Response to Anonymous Referee #1

We are very grateful for your valuable and instructive comments and suggestions. 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)

This study uses stable water isotopes to look at the mean residence time (MRT) for a catchment in the Tibetan Plateau. The novelty here is the long-term nature of the data series being leveraged for the MRT estimate as these types of sampling campaigns are challenging to coordinate in cold and alpine regions. The study is well written and well structured making it easy to read. Still, I do struggle some with the uniqueness of the study presented as while these data types of are challenge to collect and not often presented in the literature, there is a question of what we learn here for this catchment that advances beyond previous regional efforts like in Song et al. (2017)? I think bringing forward the improved process understanding in face of the possible uncertainty is needed here to move this manuscript beyond a presentation of the uniqueness of place that leverages data alone.

Response: Thanks for your comment. Song et al (2017) previously focused on studying the young water fraction of river water in the Zuomaokong watershed of the hinterland of the Tibetan plateau (TP) and its controlling factors (topography and vegetation), but not considered the effects of permafrost changes, especially active layer changes, on permafrost hydrological processes. Comparatively, we investigated not only the streamwater MRT, but also the groundwater (supra-permafrost water) in a long time series (5-8 years). Moreover, we analysed the impact of permafrost changes on MRT to explore permafrost hydrological processes. We believe these are aspects go beyond previous research by Song et al (2017).

The MRT estimation in our study does have some uncertainty, thus, we recalculated the uncertainty of MRT and analyzed the possible reasons for this uncertainty, including model assumptions, spatial variability of isotope input and output, and isotopic fractionation. We added relevant discussion on MRT uncertainty in the subsequent reply and revised manuscript (line 440-498).

One aspect that needs attention is the intercomparison of MRTs between various catchments and studies presented in the manuscript. I appreciate the effort and thinking to place this one catchment in a broader context; however, the different methods and models used when estimating MRT can have significant impacts on the resolution MRT and the entire travel time distribution. Caution is needed when comparing absolute MRT with other catchments. I think if the authors want to keep these comparisons, more information needs to be added (like a column or two in Table 4) indicating the model type and technique used to estimate MRT. Further, a richer discussion of the impacts of the modeling assumptions should be provided as they pertain to this region. There has been significant research and literature on these topics over the last decades and it seems some of the more modern interpretations are missing from this study. All in all, I would anticipate a more thoughtful consideration of the assumptions behind the convolution approach you are implementing here.

Response: Thank you for the suggestion. Indeed, MRT estimation based on different models may impact the intercomparison between various catchments and studies. Thus, we removed MRT studies that were not calculated by exponential model and added more information about the model type and technique in Table 5 (line 396-399).

Table 5. *Statistics of MRT-related research results.*

Site	Altitude (m)	Water type	Model type	Tracer	Data length (years)	MRT	References
Our study site^{a}	5100–5435	Stream water	Exponential	$\delta^{18}O$	8	100 days	This study
Huanjiang t^{b}	272–627	Stream water	Exponential	$\delta^{18}O$	2	300 days	(Wang et al., 2020)
Mandava^{b}	383	Stream water	Exponential	$\delta^{18}O$	2	444 days	(Sanda et al., 2017)
Upper Váh^{b}	1500	Stream water	Exponential	$\delta^{18}O$	4	390–570 days	(M. et al., 2011)
Dee^{b}	1000	Stream water	Exponential	$\delta^{18}O$	3	601 days	(Soulsby et al., 2010)
Minjiang upper^{b}	300–7100	Stream water	Exponential	$\delta^{18}O$	1	698 days	(Xia et al., 2021)
Our study site^{a}	5100–5435	Groundwater	Exponential	$\delta^{18}O$	5	255 days	This study
Himalaya^{a}	1600–5200	Groundwater	Exponential	δD	1	4.5 months	(Shah et al., 2017)
Vermigliana^{b}	1221	Groundwater	Exponential	$\delta^{18}O$	1	1.3 years	(Chiogna et al., 2014)
Allt^{b}Mharcaidh^{b}	300–1111	Groundwater	Exponential	$\delta^{18}O$	4	>5 years	(Soulsby et al., 2000)
Huanjiang^{b}	272–627	Groundwater	Exponential	$\delta^{18}O$	2	161–1407 days	(Wang et al., 2020)

Note: "a" indicates the catchment covered by permafrost; "b" indicates the catchment not covered by permafrost. The symbol "—" indicates no data were available in the references.

Meanwhile, the assumptions of exponential model have been added in "Materials and methods" (line 170-172) and "Uncertainty and limitations" sections (line 441-460):

In this study, long-term stable isotopic data of stream and supra-permafrost water were used to estimate water MRT and determine the mechanism underlying MRT variability in a high-altitude permafrost catchment of the TP. Nonetheless, some uncertainty remains in the results of MRT estimation, including model assumptions, spatial variability of isotope input and output and isotopic fractionation.

Different transit time distribution (TTD) models are applicable to different watershed conditions (Małoszewski and Zuber, 1998), which may affect the assessment of residence time. The exponential model, a commonly used model for MRT estimation, describes the catchment with flow times that are exponentially distributed (Mcguire and Mcdonnell, 2006), which assumed that the system is in steady-state conditions and operates as a perfect mixer (Sánchez-Murillo et al., 2015; Smith, 1984; Chiogna et al., 2014). This perfect mixer indicates that the mixing between input and baseflow is rapid and complete, whereas an ideal mixing cannot exist in an aquifer, which is an important uncertainty source of the applied model (Małoszewski et al., 1983; Fenicia et al., 2010). Nevertheless, exponential model is suitable for MRT estimation in unconfined aquifers with shallow sampling points (Małoszewski and Zuber, 1998; Małoszewski et al., 1983; Stewart and Mcdonnell, 1991). In effect, the exponential TTD *model could also approximate TTD in some non-steady cases (Haitjema, 1995; Rodhe et al., 1996). In this study area, the underlying surface was relatively uniform with less landscape heterogeneity and characterized by rapid hydrological processes. Moreover, the active layer of permafrost belonged to an unconfined aquifer and functioned as a water reservoir, thereby allowing for more precipitation recharge into the active layer to mix with old water. The amplitudes of output isotopes (stream and supra-permafrost water) were much lower than those of input (precipitation) and the dominant contribution of supra-permafrost water to stream water, both of which indicated that the precipitation was well mixed with other water within the catchment. Thus, the exponential model is suitable for application in permafrost catchment to some extent.*

In addition, if there is a connection between the MRT and the unique processes in permafrost environment, it would be more insightful to describe them explicitly. Modeling literature (e.g. Frampton and Destouni, 2015) exists on the subject and would help reduce the ambiguity connecting water movement and process as they are considered in this study. Further, and connected with this comment, there is need to separate the result and discussion section in to two separate sections. Given the amount of data being presented and the analysis put forward, plenty of material for results. Also, mixing the two sections together as is currently done creates confusion about what your data show and how you are interpreting it relative to the science. And it would be good in a separate section of the discussion to consider more the potential limitations of the current study as they pertain to assumptions, data representativeness and the models being considered.

Response: Thank you for the suggestion. To be clear, we have described accordingly and explicitly the connection between the MRT and hydrological processes of permafrost in the revised manuscript as follows:

In this study, the estimated MRT of supra-permafrost water was distinctly longer than that of stream water, which reflects the more complex water movement and recharge processes for supra-permafrost water. On the one hand, this is because supra-permafrost water stored in active layers is replenished by more old water compared with surface runoff. On the other hand, it is related to the longer flow path for supra-permafrost water since the active layer increases the length of water flow path (Frampton and Destouni, 2015; Ma et al., 2019). (line 380-384)

In this study, the significant positive correlation between MRT and active layer thickness support previous findings showing that the MRT of permafrost catchments is highly dependent on the depth of the active layer due to the warming effects (Frampton and Destouni, 2015). From the mechanism perspective, the deepening of the active layer can increase the length of water flow pathway and reduce transport velocities due to a shift in flow direction from horizontal saturated groundwater flow to vertical flow infiltrate into deeper subsurface, thereby increasing water MRT in permafrost catchment (Frampton and Destouni, 2015). (line 404-408)

We separated the "Results and discussion" into two sections, and added a section "Uncertainty and limitations" to the "Discussion" section, where we discussed the uncertainty of estimated MRT, including model assumptions, spatial variability of isotope input and output, and isotopic fractionation. The following statements have been added in the revised manuscript (line 440-498):

4.3 Uncertainty and limitations

In this study, long-term stable isotopic data of stream and supra-permafrost water were used to estimate water MRT and determine the mechanism underlying MRT variability in a high-altitude permafrost catchment of the TP. Nonetheless, some uncertainty remains in the results of MRT estimation, including model assumptions, spatial variability of isotope input and output and isotopic fractionation.

Different transit time distribution (TTD) models are applicable to different watershed conditions (Małoszewski and Zuber, 1998), which may affect the assessment of residence time. The exponential model, a commonly used model for MRT estimation, describes the catchment with flow times that are exponentially distributed (Mcguire and Mcdonnell, 2006), which assumed that the system is in steady-state conditions and operates as a perfect mixer (Sánchez-Murillo et al., 2015; Smith, 1984; Chiogna et al., 2014). This perfect mixer indicates that the mixing between input and baseflow is rapid and complete, whereas an ideal mixing cannot exist in an aquifer, which is an important uncertainty source of the applied model (Małoszewski et al., 1983; Fenicia et al., 2010). Nevertheless, exponential model is suitable for MRT estimation in unconfined aquifers with shallow sampling points (Małoszewski and Zuber, 1998; Małoszewski et al., 1983; Stewart and Mcdonnell, 1991). In effect, the exponential TTD model could also approximate TTD in some non-steady cases (Haitjema, 1995; Rodhe et al., 1996). In this study area, the underlying surface was relatively uniform with less landscape heterogeneity and characterized by rapid hydrological processes. Moreover, the active layer of permafrost belonged to an unconfined aquifer and functioned as a water reservoir, thereby allowing for more precipitation recharge into the active layer to mix with old water. The amplitudes of output isotopes (stream and supra-permafrost water) were much lower than those of input (precipitation) and the dominant contribution of supra-permafrost water to stream water, both of which indicated that the precipitation was well mixed with other water within the catchment. Thus, the exponential model is suitable for application in permafrost catchment to some extent.

In general, measurement inputs represent spatial and temporal inputs for the entire catchment (Mcguire and Mcdonnell, 2006). At the catchment scale, elevation, air temperature, and rainfall intensity may cause considerable variation in isotopic composition of precipitation, particularly in mountainous areas (Ingraham, 1998). Thus, inputs of tracer to the catchment system are highly variable in space and time and important sources of uncertainty in interpretation of catchment response (Mcguire and Mcdonnell, 2006; Hrachowitz et al., 2009). A previous study suggested that precipitation at high altitudes is characterized by high isotopic amplitudes (Jasechko et al., 2016), which may result in underestimation of MRT in the study area due to one sampling site for precipitation. In practice, the isotopic composition of precipitation is often sampled at one site (Mcguire and Mcdonnell, 2006).

Considering the catchment area of our study was relatively small (2.7 km^2) with an altitude drop of 300 m. The size of the selected catchment in this study was much smaller than that of most catchments previously reported (Mcguire and Mcdonnell, 2006). Therefore, the effects of elevation on meteorological data and precipitation isotopic variability are minor and one precipitation sampling location could represent the whole catchment to some extent. Additionally, this study only collected supra-permafrost water from one sampling point due to economic and logistical constraints in the alpine regions, which is a limitation in estimating MRT. Given that the supra-permafrost water is primarily derived from precipitation, the spatial variability of isotopes in supra-permafrost water may also be minor in such small catchment. Even so, the spatial variability of isotopes in supra-permafrost water may result in underestimation of MRT in the study area.

The fractionation effects attributed to evaporation may potentially increase the uncertainty of water age estimation due to its impact on isotopic compositions and signals (Richardson and Kimberley, 2010; Mcdonnell et al., 2010; Song et al., 2017). Hence, the fractionation effects during the transformation from actual precipitation to effective input must be considered (Mcdonnell et al., 2010; Rusjan et al., 2019). In the study area, the atmospheric precipitation is primarily solid; the solid precipitation will be melted rapidly over a short period following deposition to form liquid water that enters soil and river channels, therefore it is difficult for snowpack to exist within this catchment. Thus, we did not collect snowpack or snow melt water as an input signal for MRT estimation. Nonetheless, solid precipitation may be subjected to evaporative fractionation to some degree when melted to be surface and subsurface runoff, thereby increasing the uncertainty of MRT estimation. Considering the rapid transformation of snow into infiltrated water and low air temperature, the potential effect of evaporation on the isotopic composition in precipitation, and consequently on MTT estimates, is relatively limited, which was not considered in the MRT estimation in this catchment.

To further analyse the uncertainty of MRT derived from the seasonal variability of isotope composition in hydrological component, we used the amplitude coefficient of input and output to estimate the uncertainty of MRT and found it larger for water with long residence time. Regression analysis showed that after considering the uncertainty of MRT, an improved R^2 for the thickness of the active layer with fewer differences for other factors. This suggests that uncertainty of estimated MRT may affects the sensitivity of MRT to specific factors (Hu et al., 2020), indicating that the uncertainty of estimated MRT should be considered when discussing MRT influencing factors. Therefore, future research should consider the uncertainty of MRT and improve the accurate assessment of MRT in alpine catchments.

Overall, although there remain uncertainty and limitations for MRT estimation in our study, isotope-based MRT estimation is valuable for identifying changes in hydrological processes of the permafrost regions, where there is a lack of observational data. Thus, it is necessary to utilize more measurements in different sub-catchments to augment the data representativeness in future research.

Given the complexity of sampling precipitation in cold regions, more information is needed to help the reader understand how you were sampling here. For example, were how was snow treated throughout the sampling? Were snowpacks or snow melt water collected and considered as inputs in any sense? Also, looking at the variation in elevation in the region, how representative of the catchment is the one meteorological station and precipitation sampling location? Rainfall isotopic composition is rather variable with elevation and snowpack and snow melt rates are really variable. How is the isotopic input variability considered within this study? It seems ignored based on the methodology presented.

Response: Thank you for the suggestions. We added more information about precipitation sampling in the revised manuscript as follows (line 118-120):

Liquid precipitation samples were collected immediately following every precipitation event using bulk collector to minimize the effects of evaporation. Solid precipitation (snow) samples were collected into a plastic bag and taken to a warm place to be thawed, following which water samples were transferred into 50-mL PE bottles.

The elevation, air temperature, and rainfall intensity may cause considerable variation of isotopic composition in precipitation, particularly in mountainous areas (Ingraham, 1998), which may result in underestimation of MRT in the study area due to one sampling site for precipitation. Considering the size of the selected catchment in our study is small, we believed that the effects of elevation on meteorological data and precipitation isotopic variability are minor and one precipitation sampling location could represent the whole catchment to some extent. The following statements have been added to the manuscript (line 462-472):

At the catchment scale, elevation, air temperature, and rainfall intensity may cause considerable variation in isotopic composition of precipitation, particularly in mountainous areas (Ingraham, 1998). Thus, inputs of tracer to the catchment system are highly variable in space and time and important sources of uncertainty in interpretation of catchment response (Mcguire and Mcdonnell, 2006; Hrachowitz et al., 2009). A previous study suggested that precipitation at high altitudes is characterized by high isotopic amplitudes (Jasechko et al., 2016), which may result in underestimation of MRT in the study area due to one sampling site for precipitation. In practice, the isotopic composition of precipitation is often sampled at one site (Mcguire and Mcdonnell, 2006). Considering the catchment area of our study was relatively small (2.7 km^2) with an altitude drop of 300 m. The size of the selected catchment in this study was much smaller than that of most catchments previously reported (Mcguire and Mcdonnell, 2006). Therefore, the effects of elevation on meteorological data and precipitation isotopic variability are minor and one precipitation sampling location could represent the whole catchment to some extent.

In the study area, the atmospheric precipitation is primarily solid; the solid precipitation will be melted rapidly over a short period following deposition to form liquid water that enters soil and river channels, therefore it is difficult for snowpack to exist within this catchment. Thus, we did not collect snowpack or snow melt water as an input signal for MRT estimation (see Fig 1e). Thus, we did not collect snowpack or snow melt water as an input signal for MRT estimation. The following statements have been added to the manuscript (line 480-487):

In the study area, the atmospheric precipitation is primarily solid; the solid precipitation will be melted rapidly over a short period following deposition to form liquid water that enters soil and river channels, therefore it is difficult for snowpack to exist within this catchment. Thus, we did not collect snowpack or snow melt water as an input signal for MRT estimation. Nonetheless, solid precipitation may be subjected to evaporative fractionation to some degree when melted to be surface and subsurface runoff, thereby increasing the uncertainty of MRT estimation. Considering the rapid transformation of snow into infiltrated water and low air temperature, the potential effect of evaporation on the isotopic composition in precipitation, and consequently on MTT estimates, is relatively limited, which was not considered in the MRT estimation in this catchment.

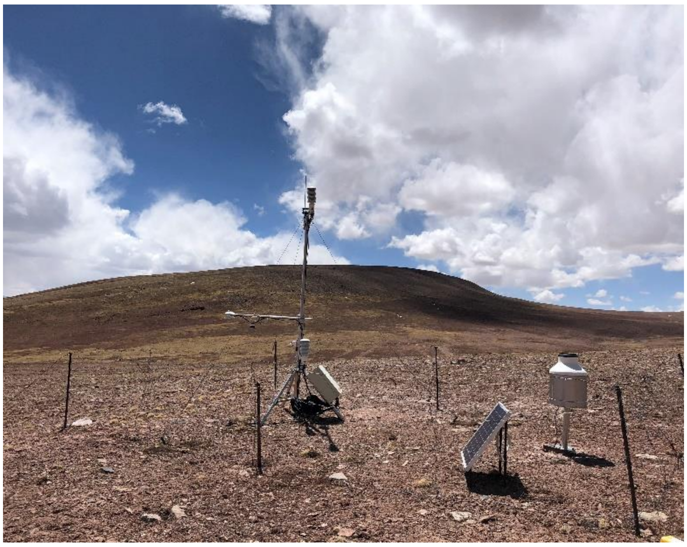

Figure 1e Photograph of the underlying surface in the catchment and meteorological station taken in June 2018. We added this picture to the study area map in the revised manuscript.

The input variability and source water variability of only having one location for monitoring supra-permafrost water sampling seems as if it could confound the results and interpretation to some extent. Specifically, if there are large frozen regions upstream of the stream sampling location, these would have significant impacts on the ability of precipitation to transfer to the stream over the entire catchment. Variability of isotopic compositions in springs and sub-watersheds is well documented (e.g. Lyon et al. 2018). The spatial variability at play in the catchment must be either accounted for or the potential impacts at least taking into consideration via discussion within this study.

Response: Thank you for the suggestion. This study only collected supra-permafrost water from one sampling point due to economic and logistical constraints in alpine regions, which is a limitation for estimating MRT in our study. Considering the small size of the selected catchment in this study and the supra-permafrost water mainly derived from the contribution of precipitation, we believed that the spatial variability of isotopes in supra-permafrost water also may be minor in such a small catchment. Even so, the spatial variability of isotopes in supra-permafrost water may also result in underestimation of MRT in the study area. The following statement have been added to the manuscript (line 469-476):

The size of the selected catchment in this study was much smaller than that of most catchments previously reported (Mcguire and Mcdonnell, 2006). Therefore, the effects of elevation on meteorological data and precipitation isotopic variability are minor and one precipitation sampling location could represent the whole catchment to some extent. Additionally, this study only collected supra-permafrost water from one sampling point due to economic and logistical constraints in the alpine regions, which is a limitation in estimating MRT. Given that the supra-permafrost water is primarily derived from precipitation, the spatial variability of isotopes in supra-permafrost water may also be minor in such small catchment. Even so, the spatial variability of isotopes in supra-permafrost water may result in underestimation of MRT in the study area.

Finally, some consideration of uncertainty should be presented. There are several fitted relationships that are being compared across the research. In and of themselves, these are wrought with uncertainty and confidence intervals that can impact the significance of the findings. I would want to see some assessment of the robustness of the results relative to the uncertainty or lack of representativeness of the data being presented. At the least, the two-component hydrograph can directly incorporate the uncertainty via the approach put forward by Genereux (1998). Without characterization of the uncertainty, I am left wondering how much of the results is driven by under-represented variability in the sampling at a catchment scale, the simplifying assumptions within the model, and the fitted equations that smooth out all the between event variability and extremes. That last point is rather important given potential flashy nature of these systems during certain times of the year and more dampened responses as the systems thaw seasonally.

Response: Thank you for the suggestions. The uncertainty of MRT results has been recalculated by the method described in Morales and Oswald (2020). We considered the uncertainty of the estimated MRT in the regression analysis. The results showed that after considering the uncertainty of MRT, the R^2 of the regression analysis for the thickness of permafrost active layer has been improved, while less difference for other factors (see Table 4, line 346-350). The following statement have been added to the manuscript (line 488-494):

To further analyse the uncertainty of MRT derived from the seasonal variability of isotope composition in hydrological component, we used the amplitude coefficient of input and output to estimate the uncertainty of MRT and found it larger for water with long residence time. Regression analysis showed that after considering the uncertainty of MRT, an improved R^2 *for the thickness of the active layer with fewer differences for other factors. This suggests that uncertainty of estimated MRT may affects the sensitivity of MRT to specific factors (Hu et al., 2020), indicating that the uncertainty of estimated MRT should be considered when discussing MRT influencing factors. Therefore, future* *research should consider the uncertainty of MRT and improve the accurate assessment of MRT in alpine catchments.*

Table 4. Relationships between active layer thickness, soil temperature, air temperature, precipitation, NDVI, and MRT. x indicates the factor as the independent variable. (line 342)

		Regression based on mean MTT (days)			*Regression based on MTT uncertainty (days)*		
	Factor	*Regression equation*	R^2	*Sig*	*Regression equation*	R^2	*Sig*
Supra-permafrost water	*ALT*	$y=4.23\exp(0.24x)+48.62$	0.11	$P>0.05$	$y=1.43\exp(0.63x)+150.68$	0.44 ↑	**$P<0.05$**
	ST	$y=929x+1299$	0.87 ↑	**$P<0.05$**	$y=956x+1337$	0.78 ↑	**$P<0.05$**
	AT	$y=752x+4307$	0.69 ↑	**$P<0.05$**	$y=767x+4283$	0.67 ↑	**$P<0.05$**
	P	$y=-1.89x+1169$	0.58↓	**$P<0.01$**	$y=3479\exp(-0.005x)-125$	0.64↓	**$P<0.01$**
	NDVI	$y=0.103x^{-4.405}$	0.51	$P=0.07$	$y=0.143x^{-4.286}$	0.65↓	**$P<0.05$**
Stream water	*ALT*	$y=4.67\exp(1.11x)+71.56$	0.81 ↑	**$P<0.01$**	$y=3.02\exp(0.37x)+59.23$	0.59 ↑	**$P<0.01$**
	ST	$y=(1.7x+1.35)^{-0.26}$	0.81 ↑	**$P<0.001$**	$y=3.79E+14\exp(35.47x)+76$	0.79 ↑	**$P<0.001$**
	AT	$y=51x+372$	0.05	$P>0.05$	$y=42x+325$	0.01	$P>0.05$
	P	$y=4.94E+5(x^{-1.77})$	0.47↓	**$P<0.01$**	$y=1.67E+10(1.7x)^{-3.25}+52.6$	0.32↓	**$P<0.01$**
	NDVI	$y=1.422x^{-2.394}$	0.20↓	**$P<0.05$**	$y=1.50x^{-2.384}$	0.26↓	**$P<0.05$**

Note: ALT = active layer thickness, ST = Soil temperature (℃), AT = air temperature (℃), P = Precipitation (mm), NDVI= normalized differential vegetation index; Sig indicates statistical significance; ↑ and ↓ indicates significant trend of increase and decrease, respectively; Bold font indicates that it passed significance test of 0.05.

Minor Comments

L100: This sentence is random and does not make sense here. Further, not sure what you mean with efficiently?

Response: Thank you for the suggestion. This sentence has been deleted in the revised manuscript.

L171: This first sentence is odd. Separate the results and discussions to increase presentation clarity.

Response: Thank you for the suggestion. We have removed this sentence, spilt the "results and discussion" into two parts, and added a section "Uncertainty and limitations" to the "Discussion" section, which discussed the uncertainty of estimated MRT, including model assumptions, spatial variability of isotope input and output, and isotopic fractionation (line 440-498).

References

Chiogna, G., Santoni, E., Camin, F., Tonon, A., Majone, B., Trenti, A., and Bellin, A.: Stable isotope characterization of the Vermigliana catchment, Journal of Hydrology, 509, 295-305, https://doi.org/10.1016/j.jhydrol.2013.11.052, 2014.

Fenicia, F., Wrede, S., Kavetski, D., Pfister, L., Hoffmann, L., Savenije, H. H. G., and McDonnell, J. J.: Assessing the impact of mixing assumptions on the estimation of streamwater mean residence time, Hydrological Processes, 24, 1730-1741, https://doi.org/10.1002/hyp.7595, 2010.

Frampton, A. and Destouni, G.: Impact of degrading permafrost on subsurface solute transport pathways and travel times, Water Resources Research, 51, 7680-7701, https://doi.org/10.1002/2014WR016689, 2015.

Haitjema, H. M.: On the residence time distribution in idealized groundwatersheds, Journal of Hydrology, 172, 127-146, https://doi.org/10.1016/0022-1694(95)02732-5, 1995.

Hrachowitz, M., Soulsby, C., Tetzlaff, D., Dawson, J. J. C., and Malcolm, I. A.: Regionalization of transit time estimates in montane catchments by integrating landscape controls, Water Resources Research, 45, 207-213, https://doi.org/10.1029/2008WR007496, 2009.

Hu, M., Zhang, Y., Wu, K., Shen, H., Yao, M., Dahlgren, R. A., and Chen, D.: Assessment of streamflow components and hydrologic transit times using stable isotopes of oxygen and hydrogen in waters of a subtropical watershed in eastern China, Journal of Hydrology, 589, 125363, https://doi.org/10.1016/j.jhydrol.2020.125363, 2020.

Ingraham, N. L.: Chapter 3 - Isotopic Variations in Precipitation, in: Isotope Tracers in Catchment Hydrology, edited by: Kendall, C., and McDonnell, J. J., Elsevier, Amsterdam, 87-118, https://doi.org/10.1016/B978-0-444-81546-0.50010-0, 1998.

Jasechko, S., Kirchner, J., Welker, J., and McDonnell, J.: Substantial proportion of global streamflow less than three months old, Nature Geoscience, 9, 126–129, https://doi.org/10.1038/NGEO2636, 2016.

M., L., D., Holko, Z., and Kostka: Estimation of the mean transit times using isotopes and hydrograph recessions, Die Bodenkultur, 62, 47-52, 2011.

Ma, J., Song, W., Wu, J., Liu, Z., and Wei, Z.: Identifying the mean residence time of soil water for different vegetation types in a water source area of the Yuanyang Terrace, southwestern China, Isotopes in Environmental and Health Studies, 55, 1-18, https://doi.org/10.1080/10256016.2019.1601090, 2019.

Małoszewski, P. and Zuber, A.: A general lumped parameter model for the interpretation of tracer data and transit time calculation in hydrologic systems, Journal of Hydrology, 204, 297-300, https://doi.org/10.1016/S0022-1694(97)00122-4, 1998.

Małoszewski, P., Rauert, W., Stichler, W., and Herrmann, A.: Application of flow models in an alpine catchment area using tritium and deuterium data, Journal of Hydrology, 66, 319-330, https://doi.org/10.1016/0022-1694(83)90193-2, 1983.

McDonnell, J. J., McGuire, K., Aggarwal, P., Beven, K. J., Biondi, D., Destouni, G., Dunn, S., James, A., Kirchner, J., Kraft, P., Lyon, S., Maloszewski, P., Newman, B., Pfister, L., Rinaldo, A., Rodhe, A., Sayama, T., Seibert, J., Solomon, K., Soulsby, C., Stewart, M., Tetzlaff, D., Tobin, C., Troch, P., Weiler, M., Western, A., Wörman, A., and Wrede, S.: How old is streamwater? Open questions in catchment transit time conceptualization, modelling and analysis, Hydrological Processes, 24, 1745-1754, https://doi.org/10.1002/hyp.7796, 2010.

McGuire, K. J. and McDonnell, J. J.: A review and evaluation of catchment transit time modeling, Journal of Hydrology, 330, 543-563, https://doi.org/10.1016/j.jhydrol.2006.04.020, 2006.

Richardson, B. and Kimberley, M.: Lessons Learned from Monitoring the Effectiveness of the Asian Gypsy Moth Aerial Spraying Eradication Program, Applied Engineering in Agriculture, 26, 355-361, 10.13031/2013.29950, 2010.

Rodhe, A., Nyberg, L., and Bishop, K.: Transit Times for Water in a Small Till Catchment from a Step Shift in the Oxygen 18 Content of the Water Input, Water Resources Research, 32, 3497-3511, https://doi.org/10.1029/95WR01806, 1996.

Rusjan, S., Sapač, K., Petrič, M., Lojen, S., and Bezak, N.: Identifying the hydrological behavior of a complex karst system using stable isotopes, Journal of Hydrology, 577, 123956, https://doi.org/10.1016/j.jhydrol.2019.123956, 2019.

Sánchez-Murillo, R., Brooks, E., Elliot, W., and Boll, J.: Isotope hydrology and baseflow geochemistry in natural and human-altered watersheds in the Inland Pacific Northwest, USA, Isotopes in environmental and health studies, 51, 1-24, https://doi.org/10.1080/10256016.2015.1008468, 2015.

Sanda, M., Sedlmaierová, P., Vitvar, T., Seidler, C., Kändler, M., Jankovec, J., Kulasova, A., and Paška, F.: Pre-event water contributions and streamwater residence times in different land use settings of the transboundary mesoscale Lužická Nisa catchment, Journal of Hydrology and Hydromechanics, 65, 154-164, https://doi.org/10.1515/johh-2017-0003, 2017.

Shah, R., Jeelani, G., and Noble, J.: Estimating mean residence time of karst groundwater in mountainous catchments of Western Himalaya, India, Hydrological Sciences Journal, 62, 1230-1242, https://doi.org/10.1080/02626667.2017.1313420, 2017.

Smith, J.: Mixing in continuous flow systems Chemical Engineering Science, 39, 1643-1644, https://doi.org/10.1016/0009-2509(84)80094-9, 1984.

Song, C. L., Wang, G. X., Liu, G. S., Mao, T. X., Sun, X. Y., and Chen, X. P.: Stable isotope variations of precipitation and streamflow reveal the young water fraction of a permafrost watershed, Hydrological Processes, 31, 935-947, 10.1002/hyp.11077, 2017.

Soulsby, C., Tetzlaff, D., and Hrachowitz, M.: Spatial distribution of transit times in montane catchments: conceptualization tools for management, Hydrological Processes, 24, 3283-3288, https://doi.org/10.1002/hyp.7864, 2010.

Soulsby, C., Malcolm, R., Helliwell, R., Ferrier, R. C., and Jenkins, A.: Isotope hydrology of the Allt a' Mharcaidh catchment, Cairngorms, Scotland: implications for hydrological pathways and residence times, Hydrological Processes, 14, 747-762, https://doi.org/10.1002/(SICI)1099-1085(200003)14:4<747::AID-HYP970>3.0.CO;2-0, 2000.

Stewart, M. K. and McDonnell, J. J.: Modeling Base Flow Soil Water Residence Times From Deuterium Concentrations, Water Resources Research, 27, 2681-2693, https://doi.org/10.1029/91WR01569, 1991.

Wang, F., Chen, H., Lian, J., Fu, Z., and Nie, Y.: Seasonal recharge of spring and stream waters in a karst catchment revealed by isotopic and hydrochemical analyses, Journal of Hydrology, 591, 125595, https://doi.org/10.1016/j.jhydrol.2020.125595, 2020.

Xia, C., Liu, G., Zhou, J., Meng, Y., Chen, K., Gu, P., Yang, M., Huang, X., and Mei, J.: Revealing the impact of water conservancy projects and urbanization on hydrological cycle based on the distribution of hydrogen and oxygen isotopes in water, Environmental Science and Pollution Research, 28, 1-18, https://doi.org/10.1007/s11356-020-11647-6, 2021.