Authors' response

Editor

Editor: Thank you for your reply and revised version following the review by Referee #2. However, following the new reply by Referee#2 and my own reading, in many cases the modifications you indicate in your reply are not implemented in the revised text (nor in the tracked-changes document). Could you please check again carefully whether all the changes were implemented in the revised version, or whether a previous version of the manuscript was wrongly uploaded? Referee#2 provides some examples of these mismatches, but more cases can be identified along the text. For further clarification, the current versions you uploaded are named as follows:

hess-2020-21-ATC1.pdf
hess-2020-21-manuscript-version4.pdf
hess-2020-21-author_response-version2.pdf

Looking forward to receiving your news, I apologize for my delay, due to health issues in my family that have expanded longer than expected. I am sorry for the inconveniences.

Reply: We are sorry for the misunderstandings. We made some efforts to reply each comment of the Reviewer #2 clarifying the aspects.

Reviewer #2

Reviewer: 1) The authors analysed trends over one common time period, 1950-2013, and allowed a maximum of two years missing data. 3485 stations of their original 3913 stations fulfilled this criterion (and further quality criteria). Unfortunately, they decided to keep the new Fig. 1 instead of a figure that shows the number of available stations over time (similar to the previous Fig. 2a). In the previous Fig. 2a the number of stations during the 1950s is around 1000-1500 and always smaller than 2500 during the studied period. It is unclear how 3485 stations could be found that have less than two years missing between 1950-2013. Could the authors please clarify? If the series have different length, this needs to be described very clearly in the methods and be taken into account for the interpretation of the results.

Reply: As we already answered in the second round of revision, Fig.2a was deleted because it created misunderstanding both in Rev#1 and #2. The original dataset included 3913 stations and after the checks on reliability, consistency and uniformity of series of data, 428 stations were discarded. The 63-year study period (from 1950 to 2013) has been chosen as the optimal threshold between maximizing series length and avoiding missing data. We agree with the Reviver about the influence of length of series of data on trend identification. As already we answered, Dixon et al. 2006 coped with this problem by splitting the dataset in time frames of different length, with a different number of stations for each period (see also Birsan et al. 2005). Nevertheless, one of the added values of our work was to consider a continuous dataset as large as possible over the entire study domain in order to evaluate spatial trends over European basins with a consistent sample size. It was the same approach proposed in the recent work by Durocher et al. (2019) where stations with long series of missing data were discarded and a single time frame for all study domain was considered.

Reviewer: 2) The authors have amended their discussion on the causes of the streamflow trends. In their discussion on precipitation changes as a driver they state "Concerning rainfall changes, the southern regions are affected by a marked negative trend (even below -3 mm/decade), while the northern regions are characterized by a positive trend which can overcome 10 mm/decade. The spatial distribution over the 230 continent of both patterns appears perfectly congruent with the findings in annual streamflow volumes, as shown in Fig.6." I still strongly disagree with "perfectly congruent" changes in spatial patterns of streamflow

and precipitation changes. For example over Germany, precipitation has largely slightly decreased while discharge has increased. What could be the possible reasons for this pattern? This needs to be discussed in the manuscript.

Reply: Here, we referred to "Mediterranean" and "Atlantic-Boreal" areas for "Southern" and" Northern" regions, respectively. It seems clear that there are transition or intermediate areas in which these trends are not marked as the Central part of Germany. Thus, we clarified modifying the sentence as follows:

"*Concerning precipitation changes, the Mediterranean regions are affected by a marked negative trend (even below -3 mm/decade), while Boreal and Atlantic regions are characterized by a positive trend which can overcome 10 mm/decade*."

Reviewer: 3) While the authors already agreed with many of the referee comments in their previous version of their responses to the referee's comments, these changes could not be found in their revision 1 text. In the second revision, more of the changes that are described in the author responses are actually implemented in the text. However, this does not apply to all changes and it is annoying to see that the authors state in two rounds of revisions in their replies that changes were undertaken that in the end cannot be found in the text. Is it the reviewer's responsibility to check one by one that authors are not only pretending to undertake changes? I ask the authors to go very carefully through their replies and check whether really all of them are also in the text. Here are examples that I could not find in the text:

Reply: We are sorry for the misunderstandings. We carefully check the last version.

Reviewer: The calculation of the Sen's slope from annual streamflow anomalies is described as innovative, but if I do not overlook something this should not affect trends (and has probably been done in many studies).

Reply: By using anomalies to detect trends, the absolute random error is minimized (Pandžić and Trninić, 1992), but the reviewer is right in that it does not affect the trend (i.e., regression slope against time). Also, it is routinely carried out in both hydrologic and climatologic research. The methods section has been amended accordingly.

New Reply: The term "innovative" was removed. We modified as follows:

"Theil-Sen's line, known as Theil-Sen's slope or Sen's slope, was calculated on the annual anomalies in streamflow volumes, an alternative modality with respect to the common application on direct streamflow data (Birsan et al. 2005). "

=> Not implemented in the text.

Reply: We inserted the sentence in red inside the manuscript with corrections.

Reviewer: P6, L151: The unit of annual streamflow per area is length/time (e.g. m3/(km2 year), or mm y-1). Therefore the change in runoff over a certain period is length/time2 (e.g. m3/(km2 year2)).

Reply: Accepted – the values and units will be updated to reflect yearly change expressed in m3/(km2 year2).

New Reply: Done.

=> Not implemented in the text.

Reply: Probably, there was a misunderstood. In our work we refer to 'annual streamflow volume' as declared immediately in the abstract. The trend of this variable over the years is expressed in volume/time. Therefore, the annual streamflow volume per area is expressed in volume/(time x surface).

Reviewer: P7, L170; legend and caption of Fig. 5: replace rainfall by precipitation (assuming that snow is included).

Reply: Snow is included. Suggestion accepted.

New Reply: Done. We modified the caption as follows:

“Fig. 8. Comparison between annual streamflow volume trends and daily mean temperature (a) and rainfall (included snow-to-liquid equivalent) (b) trends over the European continent. Only significant trend are shown.”

=>Not implemented in the text.

Reply: We inserted the sentence in red inside the manuscript with corrections.

Please also replace rainfall with precipitation in the main text.

Reply: We replaced “rainfall” with “precipitation”.