

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

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**\*\*Note:** Reviewer questions are shown in black text, response to reviewers comments in blue text with changes in manuscript shown in red text in the attached pdf file.

Reviewer 1- J. Constantz This manuscript represents a very nice scientific piece of work, describing an innovative heat-tracing tool to track 3-D shallow groundwater flow that's especially useful in streams, but also useful such hydrologic settings as hillslopes with measurable shallow interflow (which the authors might consider mentioning in their final draft).

Good suggestion. Have added a sentence in the conclusion section: 'The concept and design of the active heat pulse sensing instrument could also be adapted to other

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hydrological research areas, including the measurement of shallow interflow along hillslopes and discharge from groundwater seeps and springs.'

Reviewer specific comments

1. This review assumes Eq. [6] thru [18] are correct, since this is not this reviewer's field of professional interest. The equations have been revised based on suggestions from reviewer 2.

2. A summary of the extensive use of down-hole thermal pulse techniques in groundwater flow studies should be included, focusing on these equipment, methods and results.

The authors did not focus extensively on the historical development of thermal pulse techniques as this was covered in greater depth by Lewandowski et al. 2011. The technique has been widely used in downhole applications, particularly with the use of distributed temperature sensing and a number of references have been referred to in the manuscript. To keep the focus of the paper on examining the 3D flow processes in the streambed and the design of the instrument, the authors do not see that it is necessary to provide any further additional summary of down-hole thermal pulse techniques within the literature review.

3. Discussion in this manuscript jumps from 1-D to 3-D streambed flow patterns, without any mention of several good 2-D studies using heat as a tracer, such as, Constantz et al. (WRR, 2013) and Constantz et al. (WRR, 2016).

Yes. Good point. We wanted to highlight the contrast between the interpretation of 1D and 3D data. 3D data is also often distilled down to a 2D array when there is a dominant horizontal direction of flow. Reference to the use of vertical temperature profiles along transects to examine 2D flow fields in the streambed has been included in the revised manuscript.

Added to the introduction section (P1L30): 'Series of vertical temperature profile sticks

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installed along transects have also been used in other studies to examine 2D flow fields in the streambed (Constantz et al., 2013; Constantz et al., 2016; Shanafield et al., 2010).'

4. Finally, all the figures are very nice; however, in Figure 3, visually it's unclear why there is upward flux in the specific drawing to represent this direction of flow, which requires a significant hydraulic head to create this flow pattern. Is it possible to show this in the figure itself, in addition to explaining in the text?

In Figure 3 there are subtle differences in the arrangement of the sand tank arrangement for the different flow scenarios. The upwards flux scenario (Figure 3c) is different to the downwards flux scenario (Figure 3d) by where the water enters and exits the tank as described by the words in the figure with "inflow" and "outflow" at the top and lower boundaries. Figure 3 (c) is upwards as water enters via the inlet at the tank base and exits at the top boundary via the constant head overflow points (the upwards head gradient was maintained via a hose attached to the inlet at the base of the sand tank); on the other hand, Figure 3 (d) is downwards with flow entering across the top boundary and exiting via the outlet at the tank base. Arrows and additional text have been added to the figure to provide some further clarity.

Please also note the supplement to this comment:

<https://www.hydrol-earth-syst-sci-discuss.net/hess-2017-582/hess-2017-582-AC1-supplement.pdf>

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2017-582>, 2017.