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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Technical Note: Analytical Inversion of the Parametric Budyko Equations" *by* Nathan G. F. Reaver et al.

Anonymous Referee #4

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This technical note outlines the steps for analytically deriving the values of the parameters used in the two main versions of the Budyko model; w for the Fu version and n for the Choudhury-Yang version. The authors derive these as functions of the main model variables: average E, P and Ep. Their key point is that the w/n parameters are only correctly derived as functions of three model variables and should not be expected to be physically related to any other biophysical process, except through the dependence other processes have on E, Ep and P themselves. They conclude that this derivation provides a needed solution to the question of how w/n are related to biophysical processes.

I can not comment on the maths in this article as it is beyond my expertise. I can comment on the concepts and implications of the maths. I have two main points to

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make. Overall, I find nothing technically wrong with the article but question the value of its contribution.

Firstly, the derivation of analytical solutions to the two parameters doesn't seem like a new contribution. Sposito [2017, Understanding the Budyko Equation, Water, 9(40)] has done similar including analytically deriving the data space of each parameter. I seek guidance from the editor on the requirements for novelty in technical notes and ask the authors to explain how their study provides an advance over what has already been done. My other point is that, while the authors provide an analytical solution to how to define w and n, I am unsure of what problem it is that they are solving. They indicate the problem has been stated in the literature (L62): "Notably, there has not been an analytical derivation illustrating how ðİŚŻ and ðİŚď relate to biophysical features, though the importance of doing so has been noted many times." and (L169): ". . .the literature-identified need of an analytical expression." However, the motivation behind trying to predict a catchment's parameter value is to be able to use Budyko to make predictions about E and Q based on Ep and P – that is, in ungauged catchments. The analytical definitions of w and n are given here as functions of E and so cannot address the need most of the literature is trying to address, which is prediction in ungauged catchments. Further, the need stated in the literature calls for a biophysical understanding of the parameters. The authors claim their solution ". . ..thus fulfills the literature-identified need of an analytical expression for ðİŚŻ and ðİŚď in terms of biophysical features." . While they have provided an analytical solution I am not convinced it provides a solution that is any more connected to biophysical features any more than the original formulations are. Another way of saying this is, the solution doesn't provide any greater biophysical understanding of the meaning of w or n than previously existed, nor does it make Budyko any more useful. Again, how does this then address the need to be able to predict w and n ungauged catchments? I think that the authors need to rethink what is the question they are trying to address and ensure it represents an advance in the use of Budyko to make hydrological predictions.

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