An Advanced Joint Inversion System for CO_2 Storage Modeling with Large Data Sets for Characterization and Real-Time Monitoring-Enhancing Storage Performance and Reducing Failure Risks Under Uncertainties

Award Number: DE-FE0009260

Project Summary:

The objective of this project was to develop, test, and apply an advanced joint data inversion tool to enhance the predictive capability of models regarding the fate of carbon dioxide (CO_2) plumes, and to improve storage performance through better understanding storage systems. The joint inversion tool can be used for decision-making for optimal control of CO_2 injection and storage by linking forward simulation, dynamic monitoring and inversion, uncertainty quantification, and risk assessment under a consistent framework. Specifically, the project focused on the development of advanced and efficient computational algorithms for joint inversion of hydro-geophysical data, coupled with state-of-the-art forward process simulation.

Prime Performer:
Stanford University

Principal Investigator:
Peter Kitanidis

Project Duration:
10/01/2012 – 01/31/2016

Performer Location:
Stanford, California

Program:
Carbon Transport & Storage

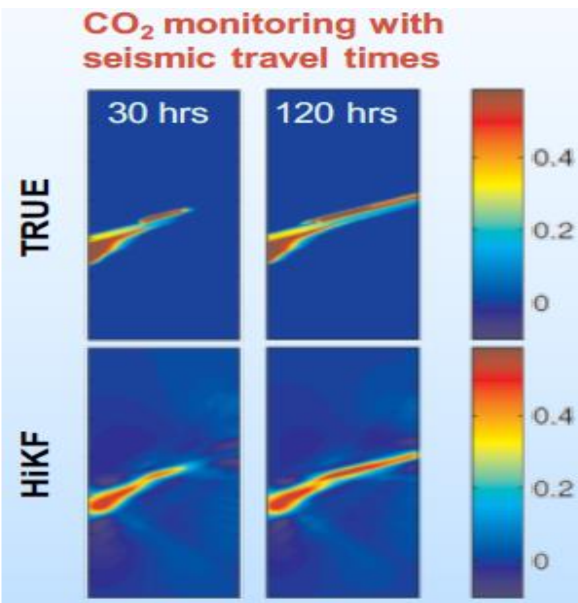

Figure 1: Hierarchical Kalman Filter (HIKF) for quasi-continuous data assimilation.

Project Outcomes:

These algorithms were built, tested, and demonstrated in the context of carbon capture and storage (CCS) projects in deep subsurface geological formations. The fast inversion algorithms developed in the project combine Bayesian methods, for stochastic inversion, with fast linear algebra techniques that accelerate matrix-matrix multiplications, the latter being the bottleneck of traditional inversion. Alternatives to traditional inversion techniques were created with these tools, each designed to suit different CCS applications. Parameters that determine which of the developed algorithms is most appropriate include the frequency of data acquisition, the type of data used, and the heterogeneity of the system. Researchers demonstrated the efficiency of their methods using a large realistic 3D synthetic scenario with datasets similar to those collected at real field sites and were able to demonstrate that in reasonable time frames, good quality estimates are possible even with limited and diverse datasets, a typical scenario in real CCS projects.

Presentations, Papers, and Publications

Final Report: [An Advanced Joint Inversion System for CO_2 Storage Modeling with Large Data Sets for Characterization and Real-Time Monitoring-Enhancing Storage Performance and Reducing Failure Risks Under Uncertainties] (April 2016) – Peter Kitanidis