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Discussions

Interactive comment on "Frequently used drought indices reflect different drought conditions on global scale" *by* Niko Wanders et al.

Anonymous Referee #4

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The paper of Wanders et al provides an ambitious global analysis of the performance of a wide suite of drought indices. I see from previous reviews the main concern is that there is considerable bias in the application of the hydrological model at the global scale for the evaluation of hydrological drought. In the interest of discussion, I agree in principle that there is of course a bias, but I would note that no satisfactory model representation of global catchment water balances exists, even on average, let alone focused on one end of the hydrological distribution, which drought conditions represent. As I understood the paper, the purpose does not seem to be to perfectly emulate water balances during drought periods across the globe with the model, but rather to provide a hydrologically consistent and globally distributed template from which the various indices can be derived and compared with each other. In an ideal world this would

perfectly match observations, but if the aim is to consistently compare indices rather than exactly simulate drought behaviour, I don't see this being a major issue. Therefore, my perception is that this is more of a conceptual issue that can be addressed by editing the language and arguments within the paper to reflect the soil moisture and hydrological droughts as 'estimated' or 'conceptual' droughts, that of course will deviate from actual measured water balances, but are suitable for the purposes of the paper. Where this becomes problematic in my view is when specific arguments from regional or regions are made regarding trends or magnitudes that rely on these biased water balance estimates. I will comment on this later.

The authors look at the spatial and temporal comparative performance of a wide variety of drought indices. I think the most interesting part of the paper is Figure 6 and the analysis therein. My strong feeling is that this should form the beginning of a deeper analysis of the relative performance of drought indices. As it stands, the paper provides cross correlations between the indices, and some separation of these results on the basis of broad climatic zones globally, but this only tells us 'if' the indices are useful for a particular purpose, and not the far more interesting and relevant question of 'when' they are useful. Thus, the conclusions of the paper are somewhat limited, and could easily be enriched using existing data and analyses. The correlation analysis is informative in explaining the 'overall' relationships between the indices, but if the focus is on droughts, then surely we are more concerned about their performance during these periods. For example, are the indices converging during periods of stronger drought, and less coherent during weaker droughts? This kind of performance could be summarised in a table, according to both the drought type and climatic region. This might better highlight the difficulty of representing all droughts in snow dominated areas (if the performance is consistently low compared to other regions, even when very strong drought conditions are prevailing). A table could also provide a short explanation, again by drought type and by climatic region, as to why the indices are not performing well (e.g. strong lag effects etc), and the authors recommendations on which index is more appropriate for the circumstances. This would allow the discussion to be more systematic, rather than

example driven (as is currently the case), and of greater relevance to the hydrological drought research community. As an aside, I would also strongly recommend a separate discussion and conclusion section, as the discussion can go into depth and provide some degree of speculation, whereas the conclusion provides a nice opportunity to distil the key messages of the paper.

Finally, a more formal discussion of the potential biases introduced by the model would be useful. In particular, I'm thinking of the index performance a) in areas with dynamic topography and variable climate, in which groundwater storage and release effects would have a dominant role in the hydrological drought response, and b) on the role of dynamic vegetation responses (not captured in the model) and the implications for soil moisture drought representation (and therefore its comparison with precipitation and hydrological drought).

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