Review3:

This paper proposes, based on a series of LST measurements derived from Modis, to analyse the effects of thermal and water stress by considering a big data set over a large territory and a long time series 2003-2016. The originality of this work, beyond the considerable corpus of data, is to analyse the contributions of both types of stress.

Thank you for this detailed and constructive review. We have made the suggested changes, as detailed in the point-by-point response below.

The approach nevertheless presents an important methodological flaw in the separation of thermal and hydric effects. Indeed, water stress leads to a decrease in photosynthesis and therefore in yields, but also to an increase in temperature, which itself can have an effect on yield. Therefore, to separate the thermal effect it is necessary to be able to control the water stress. This is the case with irrigated conditions and Figure 8b does not show a clear effect of heat stress under these conditions. The authors use an empirical model (eq 8) which is not at all suitable for separating the temperature and water effects or it should be demonstrated.

Your intuition is spot-on, and is exactly what the statistical methodology employed in this analysis achieves. That is, the coefficient on extreme heat is the partial effect of heat on yield, controlling for water stress; the coefficient on water stress is the partial effect of water stress on yield, controlling for heat. This is the advantage of a panel statistical model -- to be able to tease apart the two effects. It is true that there is some interaction between the two impact channels (as you mentioned, water stress reduces photosynthesis and also raises plant temperature) and so these "heat" and "water stress" channels should be interpreted carefully. The temperature coefficient would represent the net of all effects raising surface temperature. We have added text to better explain this in the discussion in line 466 "As what we have shown, the cooling effect of irrigation lowers evaporative demand (PET) and thus indirectly contributes to lower water stress (higher ET/PET). In addition, water stress reduced photosynthesis and ET, resulting in higher plant temperature. Our disentangling methods do not account for the water stress and heat stress interaction effects, so these "heat" and "water stress" channels should be interpreted carefully. We note that our statistical model estimated temperature coefficient should be interpreted as the net of all effects raising surface temperature." .

Therefore i found that the conclusions (as the 65% and 35%, heat) cannot be supported by such methodology and probably the author give too much importance to the heat stress.

The 65% and 35% come from our statistical model, which (as explained above) is the state-of-the-science for statistical isolation of individual parameter impacts on yield. However, we understand the reviewer's intuition that moisture stress is the dominant factor. One of the surprising findings across the statistical crop-climate literature has been the persistent finding that heat itself matters, and not just through moisture. Our desire to explore this interesting finding is what prompted the analyses in this paper.

In fact this study does not refer to existing knowledge in ecosphysiology on heat stress on field crops which would have allowed a better understanding of the periods and impact of heat stress on yields. This is reflected in the choice of crop models, which is documented in a much too summary manner. Because of the strong link between water stress and temperature, on the one hand, and the pre-eminence of water stress on yields, it seems difficult to isolate the effect of heat stress on yield with a simple statistical analysis as is done in the paper. Moreover, the choice of explanatory variables aggregated over two parts of the cycle does not help to analyse phenomena that occur over short periods of time linked to climatic variability and the sensitivity of the yield to heat stress.

We agree that many processes over shorter time scales affect crops, including (eg) water stress raising plant temperature. We do not claim to be able to isolate the individual processes over the lifecycle of the crop, but instead seek to understand the net heat- vs water stress- driven impacts over the whole season. We agree that analyses complementary to ours (e.g., detailed phenological studies) are important for completing our understanding of the heat- and water- stress puzzle.

The main reason why we used the crop models is to test how well crop models had simulated the net irrigation benefits we identified in different phases of crop growth. We did not make a choice of the crop models but just used all available crop model results participating in GGCMI. It is indeed likely true that other crop models have a better representation in crop physiological response to climate stress and canopy temperature simulation. But here we find that only one of these readily-available models has a good performance in representing canopy temperature.

Because of the unsuitable approach to adress thermal stresses which would have been the true originality of this work, I do not recommend the publication of this article. Moreover, it has some formal defects:

We respectfully disagree. These statistical models are the state of the art for long panel analyses, and do in fact enable us to tease apart the various impact pathways. They may not be as detailed or process-based as the reviewer would prefer, but they are very useful for leveraging long time series data over large areas.

The authors could describe a little better the sources of performance data

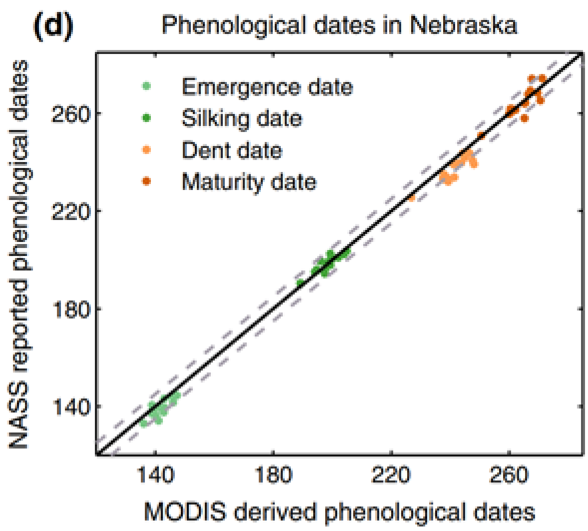
We have detailed below answers to your specific questions about the data, and have added additional clarification to the manuscript accordingly.

L126 what is a MODIS sinusoidale projection

This is the projection system used by many MODIS products. This projection is pseudocylindrical equal-area projection displaying all parallels and the central meridian at the real scale. It uses a spherical projection ellipsoid and a WGS84 datum ellipsoid.

L141-144 : better describe how phenology is retrieved. Site observations in Figure 4c show that the phenology was not well characterized (gap of 20 days with VP this gap might have commented

The inconsistency between site observations and satellite derived crop phenology is likely due to the different spatial scales: Figure 4b shows the statistics of the whole state; while Figure 4c is only for the selected site. In addition, Figure 4c is presented here mainly to support our finding that irrigation extended the crop growing duration especially for the grain filling period but not to compare the absolute value of phenological stages derived from two different sources and scales. Actually, the satellite derived crop phenological stages have been validated against USDA statistics in the previous study for Nebraska state (Zhu et al., 2018). Please see the comparison below:



The two dashed lines in the figure define the region where the errors between satellite derived phenological stages and NASS statistics are less than 5 days.

Zhu, P**.,** Jin, Z.**,** Zhuang, Q., Ciais, P., Bernacchi, B., Wang, X., Makowski, D., Lobell, D. The important but weakening maize yield benefit of grain filling prolongation in the US Midwest. Glob Change Biol. 2018;00:1–13.

L176-180 : I guess that met data are obtained hourly, why using sine function (is the fact of using sine function has an impact on GDD and EDD

As its name (Daymet) indicated, the meteorological data are daily time-step, so we use this interpolation to better capture the sub-daily temperature stress. We clarified this in line 169 “we also obtained daily minimum and maximum surface air temperature (Tmin and Tmax) at 1-km resolution from Daymet version 3”

L301 not clear

We clarified this as “this suggested that irrigated and rainfed cropland were distinguishable based on satellite derived crop seasonality information”.

L328-329: are irrigated and non irrigated using varieties. Probably not and we can expect that phenological characteristics might be different. This can explain shorter cycle with non irrigated crop.

Yes, irrigated and non irrigated corn fields probably use different varieties. So we also used Figure 4d-f to show how much the difference in growing duration can be partially explained by the LST differences.

L390-403 : in Agmip there several models that compute crop temperature (STICS for instance), wihy not using them. Are sure that LPJ-guess do no not compute crop temperature.

We do not deliberately make model selections but just used all models available in AgMIP Global Gridded Crop Model Intercomparison (GGCMI) project (Müller et al., 2019). Indeed, STICS simulates canopy temperature, but this model is not available in AgMIP GGCMI project.

Müller, C., Elliott, J., Kelly, D., Arneth, A., Balkovic, J., Ciais, P., Deryng, D., Folberth, C., Hoek, S., Izaurralde, R. C., Jones, C. D., Khabarov, N., Lawrence, P., Liu, W., Olin, S., Pugh, T. A. M., Reddy, A., Rosenzweig, C., Ruane, A. C., Sakurai, G., Schmid, E., Skalsky, R., Wang, X., de Wit, A. and Yang, H.: The Global Gridded Crop Model Intercomparison phase 1 simulation dataset, Sci. Data, 6(1), doi:10.1038/s41597-019-0023-8, 2019.