Review report for egusphere-2022-1058
Anonymous Referee #1

Referee comment on "Historical rainfall data in Northern Italy predict larger meteorological drought hazard than climate projections" by Rui Guo and Alberto Montanari, EGUsphere, https://doi.org/10.5194/egusphere-2022-1058-RC1, 2022

Summary

The paper evaluates the ability of latest generation climate models to simulate rainfall time series that emulate well the observed rainfall time series in terms of a variety of statistics and patterns with a focus on multiyear meteorological droughts. It also infers how precipitation and drought risk will change in the future for the region of Bologna. For achieving these, a long record of daily rainfall observations is exploited, along with daily rainfall simulations issued by 13 climate models for the region of interest. The observed time series and the model simulations refer to the periods 1850 – 2014 and 1850 – 2100, respectively. The results suggest that several rainfall statistics and patterns are fairly similar for the observed records and the model simulations. Still, the lag-1 sample autocorrelation at the annual temporal scale is notably less intense for the model simulations and, more generally, the historical sequence of the observations at the same temporal scale is not satisfactorily reproduced by the climate models. In terms of meteorological droughts, it is concluded that “historical rainfall data in Northern Italy predict larger meteorological drought hazard than climate projections”.

General evaluation

The paper consists a timely and valuable contribution to the dedicated efforts of hydrologists towards achieving a better understanding and a better management of drought events.

Moreover, it provides useful insight on how a large variety of rainfall statistics, including statistics referring to autocorrelation and seasonality patterns, compare between a long record of daily rainfall observations and daily rainfall simulations provided by latest generation climate models.
The methodological design is innovative and well-conceived, the results are very interesting and the manuscript is excellently well-written.

Here below, I list a few minor comments that could be addressed for achieving some improvements in terms of presentation.

**Minor comments**

1) Maybe the following lines (i.e., lines 278-280) could be somewhat extended for including as much information as possible from the analysis outputs: “In general, few models only predict the worst meteorological drought statistics during 2015-2100 with respect to 1850-2014 observations, and MME does not resolve the problem as it delivers a less conservative prediction with respect to past occurrences of multiyear droughts”. For instance, the “few models” and the “worst meteorological drought statistics” could be reported. Discussing the related analysis outputs in greater detail would be beneficial, to my view, as they consist one of the most interesting parts of the paper.

2) Additional recommendations for future research (aside from the general directions already provided in the paper) could be added (e.g., in the “Conclusions” section). These recommendations could include the application of the methodological framework of this work to other areas around the globe. Discussions on the minimum observed data availability requirements for such an application would be also beneficial, to my view.

3) In line 233, it is written that “the ensemble mean performs better than any individual model for all indices”. However, according to Figure 10, the ensemble mean performs better than the individual models for most, but not all, indices. Note that, for instance, it exhibits worse performance than GFDL-ESM4 in terms of the index referring to very heavy rainfall days (R20mm).

4) Figure 9 could be extended for providing information about the seasons December-January-February (DJF) and June-July-August (JJA) as well.

5) Some amendments could be applied to Figures 4, 5 and 7 for improving their readability. Specifically, for all the sub-figures belonging to each of these figures, the axes limits could be set the same. Moreover, a note could be added to the caption of Figure 8 for explaining that the thick lines represent the observed time series and the ensemble mean or, even better, the legend could be amended for providing this information. Lastly, the text size in Figure 6 could be increased.