

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2
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Comment on hess-2021-80

Anonymous Referee #2

Referee comment on "The application of Budyko framework to irrigation districts in China under various climatic conditions" by Hang Chen et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-80-RC2>, 2021

The authors present a study where they investigate the role of irrigation in the Budyko framework. This is a long standing issue in Budyko framework that is not solved yet (see e.g., Han et al 2011; Mianabaid et al 2020), mainly due to the lack of data on irrigation. This paper is fortunate to have irrigation data for 371 catchments in China, and is therefore unique in its kind. However, this data is not public as stated in the 'data availability' section. In my opinion the given author statement is not in line with HESS's data policy (https://www.hydrology-and-earth-system-sciences.net/policies/data_policy.html). Additionally, irrigation data is also more complex in comparison to hydrometeorological data, as the data highly depends on irrigation type, associated losses, etc. I appreciate the authors effort to explain the underlying principles in the Appendix; however, this information is not enough (e.g., how is the water use efficiency calculated or measured??; is the irrigation water originating from the same catchment?). This results in the fact that I can not judge the validity of the data (which is essentially modelled irrigation), which is at the core of this study. Hence, I highly recommend to share the data so that your study can be verified.

Next, to the data issue I am not sure whether your calculations are correct. According to Eq 4 you calculate the equivalent precipitation as the sum of irrigation (I), precipitation (P) and groundwater evaporation (ETg). But how does this relate to your water balance in Eq 9? Is ETg part of ET? And more importantly: how do you define ET? I think that in Eq 9 ET equals the total actual evaporation (=sum of interception evaporation E_i , transpiration E_t and soil evaporation ET_g). However in Eq 10 it seems that ET is equal to transpiration, as P_{effd} equals P minus interception. And how is it possible that according to Eq 10 all water entering the unsaturated zone is evaporating? This would mean that no water is percolating to the ground water reservoir? Hence, to summarize, I have some doubts on the water balance closure in relation to how you define evaporation. A schematic conceptual overview might help to clarify this.

Besides my major concerns related to the data validity and water balance calculation, the manuscript is well written. It's easy to read in good English, well structured, and the Figures are OK.

Detailed comments:

- P3 L44: "...used AT global and regional scales...."
- P4 L70-71: the unit of ET, ET₀ and P is mm/y.
- P5 L103-106: are this the only irrigation methods? What about furrow or sprinkling? This would have a large impact on e.g., interception 'losses'
- P5 L111: Figure 1A doesn't show meteo data. It shows the aridity index. Similiar to my comments on data availability regarding irrigation: is meteo data available?
- Eq2: I hightly recommend to use single characters in equation and not to use acronyms like ET. ET can be mathematically confused with E*T. Better use sub- and superscripts.
- P6 L120-121: I don't understnad this sentence.
- Section 2.2: How do you know that the irrigation water is originating from the same catchment. If you have transport external water into your catchment, you are violating the water balance.
- P8 L149: Why do you add ET_g? What does it matter if the plants use water from the unsaturated zone, shallow or deep groundwater?
- P10 L189-190: How is the net irrigation determined? Is transpiration measured to calculate the Water Use Efficiency? How is transpiration measured?
- Eq8: this equation effectively calculates interception. Interception is highly dependent on vegetation type; however, I do not see where vegetation has a role in Eq8.
- Eq 9: I think this equation should read: $E_i + ET = I + P - D$
- P11 L217: unit RSME is mm/y
- Fig 2: is the water balanced ET on the y-axis calculated based on Eq 9, and thus includes I? If so, it shows to me the potential errors in the irrigation estimates, as for high MODIS-ET the data points start to deviate from the 1:1. Especially, for arid areas irrigation is important.
- Fig 3: why is the x-axix of 'semi-arid' different? And should ET_g not be included here? And how is ET_g determined?
- Eq 11: 'exp' should not be in italic.
- Fig 8b: Are the observed ET values from MODIS? Please note that MODIS is a model.

References:

Han, S., Hu, H., Yang, D., & Liu, Q. (2011). Irrigation impact on annual water balance of the oases in tarim basin, northwest china. *Hydrological Processes*, 25(2), 167-174. doi:10.1002/hyp.7830

A. Mianabadi, K. Davary, M. Pourreza-Bilondi, A. M. J. Coenders-Gerrits; (2020) Budyko framework; towards non-steady state conditions, *Journal of Hydrology*. <https://doi.org/10.1016/j.jhydrol.2020.125089>