

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2  
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## **Comment on hess-2022-195**

Anonymous Referee #2

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Referee comment on "A mixed distribution approach for low-flow frequency analysis – Part 1: Concept, performance, and effect of seasonality" by Gregor Laaha, Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-195-RC2>, 2022

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This study develops a mixed distribution approach for low flow frequency analysis, particularly focused on regions that potentially have a distinct winter low flow period, due to freeze/snowfall/lack of moisture, and a summer flow flow period, due to high ET and low precipitation. The approach is built off similar mixed distribution statistics used for flood frequency analysis, but applies it in a unique way, due to the nuances of low flow. The paper first develops the concepts/statistical underpinning and then applies it to characteristic sites in Austria to show how the model responds when hydrologic drought is dominated by one season or a mix of both seasons.

Overall, I believe this is a useful and well conceived study. I list a few major comments that I believe should be addressed before this study could be published. With that said, I do believe this study has the novelty and value to ultimately be published in HESS.

I ultimately recommend a major revision.

### **Major issues:**

1. Line 85 states that summer and winter events are independent of one another. This is a relatively strong assumption that underlies the method. I question this assumption. Given that baseflow has long persistence along with the climate drivers that create hydrologic drought, I imagine potential for strong temporal autocorrelation between summer and winter events.

Please test the temporal correlation of Summer and Winter, lagged in either direction.

To further eliminate the potential for temporal autocorrelation, I recommend checking the dates of each hydrologic drought and potentially including a buffer period. If November 1 is the division between Summer and Winter (see comment 3 below), please make sure there are no years where Summer drought occurs on Oct 25 and Winter drought occurs Nov 7, for example.

2. Overall issue - use of the word "gain" and, for example line 12 of the abstract "the error is reduced by ...". I am not convinced, if the underlying assumptions are not checked (above), that the new mixed distribution estimates are exactly correct. Therefore, this phrasing that the estimates are improved by XXX% or that error is reduced by XXXX% should be softened or modified. In the derivation of gain (Eqs 10-12), this is referred to as "change in return period" or "relative deviation". Those terms, e.g. Delta T, are more neutral, and in my opinion more accurate, than stating that error is reduced by XXXX. I would be more willing to accept the stronger wording only with centuries of simulated data.

3. Line 36 - You state that many studies have suggested defining summer from about April or May to November, and winter as remaining. But, you never state how you are defining the two seasons for the analysis in Sections 2.4 and 3. Is this the division? Is it April or May? Please provide the exact day.

4. Please provide how many years of data are used for each river (n = ?).

5. Line 242 - Please explain how the deviation can be exactly zero. I find this highly unlikely given the fitting of two distributions and then comparisons of the extreme tails of each distribution. If this occurs because the Mixed Model defaults to the single season, explain this. Although, I doubt it would be exactly the same to 1 or 2 decimal places.

This shows up in Figure 4 as well and is confusing.

**Minor issues:**

Line 14 - misspelling "broade"

Line 70 - misspelling "extreme events"

Line 130 - I appreciate the link to Laaha and Blöschl 2006, but the first time you introduce SR, please insert the sentence from the caption of Fig 5 "SR > 1 indicates ..., SR < 1 indicates." Perhaps add in "Seasonality ratio ranges from XXX to YYYY".

Line 216 - spelling of Pearson

Line 270 - "Despite there is a large". Please revise for grammar

Line 285 - It looks like there are some words missing "as the have an "

Line 301 - misspelling "one"