RC1: 'Comment on egusphere-2025-952', Anonymous Referee #1, 14 Apr 2025

This study investigates the physiological and growth responses of Himalayan fir to climate warming and CO_2 fertilization across elevational gradients in wet and dry regions of the Tibetan Plateau. The research addresses a critical knowledge gap regarding the interplay between CO_2 fertilization, temperature, and drought stress in high-elevation forests. While the manuscript presents valuable insights, several issues need clarification to strengthen the conclusions.

[Response]: We are very grateful to the reviewer for the insightful and constructive comment on our paper. We have addressed the comments and concerns by carefully responding to each of the comments.

Major Concerns:

1. Interpretation Issue of Ci/Ca Scenarios: The comparison of observed Ci/Ca trends to theoretical scenarios lacks quantitative validation. The statement that Ci/Ca "largely followed Scenario 1" is qualitative and not statistically tested. Please quantify deviations from theoretical scenarios using goodness-of-fit metrics (e.g., RMSE, AIC) and report significance tests.

[Response]: We appreciate the reviewer's insightful comment regarding the statistical tests for the theoretical treatment of Ci/Ca in our initial analysis. We acknowledge that these models were oversimplified and failed to provide meaningful mechanistic explanations for our core findings. As this limitation was also noted by Reviewer #2, we have removed both the Ci/Ca analysis and related discussion from the revised manuscript.

2.Temporal coverage issue: The results section mentions post-1965 trends for most of the analyses, but we lack a temporal changes of temperatures to justify its relevance to modern climate change. Consider add a figure to show the climate warming in the study region.

[Response]: Comment accepted. We have provided the main climate variables over the past decades to better contextualize the research. According to the climate data,

the study area has experienced a significant and continuous warming trend over the past century (Fig. S5a). The change rate of the average temperature increased from 0.007°C/year (1901-1964) to 0.032°C/year (1965-2013) in the drier site (DJ), while the change rate of temperature in wetter site (SYD) increased from 0.008℃/year (1901-1964) to 0.023℃/year (1965-2013). However, the annual precipitation showed no significant changes since 1901 (Fig. S5b), resulting a general decreasing trend of SPEI for both sites (Fig. S5c)

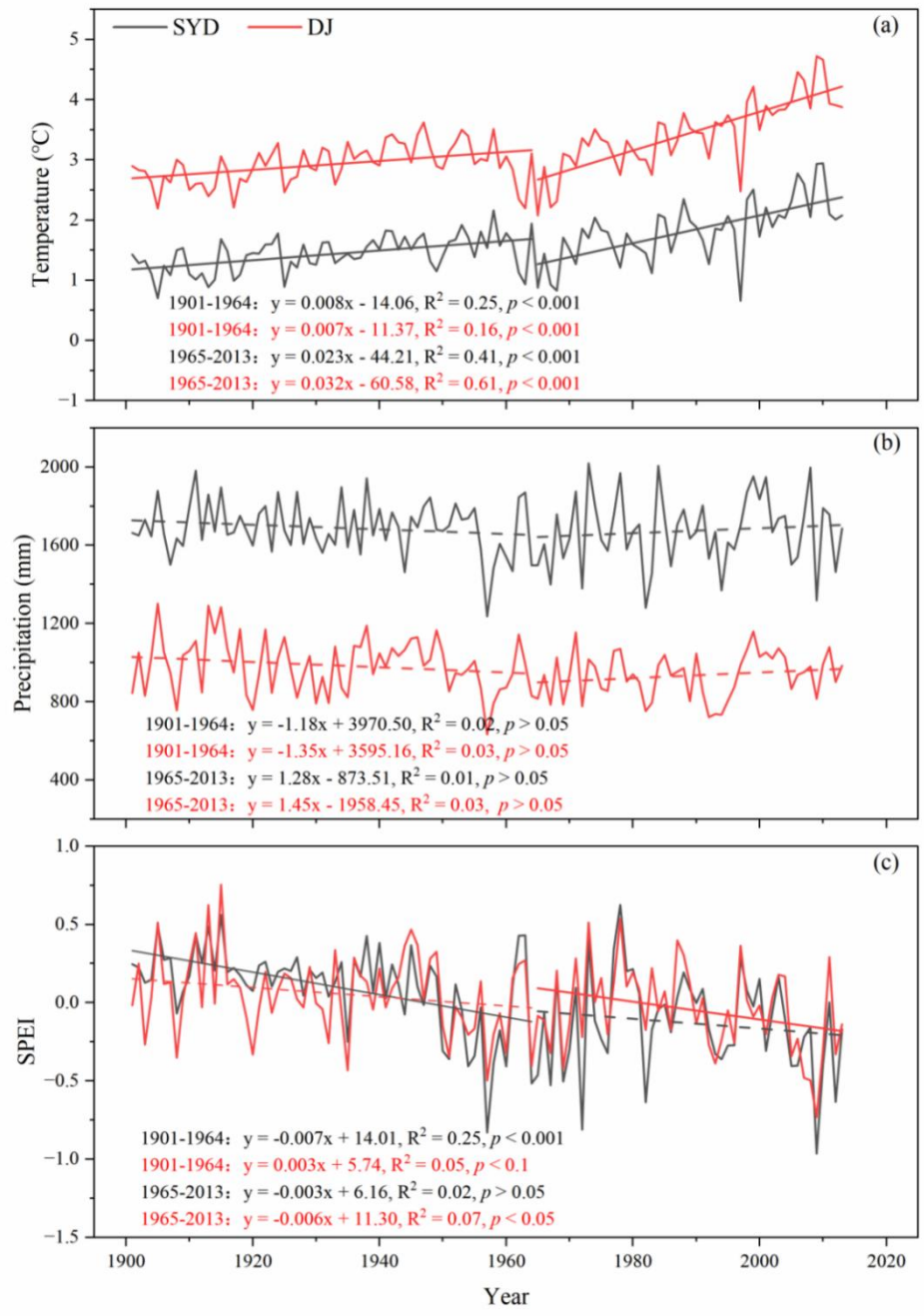

Fig. S5 Temporal variations of mean temperature (a), total precipitation (b), SPEI (c) for the

sampling sites based on the climate data extracted from the CRU TS 4.04 for the period 1901–2013.

Specific Concerns:

L14: The species name should be in italic. The same for L64.

[Response]: Thanks for your comment. Done as suggested.

L86: Liang et al., (2016) did not analysis this tree species, please remove it from here.

[Response]: Comment accepted. We have removed the reference in the revised manuscript.

L120: The text briefly mentions that the data on atmospheric carbon dioxide concentration is derived from ice core data, but does not elaborate on the specific source. Please provide the source and the reference literature.

[Response]: Thanks for your comment. Detailed information on the CO_2 were added in the revised manuscript: "CO_2 concentration data was derived from a combination of the reconstructed values (period 1900-2003) using ice cores (Mccarroll and Loader, 2004; Boucher et al., 2014) and the direct observations of CO_2 concentration for the period 2004-2013, which were obtained from the Mauna Loa Observatory of America (http://www.esrl.noaa.gov/gmd/obop/mlo/)."

L217: The sections 4.2 and 4.3 should be merged and summarised by a more physiologically meaningful title.

[Response]: We sincerely appreciate your insightful comments, which have helped strengthen our manuscript. In response to your suggestions, we have consolidated Sections 4.2 and 4.3 into a more focused section titled: "4.2 Spatial heterogeneity of tree growth-iWUE relationships ".

Specifically, we firstly removed the discussions on the oversimplified theoretical models of Ci/Ca changes, as they did not provide meaningful mechanistic explanations, then sharpened our discussion to emphasize the potential physiological

mechanisms driving the spatial heterogeneity in BAI-iWUE relationships as modulated by the interaction between altitudinal and moisture gradients. These revisions have allowed us to present a more coherent and mechanistically grounded interpretation of our main findings.

Reference

Boucher, E., Guiot, J., Daux, V., Danis, P. A., and Dussouillez, P.: An inverse modeling approach for tree-ring-based climate reconstructions under changing atmospheric CO_2 concentrations, Biogeosciences,11,12(2014-06-17), 10, 3245-3258, 2014.

McCarroll, D. and Loader, N. J.: Stable isotopes in tree rings, Quaternary Science Reviews, 23, 771-801, 10.1016/j.quascirev.2003.06.017, 2004.

Again, thank you very much for your insightful comments. We believe these revisions have substantially elevated the quality of our work. Should any additional clarifications be needed, we would be happy to address them.