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Hydrology and Earth System Sciences Discussions

Interactive comment on "Quantifying spatial and temporal discharge dynamics of an event in a first order stream, using Distributed Temperature Sensing" *by* M. C. Westhoff et al.

Anonymous Referee #1

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The manuscript deals with the calibration of a numerical model with observations as a learning tool to understand the dynamics of a small stream flow. In particular, the Authors try to reconstruct the spatial and temporal variation of the discharge of the stream by comparing the model results with high resolution temperature measurements.

The narrative description of the model calibration is interesting and allows the reader to explore the steps towards the definition of the set of parameters that best fit the observations and to test critically the assumption and rejection of different hypotheses. On the other hand, with so many parameters to be calibrated and such a large number of degrees of freedom in the search, doubts may arise about the uniqueness of the solution. The Authors partially tackle this problem in section 5, but the analysis is not always clear. Another shortcoming of the work is the lack of clarity in the description of the model.

As a whole, the manuscript may be of interest of the readers of HESS, but some improvements are needed.

MAIN ISSUES

1) The description of the model in section 3.1 is not sufficient to understand its correctness. The Authors write: "This study builds on previous work by Westhoff et al. (2007, 2010, 2011). In this section we only give a short description of this work. For further details, the reader is referred to the original studies." However, the model for the hyporheic zone is described in Westhoff et al. (WRR 2011) that is only submitted and therefore is not available at the moment of this review.

2) Equations 1-3 do not constitute the complete set of governing equations: there are several unknowns (at least Aw, Q, Ab, Tw, Thz, Ts) and only three equations. Let's see what is missing: 1. a geometrical relationship can be probably found to infer Ab from Aw; 2. the discharge Q (which is a "spatial and temporal varying discharge", p. 2181, l. 9) can be determined by means of the usual momentum equation; 3. an equation for the hyporheic temperature Thz is needed (or is it an imposed boundary condition?). Moreover, equation (3) is questionable from a formal point of view: it has the form of a second order differential equation describing the diffusion of temperature in the subsurface zone, but the boundary condition (Phi_bed) is included in the equation, with a specification in the text (p. 2183, l. 8-9) that the term should be considered only in the top layer (presumably, but it is not said, dz is the thickness of the top layer). Although the computational result can be the same, the equation could be written in a more precise form.

3) The model (eqs. 1-3 and following lines) uses a lot of variables with different sub-

scripts representing quantities in different parts of the cross-section. It is not easy to understand where the variables are defined and how they interact. To improve clarity, the Authors should include a conceptual illustration of the different regions of the cross-section indicating variables and fluxes.

4) It is not always easy to follow the changes discussed in the sections 3.2 and 4 concerning the set of parameters used in the model. A table summarizing the values of all the main parameters and their changes during calibration is needed.

SPECIFIC REMARKS

- p. 2184, l. 4, “losses of water”: indicate which is the corresponding parameter in the model.

- p. 2184, l. 22, “Qhyp” and “Vhz”: why are they used instead of the parameters per unit length (alpha Aw, Ahz) that are presented in the model in section 3.1? Formally, they depend on the spatial integration step (if this is the meaning of “dx”, which is not defined) so their value will change with the discretization.

- p. 2190, l. 6, “when the infiltration loss ... is taken constant over time, the peak in downstream discharge occurs 50 min too late. Therefore we can conclude with high certainty that this loss increases with increasing discharge”: this statement is not obvious. It is not clear how a delay of 50 minutes can depend on the infiltration loss. If the delay is due to the infiltration of water and its release after some time, much more diffusion in the discharge peak is expected (i.e. a much wider peak).

- fig. 2, caption, “the noise in upstream discharge observations was removed to decrease calculation time”: filtering the noise may be reasonable, but why does it increase calculation time?

- fig. 2 and fig. 5 are almost identical, so they can be joined in one single figure.

TYPOS

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There are several typos in the manuscript. I list a bunch of them below.

- p. 2177, l. 24, “Stream water losses (or downwelling fluxes) are difficult to quantify, since it does not influence. . .” -> “since THEY DO not influence”.

- p. 2179, l. 14, “Around the stream, colluvial sediments and a thin soil layer, cover the schist”: delete comma -> “Around the stream, colluvial sediments and a thin soil layer cover the schist”.

- p. 2180, l. 2, “demonstrated, that at least part”, l. 3, “the water that infiltrates between 60 and 77 m, returns”; l. 17, “see, Selker”: delete commas.

- p. 2182, l. 6, “to this model: The riverbed” -> “to this model: the riverbed”.

- p. 2184, l. 11, “orriginating” -> “originating”

- p. 2185, l. 21, “would then easily directed” -> “would then easily direct”

- p. 2188, l. 3, “encount” -> “account”

- p. 2188, l. 3, “Comparing . . . source, shows” -> “Comparing . . . source shows”

- p. 2188, l. 19, “effect” -> “affect”

- p. 2189, l. 15, “both, rainfall” -> “both rainfall”

- p. 2191, l. 24, “alhough” -> “although”

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Interactive Comment