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Comment on hess-2021-329

Anonymous Referee #1

Referee comment on "Historical simulation of maize water footprints with a new global gridded crop model ACEA" by Oleksandr Mialyk et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-329-RC1, 2021

The paper introduces AquaCrop-Earth@lternatives (ACEA), a global gridded crop model that was used to estimate maize WF over a longer period, splitting the WF into green, blue-irrigation, and blue-capillary rise. It's well-written and will make a valuable contribution to the literature. However, before the work is accepted, I have a few concerns that must be addressed:

Major comments:

- The ability to model the role of capillary rise to meeting crop water demand at a worldwide level with high spatial resolution is one of the current study's key achievements. That is something I applaud the authors for. However, I have reservations about using a simplified strategy and depending on a single static groundwater table data set that does not account for interannual change or variation during the irrigation season. Fan et al. (2013) have stated clearly that their data is based on a simple WTD that ignores local geology and is presented in its natural state, without groundwater pumping and drainage. You extrapolated this modeled data, which represents a natural condition during the modeling period, over decades. You're presuming that the WTD remains constant across decades and season to season. This assumption is not supported by scientific evidence. I have a few reservations about this strategy: 1) due to natural fluctuations in precipitation, the groundwater table varies within a year and over time; 2) depending on the intensity of groundwater pumping during the irrigation season, the groundwater level declines by as much as 20 meters or more. As a result, the blue WF from the capillary rise is only 'potential' and not actual. I recommend that you address this limitation by using data that includes interannual and seasonal groundwater level fluctuations. Alternatively, you may refer to your estimate as the potential blue WF assuming everything remains the same.
- The yield scaling factor is another concerning simplification. The argument is that others have done it before us, so it's fine if we do it the same way. Because of improved maize types with higher HI, yield has increased over time. The crop structure has altered from a larger plant with leaves that fall laterally to a more compact plant

with leaves that grow vertically, allowing for closer planting and increased grain output. How do you explain a +56 percent increase in yield factor (S) with no influence on evapotranspiration? Please support your claim with evidence from the literature that new maize varieties have the same ET as older varieties but yield more.

Specific comments:

Introduction: - Some of the notes have mischaracterized the earlier studies:

- Line 44-45- point 1: True, the cited studies did not take into account thermal stress, but they did take into account water stress. Have you looked at the impact of thermal and water stress on crop output separately? Please clearly show the influence of thermal and water stress on crop production as well as the WF (m3/t) as you stated this is one of your additions to the worldwide WF study. You can include a map in the SI.
- Line 54: " To our knowledge, global crop WFs have never been studied with GGCMs". This is not They may have not used the term WF but there are some global studies - look EPIC (Liu et al. 2007, Liu and Yang 2010, Liu et al. 2009, Liu et al. 2016) and LPJmL (Fader et al. 2010, Rost et al. 2008).
- Line 61-63: true AquaCrop requires different input files for each site, which adds to the processing time and effort. However, I disagree with your assertion that it increases model complexity and computational load without providing evidence. One effort to make input and output processing easier is the AquaCrop-GIS created by Lorite et al. (2013). Others have written their own script to handle a huge number of simulations' input and output.

Method section:

- Line 131-134: Please define the scenarios s1 to s6

Result section:

- You talked about the different regions' relative reductions in WF, yet you didn't even mention the vast red shaded areas in Figure 6. How can you account for the rise in WF in those dark red areas? You listed some countries where the WF has increased on lines 281-283, but you didn't explain why. Please discuss your findings and try to explain why some locations have seen an increase in WF.

References

Fader, M., Rost, S., Müller, C., Bondeau, A. and Gerten, D. (2010) Virtual water content of temperate cereals and maize: Present and potential future patterns. Journal of Hydrology In Press, Corrected Proof.

Liu, J., Williams, J.R., Zehnder, A.J.B. and Yang, H. (2007) GEPIC – modelling wheat yield and crop water productivity with high resolution on a global scale. Agricultural Systems 94(2), 478-493.

Liu, J. and Yang, H. (2010) Spatially explicit assessment of global consumptive water uses in cropland: Green and blue water. Journal of Hydrology 384(3-4), 187-197.

Liu, J., Zehnder, A.J.B. and Yang, H. (2009) Global consumptive water use for crop production: The importance of green water and virtual water. Water Resources Research 45(5), n/a-n/a.

Liu, W., Yang, H., Folberth, C., Wang, X., Luo, Q. and Schulin, R. (2016) Global investigation of impacts of PET methods on simulating crop-water relations for maize. Agricultural and Forest Meteorology 221, 164-175.

Rost, S., Gerten, D., Bondeau, A., Lucht, W., Rohwer, J. and Schaphoff, S. (2008) Agricultural green and blue water consumption and its influence on the global water system. Water Resources Research 44(9).