Abstract

**Optimal monitoring design for uncertainty quantification during geologic CO2 sequestration: A machine learning approach**

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An effective monitoring design is crucial to ensure the safe and permanent geologic storage of CO2. Optimal monitoring design involve an optimal placement of monitoring wells, and optimal monitoring measurement data (pressure, CO2 saturation, temperature, etc.). We developed a filtering-based data assimilation approach to design an optimal monitoring strategy for well placement and monitoring data design. To efficiently solve the optimization problem and reduce computational costs, Artificial Neural Networks are used to develop computationally efficient reduced-order models based on full-physics numerical simulations of CO2 injection in saline aquifers. We demonstrate our approach in two scenarios of CO2 leakage through legacy or abandoned wellbores where an optimal monitoring strategy are devised to reduce the uncertainty in cumulative CO2 leakage in the geologic CO2 sequestration (GCS) site. The optimal monitoring design resulted in an uncertainty reduction in the cumulative leakage of CO2 of approximately 73% and 62% in each case, respectively. The proposed approach is efficient in developing monitoring designs under geologic uncertainty and enables safe geologic carbon sequestration operations.