

Interactive comment on “Modeling water balance using the Budyko framework over variable timescales under diverse climates” by Chuanhao Wu et al.

Anonymous Referee #2

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The authors assess the application of the Budyko framework at short-time scales (monthly, seasonal and annual) in several major basins in China. They study steady-state conditions at these time-scales and the implications of water storage change on estimates of evapotranspiration by comparing estimates from the Fu equation and the "expanded" Fu (with effective precipitation) to "observations". They find that the Fu and expanded Fu models show important estimation improvements in arid basins but not in humid basins. They also note that estimates deteriorate at shorter time scales (monthly and wet-seasonal scale). First, I must say that the article is well written, consequent and explicative. The main objectives of the study also agree with current trends in Budyko framework research. However, I am concerned by one technical issue and

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also the novelty of the work which should be better justified. I also think that the article could benefit from changes in structure that no make the Introduction too broad and the results too repetitive.

1. The authors compare the estimates of actual evapotranspiration from the Fu and expanded Fu (with effective precipitation) models (i.e., which they called the modelled results) with a product that they call "observations". My question is if this product really comprises "observations". From what I see, the "observations" are really "a model simulation forced by daily climate". Therefore, in reality, you are not comparing the Budyko-type models to observations but rather to a processed-based model. This needs to be clarified from the Abstract to the Conclusions. This is why you are getting extremely good model performances. If you really compared the two models with runoff observations, your results would show much worse model performances. So please justify the use of the VIC (Zhang, et al, 2014) data set as the main source to be compared with. Zhang et al. even say their ET estimates are just "reasonable". So maybe a good improvement to this article would be at least for the 14 basin scales to add the same analysis but with "real" runoff observations. 2. You have to be more specific in the way that your study is novel and unique (L. 72-78). There are many studies that are also studying water storage change and its implications within the Budyko framework. What novelty is you study presenting that it is not included in the references you mention (L. 87-99)? Now, it is not clear. Maybe you could be more specific, for example, regarding the specific case of China. 3. Literature review: I see important recent articles of water storage analysis and its implications for steady-state conditions in the Budyko framework missing from the Introduction. These also use both long and short-term assumptions on water storage change. Maybe they could benefit the introduction and discussion of this manuscript:

Åć Gudmundsson, L., Greve, P. and Seneviratne, S. I.: The sensitivity of water availability to changes in the aridity index and other factors – A probabilistic analysis in the Budyko space, *Geophys. Res. Lett.*, 2016GL069763, doi:10.1002/2016GL069763,

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2016. Jaramillo, F. and Destouni, G.: Developing water change spectra and distinguishing change drivers worldwide, *Geophys. Res. Lett.*, 41(23), 8377–8386, doi:10.1002/2014GL061848, 2014. Moussa, R. and Lhomme, J.-P.: The Budyko functions under non-steady-state conditions, *Hydrol Earth Syst Sci*, 20(12), 4867–4879, doi:10.5194/hess-20-4867-2016, 2016. Ye, S., Li, H.-Y., Li, S., Leung, L. R., Demissie, Y., Ran, Q. and Blöschl, G.: Vegetation regulation on streamflow intra-annual variability through adaption to climate variations, *Geophys. Res. Lett.*, 42(23), 2015GL066396, doi:10.1002/2015GL066396, 2015

4. The structure becomes too repetitive in the results and extended when jumping from multi-annual, annual, seasonal, monthly. Figure 3, 5 and 9 have to be simplified. Maybe just choose two example basins per each and discuss them thoroughly, and put the rest in Supplementary Information.

Other issues:

L. 30 “change in” soil water storage

L. 65 You are missing the reference study here.

L. 78 What do you mean by the “modelling errors”

L. 87 More details are needed concerning the VIC model since it is a core product used in your study.

L. 112 Citation?

L. 156 What is RE? You need to explain what this ratio represents and how it relates to model performance.

L. 162 replace “adequately” by “captures most of the”

L. 163 Again, I do not think calling this “observed” is adequate

L. 165-166 Where did you get this observation from?

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Fig 4 and 6 Why giving so much emphasis to $PET/P > 10$, they are extremely unique. Most of the grid points are $PET/P < 10$ or even $PET/P < 5$ so I would adjust the scale. Remember that $PET/P > 1$ is still considered dry or arid so there is more to talk about in this range.

L. 187 Which basins are these.

L. 204-205 I could not get what you are referring to here.

What you all “Discussion” is still Results. You are missing the Discussion were you compare your results with other previous work on the field. See the references you are citing.

Interactive comment on *Hydrol. Earth Syst. Sci. Discuss.*, <https://doi.org/10.5194/hess-2017-441>, 2017.

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