

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

Anonymous Referee #1

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General comments

The authors apply a diverse range of indicators to compare and contrast differences in the expression of drought. The manuscript aims to test the transferability of these indicators in characterising and monitoring drought in different elements of the hydrological cycle, concluding that no single indicator is appropriate for all elements. The paper is clearly written and casts an important light on the wide range of drought indicators available and some of the subjective decisions involved. Figure 6 is particularly successful in summarising a lot of information in an appealing format. In my view, there are a few omissions from the detail of the method and parts of the discussion and conclusions, but once these have been addressed I would recommend this paper for publication.

C1

Specific comments

Selection of indicators (Table 1): The 24-month accumulation period for SRI has been omitted from the analysis when the 24-month is considered for both SPI and SPEI. For the sake of consistency and cross-comparison, it would be useful to include 24-month SRI. This timeframe is hydrologically relevant in those areas that are less responsive, to adequately characterise multi-year droughts.

Correlation of standardised and threshold-based indicators (Page 6, lines 5-9): From the text currently written on the correlation procedure, it is not clear how these two broad categories of indicators are compared, assuming that the standardised index generates a monthly time series and the threshold method produces a list of events. Or have thresholds in the standardised indicators been used to delineate events? The rest of the paper would seem to suggest that monthly time series exist for each indicator, in which case is the threshold-based output a binary time series of below / above threshold? More detail is required here.

Criteria for drought characteristics (Page 7, lines 1-7): There is discussion here about timeframes of when droughts start and end, but no information on the criteria used to determine these. Figure 5 presents monthly time series of data but does not indicate when drought is occurring. The "substantial impact on the identification of drought onset and termination" is noted (Page 7, line 7), and whilst onset is discussed (lines 1-3) perhaps a similar brief comment could be provided on the recovery.

Colour scheme in Figure 5: I understand from the caption that the colours in Fig 5 represent the 'normalized drought severity'. Are the colours comparable with the numeric scale on the y-axis? If so, they are not consistent across indicators (e.g. red lines that exceed zero, green lines higher than blue lines). But if not, it is not clear how these numbers have been generated. Is it a normalisation of (in some cases) a standardised indicator? Some further explanation is required here.

Intersubstitution of drought indicators (Page 9, lines 14-15): This sentence provides

C2

an explanation for the short aggregation periods, but no suggestion is provided for the more prolonged accumulation periods (e.g. SPI-24). Perhaps one could be provided? I also think it might be worth alluding to the increasing correlation of SPI and SRI as SPI accumulation period increases.

Utility of SPI where discharge data absent (Page 11, lines 9-10): Whilst this statement is certainly correct based on Figure 3, would the authors consider an SPI-based approach to monitoring hydrological drought (probably a higher accumulation period to account for hydrological memory) be better than nothing in those parts of the world with limited hydrological data?

Relevance of findings for data sparse regions (Discussion and Conclusions): The paper concludes with the message that indices cannot really be substituted between meteorological, agricultural and hydrological applications. This is probably as we would expect, but there is novelty here in its quantification. Along similar lines to the comment above, the conclusions would benefit from a consideration of how we might proceed with drought monitoring in data-sparse regions of the world. If there is no choice but to substitute indicators, can the authors make recommendations on the most closely related, or the least misleading? And how do those 'next best' indicators vary by region / climate zone?

Technical corrections

Page 1, line 20: Capital 'S' for "United States"

Page 3, line 8: "local climate on the correlation"

Page 4, line 7: 21 indices (not 20)

Page 6, lines 2-3: This sentence on the reanalysis data is repetition of Page 3, lines 20-21, so can be removed

Figure 3/4/5: For improved comparison between standardised indicators, it might be best to slightly re-arrange the panels so that SPI 1,3,6,12,24 are directly above SPEI

C3

1,3,6,12,24 and SRI's on the line below (perhaps including SRI-24; see comment above), so that viewing down columns allows more straightforward cross-comparison between specific accumulation periods. Could also do the same for MAP / MAS / MAQ.

Figure 6 caption: 1958-2001, rather than 2002

Figure 6: It might be personal preference, but I would tend to think of high correlation as red and low correlation as blue, so a reversal of the colour bar?

Page 11, lines 21-22: Are there numbers to confirm this statement? Figure 6 seems to suggest that there is no systematic climate zone determination of correlation between indices?

Page 11, line 21; page 13, lines 4-5; page 13, lines 8-9: I think "intersubstitution" and "intrasubstitution" are fine to differentiate between within and between drought type indices. But "intersubstitutional", "intrasubstitutional" and especially "intersubstitutionality" are starting to become less clear or meaningful. Maybe more simplistic re-phrasing like "Intersubstitution of drought indices is more feasible in tropical..." (Page 11, line 21) and "Both intra- and intersubstitution of drought indices are not possible..." (Page 13, lines 8-9), or similar.

Page 12, line 2: "In general, the low correlations...", or "The generally low correlations..."

Page 12, lines 15-16: Reference to Lloyd-Hughes (2014) would help here – Lloyd-Hughes, B. (2014) The impracticality of a universal drought definition. *Theoretical and Applied Climatology*, 117, 3-4, 607-611.

Page 12, line 34: "study quantitative changes" (no "at")

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C4