

Reviewer 2

We thank the reviewer for their positive feedback and their comments on our manuscript. We believe these comments can be straightforwardly incorporated into our manuscript and will strengthen the message and key points of the paper. Below we address their comments point by point.

General comments:

Not sure the title makes complete sense as written. Taken in parts... Onset of drought into soil moisture responses? Consider reworking, with a focus on natural grasslands.

We take the point that the title could have been clearer. We have therefore adopted a new title: 'Drought onset and propagation into soil moisture and grassland vegetation responses during the 2012–2019 major drought in Southern California'.

In general, I would recommend reducing use of “we” and shifting to a more passive tone throughout the manuscript. Shifts the emphasis from what the authors did and thought to a more objective viewpoint.

We respectfully disagree with reviewer and find passive voice to be less engaging to modern readers. We decided to maintain the use of active voice.

Parts are overly wordy and could use some critical editing to pare down to what is really essential to move the key story forward. The first paragraph of the introduction, for example, discusses forest response to drought in depth before getting to grasslands, which is the focus of the paper. Revisit the wording of the first sentence – could read something like “resulting in substantial impacts to water resources and ecosystems. These impacts varied regionally, depending on climate, elevation and biome... For example, upland forests:...[1 or 2 sentences]. The impacts of drought on California’s grasslands have been less well studied...”

Fair point. We have adapted the first paragraph to highlight the key points and set up the rationale of our research.

Specific comments:

L158: Add citation for the Penman-Monteith equation.

L158: Added.

L165: Explain the choice of the shallowest soil moisture observations as reference in this study. Why not the 20 or 50 cm measurements, which may be more representative of the root zone?

L165: We decided to use the shallowest soil moisture as reference because we are specifically interested in the response and behavior of the shallow soil moisture balance which comprises the majority of the moisture availability to grasses. The shallow sensor is capturing the precipitation and ET dynamics we were investigating, and we used it to calibrate our model to capture the dominant processes.

The simulated moisture content represents an integrated bucket over the root zone and is therefore not an exact reproduction of shallow moisture observations. In general, bucket model results cannot be directly compared to point measurements at specific depths without calibration.

Fig. 2: Can the time markers in this figure be at 1-1-YYYY rather than 1-4-YYYY (is that April 1)? Seems a little cleaner: : and less ambiguous re. date format. Inclusion

of 2008 and 2009 in the non-drought period is problematic, since most of SB County was under moderate-severe drought in those years. Why not separate out truly non-drought years, defined as years with some prescribed fraction in drought-free conditions, even if they are not temporally contiguous?

Fig 2: We acknowledge the confusion over the time markers in the figure. We adopted the format of the time markers from the USDM and are in US date format, thus start on January 4. We have changed the date format to a more coherent format of 01-01-YYYY. The issue of our initial classification of drought and non-drought periods was also mentioned by Reviewer 1, and we have made the changes outlined in the responses to Reviewer 1. We believe this strengthens our analysis and better highlights our findings.

Sec 2.4: Discuss noise reduction and normalization applied to the NDVI data obtained from Landsats 5, 7 and 8 to generate multi-year timeseries. Were TOA band values used, or surface reflectance?

Sect. 2.4: We have addressed this point in our comments to Reviewer 1 and have adapted the suggested approach from Goulden and Bales (2019) to homogenize the NDVI data of the different Landsat missions. We used NDVI images produced by the USGS from surface reflectance in our analysis.

Sec 2.5.1: The description of the Soil Moisture Balance Model could be shortened significantly.

Sect. 2.5.1: Agreed. Shortened.

L215: "...to estimate potential evapotranspiration (PET)..."

L215: Changed.

Table 1 caption: Remove first of two "used" in first sentence.

Table 1 caption: Caption amended.

L253: This sentence does not read well. Is there a missing comma after NDVI?

L253: We have reworded this section to make it more coherent and easily understandable.

Sec 2.5.4: Seems to be an inconsistency in stated calibration range between line 267 (2008-2019) and L 272 (2008-2014). Please clarify.

Sect. 2.5.4. We acknowledge the inconsistency in the presentation of our methods. Data from 2008-2014 was used for calibration and the data from 2014-2019 was only used to validate the model. We have amended the relevant section to make this clearer.

L339: It is surprising that there is no difference in precipitation between drought and non-drought years. Perhaps a more stringent separation of these years would yield greater difference?

L339: We agree that separating the data into more stringent drought categories highlights the climatic differences more clearly. Dividing the data into three drought categories shows the underlying trend of declining precipitation totals during the drought periods.

L366: What is meant by "aggressive strategy"? Maybe a use a different term.

L366: We meant to emphasize the extreme increase in greenness as seen in the NDVI signal following the rainy season, as opposed to a more gradual increase in greenness. We accept the suggestion and have reworded this sentence. “These differences in the seasonal variation of NDVI suggest a strategy of rapid green up after winter rains, ...”.

L 451-452: The difference in response isn't only due to soil texture, right? Difference in climate (aridity) also drove response.

L451-452: Yes, the difference in the drought response is not only due to soil texture, but also due to the local differences in climate. The interaction between soil and climate led to the differing response we highlighted. We have reworded this sentence to make this clearer. “The results from contrasting sites (coastal and inland) corroborate studies showing differential responses to the drought over short distances due to spatial variation in soil texture as well as local climate and aridity ...”.