**Hydrology and
Earth System
Sciences**

Discussions

Open Access
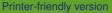
HESSD

Interactive
comment

Interactive comment on "Using StorAge Selection functions to quantify ecohydrological controls on the time-variant age of evapotranspiration, soil water, and recharge" *by* Aaron A. Smith et al.

Anonymous Referee #2

Received and published: 1 April 2018

In this article, the authors would like to propose a new method to quantify ecohydrological controls based on time-variant water ages. The main novelty of this study is using the mass balance of isotopes from different water sources (rainfall, xylem and soil water) to characterise retention times for different storages. The research questions of the work are interesting. However, (1) the proposed methods are poorly explained, (2) the model assumptions and results are not properly tested and evaluated, and (3) the overall writing can be better. I would like that the authors can evaluate their method by a comprehensive sensitivity study, so that I suggest a major revision.

(1) Poor explanation

The paper is difficult to read because of its inconsistent labelling, poor word choices and bad abbreviations. As a result, the paper cannot explain the method. Here are only few examples to illustrate the problems.

(1a) A label is used for multiple variables. For an example, all the "T"s are confusing.

(1ai) P4 Ln 14 the absolute age (T) (1aii) P5 Ln 25 the isotopic composition of water ranked by age (T) (1aiii) P5 Ln 29 evaporation fractionation for each water age (T)

(1b) Different labels are used for a variable

(1bi) For an example, when Precipitation is defined to be "J" in P3 Ln 9, Figure 1 uses P.

(1c) The word choice can be strange.

(1ci) In P3 Ln15 and Ln18, "Diffusion (D)" is an odd choice. Can it be "infiltration", "recharge" or "surface flow"? Honestly, I don't know. Maybe, it will be clearer if the authors can label it on Figure 1. (1cii) I feel that "control volume" or "CV" is a jargon. Can the author just say a "compartment", "gird", "cell" or "element" instead?

(1d) There are some unnecessary abbreviations

(1di) For an instance, "kernel density estimation" (KDE) only appeared two times in the article. When I read KDE in P14 Ln 18, I needed to try to see what KDE is in P9 Ln10.

(1e) The definitions are bad.

(1ei) I don't understand what "T (CV from 0 to delta) or zeta (CV below delta z)" are in P5 Ln 4, because I don't understand why absolute age (T), relative age (zeta), depth (delta z) and Control volume (CV) are related. (1eii) I don't know how high soil and low soil moistures are defined in Figure 6 All of these make the theory and methodology session difficult to read. The whole article should be revised with a better notation housekeeping.

Interactive comment

(2) Technical issues

Overall, the evaluation is weak. In P17 Ln 22, uncertainty is recognised to be important, but nothing has been done in terms of model structures and model parameters. The data quality issues were not explored. At the moment, the results are based on the face values of outputs from a complicated model based on some coarse-temporal data. At a result, the assumptions of the models are poorly validated. In fact, the isotope model results are very bad in Figure 3b-i. How these poor results affect the overall retention results should be quantified by a sensitive study.

(2a) Data issues: The author recognised the data issues in P20 Ln14. However, they did not do much about it. The uncertainty related to data measurements is not quantified.

(2ai) How measurement errors affect the retention results was not studied (2aii) The justification for using Ic-excess is weak (P8 Lns 27-28)

(2b) Model issues

At the moment, the authors are subjectively selected its model structure without much evaluation. They need to provide results to show how different variables (e.g. different soil water depths) should be included in the proposed method. The authors should explain how different model structures affect the retention results. Because using isotopes is the main novelty here, I want to see more evaluation for the isotope model selection. I want to see how it was set up. I want to know how different models replacing Equations 8 or 9 can affect the overall retention age results. I also want to see how the sensitivity of the model parameters of Equations 8 or 9 affects the storage retention. Similarly, different distributions should be tests for the hydrology part. For example, in addition to the beta distribution in P7 Ln 24, the author should try gamma and other distributions. In fact, the authors have some ideas about it in P19 Ln 10. The authors should explore the sensitivity of parameters (both constant and time-variance) in Equation 14 (P7 Lns 26-27) The temporal scale of data is very coarse. The model

includes processes across different temporal scales. This kind stiff model has a lot of numerical stability issues because of different scales. The authors recognised some stability problems in P9 Ln 19. Explaining how different processes scales affects the stability of the numerical schemes can be useful information for possible model users to know the technical issues related to the implemented model. The authors should illustrate how their numerical schemes may introduce artefacts. The authors need to try different numerical scheme to illustrate that their parameter estimates are not biased. Overall, the above model issues can be resolved by a comprehensive sensitivity study. Of course, the authors can also do some laboratory or field experiment to validate model assumptions at Heather Site A and B.

(3) Poor writing

The discussion is a bit haphazard. For an instance, I don't understand why the fractionation of xylem water is discussed in P18 Lns 12-18. I am not sure whether the proposed model can address this fractionation issue, or it is a limitation of the proposed model. When the authors discuss ecohydrological and hydrological controls of their sites, they need to link them to their test methods and their results. Currently, Sections 4.1 and 4.2 are like a literature review. The conclusion is very weak. The authors just said "improved understanding" in P20 Ln 29. After the whole study, the authors should be able to articulate their "improved understanding". In short, the authors should be able to frame the overall article better.