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Earth System Dynamics
Discussions

Interactive comment on "Storylines of the 2018 Northern Hemisphere heat wave at pre-industrial and higher global warming levels" *by* Kathrin Wehrli et al.

Anonymous Referee #1

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The concept of asking how a given meteorological event might have been exacerbated by global warming has been growing in popularity as an alternative to the more common approach of probabilistic event attribution. As first proposed by Trenberth et al. (2015 doi: 10.1038/NCLIMATE2657) and Shepherd (2016 doi: 10.1007/s40641-016-0033-y), this 'storyline' approach takes the atmospheric flow configuration leading to the event as given, and quantifies the impact of global warming conditional on that flow configuration. The arguments for why this may be useful are given in those two papers, but the general concept is that generality is sacrificed in order to obtain a more detailed and hopefully more informative statement of impact (since tied to a particular event). The storyline approach was first applied to synoptic-timescale weather phenomena,

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e.g. tropical cyclones, where the conditionality was applied either through the initial conditions in a forecast, or through the boundary conditions in a regional model. Here the storyline approach is applied to a multi-week heat wave event, nudging the circulation in a global model to reanalysis, following the methodology previously used by the authors in their 2019 JGR paper to understand the role of soil-moisture feedbacks in heat waves.

It is important to document applications of the storyline approach in different contexts so that we can learn to understand its strengths and weaknesses. From that perspective this study is welcome, and for the most part the results are carefully explained and clearly presented. I find Figure 7 to be the most interesting of all. I am happy to recommend publication, provided the following points are addressed:

1. Figure 3 shows only temperature anomalies. It would be good to also show absolute temperatures (e.g. in the maps), so that the reader can see the extent of the temperature bias of the model.

2. In some periods and regions, the differences between the nudged run and ERA-Interim anomalies in the time series in Figure 3 can exceed 1°C for extended periods. Do you have any idea why this would be the case, given that generally the differences are much smaller?

3. Comparing Figure 1 and Figure 3, with the exception of the southern portion of NEU the study areas seem almost to be orthogonal to the areas of maximum temperature anomaly, and one of the most striking AgPop regions where there is a high temperature anomaly, eastern Asia, is not included in the study. Thus the choice of study areas seems quite odd. It would surely be straightforward to include a relevant east Asian SREX region for completeness, which would mitigate the European/North American bias of this study.

4. In all three SREX regions of North America, the difference between the nudged run and either ERA-Interim or Berkeley for the maximum daily temperature anomalies

(Figure A4), especially for some of the largest values, can be much larger than the difference of the mean daily temperature anomalies (Figure 3). What is the reason for that? And how does it affect your estimates of extreme temperature? This feature suggests that using the climatological mean TX to bias-correct the TX values may not be adequate.

5. The left column of Figure 4 apparently includes a bias correction of the model output. This is only mentioned in the figure caption, not in the methods or anywhere else. Since the bias correction is almost certain to affect the results of the study, which are framed relative to a fixed temperature threshold of 40°C, a much more detailed assessment of its effect, and the potential error incurred thereby, is required. It appears that the bias correction was simply an adjustment of the mean, which assumes that the model TX distribution is perfect. Can you support this assumption with evidence? As noted in the previous comment, the assumption would appear to be contradicted by your own results. Why did you not use quantile mapping or some other more detailed method, which would treat the tails differently from the mean?

6. In lines 9-10, you should mention also the percentage value for the actual event, as a reference.

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