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Impact of connectivity properties of soil on effective parameters for Richard's equation

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Upscaled models and uncertainty predictions are often based on a stochastic approach. Such models mostly include second order statistical moments of the parameter fields (i.e. variance and correlation length) only to characterize heterogeneity. However, only Gaussian fields are sufficiently characterized by these parameters. Several authors have recently suggested, that geometric parameters of the field (such as two-point cluster functions calculated from indicator fields of the parameter fields, but there are many possibilities) should be considered for characterization of heterogeneity (e.g. Western et al. 2001).

In this contribution we want to illustrate the influence of such geometric properties of the soil parameter field on effective parameters for water infiltration in the unsaturated zone. To do this, we derive an upscaled form of Richard's equation in a periodic and continuous permeability (and capillary entry pressure) field using homogenization theory. We analyze the case of slow flow processes. The upscaled equation has the same shape as the original Richards equation, but has effective parameter functions for the relative permeability and the retention curve. These effective parameter functions can easily be calculated numerically for any periodic field.

We then consider a unit cell as a Gaussian stochastic field. We apply a Brooks Corey formulation for the local parameter functions. For this case the statistically averaged effective parameter functions can be calculated analytically, provided that capillary forces dominate the flow on the small scale. The analytical results are compared to numerically calculated parameter functions for test fields with different geometric pa-

rameters. We use fields generated from Gaussian fields with a Gaussian covariance, where the connected parts of the fields (which are in the intermediate parameter range for a Gaussian covariance) have been shifted to the high end or to the low end of the parameter range using the method of Zinn and Harvey, 2003. All test fields would not be distinguishable from their second order statistical moments, but differ clearly in their higher moments and their connectivity properties. The effective permeabtility curves exhibit considerable differences for these three fields.

We could recover the relevant information about the connected zones from two-point correlation functions of the indicator fields. This kind of information has an important influence on the effective parameter functions for water infiltration in the unsaturated zone.

References:

A. Western, G. Bloeschl and R.B. Grayson, 2001: Toward capturing hydrologically significant connectivity in spatial patterns, Water Resour. Res. 37(1): 83-97

B. Zinn and C.F. Harvey, 2003: When good statistical models of aquifer heterogeneity go bad: A comparison of flow, dispersion, and mass transfer in connected and multivariate Gaussian hydraulic conductivity fields. Water Resour. Res. 39(3):1051, doi10.1029/2001WR001146