Response to Reviewer#3

Anonymous Referee #3

Received and published: 6 December 2019

This manuscript presented interesting work on detecting hydrological processes via stable isotope technique conducted in the source area of the Yellow River, where undergoing permafrost degradation caused by climate changes. However, some major issues with the isotope data interpretation, the basis of hydrograph separation and the model calculations, which brought in large uncertainties. Meanwhile, in the discussion section, especially in 4.3, the authors seemed to simply put on existed references or just to repeat reporting similar opinions and reviews from previous studies to support their results, which resulted in the lack of novelty and scientific significances. How the data and results presented in this manuscript can defend for the permafrost hydrology. Besides, there was no discussions on the glacier melting. Overall, I feel sorry to say that the current quality of this manuscript cannot reach the requirement to be published in HESS, as it did not clearly focus on the "Hydrological and Runoff Formation Processes", nor solve the evolution mechanism of regional runoff involved with climate changes, permafrost degradation, glacier hydrology. I hope the authors can rewrite their manuscript, not only to improve the writing skills and English expressions, but also to significantly contribute to new hydrological insights.

Thank you very much for your comments.

Major concerns:

1. There is no clear 2H- 18O space to show the isotopic differences between precipitation, runoff water, permafrost meltwater, glacial meltwater as well as no description on the isotopically comparisons.

Thank you very much for your comments. the isotopic differences between river water, supra-permafrost water, glacier snow meltwater, and precipitation analyzed in Section 3.4. Fig. 7 also showed the isotopic differences between river water, supra-permafrost water, glacier snow meltwater, and precipitation. The results showed as: "The distribution of δD and $\delta^{18}O$ for river water among other water bodies are shown in Fig. 7 during the different ablation periods in 2016 and ablation from 2016 to 2018. The results of the distribution of δD and $\delta^{18}O$ of river water indicate the possible recharge sources of river water. However, the δD and $\delta^{18}O$ of river water, supra-permafrost water, glacier snow meltwater, and precipitation exhibited little change during the initial ablation in 2016 (Fig. 7a, b). This phenomenon suggests that precipitation may be the major recharge sources for river water during the initial ablation. A plot of δD versus $\delta^{18}O$ for river and supra-permafrost water, glacier snow meltwater, and precipitation is shown in Fig. 7c. The δD and $\delta^{18}O$ values of glacier and snow meltwater from above the LMWL are the most negative compared to other water bodies. The stable isotope of supra-permafrost water was relatively more positive, located below the LMWL, confirming the influence of strong evaporation. The stable isotope of river water was close to the LMWL, and its concentration value was between precipitation, glacier and snow meltwater, and supra-permafrost water, reflecting that river water was recharged and affected by multi-source water in the study area. Moreover, the distribution of river water, glacier and snow meltwater, and supra-permafrost water also indicated that there was a hydraulic relationship between the source and target in the different ablation periods in 2016 and ablation from 2016 to 2018."

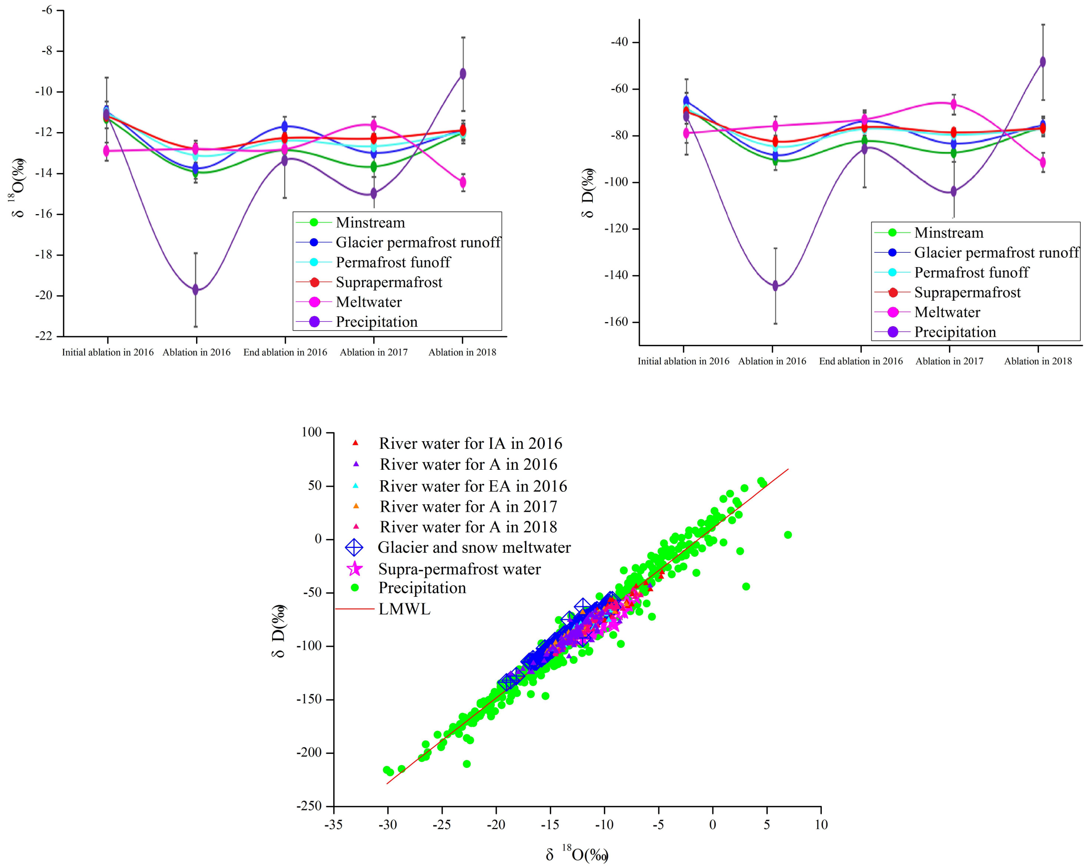

Fig.7 The distribution of δD and $\delta^{18}O$ for river water among other water bodies in study area

2. The EMMA was based on 18O and d-excess, however, d-excess= 2H-818O, the second tracer was partially relied on the first tracer. According to the basic principles of hydrograph separation (J. Klaus, J.J. McDonnell; Hydrograph Separation Using Stable Isotopes: Review and Evaluation, Journal of Hydrology), using 18O and dexcess to do three-sources hydrograph was very weak to achieve reliable results.

Thank you very much for your comments. Hydrograph separation is a widely applied technique that uses the stable isotopes of water (^2H and ^{18}O) or other tracers to quantify the contribution of different water sources to streamflow. For its successful application it is critical to adequately characterize these sources (end-members). Although using ^{18}O and d-excess to do three-sources hydrograph was very weak to achieve reliable results, the uncertainty of hydrograph separation results is analyzed systematically in this study. Meanwhile, there are many studies have used ^{18}O and d-excess as tracers to segment runoff (such as: Liu et al., 2008 (Journal of Hydrology); Kong and Pang, 2012(Journal of Hydrology); Penna, D., & van Meerveld, H. I, 2019 (Wiley Interdisciplinary Reviews: Water).

3. The authors seemed to use single average isotopic content to represent each source (precipitation, permafrost, glacier). However, to estimate the proportions of each component in areas influenced by different permafrost/glacier degradations without considering the spatial and temporal heterogeneity of isotopes as well as evaporation effects along the water flow (changing isotope values) in such extensive watershed might cause great uncertainties.

Thank you very much for your comments. I have added uncertainty method as:

"**Uncertainty in hydrograph separation**

The uncertainty of tracer-based hydrograph separations can be calculated using the error propagation technique (Genereux, 1998; Klaus & McDonnell, 2013). This approach considers errors of all separation equation variables. Assuming that the contribution of a specific streamflow component to streamflow is a function of several variables c1, c2, …, cn and the uncertainty in each variable is independent of the uncertainty in the others, the uncertainty in the target variable (e.g.,the contribution of a specific streamflow component) is estimatedusing the following equation (Genereux, 1998; Uhlenbrook & Hoeg,2003):

$$W_{fx} = \sqrt{\left(\frac{\partial z}{\partial c_1} W_{c1}\right)^2 + \left(\frac{\partial z}{\partial c_2} W_{c2}\right)^2 + \cdots + \left(\frac{\partial z}{\partial c_n} W_{cn}\right)^2}, \quad (3)$$

where W represents the uncertainty in the variable specified in the ubscript. fx is the contribution of a specific streamflow component x to streamflow. The software package MATLAB is used to apply equation 3 to the different hydrograph separations in this study."

And added uncertainty analysis: "Using the approach shown in Equation (3), the uncertainty originating from the variation in the tracers of components and measurement methods could be calculated separately (Uhlenbrook & Hoeg, 2003; Pu et al., 2013). According to the calculations made using Equation (3), the uncertainty was estimated to be 0.07 for the three - component mixing model in the study region. The uncertainty terms for supra-permafrost water accounted for more than 50.0% of the total uncertainty, indicating that the $\delta^{18}O$ and δD variations of supra-permafrost water accounted for the majority of the uncertainty. Although there is some uncertainty for hydrograph separation, isotope-based hydrograph separations are still valuable tools for evaluating the contribution of meltwater to water resources, and they are particularly helpful for improving our understanding of hydrological processes in cold regions, where there is a lack of observational data. "

4. The uncertainties should be addressed. Many factors instead of the only measurement error.

Thank you very much for your comments. I have added as: “Using the approach shown in Equation (3), the uncertainty originating from the variation in the tracers of components and measurement methods could be calculated separately (Uhlenbrook & Hoeg, 2003; Pu et al., 2013). According to the calculations made using Equation (3), the uncertainty was estimated to be 0.07 for the three - component mixing model in the study region. The uncertainty terms for supra-permafrost water accounted for more than 50.0% of the total uncertainty, indicating that the $\delta^{18}O$ and δD variations of supra-permafrost water accounted for the majority of the uncertainty. Although there is some uncertainty for hydrograph separation, isotope-based hydrograph separations are still valuable tools for evaluating the contribution of meltwater to water resources, and they are particularly helpful for improving our understanding of hydrological processes in cold regions, where there is a lack of observational data. ”

Minor comments:

Too many grammatical and word errors, as well as mistakes in graphs and captions. Authors should check their manuscript very carefully and ask for some native speaker to edit to make paper readable before submission.

Thank you very much for your comments. Grammatical and word errors have been revised by native speaker. Other mistakes had been checked and revised.