Review: Evaluation of drought representation and propagation in Regional Climate Model simulations over Spain

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Summary

This paper assesses the use of LCMs, RCMs and HMs to investigate drought propagation in Spain. They conclude that one can use RCMs to investigate metrological droughts in Spain, but further work should be undertaken to model soil moisture and hydrological droughts.

This paper is of sufficient novelty and fits well within the scope of HESS. However, in its current form it is difficult to understand what was done, and crucially why it was done and what the applications of the research are. As such, I feel this paper cannot be accepted as is but I provide my comments below which I hope the authors will consider before resubmitting to HESS, I will be happy to re-review this paper upon resubmission.

Decision: Reconsider on resubmission

General comments

I have not listed detailed line by line comments as I feel more work is needed to address the more general issues given below.

The language throughout makes it difficult to understand at times (for example, P23L18-19: It is not clear if this means that RCMs are not appropriate to calculate SPI at longer accumulation periods) and should be improved dramatically before publication.

The paper lacks clearly defined aims and applications, currently it reads as a modelling exercise rather than science to support real-world applications – this can be addressed by a better structured introduction as it currently jumps around without a coherent story (e.g. what is the problem, what have others done in the past, what is the research gap, what is the aim of this study and how this will address the research gap).The introduction and literature review also relies heavily on the IPCC reference, without reviewing peer reviewed publications (and where papers are introduced, they are often listed as 'other papers on the topic' such as P2 L32) and outlining the research gap this paper is aiming to fill. The lack of aims and disjointed nature of the paper make it difficult to reach the conclusions set out in the final section of the paper.

It has not been made clear why this modelling approach was used. The assertion on P6L20 that the atmospheric feedback not being accounted for makes LSMs a good tool to study drought because they can be treated like physically distributed hydrological models, does not provide explanation – why do you want them to behave like a physically distributed model?

You don't mention or address the issue of uncertainty – what about the uncertainties of the modelling approach? Could you explore this using a multi-model ensemble?

In many places, there is text seemingly in the wrong section of the paper, for example P3L33-P4L4 should more likely sit in the data/methods section as this is detailed for the introduction. P5L1-8 would be better placed in the introduction. P11L24-27 would be better placed in the discussion describing why there were discrepancies between the modelled outputs. The authors should review the text to ensure that descriptions of data and methods and discussion text are in the appropriate sections.

Section 3.1: this should have more introductory information before diving into the detailed descriptions of SAFRAN and ERA, in 3.1 please outline what variables you use and what they are needed for before describing them in turn.

In Section 3 the RCMs are introduced third but surely start the modelling chain, I suggest you introduce these first, then the LSMs then Hydrological Models. Was it necessary to calibrate and validate your models – how did you do this?

A lot of detail is provided about the LSMs which is published elsewhere and appears to pad the paper, much of the model background can be removed – the focus should be on why the models were chosen and what they will be used for.

Section 3.4: It would be useful to include a map of the observation stations used- how many stations were used? Only 8 across the whole of Spain? Why not more – there must be more than 8 stations that have 95% data completeness?

P18L8: What evidence or scientific literature did you use to select the 'arbitrary' KGE of 0.5? Later in Section 5.3.1 you say performance of CL4 is poor because KGE is generally below 0.5, but the best performance is for RS4 with KGE of 0.7 – is this enough of a difference between poor and best (reading 'good') performance?

Section 5.3.1 – why were the temporal analysis not shown? If you only have 8 gauging stations, it would be simple to include time series plots showing the modelled ensemble data against the observations.

Table 6: This might be better as a figure with the catchment areas coloured by SPI-n_x – as readers we don't know where your catchments are, how do the results vary spatially? What might the effect of catchment properties be on the propagation process? How well do the different models represent these catchment properties?

Table 6: What r values are associated with the Evans classification? How significant are these correlations? The bold type face mentioned in the caption is not obvious in the table.

P22L4: why do you believe standardised indicators are appropriate for this study? This should have been outlined previously.

P22L10: what is meant by event extension? The duration and intensity (and extension) of events is not described elsewhere nor shown in any figures – what do you refer to here?

In general the figures were too small and labels too small to read. You should avoid the red-blue colour schemes of Tables 3-6, they are not appropriate for those who are colour blind. You can check whether your figures are colourblind friendly here: http://www.color-blindness.com/coblis-color-blindness-simulator/ or by using the CVSimulator app

In regards to the Barker et al. (2015), you have cited the Discussions paper, please cite the final 2016 paper (https://www.hydrol-earth-syst-sci.net/20/2483/2016/hess-20-2483-2016.html).

On P3L31 Lopez-Morreno's name has been misspelled.

The tense throughout is the present tense, however, research is conventionally written up in the past tense (as it is work that has been completed), please correct this in the next version of the paper.