

September 14th, 2026

To: Prof. Margaret Zimmer, Editor of *HESS*

Subject: **Submission of EGUSPHERE-2026-3213 after revision**

Response to Editor comments:

General comments:

Thank you Dr. Zhang for your revised manuscript and thorough response to reviewers. We were fortunate to have the same reviewers assess your revised manuscript. One was sufficiently satisfied with your revisions. Another had relatively minor revision requests. In addition, I read through your revised manuscript and I have minor revision requests as well. Please address these reviewer and editor comments and resubmit a revised manuscript. Thank you.

Reply: We appreciate your detailed annotations in the manuscript. The comments from the editor and reviewers are very helpful to improve the quality of our manuscript (see the replies to the following comments).

1. Comment:

P 4 L114-115: Please explain what MixSIAR and IsoSource models are. This is the first mention of these and there isn't a clear explanation of what they are.

Reply: According to your suggestion, we have added brief descriptions of the MixSIAR and IsoSource models at their first mention in the manuscript to clarify what they are and improve readability. The detailed explanation is as follows (see Lines 114-120):

In the quantitative attribution of recharge sources, MixSIAR is an open-source R package for Bayesian isotope mixing models that estimate the relative contributions of potential water sources and their associated uncertainties (Moore and Semmens, 2008; Parnell et al., 2010), whereas IsoSource identifies feasible combinations of source contributions based on isotope mass balance (Phillips and Gregg, 2003). MixSIAR models are more accurate than IsoSource models in tracing water sources in permafrost regions (Fang et al., 2022).

2. Comment:

P 5 L 136: Significant digits. You have 3 significant digits for the area, so perhaps reduce significant digits for the percentages to 3 as well (e.g., change 41.52% to 41.5%).

Reply: According to your suggestion, we have revised the percentages from 41.52% and 58.48% to 41.5% and 58.5%, respectively, to match the three significant figures used for the area values. The detailed explanation is as follows (see Lines 140-143):

Among these, permafrost primarily occurs in the upstream and high-altitude areas, covering approximately $1.23 \times 10^4 \text{ km}^2$, which represents 41.5% of the basin's entire area. Seasonally frozen soil is mainly distributed in the midstream, downstream, and areas surrounding the lake, covering $1.74 \times 10^4 \text{ km}^2$, accounting for 58.5% of the total basin area.

3. Comment:

P 8 L 193-197: Please update the new text to be past tense.

Reply: According to your suggestion, we have revised the description of the snow sampling procedure to use the past tense consistently throughout the paragraph. The detailed explanation is as follows (see Lines 198-201):

Rainfall samples were placed in 100 mL polyethylene bottles and stored frozen. Snow samples were collected from the snowpack using clean, sealed plastic bags. During sampling, the surface layer of snow was first removed, and snow samples were then collected immediately adjacent to the soil interface and allowed to melt naturally at room temperature on the day of sampling. All water samples, including snowmelt, rainfall, and groundwater, were filtered through a 0.45 μm membrane filter before being transferred to 100 mL polyethylene sample bottles.

4. Comment:

Figure 1 f: It is hard to tell how close the soil cores are, perhaps adding a scale bar could help with perspective.

Reply: According to your suggestion, we have added a scale bar to Fig. 1f using

ArcGIS software to clarify the spacing between the soil coring locations. The detailed explanation is as follows (see Line 154):

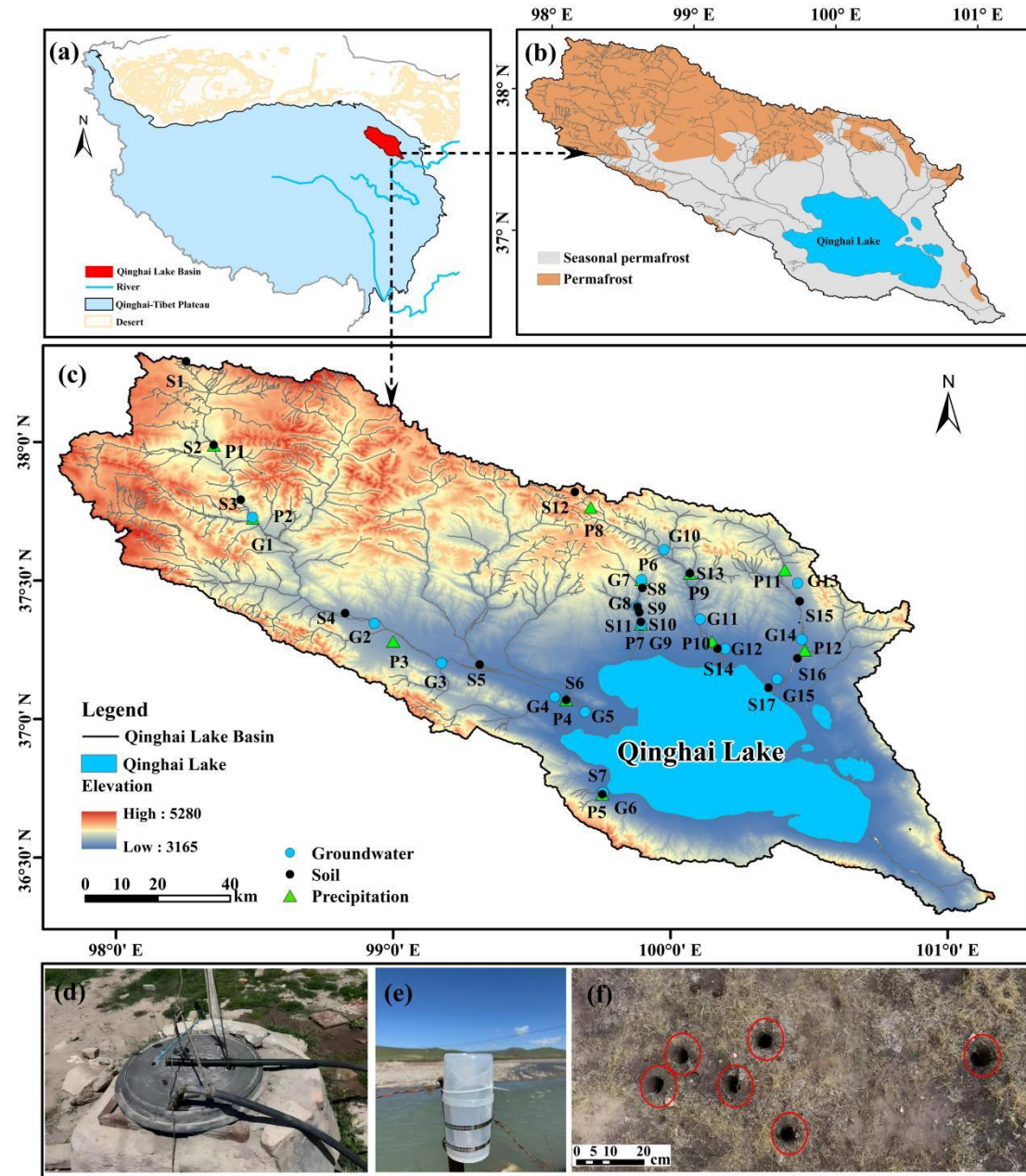


Fig. 1. (a) Location of the QLB on the QTP. (b) Spatiotemporal distribution of permafrost in the QLB, where gray and orange represent seasonal permafrost and permafrost, respectively. (c) Location of the QLB and distribution of sampling points. (d) Groundwater sampling. (e) Precipitation sampling. (f) Soil samples are collected monthly at adjacent locations.

5. Comment:

Table 2: It is not clear why the last column says "Example"... why not be more direct and list the months?

Reply: According to your suggestion, we have replaced “Example (Month)” with “Months” in Table 2 and listed the months directly as May–June, July–September, and October for the thawing, thawed, and freezing periods, respectively. The detailed explanation is as follows (see Line 218):

Table. 2 Division of FT Periods in the QLB

FT period	Criterion	Months
Thawing	Tmax, air > 0°C, Tmax,soil > 0°C	May and June
Thawed	Tmin, air > 0°C, Tmin, soil > 0°C	July, August, and September
Freezing	Tmin, air < 0°C, Tmin, soil < 0°C	October

6. Comment:

FT periods vs month: I appreciate that the authors added more clarity around the freeze thaw progression. However, it isn't quite clear why some figures (e.g., figures 3 and 4) are shown by their freeze-thaw condition, while others (e.g., figures 5 and 7) are still by month.

Reply: Thank you for highlighting this inconsistency in presentation. Figures 3 and 4 are organized by FT period to facilitate comparisons among periods, whereas Figures 5 and 7 retain the monthly resolution to show temporal variability, including changes within individual FT periods. To make this relationship explicit, we have added FT period annotations to Figures 5 and 7 while retaining the month labels. In addition, we have included a more detailed explanation in the caption for Figure 6. These changes allow the monthly results to be interpreted directly within the same FT framework. The detailed explanation is as follows (see Lines 361, 383 and 441):

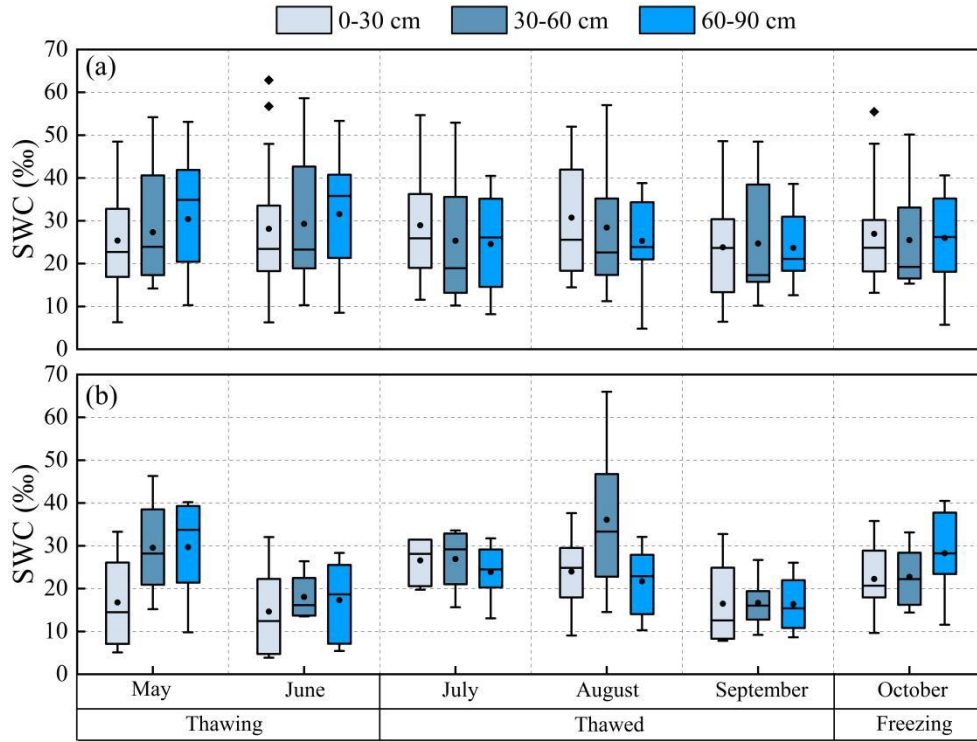


Fig. 5. Variations in SWC among different depths during the FT periods (a: middle and upper reaches; b: downstream). The error bar represents the variance of the calculated results across all data points.

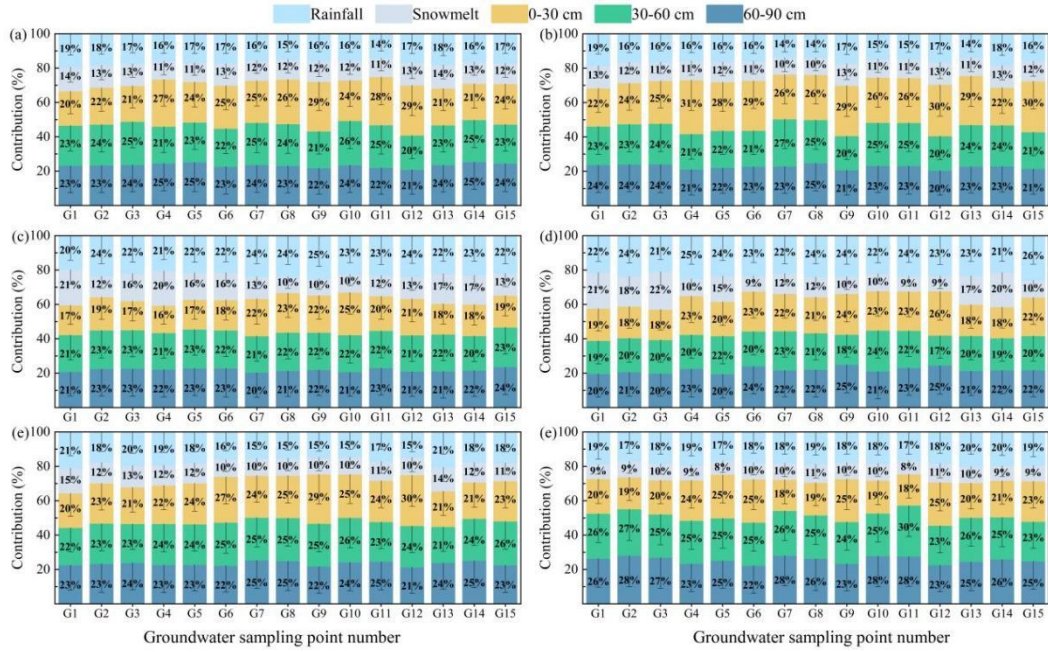


Fig. 6. Contribution of rainfall, snowmelt, and soil water from different depths to groundwater in the QLB during the FT periods (a and b: thawing; c, d and e: thawed; f: freezing). The error bar represents the variance of the calculated results across all data points. The x-axis labels denote sampling point numbers.

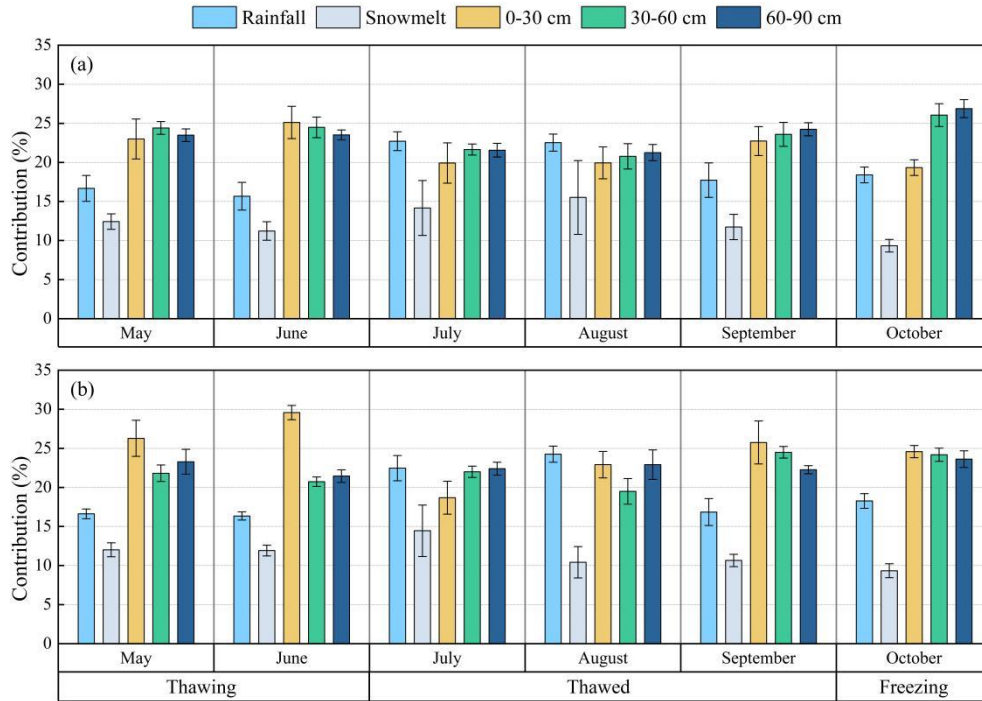


Fig. 7. Contribution of rainfall, snowmelt, and soil water from different depths to groundwater during the FT periods. (a) Middle and upper reaches. (b) Downstream. The error bar represents the variance of the calculated results across all data points.

Response to Anonymous Referee #1:

The authors addressed the comments well, and much improved the paper. I think it can be accepted.

Reply: We sincerely thank the reviewer for the positive assessment and recommendation for publication.

Response to Anonymous Referee #2:

The authors have carefully and constructively addressed all the major concerns raised in the previous review round, particularly regarding the mechanistic evidence for soil water as a transitional reservoir, the acknowledgment of model uncertainties, and the refined interpretation of lc-excess dynamics. The revised manuscript has been

substantially improved in both scientific rigor and clarity. However, before final acceptance, I suggest the authors consider the following minor points to further polish the paper:

Reply: We sincerely thank the reviewers for their positive feedback on our revised manuscript. We have carefully considered the remaining minor comments and revised the manuscript accordingly.

1. Comment:

While the authors have discussed the limitations of monthly sampling, they could briefly state in Section 2.3 or 2.4.3 why this low-frequency sampling is still sufficient to capture the seasonal recharge patterns during the freeze-thaw periods.

Reply: According to your suggestion, we have added a brief explanation in the 2.4.3 section of why monthly sampling is sufficient to capture seasonal recharge patterns during the FT period. The detailed explanation is as follows (see Lines 260-263):

Given the seasonal nature of FT processes, their effects on groundwater recharge extend beyond individual recharge events or daily variations. Therefore, we employed monthly sampling to investigate changes in groundwater recharge sources and pathways over a complete FT period.

2. Comment:

In Figure 3, the error bars are somewhat difficult to distinguish for the different soil layers. It would be helpful to slightly increase the transparency of the bars or use dashed borders to improve visual clarity, especially in black-and-white printing.

Reply: According to your suggestion, we have increased the length of the error bar end caps in Figure 3 to more clearly distinguish between the error bars for different soil layers and to improve their legibility in black-and-white print. The detailed explanation is as follows (see Line 312):

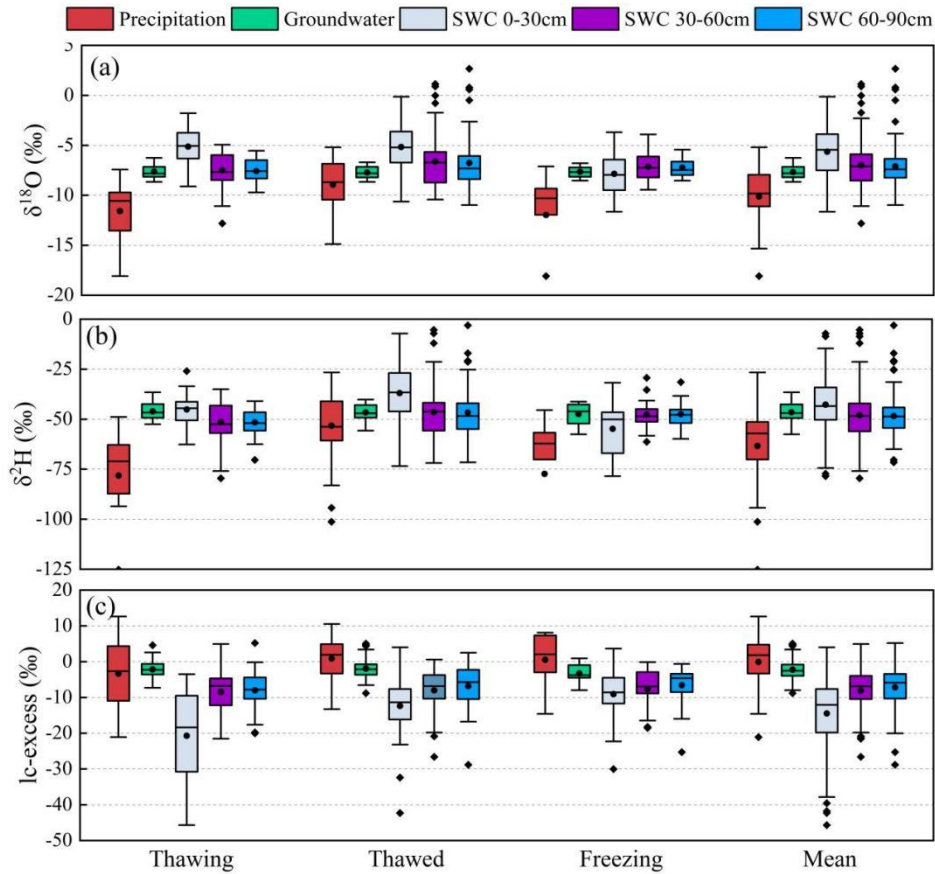


Fig. 3. Variations in $\delta^2\text{H}$ (a), $\delta^{18}\text{O}$ (b), and lc-excess (c) of precipitation, groundwater, and soil water at different depths during FT periods. The error bar represents the variance of the calculated results across all data points.

3. Comment:

In the reference list, the entry “Lu, S., Zhu, G., ... and : Optimizing irrigation...” (line ~733) appears to have a missing author name after “and”. Please double-check and complete this entry.

Reply: According to your suggestion, We have checked the reference and corrected the author list to include the missing name. The detailed explanation is as follows (see Lines 740-743):

Lu, S., Zhu, G., Qiu, D., Li, R., Jiao, Y., Meng, G., Lin, X., Wang, Q., Zhang, W., and Chen, L.:
Optimizing irrigation in arid irrigated farmlands based on soil water movement processes:
knowledge from water isotope data, *Geoderma*, 460, 117440,
<https://doi.org/10.1016/j.geoderma.2025.117440>, 2025.