

# Surface and Airborne Monitoring Technology for Detecting Geologic Leakage in a CO<sub>2</sub>-Enhanced Oil Recovery Pilot, Anadarko Basin, Texas

Award Number: DE-FE0012173

## Project Summary:

Oklahoma State University (OSU) conducted a three-year research and development project that aimed to develop and demonstrate an integrated monitoring system that is capable of directly detecting and quantifying seepage of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>); into the soil and atmosphere. The approach employed in-ground and surface sensors and unmanned aerial vehicles (UAV) to collect data. OSU proposed to develop the CO<sub>2</sub> and CH<sub>4</sub>; sensors and the UAV platform at OSU facilities. The integrated system would then be installed, tested, and optimized at a field site, the Farnsworth Unit (FWU), site of the Southwest Regional Partnership on Carbon Sequestration (SWP) Phase III field site.

**Prime Performer:**  
*Oklahoma State University*

**Principal Investigator:**  
*Peter Clark*

**Project Duration:**  
*10/1/2013 – 3/31/2017*

**Performer Location:**  
*Stillwater, Oklahoma*

**Field Sites:**  
*Farnsworth Unit site, Texas*

**Program:**  
*Carbon Transport & Storage*



**Figure 1: The Skywalker X8 platform will act as the UAV for sensor testing at the FWU site**

## Project Outcomes:

This project developed a ground-based system and an airborne system for directly detecting and quantifying seepage of CO<sub>2</sub> into the atmosphere. The ground-based sensor network consists of a three-tiered hierarchy. The lowest tier (tier 1) consists of solar-powered low-cost, low-power, and transportable sensor nodes with radios for wireless communication with other nodes. The second tier consists of communication nodes that receive data from the tier 1 sensors, store the data locally, and transmit the data via cell modem to the tier 3 node. The tier 3 node is a computational workstation housed at the base of operations, with the capability to process and analyze the data. The ground-based system was tested at the FWU project site. The sensors and associated electronics were stable and reliable; failure rates of the units were 1% or less. Several short-duration CO<sub>2</sub> releases, unrelated to subsurface

geologic containment of the injected CO<sub>2</sub> were recorded during the study.

The airborne CO<sub>2</sub> monitoring system consisted of a UAV that was flight tested at various sites. While the system is able to detect increased CO<sub>2</sub> levels, further testing and improvements are required to be able to accurately quantify the CO<sub>2</sub> levels. Initial flight testing was also carried out on the Anaconda UAV, a larger aircraft capable of carrying more payload, flying for longer periods of time, and automated take-off and landing for use by a more general end user.

In addition to sensor development, theoretical studies showed the feasibility of using machine learning to model flight paths for detection of a CO<sub>2</sub> plume in the air. A model was developed to determine optimal paths in the presence of a non-stationary plume.

## Presentations, Papers, and Publications

**Final Report:** [Surface and Airborne Monitoring Technology for Detecting Geologic Leakage in a CO<sub>2</sub> Enhanced Oil Recovery Pilot, Anadarko Basin, Texas](#) (June 2018) Peter Edward Clark, Jarney Jacob, Tyler M. Ley, Nicholas F. Materer, Jack Pashin