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Benchmark scenarios and invitation to participate to a community-wide benchmarking effort for stochastic inverse modeling of groundwater flow

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Geostatistical inversion refers to the problem of evaluating optimal estimates of spatial distributions for (typically hydraulic) properties, often associated with quantified uncertainty. Several methods are available in this context, each being characterized by a given set of assumptions, approximations and numerical implementations. Only a few intercomparison studies have been performed (in the remote past) amongst diverse approaches. Notably, these studies are grounded on comparisons among approximate methods, in the absence of firm reference solutions.

This makes comparison of best estimates and uncertainties a matter of expert guessing: statements such as "good solutions should resemble the artificial-truth scenario used to produce the test case" and "estimation variance should be as small as possible" do not reflect the true character of geostatistical inversion. Instead, the information content associated with data to be employed in the inversion process should be used candidly and processed accurately. In this context, it is clear that comparison studies guaranteeing a broad participation form a solid basis to push forward research efforts of the entire geostatistical inversion community. As an example of the power of clearly defined test cases, we recall the SPE-10 set of test cases, which is widespread across the petroleum engineering community. We strive at proposing an agreed-upon set of benchmarking cases with accurate reference solutions for the inverse problem to assist the entire community and form the basis for accurate and critical testing and comparison of methods.

Our current initiative defines benchmarking scenarios for geostatistical inversion targeted to a community-wide use as test cases and intercomparison scenarios. Learning from past experience, we will provide highly accurate reference solutions produced with massive high-performance computing and with latest MCMC-type solution algorithms for high-dimensional, non-linear Bayesian inference.

These techniques and reference solutions will be presented in a series of conference contributions. Here, we emphasize the need for a community-wide set of benchmarking cases, illustrate details of our designed benchmarking scenarios (final tuning and refinement being foreseen upon feedback from the community), and initiate a community discussion on appropriate sets of benchmarking metrics. We invite all interested researchers to download the publicly available benchmarking data (once available) for their personal and between-group use as standard cases for testing and comparison and promote participation to a dedicated workshop we will organize.