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Discussions

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Interactive comment

Interactive comment on "At which time scale does the complementary principle perform best on evaporation estimation?" *by* Liming Wang et al.

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Response to interactive comment on "At which time scale does the complementary principle perform best on evaporation estimation?" by Liming Wang et al. #2

(Reviewers comments in Italic and responses in upright Roman)

Anonymous Referee #2

General response: Thank you for the timely review. We are very appreciative of your valuable and constructive revision suggestions. The point-by-point responses were provided as follows.

-Ln 9. Suggest change "Energy correction methods" to "energy balance closure methods"

Response: Thanks for your advice. The manuscript will be revised accordingly.

-Ln 154-157, does this mean that the two model parameters (i.e. m and n) are determined from alpha and b only?

Response: Yes, it is. The variable $x_{0.5}$ in Eq.(4) is also determined by α and b only. Thus, all the parameters in Eq.(4) can be determined from α and b only. Thank you.

-Ln171-177, What is the justification for the treatment of parameter alpha?

Response: Thanks for your question. Typically, α has a default value of 1.26 (Priestley Taylor, 1972). Since some studies showed that a constant α may cause irrational results and biases in estimating E, it is suggested to specify α for diverse scenarios (Hobbins, Ramírez, Brown, Claessens, 2001b; Ma et al., 2015a; Sugita et al., 2001; Szilagyi, 2007). According to the complementary principle, in wet condition, E is close to E_{pen} (Penman evaporation) and the Priestley-Taylor's evaporation (E_{PT} = α E_{rad}). Specifically, when E/E_{pen} is larger than a threshold (0.9 is commonly adopted), E_{PT} can be considered to approximately equal to the observed E, thus α can be calculated by E/E_{rad} (Kahler and Brutsaert, 2006; Ma et al., 2015a). In this study, α was calculated by this method based on the mean value of E/E_{rad} in the wet condition (E/E_{pen} > 0.9). When all the E/E_{pen} values are less than 0.9, α is set as the default value of 1.26. The manuscript will be revised accordingly.

-Was the optimization done for each flux site at daily, weekly, monthly, and annual time scales respectively?

Response: Yes, the optimizations were done separately. Thank you.

-Why was equation (5) was tested instead of (6)? Brutsaert (2015) suggested that "it is preferable to use Eq.(6) and the c parameter should only be introduced to accommodate unusual situations."

Response: Thanks for your question. Brutsaert (2015) suggested that *c* should be 0 in usual situations, thus, the PGC function (Eq.(5)) becomes a concise cubic polynomial function including only two terms (Eq.(6)). Although the concise version of the PGC function has been frequently used recently (Brutsaert et al., 2017; Hu et al., 2018; Liu et al., 2016; Zhang et al., 2017), researchers still have different opinions on the true value of *c*. For example, Han and Tian (2018) found that the mean *c* value of the 20 sites of FLUXNET is -1 and Szilagyi et al. (2016) suggested that *c* is equal to 2 for 334 catchments in America. The results of Zhou et al. (2020) showed that the mean *c* value is 6.62 for 15 catchments on the Loess Plateau, China. Moreover, we had tested Eq.(6) in the analysis before, and the results showed that the performance of Eq.(6) is much worse than Eq.(5). We provided the results in Table R1 and Figure R1. Since we have used the optimization algorithm to determine the parameter *b* in the SGC function, it is a fair manner to use the optimal *c* value instead of a constant value (c = 0) in the PGC function. The manuscript will be revised accordingly.

Table R1. The evaluation merits (NSE, R^2, and RMSE in W m^{-2}) based on Eq.(5) (optimal *c*) with the subscript B-5 and Eq.(6) (c = 0) with the subscript B-6.

	Day	Week	Month	Year
NSE_{B-5}	0.19	0.3	0.5	0.25
NSE_{B-6}	-0.47	-0.61	-0.69	-8.98
R^2_{B-5}	0.61	0.7	0.75	0.63
R^2_{B-6}	0.61	0.69	0.72	0.62
$RMSE_{B-5}$	26.83	19.17	13.7	6.96
$RMSE_{B-6}$	33.65	28.51	23.98	21.47

Table 1.

Figure R1. The estimated evaporation based on the polynomial function with c = 0 (Eq.(6)) vs the observed evaporation at daily scale (a), weekly scale (b), monthly scale (c), and yearly scale (d).

-Ln220-227, The results shown in Figure 1 do not indicate the model performance at daily, weekly, monthly, and annual time scales. If the authors want to know how the model performs at these time scales, they need to show daily to annual results for each site and present a summary of the 88 flux sites.

Response: Thanks for your suggestion. Figure 1 just provides a general cognition of the performance. To accurately show the model efficiency at different time scales, we will provide the results at different timescales for each site in Table S2 following the advice of the reviewer. A summary of these results will be added in the revision.

-Ln 241, Morton (1983) suggested that the complementary relationship should be applied at longer time scales (e.g. monthly), but it does not explain why the weekly or monthly results are better than the daily results.

Response: Yes, we agree with the reviewer. Morton (1983) just inferred that the complementary relationship should not be applied at short time scales because of the potential lag times associated with heat and water vapor change (p24 - p25 in Morton, 1983). However, it does not provide solid evidence or theoretical derivation to prove this inference. The statement will be revised. Thank you.

-Ln370, Figure 5 should be Figure 7. What is the significance of this relationship?

Response: Thanks for your careful review. The manuscript will be revised accordingly. The relationship provides the additional evidence besides Figure 2 that the two functions can substitute each other in a sense. In other words, the two functions with calibrated parameters substantially provide the similar descriptions of the distribution of results in the state space ($x = E_{rad}/E_{pen}$, $y = E/E_{pen}$). They can covert to each other in most situations since the two functions are roughly equivalent to the linear asymmetric function when x is neither excessively large nor excessively small.

-Ln 409 – 436, This section deals with the issue of the energy balance closure. To me, this is a separate question and I don't see the relevance to the performance of the

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complementary relationships.

Response: Thanks for your comment. This part will be deleted in the revision.

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Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2020-379/hess-2020-379-AC2-supplement.pdf

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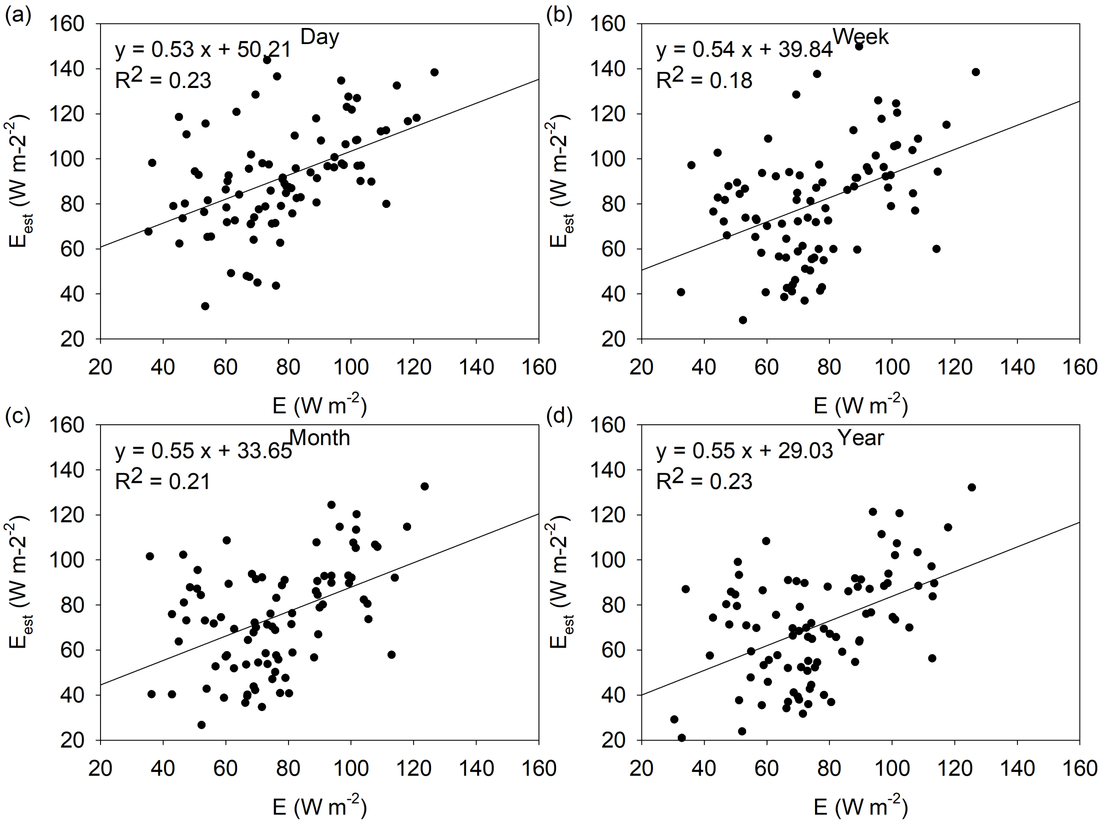

Fig. 1. Figure R1 The estimated evaporation based on the polynomial function with c = 0 (equation (6)) vs the observed evaporation at daily scale (a), weekly scale (b), monthly scale (c), and yearly scale (d)

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