

## Review - Projected changes in droughts and extreme droughts in Great Britain strongly influenced by the choice of drought index

This paper examines projected changes in drought frequency, extent, seasonality and duration for Great Britain using the latest UKCP18 projections. It analyses the differences between two atmospheric drought indicators (SPI and SPEI) and shows that the choice of drought indicator can have a big impact on the derived drought indicator.

Overall, this is an interesting study that is well written and well presented. The analyses are extensive, well thought out and well executed. I believe the paper will have appeal to a wide readership, however, there are some core issues that need to be resolved to enhance the key messages of the paper. Firstly I think the motivation of the study needs to be more clearly defined and more detail is required on the choice of climate projections and bias correction. Secondly, I strongly encourage the authors to take a critical read of the discussion and shorten it to the core messages – it is currently very long and your interesting results are getting lost.

More detailed comments are provided below that I hope the authors find useful.

### **Comments**

1. **Motivation.** The motivation for the study needs to be clearer. Currently the introduction reads like a series of definitions rather than a compelling story of why this study should be undertaken. There are two core areas where I think this could be improved:
  - a. There have been quite a few studies that have used or compared drought indices (many are cited in your discussion) so what does this study offer that is novel and different?
  - b. Why focus on Great Britain (which often isn't thought of as a country that experiences lots of droughts!) and how are your research questions relevant to this region?
2. **Use of UKCP18.** There needs to be better justification for the use of the regional projections from UKCP18 in this study – why use this set of projections instead of the local UKCP18 projections for example? Or use a set of climate projections that encompasses different GCMs or RCP scenarios (for example)?
3. **Bias Correction.** At the end of Section 2.2 there is a section on bias correction which needs more detail. Why did you choose these bias correction methods and how are they applicable to the types of biases you observe between the climate projections and observational data? It would be helpful to add some plots in the supplementary information showing these biases to help the reader understand the nature of the biases and how they were corrected. For example, you note in section 3.2 that a direct comparison of the results between climate model ensemble members and observations is only possible because their distributions are similar – it would be helpful to see evidence of this.
4. **Discussion.** The discussion section is extremely long and as a result, a lot of your interesting results get a little lost amid all the discussion. The authors need to have a critical read of the discussion and carefully consider if all the text is needed. As a suggestion, I would significantly shorten section 6.4 as this tends to be a review of the

literature, rather than a discussion of your results with context from the literature (you could just use the summary paragraph – you don't really need all the preceding text).

### Minor/Technical Corrections

P2 L45. 'Drought indices that only rely on atmospheric data are a popular choice due to data availability and **propagating model uncertainties**.' I don't understand this sentence – why are they a popular choice due to propagating model uncertainties?

P3 L65. You could add into the third research question the uncertainty in the RCM as a lot of your results focus on the differences between ensemble members. E.g. How sensitive are the projected changes in drought characteristics to the choice of atmosphere-based drought indicator and parametric uncertainty in regional climate models?

P3 Section 2.1. It may be useful to state the time-period you used from each observational dataset.

P5 L141-142. Why did you include aridity as well? What does it add to the story? The motivation could be a little clearer.

P6 L168. The area for London is small, but it is a central hub which contains around 14% of the population of GB and is likely to be significantly affected by droughts in the future. Consequently, leaving out the figures for London because the area is small seems an odd choice, given the significant impacts changes in droughts will have in this small part of GB. Potentially a better reason would be because the results are very similar the South-East region or East of England?

Figure 1. It is difficult to see the labels for North and West Scotland – can these be moved or made clearer?

P9 L203-205. This sentence is a little difficult to understand – can it be rewritten?

P9 L209. 'For extreme meteorological drought, all ensemble members **project multiples** of the reference period frequency by +4 °C.' I don't understand what you mean here.

P10 L233 'due to SPEI6 occurrences beginning to saturate when they have already become quite frequent'. What do you mean by 'beginning to saturate'?

P28 L666. I think you are missing some key references from the brackets?

Code and Data Availability – Great to see that the data you produced are available but this section needs to be a full description of all the data used in the study, including links to all the data you used for analysis (i.e. for the CHESS-PE, HadUK and UKCP18 data). I would also reword to 'The SPEI and SPI data **produced in this study** are available on Zenodo (doi:10.5281/zenodo.6123020) (Reyniers et al., 2022b) alongside the bias adjusted UKCP18-based PET (doi:10.5281/zenodo.6320707) (Reyniers et al., 2022a).'