Quantifying Uncertainty in Complex Groundwater Flow Models

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Summary

Despite the intensive research over the past decades in the field of stochastic subsurface hydrology, our ability to analyze and model heterogeneous groundwater systems remains limited. Most existing theories are either too restrictive to handle practical complexity or too expensive to be applied to realistic problem sizes. In this study we present a hybrid nonstationary spectral method for predicting uncertainties in complex groundwater flow models. This method, based on solving stochastic perturbation equations, involves two major computational steps after the deterministic mean flow equation is solved. We first apply a set of closed form formulas to predict the nonstationary variances for the entire modeling area. Then we employ first-order numerical spectral method to correct the "regional" solution in localized areas where the variance distribution is highly nonstationary (e.g., around inner boundaries and strong sources/sinks). The boundary conditions for the local numerical solutions are based on the closed form formulas and are implemented on an as-needed basis in a real-time visual software system called Interactive Ground Conceptual representation (IGCR).

Nonstationary and Unsteady Modeling of Velocity Variances in Confined/Unconfined Aquifers in the Presence of Complex Sources and Sinks

Nonstationary Spectral Method

Monte Carlo Simulation Nr=10000

Nonstationary Spectral Method

Monte Carlo Simulation Nr=5000

Approximate Spectral Method

Nonstationary Spectral Method

Monte Carlo Simulation Nr=10000

Case 1- Single Well

Case 2- Complex Trend with Sources/Sinks

Hybrid Spectral Method

An Integrated Software Environment for the Hybrid Spectral Method

The software environment allows users to define the local correction areas interactively.

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