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Discussions

Interactive comment on "Spatial Dependency in Nonstationary GEV Modelling of Extreme Precipitation over Great Britain" *by* Han Wang and Yunqing Xuan

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We thank the referee Worms (Worms, 2020) for spending time reading the manuscript and providing valuable and in-detail comments that will certainly help improve the quality of paper via revision.

We particularly appreciate the points the referee highlighted regarding the use of the K-S test and the way of stating the return level in the context of nonstationary application – which will be further strengthened in the revision (see the detail response below). However, while we agree in principle with the referee that there are still spaces for clarification, we would argue that other comments, mainly related to 'sampling' and

'simulation', are unfortunately due to misunderstanding either of the context or of the technical approach employed. Our responses are as follows:

1 Responses to the 'Main Comments'

There are several terms used in this paper which have a slightly different meanings compared with the conventional cases where they appear. 'Sample/sampling' and 'simulation' are the two main terms which we believe are the major cause of the misunderstanding. We will rephase them to make it clearer thanks to the referee's feedback. Firstly, regarding the term "sample". We use "sample" to present the sampled areas which have the same shape and size and regularly distributed in the mainland of GB. These samples, or sampling areas, are generated by using a spatial random sampling toolbox which can randomize the characters (i.e., central location, size and shape) of the samples. We agree with the referee that ideally those areas should have been sampled in a pure random fashion with randomised location, shapes and sizes. In fact, the toolbox we developed and used can be easily set up to help achieve this. The reason we decided not to do it in this paper is based upon:

1. The scope of this paper is the non-stationarity in GEV applications in catchment hydrology. It does not intend to work fully fledged to reveal how the rainfall extremes vary over space and time continuously. This is also why a medium size is chosen to mimic a typical catchment. Certainly, there are other interesting features about the size, shape, local topography as well as the orientation of the shapes, which obviously deserves a separate study. In fact, we have already done such study which was briefly discussed in Wang Xuan (2020) with a full paper is due to submit. Again, in the present paper, the main interest is to investigate how non-stationarity vary with location and the setting (although not idea) will suffice for hydrological communities.

2. The choice of using 'sampled areas' instead of point or grid rainfall data is again for the consideration of hydrological applications. A no-space-left approach, as suggested by the referee, could have been easily implemented, i.e., just conduct and fit distribution grid-by-grid. This might be a better choice from a statistical analysis viewpoint but less so for hydrological applications.

Secondly, regarding the choice of GB and the GEAR dataset, we agree that the study area may not be as large as those studies aiming at revealing climatic variations at larger scale. Again, our choice is based on the practicality: 1) that the GEAR dataset is ideal for non-stationarity study as it contains long enough records with high spatial resolution, but unfortunately its coverage is limited, e.g. GB only; 2) that even within GB, the variation of GEV is remarkable as shown in the study and results are of great relevance for the scientific community in the UK; and 3) the methodology presented is not limited by the area or the dataset and can be extended to other areas with suitable datasets.

Thirdly, the argument around 'simulated samples' is where one of the main critical points is drawn from. We did not use the term "simulated samples" but we reckon the referee meant "the simulated AMDR". There are two scenarios with which 'simulation' is associated. The first scenario is that the once stationary GEVs are fitted to the samples of AMDR, the fitted distributions can be used to generate the 'simulated' AMDR from the inversion of the GEV's with input as the original empirical probability. This is a deterministic process. The 2nd scenario is when using the Bayesian MCMC method to fit non-stationary GEV's where multiple simulations can occur. These simulated AMDR's (the grey band in Figure 4,5,6) can also give an idea about the uncertainty of the nonstationary model. It should be noted that the AMDR's sampled from those regular areas do not involve any simulation (as previously explained). We regret that this has caused confusion and we will clarify this in the revised version.

Next, we appreciate the referee's remark on the use of the K-S test and the common problems may occur if it is not treated carefully. The present study follows largely the applications in many previous studies using this test for selecting GEV distribution in fitting hydro-climatic extreme datasets (Fischer et al., 2012; De Michele Avanzi, 2018; Ayuketang Joseph, 2016). And Many studies have shown that the GEV distribution fits well to extreme precipitation (Gong, 2013; Bonnin et al., 2006; Alila, 1999; Kysel′y Picek, 2007). We did not include the detail sampling procedure (of candidate distributions/parameters using another type of MC simulation) for the calculation of the p-values as we were concerned about potential over-sized paper. This will be addressed fully in the revision alongside another test to support the choice of GEV.

For the introduction of 'diff', we proposed this as an additional measure to check the performance of the fitted non-stationary GEV's as it is very hard if not impossible to use the K-S test for the non-stationary models. The selection between S-GEV and NS-GEV or among GEV family is based on not only the p-values but also the "diff" measure. Figure 7b shows the difference of 88 sampling areas between modelled AMDR and empirical AMDR. Meanwhile QQ plot is also used for double checking by visual comparison (for example in Figure 7a). We will improve the definition and justification of the 'diff' measure, possibly with a less-confusing term in the revision.

Regarding the 'return level' in the context of nonstationary distribution, we thank the referee for highlighting this and agree that we should have been careful as to the definition of the return level. However, our intention is to make use of a concept of 'snapshots' looking at different exceedance probability calculated for the same rainfall value at both the beginning and the end (or any other middle point) of the period. This is a rather a Poor Man's approach, but it helps avoid the complex discussion of the return levels. This is also a common practice in the engineering community where practitioners tend to use reduced return levels (higher exceedance probability) to describe climate change impact. We will clarify this further in the revision.

Lastly, thanks for pointing out the strange look due to 'fixed' decimal places of Fig. 3d. This was inadvertently done, and we do apologise for the overlook as somehow the script we used truncated the values of the parameters to 2 decimal places. We will ensure the original values of the parameters be used in the revision version. And to Figure 3c, as we did not make use of any secondary process of GEAR dataset (do not have to), the estimation of parameters is all based on the original dataset.

2 Response to the 'Minor comments'

We are thankful to the referee for other advices and suggestions of the necessary corrections and will consider and implement them where appropriate in the next iteration.

3 References

Alila, Y., (1999) A hierarchical approach for the regionalization of precipitation annual maxima in Canada. J. Geophys. Res., 104(D24), 31645–31655.

Ayuketang Arreyndip, N. and Joseph, E. (2016). Generalized extreme value distribution models for the assessment of seasonal wind energy potential of Debuncha, Cameroon. Journal of Renewable Energy, 2016.

Bonnin, G M, Martin, D, Lin, B, Parzyok, T, Yekta, M, and Riley, D. (2006). Precipitation-Frequency Atlas of the United States, Volume 1, Version 4.0: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico). NOAA Atlas 14.

De Michele, C. and Avanzi, F. (2018). Superstatistical distribution of daily precipitation extremes: A worldwide assessment. Scientific reports, 8(1), 1-11.

Fischer, T., Su, B., Luo, Y., and Scholten, T. (2012). Probability distribution of precipi-

tation extremes for weather index–based insurance in the Zhujiang River Basin, South China. Journal of Hydrometeorology, 13(3), 1023-1037.

Gong, S. (2013). Extreme Analysis of an Annual Rainfall Dataset. In Advanced Materials Research (Vol. 610, pp. 2756-2760). Trans Tech Publications Ltd. Kysel′y, J, Picek, J., (2007). Regional growth curves and improved design values estimates of extreme precipitation events in the Czech Republic. Clim. Res., 33, 243–255.

Wang, H. and Y. Xuan (2020): Temporal and Spatial Variation of Extreme Rainfall in Great Britain and Australia using the SRS-GDA toolbox, 6th IAHR Europe Congress, June 30th – July 2nd, 2020, Warsaw, Poland, accepted, https://doi.org/10.13140/RG.2.2.31765.27366

Worms, J. (2020): Interactive comment on "Spatial Dependency in Nonstationary GEV Modelling of Extreme Precipitation over Great Britain" by Han Wang and Yunqing Xuan, Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-44-RC2

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