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Comment on hess-2022-97

Anonymous Referee #1

Referee comment on "Vegetation optimality explains the convergence of catchments on the Budyko curve" by Remko C. Nijzink and Stanislaus J. Schymanski, Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-97-RC1, 2022

The Budyko hypothesis has been widely used to assess catchment water balance and hydrological response under climate change. There are several equations for the Budyko hypothesis, and it has been attracting many attentions to give more physical explanations on the parameter of those equations. This manuscript conducted numerical experiments using a vegetation optimality model and three conceptual hydrological models to understand the convergence and self-organization around Budyko curve. And it shows an interesting phenomenon that increasing precipitation increases vegetation, which leads to more evaporation. As a result of the change in vegetation, there appears a perfect Budyko relationship among P, E0, E with a constant parameter. It indicates two aspects of new understanding, i.e. on the one hand, the change in vegetation can't be ignored when assessing the impact of climate change on runoff; and the other hand, the parameter of the Budyko curve holds constant for a special catchment although vegetation is changed due to climate change for a long term time, since the change in vegetation leads to the convergence of catchments on the Budyko curve. In addition, it falls within the scope of Hydrology and Earth System Sciences. Therefore, I recommend accepted after addressing the following issues.

- This manuscript used three conceptual hydrological models to model evaporation under different vegetation conditions. In the current version, it isn't clear how to deal with the impact of changing vegetation in the hydrological models. More descriptions on the parameterization of vegetation, including root depth, are required.
- I suggest a flow chart for the experimental design, which can help readers more easily understand the design scheme.
- It is interesting that n might initially increase in response to suddenly reduced P, and only slowly returns to into original. It is valuable to exhibit the evolution process that the parameter n slowly returns to its original, and how long it can return to its original value. In a previous study, Zhang et al. (2016, GRL, doi:10.1002/2015GL066952) found a linear relationship of n with vegetation during 1982-2011, which possibly indicates that n can't return to its original for a 30-years period.

I agree with the authors that vegetation is a result of climate. Yang et al. (2014, JoH, http://dx.doi.org/10.1016/j.jhydrol.2014.05.062) found that the parameter n has a logarithmic relationship with catchment slope, but doesn’t have a significant relationship with vegetation coverage. I guess that vegetation is the result of climate and catchment characteristics (such as slope, topography, permeability and etc.), and consequently the relationship of n with vegetation can be contained in the relationship of n with catchment characteristics.