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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.

Anonymous Referee #2

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Thanks for the response and explanation.

My main criticism is that for the derivation of MTT and Water Age, under unsteady-state flow conditions, tracer **concentrations** $Oj(t)$ are used, while **mass fluxes** should be used. Just for clarity, my interpretation of mentioned tracer concentrations $Oj(t)$ in the Manuscript, is of actual tracer concentration ($[gl^{-1}]$) in the output fluxes. In case of unsteady-state flow conditions mass fluxes, and not concentrations, should be used for the calculation of MTT and Water Age.

With regard to derivation of MTT:

The authors agree that unsteady-state conditions occur and mentiond in their response "that we are using mass fluxes of E, T and R to calculate the median travel times".

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Does this mean:

1) the authors will re-calculate the median travel times? or

2) mass fluxes were used already for the analysis of MTT?

The reason for asking this is that the authors state on page 5, lines 1-4, in the Manuscript that tracer concentrations were used, specifically in lines 3-4: "Tracer concentrations $Oj(t)$ in the output fluxes for each day after introduction of the virtual tracer I_j at time t_0 were normalized by the infiltrated tracer mass ($Oj(t)/Ij(t0)$, Figure 1 left)."

Furhermore the authors proposed in their first repsonse to change this sentence to:

"Tracer concentrations $O_j(t)$ in the output fluxes for each day after introduction of the virtual tracer I_j at time t_0 were normalized by the infiltrated tracer mass of the tracked precipitation or snowmelt event $(O_j(t)/I_j(t_0)$, Figure 1 left)."

In my opinion this should be changed to for example:

"Tracer mass fluxes $M_j(t)$ in the outputs for each day after introduction of the virtual tracer I_j at time t_0 were normalized by the total recovered mass M_t of the output fluxes $(M_j(t)/M_t$, Figure 1 left)."

mass flux is calculated then as follows:

$Massflux(t) = O_j(t) \cdot flux$

with flux for example in $[ls^{-1}]$

Indeed as the authors state in their response, normalization is not required here, since the median travel time is defined as the time half of the cumulative mass flux was passed the flow. In addition, a PDF with unity of one is not required for their analysis (reason why one would normalize by the total recovered mass in the output).

With regard to derivation of Water Age:

As for the derivation of MTT my main concern here is the use of tracer concentrations

$O_j(t)$, during unsteady-state flow conditions, for the calculation of water ages. Because of the unsteady-state flow conditions, you need to include a flow rate (E, T and R) or volume in case of storage. This also means,at least for E, T and R you cannot normalize by the tracer mass inputs, since not all input tracer mass is recovered at these flux boundaries.

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