Comment # 2

We thank the independent reviewer for the comments. The comments are all valuable and extremely helpful for revising and improving our paper, as well as the important guiding significance to our research. We have studied comments carefully and have made corrections accordingly, which we hope meet with approval. The main corrections in the paper and the response to the reviewer's comment are as follows:

This study investigates the duration required for ecosystems in China to revert to their pre-flash drought state, emphasizing the spatiotemporal patterns of recovery and the factors influencing them. Particularly notable are the findings regarding the impact of post-drought radiation, aridity index, and temperature on recovery time, especially in semi-arid and sub-humid regions. These findings hold significant implications for eco-hydrological research. However, substantial revisions are necessary before the manuscript can be considered for publication.

***R*: Thank you for your summary. We really appreciate your efforts in reviewing our manuscript. We have revised the manuscript accordingly. Our point-by-point responses are detailed below.**

Major comments:

(1) While the writing is satisfactory and effectively conveys the scientific ideas, the paper would benefit from further polishing to enhance clarity and coherence. Specifically, the introduction should be expanded to provide more detailed information rather than merely listing literature.

***R*: Thank you for your insightful feedback. We appreciate your suggestion regarding the clarity and coherence of the paper. We agree that expanding the introduction could provide a more comprehensive background and strengthen the paper's foundation. We will revise the introduction to include a more detailed discussion of the relevant literature and the context of the study, rather than just listing previous works. This should help to better frame the research and highlight**

its significance. Thank you for your valuable input; it will undoubtedly enhance the quality of the paper.

(2) A more in-depth discussion is needed, particularly regarding the detailed process analysis and discussion of GPP recovery from flash droughts. The manuscript currently lacks this depth. Incorporating an analysis of the unprecedented 2022 mega-drought in the Yangtze River Basin could serve as a valuable case study to enhance the discussion.

***R*: Thank you for your valuable comment. We recognize the need for a more detailed discussion in the manuscript. To address this, we will expand the discussion section to include an in-depth analysis of the 2022 mega-drought in the Yangtze River Basin. This will encompass a thorough examination of the causes of the event and its impact on Gross Primary Production (GPP) recovery. By incorporating this case study, the manuscript will provide a concrete example to better illustrate the effects of flash drought conditions on GPP dynamics. We appreciate your suggestion and will revise the manuscript accordingly to enhance its depth and relevance.**

(3) The definition of ecosystem recovery focuses on changes in Gross Primary Productivity (GPP) anomalies. However, in the current results, there are flash droughts lasting more than 100 days where GPP negative anomalies occur for only 5 days. Such cases should be excluded from the analysis.

***R*: Thank you for pointing this out. We agree that the definition of ecosystem recovery should be aligned with significant and sustained changes in Gross Primary Productivity (GPP) anomalies. To address this issue, we will refine the analysis criteria to exclude cases where flash droughts last more than 100 days but only exhibit GPP negative anomalies for a brief period of 5 days or less. This adjustment will ensure that the results more accurately reflect meaningful GPP anomalies and improve the robustness of the analysis. We appreciate your suggestion and will incorporate these changes in the revised manuscript.**

Specific comments:

L23: “response function functions”

***R*: Thank you for pointing out the spelling error "response function functions" in our manuscript. We will correct this mistake in the revised version.**

Line 48-49: It is interesting to study to what extent these ecosystems compensate. Even in the annual carbon balance, will flash drought have a lasting impact.

***R*: Thank you for your valuable feedback. While our study primarily focuses on ecosystem recovery following flash droughts, we acknowledge the importance of understanding the broader impacts, including potential long-term effects on the annual carbon balance. In response to your suggestion, we will include a discussion on this topic in the revised manuscript to provide additional context and highlight any lasting implications. We appreciate your input and will address this aspect in the discussion section accordingly.**

Line195-197: How were these vegetation classifications determined? Briefly discussing the phenological characteristics of these classifications would be helpful.

***R*: Thank you for your insightful question. To analyze the distinct responses of different vegetation types, we utilized the MODIS dataset from the International Geosphere-Biosphere Programme (IGBP) MCD12C1. This dataset provides global vegetation classifications based on various land cover types and phenological characteristics. In the revised manuscript, we will include a brief discussion on the phenological characteristics of these vegetation classifications. This additional information will help clarify how the different vegetation types were classified and their relevance to the study's analysis of ecosystem responses.**

Line 231: Please standardize the manuscript by changing all instances of "figure" to "fig".

***R*: Thank you for your suggestion. I will standardize the manuscript by replacing all instances of "figure" with "fig" to ensure consistency throughout the document.**

This change will be made in the revised version of the manuscript. We appreciate your attention to detail and will incorporate this adjustment accordingly.

Line 247-248: Please add the discussion about ecological drought.

***R*: Thank you comment. We will add a discussion on ecological drought with a focus on its relevance to flash droughts and ecosystem resilience. Ecological drought and flash drought are both types of drought phenomena, but they differ significantly in terms of time scales, impact mechanisms, and recovery processes. Ecological drought, characterized by prolonged conditions lasting months to years and resulting in long-term changes to ecosystem functions and structure (Sadiqi et al., 2022). In contrast, flash drought develops rapidly within days to weeks due to extreme weather, leading to immediate reductions in soil moisture and plant health (Yuan et al., 2023). The long-term nature of ecological drought can cause profound impacts such as reduced plant populations, increased soil erosion, and decreased biodiversity, necessitating a longer recovery period (Cravens et al., 2021). In contrast, flash droughts, while shorter in duration, cause rapid plant wilting, reduced crop yields, and soil cracking, with significant long-term consequences for ecosystem recovery (Xi et al., 2024). These two types of droughts can interact, with ecological droughts potentially making ecosystems more susceptible to flash droughts, and flash droughts exacerbating the impacts of ongoing ecological droughts. The combined effects of both types can intensify stress on ecosystems, complicating and prolonging the recovery process. We appreciate your suggestion, and this addition will be integrated into the discussion section of the revised manuscript.**

Line 251-253: The manuscript should emphasize the mechanisms underlying the study's findings. Adding a discussion on the differences between grasslands and forests, particularly focusing on root depth levels, would be beneficial.

***R*: Thank you for your suggestion. To enhance the manuscript, we will include a detailed discussion on the mechanisms underlying the study's findings. Specifically,**

we will address the differences between grasslands and forests, with a focus on the following aspects:

1. Root Depth Levels: Comparing the root depth profiles of grasslands and forests, highlighting how these differences affect their respective responses to flash droughts and their recovery mechanisms.

2. Mechanisms of Drought Resilience: An exploration of how root depth influences the ability of these ecosystems to withstand and recover from flash drought conditions. This will include a discussion on water uptake, soil moisture retention, and the role of root systems in mitigating drought impacts.

3. Ecological Implications: Discussion how variations in root depth and other physiological characteristics between grasslands and forests contribute to their recovery dynamics. This will provide a deeper understanding of the study's findings in the context of different vegetation types.

Incorporating this discussion will provide a more comprehensive view of the factors driving the observed differences in ecosystem responses and recovery. Thank you for highlighting this important aspect.

References:

Cravens, A. E., McEvoy, J., Zoanni, D., Crausbay, S., Ramirez, A., & Cooper, A. E. (2021). Integrating ecological impacts: perspectives on drought in the Upper Missouri Headwaters, Montana, United States. *Weather, Climate, and Society*, 13(2), 363-376.

Sadiqi, S. S. J., Hong, E. M., Nam, W. H., & Kim, T. (2022). An integrated framework for understanding ecological drought and drought resistance. *Science of The Total Environment*, 846, 157477.

Xi, X., Liang, M., & Yuan, X. (2024). Increased atmospheric water stress on gross primary productivity during flash droughts over China from 1961 to 2022. *Weather and Climate Extremes*, 44, 100667.

Yuan, X., Wang, Y., Ji, P., Wu, P., Sheffield, J., & Otkin, J. A. (2023). A global transition to flash droughts under climate change. *Science*, 380(6641), 187-191.