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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Little change in Palmer Drought Severity Index across global land under warming in climate projections" *by* Yuting Yang et al.

Anonymous Referee #3

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This very innovative and important study shows that when the familiar Palmer Drought Severity Index (PDSI) is computed directly from global Earth System Model output of precipitation, evaporation, runoff and soil moisture storage (rather than box-modeling all those quantities from an offline-computed potential evaporation of questionable accuracy as is traditionally done), the dire projections of ubiquitous future global drought from those traditional studies vanish. Instead, the PDSI projections become both wetting and drying depending on region, consistent with the *direct* simulations of runoff, deep-layer soil moisture, etc. by the ESMs but not with the traditional PDSI studies.

This is a key methodological advance and shows that the PDSI index itself is not flawed

under climate change, rather its known problems stem from the traditional potential-evaporation input which is inaccurate, leading to inaccurate inferred water flux changes. The inaccuracy of the traditional potential-evaporation input is because leading-order biological effects of changing CO2 and vapor pressure are taken into account in the ESMs but not in the potential-evaporation calculation, as the authors show well here.

I recommend only minor revisions before publication, since I was anonymous Reviewer #2 on the earlier version of this study that was originally submitted to Environ. Res. Lett., and I already had my concerns largely addressed during that review process at that journal. My strongly recommended minor revisions are listed below.

30: This kind of parenthetical remark/qualification is appropriate for the body text, but I don't think is needed for the Abstract - it makes the Abstract too complicated and clunky. At least, that is how I read it. So I think you should either remove or greatly shorten this remark. You can put something like this in the body text instead.

54-57, 94-96, 122, 226, 271, 418: Should also mention the impact of increasing/elevated vapor pressure deficit, as you do in the Abstract. The direct effect of CO2 is only part of the story, as you explain well at 235-237 but the text does not reflect here at all.

88-89: It should be clarified here that this corresponds to the center stream in Figure 1, parallel to how you point out the right stream and left stream later in the paragraph.

117-120: Similarly, this should mention that it is the right stream in Fig 1.

120-123: Similarly, this should mention that it is the left stream in Fig 1.

126-135: Similarly, this should mention that it is the center stream in Fig 1.

178: Should be 3d, not 3e.

238: As stated in previous review for Environ. Res. Lett., "our results" on this line will be read by most readers as meaning "the current study" (even though that's not what

you actually mean.) Since it's actually Yang et al (2019) that showed this key fact (not the current study), this needs to be rephrased to make that clear. It's largely the same authors, but different study, and the distinction is important.

Fig 2: Caption should point out which rows respectively correspond to the left, right and center streams of Fig 1.

Fig 3d-f: Stippling when >50% of models agree on sign of change is trivial - this will almost always be true (unless exactly 8 models have increase and exactly 8 have decrease.) Rather, you should stipple when, say, >67% or >80% of models agree on sign of change. This better filters out changes that are just noise.

It is true that I suggested 50% threshold in previous review, but that was for models with dPDSI < -1, not for basic sign of change! 50% makes sense if the criterion is dPDSI < -1 because that's not likely to occur by chance. But it doesn't make sense for dPDSI < 0 or dPDSI > 0, since that occurs most of the time by chance (unless *exactly* 8 models happen to have a decrease!)

Supp Fig S1: This is greatly appreciated, but I think it would have an even greater impact if you reversed the color scale in panels b and c (i.e. make negative green/blue, and positive yellow/brown.) This is because in this context we are thinking of E as a loss term in the water budget, and so increasing trend of E -> more drying. (I know that in other contexts/purposes more E -> wetter, but here the purpose is clearly to indicate that panel c is not as "drying" as panel b, so the colors should intuitively reflect that!)

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