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Geological storage of CO_2: sensitivity analysis and risk assessment using arbitrary polynomial chaos expansion

M. Ashraf (1,2), S. Oladyshkin (), and W. Nowak ()

(1) Universit of Bergen, Norway (meisam_ashraf@yahoo.com), (2) University of Stuttgart, Germany (Sergey.Oladyshkin@iws.uni-stuttgart.de), (3) University of Stuttgart, Germany (wolfgang.nowak@iws.uni-stuttgart.de)

Geological storage of CO_2 is a proposed solution for fighting the climate change. The considerable costs and potential hazards of the technique requires feasibility studies to assess all possible risks embedded in the process. Modeling of CO_2 storage, requires working with large time and space scales, which in practice are accompanied by huge geological uncertainties.

In this work, we practice a study of geological CO_2 storage for injection and early migration time. A typical CO_2 injection scenario is implemented on a set of geological realizations. A number of uncertain parameters are chosen with an assumed knowledge of probability. A framework based on arbitrary polynomial chaos expansion is used for projection of flow responses on high-dimensional orthonormal polynomial bases, which forms a so-called response surface. This approach works with arbitrary probability knowledge and treats available input data directly without additional assumption on shape of uncertainty distribution.

Sensitivity analysis is used to rank the model parameters by their influence in the modeling outcome. For global sensitivity analysis we use Sobol indices which are robust for a general problem in terms of non-linearity and complexity. The reduced model represented by the response surface is vastly faster than the full original model and used for probabilistic risk assessment via Monte-Carlo post-process.