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# Stochastic reconstruction of structural connectivity and hydrological response in random heterogeneous media

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**Abstract**

Flow and transport in heterogenous media is determined by its structure. Beside spatial correlation, especially the connectivity of heterogeneous conductivities is acknowledged to be a key factor for the hydrological response. This has been demonstrated for well defined random fields having different topological properties. Yet, it remains an open question which morphological measures carry sufficient information to actually predict flow and transport behavior of the domain.

We analyze flow and transport in two types of classical, two-dimensional random fields (multigaussian and non-multigaussian) showing different topology. These serve as reference heterogeneity models. We determine a selection of structural characteristics from the reference media including classical two-point statistics (autocovariance), chord-length distribution and Minkowski functions (four-point statistics) including the Euler number as a topological measure. Using the approach of simulated annealing for global optimization we generate analog random fields that are forced to reproduce one or several of these structural characteristics of the reference media. This stochastic reconstruction procedure allows us to investigate an ensemble of realizations through global optimization where the structural characteristics are given *a priori* without any additional restriction. Finally we evaluate in how far the generated analogons reproduce the original flow and transport behavior as well as some more elaborate structural characteristics including percolation probabilities and the pair connectivity function.

The results confirm that two-point statistics is insufficient to capture functional properties since it is not sensitive to connectivity. In contrast, the combination of Minkowski functions and chord length distributions carries sufficient information to reproduce the breakthrough curve of a conservative solute. Hence, global topology provided by the Euler number together with local clustering provided by the chord length distribution seems to be a powerful condensation of structural complexity with respect to functional properties.

## References

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