Hamed and co-authors present an analysis framework to link crop yield anomalies to crop growing conditions and subsequently the underlying climate drivers in a causal chain of analysis. They build on past work to demonstrate that their method is relevant in the case of multiple crop yield shocks to soybeans in North and South America. The authors present a well written and well-motivated study with easy to interpret graphs. I thank the authors for the time and care that has gone in to the manuscript. I generally think the manuscript sound and I have only three minor comments and suggestions for the authors to consider.

We thank the reviewer for their kind words and positive evaluation of our study. In what follows, we provide a point-by-point reply to the reviewer constructive comments.

Specific comments:

1. For central Brazil, the relative soybean growing seasons have changed over time with the increase in Safrinha cycle cropping. If you are using a static harvested area map and crop calendar to weight the climate anomalies and produce a regionally aggregated weather time series to relate to the regional crop yield time series, the change in dominance from traditional crop cycles to a safrinha soy-maize crop cycle may introduce error. Your approach is a reasonable enough as it is, but this limitation may be worth mentioning in the context of the smaller variance explained by climate variables in central Brazil as compared to SESA. South Brazil does not produce much Safrinha cycle soy-maize crop rotations, so the analysis in South Brazil would not be strongly affected by this.

   Thank you for highlighting this. We will add this information to the revised manuscript and mention that future studies can further explore such aspects when studying soybean yield and climate variability in Brazil.

2. The soybean growing season in the US (May-Oct) intersects typical ENSO development (~Jul) and decay (~Mar) such that one could develop reasonable hypotheses that the intersection of the soybean season with either a developing ENSO event (Jul-Oct) or the lagged effect of a decaying ENSO event (Apr - Jun) might affect the soybean growing season. Can your causal framework distinguish between these two different cases, and if so what do the conclusions say about whether we should be considering developing ENSO events, decaying ENSO events, or both when evaluating the effect of ENSO on summer-grown crops in the US? It would be helpful to clarify this, especially because the past literature you cite (e.g. Anderson et al. 2017a, 2017b, 2018) outlines the effects of ENSO primarily as developing events, although Jong et al. (2020) highlight the importance of antecedent SST anomalies in the west pacific for US summertime heat during La Niñas (https://journals.ametsoc.org/view/journals/clim/33/14/jcliD190701.xml).

   Our framework highlights the north pacific pattern as the direct driver of summer weather conditions in the US and therefore yield impacts in

the region. To illustrate this relationship, we plot timeseries of the NP pattern, soybean yields and summer soil moisture in the US (Figure R6). In black, we mark persistent La Niña years (Niña events that persist into AMJ). In gray, we mark developing La Niña events following Jong et al. (2020).

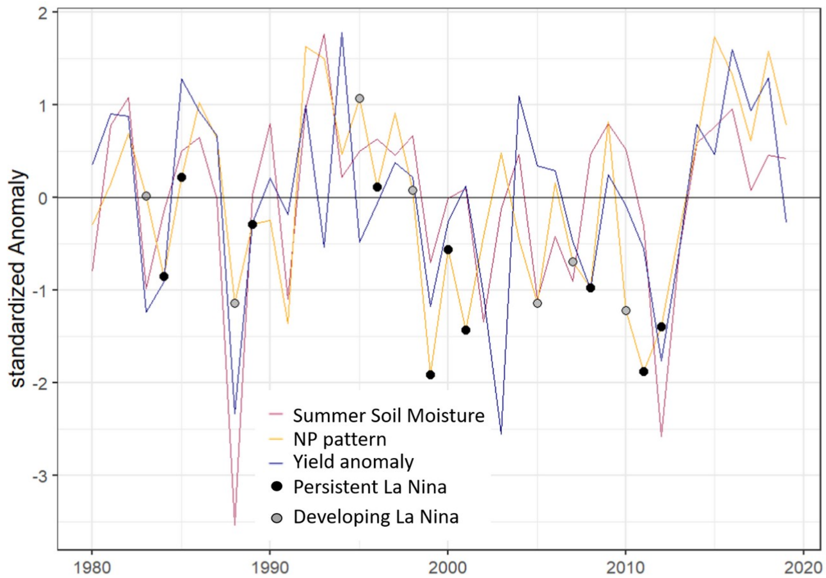

Figure R6: NP pattern, summer soil moisture and yield anomalies in the US. Black dots highlight persistent La Niña events. Gray dots highlight developing La Niña events.

Negative NP pattern conditions occur during both developing and decaying (persisting) La Niña events which suggests that both should be considered when evaluating the effects of ENSO on summer grown crops in the US.

Composite maps based on developing and persistent ENSO events for summer soil moisture, extreme heat (EDD) and soybean yields both report hot and dry conditions in addition to low soybean yields over large US producing regions.

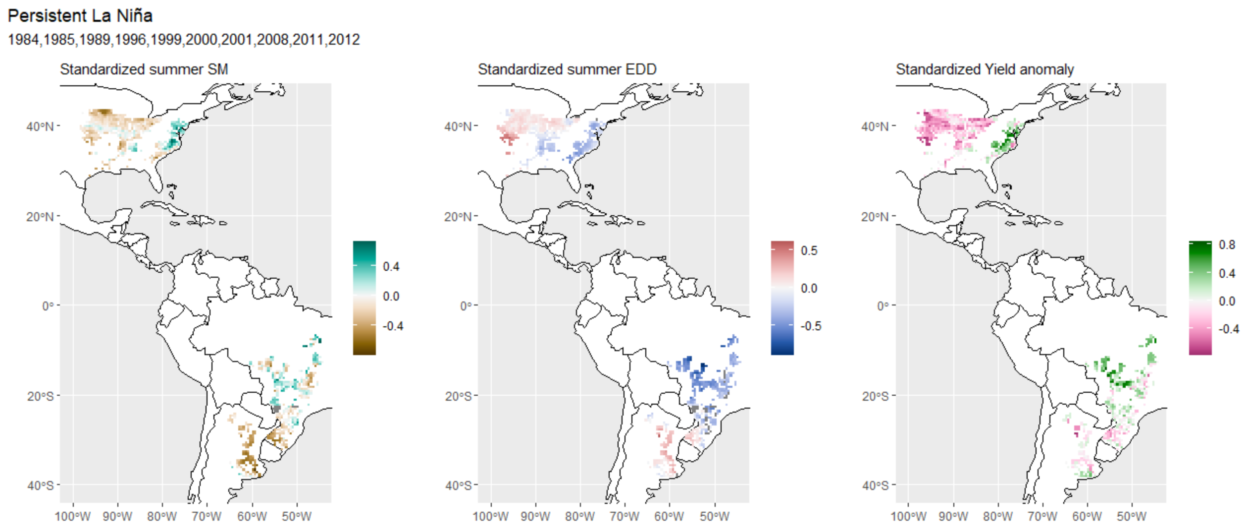

Figure R1: Composites of Summer soil moisture, summer extreme heat and soybean yield anomalies for persistent La Niña years (indicated in the subtitle). Summer periods are JFM in the southern hemisphere and JAS in the northern hemisphere.

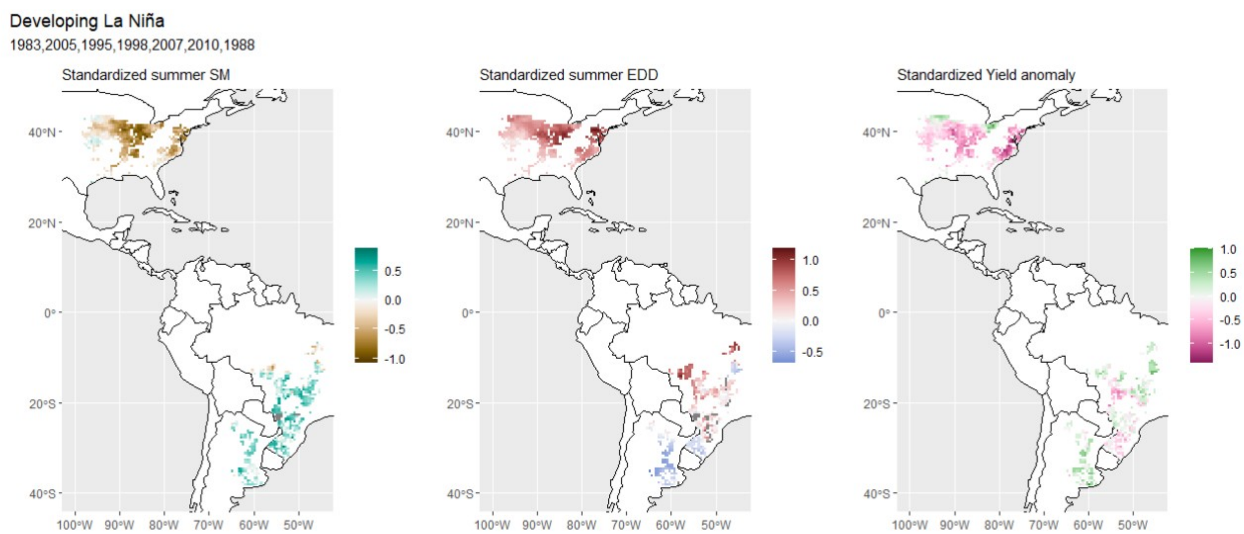

Figure R2: Similar to Fig. R1 but considering developing La Niña years as per (Jong et al., 2020).

Nevertheless, we note that for persistent La Niña events, hot-dry and negative yield anomalies are more concentrated in the Midwest (A key soybean producing region) whereas the most eastern states show cool, wet and positive yield anomalies (Figure R1). In the case of developing La Niña events, the hot-dry and low yield anomalies are present over practically the entire US soybean producing region (Figure R3). We will add text in the manuscript to highlight the potential differences between developing and persisting La Niña events.

Clarify what is meant by “persistent” La Niñas. Do you mean multi-year, or La Niña events that persist into AMJ?

We mean La Niña events that persist into AMJ. We will clarify this in the manuscript.