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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Water ages in the critical zone of long-term experimental sites in northern latitudes" *by* Matthias Sprenger et al.

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Response to T. Walter (Referee 1)

General Comments:

This study uses a previously calibrated 1-D model to ascertain estimates of travel times for different hydrological fluxes and water ages throughout the soil-plant continuum. The results generally agree with conceptual conclusions drawn from empirical studies but provide order of magnitude quantification that is hard to extract from field studies. I commend the authors for showing full distributions of travel times and water ages

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in their figures even though they mostly concentrate on means or medians in their narrative; I think there is some potentially interesting information in distributions that is not easily distilled into a single number. Overall, I really liked this paper and appreciated the clearly articulated short-comings, e.g., no consideration of lateral flow.
Response: We thank Todd Walter for taking the time to review our manuscript and for his generally positive feedback on our study.

Specific Comments:

1) It was not clear if/how water among the different flow regimes and soil storage interacted in the model? It is possible I simply missed this detail or that it was explained in the authors' proceeding paper.
Response: We will add and change in the methods the following sentences for clarification: " Ingraham and Criss (1993) found that two water pools approach as a function of water volumes, surface area and saturated vapor pressure (temperature) a weighted average isotopic composition of the two pools. Our previous study showed that a conceptualization of the subsurface with two pore domains that exchange water in accordance to Ingraham and Criss (1993) via the soil gas phase improved the simulation of the soil water stable isotopic composition at 10 and 20 cm depth at the investigated sites compared to an assumption of uniform flow. Therefore, we apply the same model set up of SWIS as presented in detail by Sprenger et al. (2018b) with the parameters given in Table 1. In accordance to Vanderborght and Vereecken (2007), we set the dispersivity parameter to 10 cm at all sites. The soil physical parameters were the same for the two pore domains and the exchange was solely conceptualized as vapour exchange not via hydraulic dispersion. The implemented tracer exchange between the slow and the fast flow domain results in a slow approach of the virtual tracer concentrations in the two pore domains. Thus, the exchange leads towards a homogenization of water ages between the two flow domains. In line with soil physics principles, the slow flow domain is filled first and remains saturated until the fast flow

domain is emptied (Hutson and Wagenet, 1995). Water flow and tracer transport occurs in both domains and recharge is generated accordingly. However, only the average recharge flux rate and weighted average tracer concentrations from both domains are provided. "

2) E and T were partitioned by vegetative cover? Was this a simple 2-d percentage over the landscape or in terms of something like leaf area index?

Response: The partitioning was based on the canopy coverage, which will be now provided in a Table that lists all the parameters. We will change the sentence as follows and provide a reference: " ET was partitioned into potential E and potential transpiration (T) according to the canopy coverage (Table 1) according to Ritchie (1972)."

3) The empirical tracer experiments to which the authors compare their results are generally pretty simplistic. I encourage them to consider Kung et al. 2005. Quantifying pore-size spectrum of macropore-type preferential pathways. SSSAJ 69(4) because this empirical study used a much more complex tracer design than most studies and it sort of matches the model design used here.

Response: Thanks for the suggestion. It is an interesting study and we will see if we can include it into the discussion.

Editorial Notes:

1.) The first line of the abstract seems awkward; the word "respond" seems wrong.

Response: We will change the sentence as follows: "As northern environments undergo intense changes. . ."

2) I really like the use of colors in the figures but they are not always well explained (e.g., fig. 6); please make this clearer.

Response: We will change and add in the caption of Figure 3: "The dots show the MTT_R each day of rain and the colour code represents the season when the traced

water infiltrated the soil." and in the caption of Figure 6: "The dots show the relationship between water ages and storage for each day and the colour code represents the season of the corresponding days."

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