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Hydrology and Earth System Sciences Discussions

Interactive comment on "A steady-state saturation model to determine the subsurface travel time (STT) in complex hillslopes" *by* T. Sabzevari et al.

Anonymous Referee #1

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In this paper, the authors develop a methodology to calculate travel times and saturated zone lengths for aquifers of varying shapes. Although basically the idea is good, a number of issues need to be resolved before the paper can be published.

My remarks are:

- There are a number of linguistic mistakes in the paper, that I am not going to list. A native English speaker could correct these.

- Page 7182, line 4-8. Actually, there is a paper (Huyck et al, wrr, 2005) in which a similar Boussinesq equation (for aquifers with varying width, linearized) has been solved analytically for temporally changing recharge rates. I think this should be added

to this paragraph, because it is an advancement compared to the references that are already listed.

- After equation 1: please provide units or dimensions to the variables.

- After equation 2: perhaps better to refer to the original Boussinesq paper for the Boussinesq-equation, than to Troch et al (2003) ?

- After equation 2 and 3: please provide units or dimensions to the variables.

- Equation 5: the "omega", should this be "W" ?

- Please provide more details in the derivation of equation 6. It is important to understand where this equation comes from. Perhaps in appendix.

- Equation 7: remove the last bracket (the large }). Also, the bottom equation means that the storage everywhere is zero, for all t ?

- Page 7186, first paragraph. The point of saturation is mentioned. What if there is no saturation anywhere ?

- After equation 9, please add units to the variables. Also, at the end of this explanation, the notation "delta" is used, while in the equation itself, "sigma" is used. Please make consistent.

- We need more details in te derivation of equation 10. This is an important equation, so it's important to explain where it comes from. Again, this may happen in appendix.

- After equation 11, please add units to the variables. Also, this equation seems rather bizarre to me (I also do not think that this equation is ever used in Peter Troch's or similar papers on the subject). If x is equal to L, the width becomes equal to Wo*exp(-2 omega L^2/H). What is H equal to zero ? This is not impossible, this simply indicates a horizontal aquifer. Also, I would expect the width at the bottom to be independent of L, but it depends on L squared. Also, this equation means that the parameter omega in equation 1 is always the same as the parameter that determines the shape here. Also,

why does the aquifer width have to depend on the aquifer slope ? Why not simply make W(x) equal to Wo*exp(par*x), with par a shape parameter (unit 1/m) ? This equation needs a lot more explanation.

- Please provide more explanation for equation 13. This may again happen in appendix.

- Equation 14 uses a "sigma" and the explanation a "delta". Please make consistent.

- Equation 15: does the "log" have to be a "ln" ?

- Equation 15: if omega is between zero and -N/(2kD), the argument of the logarithm is between 0 and 1, which will lead to a negative logarithm. This means that the saturated zone length is larger than the aquifer length. This does not make much sense to me. Please explain how this is possible. However, in the tables and figures with the results, realistic values for SZL with negative omegas have been obtained. Please explain this discrepancy.

- Also, equation 15, if omega is smaller than -N/(2kD), the argument of the logarithm is negative, and a complex number is retained for SZL. However, in the tables and figures with the results, again, realistic values for SZL have been obtained in this case. This needs to be explained.

- Also, immediately before equation 15, sigma (not delta) needs to be equal to 1, not zero.

- Please add a reference to substantiate where equation 17 comes from.

- I do not understand how equation 23 has been derived (I can't get there). Please add more details, perhaps in appendix.

- Figure 8: why are beta and omega varied simultaneously ?

I think the authors need to address all these comments (certainly the comments regarding the inconsistencies between equation 15 and the tables and figures with results, because this is very important for the paper), before the paper is publishable.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 7179, 2009.