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Hydrology and Earth System Sciences Discussions

Interactive comment on "Comparison of heat tracer models in the estimation of upward flux through streambed sediments" *by* M. Shanafield et al.

Anonymous Referee #2

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This manuscript attempts to determine if existing methods for inverting streambed thermal records to yield vertical groundwater fluxes can be used when both fluid and heat flow are upward. The authors conclude that two such methods can be used "under some conditions." This subject matter is relevant to the readers of Hydrol. & Earth Syst. Sci., and the manuscript is well-written and the presentation is clear. However, I feel that major revisions are necessary before I would recommend this manuscript for publication, particularly regarding the authors' conclusions.

Major Comments:

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Interactive Discussion
Discussion Paper

My main criticism of this manuscript is that I am not sure what the quantitative answers are to the three questions listed at the end of the introduction. Taken one by one:

1) “Can we use the BP and HK analytical solutions when both streambed convection and conduction are upward?” First, the criteria used to answer this question are not clear. For example, the authors state that “flux estimates over the entire vertical streambed column can be within one order of magnitude of the numerical model under some conditions.” Do the authors consider “within an order of magnitude” to be acceptable? And more importantly, what are the “some conditions” under which the estimates were acceptable? Both the criteria used to evaluate the analytical solutions, and the conditions under which the solutions were acceptable, should be made more clear and more quantitative.

On a related note, it would seem that there would be some threshold upward temperature gradient above which the analytical solutions would not be satisfactory. However, I am not sure that testing only two temperature gradients (0 and 7 deg C) as the authors have done can adequately address this issue. Why did the authors not repeat these calculations for a range of temperature gradients? I would recommend such an exercise before publication.

2) “How important are the sampling depths under these conditions?” In the conclusions, the authors state that “temperatures at intermediate depths in the sediment column provided necessary information on heat transport and water flux through the sediments.” But it is not clear what is meant by “intermediate” – does this simply mean that more than one temperature sensor is needed? If so this doesn’t tell us anything about the depths that should be required. The authors also mention the well-known “need for consideration of sensor spacing and selection in determining flux through streambed sediments,” but it is not clear what new information or insight this study provides with respect to this consideration. For example, how deep do the sensors need to be? The answer to this important question is not clear.

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3) “How do results from each of these analytical models compare to the numerical estimates under these conditions?” While this is the most straightforward of the three questions, it seems to me to be a restatement of the first question. I would recommend combination of the two.

Minor points:

P4312, L3: define RMSE when first used

P4314 L10-11: “Surface water discharge during this period was 10.60 $\pm$ 0.38 m3 s$-$1” Please cite the source of this value.

P4316 L14-15: “Mean differences in fluxes between Hydrus and BP3 was 0.01 deg C and even less for BP2.” This is confusing – are you comparing fluxes or temperatures?

P4320 L5: Does it have to be “hyporheic” flow? Wouldn’t non-vertical discharging groundwater cause the same problem?

P4320, L28 to P4321, L12: This summary of previous work doesn’t seem appropriate for the Conclusions section. I would recommend moving to the introduction.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 4305, 2012.