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Low percolation threshold found in correlated random media

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Patterns and connectivity in random, heterogeneous or composite media affect many physical and geologic flow and transport phenomena. In physics, so-called percolation properties have been studied mostly on uncorrelated random fields. Yet, environmental and many engineered systems are inherently correlated in space. A key measure of connectivity in these system is the so-called percolation threshold, p_c, which is known to be 31.16% in uncorrelated media. Our work shows that the percolation threshold in correlated random fields (e.g., aquifers) is only 12.6%, significantly lower than in the uncorrelated random fields. The percolation thresholds are similar for Markov chain, sequential Gaussian, and indicator random fields. The threshold is also a function of the system-size (finite-size effects) and of the correlation scale (relative to the resolution of the random field), decreasing with increasing correlation scale. Appropriate grid resolution and choice of simulation boundaries are shown to be critical to properly simulate connectivity in correlated natural geologic systems, which often have a finite extend.