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A Geostatistical Scaling Approach for the Generation of Non Gaussian Random Variables and Increments

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We address manifestations of non-Gaussian statistical scaling displayed by many variables, Y, and their (spatial or temporal) increments. Evidence of such behavior includes symmetry of increment distributions at all separation distances (or lags) with sharp peaks and heavy tails which tend to decay asymptotically as lag increases. Variables reported to exhibit such distributions include quantities of direct relevance to hydrogeological sciences, e.g. porosity, log permeability, electrical resistivity, soil and sediment texture, sediment transport rate, rainfall, measured and simulated turbulent fluid velocity, and other. No model known to us captures all of the documented statistical scaling behaviors in a unique and consistent manner.

We recently proposed a generalized sub-Gaussian model (GSG) which reconciles within a unique theoretical framework the probability distributions of a target variable and its increments. We presented an algorithm to generate unconditional random realizations of statistically isotropic or anisotropic GSG functions and illustrated it in two dimensions. In this context, we demonstrated the feasibility of estimating all key parameters of a GSG model underlying a single realization of Y by analyzing jointly spatial moments of Y data and corresponding increments. Here, we extend our GSG model to account for noisy measurements of Y at a discrete set of points in space (or time), present an algorithm to generate conditional realizations of corresponding isotropic or anisotropic random field, and explore them on one- and two-dimensional synthetic test cases.