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Time-Series Analysis of Natural Tracers: Comparison of Electrical Conductivity and Temperature in Different Frequency Ranges

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Natural tracers can be used for quantification of exchange fluxes between surface waters and groundwater. Especially temperature has become a widely-used parameter due to progress in sensor technique and data loggers. Compared to solute mass, heat is retarded. The retardation depends on porosity, heat capacity and heat conductivity of the saturated riverbed sediments. As the porosity and mineral composition of the sediments can only be roughly estimated, the retardation factor remains uncertain.
Electrical conductivity (EC) is a valuable amendment to temperature in losing river systems, if distinctive fluctuations exist. EC is an easy to measure parameter, but it is not conservative due to mineralization processes and cation exchange in the aquifer. However, the propagation of the EC signal into the aquifer reflects solute transport. We present results of a study on bank filtration at a test site in northeast Switzerland. The field site has been established by the RECORD Project (Assessment and Modeling of Coupled Ecological and Hydrological Dynamics in the Restored Corridor of a River (Restored Corridor Dynamics)); it is located at a channelized and a restored section of the prealpine losing River Thur. We analyze time series of temperature and EC in the river and riparian groundwater wells to quantify travel times. Both signals show variations on various time scales, which we analyze by different methods. For the diurnal and seasonal signal, sinusoidal functions are fitted to the data and the time shifts are determined. Cross-correlation and non-parametric deconvolution methods are used to calculated mean travel times and mixing ratios from filtered data sets without diurnal and seasonal signal. The comparison of the travel times of temperature and EC shows that the retardation of the temperature signal varies in space.