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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Assessment of extreme flows and uncertainty under climate change: disentangling the contribution of RCPs, GCMs and internal climate variability" *by* Chao Gao et al.

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Dear Referee #2,

We highly appreciate your review and useful suggestions for our manuscript. We provide our answers to your queries below.

Kind regards, all authors

Queries by anonymous referee #2 RC2 & answers by authors are as follows:

Comment #1: This manuscript only explained how to disaggregate monthly precipitation into daily precipitation considering the internal climate variability. How to down-

scale air temperature from monthly scale to daily scale should be also explained in the manuscript.

Authors' response: Thanks for your comments. In this study, we did not disaggregate monthly rainfall into daily rainfall, because we directly used the daily rainfall and temperature data of GCMs downloaded from https://data.cma.cn/ as described in Section 2. In fact, we spatially downscaled GCM simulated rainfall and temperature data in the historical and future periods rather than temporally downscaled the data, i.e. downscaling from the coarse GCM spatial resolution to the catchment resolution. This has been done using the distribution mapping (DM) method. The detailed downscaling methods are described in Section 3.1. In addition, this study indeed only considered the internal variability of rainfall through directly generating realizations of rainfall using the developed stochastic rainfall model SDRM-MCREM, the internal variability of temperature is not taken into consideration. Considering that the internal variability of rainfall is always large and comparable to or even greater than the recognized large uncertainty of GCMs (Hingray and Saïd, 2014; Giorgi, 2002), it should not be neglected in the analysis of different uncertainty sources in rainfall projections. Regarding the internal variability of temperature, several studies pointed out that it is usually very small compared with other uncertainty sources of temperature like GCM uncertainty and RCP uncertainty and therefore can be ignored without large consequences (Lafaysse et al., 2014; Hingray and Saïd, 2014; Fatichi et al., 2016). For that reason we did not consider the internal variability of temperature in this study as an uncertainty source and this has also been explained in the discussion section (see Page 22, Line 416-420).

References:

Hingray, B., and Saïd, M.: Partitioning Internal Variability and Model Uncertainty Components in a Multimember Multimodel Ensemble of Climate Projections, J. Clim., 27, 6779-6798, https://doi.org/10.1175/jcli-d-13-00629.1, 2014.

Giorgi, F.: Dependence of the surface climate interannual variability on spatial scale,

Geophys. Res. Lett., 29, 16-11-16-14, https://doi.org/10.1029/2002gl016175, 2002.
Lafaysse, M., Hingray, B., Mezghani, A., Gailhard, J., and Terray, L.: Internal variability and model uncertainty components in future hydrometeorological projections: The Alpine Durance basin, Water Resour. Res., 50, 3317-3341, 2014.

Fatichi, S., Ivanov, V. Y., Paschalis, A., Peleg, N., Molnar, P., Rimkus, S., Kim, J., Burlando, P., and Caporali, E.: Uncertainty partition challenges the predictability of vital details of climate change, Earth Future, 4, 240-251, https://doi.org/10.1002/2015ef000336, 2016.

Comment #2: Section 4.2.2: Since this paper focuses on extreme flow projections, please add a short paragraph on the performance of the hydrological model in extreme high and low flow simulations in the historical period.

Authors' response: Thank you for your useful suggestion. We will add a relevant figure and some information about the performance of the GR4J hydrological model with the selected optimum parameter set in reproducing extreme flows including high flows and low flows in Section 4.2.2.

Comment #3: Figure 2: Replace 'dry spell' with 'Dry spell'. 'Modium' in the table should be'Medium'.

Authors' response: Thank you. These will be modified accordingly, i.e. "dry spell" being replaced with "Dry spell" and "Modium" replaced with "Medium" in Figure 2.

Comment #4: Figure 3 is not clear enough. Please enlarge the figures to improve the readability.

Authors' response: Thank you. We will redraw Figure 3 to make it much clearer to read.

Comment #5: Figure 4: In each sub-figure, there is a small plot box with three curves. Please denote the plot box in the figure caption.

Authors' response: Thank you very much. We will add a description for these small plot boxes to the caption of Figure 4. The adjusted caption of Figure 4 will read "Ensemble averages of GCM simulated monthly mean (a) rainfall, (b) daily maximum temperature, (c) daily minimum temperature and (d) daily mean temperature for the historical and two future periods under four RCPs after bias correction. The small graph in each sub-figure shows the ensemble averages of all GCMs and RCPs for the corresponding variable in the historical period and the two future periods, i.e. 2050s and 2080s."

Comment #6: Figure 6: Replace 'DRM-MCREM' with 'SDRM-MCREM'.

Authors' response: Sorry for the mistake. We will replace "DRM-MCREM" with "SDRM-MCREM' in the caption of Figure 6.

Comment #7: Line 139: 'he features' should be 'the features'.

Authors' response: Thank you. We will modify "he features" to "the features".

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