

## Reply on RC2

Gregor Laaha

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Author 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-AC1>, 2022

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We thank the reviewer for the positive and constructive feedback. Please find my responses below.

1. Line 85 states that summer and winter events are independent of one another. This is a relatively strong assumption that underlies the method...

Response: I fully agree with this statement that the methods proposed in the paper rely on the independence assumption and there will be certainly catchments where the assumption is not strictly fulfilled. This is similar to the iid assumption of other estimators that is often not strictly fulfilled in practice, yet useful for model development.

I have therefore structured the research in a two-part paper series where the first part develops methods assuming there that dependency will have no significant effect. The second part extends the scope will explore seasonal dependency in detail. It examines the value of an extended estimator that accounts for the seasonal correlation of low-flow events and assesses its value in a hydrological context. This companion paper (hess-2022-358 A mixed distribution approach for low-flow frequency analysis – Part 2: Modeling dependency using a copula-based estimator) was submitted to HESS on 13 Oct, and is currently in the state of editor assignment.

In the MS of this paper, the effect of possible seasonal correlation has been discussed at the end of the paper and I see from your comment that it should come earlier, where the reader starts to question the assumptions of this paper. We will therefore add at Line 90: It should be noted that the assumption of strict seasonal independence will only be met in part of the catchments, while there may be cases where some dependency of seasonal minima exists. This is explored in detail in the second part of this two-paper series [\citep{Laaha\\_copula\\_2022}](#), where we examine the value of an extended estimator that accounts for the seasonal correlation of low-flow events.

I need to note here that the results of the second part show that there is indeed some correlation in a part of the catchments, but this has only impact on the estimates of mild (e.g. 2-year) low flow events, which are usually of little interest. For severe events the difference is negligible what supports the validity of the estimates of this study (and supports the interpretation of "deviation" being a "gain" based on being a valid generalization of the common estimator).

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...

I see your point, but argue from the findings of the companion paper (where not only the

assumptions, but also their impact on the estimates have been checked) that for the return periods we are usually interested in, the differences between the mixed and the extended mixed copula estimator are negligible so that the mixed distribution approach is indeed a valid and accurate estimator of the low-flow event. Given that the terminology is also set out in Section 3.2.1, I would like to keep this wording, but suggest to add the following sentence (Line 212):

It should be noted again that the interpretation of the deviation as a gain depends on the (reasonable) assumption that the model is superior to the alternative model, and the terminology of the study should be understood as such.

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.

Thanks – The period in the Austrian study starts in April and this will be added to the MS.

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

Thanks – will be added.

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.

Yes, it occurs as you said because the Mixed Model defaults to the single season and this will be added.

Minor issues:

Many THANKS, they will be amended.