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Discussions

Interactive comment on "The effect of sediment thermal conductivity on vertical groundwater flux estimates" *by* Eva Sebok and Sascha Müller

Anonymous Referee #2

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Author comments

General comments: The manuscript "The effect of sediment thermal conductivity on vertical groundwater flux estimates" used measured profiles of sediment temperatures and bulk thermal conductivities (ke, using a KD2Pro thermal property analyser) with depth in two contrasting environments, and used these data in conjunction with HydroGeoSphere (HGS) and PEST to determine upwelling fluxes. The analyses investigated the use of the detailed ke profiles as well as homogeneous profiles on the resulting fluxes from HGS.

Overall, the manuscript was interesting to read, well written and clearly explained. The figures were also of a high quality.

Specific comments: The temperature-depth profiles are taken at a specific point in time. Presumably the profiles at a particular site were all taken within a short time frame? At any rate, the use of steady state temperatures is likely an additional source of uncertainty in these analyses. There is an equation presented in Briggs et al. (2014, JoH) that can be used to determine the propagation depth of a diurnal signal. This could be used to determine whether transience is likely to be influencing the temperature profile at each depth. Presumably the upper part of all profiles is not in steady state, especially the lower flux site. An investigation into the implications of this, and comments on the influence of transience in the temperature profiles would be useful.

There are a number of numerical modelling programs that are custom made to fit temperature data to determine fluxes (e.g. Munz and Schmidt, 2017 HP, Koch et al. 2015, GW). Is there any particular reason why HGS was used over these other approaches?

I think that the selected boundary conditions in the HGS simulations are also a major source of uncertainty/error. Rather than setting the water temperature at z = 0 and a deeper groundwater temperature, why not use the measured temperatures at the top and bottom of the profile as the boundary conditions? This would dramatically improve the fits on some of these profiles (e.g. P4, upper part of S4, P1, S7, H4). This will likely significantly change the resulting flux estimates. The large mismatch between observed and modelled data look to be a major source of uncertainty.

It would also be useful to see the T-z profiles from all (or more) of the sites. In particular, the low flux environments. Alternatively, a way to show the RMSE that goes with the values in Fig3 and Fig4 would help show whether poor fits are a major source of error or not.

Page 2 lines 6-7, there are also time series based methods for mapping fluxes (e.g. Lautz and Ribaudo 2012, HJ, Irvine and Lautz 2015 JoH).

Page 2, lines 24-25: The McCallum/Luce methods do not require thermal conductivity to estimate fluxes. They can also be used to determine thermal conductivity. i.e. these are two separate approaches. It is not immediately clear if this is what is meant in the first two sentences here.

Technical corrections: Page 9, lines 23-25: In the sentence about the paper from Duque et al, is this depth supposed to be 0 m?

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