Response to Referee #1:

Thank you very much for your insightful comments, valuable suggestions, and thoughtful recommendations, all of which have greatly contributed to improving this paper. The response to all your comments are listed below. There was an extensive discussion among the authors regarding how to revise the content, and this paper is subjected to a major revision for addressing the concerns by all the referees. Thus, the response is delayed, and we are sorry for this.

This paper discusses the CO flux and concentration over the Tibetan Plateau. The general idea and research findings are interesting, and I have a few comments to help improve the manuscript:

Specific Comments:

Figure 1: The figure does not clearly explain what the black, blue, orange, and red arrows represent. Please clarify in the caption.

Response: Thank you for your comment. We have adjusted the colors to better differentiate what each arrow represents and have updated the figure caption for clarity in the revised version: Figure 2: The black arrow $\boldsymbol{\omega}$ represents the wind field vector, $\boldsymbol{s}$ is the step vector for integration, and the blue arrow $\boldsymbol{n}$ denotes the boundary normal vector. $\boldsymbol{\beta}$ is the angle between the wind field vector $\boldsymbol{\omega}$ and the boundary normal vector $\boldsymbol{n}$, while Δs represents the integration step length. White arrows indicate the westerly circulation over the plateau, red arrows represent the South Asian monsoon, and orange arrows indicate the East Asian monsoon.

Figure 3: Why does the southeastern segment show high peaks (blue dots) from January to June 2021? Is this high concentration caused by emissions from South Asia? Please provide an explanation.

Response: The high peaks (blue dots) observed in the southeastern segment from January to June 2021 are primarily attributed to increased emissions from South Asia, including Nepal, India, and surrounding regions. A comprehensive analysis of TROPOMI data (Fig. S2 and Fig. S3) reveals a significant rise in CO concentrations during the winter of 2020 (January and February) and the spring of 2021, closely linked to a substantial increase in emissions across this region in early 2021. Additionally, analysis of MODIS fire data (Figs. S5 - S9) indicates a notable rise in fire occurrences in certain parts of South Asia during this period(Govardhan et al., 2023). Multiple studies and reports(Madineni et al., 2021; Davis et al., 2022) suggest that the post-pandemic economic recovery and rising energy demand were key drivers of the sharp rebound in global and South Asian emissions in 2021. In particular, increased energy consumption in the power and transportation sectors contributed to higher emissions.

Davis, S. J., Liu, Z., Deng, Z., Zhu, B., Ke, P., Sun, T., Guo, R., Hong, C., Zheng, B., Wang, Y., Boucher, O., Gentine, P., and Ciais, P.: Emissions rebound from the COVID-19 pandemic, Nature Climate Change, 12, 412-414, 10.1038/s41558-022-01332-6, 2022.

Govardhan, G., Ambulkar, R., Kulkarni, S., Vishnoi, A., Yadav, P., Choudhury, B. A., Khare, M., and Ghude, S. D.: Stubble-burning activities in north-western India in 2021: Contribution to air pollution in Delhi, Heliyon, 9, e16939, 10.1016/j.heliyon.2023.e16939, 2023.

Madineni, V. R., Dasari, H. P., Karumuri, R., Viswanadhapalli, Y., Perumal, P., and Hoteit, I.: Natural processes dominate the pollution levels during COVID-19 lockdown over India, Sci Rep, 11, 15110, 10.1038/s41598-021-94373-4, 2021.

Zhang, L., Liu, X., and Wang, Y. (2021). Carbon emissions rapidly rebounded following COVID pandemic dip. Nature, [Online] Available from: https://www.nature.com/articles/d41586-021-03036-x (Accessed: 24 February 2025).

Figure 5: Consider adding a slope to the yellow line to highlight the decline or increase in flux (also Figure 2) . Additionally, the statement on Page 9, Line 40, "the internal efflux transported through the northeastern segment is declining," is not clearly reflected in Figure 5. Please ensure the figure supports this observation.

Response: We have added a slope annotation to the yellow line to more clearly highlight the trend in flux changes. Additionally, we have updated the units for annual growth to ensure a more accurate representation of data variations and to improve the readability and consistency of the figure.We apologize for the confusion caused by our wording, which led to some misinterpretation. What we intended to convey is that "the CO flux transported outward through the northeastern segment is declining", which corresponds to the "flux, out" shown in Figure 7 under the "northeastern segment" title. Additionally, we have revised the original statement "the internal efflux transported through the northeastern segment is experiencing a decline" to "the efflux transported from the Tibetan Plateau through the northeastern segment is declining" for clarity.

Figure 6: The caption does not clearly state that the total column has already been adjusted by subtracting the mean annual CO total column. Please revise the caption for clarity. Can the author also provide the months for those four panels?

Response: We have revised the caption for clarity, as requested. The total column data has been adjusted by subtracting the mean annual CO total column. Additionally, we have provided the specific months for the four panels in the revised version of the figure caption.

Page 7, Lines 36–40: Does the flux change lead to an increase in the CO total column over the Tibetan Plateau? Additionally, how does the local CO emission rate change during this period? Please elaborate.

Response: The CO concentrations measured by CNEMC and TROPOMI reflect variations in near-surface CO levels and total atmospheric CO column over the Tibetan Plateau, respectively. According to TROPOMI data (Fig. S2 and Fig. S3) and model fitting results (Fig. 9), the total CO column over the Tibetan Plateau increased at a rate 0.76×10^{16} molec cm^{-2} yr^{-1} during the study period (Please see Section 4.2 for details). However, the trend in surface CO concentrations observed by CNEMC contrasts sharply with that of the TROPOMI total CO column. With the exception of

Shigatse and Nyingchi, surface CO concentrations in most cities exhibited a declining trend. Notably, Shigatse and Nyingchi, located near the borders of Assam, India, and Nepal, experienced an increase in surface CO concentrations at a rate of 0.02 mg m^{-3} yr^{-1} (Please see Section 3.1 for details), likely influenced by emissions from neighboring regions.

Figures 8: Could you add a wind speed legend for the arrows? This would help readers better understand the wind patterns and their impact on CO distribution.

Response: We have added the wind speed legend for the arrows in the revised version.