

Interactive comment on “New interpretation of the role of water balance in an extended Budyko hypothesis in arid regions” by C. Du et al.

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The authors extended the Budyko hypothesis (BH) to an arid basin, by taking inflow and storage change into account. Considering inflow from upper basins as part of the total water supply to evaporation in an unclosed basin is quite novel. The authors found that accounting for the inflow in BH is beneficial to improve BH performance both in annual and monthly time scale. This paper is well written, clearly structured. And it matches well with the scope of HESS, will be of interest for HESS readers. I recommend minor revision. But some parts need further clarification before it can be published.

Major comments:

1. Clarify how the authors calculate the Q_{in} . Accounting Q_{in} in BH is the most novel

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part of this paper, to my point of view. Maybe I missed it, but I did not get the clear definition of Q_{in} and how the authors do the calculation, especially for the basins in downstream. I guess the authors estimated Q_{in} by channel inflow and outflow, which implicitly takes all types of water consumption into account, such as irrigation, domestic and industrial water usage, but neglect the capillary rise from groundwater reservoir. I personally suggest the authors confirm this important term is well defined and clearly described.

2. Page 11018 Line 9: The term ΔS is not well defined. It is defined as “soil water storage change” in the article. But what is the depth of the soil? Since soil depth in some places may be deeper than 50 meters, i.e. on Loess Plateau, which is obviously not what the authors intended to say. And I think the authors mean the top soil layers which can be used for ecosystem to absorb water by roots. I recommend using root zone storage (Gao et al., 2014) change as a clearer definition, which is the dynamic part in soil.

3. Page 11024 Line 13-14: “. . .The runoff data set includes monthly runoff at 4 stations located at the inflow or outflow of the six sub-basins.” How 4 gauge stations can observe the inflow and outflow of six sub-basins? Please clarify.

4. Section 4.1. The role of abcd model in this study. To my understanding, it provides the time series of monthly “soil water storage change” and “monthly inflow” in downstream basins (due to the influence of hydraulic engineering), which are necessary for the new BH model. Am I right? Please do clarification in the revised manuscript. And how was the abcd model applied to calculate the water balance of Regions III and IV? The authors used evaporation observation to do calibration in Regions III and IV. But basin III and IV is the downstream of basin I and II. How does the abcd model handle the inflow from upstream? And how is the abcd model conducted in Region V? I did find it in Section 4.1.

Small comments:

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Page 11025 Line 21: "... completely controlled by hydrological stations...". Do you mean "hydraulic engineering"?

Reference:

Gao, H., M. Hrachowitz, S. J. Schymanski, F. Fenicia, N. Sriwongsitanon, and H. H. G. Savenije (2014b), Climate controls how ecosystems size the root zone storage capacity at catchment scale, *Geophysical Research Letters*, 2014GL061668.

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