Response to Anonymous Referee #2

We are very grateful for your valuable and instructive comments and suggestions. We have thoroughly revised the manuscript by addressing all the comments point by point. The review comments are listed below and marked in blue, followed by the detailed responses marked in black. The sentences added in the revised manuscript were marked in red and italic.

Kind regards,

Xiaobo He

(on behalf of the co-authors)

One issue is that the authors argued in their response to Referee #1's comment (https://tc.copernicus.org/preprints/tc-2022-17/) that this study considered the permafrost change effects on stream water ages beyond Song et al (2017) study, this argument did not convince me since the permafrost change data are not from this study region (detailed below). The permafrost temperature and active layer data should be representative. Anyway, this is a great study. The paper may be publishable after resolved those issues properly.

Response: Thank you for the comments and suggestions. The permafrost data we observed in our site is limited, which cannot support us to conduct a comprehensive regression analysis. Although the permafrost data (the soil active layer bottom temperature and active layer thickness) we used are regional average data, our study site was located in this region. Moreover, the data we currently have are in good agreement with the permafrost data reported in the Blue Book on Climate Change in China 2021, with R^2=0.80 and P=0.000 for active layer thickness and R^2=0.56 and P=0.003 for active layer bottom temperature, respectively. Thus, these regional data of permafrost can be used for regression analysis in our study site to a certain extent.

L56: Yang 2021 reference is missing in the reference list.

Response: Sorry for this mistake. We have added this (Yang et al., 2021) reference in the revised manuscript.

Yang, Y., Weng, B., Yan, D., Gong, X., Dai, Y., and Niu, Y.: A preliminary estimate of how stream water age is influenced by changing runoff sources in the Nagqu river water shed, Qinghai-Tibet Plateau, Hydrological Processes, 35, e14380, https://doi.org/10.1002/hyp.14380, 2021. (line 729-729)

L93 and Figure 2: At what depths were the soil moisture and temperature measured? Please clarify. Soil moisture and temperature can have large differences between the upper and deeper layer. Authors must specify the exact depth measured.

Response: Thank you for the suggestion. In our study, the soil moisture and temperature data were measured at depths of 5, 20, 40, 60, 100, 160, 220, and 300 cm. We have added this statement in the revised manuscript as follows:

The soil moisture and temperature data were measured at depths of 5, 20, 40, 60, 100, 160, 220, and 300 cm. (line 93-94)

Table 1: This table provides a lot data that seems not measured in this study. For example, according to L102-103, the soil active layer bottom temperature and active layer thickness are from the Blue Book on Climate Change in China 2021 (Fig 3.5 as I know). Those data are regional average data along the Kunlun Mountain-Liangdaohe section, which may not be suitable to represent the permafrost and active layer condition in this study area. More importantly, these data were used in the regressions in Table 4, which brings more uncertainty to the results. Please use the permafrost and active layer observation data in your site. If these data are unavailable, please at least clarify the data source in Table 1 and uncertainties in Table 4.

Response: Thank you for the comment and suggestion. The permafrost data we observed in our site is limited, which cannot support us to conduct a comprehensive regression analysis. Although the permafrost data (the soil active layer bottom temperature and active layer thickness) we used are regional average data, our study site was located in this region. Moreover, the data we have are in good agreement with the permafrost data reported in the Blue Book on Climate Change in China 2021, with R^2=0.80 and P=0.000 for active layer thickness and R^2=0.56 and P=0.003 for active layer bottom temperature, respectively. Thus, these regional data of permafrost can be used for regression analysis in our study site to a certain extent. Meanwhile, we clarified the data source again and added statement of uncertainty in the revised manuscript as follows:

The soil temperature data (active layer bottom temperature) and active layer thickness of permafrost were obtained from the book of Blue Book on Climate Change in China 2021, which published long-term data, related to the permafrost along the Kunlun Mountain to the southern slope of Tanggula Mountain in the central TP (Cma Climate Change Centre, 2021). (line 103-105)

In addition, the permafrost data used in regression analysis are regional average data, which may increase the uncertainty of the regression analysis (Table 4). (line 504-506)

L146: Two isotopic tracers can track three water sources. Only one isotope tracer is needed to perform two-source separation. So which isotope do you use in the two-component hydrograph separation?

Response: Thank you for the suggestion. In this study, the $\delta^{18}O$ data were used in the two-component hydrograph separation. Because, in previous studies, $\delta^{18}O$ have been widely used to segment river components. We have added this statement in the revised manuscript as follows:

In this study, the $\delta^{18}O$ data were used in the two-component hydrograph separation. (line 148-149)

Section 2.5: Kirchner in 2016 (www.hydrol-earth-syst-sci.net/20/279/2016/ and its companion paper) showed that the young water fraction (Fyw) is also a useful descriptor of stream water age. Your dataset can estimate the Fyw reliably. Why this study uses MRT not Fyw?

Response: Thank you for the suggestion. Indeed, the young water fraction (Fyw) is also a useful descriptor of stream water age, especially in heterogeneous and nonstationary catchments. In this study, our catchment is a typical permafrost catchment, its underlying surface was relatively uniform with less landscape heterogeneity and characterized by rapid hydrological processes. The estimated MRTs have low bias in such catchment. Thus, MRT may be more intuitive and clear indication of water age than the proportion of young water within the permafrost catchment. Nevertheless, in future research, we might attempt to contrast the application between these two parameters in permafrost catchment.

L197: All the citations (Wang et al., 2022; Sugimoto et al., 2003; Throckmorton et al., 2016) are missing in the reference list.

Response: Thank you. We have checked all references in the manuscript.

Figure 7: Stream water in June 2018, June 2019, June & July 2020 are completely precipitation sourced. Why?

Response: Thank you for the comment. Because we did not observe the generation of supra-permafrost water in the sampling well in June 2018 and June 2019 due to the low air temperatures and thin active layer of permafrost, resulting in not much water within the permafrost. The monthly mixing diagram in June and July 2020 using the mean $\delta^{18}O$ and δD showed that the isotope values in stream water are very close to the that of precipitation (Fig. 6). Thus, in these stages, the components of stream water were dominated by precipitation. These statements have been added in revised manuscript (line 266-267 and 278-279).

References

Yang, Y., Weng, B., Yan, D., Gong, X., Dai, Y., and Niu, Y.: A preliminary estimate of how stream water age is influenced by changing runoff sources in the Nagqu river watershed, Qinghai-Tibet Plateau, Hydrological Processes, 35, e14380, https://doi.org/10.1002/hyp.14380, 2021.