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Reply on CC1

Peng Zhu and Jennifer Burney

Author comment on "Untangling irrigation effects on maize water and heat stress alleviation using satellite data" by Peng Zhu and Jennifer Burney, Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2020-627-AC6>, 2021

I came across this paper which is a very nice study. The authors used remote sensing data and statistical methods to quantify irrigation effects on maize yield in Nebraska. It is found that water and high temperature stress alleviation contributes to 65% and 35% of yield benefit. 1) This paper reminds a recent paper by Li et al in Global Change Biology. Interestingly, these two studies are very similar in many aspects (topic, data, and Nebraska) but show quantitatively different results. Li2020 reported that 16% of irrigation yield increase is due to irrigation cooling, while the rest (84%) is due to water supply and other factors. This work (Line 373-383) reported a 79% (water) and 21% (temperature) contribution for water and temperature respectively using eq 8 while the numbers became 65% and 35% with Eq 9. However, the later numbers appeared in the abstract. This shows that there might be large uncertainty in the reported contribution numbers. The important questions are how to understand these different results and which one is more reliable? I feel that numbers with range is more appropriate than just a single number. A comparison or discussion with Li2020 and with the authors' own results would be very needed for the readers to understand the robustness and possible causes for different results. 2) In my opinion, the usage of 1km Daymet air temperature is not suitable for studying the irrigation cooling. The gridded air temperature data were typically produced by interpolation of weather stations with many assumptions and tricks. The irrigation cooling signals would be lost in the interpolation and processing. This is probably the primary reason why air temperature showed no cooling compared to LST. Ref Li, Y., Guan, K., Peng, B., Franz, T. E., Wardlow, B., & Pan, M. (2020). Quantifying irrigation cooling benefits to maize yield in the US Midwest. *Global Change Biology*, 26(5), 3065–3078. <https://doi.org/10.1111/gcb.15002>

Response: Thanks for your appreciation and the constructive comments. Yes, we also feel quite coincidental that both studies have addressed a similar topic in the same states of the US. Nebraska attracts our attention probably because Nebraska is an important maize production state with a heavily irrigation application. Indeed, it will be better to discuss the difference between the two studies, but we did not get the chance to read this Global change biology paper (GCB paper hereafter) until we finalized this manuscript. The reason why we used the second estimation based on LST is explained in line 385: "Because the distribution of ΔEDD was truncated for points with $\Delta EDD > 0$ (Figure 8e), we explored an

alternative model with quadratic functions of ΔLST and $\Delta ET/PET$ (Eq. (9)).”

The main reason why the estimation in this paper is larger than the estimation in GCB paper is probably because in this study cooling effect contribution is estimated as cooling effect relative to sum of cooling effect and water stress effect. In the GCB paper, cooling effect contribution is estimated as cooling effect relative to net yield differences between irrigated and rainfed maize. Since other effects (like cultivator and fertilizer application) might also contribute to the yield difference between irrigated and rainfed maize, the cooling effect in the GCB paper will be lower than this one. We discuss this in line 395 “We also note that the high temperature stress alleviation estimated here is larger than the estimation in a recent study (Li et al., 2020) where LST is also employed to detect the yield benefit of irrigation cooling effect. The greater benefit of cooling effect identified in this study is probably because in this study cooling effect benefit is estimated as cooling effect relative to sum of cooling effect and water stress effect. However, cooling effect benefit is estimated as cooling effect relative to net yield differences between irrigated and rainfed maize in Li et al., (2020). Since other effects (like cultivar difference and fertilizer application) might also contribute to the yield difference between irrigated and rainfed maize, the cooling effect in Li et al., (2020) is lower than our estimation.”

And also we followed your suggestion by adding the 95% confidence interval for the estimated irrigation contributions.

For the second point, yes, we agree that LST is better than air temperature to capture the irrigation induced cooling effect. So LST is used for the disentangling analysis. We have added a clarification in line 324 for this point: “The difference between spatial-temporal patterns identified using LST and air temperature was mainly because LST reflects canopy energy partition between latent heat flux and sensible heat flux. Additional moisture provided by irrigation makes more heat transported as latent heat flux, resulting in a cooling effect.”