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Hydrology and Earth System Sciences
Discussions
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Interactive comment on "Projected changes in Rhine River flood seasonality under global warming" *by* Erwin Rottler et al.

Anonymous Referee #2

Received and published: 23 December 2020

1. General comments

Overall quality of the preprint: A well-structured paper that supports earlier results and adds additional insights into the shifts of flood genesis under climate change. The latter could be highlighted a bit more in the abstract and other parts of the text (suggestions under "specific comments). Principle review criteria (scientific significance, scientific quality, and presentation quality) are generally evaluated as "good". Suggest to accept with revisions.

2. Specific comments

The specific individual scientific questions/issues are labelled as "Change requests" that should be changed before publication and "Suggestions" that could be changed

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Discussion paper

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before publication.

- Page 1, Abstract - change request: The abstract describes basic mechanisms of the flow regime of the Rhine River in a warmer climate. This is neither new – cf. e.g. to Kwadijk Romans (1995; https://link.springer.com/article/10.1007/BF01093854) - nor the core of the study presented here. It is suggested (a) to highlight a set of change signals of the hydrological characteristics you evaluated (number of years with snowmelt fraction above a threshold or lift of "melt elevation" etc.) and/or (b) focus more on the hypothesized new flood type superimposing rainfall- und snowmelt-induced runoff.
- Page 1, line 16 - suggestion: The term "current climate crisis" has a political flavor.
- Page 2, lines 1ff - suggestion: Add reference to IPCC SROCC
- Page 3, lines 9ff - change request: Please add here, that hydrological processes are modelled at 5 km grid resolution (referring to page 5). Otherwise the reader waits for a final downscaling step of met. data to the 500 m grid of mHM.
- Page 3, line 16 – change request: The quoting used here reads like the authors do not understand what this part of the procedure/sentence means. Is that the intention here? The bias correction procedure is important when dealing with peak flow analyses (and heavy precipitation). Please rephrase.
- Page 3, line 22ff – change request: Please explain how you treated the catchment upstream of Basel. As it reads now you would end up with two parameter sets; one from the calibration of Basel, one from the calibration of Lobith (also containing the catchment upstream of Basel). Please clarify, which parameter set you used for the overlapping part of the catchment or if you used individual model set ups for each gauging station.

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- Page 6, line 17f – change request: Please add some details on your experience concerning the 14-day time window for snowmelt and evaporation. Is it based on investigations of historical floods? Or on model simulations?
- Page 6, line 25f – change request: The flow regime at gauge Cologne is usually regarded as "complex" regime containing "nival" and "pluvial" characteristics. This should be added here. Now, the gauge is described as another pluvial example.
- Page 7, Figure 3 – change request: The map shows the Rhine River basin up to Lobith, not the entire Basin. This should be added in the scheme and/or caption.
- Page 7, Figure 4 – suggestion: For reasons of consistency it is suggested not to introduce an additional reference period here (1971-2016). The period 1971-2000 should be chosen here as well.
- Page 8, line 11ff – suggestion: For some readers it may be interesting to note that according to your results there will still be some snowmelt at gauge Cochem even in a 3°C warmer world. Suggest to add this point.
- Page 8, line 13 – suggestion: The units of the variables could be changed to give a better "grip" of the results. For example, "the number of streamflow maxima having an estimated runoff contribution of snowmelt of more than 20
- Page 8, line 21 – change request: "Decreases in solid precipitation are most prominent in winter" ← That's not surprising because according to your results the historical period shows is no solid precipitation in summer. Rephrase, e.g. referring to meteorological seasons (DJF, MAM, JJA, SON).
- Page 9, lines 3 – suggestion: Suggest to repeat here that the timing of the highest annual flow remains unchanged.

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- Page 10, lines 6f – suggestion: The role of evaporation simulated under climate change conditions strongly depends on the evaporation approach used and the area of interest. Suggest to transport this uncertainty of hydrological modelling by formulating more carefully. For example: "With the approach used here, evaporation seems to play a minor role . . .".
- Page 11, line 6f. – suggestion: It would be also interesting to state already here that snowmelt-driven flooding is possible despite of rising temperatures. At least in low warming levels there may still be relevant snowmelt events. This follows only two pages later.
- Page 11, line 11 – change request: The hypothesis mentioned in the introduction was on flood risks resulting from the overlap of nival and pluvial peak flows. Here, the focus is on snow-melt driven floods only. Check consistency.
- Page 12, figure 8 – suggestion: Add the range that is displayed by the boxes.
- Page 12, line 1f – suggestion: Suggest to stay focused on floods and skip low flows.
- Page 12, line 3ff – change request: In this paragraph it is advisable to be very clear about (a) the statistics (e.g. to avoid confusion between monthly and annual stream flow maxima) and (b) the gauge/regime that is discussed. Otherwise the reader will be lost. For example the statement that "with rising temperatures, most flood events will occur in winter" does obviously not relate to Basel/nival regimes. This has to be more transparent.
- Page 14, line 7 – change request: In how far are peak elevations (here: 1300 m a.s.l.) and the related processes interpreted here reflected in the hydrological model, given the 5 km grid resolution? Please add this to the method description (page 3f.).

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- Page 14, line 30ff. – suggestion: cf. comment on abstract. Suggest to refocus this paragraph in the same way.
- Page 15, line 14f. – suggestion: Suggest to stay focused on floods and skip low flows. Lakes and reservoirs play an important role for high flow, too. If they are not yet implemented in the model, this should be mentioned in the methods chapter (page 3f.)

2. Technical corrections

- General comment: It was difficult to print the pdf. Presumably one of the graphs is oversampled – please check.
- Page 8, line 5 – change request: Figure 5b contains no information on the timing of runoff maxima. Wrong reference. Please correct (-> 5d?) and repeat the reference to "Basel" in the text/line 5.
- Page 8, line 13 – change request: "more the" -> "more than"
- Page 9, Figure 5 – change request: The horizontal grid lines do only occasionally match the tick marks. Please correct.
- Page 10, Figure 6 – change request: The horizontal grid lines do only occasionally match the tick marks. Please correct.
- Page 12, line 6 – change request: Replace "Smax14" by plain text.
- Page 12, Figure 8 – change request: The horizontal grid lines do only occasionally match the tick marks. Please correct.
- Page 13, Figure 9 – change request: The horizontal grid lines do only occasionally match the tick marks. Please correct.

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- Page 24, Figure B1 – change request: The horizontal grid lines do only occasionally match the tick marks. Please correct.
- Page 25, Figure C1 – change request: The horizontal grid lines do only occasionally match the tick marks. Please correct.

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