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Percolation and filtration properties of multiscale soil models: existence of critical pore sizes

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We present a review of previous research work conducted to quantify the connectivity of pore networks as regards fluid flow and filtration processes of contaminants in porous media. In a recent paper (Perrier, Bird, and Rieutord, Biogeosciences 2010), we showed that the link between the distribution of pore sizes and the distribution of the size of entities which can be trapped inside soil has to be complemented by information on a Critical Filtration Size (CFS) delimiting the transition between percolating and non percolating regimes in multiscale pore networks. These results are first based both on theoretical arguments, by exhibiting renormalisation functions generalizing percolation theory in random network to multiscale hierarchical networks (Bird and Perrier, Geoderma 2009). Numerical experiments on 2-D and 3-D fractal media confirmed the qualitative theory. On-going modelling work addresses the possibility of building reliable soil structural models, accounting for observed relationships between pore and solid size distributions, between soil stability and soil conductivity, by means of the comparison of the renormalization functions associated with the classical mass fractal model and the PSF model (Perrier et al., 1999; Bird et al., 2000).