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Geostatistical Inversion under Transient Flow Conditions

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The assessment of hydraulic aquifer parameters is important for the evaluation of anthropogenic impacts on groundwater resources. The distribution of these parameters determines flow paths and solute travel times and is therefore critical for the successful design and deployment of remediation schemes at contaminated sites.

The geostatistical approach characterizes these hydraulic parameters without predetermined zonation. We present an extension of the existing inversion methods to instationary flow regimes, using adjoint equations to efficiently estimate the hydraulic parameters. This facilitates the treatment of applications with variable boundary conditions (nearby rivers, precipitation). As the computing time of our approach is largely independent of the number of measurements used for inversion, the presented method can be applied to large data sets, e.g. high-resolution time series.

We integrate the geostatistical inversion method into the software framework DUNE, enabling the use of high-performance-computing techniques and full parallelization. The method is implemented as a flexible framework, allowing for easy addition of measurement variables and their governing equations. As a proof of concept the method is applied to pregenerated random parameter fields by computing the data an experiment would yield and using these values as input, resulting in an approximation of the original parameter field. A comparison of the new method with existing geostatistical inversion approaches highlights its advantages and drawbacks and demonstrates scenarios in which our scheme can be beneficial.