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Interactive Comment

Interactive comment on "Does the Budyko curve reflect a maximum power state of hydrological systems? A backward analysis" *by* M. Westhoff et al.

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We would like to thank Referee 1 for his/her positive feedback and useful comments on how to improve the paper.

The first major point made is about the derivation of power (Eq. 11-13).
We are indeed looking for a function $G(h)$ so that d$P/$d$k_e = 0$, but we do that in a *backward* analysis, meaning that we start with the power function. We first chose a function for power depending on k_e with the constraint that this function has a maximum and that it is always above zero. Once this function is chosen, the gradients are fixed

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and will always lead to a maximum in power corresponding to a point on the Budyko curve (assuming constant forcing).

Another important point raised by the referee is the use of parameter n in the optimization, where he/she suggests treating n as a free parameter to really move away from empiricism.
However, our aim was to start with a curve expressing the asymptotes of the Budyko curve and deviate from these curves by only adding dynamics in forcing or evaporation. We used the formulation in Eq. (9), which, with a large n, follows the asymptotes closely. So the parameter n is only introduced because it is in one of the available mathematical expressions of the Budyko curve. Note, however, that not all expressions of the Budyko curve can follow the asymptotes closely: e.g. the expression of Zhang et al., [2001] or the original formulation of Budyko [1974].

In the revised manuscript we will make this clearer. We will make Eq. 10 and 14 more general by replacing the expression for the Budyko curve (Eq. 9) by a function $B(k_e^*)$ representing any kind of mathematical expression that follows the asymptotes closely. We will furthermore show that the expression proposed by Wang and Tang [2014] will give the same results (and even better, since their expression can follow the asymptotes exactly). Furthermore, we will reconsider if Figure 2 is still appropriate.

The last important question raised by the referee was why we did not start from the other extreme curve derived with low values of n.
The answer is indeed that when dynamics are introduced, the slopes of the curves decrease. This is because when these dynamics are introduced, the optimum k_e^* values always increase [which is consistent with the results of Westhoff et al. 2014] and therefore the aridity index as well. Also, starting from the other extreme of $n = 0$ results in a $k_e^* = 0$ in Eq. (10) and (14) and subsequently $G_e(k_e)$ (Eq. 13) and power are zero.

For the other points, we will add more explanation at the requested locations.

On behalf of all authors,

Martijn Westhoff

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