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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Reinterpreting the Budyko Framework" *by* Nathan G. F. Reaver et al.

Randall Donohue

randall.donohue@csiro.au

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I have eagerly read this manuscript and am welcoming of a new perspective on the Budyko curve. While the theoretical understanding of the curve has been continuing to grow, my perspective is that actual improvements to the performance of the model in hydrological applications stalled a few decades ago (my own work included!). It would be great to kick-start that process again. So I am glad to read a critical appraisal of the use of the Budyko curves.

I have one comment to make on this manuscript, which relates to the claim that catchments in reality don't follow Budyko-like curves. The authors show this using catchment data from the US and the UK (Figure 2). The data show that the catchments do generally follow a curve when using the long-term averages but not when using time-series (looking at a catchment through time). This is an expected result due to the underlying

assumption in the framework that precipitation is the *only* supply of water. This is often interpreted in terms of catchments needing to be in steady state.

Given this inherent model assumption, one should expect time-series catchment data NOT to follow a single curve. Hence, when the authors say that

"...we can conclude that individual catchments do not generally or consistently follow Budyko curve trajectories as posited by the catchment trajectory conjecture..." (page 17 line 8)

what the authors have (re)discovered is what happens when one violates a key model assumption.

Hence, their assertion that

"...this conjecture in hydrological analyses (e.g., precipitation partitioning sensitivity and causal attribution to anthropogenic and climatic impacts) will likely introduce significant errors and may lead to spurious conclusions."

seems to be difficult to support from their empirical test but also seems unfair both to the model itself and to those in the community who apply the model in accordance to its inherent limitations.

Is it not the case that only time-series (daily, weekly, yearly etc) hydrological data that have water storage change effects accounted for can be used to test, empirically, whether the catchment specific parameter is temporally constant?

Might it be that water storage provides the link between the analytical meaning of the parameter and the physical understanding of how individual catchments have different E for the same P and Ep? That is, when a stored water term is included as a water supply term alongside P, then it introduces a catchment-specific and time-dependent term into the model fundamentals and into your analytical analysis?

584, 2020.