Geophysical Research Abstracts, Vol. 9, 01197, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-01197

Simulation of random fields with non-Gaussian dependence

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As flow and transport simulations are often used for environmental risk assessment (for example the contaminant plume underground) and the flow behavior is considerably influenced by the spatial structure of heterogeneous hydraulic conductivity fields, it is of vital importance to clarify the role of spatial dependence structures for the estimation of flow and transport. In the traditional spatial simulations, a multivariate lognormal distribution is often assumed for the conductivity fields, which contradicts the heavily tailed marginal distribution of conductivities in reality. Moreover the sole descriptor for spatial dependence which is used by the multi-Gaussian assumption fails to characterize the often occurred deviation from the central tendency. Therefore there is a need for new non-Gausssian simulation methods and hence for new types of random functions.

Recently, copulas have been evoking considerable interest in financial mathematics because they provide an innovatory way of modeling the dependence structure between variables. Our research is carried out to develop new families of random functions with distinctly non-Gaussian properties for spatial simulations of hydraulic conductivities.

In the presentation, at first, a brief introduction for the concept of copulas will be given. Then the methodology of using copulas to investigate spatial variabilities will be presented. After that, several random fields of hydraulic conductivity with arbitrary marginal distributions and a given copula will be demonstrated and compared. Finally, the application of the simulation method to a selected flow problem and comparison of combinations with different marginal distributions and copulas will be discussed as an outlook for the future work.