

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2
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Comment on hess-2021-213

Anonymous Referee #2

Referee comment on "Benchmark tests for separating n time components of runoff with one stable isotope tracer" by Simon Hoeg, Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-213-RC2>, 2021

Author validated the iterative extension of standard two-component hydrograph separation method using a single isotopic signature (published in WRR in 2019) through a random rainfall generator and a rainfall-runoff model. I am happy to see that author has addressed a critical question raised during the WRR review why the new modeling approach did not overall improve the model's uncertainty but instead increased uncertainties for some events. This current study confirmed the speculation at the time via "condition number" that it is the difference between new and old water that caused the increase in uncertainty. In addition, author demonstrated in the current study how the volume weighted separated event water response can serve as an estimator for a time-varying backward travel time distribution, which I consider is a novel contribution and will be of great interests to watershed hydrologists.

One defect in the design, however, is that ET (evaporation + transpiration) is entirely ignored in the rainfall-runoff model (Figure A2, though considered in equations 1 and 2), which is not realistic in the real-world scenario. It is unclear how consideration of ET will affect the modeling outcomes. Not to mention the impact of evaporation on isotopic fractionation (e.g., via bare soil evaporation and canopy interception), the influence of ET on streamflow quantity alone should affect the magnitude and timing of hydrograph and thus in my opinion possibly the isotopic signature of pre-event water, which is taken from streamflow right before an event. This defect will limit the application of this method to concept proofing and prevent it from broad application to real world-problem solving. But I am aware of the fact that adding ET impact in current study would make it way too complicated and extremely hard to follow. I think author should talk about any possible ET effect in a very general way in the current study and let readers be aware of its potential impact and explore whether or not this could be one of future studies.

Additionally, I am curious if both isotopic tracers (2H and 18O) are used, whether or not isotopic fractionation due to evaporation and phase change can be incorporated into the hydrograph separation model. If so, this would significantly boost its application and extend to snowmelt-dominated catchments. I do not think the current model is applicable

to streamflow generated primarily from snowmelt.

I am also curious about the potential impact of prolonged droughts on the model results. What if there are two events that occur several months apart?

Though I am not suggesting significant revisions to address the above issues in the current study, any potential impact and future extension should be discussed in the discussion section and the limitation should be cautioned in the conclusion section.

To promote this study and extend the use of the method, I suggest author to add more details to some of the mathematical equations. I have some questions on these equations (see below), which basically require clarification or more information.

P3/L77: The bracket not closed at the end?

P3/Equation 3: The time factor is muted for all quantities in the equations. That is fine, but readers must be reminded that within an event isotopic signature in all components is assumed to be constant. This implicit assumption was discussed later in the discussion section, but I think this assumption should be explicitly stated here and then discussed later in the discussion section.

P5/L122: Isn't "sequential event water response" a better term than "separated event water response"?

P5/Equation 12: Why does the integral start from negative infinite, not t_{in} (in as subscript)?

Why not dt but dt_{in} instead? Need to explain. I have the same question for equation 15 in page 6.

P7/L188: As "condition number" appears for the first time in the text and is not a well-known term in hydrology, it needs either a reference or a further explanation or at least an indication it is being explained below.

P8/Equation 23: It is unclear how the term after the plus sign is derived or defined.

P8/L208: What is gamma here? Explain.

P8/Equation 24: "f" should be better explained.

P11/L313: ET was not considered, but why were precipitation and runoff not equal?

P15/L411-421: Need to mention that the current model setup does not work for snowmelt-dominated system.

P16/L471: It is not constant due to the variable nature of Q_t ? If so, explicitly say so.

P18/Conclusions: The limitations of current model need to be briefly summarized as well.

Figure A1: This figure gave me hard time at the beginning, as it is depicted by forward concept not backward notation, while the latter is dominated the text. Need more information in the caption to explain this so that readers follow it easily.

Figure A2: Though this model was explained in the text, enough information should be given in the caption to make it stand by itself. At least parameters (alpha and eta) need to be explained in the caption for better readability.

Figure A3: Missing the second y-axis labels.

Figure A4: For one or two curves, why not smoothed near the end? I do not remember if this has been explained in the text.

Figure A5: Extremely hard to distinguish the curves, which occurs in other figures as well.

Figure A9: Need to say what the two arrows are for in the caption.

Figure A15: Where is precipitation? Also, missing mentioning c_e (e as subscript) in the caption. The same issue exists for Figure A18.