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Transient inverse groundwater flow modelling using Random Mixing and Multiple-Point Statistics

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The conditioning to measurement data by inverse modelling techniques aims to reduce the inherent estimation uncertainty of flow and transport predictions. Besides conditioning to hydraulic head measurements, especially in geological formations with contrasting facies of highly different hydraulic conductivities, conditioning to concentration data (e.g. resulting from tracer tests) may improve the estimation of spatially variable aquifer properties like hydraulic conductivities (K).
In general the aim of inverse groundwater flow modelling is to obtain fields:

1. with prescribed spatial variability
2. with the observed values of the variable of interest at the observation locations (maybe also at different spatial scales)
3. with observations (hydraulic head, concentration) coupled through the model.

Those goals are achieved using inverse modelling by random mixing. This method uses a high dimensional geometric concept to generate conditional random fields as a weighted sum of unconditional fields. The idea of the inverse modelling approach is to generate fields that fulfill the first and the second conditions so that these fields form a connected domain which has a continuous parametrization. Then the third condition can be handled by optimization inside the above described connected domain. If no sufficient solution can be obtained the dimensionality of the problem is increased by enlarging the continuous domain and the optimization is continued. To include curvilinear features in the spatial distribution of K, the methodology can be coupled with a multiple-point geostatistics approach.
To illustrate the performance a synthetic test case example is applied.