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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Attribution of high resolution streamflow trends in Western Austria – an approach based on climate and discharge station data" *by* C. Kormann et al.

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General comments

This manuscript analyses and attributes the annual and daily/subdaily streamflow trends in 32 alpine catchments of Western Austria. Results indicate that there is no consistent significant regional trend in annual streamflow. The significant increasing and decreasing trend is found in 7 and 2 basins, respectively. In addition to a classical trend evaluation, daily resolution streamflow trends are derived and linked with the trends (exact day of year) of other hydroclimatological characteristics, such as air

temperature and snow height. These results indicate that the main drivers of alpine streamflow changes are increased glacial melt and earlier snow melt. The authors conclude that some further research is needed, which will explicitly determine which processes are related to the summertime streamflow decreases.

Overall, the study is interesting and fits well within the scope of the journal. I enjoy reading it, and like, in particular, the analyses and evaluations based on observed data. However I have also some critical comments which need to be considered before the publication. Statistical assessment of trends and their attribution is interesting (and needed), however, it does not allow a fully robust causal interpretation of hydrological processes (in physical sense). Some interpretations/statements used in this paper are not fully precise and do not consider this feature of statistical assessment. So, I would suggest to consider carefully revising some statements/interpretations made. In particular, following points need to be considered:

1) One of the main messages of the paper is: "...it was confirmed that the main drivers of alpine streamflow changes are increased glacial melt and earlier snow melt". Is this statement really confirmed by presented results, particularly for earlier snow melt? I would say that the results (trend assessment and attribution) indicate this, but not confirm. Why are the significant changes observed only in a few catchments? Why in some very close basins do different trends (significant/not significant) occur? What is the role of other physiographic catchment (storage, vegetation, land use) properties? There are many unanswered questions and simple trend assessment does not allow to confirm causal physical processes, so more careful interpretations would be needed here. In addition, a definition of research hypotheses is based on only 9 (be precise in the statements) stations with statistically significant (and not consistent) runoff changes (out of 32 stations), which needs to be considered and reflected in statements based.

2) The statement (on p.6883) that there is not much literature on hydrological changes is not precise. There is (at least) a number of relevant studies focusing and summarizing trend assessment studies, seasonality analyses and climate change effect as-

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sessments published in recent years and covering the Alps or Austria. Below are some reference suggestions which might be considered and added to the story (Introduction and Discussion sections).

3) Using terms "high-altitude" and "low altitude" stations is confusing as the low altitude basins have the mean elevation almost 1500 m a.s.l.. Such elevation would not be considered as low altitude basin in many regions of the world. I would suggest to use some more clear stratification of the basins, i.e. according to glacier proportion, but generally refer to them as to alpine basins.

4) Discussion of results is, in my opinion, an important part of the assessment, but is missing. Please add (i.e. revise the Summary) a separate Discussion section, which will discuss and relate the findings and implications found in this work with existing literature.

5) It would be interesting to see a real discharge data and its changes (instead of or in addition to schematic representations in Figures 8 and 9). How are the significant runoff trends represented/translated in measured streamflow hydrographs?

Specific comments

p.6886: " a relatively dry region in the rain shadow". Please consider to add a range of mean annual precipitation in the study region, otherwise it might be confusing.

p.6887: " so we assume that the impacts on the seasonal discharge behavior are very limited as well". What are the effects on daily and sub-daily discharge fluctuations? How are the ice effects on discharge measurements in winter accounted?

p.6894: " earlier snowmelt and less precipitation falling as snow. This in turn leads to multiple hydrological changes such as higher evapotranspiration, higher infiltration or changing storage characteristics ..." It is not clear (not visible from presented results) how is earlier snowmelt causing higher evapotranspiration or higher infiltration. Please consider to provide more details/reasoning for this hypothesis. Kormann et al.

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(2014) is not freely available. Difficult to justify the interpretations made (by referring to that paper) and also to recognize what are the differences between this study and the manuscript.

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