

Dear Editors and Referees:

Thank you very much for your careful review and constructive comments on our manuscript acp-2025-737. We have accordingly revised the manuscript carefully. The revised portions are highlighted in the revised manuscript. In the followings, we quoted each review question in the square brackets and added our response after each question.

Responses to Reviewer #2

[This work analyzes the role of Tibetan Plateau thermal forcing in stratosphere-troposphere transport through the Asian monsoon anticyclone and the westerly jet. Overall, the manuscript is very well written, the logic is sound, and the figures are clear. I did not find any major issues, and I recommend accepting it after minor revision.]

Response: Many thanks for the encouraging comments and helpful suggestions on our manuscript. Following the reviewer's suggestions and comments, we have accordingly made careful revisions. Please find our point-to-point responses as follows:

Major comments:

1. *[Lines 44-59: some necessary introduction of the background dynamics was missing in this paragraph. For example, which altitude is the westerly, and which altitude of the two branches? How are they connected with the Asian monsoon anticyclone?]*

Response 1: Thank you for the suggestion. In the revised manuscript (lines 50–57), we have accordingly added some necessary introductions of the background dynamics as follows:

“Climatologically, the westerly jet is located near the tropopause between 200 hPa and 300 hPa, with the southern branch extending northeastward from the southern side of the Tibetan Plateau (TP) to the Northwest Pacific and the northern branch stretching southeastward from the 40°–65°N region north of the TP toward the Northwest Pacific

(Cressman, 1981). During spring and summer, the thermal forcing of the TP induces the Asian summer monsoon anticyclonic circulation in the upper troposphere and lower stratosphere (UTLS) (Wu et al., 2007), intensifying the northern branch westerly jet northward, and inhibiting the southern branch westerly jet, which may even disappear by late June (Duan and Wu, 2005; Luo and Yanai, 1984).”

References:

- Cressman, G. P. (1981). Circulations of the West Pacific jet stream. *Monthly Weather Review*, 109(12), 2450-2463.
- Wu, G., Liu, Y., Zhang, Q., Duan, A., Wang, T., Wan, R., Liu, X., Li, W., Wang, Z., and Liang, X.: The influence of mechanical and thermal forcing by the Tibetan Plateau on Asian climate, *Journal of Hydrometeorology*, 8, 770–789, 2007.
- Duan, A., & Wu, G. (2005). Role of the Tibetan Plateau Thermal Forcing in the Summer Climate Patterns over Subtropical Asia. *Climate Dynamics*, 24, 793–807.
- Luo, H., & Yanai, M. (1984). The Large-Scale Circulations and Heat Sources over the Tibetan Plateau and Surrounding Areas during the Early Summer of 1979. Part I: Precipitation and Kinematic Fields. *Monthly Weather Review*, 112(6), 966–989.

2. *[Section 2.2: TP covers a smaller region compared with the Asian monsoon region. I understand that the authors want to emphasize the role of the TP, however, figure 3 and 4a show some significant region near the border of the TP region as selected. Some discussion is necessary for the regions beyond the selected region.]*

Response 2: Thanks for your suggestion. In the revised manuscript (lines 242–249), we have accordingly added the dissuasions as follows:

“Although TP covers a smaller region compared to the broader Asian monsoon region, the thermal forcing over the TP, as “the world roof”, is the decisive factor in the formation of the Asian monsoon anticyclone and plays a significant role in building the Asian monsoons (Wu et al., 2015; Duan et al, 2024; Xu et al., 2010). Fig. 3a and Fig. 4a encompass the region from 78°–103°E and 28°–38°N, covering most areas with elevations exceeding 3000 m, which are identified as the extent of the TP (Xu et al.,

2016). Moreover, the areas with heterogeneous correlations passing the significance test are primarily concentrated over the TP region including the TP platform within the 3000 m elevation border (black line) and some regions of the TP slopes near the TP platform. Therefore, our study focuses on this region to investigate the relationship between TP thermal forcing and STT variations.”

References:

Wu, G., Duan, A., Liu, Y., Mao, J., Ren, R., Bao, Q., ... & Hu, W. (2015). Tibetan Plateau climate dynamics: recent research progress and outlook. *National Science Review*, 2(1), 100-116.

Duan, A., Wu, G., Wang, B., Turner, A. G., Hu, J., Hu, W., ... & Tang, Y. (2024). Drivers of East Asian summer monsoon variability: Global oceans and the Tibetan Plateau. *Science Bulletin*, 69(16), 2487-2490.

Xu, X., Lu, C., Shi, X., and Ding, Y.: Large-scale topography of China: A factor for the seasonal progression of the Meiyu rainband?, *Journal of Geophysical Research: Atmospheres*, 115, <https://doi.org/10.1029/2009JD012444>, 2010.

Xu, X., Zhao, T., Liu, F., Gong, S. L., Kristovich, D., Lu, C., Guo, Y., Cheng, X., Wang, Y., and Ding, G.: Climate modulation of the Tibetan Plateau on haze in China, *Atmospheric Chemistry and Physics*, 16, 1365–1375, <https://doi.org/10.5194/acp-16-1365-2016>, 2016.

Specific comments:

1. *[line 36: multiscale climate patterns: what are the patterns?]*

Response 1: Thanks for your comment. We have revised the sentence to enhance clarity in the revised manuscript (lines 36–38) as follows:

“tropospheric ozone can influence global radiation balance and then the multiscale climate patterns of global, hemispheric, and regional circulations in the atmosphere such as high-latitude warming, Hadley circulation, and East Asian summer monsoon system (Chen et al., 2007; Li et al., 2018)”

2. *[Line 126: ‘over the Asia region’: to ‘over Asia’]*

Response 2: It has been corrected in the revised manuscript.

3. *[Line 138: ‘the low period of air mass STT’ to ‘the period of low air mass STT’]*

Response 3: It has been corrected in the revised manuscript.

4. *[Figure 3 and figure 4a: Is the black lines province boundary? This could be misleading and looks like contour of certain variables. I suggest use altitude in this figure since the focus of the figures are over the Tibetan Plateau.]*

Response 4: The black lines in Figs. 3a and 4a represent the 3000 m elevation contour outlining the area of the Tibetan Plateau.

5. *[Lines 328-332: this sentence is too long, please consider breaking into shorter sentences.]*

Response 5: Following the reviewer’s suggestion, we have broken into the shorter sentences in the revised manuscript (lines 356–361) as follows:

“Through the SVD diagnostic analysis, we identify a synergistic relationship between interannual variations in the TP thermal forcing and the STT frequency. The intensifying thermal forcing in the central to eastern TP is closely linked to increasing and decreasing STT frequency respectively along the northern and southern branches of westerly jet, while the enhancing thermal forcing over the western TP is related to the western enhancement and eastern decline STT over China and surrounding regions. The thermal forcing changes over the TP regions could regulate the interannual STT anomalies over China by altering the direct and indirect pathways of ozone STT. ”