Comments to J. Parajka (Referee)

We are very happy to notice that the paper was appreciated and will address how to make further improvements based on the suggestions made by Dr Parajka.

First, we chose not to put too much emphasize on specific rivers as we wanted to avoid noise and look for more general trends of climate change. However, we also recognize that there is information in our data material that may get lost by this approach, and as Dr. Parajka points out this is especially with regard to shift in flood regime or seasonality. We therefore suggest that we include a new Figure showing the shift in seasonality for some 15 rivers across Sweden, illustrating the monthly mean for the observations and for the projections, respectively. In addition, we suggest to add the last 25 years, which has been unusually wet and warm, to detect the already achieved shift in seasonal pattern of annual flow within a year. We think this will add the information Dr. Parajka requested.

Second, we will write a paragraph on this new Figure for the results section and we will add another paragraph to the discussion section where we analyzes the findings. For instance we can already now observe the shift in increased winter runoff in the southern part of the country, which is coherent with projected climate change. A slightly earlier spring flood can also be noted for the last 25 years in Northern Sweden.

We will also include some more references to similar studies (including the reference mentioned by Parajka) and discuss more thoroughly on attribution as well as the benefits of merging the long time-series from the past with the model projections.

Finally, we will correct the reference to Hall et al. 2014 and clarify that we use 2 m temperature throughout the paper.

Comments to the Anonymous Referee #2

We are aware of the methodological problems and they are mentioned in the paper, but we do not think that they make our conclusions too weak for publishing our results.

However, the text can be clarified. In the Conclusions, we could avoid mentioning the exact percentage of change for the significant results. On the other hand, it is important to note that also the significant results are of minor magnitude, and in addition, it is good to actually high-light the results even if they are uncertain, so that they can be compared with other studies in the future. It is not possible for a single research group to quantify all aspects of uncertainties in climate impact modelling. Instead we encourage synthesis analysis and comparative studies involving many research groups and we do also participate in such international initiatives.

In this specific paper, we mainly focus on linking long observed time-series with model predictions. As suggested by Reveiwer No1, we will emphasize the benefits of this approach more in the next version of the paper, to clarify the purpose of our study.

We have carefully chosen the climate projections to work with. The two projections are representative of members showing lower and higher change in a larger ensemble of 16 projections, both in P and T and river discharge. The projections thus show most of the range of uncertainty. We already refer to other recent work using this larger ensemble, but if the Editor so wish, we could attach a supplement file to the paper with a link to a report where the spread of the larger ensemble is analyzed and the representativeness of the chosen two projections are clarified more in detail.

Furthermore, we only present and analyze deviations from the mean of the reference period (1961-1990) for each projection. This is to avoid uncertainties caused by model capability to predict absolute values and by differences in model performance from using the different Precip/Temp forcing.
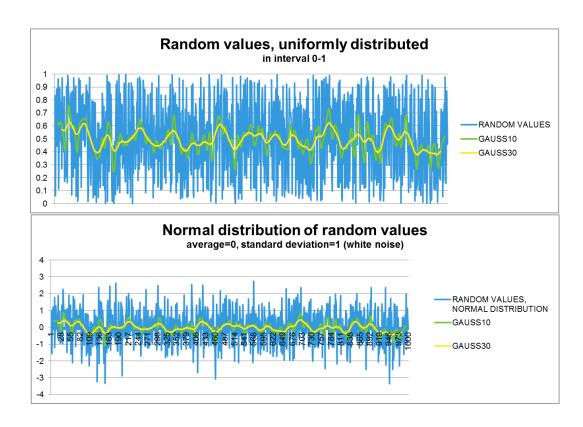
Regarding the filtering, we have used a Gauss filter to visualize trends without distraction from the noise caused by natural variability. However, as the Reviewer points out, the filter does not remove all noise and some oscillations remains also in a random dataset (see figure below). However, the filter does not introduce any new oscillations.

The past differences between periods are real, and not artefacts introduced by the filtering (which is shown in the paper Figure 2, where annual values are also given to show the effects of the filter). For instance the 1970s was a dry period in practically all of Sweden, whereas the 1920s, 1980s and 1990s were mostly wet years, with a higher frequency of high autumn flows. The same periods stand out in other Nordic countries as well. A Gauss filtered signal, which is based on random values does not show trends (as for instance in the paper Figure 5) although it creates persistence (see below).

The filtering is merely used for smoothing the signal and computing decadal averages, but without the disadvantages of an ordinary running average. The Gauss filter acts as a low-pass filter. It removes most of the year to year variation, and thus allows changes with a longer time scale, for instance decades, to be more visible. It might be interesting to note that the same pattern of more persistent periods of drier and wetter years as have occurred in the past (and which are not introduced as an artefact by filtering), seems to be preserved in the climate projections for the future.

For climate projections, it is very important not to analyze specific years as the climate models do not have that predictability but only show general trends and fluctuations that may not be in phase with the observed climate. Therefore, we chose not to show specific years from climate impact modelling but only the general tendencies, which are seen more clearly by the filtering.

<u>We suggest that we keep the Gauss filter when presenting our results to make the paper easier to read and more correct for climate interpretations.</u> It is a very common way to present climate data over long time periods.

We thank both reviewers for their time and recommendations to help us improving the paper!