Simplified Predictive Models for CO_2 Sequestration Performance Assessment

Award Number: DE-FE0009051

Project Summary:

The objective of this research project was to develop and validate a portfolio of simplified modeling approaches for carbon dioxide (CO_2) sequestration in deep saline formations – based on simplified physics, statistical learning, and/or mathematical approximations – for predicting: (a) injection well and formation pressure buildup, (b) lateral and vertical CO_2 plume migration, and (c) brine displacement to overlying formations and the far-field. Such computationally efficient alternatives to conventional numerical simulators can be valuable assets during preliminary CO_2 injection project screening, serve as a key element of probabilistic system assessment modeling tools, and assist regulators in quickly evaluating geological storage projects. The research carried out under this project utilized three broad approaches: (a) simplified physics-based modeling, (b) statistical learning-based modeling, and (c) reduced order method-based modeling. Finally, an uncertainty and sensitivity analysis-based validation framework was used to compare the results of full-physics and simplified models from probabilistic simulations.

Prime Performer:
Battelle Memorial Institute

Key Performers:
Stanford University

Principal Investigator:
Srikanta Mishra

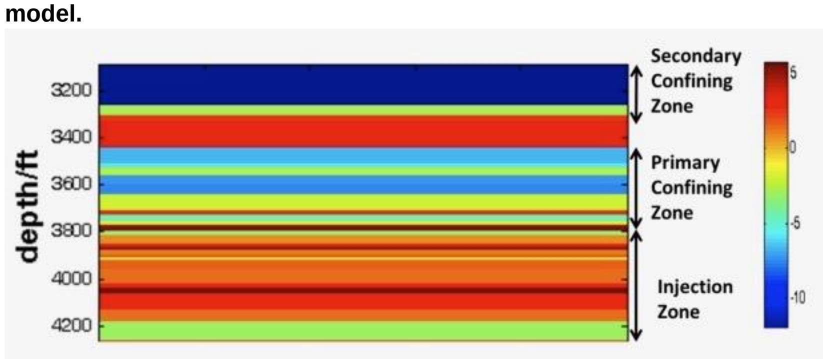
Project Duration:
10/01/2012 – 09/30/2015

Performer Location:
Columbus, Ohio

Program:
Carbon Transport & Storage

Project Outcomes:

Figure 1: Log horizontal permeability (mD) for conceptual Mount Simon model.



The main contribution of this research project is the development and validation of a portfolio of simplified modeling approaches that will enable rapid feasibility and risk assessment for CO_2 sequestration in deep saline formations. In the simplified physics-based approach, only the most important physical processes were modeled to develop and validate simplified predictive models of CO_2 sequestration in deep saline formation. Correlations determined were generally found to have good predictive ability. In statistical learning-based modeling, two approaches were compared for building a statistical proxy model (metamodel) for CO_2 geologic sequestration from the results of full-physics compositional simulations. The Box-Behnken quadratic polynomial metamodel and the maximin Latin Hypercube Sampling (LHS)–Kriging metamodel performed almost the same. Reduced-order models provide a means for greatly accelerating the detailed simulations that will be required to manage CO_2 storage operations. The statistical learning-based simplified models were found to provide a more robust representation of the reference cumulative distribution function, particularly with respect to outliers.

Presentations, Papers, and Publications

Final Report: **Simplified Predictive Models for CO_2 Sequestration Performance Assessment**
(September 2015) – Srikanta Mishra, Priya Ganesh, Jared Schuetter, Jincong He, Zhaoyang Jin, and Louis J. Durlofsky