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Quantification of groundwater-stream water interactions based on temperature depth profiles under strong upwelling conditions in a sand-bed stream

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The quantification of groundwater-surface water interactions is not only required for budgets but also for an understanding of the complex relations between hyporheic exchange flows (HEF) and the associated chemical and biological processes that take place in hyporheic zones (HZ). Thus, there is a strong need to improve methods for flux estimation.The present study aims to quantify the vertical fluxes across the riverbed from data of temperature depth profiles recorded at the River Schlaube in East Brandenburg, Germany. In order to test the capabilities and limitations of existing methods, fluxes were calculated with an analytical (VFLUX, based on the amplitude attenuation and phase shift analysis) and a numerical (1DTempPro, parametrization based on observed values) approach for heat conduction. We conclude that the strong limitations of the flux estimates are caused by thermal and hydraulic heterogeneities of the sediment properties. Consequently, upscaling of fluxes must include other thermal techniques able to portray the spatial variability of thermal patterns, along with further developments of methods to link thermal depth profiles, thermal patterns of the surface of the streambed and all the other factors involved. Considering time and costs of temperature depth profiles of riverbeds, and the need for multiple devices to cover larger areas, it is additionally tested whether vertical fluxes can be infered from the uppermost temperature sensors of a data set. That would ease hyporheic investigations at larger scales.