

***Interactive comment on* “Characterization of spatial heterogeneity of groundwater-stream water interactions using multiple depth streambed temperature measurements at the reach scale” by C. Schmidt et al.**

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Review of: Characterization of spatial heterogeneity of groundwater-stream water interactions using multiple depth streambed temperature measurements at the reach scale C. Schmidt, M. Bayer-Raich, and M. Schirmer

1. General comments

This paper presents a study of groundwater surface water interactions interpreted by matching a 1D analytical model for advective-diffusive heat transfer to observed shal-

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low temperature profiles along a 200m stream reach. This topic is of current wide interest to both hydrogeologists and surface water scientists and should be of interest to many readers of HESS. Although the use of temperature profiles to estimate fluxes is not new, and the streambed is artificial, the application at this scale and to this level of detail is novel. The background references are up to date and thorough, and the approach is technically sound and well explained. The limitations of their approach are acknowledged. The results are interesting in that they show temperature and flux heterogeneity at smaller scales than previously reported. The paper is very well written and the figures are generally good (see technical corrections below).

## 2. Specific comments

1. In Section 3 (Study Site), the gradient and flux within the stream should be given as this may be relevant to the discussion of hyporheic flow.

2. Would it be possible to superimpose air temperatures onto Fig. 3? It may be useful as reference is made to them in the text. Also, is there enough temporal data in the groundwater aquifer temperature measurements to plot here as well? (even if they remain near-uniform)

3. In Figure 6, the fit for these three groundwater discharge zones looks good; could the fit for a recharge zone also be provided?

4. In the Conclusions, the authors highlight the fact that although the streambed is artificial, there is still a high degree of spatial heterogeneity in the temperature/flux data. Could the authors comment on whether this might indeed be due to heterogeneity in the streambed, or perhaps (also, or more likely) a reflection of deeper heterogeneity and discharge zones within the aquifer?

## 3. Technical corrections

1. There is a mixture of temperature units in the paper between C and K (e.g. section 1425 lines 12-16). I suggest using C for all units.

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2. The sign convention for groundwater flux changes from positive downward (e.g. Fig. 2 and Eq. 1-5), to positive upward (e.g. Table 1, Fig. 4, S1429 line 2 etc.). This should be made consistent throughout the text and equations, to avoid confusion between groundwater discharge to the stream or stream discharge to the groundwater (I suggest positive upward). Similarly, for equations 1-5, the length coordinate  $z$  should be identified as being positive downward, if this convention is kept.
3. In the abstract, use of the phrases "can be correlated" and "can then be estimated" should be avoided. Better to use the active voice and say what was actually done. (e.g. "are correlated" and "are then estimated")
4. The first reference for Fig. 6 (section 1430 line 23) appears after the first reference for Fig. 7 (section 1429 line 9).
5. Section 1420, line 6, remove "Nevertheless"; this phrase does not contradict the previous one.
6. Section 1422 line 13: "Schachtgraben channel" (to clarify what this is, since this is the first reference to it, and is not described in detail until the end of the paragraph).
7. Section 1422 line 13: "For the past one hundred years"
8. Section 1423, line 25: add a reference to Fig. 2 at the end of this sentence as you are describing the monitoring system. Also, the existing reference to Fig. 2 (S1425 line 8) seems out of place as Fig. 2 shows the monitoring network but the paragraph is referring to time scales and temperature variations with depth.
9. S1425 line 16: "of the saturated solid-fluid system"
10. S1427 line 24-25: "Variations of streambed temperatures occur primarily along each reach"
11. S1428 line 7: "with the streambed temperatures of"
12. S1429 line 18: add comma: "maximum fluxes,"

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13. S1432 line 9: "periods where "
14. S1433 line 4: "were estimated by "
15. S1433 line 18: "surface water "
16. S1433 line 24: "that these locations be identified "
17. The font sizes in figures Fig. 4 & 6 seem too small.
18. In Fig. 4. the labels (a) and (c) are difficult to read, place them just above the temperature plots. Also, give the vertical exaggeration in the figure caption. The reader should be reminded that this is in fact a long and very thin profile. In the caption for Fig. 4, replace the "ands" with commas.
19. In Fig. 5, the length L is referred to both as a "Thickness" and "length". Perhaps "Depth" would be better, but should at least be consistent.

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