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Discussions

Interactive comment on "Technical note: An improved discharge sensitivity metric for young water fractions" *by* Francesc Gallart et al.

Anonymous Referee #2

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In their technical note, Gallart et al. propose an improved discharge sensitivity metric for young water fractions. The manuscript develops original ideas/concepts and it is well structured and written.

Leveraging previous work by Freyberg et al. (2018), Gallart et al. first develop on the current state-of-the-art related to the potential for discharge sensitivity of the young water fraction to serve as a metric for investigating streamflow generation processes and catchment inter-comparison studies. The limitation of the original linear regression approach is clearly exposed - notably in the context of a catchment characterised by a rather flashy hydrological response to precipitation input. As a way forward, the authors propose the use of an exponential-type approach to overcome the limitation of the linear regression method.

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Discussion paper

More specifically, Gallart et al. leverage experimental data (hydro-meteorological & stable isotopes of O and H in precipitation and streamflow) sampled at high temporal resolution in their Mediterranean study catchment (Can Vila). Their streamflow sampling protocol was spanning a wide range of flow conditions (from low to high flows), providing a rare view into O and H stable isotope signature behaviour – almost along the entire range of the flow duration curve (FDC). Their dataset eventually allowed for the estimation of young water fractions also on the upper tail of the flow frequency distribution. Gallart et al. demonstrate that the conventional linear regression method used for estimating the discharge sensitivity suffers from a limitation in that Fyw cannot grow with discharge indefinitely. Ultimately, they introduce their novel discharge sensitivity metric, based on an exponential equation expressing how Fyw varies with discharge. Their approach clearly is a remarkable improvement, in that it clearly outperforms the linear regression-based discharge sensitivity metric – both in terms of its physical soundness and lower sensitivity to potential changes in available tracer and discharge information.

While the proposed solution is well documented, a few additional (minor) considerations may help to further sharpen the manuscript:

(i) When comparing catchments that are characterised by very contrasted climates (as it is the case here), it would be helpful to have more information on the hydro-meteorological context. For example, annual precipitation vs annual discharge, a flashiness index (e.g. as per Holko et al., 2011. doi:10.1016/j.jhydrol.2011.05.038) would equally be helpful in this context. A plot showing how stream water samples taken for isotope analysis are distributed along the FDC would also be very informative.

(ii) In equation 6, the parameters F0 and Sd are obtained via fitting a sinusoid function to the seasonal variation of the isotopic signal in stream water cs(t). In this context, it would be interesting to further investigate and discuss if and how the catchment's wetness state (changing across seasons, but also from one rainfall event to the next) may influence the hydrological functioning of the studied system – and subsequently also the discharge sensitivity of the young water fraction. Soil moisture measurements (if available) or a (daily) water balance calculation could be helpful in this respect.

(iii) Along similar lines, are there any conclusions that can be drawn as to which reservoirs/compartments actually contribute to streamflow? Did the authors explore to what extent the intensity of precipitation events may influence hydrological responses – and trigger for example similar peak discharge for events that had different initial wetness states. Moderate rainfall may trigger high discharge when the catchment is already close to saturation; likewise, very intense precipitation may trigger similarly high discharge when the catchment has not yet reached saturation. In one case we may have saturation excess overland flow, as opposed to infiltration excess overland flow. How would this influence results and conclusions drawn on the discharge sensitivity of the young water fraction? How much would this also impact any potential catchment intercomparison between catchments with contrasted climate characteristics?

(iv) One of the main conclusions of the manuscript is that there is a need for sampling intensively the largest possible range of discharge values along the flow duration curve – with a special focus on (very) high flows. Considering potential hysteretic patterns in the rating curves, how would they impact the sampling protocol and subsequently the conclusions drawn from the obtained data? Is the dataset available for the Can Vila catchment (spanning a wide range of discharge values for O and H stable isotopes in stream water) offering the possibility to investigate this question?

(v) Possibly, the authors could conclude their work by stating one or two hypotheses that they may consider as being important to be tested in future work (for example in other physiographic contexts).

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