Experiences from the Application of Near-Surface CO₂ and Site Monitoring Techniques at the Illinois Basin - Decatur Project

Curt Blakley, Carl Carmann, Chris Kerose, Don Lumana, Joseph Zimmermana, Michael Frishb, Jeremy Doblerc, and Scott Zaccheod

Abstract
The Illinois Basin – Decatur Project (IBDP) is a large-scale carbon capture and storage (CCS) demonstration which captured one million metric tons of carbon dioxide (CO₂) from an ethanol production facility, into a deep saline reservoir (CCS) demonstration which completed injection of one million metric tons of carbon dioxide (CO₂) from an ethanol production facility, into a deep saline reservoir.

Methods
Two laser techniques and one aerial image interpretation were evaluated as potential FVA tools at an industrial scale CCS operation. Three factors were used to evaluate these techniques:
1. Operational status for the duration of deployment/operation at the IBDP site;
2. Performance at the IBDP site; and
3. Potential application to a commercial-scale injection project.

Discussion and Results
Open Path Sensor
A prototype “open-path” sensor (OPS) which uses tunable diode laser absorption spectroscopy to continuously monitor atmospheric CO₂ levels, 2) the Greenhouse Gas Laser Imaging Tomography Experiment (GreenLITE) system, an automated system for measuring the 2-D spatial distribution of atmospheric CO₂ concentrations, and 3) repeat periodic aerial imagery. Technique reliability over an extended operation period was assessed at the IBDP site to evaluate their potential use in long-term monitoring on a commercial scale. Advantages and limitations of these monitoring techniques are discussed below.


The Greenhouse gas Laser Imaging Tomography Experiment (GreenLITE)
GreenLITE is a laser absorption spectrometer system, which measures the 2-D spatial distribution of atmospheric CO₂ concentrations. This system is an emerging technology that has the ability to detect and visualize near real-time changes in atmospheric CO₂ concentrations. Because it is an automated monitoring technique, it has the potential to reduce environmental monitoring costs.

Operational at IBDP: April 1, 2013 to August 17, 2015.

The configuration of the GreenLITE system at the IBDP site (Figure 3a) consisted of a pair of laser-based transceivers, thirty retroreflectors, a simple weather station, and a set of cloud-based software tools for data processing, storage, dissemination, and the generation of 2-D maps of CO₂ concentration in near real-time. The system was designed so that both transceivers could point to each retroreflector sequentially and measure the atmospheric CO₂ concentrations along each path, or “focal plane,” in the measurement field. The monitored area did not include the injection well, but it did include the IBDP deep monitoring well known as Verification Well 1 (VW1). Figure 3B illustrates the CO₂ concentration distribution over the measurement field. Although atmospheric CO₂ concentrations in the study area were periodically larger than anticipated background concentrations (e.g., 400–425 ppm), the measured CO₂ concentrations did not detect any sustained elevated CO₂ concentrations that would suggest leakage of stored CO₂. The observed concentrations could be correlated with cropping and drainage and other nearby industrial activity (e.g., although production.

Potential Application
The GreenLITE system offers real-time feedback of atmospheric CO₂ concentrations over large areas via a web-based interface. Its autonomous operation allows for a cost-effective method to detect CO₂ leakage should it occur. Over the five months of deployment, very few manual adjustments were needed. Thus, this system has a high potential for value-added integration into a comprehensive, commercial-scale CCS monitoring program.

Aerial Imagery
The primary objective of airborne remote sensing at the IBDP site was to provide documentation of project-related and industrial activities at the site using high-resolution, digital aerial photography.

Potential Application
Industrial activities unrelated to a CCS project have the potential to cause significant land disturbances. In addition, typical agricultural practices cause land use changes which can make leak detection by CIR imagery interpretation difficult. Therefore, storage projects and associated monitoring programs should take these variations into account and, if possible, minimize surface disturbances throughout the life of the project. Although CIR-based aerial photography was not a technology that could be applied for long-term injection monitoring at IBDP, aerial photography acquisitions became invaluable for environmental data analysis, validation, and project activity documentation.