Efficient simulation of (log)normal random fields for hydrogeological applications

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Abstract

In hydrogeological investigations involving flow and transport in heterogeneous porous media, the spatial distribution of saturated hydraulic conductivity is often parameterized in terms of lognormal random field models linked to multivariate (log)normal probability distributions. Realizations or samples from such random fields (simulated conductivity values in 2D or 3D) are then used in a Monte Carlo framework along with physically-based models of flow and transport to quantify, for example, the uncertainty in the spatial distribution of solute concentration due to the uncertainty in the spatial distribution of hydraulic conductivity. The first part of this talk illustrates the conceptual links between classical simulation or sampling from a multivariate Gaussian distribution and the random placement of points on the surface of hyper-ellipsoids. Two simulation methods, multivariate Latin hypercube and stratified likelihood sampling, are then discussed for the purpose of representative sampling; i.e., for the task of generating realizations that span efficiently the range of possible attribute values corresponding to the multivariate (log)normal probability distribution. Last, the efficiency of these two simulation methods in comparison with simple random sampling is evaluated via a synthetic case study involving 2D flow and transport in a heterogeneous medium.