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Impacts of non-uniform flow conditions on stream aquifer exchange flux estimates made using streambed temperature time series and vertical head gradients

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The use of inverse 1-D analytical methods for estimating vertical stream-aquifer exchange flux is now commonplace. However, the application of such simple models can lead to significant errors in estimates of vertical exchange flux where the model assumptions are violated in real systems. An idea that is gaining acceptance in the literature is that the presence of non-vertical flow is such a violation. However, it is shown here that non-vertical flow by itself won't necessarily lead to errors in vertical flux estimation but rather that significant errors can stem from non-uniform (convergent/divergent) flow fields and/or hydrodynamic dispersion even within uniform flow fields. Non-uniform flow may also be expected, in some cases, to create discrepancies between flux estimates made on the basis of vertical head gradient measurements and those made using 1-D analytical heat tracer methods.