Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2017-602-AC1, 2018

Hydrology and Earth System Sciences Discussions

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Interactive comment on "Impacts of climate change on extreme floods in Finland – studies using bias corrected Regional Climate Model data" *by* Noora Veijalainen et al.

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Received and published: 15 February 2018

Dear Reviewer

We would like to thank you for your useful comments on our manuscript. Here are our replies to the comments.

Choice of study basins is re-evaluated with the addition of Hypöistenkoski to better enable the impacts of the method used on floods caused by daily precipitation to be evaluated on small catchment. Hypöistenkoski is a small river in south-western Finland with 325 km catchment area and 1 % lake percentage. The results of Hypöistenkoski

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(see attached Figure) show that there is no significant difference in the performance of the single gamma and double gamma distribution in correcting of the snowmelt floods as expected. However, the single gamma method corrects the maximum annual rain induced floods better than single gamma. Typically the annual maximum floods in Finland have been snowmelt floods but in the future in southern and coastal part of Finland the annual maximum floods will be more frequently rain induced floods due to climate change. Therefore we will add the results of Hypöistenkoski catchment and discussion about the importance of the performance of the bias correction methods for producing snowmelt and rain induced floods separately.

We will also re-evaluate the objectives of the study by focusing more on e.g. exploring the adequacy issue (e.g. guidelines for assessing adequacy) and less on the evaluation of climate change impacts on floods.

The observations are based on Finnish Meteorological Institute gauge observations and as described in Olsson et al. 2015: "The areal values of the meteorological observations are calculated for each sub-basin of the hydrological model from three closest observation stations by inverse distance weighting taking into account the elevation differences. The areal values were converted to the same regular 0:25lat*0:25 long grid as the RCM data." This information will be added to this paper.

- ENSEMBELS data was used because at the time the first part of this research (published in Olsson et al. 2015) was carried out the EURO-CORDEX data was not yet available and we wanted here to use the same data as in the earlier paper. Prein et al. 2015 have concluded that the best largest improvements can be found in regions with substantial orographic features. Finland is relatively flat and therefore the added value of fine resolution is smaller than in some other parts of Europe. Casanueva et al. (2016) found only limited added value of higher resolution in the precipitation frequency and intensity. Text about this will be added to the manuscript.

- Comparison with delta change method will be extended to explore the tradeoffs in these methods. Also further comparison between articles using several methods will be added.

- Adequacy issue will be further explored for increasing the importance (and novelty) of the paper. New more precise methodology for the assessment of adequacy will be presented and tested. We propose that the performance of the hydrological model and the bias corrected RCM scenarios could be tested separately for snowmelt and rain-induced floods. The estimated 2/10, and 100 year floods and their confidence limits could be compared with the control simulation/observations to testing the performance of the DBS-methods for both frequent and extreme floods.

Specific comments:

These minor corrections will be done in the paper.

Best regards

Noora Veijalainen

Juho Jakkila

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2017-602, 2017.

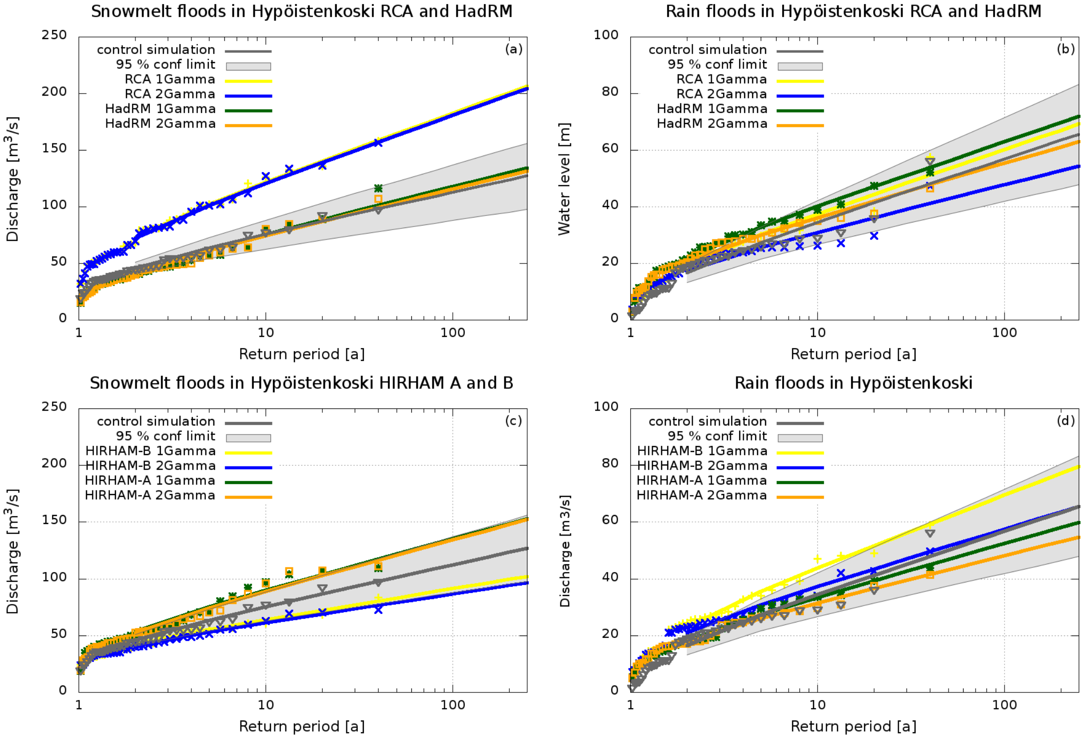

Fig. 1. Comparison of simulated maximum discharges and Gumbel distribution of Hypöistenkoski for snowmelt floods (a and c) and rain induced floods (b and d) in 1961-2000 for bias corrected RCM scenarios.

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