Review on **Emerging anthropogenic influence on Australian multi-year droughts with potential for historically unprecedented megadroughts**

The study focuses on deepening the understanding of the natural ranges of Australian droughts, which can be used to better assess intrinsic and externally forced drought risks in future planning. They address this by comparing droughts in the 20th century (1900-2000) based on observations and models, with simulated droughts during the pre-industrial millennium (850-1849). They seek to assess if drought characteristics (mean duration, maximum length, intensity, etc.) have changed during the last century, compared to the past millennium.

One of the main conclusions is that multi-year droughts have been longer on average during the 20th century over part of Australia (including the MDB), compared to the last millennium, and that anthropogenic forcing is the likely cause of this change.

The authors also conclude that having a larger sample (pre-industrial millennium) allows for a better characterization of natural drought variability, reaching out extreme events (longest droughts) that have not been observed over the last century. Based on this, the authors conclude that such extreme events are part of the natural range of droughts in Australia, and thus they can be expected in the future. This, superimposed with projected drying trends, pose critical challenges for adaptation planning.

The article is well written and the motivation and research question is clear. However, there are some methodological aspects that should be addressed before drawing robust conclusions:

1) There are models that perform better than others during the historical period, and this is quantified as part of the analysis (Sect. 2.2.1; 2.3.3; Supporting Fig. 19). In this line, the interpretation of results should also account for these different performances. We should trust more those models that better represent the observations in the historical period, right?

   For example, if the physical mechanisms represented by a particular model structure leads to lower interannual precipitation variability compared to observations, it is expected that its simulations during the last millennium reflect the same bias, and vice versa for the case of higher interannual variability. However, the conclusions of the paper are based on the average of all models, independently of their performances during the historical period.

   Given the large differences between models (spatial precipitation patterns, MAP values and performance against observations), I don't think mean ensemble values can be directly used for interpretation of results. For example, the assessment of the "Possible anthropogenic influence on Australian multi-year droughts" (Section 3.4) relies on the ensemble mean of models, however, we know that there are models that perform better than others.

A way to account for these different model performances could be to apply a statistical correction to the models before analyzing droughts, similarly than those applied to GCMs in the historical period before analyzing their future projections (e.g., Cannon, 2018 and references therein). This data-process involves that each model is corrected according to their own performances in the historical period, and then results can be interpreted similarly across models.

From Sect. 2.3.2, it is inferred that droughts are defined as deviations from the climatology of each model (right?) If the models are bias corrected, the same climatological mean (that from AWAP) could be used for drought definition. And direct comparison between models could be applied, instead of %. This is easier for interpretation than "For example, 0% represents the climatological mean precipitation, and 100% represents zero precipitation". Same for severity, it would be much easier to compare directly mm across models, instead of % ("For example, a value of 200% represents a total deficit equal to two years of mean precipitation.")

Comparing deviation metrics as % is influenced by the native MAP of each model (deviations from a low absolute MAP values represent larger % than when the MAP is larger). By comparing Fig 2.a and Fig. 3, it can be seen that some models have MAP biases up to 100%, with similar absolute biases that observed MAP in Fig. 2a.

*Cannon, A.J. Multivariate quantile mapping bias correction: an N-dimensional probability density function transform for climate model simulations of multiple variables. Clim Dyn**50**, 31–49 (2018). https://doi.org/10.1007/s00382-017-3580-6*

2) Having a more extreme event in a large sample can be somehow expected, but I am missing an assessment of the return period of such events. The longest droughts simulated over the pre-industrial millennium, can be expected to happen over the next century, couple of centuries, thousand years?

   In the same line, I think that for providing evidence for adaptation planning, the longest droughts should be assessed in conjunction with their deficits: it is not the same to communicate that 20-years of minor droughts (e.g., 0-10% deficits) can be expected that to communicate that 20-years of severe droughts (e.g., >40% deficits) can be expected in the future. This could be done by accounting for relative severity together with maximum length.

Minors comments:
Supp. Fig. 7: "Mean multi-year drought length in (a) observations (1900-2000) and (b-l) model simulations of the pre-industrial last millennium (850-1849). Showing the CESM LME ensemble mean." It should say, panel Fig. 7l presents the CESM LME ensemble mean. Same for all figures.

Title: it is a complicated title that I don’t think is communicating the main messages of the paper. I recommend the authors to consider a simpler one.

Abstract: “Model simulations suggest future droughts across Australia could be much longer than what has been experienced in the twentieth century, even without any human influence.” This can be misunderstood as future projections, please re-phrase. An option could be: Drought simulations over the last millennium suggests that future droughts across Australia could be much longer than what has been experienced in the twentieth century, even without any human influence.