Review Comment hess-2022-94

Title: Projected changes in droughts and extreme droughts in Great Britain strongly influenced by the choice of drought index

In this paper changes in drought characteristics are evaluated for GB, for 2 future climate scenarios. Two drought indices are used to characterize drought severity, SPI and SPEI, for various space and time-scales. The study finds increase in most drought characteristics (frequency, extent, duration etc) for future climate conditions, not entirely unexpected.
In particular, the authors emphasize that the choice of drought index influences the quantitative assessments of projected drought changes.

Given this perspective, it is particularly important to document not only the indices used but also the full range of methods applied to reach their conclusions. This is the main problem I see with this paper: many aspects of the methods used for analysis are not clearly explained.
Secondly, the Results and Discussion sections are very long and need to be strongly condensed to convey only the essential information. To give an example, section 5.1 covers almost 2 pages to describe a single figure, followed by 2 more pages for a second figure. That's a lot of descriptive information that can be drastically shortened, based on a critical reassessment of what pieces of information are really important and worth for the reader to know.

Detailed comments:
Abstract:

- General comment: the summary of results presented here is quite superficial, i.e descriptive rather than interpretive. Deeper interpretation of the results would make the Abstract a lot more appealing.
- Check phrasing here: the phrasing suggests that projected changes are sensitive to the choice of drought index (L5). However, projected changes are simply what the simulated climate scenarios tell us, how they are summarized in quantitative metrics is where the differences in interpretation come in.
  Same confusing phrasing is used throughout, e.g. (L14) "SPEI results in greater increases in drought frequency and extent". Obviously the drought characteristics do not change, only how the indices are computed. L16: "projected changes (..) depend on the drought index, (..)". Again, reasoning is flawed: projected changes are the same, the indices are different, not the other way around.

1. Introduction:

- P2, L 39: it is suggested here that evapotranspiration only depends on atmospheric variables, but strictly speaking vegetation also plays a role (stomatal conductance)
- P3, l65: same phrasing issue as in Abstract

3. Methods:

- P5: it would be helpful to provide the definitions (and/or the equations) of the indices that are used in the paper (AI, SPI, SPEI), so the reader doesn't need to search back in the literature
- P5, L151: "observation-based calibration": this needs clarification. How was this calibration done, this is currently not explained.
- P6, section 3.3, Drought characterization: it is stated that spatiotemporal characterization is important - agreed. Unfortunately, the authors do not specify the space and time scales used in their characterization. What is "regional", "seasonal", what range of space and time scales did they investigate?
- P6, L162: please clarify definition of 'extreme drought'. At present, the choice of SI<-2 sounds arbitrary
- P6, L177: "a distribution fitted to the relatively short times series". This needs explanation: what distributions were fitted, how exactly?

4. Projected climate changes:

- In the caption of Figure 3 it is mentioned that “after bias adjustment using change preserving quantile mapping” is applied to the ensemble members.
  This is not the right place to mention such a data processing step! Please explain adequately in the main text.

5. Projected changes in drought characteristics:

- L204: the authors refer to “2C above pre-industrial”, but as far as I understand their reference scenario is 1981-2005. That’s not exactly pre-industrial.. Please clarify or correct.
- Figure 4: the use of % as a unit for frequency is very confusing here. If I understand correctly the % is calculated based on number of years (in 25 year climate period) that index values are below a given threshold. This is a guess, it is not clearly explained.
  Much later, in Figure 10, the authors use “number of events” instead - a much more straightforward type of unit. I recommend using this unit throughout.
- LL 199-241: this is a very extensive description of a single figure (see earlier comment). Please reflect critically: what pieces of information are really worth mentioning?
- LL 242-290: same here, figure description is far too lengthy.
- L246: “the fit of the gamma and GEV distributions used in the calculation of SPI and SPEI”.
  So gamma and GEV distributions were fitted apparently..? This should have been explained in the Methods Section!
- L266: “detrended temperature simulations”. Again, please explain this properly in the Methods section – how was the detrending done, for what purpose exactly?
- L272: “purely temperature-based PET” : this seems to suggest that temperature has a strong influence on PET, yet the influence of Radiation is much stronger (linear relationship with PET in Penman equation). Please check the reasoning here, it seems flawed.
- Figure 6: this is first time Observations are shown in any of the results graphs! Why only now and not in the earlier graphs?
  Also in Figure 6: a gradual color scale is applied here which makes it impossible to distinguish clearly between the 3 scenarios. Note that in the current representation their seems to be no significant difference between the Reference and +2C scenario.

Note: I stopped reading here. Sections 5 and 6 are very lengthy and many of the results point in the same direction. Are all these figures and subsections really needed to make the point stated in the title, that “Projected changes in droughts are strongly influenced by the choice of drought index”?
I strongly recommend that the authors take a critical view of their results and make a selection of the materials that most strongly support their conclusions. Then report these clearly and concisely.