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REDUCING RISK IN CO_2 SEQUESTRATION: A FRAMEWORK FOR INTEGRATED MONITORING OF BASIN SCALE INJECTION

C. J. Seto[*], S. Ravela[†] and G. J. McRae[*]

[*] Department of Chemical Engineering, Massachusetts Institute of Technology
77 Massachusetts Avenue, 66-060, 02139 Cambridge MA USA
e-mail: cjseto@mit.edu

[†] Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology
77 Massachusetts Avenue, 54-1624, 02139 Cambridge MA

Summary. Geological sequestration of CO_2 is a key technology for mitigating atmospheric greenhouse gas concentrations, while providing low carbon energy. Current projects inject volumes on the order of Megatonnes per year, but for material reductions in ambient concentrations, existing projects must be scaled up one hundred fold. Although the technical ability to safely store CO_2 in the subsurface has been demonstrated through a number of pilot projects and a long history of injection operations in the petroleum industry, questions regarding safety and security of large scale injection projects still exist, and environmental, economic and safety risks must be addressed.

Monitoring and verification are key components in managing risk in sequestration operations. They confirm safe operation, and improve understanding of storage mechanisms and associated uncertainties. When data from monitoring is assimilated in dynamical models of CO_2 transport, early warning mechanisms for detection of anomalies in operation and means for intervention can be devised, should they be necessary.

We present a novel approach to assimilating data for monitoring basin-scale transport. Our approach begins by formulating the assimilation problem in the usual way; as a joint state parameter estimation problem to recover the subsurface structure and spatial distribution of CO_2 (with associated uncertainties). A key step in our approach, however, dramatically reduces the difficulty in solving the joint estimation problem. Using both a fluid dynamical and pattern recognition basis, we develop a nonlinear transformation of features extracted from high resolution surface observations of flow, which reveal the subsurface structure and produces far better estimates of net transport than has hitherto been shown to be possible.