Interactive comment on “Identification of Droughts and Heat Waves in Germany with Regional Climate Networks” by Gerd Schädler and Marcus Breil

Anonymous Referee #1
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In this study, the authors used Regional Climate Networks (RCNs) to identify heat waves and droughts in Germany and two sub-regions for the summer half years & summer seasons of the period 1951 to 2019. They used several metrics from RCNs to estimate the extent, intensity and collective behavior of extreme events. The results were compared with standard indices including the effective drought and heat index (EDI and EHI). Their findings suggested that the RCNs are able to identify severe extremes in all cases and moderate extremes in most cases. One highlight of this manuscript is the clear introduction of the concept of RCN. The work is interesting and the RCN methods used in this work may also be useful for other studies. However, there are still several concerns to be addressed. A major revision is needed.

Dear referee,
thank you for your time and your constructive comments.
In response to the suggestions and comments of the three referees, we have made major changes in the manuscript in addition to specific answers to your comments:

- we added a section „Sensitivity of the metrics to correlation thresholds“
- we rewrote the „Comparison of the RCN results with other extreme indices“ section. The figures are replaced by tables comparing the RCN metrics for a range of correlation thresholds with EDI/EHI.
- We focus now on the edge density as the relevant metric

Please find our answers to your specific comments on the previous manuscript below (in blue).

1. One major concern is about the added value of the RCN method compared with the standard indices (EDI and EHI). In this work, the authors compared the results from the RCN method and those from EDI and EHI, but lack a detailed summary of the advantages of the RCN method.

- It is an alternative, easy-to-apply and computationally efficient method which can be integrated into the post-processing of climate model output to provide statistics of extreme events (change of frequency, seasons of occurence, …)
- it complements standard methods to detect extremes
- it allows to study whole regions and seasons

We have expanded a bit more on this in the introduction and the summary.

2. In the manuscript, the authors used different metrics to measure the spatial extent and the intensity of the extreme event. However, detailed discussions on these two properties (extent and intensity) are missing. It seems that the main point of the work is to compare the metrics (mainly the edge density) with the EDI/EHI. It is not clear why the intensity is measured?
You are right, the main point of the work is indeed to compare the edge density with the EDI/EHI, and we do not consider intensity, which is omitted now.

3. To determine the correlation threshold, the authors conducted a series of sensitivity

runs with respective to correlation threshold and its effect on the metrics. They found that an average edge density of about 0.01 gives good results, and chose a value of 0.95 as correlation threshold. The question is, does this threshold dependent on the distributions of the variable of interest? Can this threshold be used for different variables?
We discuss this in the sensitivity section. In the modified paper, we use now the same three threshold values (0.85,0.90 and 0.95) for heat waves and droughts for the comparisons with EDI and EHI. As detailed in the sensitivity section, the results do not differ much for these threshold values, as long as they are around 0.9. However, the results for droughts are better than the ones for heat waves, which might have more to do with the construction of the network than with the choice of the thresholds.

4. When identifying extreme events, a margin of 0.2 is applied to account for averaging and moderate extreme events. Why choose 0.2? Are there any reasons?
This was confusing indeed. We omitted it and just look at values > 1 (or < -1 for EDI), but mention „border cases" with values just around 1. Note however that this entails changes in the detection of extremes.

5. When calculating the correlations using precipitation time series, dot product was used. However, I think an Event Synchronization (ES) analysis (refer to, e.g., Boers et al., Nature Communications, 2014) may be more appropriate, as in ES, one can consider a time-lag to better determine whether the two considered events from two nodes are synchronized.
It seems to us that ES is more suitable for short (e.g. daily) time scales and instationary situations. Since we are looking here at much longer (seasonal) and quasi-stationary time scales, we do not think that ES will offer advantages. But we will experiment with ES in upcoming studies. Especially in the context of heat waves, this might improve our results.

6. In table 2 and table 3, the authors compared the metrics in average years and extreme years. Here, a significance test may be needed to better show the differences. In addition, when comparing the different results from average years and extreme years, a composite analysis may be better. For example, calculate the mean metrics over all the average years, and compare them with those averaged over all extreme years.
We followed your suggestion in the sensitivity section and performed a Wilcoxon significance test.

7. In Fig. 4 and Fig. 9, what do the red and blue curves stand for?
These figures do not appear any more. Blue was the RCN degree distribution, red the corresponding Poisson distribution.

8. On page 19, lines 16-17, the reference Tsonis et al., BAMS, 2006 is repeated twice.
Corrected.

Interactive comment on Nonlin. Processes Geophys. Discuss., https://doi.org/10.5194/npg-2020-46, 2020.