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Discussions

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. #3

(Reviewers comments in Italic and responses in upright Roman)

Anonymous Referee #3

Complementary evaporation relationships have been studied at multiple time scales, which time scale is the most suitable one? In this respect, the manuscript gave very meaningful results. It is recommended that the draft should be revised on the following questions before publication.

General response: Thanks for your careful review and affirmation of this work. All the questions are very constructive and inspiring. The point-by-point responses were provided as follows.

*-(1). Ln172-173, Ln458-459, "When all the E/E_{pen} values were less than 0.9, α was set as the default value of 1.26". This default value is problematic for the PGC model. The independent variable of PGC model is E_{po}/E_{pa} = α*E_{rad}/E_{pen}, which is less than or equal to 1. When α =1.26, the range of E_{rad}/E_{pen} values is only 0-0.79. However, if α =1, the range of E_{rad}/E_{pen} values is 0-1. It could be imagined that the PGC cannot fit the data points with 0.79<E_{rad}/E_{pen}<1 if the α =1.26, but there is no problem in the case of α =1.*

Response: Thanks for your comment. Indeed, the PGC model does not work for the range of 0.79 < E_{rad}/E_{pen} < 1.0 when α adopts its default value of 1.26 (Priestley Taylor, 1972; Brutsaert Stricker, 1979), which is a shortage of PGC. In our manuscript, α was calculated by the mean value of the ratio of E_{PT} to E_{rad} during the study period (similar treatment can be found in Kahler Brutsaert, 2006). Such calculation is based on the physical definition of the Priestley-Taylor coefficient (i.e., α). Actually, the values of α for all sites besides those adopting α = 1.26 are greater than 1.0 in our study, which means the PGC model cannot work properly for the condition of 1/α < E_{rad}/E_{pen} <1.0.

In the submitted manuscript, the original results for 1/α < E_{rad}/E_{pen} < 1 calculated by the PGC function were kept. We have carried out an additional analysis that adopting E = E_{pen} for 1/α < E_{rad}/E_{pen} < 1 in the PGC function, and the resultant NSE_B (0.19 vs 0.19) and $RMSE_B$ (26.83 W m^{-2} vs 26.68 W m^{-2}) presented very similar results. The manuscript will be revised to incorporate these discussions. Thank you.

-(2). Ln294-295, Ln336-337, Ln351-352,Ln466-467, The manuscript gave a conclusion that the parameter c of PGC model decreased with the increase of time scale. The parameter c was determined under the condition of a fixed α in this study, which needs

to be specially explained. When the c is a fixed value, say 0, the α would change with the month (Liu et al.,2016).

Response: Thanks for your comment. To make the model parsimonious, it is a reasonable choice to give one value for the parameters α and *c* at each site for every different time scale. If the parameter was alterable, for example, it was monthly dependent, we will have to calibrate 12 parameters instead of one value for the whole study period. The purpose of this study is to find the most suitable timescale for the complementary functions, the variances of the key parameter within a timescale will introduce extra uncertainties. It is true that the accuracy will increase when an alterable parameter (that means higher number of parameters) is used, however, the probability of overfitting risk will increase at the same time. Besides, a general representation of the parameter is more helpful to detect its overall trend as the change of timescale than a group of parameters.

Moreover, we carried out an additional analysis that *c* is fixed to 0, and α is calibrated as α_e. We found that the two methods gave similar results (mean RMSE = 14.99 W m^{-2} for α_e vs 16.67 W m^{-2} for α) and the conclusion on the time scale issue is consistent by adopting either α or α_e in the analysis. Actually, the optimal α_e has a significantly negative linear relationship with the optimal *c* and the Pearson correlation coefficient is -0.8. It suggests that calibrating either of the two parameters (α_e and *c*) equivalent (Han et al., 2012). Thanks all the same, and the manuscript will be revised accordingly to incorporate these discussions.

-(3). By using statistical indexes such as determination coefficient, the manuscript considered that the complementary relationship of a monthly scale was the best, but the other time scales were not poor and reached to a very significant level too. Does this mean that the complementary relationship on other time scales also exists significantly, not as Morton (1983) said, only at longer timescales?

Response: Thanks for your question. Yes, we found the two complementary func-

tions perform reasonably well at shorter timescales (i.e., day and week) with pretty high R^2. Also, the estimations of site mean evaporation at shorter timescales are accurate (Figure 1 and Figure 3), especially for the SGC function. These indeed suggest the complementary relationship holds at relatively shorter time scales, or at least we can say that the generalized complementary functions have the ability to estimate the evaporation accurately even at the shorter timescales. The manuscript will be revised to incorporate these discussions. Thanks.

-(4). Ln23, "global water and energy cycle". Generally, water can have a cycle, but energy flows only.

Response: Thanks for your careful review. The statement will be revised as "global water cycle and energy balance".

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Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2020-379/hess-2020-379-AC3-supplement.pdf

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