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Hydrology and Earth System Sciences Discussions

Interactive comment on "Macropore flow of old water revisited: where does the mixing occur at the hillslope scale?" *by* J. Klaus et al.

Anonymous Referee #1

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The paper by Klaus et al. uses a tracer addition experiment to explore the now 'age old' question of where stream water comes from when a precipitation event occurs. The new water vs old water debate continues to vex catchment hydrologists decades after the first isotopic and tracer experiments exploring these interactions. Since that time, paradoxes have been identified and equivocally explained, and continued research in this area shows that hydrologists are still uncertain what water really gets from soils to the stream, and what type of interaction occurs between water in the matrix and macropores.

Klaus and co-authors attempt to tackle this problem in a very focussed manner. Three tracer experiments are conducted along with detailed antecedent and post-experiment

soil water information, to elucidate exactly when and where soil water interactions are occurring and what water contributes to flow. Compartmental modelling is used to explore soil interactions.

Four questions were asked. 1) what is the relative role of pressure wave displacement vs preferential flow, 2) what are macropore-soil matrix interactions, 3) where does mixing occur and who does intensity and duration affect this, and 4) where in the soil profile is the pre-event source water for the drain outflow?

Overall, it is uncertain if any of these questions are answered. The authors state that there is no evidence of pressure waves / matrix displacement, yet a strong mixing of irrigation water and pre-event water in the profile. Nowhere in the text is question 1 explicitly answered or clearly outlined. Questions 2 through 4 are also also not explicitly answered. The discussion meanders through sections about redefining old water, lateral vs vertical processes and the importance of the results on hydrograph separation. It would be more helpful if the authors closed the circle and attempted to directly answer the questions outlined in the manuscript. The focussed beginning does not meet the diffusive end.

In terms of improvement, I suggest that the authors tighten up the manuscript and focus it on questions that can be answered. The data is of good quality and there is information to be gained here, but this manuscript is not in itself going to answer the 'grand challenges' of hydrology. Overall, it could be shortened by $\sim$20% and focus on what the field data is actually telling us be made clear without hyperbole. In addition, greater explanation as to why this modelling framework is any way helpful to answering the research questions would be good. While I have no problem with the model, method, etc., I am unsure as to how value added this is compared to simple mixing models. If the authors used water that was spiked with respect to 2H, the experiment would have been much improved, and more definitive conclusions could likely have been reached and there would have been greater rationale to explore the results in a conceptual modelling framework.

I have a number of comments that the authors may wish to consider:

What is the compartment mixing model really telling us and how is it helping here? It seems like a clever analysis that was applied without much thought as to its implications or importance. I am not dismissing it, but I am unsure as to its real importance. Section 3.4 is a bit puzzling considering bromide was used for the 'forward' separation. As the application of water was so close isotopically (in my opinion) to soil water, and hydrograph separation was not performed, the 'backward' calculations and mixing model seem a bit weak. If the authors want to hit a six with this, they should explore the novelty (and appropriateness) of the method.

4340 | 15. I am unsure how the two years are comparable? Because they are both in September?

4341 | 10. Here and throughout the manuscript, additional information is needed as to how the six soil moisture access tubes were installed, the impact on measurements and interpretation of the results, and their relative locations.

4350 | 22. What was the source before this 'activation' of soil water? This is not overly clear.

4351 - How representative was the experiment compared with regular climate statistics? Were these 1 in 10 or 1 in 100 year storms? This is important in interpreting the results.

4360 | 18. Can you be more convincing that your results invalidate hydrograph separation? I'm not convinced. Perhaps I would be if the 2H/18O signatures of the applied water were farther from the soil water, and if an appropriate analysis of the differences between soil water and groundwater (or source water, whatever that may be) was undertaken, but in terms of this analysis, I believe this is too strong a statement.

Fig 2 - Why is the discharge series not continued to include the recession and data included there (as appears in Fig 8). From this, it appears sampling stops much earlier

than reported elsewhere.

Fig 3 - My version does not have colour as stated in the caption (although it doesn't necessarily need it). Some soils have a large shift in isotopic composition, some have a small one. Is there any explanation as to the variability among sites. In addition, what is the implication of different water under different tensions when equilibrating with N2? Obviously there is a shift here, but I am unsure as to whether this is due to the macropore (and even large pores such as 1 mm in diameter) vs matrix water. When examining figure 4, there are only modest shifts in soil moisture at depths, but fairly large shifts in 18O. Does the mass balance here work? It is not clear to me.

Fig 4 - this figure could use colour! Each profile could have its own colour and comparable symbol. The discharge for event 2 overlain would also be helpful to link the soil moisture dynamics with discharge.

Fig 5 - It should state that the separation is based on bromide.

Table 2 - dates of the experiment would be helpful.

Table 3 - depth in profile should be stated in caption.

Grammatical Issues for correction:

4334 | 10. 'at mainly' 4335 | 22. Colloquial comments are not necessary. The manuscript has places where it is overly 'chatty'. 4336 | 14. 'how do preferential flow paths are' 4338 | 8. O should be E. Grammar in following three sentences should be improved. 4338 | 23. The authors mix m and cm here. I prefer not mixing them and conforming to SI. cm is not typically a standard SI unit. 4339 | 12. 'met' - I am unsure what the HESS policy on slang is. 4339 | 16. experiment should be plural. 4343 | 10. I'm not sure 'Analytics' is the best English language term for this section. 4348 | 15. Figures should be referenced early here in the text. 4352 | 2. 'To repeat'.... is this necessary? 4352 | 20. The soil moisture figure should be referenced here. 4353 | 11. 'proofed' isn't the word to use here. 4356 | 5. I'm not a fan of rhetorical questions. 4356

| 19. 'row in the matrix of' is likely not needed. 4358 | 2. The 'heart of grand challenges' bit is a bit much.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 4333, 2012.