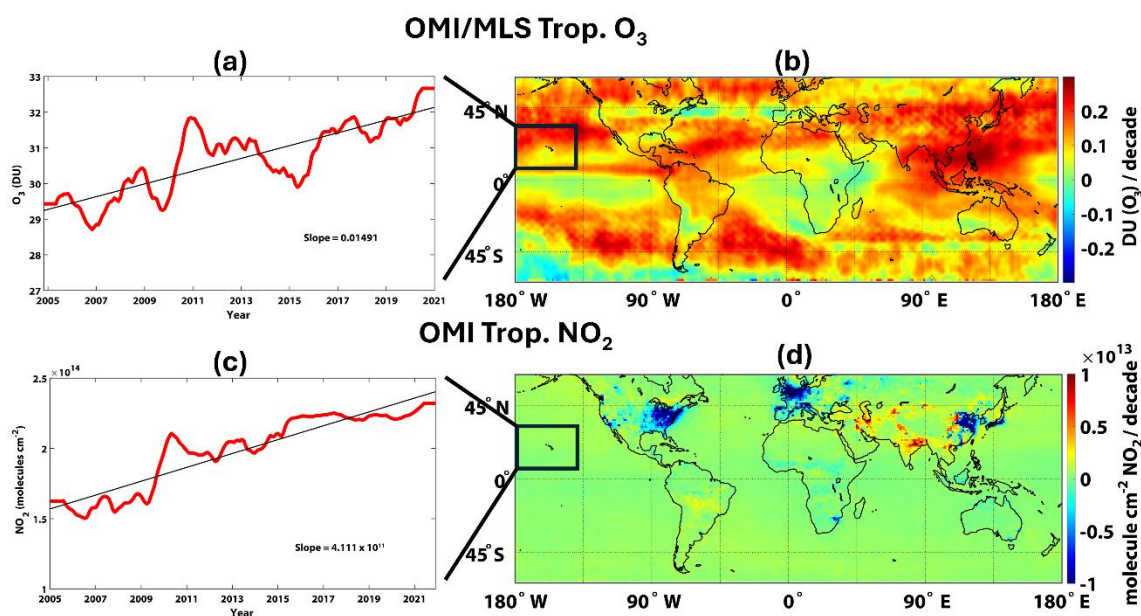


Figure R1. Trends in OMI/MLS tropospheric O_3 and OMI tropospheric NO_2 from 2005 to 2021: (a, c) over the Tropical Pacific and (b, d) globally.

However, we ultimately decided to omit these data from the original manuscript because:

- 1) The OMI/MLS O_3 and NO_2 trends show patterns consistent with TCR-2 and GMI over Western North America, including consistent increasing trends.

2) TCR-2 already assimilates OMI satellite observations, so including the raw satellite data did not provide substantial new insights.

Because these results align with our findings and support the datasets used in this study, we will remove this citation from the revised manuscript.

Citation: <https://doi.org/10.5194/egusphere-2026-1157-RC1>