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Interactive comment on "Mechanisms of consistently disconnected soil water pools over (pore)space and time" *by* Matthias Sprenger et al.

Matthias Sprenger et al.

mspreng@ncsu.edu

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Response: We thank the reviewer for their time to provide critical feedback on our manuscript. We addressed each of their comments, which are all listed below, in responses that are shown in bold font.

The manuscript titled "Mechanisms of consistently disconnected soil water pools over (pore) space and time" describes a study that uses the stable isotopes of hydrogen and oxygen in soil water, precipitation, local streams, and groundwater to identify apparently separate soil water pools and assess specific processes that result in bypass flow in soils. This study adds to the increasing amount of evidence that confirms the occurrence of the partitioning of soil water between tightly bound

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immobile water and mobile water that moves downward to discharge in streams and recharge groundwater, as suggested by the two water worlds hypothesis. In addition, this study puts effort into assessing the mechanisms that result in this partitioning.
Overall, this paper is very well written. It addresses a very relevant scientific question that has implications for determining the proper way to interpret stable isotope data in ecohydrology and for better understanding the local water balance in different areas. The scientific methods and assumptions are valid and sound, and the conclusions, which are supported by the results, add significantly to our understanding of ecohydrology.
Response: We are glad to hear that the reviewer believes that our work contributes to a better understanding of ecohydrological processes.
The only significant modification to the paper that I would suggest is the addition of a figure that shows:
1) The global, regional, and local location of the study area
2) Soil and water sample locations
Response: In the revised manuscript, we will add a figure that shows the location of the Can Vila research catchment in Spain, the study site, where the soil water sampling, piezometer sampling and rainfall sampling were done within the catchment, and the outlet, where stream water isotopes and discharge were measured.
The figure will look similar to the preliminary Figure 1.

Other minor suggested edits include:
1) Abstract – The second sentence is awkward and should be revised. The third sentence appears to describe an observation from the study before the study objectives and other details are defined. This sentence (and one or two additional sentences) should describe observations of other researchers to define the problem that this study addresses.
Response: We will rephrase the second sentence and we actually intended

to refer to earlier studies in the third sentence. We will revise this part of the abstract to be clear about that. The revised part will read as follows:
"However, how much subsurface mixing of water occurs, how much of the water is available for plants or otherwise percolating to streams and the groundwater is not yet understood. Some studies found based on stable isotope (2H and 18O) data that water infiltrating into soils can bypass older pore water. Though, the mechanisms leading to a separation between water routed to the streams and water held tightly in smaller pores are yet unclear. Here, we address the current limitations of the understanding in subsurface mixing and its consequences for the application of stable isotopes in ecohydrological studies. We present an extensive data set. . ."

2) Page 1, line 28 – Change the word "since" to "for."
Response: Will be changed as suggested.

3) Page 1, line 30 – Change the word "unraveled" to "of interest" or something similar.
Response: Will be changed as suggested.

4) Page 3, line 2 – Add a citation for a reference that describes suction lysimeters or include more details about them.
Response: We will provide a reference for the suction lysimeter.

5) Page 3, line 3 – Include a citation of the cryogenic extraction procedure.
Response: We will add a reference to (Martín-Gómez et al., 2015), where more details on the extraction can be found from the laboratory that conducted the extraction and isotope analysis.

6) Page 12, line 17 – change wording to "...mechanisms by which. . ."
Response: Will be changed as suggested.

Other comments: The figures are quite complex, and it takes time to fully understand them, but they do show a lot of valid information. The authors state that tightly bound water is composed of relatively old water. I am wondering if they could suggest an actual age or range of ages for this tightly bound water (months, years, decades??).
Response: On Page 9, line 5 – 10, we briefly discuss the difficulty to assess how much the mobile and tightly bound water are in exchange with regard to their isotopic composition and we argue that numerical models would be a way to test different hypotheses of inter-pore mixing. We are currently not aware of a isotope enabled soil hydraulic model that could account for both a dual-permeabilty representation and a variable lower boundary condition, that accounts for temporarily pressure heads that reach the soil surface (as observed in the piezometer). However, we know that we are limited in our interpretation of stable isotope data to a few years due to the annual cycle of the rainfall isotope signal. Thus, if the tightly bound water older than two years, there would be now way in detecting that with the current data set. We are planning to add on page 9 the following to the discussion to pick up the idea of Reviewer 1 and a potential solution to this question:
"Thus, based on our field data, we can currently not assess the actual age (months or years?) of the tightly bound water, but experimental approaches with deuterated (enriched in 2H) water could help assessing how much of exchange between the mobile and tightly bound water can occur (Evaristo et al., 2019)."

References:
Evaristo, J., Kim, M., Haren, J., Pangle, L. A., Harman, C. J., Troch, P. A., and McDonnell, J. J.: Characterizing the fluxes and age distribution of soil water, plant water, and deep percolation in a model tropical ecosystem, Water Resour.

Res., doi:10.1029/2018WR023265, 2019.
Martín-Gómez, P., Barbeta, A., Voltas, J., Peñuelas, J., Dennis, K., Palacio, S., Dawson, T. E., and Ferrio, J. P.: Isotope-ratio infrared spectroscopy: a reliable tool for the investigation of plant-water sources?, New Phytologist, 207, 914–927, doi:10.1111/nph.13376, 2015.

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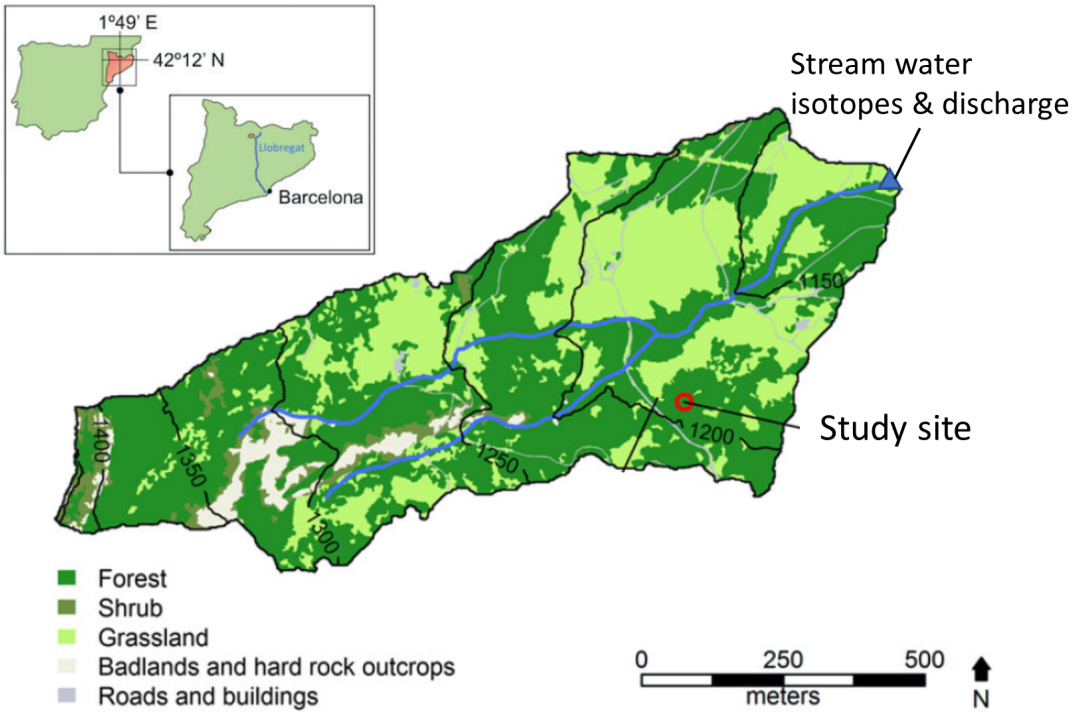

Fig. 1. Planned figure to be added during the revision showing the study site within the Can Vila research catchment.

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