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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 #1

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General comments: The paper presents an evaluation of the influence of vertical thermal conductivity variability on the estimates of vertical GW-SW exchange fluxes. The analysis and conclusion of the paper are based on depth-resolved measurements of saturated sediment thermal conductivities (ke) and the inverse modelling of observed sediemnt temperatures.

The paper is generally well written and presents original data. The authors discuss their findings in the light of the numerous other studies in the field of heat as a natural hydrologic tracer. While there are no ground-braking new results , the paper contributes to further constrain the uncertainties associated with thermal conductivity estimation in heat tracing studies.

Specific comments:

p.3. l.12-14. This sentence is redundant to the one in p.2. l. 31. , consider to remove/rephrase Section 4.1. The reported thermal conductivities of partially <0.6 W/m/K are lower than those of pure water. Could this be attributed to accidently unsatured conditions? Otherwise such low values seem very unlikely if not physically impossible in saturated sediments. The low values should be discussed in Section 5.2.

Section 4.2. and Fig. 3. The measured temperature-depth profiles, including the cases with poor model fits, seem to reasonably represent a steady state case with upward water flow. I wonder if the depth of the domain (only 1m) and the selected lower temperature boundaries are really appropriate. My impression is that the boudary conditions are too rigid to provide a good fit. For example: in Fig. 3 - P1 the lower temperature boundary seems too low. Maybe extend the model domain to greater depths or use the lowest temperature measurements as boundary condition.

p.7.l.18 and following. ke and vertical water fluxes(qz) are related. In steady-state 1D, homogeneous conditions there should be functional relationship between qz and ke. I suggest to present the results along the theoretical relationship. Then it would also be possible to evealuate/visualize the effect of heterogeneous vs homogeneous ke

p.8. l.21-28. Maybe the limited spatial resolution of the measurements calls for a geostatistical approach, similarly to generation hydraulic conductivity fields, to come up with spatially continuous scenarios of ke. Maybe briefly discuss this option.

p.9. l. 21. Does ke really increase with grain size? If porosity and the sediment material do not change one would expect ke to be constant (if one assumes that ke of the water-sediment mixture can be modelled by the volume fractions and the thermal conductivities of water and sediment grains). An alternative explanation for the observation could be that the shallow sediments are less consolidated and have a higher porosity which could explain the lower thermal conductivity. I think, as porosity was not measured, the porosity-dependence should be mentioned and dsicussed.

Technical comments:

p.5 l.4. better "within" instead of "in"

Figure 1. Add a scale to the insets in b and c

Figure 4. Cases should be "thermal conductivity" not diffusivity

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