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Earth System Dynamics
Discussions

Interactive comment on "Global meteorological drought and severe drought affected population in 1.5 °C and 2 °C warmer worlds" *by* Wenbin Liu et al.

Anonymous Referee #2

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This paper assesses changes in drought risk (and human population exposure to these risks) at 1.5 and 2 degree thresholds drawn from 11 CMIP5 models and the RCP 4.5 and 8.5 scenarios. Unsurprisingly, they find less risk/exposure at 1.5, though the abstract is missing important details of their results (where is mitigation most important for reducing risks?). I think this study has some potential merit, but I have some significant concerns and critiques that I would like to see addressed before I recommend publication.

1) The authors evaluate drought using one specific drought index: PDSI. This is generally fine, but there are some issues regarding how this index is used by the authors. First, despite the title of the original Palmer paper, PDSI is an indicator of agricultural drought risk because it emulates soil moisture availability. Meteorological drought

refers specifically to deficits in precipitation. The language in the paper, and the title, should be adjusted accordingly. Second, it is unclear what time period the authors used for the PDSI calibration (i.e., the CAFEC). Typically, one would use some common historical baseline across models so that future changes can be interpreted relative to historical variability. For this particular study, I would recommend using 1850-2000. Doing it this way would thus not require any differencing between future and historical periods, since the PDSI for the future would implicitly reflect drought changes relative to the historical period. Finally, because of the inherent memory and persistence embedded within the PDSI calculation, this index is much better for picking up long-term and seasonal-scale droughts, and is less appropriate for shorter term (e.g., 1-month) events. For example, the severe and by some indicators record breaking 2012 drought in the Central Plains of the United States only shows up modestly in PDSI, primarily because this drought intensified quite quickly. For this study, where the authors are interested in month to month changes in drought intensity/persistence/etc, it would be better for the authors to use the Z-index that comes out of the PDSI calculation.

2) Given the relative coarseness of the CMIP5 models, I think interpolation of the results to 0.5 degree spatial resolution is not appropriate. A 2 degree common grid would be better, and would avoid effectively making up data at the much finer resolution.

3) The population analysis in this study is a bit convoluted. For example, the RCP scenarios use different populations trajectories (I believe), and since you are picking somewhat arbitrary periods that just match desired warming, there will be little consistency in population structure across either the scenarios or warming targets in this analysis (see Figure 1). Since the 1.5 and 2 degree targets are stabilization scenarios, which would theoretically hold out through the end of the 21st century, I think the authors should remove all the population analyses except for the SSP1 2100 analysis (Figure 4). I would also ask the authors to turn Table 4 into one or more figures, since it is difficult for the reader to synthesize such a large table of numbers.

4) For the analyses, how many datapoints (presumably months) are included in each

warming scenario? What are the units for drought duration (Figure 5), drought intensity (Figure 7), and severity (Figure 9)? Please add this information to the figure captions. Was significance/robustness/consistency only assessed in terms of agreement across the multi-model ensemble (right columns in the aforementioned figures)? If so, what was the threshold used by the authors to determine whether a given change was sufficiently robust?

5) What is causing the changes in drought risk in these simulations? Declines in precipitation or increases in evaporative demand from warming? Since PDSI is an offline calculation, you can recalculate this index using detrended temperature/precipitation to tease this out. This would be a valuable addition.

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