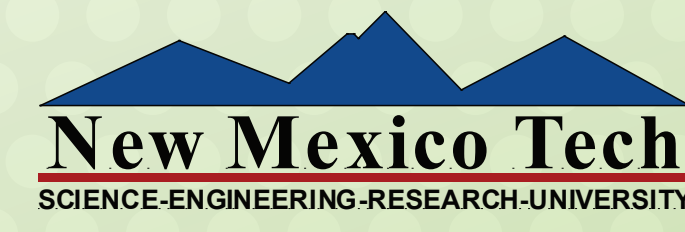


MVA Activities - SWP Farnsworth Unit Project

Rich Esser¹, Ning Liu², Brian McPherson¹, Reid Grigg², Robert Balch², Leonard Garcia², Tianguang Fan²

¹ Dept of Civil Engineering, Univ of Utah, SLC, UT ² PRRC, New Mexico Tech, Socorro, NM



MVA Strategy & Methods

The SWP Farnsworth Unit MVA program is designed to provide the data needed to characterize injected CO₂ and existing reservoir fluids, including volumes of CO₂ injected, produced, recycled and ultimately stored; fluid migration; and identification and quantification of any potential release of CO₂ and/or fluids from the reservoir. The MVA data will be used to facilitate effective simulation results and risk assessment for underground sources of drinking water (USDW - Ogallala formation), the shallow subsurface, and atmosphere.

Monitoring CO₂ at surface:

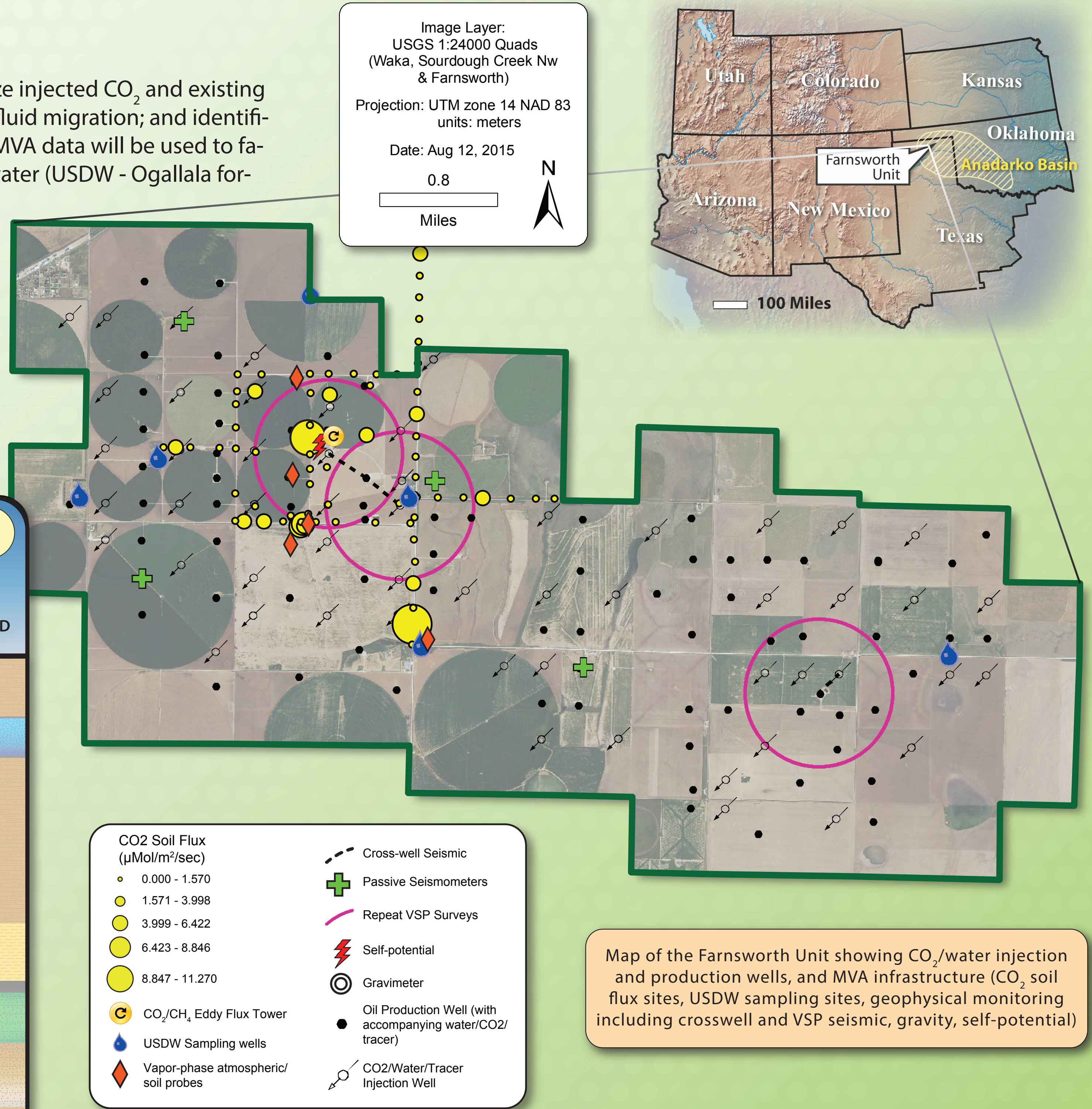
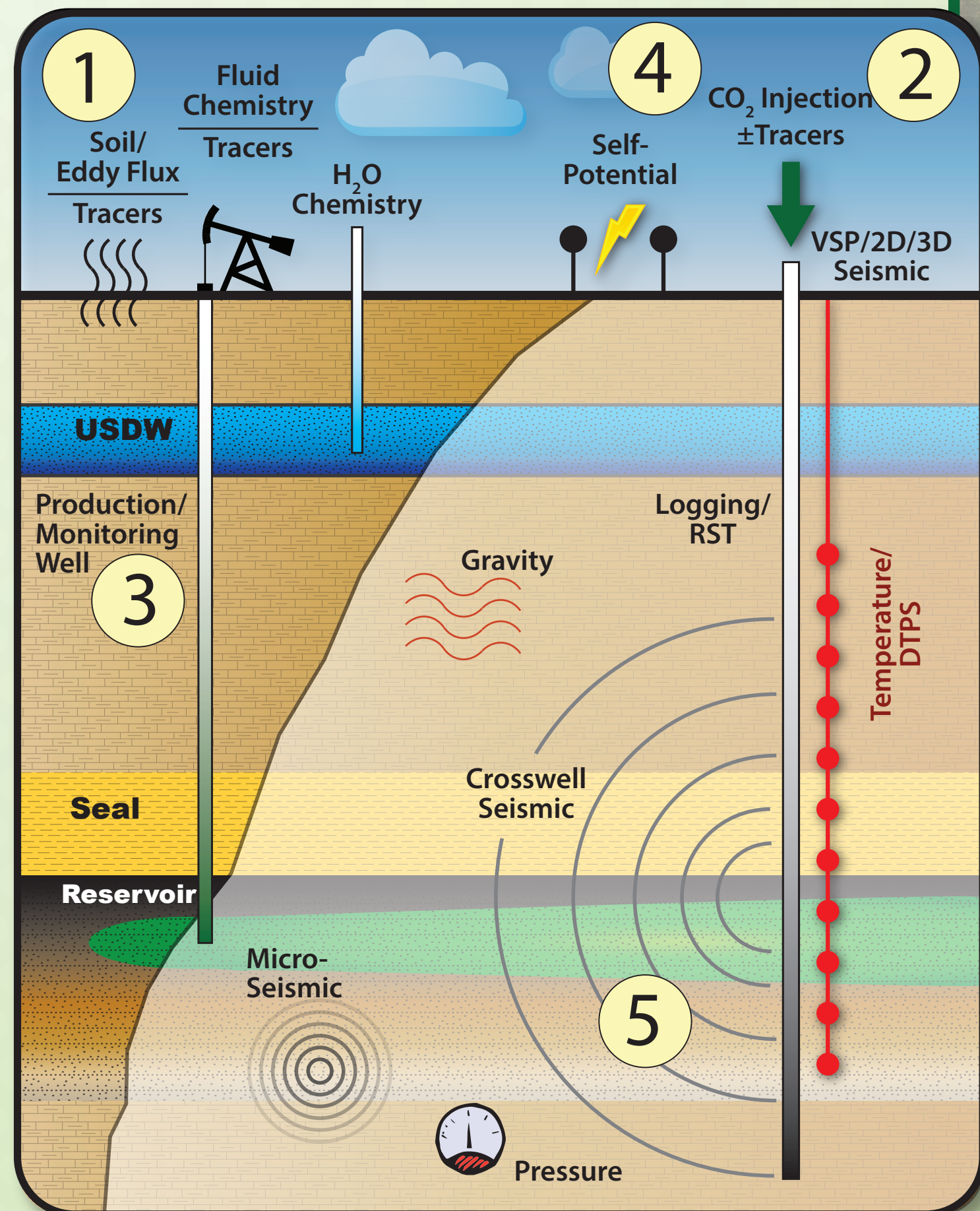
- Eddy covariance towers for measuring atmospheric CO₂ and CH₄ fluxes; used to constantly monitor large areas for increases in gas emissions and identify point source emissions.
- Surface flux measurements to detect possible CO₂ emissions from depth.

Detecting CO₂ and/or other fluid migration in Target/Non-Target Reservoirs:

- Groundwater chemistry (USDWs).
- Water and Gas Tracers.
- Self-potential (detection of minute electrical changes caused by subsurface fluid migration).
- Microgravity surveys.

Tracking CO₂ Migration and Fate:

- In situ pressure.
- Distributed temperature array (DTS).
- 2-D/3-D seismic reflection surveys.
- Vertical seismic profile (VSP), cross-well, passive seismic for detection of microseismic events.
- Water/gas chemistry (target reservoir).
- Water/gas isotopes.
- Gas Tracers.



Map of the Farnsworth Unit showing CO₂/water injection and production wells, and MVA infrastructure (CO₂ soil flux sites, USDW sampling sites, geophysical monitoring including crosswell and VSP seismic, gravity, self-potential)

MVA Results to Date

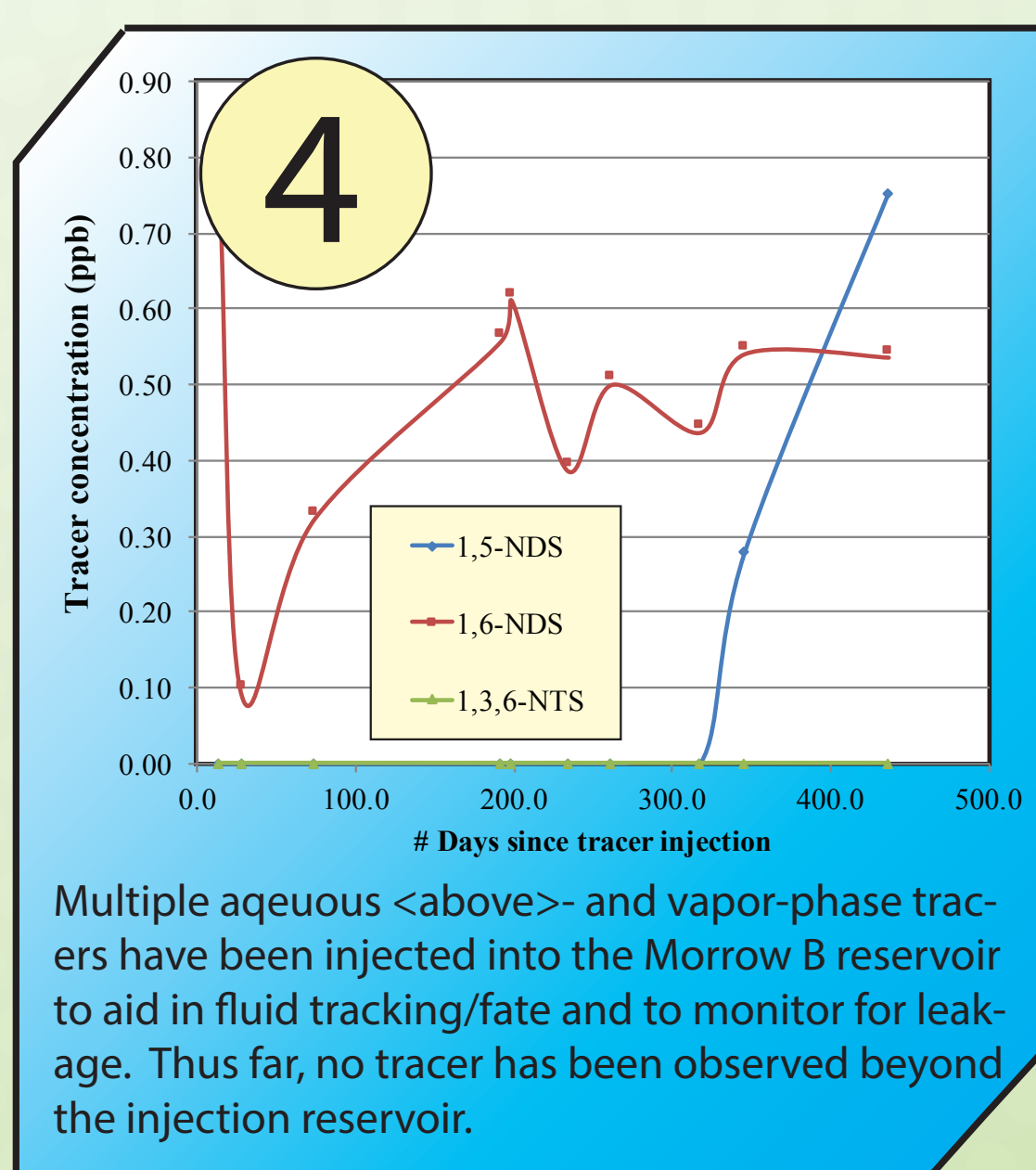
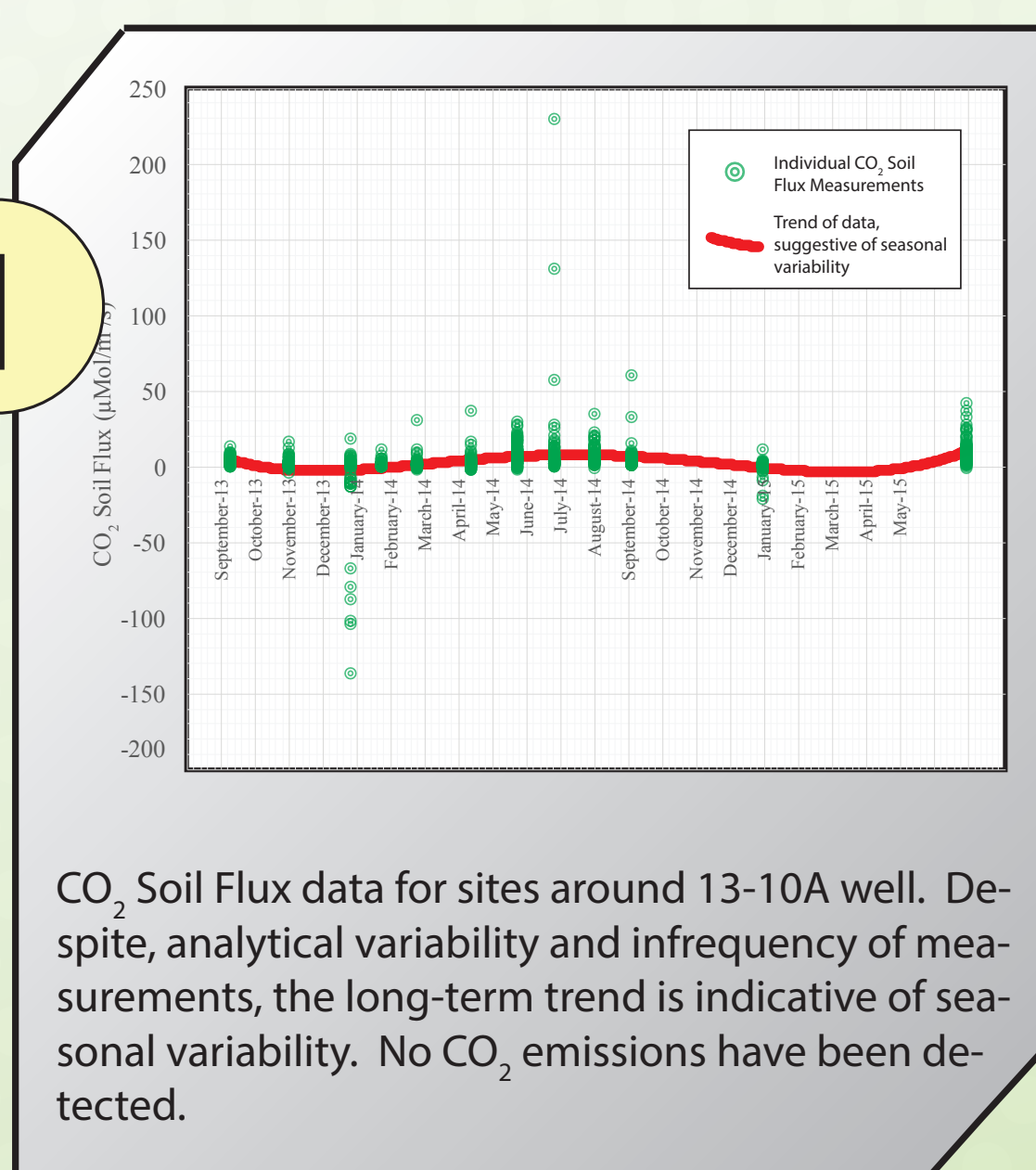
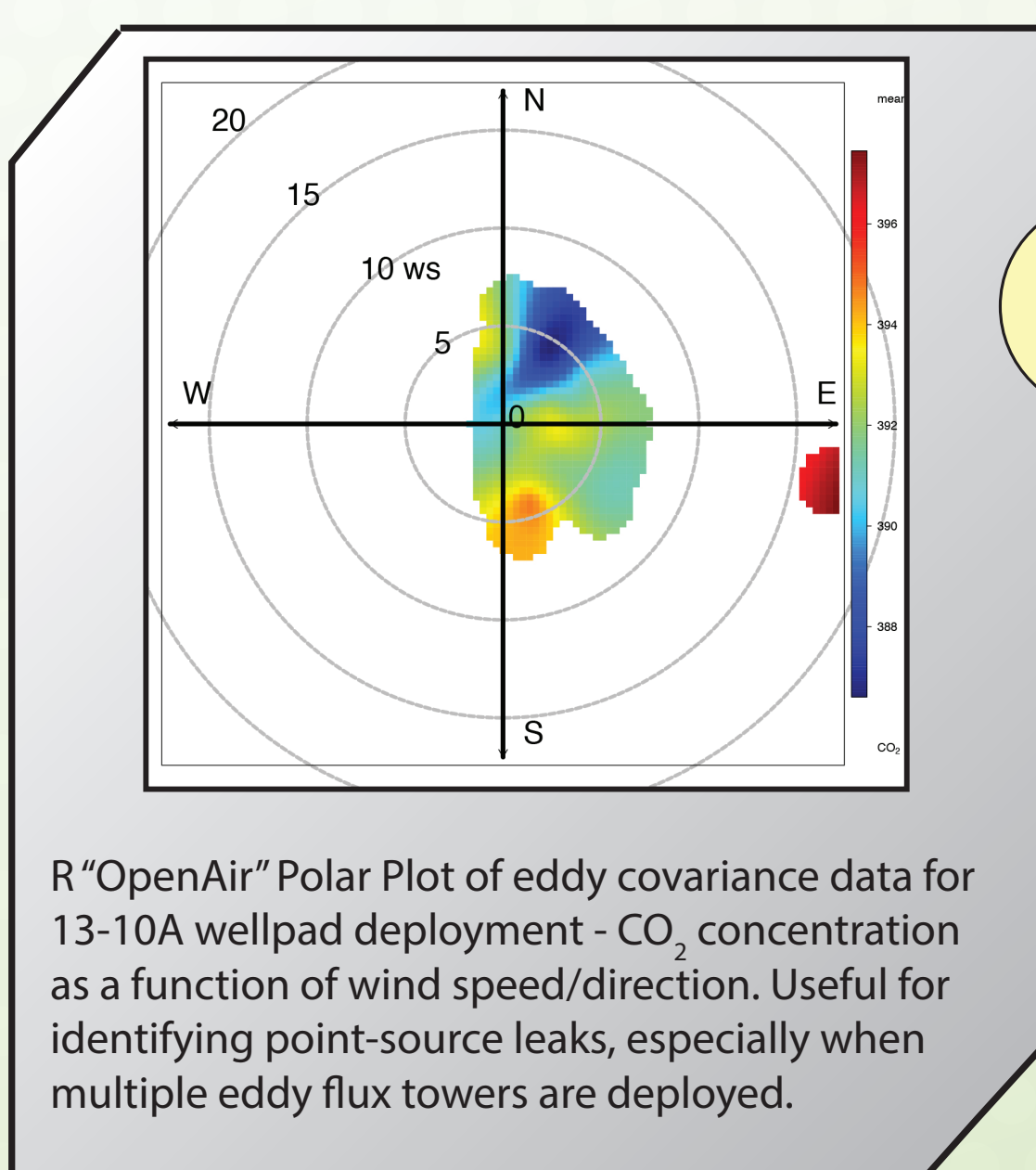


Baseline and Operational MVA at Farnsworth Unit

- Baseline begun in 2013; operational monitoring started in 2015.
- USDW and reservoir fluid samples now collected/analyzed on a quarterly basis
- CO₂ soil flux collected quarterly; CO₂/CH₄ eddy flux collected continuously.
- Borehole seismic collected continuously; periodic crosswell/VSP surveys.

... continued, Baseline and Operational MVA at Farnsworth Unit

- In situ pressure and temperature (DTS) collected continuously (currently 1 well).
- Water and gas phase tracers injected in multiple wells; monitored at surface/sub-surface.
- CO₂, water (injection and production), oil (production) accurately metered daily.
- Self-potential and microgravity data collected continuously.



MVA Database

All non-seismic MVA data collected by the SWP is incorporated into a relational database

- Built on open-source software (HydroServer & MySQL)
- Benefits of relational database architecture:
 - Fast, efficient and complex queries.
 - Automated data uploads/downloads.
 - Access to real-time/near real-time data.
 - "Portability" to other software platforms:
 - + GIS
 - + PHP/Python for automated analysis, dynamic graphing
 - + Web clients/browsers
 - + Modeling/simulation code
- SWP MVA Database: 770 Sites, 79 Variables, 259,046 data points and increasing daily.

