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Discussions

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Interactive comment

Interactive comment on “Seasonal partitioning of precipitation between streamflow and evapotranspiration, inferred from end-member splitting analysis” *by* James W. Kirchner and Scott T. Allen

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In this paper, Kirchner and Allen present and apply a methodology they call "end-member splitting", which focuses (as the name suggests) on tracking the fate of water inputs (here, precipitation) between the different outputs considered (here, streamflow and evapotranspiration). The authors use a publicly available dataset from the Hubbard Brook long-term experimental catchment, which provide the hydrometric and tracer (here $\delta^{18}O$) measurements needed for this method. Distinguishing several sub-annual time periods across the year (e.g. snowy/rainy season, dormant/growing season) with

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distinctive isotopic signature in precipitation, they evidence significant inter-seasonal carryover of precipitation (P) inputs into streamflow, implying transient storage at catchment scale. The information available for evapotranspiration (ET) shows by contrast that ET (mostly limited to rainy season) is mostly supplied by P from this same rainy season. This analysis is jointly conducted with the more traditional end-member mixing analysis and other recent metrics such as "young water fraction" and "new water fraction", providing complimentary views on how water transits in the studied catchment. Limits and sources of uncertainty of the method are also discussed, and potential applications outlined.

I really enjoyed reading this manuscript, which is also well-written. By seeking to answer the question "where will this precipitation go?", this approach importantly complements the more traditional end member mixing approach ("what is this streamflow made of?"). Crucially (and as also noted by referee P. Ala-Aho) this forward approach gives tools to track which precipitation is most likely to be evapotranspired, hereby helping predicting ecosystem response to changing precipitation patterns.

The elegance of this data-driven technique obviously comes with limitations. In particular (and this is shared with end member mixing) if some components of the water balance are overlooked (e.g. interannual carryover, significant groundwater inflow/outflow, see Fan, 2019) or if fractionation processes are significant. Such limitations are however often present in the more or less complex modelling approaches currently providing the basis for "forward-tracking" water across the landscape. Finally, although the authors highlight that they "only" combine existing methods, the ready-to-use dataset and promised R routine make it quickly beneficial for widespread test, discussion, and use in the community.

To summarize, I find it to be a very significant contribution to the field and recommend it for publication in HESS. I only have a few very minor/technical comments, easy to address.

Specific comments

- **L298-299**: The link with tree rings records is not obvious, maybe add a few words?
- **L378**: Please provides a reference for the SWE estimates
- **L456**: It can actually be a combination of both
- **L541-554**: The added values of the young water fraction comparison is not obvious to me. As the authors write right after, precise mathematical comparison is not possible, given the numerous unknown overlaps between season length and the reference 2-3 months. As a result, I find it hard to see the consistency of the 0.45±0.09 young water fraction with a 55±19% of intra-season contribution over a 4-month season AND a 62±9% of intra-season contribution over a 8-month season... Consider removing this analysis, or restrain it to the shortest seasons. Note that such limitation is much less significant for the new water fraction (as interestingly used in the next section), given the much shorter time step involved (as compared to seasons' lengths).
- **L570-575**: Considering giving more details about α and ϵ_j in Eq. (38), so that readers can get the "main" picture without necessarily reading Kirchner (2019).
- **L607-609**: I am not sure to understand how one can link “10% of growing season streamflow is less than 2 weeks old” to “half of growing season streamflow comes from P in that same 4-month season”.

Technical comments

- **Eqs. 26, 27, 28, 29**: I think there is a typo in the second member with η instead of $\Delta\eta$

- **L411**: To help the reader, consider starting this sentence with "Regarding summer precipitation, the monthly end-member [....]"
- **L411**: typo: "streamflow" instead of "rainy-season precipitation"
- **L596**: "We" instead of "I" ?
- **Fig12** This figure has a lot of different color/line type codes, making it complex to read. Consider adding (colored) mention of f or η directly on the graphs

Reference

Fan, Y.: Are catchments leaky?. Wiley Interdisciplinary Reviews: Water, e1386, 2019.
Kirchner, J. W.: Quantifying new water fractions and transit time distributions using ensemble hydrograph separation: theory and benchmark tests, Hydrol. Earth Syst. Sci., 23, 303-349, doi: 10.5194/hess-23-303-2019, 2019.

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