

Interactive comment on “The Budyko functions under non-steady state conditions: new approach and comparison with previous formulations” by Roger Moussa and Jean-Paul Lhomme

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The authors present an interesting study in which they propose an approach to extend Budyko functions to non-steady state conditions. The approach is based on a careful evaluation of the feasible limits of the Budyko-Turc space, which are subsequently adjusted for the case where additional water is available for evapotranspiration. This yields a general framework into which common Budyko functions can be inserted. Finally, the authors apply the proposed framework to popular Budyko functions and compare the results to previous studies.

Interestingly, the authors show that if their approach is applied to Fu's equation (Fu, 1981), their approach yields an equation that is mathematically identical to a recent

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extension (Greve et al, 2016), after minor rearrangements. This finding increases the credibility of the results as the presented study and Greve et al (2016) have derived the same results on the basis of two independent approaches. Nevertheless, the presented work is clearly a new development as it (1) offers a more general approach that is applicable to a wide range of Budyko functions and (2) provides more explicit insights into the role of water storage (S) to the y_0 parameter identified by Greve et al (2016).

Overall the paper is clearly structured and I find the graphical derivation of the proposed extension very convincing. Consequently, I do recommend the publication of the proposed work after some specific comments have been accounted for.

SPECIFIC COMMENTS:

**** ** Specific Comment 1: ** ****

Although the paper is well structured I had the impression that it would benefit from some linguistic fine tuning and that some sections could be presented more clearly.

**** ** Specific Comment 2: ** ****

The authors mention that the equation that is derived using their approach and Fu's equation, yields an equation that is "similar" to the equation derived by Greve et al (2016). In fact, the two equations are IDENTICAL after some minor re-arrangements, which is also shown by the authors. I therefore would like to urge the authors to clarify this issue in the revised manuscript. (As noted above, the authors work is nevertheless very valuable as it provides an independent validation of the previously derived function and allows for an explicit assessment of the amount of storage water that is available for evapotranspiration).

**** ** Specific Comment 3: ** ****

Page 4, lines 8ff: This section contains the actual derivation of the authors approach to incorporate storage water into Budyko functions. Unfortunately, I had to read this section several times before I could understand the logic underlying their approach.

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Therefore, I would like to encourage the authors to expand this section, and explain the important steps in more detail. More specifically: (1) I was wondering why the authors did search for the equation shown in line 12. (2) It took me a while to figure out how the values of beta, alpha and gamma were chosen (one or two sentences explaining the logic behind this would be helpful).

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