

Interactive comment on “Investigating the response of LAI to droughts in southern African vegetation using observations and model-simulations” by Shakirudeen Lawal et al.

Anonymous Referee #2

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The paper, "Investigating the response of LAI to droughts in southern African vegetation using observations and model-simulations" describes a study in which the authors compare the standardized precipitation evapotranspiration index (SPEI) to Leaf Area Index (LAI) based on (1) satellite observations and (2) dynamic vegetation models run using reanalysis data. The authors compare the performance of these indices calculated for different time lengths and averaged over different biomes in southern Africa.

General comments: 1. Although the paper is titled "investigating the response of LAI to droughts" and the authors mention several times in the paper various analyses they undertake with respect to drought, the authors do not actually show how LAI responds

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to drought in the paper. They use a drought index, SPEI, but these indices typically need classification schemas to define when there is a drought or not, and how severe the drought is (similar to how WMO classifies different drought severities based on SPI thresholds). So one would expect some thresholds to be defined in the SPEI as drought thresholds. This was never done in the paper, but rather the paper is a comparison of SPEI and LAI, and never states which periods does LAI correctly identify the presence (or absence of drought), or its severity, which is the type of analysis one would expect in a drought analysis.

2. The authors are encouraged to proof-read the paper to reduce several typographic/grammatical errors found in the paper including apparently incomplete sentences. Alternatively, use of a professional editing service could be taken. I have included a few examples in the specific comments below, but the authors need to please do a thorough proofing of the entire document before submission.

3. A basic expectation of papers being submitted is that all citations used in the paper should be included in the list of references, and should be cited and referenced correctly. This is not the case, several citations have not been included in the references (e.g. citations on line 82, 90, 91 are missing from the references, and on line 101 the date in the citation does not match the date in the references. This is all just on the 1st page of the manuscript, the authors should check all the citations and references in the manuscript before submission.

Specific comments: Line 81. "It is reported that there are now fewer vegetation coverage", should probably read "It is reported that there is now less/reduced vegetation coverage"

Line 81-82. "It is reported that there are now fewer vegetation coverage in the region compared to what existed between the mid 1990's and 2000's (EOS, 2007)." I am failing to understand how this reference, published 2007, can compare what is happening now (in 2020) with what happened in the 2000s.

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Line 120-125: I understand the reasons given for using LAI over NDVI. But given that satellite LAI in this study seems to be derived from NDVI, does this then not invalidate the point made by the authors. Also, given that the authors need to indicate how well does the satellite derived LAI they use estimate actual, ground-measured LAI, or at least with independent, acknowledged accurate LAI estimates.

Line 152: "These data were gotten from CRU..." would read better as "These data were obtained from CRU..."

Line 153-162: Regarding the use of CRU and CRUJRA data, the authors need to state either through their own analysis or quoting other studies how well does CRU and CRUJRA compare with actual meteorological data over southern Africa since they are using these CRU/JRA data to calculate "ground-truth" for drought (although noting that drought was not calculated by SPEI).

Line 173: "The trained neural networks were then used to produce the LAI3g and FPAR3g data sets". This description suggests that the LAI and FPAR data were derived from NDVI data. If so, then this needs to be expressed explicitly. MODIS LAI, which was used for training, is also in part derived from NDVI. This all implies that as the LAI is a derived dataset, how accurate is it in depicting actual LAI.

Line 192-193: "This was necessary to show ... how well the models simulate the LAI in the region." The authors need to provide evidence of how accurately the GIMMS LAI estimates actual LAI in the region before they can make this determination.

Line 201-204: The authors stated that they adopted a definition of drought that is defined based solely on precip, but then throughout the paper, they used an index based on PET as well as a proxy for drought. This discrepancy needs to be reconciled in the text (ie, please redefine drought on lines 201-204 to match how it is used in this paper). Additionally, the authors need to state the threshold they use for defining drought, given that this is an index-based drought analysis.

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Line 229: While P and PET are defined in the text referencing the equation (line 226-227), D is not defined likewise, please define.

Line 231-233: This sentence should be moved to line 243 which is already providing more details about how PET was calculated. Additionally, the section should state which data was used for max, min and mean temperature.

Line 237-240: In these lines, the authors provide a quotation without clearly attributing it to anyone. Can the authors please add additional text to attribute the quotation. Also, for the sake of completeness in defining SPEI, this information would be better summarized in equation form and presented together immediately after equation 1 in the form "SPEI = ... (eq 2)".

Line 248: "The study...". Which study is being referred to here, is it the manuscript's study, or Lawal et al (2019) - this needs to be clarified.

Line 252: "such" should be "such as"?

Line 259-260: given per-pixel correlation, how did you deal with the difference in spatial resolution of the CRU (0.5 deg) and GIMMS (8km)

Line 259: Reference is made to a "drought index (CRU)". which one is the CRU drought index - it has not been referred to before. Is this referring to SPEI? If so, it may be better to just say SPEI (based on CRU data), to avoid confusion of the reader.

Line 268: Citation not in the references.

Line 277-282: This explanation is quite unclear to me. It sounds like they average out correlations. Can the authors please rephrase to make this clearer.

Line 294 (Figure 1). "Contours" should be "lines".

Line 305-306: "The low standard deviation indicates that the values from the two indices are close and a standard lower deviation." I don't understand this sentence. Please rephrase and make it clearer. Additionally, the standard deviation being re-

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ferred to is for which parameter - this needs to be clarified.

Line 310: The satellite/NDVI-based LAI is being referred to as "observations". This terminology is used repeatedly in many parts of the paper (e.g. line 321). I think it will be more accurate to refer to this as "satellite-calculated LAI" or something similar rather than as observed LAI, since the satellite-based LAI is also estimated using neural networks on NDVI, and not observed directly.

Line 323: Standard deviation of what? Needs to be specified since there are 2 parameters referred to in the graph.

Line 352-353: If there is a lag between the LAI and the climatic variables (which is to be expected to some extent as vegetation takes some time to respond to climate drivers), how is this lag in the vegetation response incorporated into the analysis?

Line 361: I am surprised to see an LAI of what seems like approx 0.5 over semi-desert areas. Seems high, is this typical for observed LAI?

Line 369: Why was SPEI simulated? This is unclear

Line 374-375: It would be helpful for the authors to define what they mean when they refer to the magnitude and intensity of drought.

Line 429/Figure 6. It is apparent from Figure 6 that in many cases, the correlation with SPEI of modelled LAI is in average, much higher than that of satellite-based LAI. This is very surprising, that there would be a higher correlation for modelled than observed vegetation indices with SPEI - this seems counter-intuitive that a model would perform "better" than observed data. It would be useful for the authors please discuss this anomaly in the discussion section, it could have some useful implications for the findings. Same with Figure 7.

Line 503/Figure 8. "Spatial correlations of observed LAI response" . It is spatial correlation with what? Please state.

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Line 510: "There is variability in the global and regional temporal distribution of LAI response to drought". Based on the methodology and results presented, the reference to "drought" in this sentence should really read "SPEI" - this should be consistently applied across the paper (including the title), unless significant changes are made to the methodology, as discussed in earlier comments.

Line 580-581: The authors spent significant time (lines 540 to 580) discussing the relationship between LAI and NDVI. However, this relationship would be expected given that they derived LAI by applying neural networks to NDVI. It may be better to limit the discussion on NDVI/LAI correlations at a broad level, and highlight and discuss these differences at length for different biomes, and moving that (e.g. Figure S6) from the supplement to the main text.

Line 582-607: Section 4.2 and 4.3, as presented, do not add to a discussion of the results, and could be removed to reduce space.

Line 609-610: The authors stated that "2014). The frequent and stronger dry spells observed in Fig. 4 could be attributed to climate change." - More analysis (than what the authors presented) is required to support such a statement, it is only a 30 year period that they looked at, and the dry spells do not appear to be getting stronger and more frequent over this period simply from looking at figure 4. For example, the authors could do a frequency analysis, or even just a table showing the number and severity of drought for each 10 year period.

Lines 627-628: The authors state: "However, SPEI which requires more variables for its computation captures drought better in relatively humid zones (Benguera et al., 2014)." - It would be useful if the authors could state whether this was their finding in their study too?

Line 656-658: The sentence needs to be rephrased/corrected.

Line 707: "rounoff" (spelling)

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Line 718: In making this statement, it would be more weighty if the authors could show during the study that the SPEI or its inputs were validated against ground truth, what is its/their accuracy? How accurately does the specific SPEI dataset used measure drought?

Line 721: "mostly at a shorter time period (3-, 6-month timescale)": Does this statement refer to the second part or both parts of this sentence?

Line 722: "at 6-month timescale in the MAM season". The idea of a 6-month timescale in a 3-month (MAM) season is a little difficult to conceptualize, perhaps the authors can rephrase.

Line 732: "The relationship between the NDVI and LAI is linear thus implying..." Given that the LAI was derived from NDVI, this statement seems a little bit redundant, or perhaps I am misunderstanding something.

Line 739-740: this statement is difficult to understand. Please rephrase.

Line 742: "There is a stronger LAI response to drought in dry years than in wet years...". please rephrase. the statement is difficult to comprehend given that drought occurs in dry years not wet years.

Line 756-757: "While this study may have provided an insight into the capability of DGVMs to simulate vegetation response to drought". This sentence seems incomplete.

Line 760-761: I dont think using more models will reduce uncertainty, but perhaps may allow it to better quantified.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2020-528>, 2020.