Dear Editor,

Thank you for the opportunity to potentially publish our manuscript within this special issue on "Understanding compound weather and climate events and related impacts". We would like to thank again the reviewers for their helpful and constructive comments. We were pleased to read the reviewers support publication provided that some minor comments are dealt with. In what follows, we expand on the remaining points left to be clarified. Referenced Line numbers refer to the updated track changed version of the manuscript. Given the small amount of reviewer comments for this iteration, we also added the changes made in the text to this document in addition to providing a marked-up manuscript version showing the changes.

Point-by-point response to the reviewers:
Referee 1: Corey Lesk

A big thanks to the authors for the thorough revisions. I think the paper is basically ready to be accepted, but a few things may need to be clarified.

Thank you for the detailed revisions which helped considerably improve the quality of our manuscript. We are glad the paper is perceived almost ready to be accepted. In what follows, we expand on the remaining points left to be clarified.

1) The new analysis on sub-seasonal correlations among tmax, sm, and aet are very interesting and add a lot to the paper, so thanks to the authors for doing this. I think the method could be clarified: I'm not totally clear what 'monthly correlations' means. I'm pretty sure it is interannual correlation between pairs of variables for a given month of the year, repeated over the various months. If so, this is a reasonably fair way to quantify these couplings, but the method should be clarified, and the rationale expanded a bit (and/or simply cite Seneviratne et al. 2010). Also, does this calculation incorporate data from all the counties into the correlation?

Thank you. What is meant is indeed interannual correlation between pairs of variables for a given month of the year, repeated over the various months of the year. We adjusted the text in the method section accordingly (see Line 175-179), in the result section (Line 342-343), the caption of Figure 7, the discussion section (Line 446-449) and the caption for Figure A6. This calculation incorporates data from all counties into the correlation by first spatially averaging single variables over the entire rainfed harvested area (See Figure 1) and then quantifying the couplings. It can be argued that by including all counties, we even underestimated the effect at specific locations. For instance, if we would have focused only on counties that highlight hot-dry sensitivities in the regression model, we would have obtained even higher values. Figure A6 depicts how interannual correlation between AET and Tmax vary at the grid-cell level. Nevertheless, what is currently presented in this manuscript can be considered a conservative estimate of these couplings that can be further explored in future research.

Manuscript changes:

"Coevolution of considered variables was estimated by calculating the interannual correlation between pairs of variables for a given month of the year, repeated over the various calendar months (Seneviratne et al., 2010). This calculation incorporates data from all counties into the correlation by first spatially averaging single variables over the entire rainfed harvested area (Fig. 1) and then quantifying the couplings. Moreover, we calculated correlation at the grid-cell level between actual evapotranspiration and maximum temperature to show how these couplings can differ at the local scale."

"Interannual correlation between root-zone soil-moisture (SMroot), maximum temperature (Tmax) and actual evapotranspiration (AET) pairs for a given month of the year, repeated over the various calendar months are used to estimate the coupling strength during hot-dry summer years and normal summer years."

Figure 7. Interannual correlation between various pairs of temperature and moisture variables for a given month of the year, repeated over the various calendar months conditioned on hot-dry events. Dots indicate statistical significance at the 95% confidence. Shaded regions represent important differences in the couplings that can play a critical role in the development of hot-dry events.

"We illustrated this mechanism by analyzing the evolution of land-atmosphere coupling within the growing season, captured by interannual correlations between root-zone soil-moisture (SMroot), maximum temperature (Tmax) and actual evapotranspiration (AET) pairs for a given month of the year, repeated over the various calendar months. "

"Figure A 6. Interannual correlation between actual evapotranspiration and maximum temperature for a given month of the year conditioned on hot-dry events and repeated for the period going from June to September. Dots indicate statistical significance at the 95% confidence. "

2) I don't quite follow the claim based on Fig 4 on line 330 that soybean in the south is particularly sensitive to combined high summer temperature and low fall moisture. While the spatial pattern you describe is generally right, many counties are different between those two maps. Also, the combination of positive fall soil moisture coefficients and negative summer temperature coefficients doesn't necessarily mean 'compound impacts' – these could be just independent sensitivities. Further, the signal could be driven by different years in the regression model – i.e. dry falls some years driving the coefficient negative, hot summers in other driving that coefficient negative. I think it would be stronger to refer to Fig. A3, as significant interactions terms are more direct support for this 'compounding' effect, and a better link into Fig. 5 which really shows this compounding in detail (based on interaction terms).

We agree with the reviewer and have therefore adjusted the reference on line 260 (330 in the previously submitted manuscript including track changes) from Fig 4 to Fig. A3.

3) Fig. 4 caption is a bit confusing. The interaction coefficients are shown in Fig. A3, right, but not here? So perhaps drop the last sentence. And could explain more which among the variables in Fig. 3a are being shown in – e.g. for temperature-related, this is either Tmax or Tmin, depending on which one dominates in a given county, right? And could refer to Figs A1-2 to help reader find these.

We agree with the reviewer and have therefore adjusted the caption for Fig.4 (Line 231)

Manuscript changes:

"Figure 4. Region- and season-specific estimated sensitivity coefficients for soybean yield and selected predictors. Stippling indicates statistical significance from a t-test at 95% confidence level. Values of coefficients are interpreted as the change in soybean yield standard deviation from a one-standard deviation change in the considered independent variable. Temperature-related variables can refer to either Tmin or Tmax depending on the selected variable in a given county. Similarly, moisture-related variable can refer to either SMroot or Num_pr20. Finally, for each seasonal bracket (i.e. Early, Mid or Late), the selected time resolution for each variable can be either a seasonal aggregate or the value for a specific month within that bracket. We refer the reader to the appendix (Fig. A1, A2) for a more detailed account of selected variables per county."

A couple other interesting things you could include: One point that to me supports and ties in the new coupling analysis is that, in the updated results, there is a sharp boundary between positive and negative yield impact of mid-season temperature variables, and this boundary (somewhere in the middle of Iowa) seems curiously close to the transition from energy- to moisture-limited summer soil moisture regime in North America (see Seneviratne et al. 2010). You could mention that as it supports part of your interpretation of Figure 7. In my own work I also find a global pattern consistent with this (stronger T-ET coupling worsens yield sensitivity to temperature for soybean) in the paper I mentioned during my first review (which is out now by the way, Lesk et al. 2021)

Thank you for highlighting this. We've added the following text (Line 426-430) to the discussion to enhance result interpretation:

Manuscript changes:

[…] "These regions are characterized by a predominantly energy-limited summer regime where the role of soil moisture in related land-atmosphere feedbacks is limited (Seneviratne et al., 2010). These northern states also showed reduced sensitivity to high temperatures over summer (Fig. 4d) in line with Lesk et al. (2021b) who highlighted reduced soybean yield sensitivity to temperature in energy-limited regimes at the global scale."

The August Tmax – Sept. Tmin interaction is also very interesting and indeed may be enhanced sensitivity to cold from heat acclimation in the early season. You could expand on what physiologically might cause this (not so obvious, at least to me).

We agree that this result is interesting although we limited the discussion of this topic as the paper focuses on hot-dry conditions. Still, we adjusted the following text (Line 259-260) to clarify the physiological process that is linked to crop acclimation.

Manuscript changes:

"This might reflect increased impacts whenever anomalously hot conditions in peak summer are followed by anomalously cold conditions in September-October. Optimal temperature for crop photosynthesis fluctuates due to the capacity of the crop to seasonally adjust its physiological response to temperature (Kumarathunge et al., 2019). It follows that consistent high temperature within the growing season can make the crops more productive at higher temperatures. The abrupt change in temperature conditions from hot to cold further stresses crops and reduces the potential positive effects of crop temperature acclimation (Butler and Huybers, 2013; Carter et al., 2016)."

References: Seneviratne, S. I., Corti, T., Davin, E. L., Hirschi, M., Jaeger, E. B., Lehner, I., ... & Teuling, A. J. (2010). Investigating soil moisture–climate interactions in a changing climate: A review. Earth-Science Reviews, 99(3-4), 125-161. Lesk, C., Coffel, E., Winter, J., Ray, D., Zscheischler, J., Seneviratne, S. I., & Horton, R. (2021). Stronger temperature–moisture couplings exacerbate the impact of climate warming on global crop yields. Nature Food, 2(9), 683-691.

Butler, E. E. and Huybers, P.: Adaptation of US maize to temperature variations, Nat. Clim. Chang., 3(1), 68–72, doi:10.1038/nclimate1585, 2013.

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