Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2
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Comment on hess-2022-164

Anonymous Referee #2

Referee comment on "Linking the complementary evaporation relationship with the Budyko framework for ungauged areas in Australia" by Daeha Kim et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-164-RC2, 2022

Review comments on "Improving the calibration-free complementary evaporation principle by linking with the Budyko framework" by Daeha Kim et al.

The authors evaluated predictability of the calibration-free complementary relationship (CR) using in-situ flux and runoff observations in Australia, and found that the performance metrics were somewhat lower than shown in prior studies. They potentially attributed the low performance of the calibration-free CR formulation to the unrealistic assumption of the Priestley-Taylor (PT) coefficient, hence proposing an approach that can embed its spatial variation in the CR. To this end, they attempted to connect the polynomial CR with a traditional Budyko equation that has been widely used to describe the surface water balance at a long timescale.

I believe that this paper could help users of the CR method to reliably estimate its single parameter (i.e., the PT coefficient) based on the competition between water and energy balance. I have acknowledged the usefulness of the calibration-free formulation, because its performance could be even better than advanced land surface models in some regions. As the authors stated, the CR methods from the definitive derivation by Brutsaert (2015) have shown outstanding performance in reproducing observed evaporation in many locations over the world, while depending on some parameter calibrations and/or hypotheses that have not been validated. I agree that the assumption of the fixed PT coefficient within a continental-scale area is questionable, because many experimental studies have already found its temporal and spatial variability.

Since the Budyko framework explains the competition between water and energy availability over a land surface, the PT coefficient of the CR method may be better constrained according to overlying climate conditions. The connection to the Budyko

framework is likely to lead the CR method to less-biased evaporation estimates, because climate conditions are strongly correlated with vegetation and other land properties. I believe that the findings from this paper have some values for water managers in arid and semi-arid environments, and the topic is interesting and well suited for potential readers of the Hydrology and Earth System Sciences.

Nonetheless, I found some issues in the proposed framework and in the discussion section. Even though they may not be major issues, the authors would need to carefully consider in revision of the manuscript. I would recommend "minor revision" for this manuscript.

Major comments:

- Constraining the polynomial CR with the Budyko equation require sufficient evaporation observations to build the regression relationship between x_hat and the climate variables (Eq. 11). This makes the essential convenience of the calibration-free CR disappear. The proposed framework necessitates any reference evaporation data (e.g., water-balance estimates) to develop the empirical relationship, whereas Szilagyi et al.'s formulation never used reference data. Thus, the proposed framework has pros and cons rather than improving the calibration-free formulation. I think it plays a role in transferring implicit information from gauged to ungauged locations via a solid water-balance equation. On the other hand, Szilagyi et al.'s (2017) approach is applicable only with atmospheric forcing data. Though the constant PT coefficient is a questionable assumption, the two methods have different applicability. So, the title "Improving the calibration-free complementary evaporation principle …" could be somewhat inappropriate. I would suggest retitling it, for example, as "Regionalizing a definitive complementary evaporation relationship by linking with the Budyko framework". I think the new title should imply the authors' intention to regionalize the PT coefficients based on surface water balance explained by the Budyko framework. The introduction should also be reframed accordingly.
- The section 4.1 seems to overly emphasize limitations of the constant PT coefficient. I would recommend the authors to discuss more about the scientific meaning of the CR-Budyko framework as did in Kim and Chun (2021). This would make this paper more meaningful. Please highlight why CR needs to be constrained even at ungauged locations in the discussion section.
- Since the Budyko framework is valid at a long timescale, evaporation observations required for developing Eq. 11 should be sufficiently long. This means that usability of the proposed framework is dependent on regional data availability. Still, Szilagyi et al.'s formulation has better applicability when regional data availability is low. Please add this point in the discussion section, too.
- Some grammatical errors and typos are still in the manuscript. Please re-read the manuscript carefully, and correct them including the below technical errors I found.

Some technical errors:

Abstract:

(L12) convenient à highly utilizable

(L14) three advanced ETa models: In Abstract, no explicit list was found. The authors should more explicitly list these three ETa models.

1 Introduction:

(L39) had found à had been found

2 Methodology and data:

(L154) The authors may misuse a dash (-) with an en dash (–). Generally, an en dash can replace "to". The authors need to replace the misused dash with an en dash. These replacements should be made throughout the manuscript.

(L163) ('LE_F_MDS_QC' > 0.95) The authors need to provide more description of this for the potential readers.

(L180) a land-surface models à a land-surface model

3 Results:

(L222–223) The Pearson r between the x and the other three variables was à The Pearson r values between the x and the other three variables were (One “The” must be removed, “values” can be added after “r, and “was” should be changed into “were”)

5 Conclusions:

No explicit conclusion was found in this section. The author may change the section title into 5 Summary or add some of conclusions such as recommendations for future research or practical applications.

References

Brutsaert, W., 2015. A generalized complementary principle with physical constraints for landâ□□surface evaporation, Water Resour. Res., 51, 8087–8093.

Kim, D., Chun, J. A., 2021. Revisiting a two-parameter Budyko equation with the complementary evaporation principle for proper consideration of surface energy balance, Water Resour. Res., 57, e2021WR030838.