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Geostatistical representation of multiscale heterogeneity of porous media through a Generalized Sub-Gaussian model

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Characterization of spatial heterogeneity of attributes of porous media is critical in several environmental and industrial settings. Quantities such as, e.g., permeability, porosity, or geochemical parameters of natural systems are typically characterized by remarkable spatial variability, their degree of heterogeneity being typically linked to the size of observation/measurement/support scale as well as to length scales associated with the domain of investigation. Here, we address the way stochastic representations of multiscale heterogeneity can be employed to assess documented manifestations of scaling of statistics of hydrological and soil science variables. As such, we focus on perspectives associated with interpretive approaches to scaling of the main statistical descriptors of heterogeneity observed at diverse scales. We start from the geostatistical framework proposed by Riva et al. (2015), who rely on the representation of the heterogeneous structure of hydrological variables by way of a Generalized Sub-Gaussian (GSG) model. The latter describes the random field of interest as the product of a zero-mean, generally (but not necessarily) multi-scale Gaussian random field (G) and a subordinator (U), which is independent of G and consists of statistically independent identically distributed non-negative random variables. The underlying Gaussian random field generally displays a multi-scale (statistical) nature which can be captured, for example, through a geostatistical description based on a Truncated Power Variogram (TPV) model. In this study we (*i*) generalize the original GSG model formulation to include alternative distributional forms of the subordinator and (*ii*) apply such a theoretical framework to analyze datasets associated with differing processes and observation scales. These include (*i*) measurements of surface topography of a (millimeter-scale) calcite sample resulting from induced mineral dissolution and (*ii*) neutron porosity data sampled from a (kilometer-scale) borehole. We finally merge all of the above mentioned elements within a geostatistical interpretation of the system based on the GSG approach where a Truncated Power Variogram (TPV) model is employed to represent the underlying correlation structure. By doing so, we propose to rely on these models to condition the spatial statistics of such fields on multiscale measurements via a co-kriging approach.

References

Riva, M., S.P. Neuman, and A. Guadagnini (2015), New scaling model for variables and increments with heavy-tailed distributions, Water Resour. Res., 51, 4623-4634, doi:10.1002/2015WR016998.