

Interactive comment on “Onset and propagation of drought into soil moisture and vegetation responses during the 2012–2019 drought in Southern California” by Maria Magdalena Warter et al.

Anonymous Referee #1

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The manuscript by Warter et al. “Onset and propagation of drought into soil moisture and vegetation responses during the 2012-2019 drought in Southern California” presents a comparative analysis of climatology, soil moisture, and vegetation characteristics at two sites in southern California. This manuscript builds on earlier CA drought studies linking moisture deficit/depletion with remotely sensed vegetation characteristics with a focus on the grassland ecosystem. Measurements of precipitation, relative humidity, soil moisture, and estimated potential evapotranspiration (PET) were compared and contrasted between “drought” and “non-drought” years and two sites. Fur-

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ther, the authors have combined ground-based and remotely sensed measurements to calibrate and validate a water balance model to explore soil moisture evolution under a more “intense” future droughts. Overall, the questions posed in the manuscript are interesting and data/analysis presented supports the thesis (see few issues warranting attention below). However, the writing and presentation throughout the manuscript comes out as a little ambiguous and often redundant. A careful editing will help highlight the key points. Some points for consideration:

- 1) Delineation of “drought” and “non-drought” period is based on USDM data seems a bit random. 01-01-2008 to 31-12-2011 defined as a “non-drought” period but it contains periods of “Extreme” and “Severe” droughts. Similarly, 01-01-2012 to 01-01-2019 “drought” period contains drought-free days along with periods of “Extreme” and “Severe” droughts. Since this classification is a basis of the analysis that follows, a more robust classification, perhaps based on drought categories, is needed.
- 2) Analyzing and comparing PET and P between drought and non-drought periods, defined based on NMDC data, seems like going in circles since NMDC drought categories are derived from the very dataset.
- 3) NDVI derived from Landsat-5, Landsat-7, and Landsat-7 are not comparable and must be homogenized and filtered from clouds and other types of data noise (Goulden and Bales, 2019). I was unable to figure out if homogenization and cloud correction was performed or not. Also, considering the short growing season, a median NDVI value may not be appropriate as it may end up representing the NDVI at the beginning or end of the month. See Roche et al. 2018 <https://doi.org/10.1002/eco.1978> for centering technique.
- 4) NDVI exhibits saturation beyond some threshold precipitation or available water, it can be seen in Figure 7a. You don’t expect the NDVI to continue to increase with increasing water availability. Some vegetation expansion is possible when ample water supply is available and other resources (energy, nutrient etc.) are not limited but eventually max out. Fitting an exponential model ignores this fact.
- 5) The definition of polygons with homogeneous vegetation and soil textural properties requires further explanation. Considering the fact that you have a mixture of vegetation at both sites, how did you define “homoge-

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neous"? 6) The scenarios can be better described in the methods, I could not understand Scenario A and B until looking at figure 9. What is the meaning of the truncated rainy season and how annual P from the truncated months are redistributed? Also, these scenarios represent intense future drought as posted in the research question (iii) but the presentation of results and discussion comes out as typical climate change scenarios. 7) Figure 9 is interesting but can be conceptually predicted without running a model. Perhaps these results can be analyzed to better understand the onset and longevities of the drought. Something similar to 5a but for different scenarios.

Minor points: 1) Suggesting removing the unnecessary background information from the methods, i.e. do we need introductory sentences like these "Soil moisture is essential for plant growth and -health and accordingly, there are strong seasonal responses of vegetation to temperature and precipitation (Coates et al., 2015; Roberts et al., 2010)" to describe the study sites? 2) Precipitation values reported on top of the page 7 don't match the 20% difference reported on top of page 17 3) You mentioned inland site is not used for grazing, how about the coastal site? 4) Provide mean temperature for the two sites 5) Table S1, note the data formatting issue 6) Shortwave and longwave radiation measurements: are these net radiations? 7) L155: "For each site, we extracted daily maximum daytime temperatures, humidity and precipitation totals and calculated monthly averages to define the meteorology of the drought"- not clear. Which variables are daily maximum and which ones are totals? What do you mean by the monthly average of precipitation total? 8) PET calculation using the Penman-Monteith model need more information on how other inputs were derived i.e. conductance, ground heat flux etc. 9) Stevens hydro probe, provide manufacturer and model 10) L166: here you argue for using the degree of saturation but then end up comparing VMC in Figure 9. Relative saturation may have been more appropriate as it accounts for differences in residual WC between the two sites. 11) Fig S1 SMD can be equal to RAW as stated in the text 12) Showing F_c , W_p , RAW, and TAW in figure 3 is misleading. The picture depicts a soil profile and not a unit volume. In its current form, it looks like the W_p is always at the bottom of the root zone. 13) Equation 1, I don't quite understand what

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minimum and maximum K_c & median minimum and maximum NDVI means. Are not you regressing the monthly K_c values against monthly NDVI values with the index I being the month 1 through 12? 14) P-PET is not really a net precipitation, it is closer to aridity P/PET 15) L320 2012-2019 drought is only relevant for southern California. Statewide, the drought ended in 2016. 16) Fig. 8: At what depth these soil moisture measurements were made? Is the simulated VMC are for the same depth or integrated over the entire root zone?

Thank you for the opportunity and I hope you find these comments helpful.

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