Title

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Near-Surface Dispersion of CO$_{2}$ Seepage from Geologic Storage Sites: Interplay of Process and Detection Strategy

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Injection of CO$_{2}$ into deep geological formations entails the possibility of CO$_{2}$ leakage from the storage formation through wellbores, faults, and fractures. CO$_{2}$ leakage may ultimately reach the near-surface environment by buoyancy and pressure driving forces where it will either flow rapidly into the atmosphere as from an open well, or be emitted over a wide area as seepage. We are investigating the processes, detection, and environmental impacts of CO$_{2}$ migration in the near-surface environment. Prior simulation work has revealed fundamental behaviors for the case of small CO$_{2}$ flux including (1) the tendency to fill up the vadose zone with CO$_{2}$ at concentrations approaching 100\%, and (2) rapid mixing of CO$_{2}$ seepage as it enters the atmosphere from flat and horizontal ground surfaces provided there is wind. The effects of high CO$_{2}$ flux, weak wind, topographic depressions, and back-filled trenches are being investigated. We are using a variety of approaches from scale analysis to numerical simulation to analyze near-surface migration and dispersion of dense CO$_{2}$ by wind and gravity-driven flow. Test problems with a range of CO$_{2}$ seepage fluxes, topography, and wind conditions on length scales of order 100 meters are being considered. Topographic depressions and back-filled trenches are capable of diminishing mixing insofar as they can be sinks for CO$_{2}$ seepage and isolated from the dispersive effects of wind. As such, these features may be good places for instrumentation to detect CO$_{2}$ seepage. In addition to investigating the interplay between dispersion and detection, our work contributes to the prediction of environmental impacts in the near-surface environment.

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