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Hydrology and Earth System Sciences
Discussions

Interactive comment on "The effects of climatic anomalies on low flows in Switzerland" *by* Marius G. Floriancic et al.

Anonymous Referee #2

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In this work, the authors assess how anomalies in precipitation and potential evapotranspiration shape occurrence and magnitude of annual low flows for 380 Swiss catchments comparing preceding precipitation and evapotranspiration for different periods to the annual minimum flow. After an initial analysis of annual low flows, the authors decided to focus on summer low flows for the rest of the analysis. The paper is clearly outlined and easy to read.

I agree with reviewer 1 that I particularly like Figure 6 illustrating the increasing role of PET during development of extreme low flows.

However, different to reviewer 1 I have some major comments that I find important to address before publishing:

Summer and winter low flows
After an initial analysis of annual low flows, the authors decided to focus on summer low flows for the rest of the analysis. This analysis takes relatively much of the full paper both in text and in Figures (1, 2 and 4). While I agree that it is important to differ between summer and winter low flows particularly when analyzing the drivers, I do not see that the results of general occurrence are new (e.g. Smakhtin 2001 and references therein, Fiala et al. 2010 and basically all runoff regime literature for Switzerland in particular e.g., Weingartner and Aschwanden, 1992) nor that they deserve this weight in the article. I suggest to minimize this to the introduction refereeing to the relevant references and remove Figure 1 and focus in Figure 2 on only the summer events or split in to summer and winter low flows at the beginning and then assess both for winter how snow (or precipitation and temperature) shapes low flow occurrence and magnitude and for summer how precipitation and evapotranspiration shape low flow occurrence and magnitude.

More focus on the shaping
Instead of counting and presenting summer and winter low flows representing the annual low flow, I think it would be more interesting to try to add on the shaping of the low flows caused by precipitation and evapotranspiration. For instance, in addition to correlation between precipitation and PET separately on extreme or less extreme low flows it would be interesting to look at their combined effect. And then how much of the combined effect could be attributed to precipitation and to PET. This would allow a better relative quantification and really add to the values of this study.

Choice of summer months
The authors focus at extreme low flows and the preceding conditions and chose 2003,2011, 2015 and 2018 as the relevant years. The drought in 2011 was finished for most catchments before July, I urge the authors to look into the data and if so, adjust the analysis by either treating 2011 differently, i.e. not considering it a summer but a spring low flow and or change the analysis period for all years that was defined by the

authors Jul-Nov.

Terminology

- There is a seamless transition from “drought” to “low flow” and mixed use of “droughts” and “deficits” while the citations support both. I find this mix critical since already deficit (even when regularly/seasonally occurring) causes low flows but meteorological droughts are larger deficits than normal, i.e. the regularly/ seasonally occurring deficit. Please, revise the introduction to distinguish clearly between these. This would help the reader in the analysis that follows.
- Likewise, the authors use often only the term “low flow” when actually referring to “extreme low flow”. This can result in wrong statements (e.g. L72 “low flows are exceptional flow conditions” or L186 “triples the chance of an annual low flow”). And I would ask the authors to revise and correct the usage throughout the manuscript.

Mixed results and discussion section
In my opinion results and discussion should be separated. This allows to focus on the results. Only then what we can learn from the results and where we might to be a bit more careful, then also relate and compare to what was done elsewhere and where limitations and possibilities lay. In the present form the manuscript mixes these aspects and is more difficult to search for s specific result /argument this way.

Minor comments
L25-27 Remove this sentence for the abstract
L40/41 is “landscape” only including surface features? Maybe use rather catchment properties”.
L72 this statement is not correct they occur every year. Make clear that it is about extreme low flows here!

L92-94 a summary table (maybe only in the supplementary material) would be helpful
L121 1200m asl, why this threshold? Why not a range?
L130 remove “However, this remains to be tested”.
L147-150 For these low flows, people are usually prepared. Here it would be interesting how much more extreme are others. If it was due to a lack of precipitation, the signal should be visible in spring melt.
L154 “suggesting . . .” could be also formulated that lower elevation Swiss catchments could be representative sample for global summer low flow? (and maybe not even global but for humid regions with seasons?); This part would better fit in the introduction or methodology/catchment section.
L161 altitudinal variation in 30-day anomalies: could that be influenced by catchment size? A large catchment might not react on such an anomaly a small catchment not anymore if the driving anomaly is at the beginning of the period.
L174 “substantial site to site variability” can this be quantified?
L181 can these 8L189-196 These results are not surprising (the authors refer even to studies that found the same) but nicely illustrated and supported by the data. However, it would add to the value of this study to quantify the contribution of precipitation and evapotranspiration.
L189-196 Consider also to compare to Stahl et al. 2010
L196-197 delete sentence
L203-204 it is possible to avoid that by the study design (see also my major comment on seasonal split)
L222-228 that depends on how one looks at the drought: is the same scale as in the references used? The effect was also found in low flows but maybe not in the metric “annual low flow”, again distinguish between drought and low flows (see also major comment on terminology above) Figure 4: Looking at the figure makes me wonder how/if the regulated catchments might influence the pattern presented. Could that be picked up in the discussion?
L241 How brief since the study is about anomalies?

Figure 6: the last two sentences of the caption should go rather in the main text; add a legend to the lower plot of the figure.
L285 -311 The influence of snow might change also depending on how wet the catchment was before snowfall and on the distribution of snowfall /melt during winter not only on the pure amount of snow that fell.
L324-326 In the California snow mattered a lot for the droughts/ low flows during summer!
L331-333 I would drop that sentence

Technical comments
While I find that active voice generally a good choice, I would avoid starting every sentence with “we” (e.g. 2.1 but also elsewhere), please revise.

L22 “dry years saw” please rephrase
L28 redundant, delete either “could” or “potentially”
L44 “(PET)” -> “, PET”
L44 remove “should” and “usually”
L46 remove “made”; split sentence: “. . .to a catchment. Hence a sustained. . .”
L49 Make a new paragraph
L64 “smaller” = “lower”?
L66 “comes” -> “occurs”; remove “the” before summer and before winter
L79 “useful” = “suitable”?
L94 “quantified” -> “estimated”
L100 “years whose lowest annual flows were much” -> “years with lowest annual flows much”
L103 “low flows” -> “extreme low flows”
L224 remove “the” before summer and before winter
L238 “more strongly” -> “higher” (also in L244)

L259-262 rephrase to make more concise

References
Fiala, T., Ouarda, T. B., HladnÃ¡, J. (2010). Evolution of low flows in the Czech Republic. Journal of Hydrology, 393(3-4), 206-218.
Smakhtin, V. U. (2001). Low flow hydrology: a review. Journal of hydrology, 240(3-4), 147-186.
Stahl, K., Hisdal, H., Hannaford, J., Tallaksen, L., Van Lanen, H., Sauquet, E., ... Jordar, J. (2010). Streamflow trends in Europe: evidence from a dataset of near-natural catchments. Hydrology and Earth System Sciences, 14, p-2367.
Weingartner, R., Aschwanden, H. (1992). Discharge regime–the basis for the estimation of average flows. Hydrological Atlas of Switzerland, Plate, 5, 26.

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