# Uncertainty Quantification in Porous Media with Multi-Level Monte Carlo

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**ABSTRACT**

Geological storage of $CO_2$ is an attempt at controlling future climate changes. Modelling and simulation of underground $CO_2$ storage are however subjected to significant sources of geological uncertainties, which requires the use of stochastic approaches. Sources of uncertainties in the $CO_2$ storage problem can be classified as either geological, physical, or operational uncertainties. Ranking the importance of the model parameters based on their influence can provide a better understanding of the system. Computationally efficient methods for sensitivity analysis, uncertainty quantification, and probability risk assessment are therefore needed. Furthermore, due to the computational complexity of such problems, as even a single deterministic simulation may require parallel high-performance computing, stochastic simulation techniques based on standard Monte Carlo are currently inefficient for these problems. To overcome the prohibitive computational cost of standard Monte Carlo, we propose a Multi-Level Monte Carlo technique to estimate statistical quantities of interest within some prescribed accuracy constraint. We illustrate and verify our proposed approach by a comparison with a Monte Carlo simulation using a common benchmark problem for $CO_2$ injection. We obtain a significant computational speed-up compared with Monte Carlo.