Response to reviewer comments: HESS-2019-77

We thank the three anonymous reviewers and Peter Stucki for their constructive comments. In the following, we focus our reply to the major comments. Based on these comments, we conclude to rewrite the article. Later, we will take care of the minor comments, which then will be still important. Reviewer #1 pointed out that the title could be adjusted. However, we realized that not the title has to change but the content of the paper. Thus, a complete revision of the paper is necessary. We aim to use a different bias correction method and shorten/change the validation of the bias correction, and include corresponding literature. At this point we will also change the focus for possible applications in hydrology and what requirements are necessary for such purpose.
In the first version of the paper, we focused on downscaled ERA-Interim (and ERA-20C) simulations as an example. Now, we think that the second version of the paper would benefit a lot from the inclusion of a larger RCM dataset (ensemble of the MiKlip project, https://www.fona-miklip.de/). In total, we have over 10.000 simulated years, making it possible to do proper statistics, and which fits better to the chosen title "Towards the Development of a Pan-European Stochastic Precipitation Dataset".

RC4) Interactive comment on "Towards the Development of a Pan-European Stochastic Precipitation Dataset" by Lisa-Ann Kautz et al.

Anonymous Referee #4

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General Comments

This manuscript is concerned with the simulation of precipitation capable of generating floods in Europe, which can create major losses to life and property. The authors rightly point out that precipitation records are often limited in length and spatial extent, which prevents them from being useful to drive hydrological models to simulate flooding responses to extreme rainfall. They argue that an appropriate strategy is to downscale coarse climate output from global climate models, which represents spatial fields of climate over historical time, nudged by re-analyzing these data with local observation information. They further suggest that to overcome the limitations of climate models in capturing the effects of extreme rainfall that occurs during convective storms, bias correction should be employed. The authors then set out a goal of determining the most appropriate bias correction method for such an application and to then assess the relationships between historical precipitation events and flooding over parts of Europe. They use ECMWF re-analysis global GCM output for the historical period and then dynamically downscale these modeled data via an RCM to obtain precipitation fields of 25 km resolution. Then they apply bias correction to overcome artifacts such as 'the drizzle effect'.

I believe this work is a solid and competent approach to the problem of attributing climate phenomena to flooding. I'm not very familiar with the extensive literature on downscaling climate model output and bias correction to explore its influence on hydrology, so I cannot evaluate the details of such an approach. More to the point, I am not terribly enthusiastic about this approach because of its limited utility in understanding the processes by which weather events translate into flooding. My biggest concern is that you are always left scratching your head about which method works where and for what circumstances. And furthermore, this uncertainty changes between events of different types and with different antecedent conditions (a point made briefly on p.12, Line 7).

This may yield nonlinear errors in the representation of precipitation over the region (note differences in accuracy for the Danube v. Vistula rivers in the 2009 event), which are compounded when routing this into runoff and streamflow. These factors make it challenging to imagine that we can ever make considerable intellectual progress in attributing flooding to specific precipitation events in a generalizable way. Nevertheless, I can see the attractiveness of such methods, given the proliferation of global climate model re-analysis output. Overall, it seems that work is on solid footing and should ultimately be published, following a revision that addresses reviewers' comments. I would like to see some intellectual realism injected here. How worth it is it to take a downscaling approach and what do we learn from doing it?

We thank the reviewer for these comments. In the revised version of the paper, we will emphasize the novelty of the study that an ensemble of ~10.000 simulated years is available, which is a great basis for statistical analysis. As we wanted and still want to focus on the added value of our approach to deliver a product (meaning the bias-corrected downscaled precipitation) which is suitable for hydrological models, we do not plan to go into detail about dynamical processes being relevant for extreme precipitation and thus flooding. Furthermore, we have to choose a generalized method to keep consistence. Otherwise every single event has to be corrected separately which is not the purpose of doing stochastics.
Regarding the choice of the bias correction method, we will try to point out the advantages and improvements by the selected method (in comparison to the uncorrected data and other approaches) more clearly. The added value of the bias correction will be shown by including results from the hydrological model. Moreover, we will add further information about the dynamical downscaling (by naming uncertainties) – as suggested by Peter Stucki.