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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Active heat pulse sensing of 3D-flow fields in streambeds" *by* Eddie W. Banks et al.

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General comments The authors introduce a new device to measure flow in the hyporheic zone three depths with an active heat tracer experiment. The authors share sufficient knowledge about their device and the design choices. The device was first tested in a lab-environment with good results, after which it was used in a field case. I hereby recommend this article to be published, however I do have a comment on the formula used and a few suggestions.

Specific comments Equation 4 is the impulse response. To end up with a pulse response, Eq4 needs to be integrated over time to end up with a step response. Subtract a shifted step response from a not-shifted step response to end up with a pulse re-

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sponse. For example, see Bakker et al. 2015. The 3D step response, is quite difficult to derive, but is done by [Hunt 1983, Mathematical analysis of groundwater resources], see Equation 6.53, page 135. And is used in [Rau et al. 2012, Experimental investigation of the thermal dispersivity term and its significance in the heat transport equation for flow in sediments], Equation 13. Stretching an impulse response to a pulse response, can be done if the width of the pulse is much smaller than the response duration, which is not the case here I would say. The pulse width here is 1 minute and most of the dynamics/response appear within the first 10 minutes. Furthermore, the units on the right hand side of Equation 4 are in $^{\circ}Cs^{-1}$.

The effects of hydrodynamic dispersion are neglected/not mentioned throughout the entire analysis. There is plenty of research done that suggests that with these velocities, hydrodynamic dispersion does play part. Make sure it can be neglected before you neglect is. For example [Rau et al. 2012, Experimental investigation of the thermal dispersivity term and its significance in the heat transport equation for flow in sediments].

I would like to see a back-of-the-envelope calculation that the tank in the lab setup is sufficiently large and the boundaries do not affect the uniformity of the flow. Especially in the diagonal flow situation. This might end up being one or two lines of text in the article, but important.

Technical corrections

P2L4: What makes it challenging to determine the non-vertical component?
P2L16: Kind of vague, ‘more robust’ and ‘advanced analysis’. (there is a ‘the’ too much)
P2L28: R1, R2, and R3 are not listed as such in Figure 1.
P3L27: Pore flow velocity is never being calculated; there is no porosity in the entire formulation.
P4 Equation 3: Not needed perse

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P5 Equation 6: For the original formulation with the impulse response, the q_y and q_z could have been put directly in the exponent of the equation.
P6L5-7: Be more specific, rephrase. Also, see previous comment.
P6L11: Be specific which boundary condition you may variate.
P6 Equation 16: see first of the specific comments.
P7L1: some subscripts are italic and others not.
P9L27: boundary conditions in the tank to establish flow. The great advantage of having a lab setup is that all boundary conditions are under control. This should be an important aspect of that section.
P10L5:active heat pulse sensor. try to be consistent with the naming of the device.

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