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Hydrology and Earth System Sciences Discussions

Interactive comment on "What can flux tracking teach us about water age distributions and their temporal dynamics?" *by* M. Hrachowitz et al.

Anonymous Referee #1

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General Comments

This manuscript is an important contribution to the field of water age distribution modeling in more than one way. To begin with, the authors provide an excellent summary and review of transit time modeling in hydrology. The summary includes basics as well as the newest developments in the field. It also tackles questions that have not been discussed in detail yet (e.g. the differences of age distributions of water and solutes). Furthermore, the presented results on the effects of complete vs. partial mixing on transit time modeling is a welcome and necessary contribution to hydrologic catchment response research. Finally, relating the individual properties (e.g. shapes, breaks) of the water age distributions to specific runoff processes and storage mixing

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assumptions is a step forward on the way to determining hydrologic response controls, enhancing our process understanding and process analysis capabilities and thereby making hydrologic prediction easier.

Some parts of the manuscript need clarification though. Especially helpful would be more consistency in terminology as we find it in other recent papers. For example the definition of the three different age distributions (resident water, water in flux, transient water): Why not use the names that have been established before (residence time, reverse transit time, transit time (cf. van der Velde et al. 2010))? Also, when describing the age distributions in figures 6 and 8 there is no proper explanation on what they actually are. I suppose the age distributions are variable in time. Then what are the distributions that are shown in these figures? You say they are median distributions, so how did you compute the median values? Are they comparable to 'master transit time distributions'? Is there weighting involved? Please give some more details.

The manuscript is dense and full of information. The review section alone can make a good paper. The authors proceed to investigate the influence of a) different mixing assumptions, b) different dominant catchment processes represented by different model configurations and c) different wetness conditions on 1) transit time distributions 2) residence time distributions and 3) reverse transit time distributions in both streamflow and evapotranspiration. Other authors would split the research that went into this paper and write four papers instead of one. On the one hand splitting up the paper would make the results more easily digestible (smaller bites). On the other hand one could argue that all this information belongs in one paper to make it a more or less complete overview of the field of water age distributions. I agree with the latter argument and would like to see the paper published in the current format.

The order of the presentation of the results might be enhanced if the authors first presented the variation of pF, pR and pT in the different catchments before proceeding to discuss the differences of pF due to variations in wetness conditions.

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Specific Comments

p. 11368, l. 19: The difference between flux and transient water is not clear. I know you mean water at the outlet with 'flux' and water on the way to the outlet with 'transient', but you explain the concept only later in the paper.

p. 11368, l. 23: 'changes in the hydrological regime'. Can you be a little more specific here? Dominant flow paths, antecedent conditions, storage dynamics?

p. 11372, l. 7: Why not report the Nash Sutcliffe Efficiencies and the AIC for the three best models?

p. 11378, l. 2: Would be nice to see a figure of that relationship of soil moisture and mixing coefficient.

p. 11378, l. 3-21: very interesting conceptual model that connects mixing dynamics with new-old water

p. 11379, l. 14: What do you mean by saying that they were chosen to be comparably simplistic? Would you rather have used a more complicated approach because it would have given you better results in terms of NSE?

p. 11382, l. 3: Thanks for the nice clarification on these issues. It was high time that someone wrote it down.

p. 11382, l. 9-20: Your definition of the three different age distributions (resident water, water in flux, transient water): Why not use the names that have been established before (residence time, reverse transit time and transit time)?

p. 11384, l. 11-18: I recommend mentioning the fact that if you are interested in the actual hydrologic catchment response you should only use the N components (flow generating processes) when assembling your time distributions. Adding the M components (evaporative processes) is very likely to skew your distributions towards the faster responses.

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p. 11387, l. 21: You presented three mixing model hypotheses (complete, static partial, dynamic partial) and you should stick with these distinctions.

p. 11389, l. 10: What exactly are you showing here? Is it a snapshot of one flux water age distribution? Is it an average distribution assembled from all the individual distributions? Weighted or unweighted? Is it a master distribution for the specific wetting scenario? This is important, please give more details.

p. 11394, l. 14: This is the first time that you mention that figure 6 shows median distributions. How do you define a median distribution? Do you select for every transit time the median probability value? Do you weight the individual distributions by mass or volume? These are important aspects that should be explained.

p. 11400, l. 10: Terminology: to enhance clarity I recommend calling 'transient age distribution of water conditional on runoff' simply 'water transit time distribution to runoff' to differentiate it from 'water transit time distribution to evapotranspiration' or from 'solute transit time distribution to runoff'. Vice versa the terminology would be e.g. 'reverse water transit time distribution from overland flow' or 'reverse solute transit time distribution from baseflow'...

p. 11400, l. 27: . . .'transit' times of water. . .

p. 11403, l. 15: 'higher' or 'larger'?

p. 11404, l. 10: . . .shorter 'transit' times. . .

Figure 2: It is very difficult to compare modeled to observed runoff in these figures. You probably want to show the whole time series for completeness, but I would select one (or five) years of data so that an actual comparison becomes possible.

Figure 4: Very important figure. I would also fill the first 4 time steps with numbers, so that the selection aspect (of runoff vertical and event horizontal) becomes more obvious.

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Figures 6: the y-axis goes to 10-5, in figures 8 it's only 10-4 (comparability?).

Figures 6, 8, 11 and maybe 12: General recommendation: If you convert the figure to a log-log plot then it is easier to see the variations in fast response behavior.

Technical Corrections

p. 11364, l. 4: flow path(s) distributions

p. 11368, l. 16: do you mean 'modeled' internal fluxes?

p. 11368, l. 25: . . .a summary 'of' their. . .

p. 11372, l. 1: It should be 'DYNAmic MIxing Tank'.

p. 11380, l. 25: . . .as 'a' free calibration parameter. . .

p. 11381, l. 20: Better write: 'On the one hand this can be. . .'

p. 11384, l. 13: Delete one 'further'.

p. 11391, l. 5: . . .a break 'in' at. . .?

p. 11392, l. 8: . . .as 'an' individual process. . .

p. 11394, l. 27: . . .with the only major difference 'being' that. . .

p. 11399, l. 17: . . .in 'a' modeled average. . .

p. 11399, l. 28: delete ',' before could.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 11363, 2012.