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Interactive comment on "Spatial and temporal variability of Terminal Classic Period droughts from multiple proxy records on the Yucatan Peninsula, Mexico" *by* Stephanie C. Hunter et al.

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Comment: The problem that this paper tackles is an interesting one: there has been much debate about whether the so-called 'Terminal Classic' drought represents a coherent interval of climate change across the Yucatan Peninsula, and what dynamics may be responsible for the drought. This paper definitely has potential, but the authors should review additional relevant literature and reframe or expand some of their analyses.

Response: We would like to thank Referee #2 for taking the time to read our manuscript and for their suggestions. We will respond to each comment individually for clarity.

Comment: First, why does the study only focus on the Yucatan Peninsula? If the authors are interested in looking for evidence of ITCZ changes, we would expect to see changes in the Caribbean, Gulf of Mexico, Central America, and northern South America. We may also expect to see antiphased changes in records from places farther south in the Amazon. We also have records of tropical storms from the wider circum-Caribbean region (see the work of Jeff Donnelly's group at WHOI). Can we more rigorously test the idea that the ITCZ may have shifted in this interval by using additional proxy records? The claim of using of '23' proxy records is a little bit misleading because many of the proxy records are from the same sites, and therefore are not really independent datapoints.

Response: Following the reviewer recommendation we will clearly state "23 proxy records from X sites". This approach recognizes that each proxy type may record changes in moisture differently while also emphasizing the number of unique proxy records examined. The reviewer makes a great suggestion to consider evidence for broader changes in the ITCZ to support our suggestion that drought responses in the Yucatan were driven by changes in the ITCZ. While we think that looking at the regional response of ITCZ movement in this area would be an interesting area of study, proxy records from the Yucatan Peninsula were specifically chosen to identify periods of potential drought which may have been related to the collapse of the Maya Civilization. Therefore, including more proxy records would be beyond the scope of this study. However, we plan to expand our discussion of shifts in the ITCZ to incorporate the regional records suggested by the reviewer.

Comment: Line 121: Given that pollen is not necessarily a linear indicator of forest cover, it is possible that there could have been intensified deforestation at the Terminal Classic – I recommend checking the land use reconstructions of Kaplan et al. 2011 "Anthropogenic Land Cover Change scenario for the preindustrial Holocene" to see what the reconstruction looks like in this particular region.

Response: The Kaplan et al. (2011) reconstructions are quite interesting, and in fact support the pollen study by Leyden (2002) that suggests that there was wide deforestation on the Yucatan Peninsula 800 years prior to the TCP. The Kaplan et al. (2011) reconstruction suggests that nearly 60% of the land in Mesoamerica was cleared by the year 1 C.E. We will include this study in the discussion of potential drought mechanisms in our manuscript.

Comment: One factor that isn't really considered in this study is the timing of social change or site abandonment in the archaeological record – we know for a fact that this was not uniform across the Maya region - see for instance Aimers et al., 2007 – this could be discussed more in the paper.

Response: We agree, and it was also pointed out by Referee #1 that we could incorporate a section discussing archaeological evidence of the timing of the Terminal Classic Period. We would like to add this to the discussion section of our manuscript, and we think this would also be a good place to include a discussion of evidence for the spatial differences in site abandonment across the Yucatan Peninsula.

Comment: The citations in this paper are not really up to date - A few other papers that already address some of the themes in this paper, in some cases with more detailed analyses of the climate dynamics and age models for each site, should be discussed and cited. -Bhattacharya et al., 2017 in Quaternary Science Reviews includes a detailed analysis of the timing of drought in multiple records accounting for age uncertainty, and analyzes the drivers of drought in comprehensive climate models. -Evans et al 2018 in Science used new measurements of gypsum hydration waters and lake level modeling to estimate large changes in precipitation at the Terminal Classic. The estimates stand in contrast to Medina-Elizalde and Rohling, 2012, which estimated a modest change in rainfall. -There is also an interesting discussion in Metcalfe and Barron, 2015, which reviews an extensive dataset of proxy records from across Mexico and parts of the Caribbean and Gulf of Mexico. These should be incorporated into the discussion, and can provide pointers on additional proxy records to incorporate into the text.

Response: We agree that these papers should be added to our discussion, and this was pointed about in the short comment from Nicholas Evans. These papers will be cited and discussed in the text along with other relevant work discussed in our manuscript.

Comment: Line 430: El Nino events do increase winter rainfall in this region, but they actually decrease summer rainfall. This is because warm ENSO events generate an atmospheric Kelvin wave that dampens surface precipitation in much of the tropics – see Lintner et al., 2005, Journal of Climate. There is a delayed response in the following spring that enhances rainfall as a delayed response to ENSO.

Response: We agree- this imbalance in the timing of precipitation is noted in lines 434-438 of our manuscript.

Comment: Line 442: I am skeptical of the inferences of Knudsen et al about the inverse relationship of AMO precipitation and Yucatan rainfall – it runs counter to much of what we know about the dynamics of the region. See the work on the Atlantic Warm Pool by Wang et al., 2005 in Journal of Climate, as well as the work by Giannini et al. that is cited in this paper. Overall, the paper addresses a topic worthy of study – it just needs revisions to the text and the inclusion of a greater number of proxy records to fully test the hypotheses it sets forth.

Response: This is an interesting point, and when we looked into this further, it seems there are varying opinions on the effect of AMO specifically on the Yucatan Peninsula, which lies between an area with a positive response to AMO (the Caribbean) and an area with negative response to AMO (Midwest/Central United States and Northern Mexico). We found reference to a negative precipitation response over the Yucatan Peninsula (e.g. Curtis, 2008; Knudsen et al., 2011) and more generally to a positive precipitation response over the Caribbean (e.g. Giannini et al. 2000; Wang et al., 2005; Wu and Kirtman, 2010). It is possible that the local response on the Yucatan Peninsula to AMO is more complex than in the Caribbean, and perhaps even a seasonal response. The study by Curtis et al. (2008) suggests that while there is a decrease in mean rainfall during a positive AMO, there is also an increase in extreme rainfall events on the Yucatan Peninsula. We thank the reviewer for pointing this out, and plan to add a more in depth discussion of the possible climate effects of the AMO, and what this means for the TCP droughts.

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