Hydrology and Earth System Sciences Discussions

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Reply on RC1

Li Zongxing et al.

Author comment on "Soil water sources in permafrost active layer of Three-River Headwater Region, China" by Li Zongxing et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-558-AC1, 2022

General comments

Comment 1:

In this manuscript, the authors analyzed the spatial variability of the isotopic composition of soil water at different depths in the Three-River Headwater Region (China). The isotopic composition of soil water was compared to the isotopic signatures of precipitation and ground ice, and it was related to elevation, soil moisture and soil temperature. In addition, the authors quantified the contribution of precipitation and ground ice to soil water. The topic of this manuscript is potentially interesting for the readers of Hydrology and Earth System Sciences. I think the authors presented a valuable and interesting dataset that it is difficult to collect at high-elevation catchments. Nonetheless, several important methodological details were not presented in the manuscript, and I have major concerns about the approach adopted for the data analyses.

Response 1:

Thank you very much for your guidance and advice. We will revise the manuscript thoroughly according to your comments. Frankly speaking, this is the first time that a systematic study of the sources of soil water on the Tibetan plateau has been carried out. As you say, the authors presented a valuable and interesting dataset that it is difficult to collect at high-elevation catchments.

Comment 2:

Firstly, it seems that the authors have not considered how the likely heterogeneous soil properties, the local topography, the climate and other characteristics could have affected the main results of the study. Indeed, the authors carried out their study in a very wide study area, but besides grouping the data based on soil depth, main land use or aspect, they have not analyzed the dataset based on other characteristics (e.g., data could have been grouped by subcatchment, homogeneous soil properties, presence of permafrost etc.).

Response 2:

Thanks for your comment. We will analyze the influence from the heterogeneous soil properties, the local topography, the climate, the main land use or aspect and the presence of permafrost on stable isotope of soil water in study region, and we have the data for it.

Comment 3:

Secondly, the authors have not described the soil type and in general, the main soil properties in the study area, as well as the spatial distribution of permafrost and the ground ice (details about how the presence of permafrost was determined and thickness of these layers should be added). Furthermore, given the large study area, I recommend a better characterization of the climate and estimates of potential evapotranspiration, as well as an analysis of the temporal variability of the meteorological variables and the isotopic composition of the water sources.

Response 3:

Thanks for your comment. On the one hand, we will add the introduction of the soil type, the main soil properties, as well as the spatial distribution of permafrost and the ground ice, and we have the data for it. On the other hand, we will analyse the climatic characteristics and its changes in the study region, including potential evapotranspiration. In addition, we will briefly introduce the isotopic composition of the water sources.

Comment 4:

Thirdly, in the quantification of the contribution of precipitation and ground ice to soil water, the authors should estimate the uncertainty due to the measurement errors and the high spatial and temporal variability in the isotopic composition of the various water sources. In addition, I think these contributions should be related to the specific subcatchment and sampling period (particularly, if the samples were collected during different sampling times, from June 2019 to July 2020).

Response 4:

Thanks for your comment. On the one hand, the uncertainty of tracer--based hydrograph separations can be calculated using the error propagation technique (Genereux, 1998; Klaus and McDonnell, 2013). On the other hand, precipitation samples were collected during from June 2019 to July 2020, whereas other samples for Ground ice, River water, Supra-permafrost water and Glacier snow meltwater in July 2019. In addition, The Three-River Headwater Region covers 363,000 km^2 (31°39'–36°12'E, 89°45'–102°23'E), accounting for 50.4% of the total area of Qinghai Province with Very large number of subcatchments. so it is Achievable and reasonable for the quantification of the contribution of precipitation and ground ice to soil water in July 2019.

Genereux, D.P., (1998). Quantifying uncertainty in tracer-based hydrograph separations. Water Resources Research, 34(4), 915-919.

Klaus, J., McDonnell, J.J., (2013). Hydrograph separation using stable isotopes: Review and evaluation. Journal of Hydrology, 505, 47-64.

Comment 5:

Finally, I think some parts of the results and the discussions should be revised to avoid a mixture of the two sections (please see my technical corrections).

Response 5:

Thanks for your comment. We will double check and revise some parts of the results and the discussions in order to avoid a mixture of the two sections based on technical corrections.

Specific comments

Comment 6:

In section 2.1, the authors should present (by also using a table) quantitatively the land use in the study region, as well as information about the main soil types, their average depths, and other available details on soil properties. Furthermore, details about the spatial distribution of discontinuous permafrost and how the presence of permafrost was assessed should be added in this section.

Response 6:

Thanks for your comment. Based on our data and field observations, we will add the analysis on the land use, the main soil types, the average soil depths and other available details on soil properties. Furthermore, details about the spatial distribution of discontinuous permafrost and how the presence of permafrost was assessed will also be added in this section.

Comment 7:

Lines 148-152: I suggest providing mean annual precipitation and temperature data here, and adding a table with the monthly characteristics of the meteorological variables during the sampling period.

Response 7:

Thanks for your comment. Based on our previous studies (Li et al,2021) and data, we will add a table with the monthly characteristics of the meteorological variables during the sampling period.

Li Zongjie, **Li Zongxing*,** Feng Qi*, Wang Xufeng, Mu Yanhu, Xin Huijuan, Song Lingling, Gui Juan, Zhang Baijuan. (2021). Hydrological effects of multiphase water transformation in Three-River Headwaters Region, China. Journal of Hydrology, 601, 126662: 1-16.

Comment 8:

In sections 3.1 and 3.2, the isotopic composition of soil water is not presented in relation to the isotopic signature of precipitation determined in the same sampling period.

Response 8:

Thanks for your comment. Based on the spatial distribution of national meteorological observation stations, A total of 375 precipitation (event scale) samples were collected from five stations at different altitudes from June 2019 to July 2020: Zhimenda (92.26° E, 34.14° N, 3540 m), Tuotuohe (34.22° N, 92.24° E, 4533 m), Zaduo (32.53° N, 95.17° E, 4066.4 m), Dari (33.45° N, 99.39° E, 3967 m), and Maduo (34.55° N, 98.13° E, 4272.3 m) In study region, which is because these five meteorological stations are staffed by observers, while the others are all automatic stations. Meanwhile , soil profiles of 1 m were excavated at 90 sampling sites In July 2019. So it is reasonable to analyze the stable isotope in soil water. In addition, the The spatial and temporal patterns of precipitation stable isotopes and their environmental significance have been analysed in previous studies (Li et al,2022, under review), so the basic information on stable isotopes of precipitation will be added in the revision.

Li Zongxing*, Feng Qi*, Wang Xufeng, Mu Yanhu, Xin Huijuan, Song Lingling, Gui Juan, Zhang Baijuan. (2022). Spatial and temporal patterns of precipitation stable isotopes and their environmental significance in the Three-River Headwater Region. Journal of Hydrology, under review.

Comment 9:

Lines 581-592: Figure 8 alone cannot support this discussion because the dual isotope plot depicts the isotopic composition of various water sources, from very distinct sampling sites distributed in a very large study area. My suggestion is providing an analysis based on small subcatchments where there are homogeneous soil characteristics.

Response 9:

Thanks for your comment. In addition to the average conditions in the study region, we will further analyse the sources of soil moisture in the permafrost and seasonal frozen zones of the Yangtze River, Yellow River and Lancang River sources region. It should be emphasised that this study mainly explores soil water sources from a large regional scale, while further systematic observations are needed for micro-scale studies, such as subcatchments.

Comment 10:

Lines 629-631: This sentence needs to be supported by the results of a statistical test.

Response 10:

Thanks for your comment. We will analyze the results of a statistical test in the revision.

Comment 11:

Lines 632-635: Figure 9 is not meaningful because it presents a regression line fitted to only three data points.

Response 11:

Thanks for your comment. This is not the regression line fitted to only three data points, whereas The straight lines have been artificially added only to reflect the relationship between the three end elements when the soil water source is determined.

Comment 12:

Lines 637-647: Uncertainty should be added when presenting the contribution of precipitation and ground ice to soil water.

Response 12:

Thanks for your comment. the uncertainty of tracer--based hydrograph separations can be calculated using the error propagation technique (Genereux, 1998; Klaus and McDonnell, 2013).

Comment 13:

Lines 692-693: Based on Figure 11, I disagree with this sentence because all regressions seem to have very low coefficients of determination. Are the regressions significant?

Response 13:

Thanks for your comment. We will analyze the results of a statistical test in the revision.

Comment 14:

Lines 698-703: The regressions should be tested to assess whether they are statistically significant or not.

Response 14:

Thanks for your comment. We will analyze the results of a statistical test in the revision.

Comment 15:

Lines 698-736: Most of the sentences report results, which should be moved to the previous sections.

Response 15:

Thanks for your comment. These sentences reported the altitude effect of stable isotopes in soil water, which is different and Non-repetitive from the previous sections.

Comment 16:

Lines 766-770: The relations shown in Figure 12 are very weak, and thus they cannot

support the statement that the isotopic composition is related to the soil moisture.

Response 16:

Thanks for your comment. We will analyze the results of a statistical test in the revision.

Comment 17:

Lines 805-812: The soil temperatures reported in Figure 12 and Table 3 are very high for soils where there is a permafrost layer. Are there soil temperature data measured very close to the permafrost layer? I suggest providing clear details about the spatial distribution of permafrost (and its depth) for the sampling sites where soil water was collected.

Response 17:

Thanks for your comment. Soil water and temperature were simultaneously measured at intervals of 20 cm in the soil profile during sampling using a portable soil water measurement instrument (TZS-IW) (Fig. 1). Soil temperature ranged from -40 ºC to 100 °C with an accuracy of ± 0.5 ºC. Soil moisture (% (m^3/m^3)) ranged between 0–100% with a response time of < 2 s. also, we will provide the clear details about the spatial distribution of permafrost (and its depth) for the sampling sites where soil water was collected.

Comment 18:

Tables 1, 2 and 3: Sample size per each group of data should be provided in the tables. Furthermore, information about the sampling times should be added in the captions of the tables.

Response 18:

Thanks for your comment. The average values of stable isotope, Sample size and sampling times will be added in the captions of the tables.

Comment 19:

Figure 1: I suggest adding the spatial distribution of permafrost in the study area, and showing the land use. The size of the labels is too small.

Response 19:

Thanks for your comment. Figure 1 will be revised based on our data.

Comment 20:

Figures 5 and 6: I suggest using the same colour scale for all depths, and showing where bare rocks and glaciers are located (it does not make sense having interpolated isotopic

values where there is no soil). Furthermore, details about how the interpolated maps were obtained are not present in the Data and methods section.

Response 20:

Thanks for your comment. Figures 5 and 6 will be revised based this suggestions, and the spline function method with altitude effect of stable isotope will be presented in the Data and methods section.

Comment 21:

Figure 9: Error bars representing the spatio-temporal variability should be added but, given that the figure is not meaningful, I suggest removing the figure.

Response 21:

Thanks for your comment. This is not the regression line fitted to only three data points, whereas The straight lines have been artificially added only to reflect the relationship between the three end elements when the soil water source is determined.

Comment 22:

Figure 11: The figure is unreadable because the labels are too small, there are too many regression lines (probably the regressions are not significant), and the legend is missing. I suggest moving the equations in a new table.

Response 22:

Thanks for your comment. Figure 11 will be revised, and We will analyze the results of a statistical test in the revision. In addition, the equations will be moved in a new table.

Comment 23:

TECHNICAL CORRECTIONS

Lines 167-171: Please add a reference to support this sentence.

Line 183: It is unclear whether it is snowmelt water, glacier melt water or snowmelt from a glacierized area. I suggest rewording.

Line 236: Based on the description this seems to be glacier melt water, but it cannot be assessed whether it consists more of snowmelt or ice melt water.

Lines 315-327: This explanation belongs to the discussion. I suggest moving the sentences to the proper section.

Lines 338-345: This explanation also belongs to the discussion. I suggest moving the sentences to the proper section.

Lines 348-354: This explanation also belongs to the discussion. I suggest moving the

sentences to the proper section.

Line 526: I suggest replacing ‘there were high variations’ with ‘there was a high variability’.

Lines 560-568: This explanation belongs to the discussion. I suggest moving the sentences to the proper section.

Line 579: It should be ‘indicating’.

Lines 582-594: This explanation belongs to the discussion. I suggest moving the sentences to the proper section.

Lines 832-838: These results should be moved to the previous sections.

Lines 647:655: This explanation belongs to the discussion. I suggest moving the sentences to the proper section.

Lines 685-687: This explanation belongs to the discussion. I suggest moving the sentences to the proper section.

Line 692: The citation should be (Sprenger et al., 2017).

Response23:

Thanks for your corrections, and we will revise these in the newest version of paper.