Reproducing the small-scale variability of a transmissivity field by embedding direct-inversion methods in multiple-point geostatistics

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Introduction

Parameter estimation represents one of the critical steps in every modeling workflow. Among the techniques proposed to tackle this problem, direct inversion methods are appealing because they are faster than indirect methods by some order of magnitude. Nevertheless, they cannot reproduce the small-scale variability of the parameters fields because they rely upon information, like for example hydraulic head measurements h, that represents only the long-wavelength components of the parameter field.

In this work we apply a direct inversion method, the Comparison Model Method (CMM) [1], which is used to estimate the long-wavelength components of a transmissivity field T. The CMM is used in conjunction with a geostatistical simulation method, multiple-point geostatistics (MPG) [2], which is based on the concept of training image (TI) [3]. The TI is a conceptual model containing the heterogeneity patterns that could be found in a given geological environment (akin to the site under investigation) and that contains all the components of the expected heterogeneity. The long-wavelength T field, estimated with the CMM using the reference h fields estimated on measurements and other information from the conceptual model, is used as an auxiliary variable in the MPG simulation. This allows injecting into the MPG simulation additional site-specific information. The procedure can be iterated to improve the agreement with the measurements.

The T field resulting from this hybrid-inversion procedure contains the short-wavelength components that cannot be reproduced by direct inversion methods alone. In addition, multiple realizations of the estimated T field can be obtained using different random seeds.

Both the advantages and the disadvantages of the proposed procedure lie in the usage of a TI image. The TI allows including useful soft information in the inversion procedure, but at the same time represents a strong a priori assumption.

References

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