UNCERTAINTY QUANTIFICATION OF THE CO2 STORAGE SYSTEM FOR A HYPOTHETICAL GCS PROJECT IN THE SOUTHERN SAN JOAQUIN BASIN IN CALIFORNIA

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This work presents an uncertainty quantification (UQ) study on CO_2 sequestration, using a high-resolution basin-scale model. The model was developed for a hypothetical industrial-scale storage project in the Southern San Joaquin Basin in California, USA. The geological structure and hydrogeological parameters of various subsurface layers were determined from field data originally assembled for a planned CO2 pilot project in the area. We used the massively parallel version of TOUGH2 to simulate CO2/brine migration and pressure buildup within the CO2 storage formation and overlying/underlying units. This model provided us with a unique opportunity to investigate the impact of hydrogeological parameters and their uncertainty on various performance measures of the CO2 storage system in a realistic setting.

We first performed Monte-Carlo simulations based on the estimated/prescribed parameter distributions to quantify uncertainty in multiple performance measures such as pressure buildup, CO2 plume extent, and brine flux at the reservoir boundary. We perturbed the two-phase parameters (i.e., van Genuchten parameters) as wells as single-phase parameters (i.e., permeability, porosity and compressibility) in the storage reservoir and caprock. We then computed the sensitivity of each parameter to multiple performance measures. In addition to the magnitude of sensitivity for identifying the most significant parameters, we interpreted the directional component of sensitivity for understanding the interaction among different performance measures. To address the computational issues of UQ associated with such a large-scale model, we also compared several alternative sensitivity analysis methods, including local sensitivity, Morris' one-at-a-time method, and Saltelli's method, in terms of their computational requirements and interpretation.