Reply to Referee #2

This paper presents interesting experimental (tracer) data to study young and new water fractions (fnew and fyw) of hillslope water based on methods introduced by Kirchner (2016, 2019). While the overall results seem interesting at first glance (relation between Fnew and Fyw and relation with HAND), there are two critical points, which lead me to the conclusion that this paper should be rejected:

Reply: Thank you for your feedback on our paper. We appreciate the recognition of the interest and potential of our experimental data and findings. However, we respectfully disagree with the conclusion to reject the paper.

- regarding the interpretation of the relation between Fnew and Fyw: Kirchner 2019 showed that Fnew can probably not predict Fyw; if the results presented here seem to show a strong relation, this is most likely due to the small sample size (3 points for streamflow, 4 points for hillslope water); this might be nearly impossible to interpret without further data or a model

Reply: We would like to clarify our position regarding the referee's concerns.

We did not intend to present a method for predicting the regression between F_{yw} and F_{new}. Instead, our focus was on highlighting the distinct relationship between F_{yw} and F_{new} for hillslope seepages and streams. While Kirchner (2019) used the benchmark model to introduce the significant uncertainty in the "time-variant" F_{yw} and F_{new} within a single stream, our field data demonstrate an "average-stated" F_{yw}-F_{new} relationship across different hydrological systems (multiple seepages and streams). Therefore, our study does not challenge Kirchner's model but rather addresses a different aspect of the F_{yw}-F_{new} relationship.

We understand the reviewers' concerns regarding the sample size of hillslope seepages. However, it is important to note that sampling seepages in high mountain areas is inherently challenging compared to streamflow, which is reflected in the limited number of studies analyzing F_{yw} or F_{new} in hillslope seepages. To our knowledge, no other study has a larger sample size for hillslope seepages across a wide range of HAND. We believe this highlights the potential for identifying a linear (or nonlinear) F_{yw}-F_{new} relationship across different hydrological systems. The referee's comment is important, and we will highlight this issue in the introduction to provide clearer context and address the significance of our study.

- regarding the relation to HAND: the small sample size prevents the identification of a threshold. Its the resolution of the DEM good enough to reliably estimate HAND for the hillslopes?

Reply: Although there may be large uncertainty due to the small sample size, we used segmented regression analysis to identify the break point of HAND for Fyw, Fnew, and α. We tested different HAND values and obtained determined coefficients and p-values. The results indicate a possible threshold of 10-15 m, which is statistically significant. We will include this result in the new version of the manuscript. However, the small sample size remains an issue. We will rewrite the discussion to remind readers that our field results indicate this threshold, providing insights for future model studies.

The 20m spatial resolution DEM used in this study has a measurement error of approximately one meter (control point error), and the HAND values at the four points differ by more than one meter. Therefore, the 20m resolution is sufficient to satisfy the elevation resolution required for HAND. We will add above descriptions in materials and methods.

In addition to above, we miss methodological details: how as hillslope water sampled, from where? how do you define seepage water? how did you estimate the regression slopes (least squares)? how did you adjust the sine curves to estimate Fyw? how uncertain are these esimates? weighted/unweighted estimates? how are the values of figure 4 estimated (theory, reference?).

Reply: Thank you for your comments and suggestions. We apologize for not providing enough detail in the methodology section, and we will add these details in the Materials and Methods section. Here, we briefly address the questions raised:

Hillslope seepage returns to the surface, so we directly sample the water manually. We define seepage water as rainfall that infiltrates into the ground and returns to the surface. We believe Reviewer 2 referred to the regression slope in Fig. 3. After consideration, we decided to use dashed lines to introduce the distinct F_{yw}-F_{new} relationship instead of removing the regression line.

We fitted the isotope data to sine curves using iteratively re-weighted least squares. We estimated the uncertainty of F_{yw} and F_{new} following Kirchner's method. We calculated weighted A_P, A_S, F_{yw}, and F_{new}. The F_{new} value in Fig. 4 follows Kirchner (2019) in calculating F_{new} for different time intervals but uses the cumulative form.

We will add these details to the Materials and Methods section to provide a clearer understanding of our approach and ensure transparency in our methodology.

The literature does not cover all relevant papers, as already highlighted by reviewer 1.

Reply: We agree with Reviewer's comment. We will cite more papers on the young water fraction and new water fractions in streamflow. It is important to place our study within the existing literature. We will add a paragraph in the introduction providing background information about new and young water fractions in streamflow and highlight that our study sampled the hillslope seepages. Additionally, we will rephrase our discussion to compare our findings with previous studies.

Furthermore, there is no discussion of how the presented results are related to the climate: the studied catchment has a relatively high precipitation input, probably more than most other published work in alpine environments; at the same time, it is very warm, with no snowfall at elevations above 3000 asl. How does this influence the Fnew and Fyw?

Reply: We thank the reviewer for comments. We will compare our results to other works in alpine watersheds, which is important for inspiring new perspectives on hydrological processes. This unique climatic condition might influence F_{new} and F_{yw} by providing continuous and substantial water input without the seasonal delay caused by snowmelt, leading to more immediate infiltration and surface return flows. We will include a discussion on how these climatic factors impact our results. Before doing this, we will recalculate F_{yw} and F_{new} using the volume-weighted approach.