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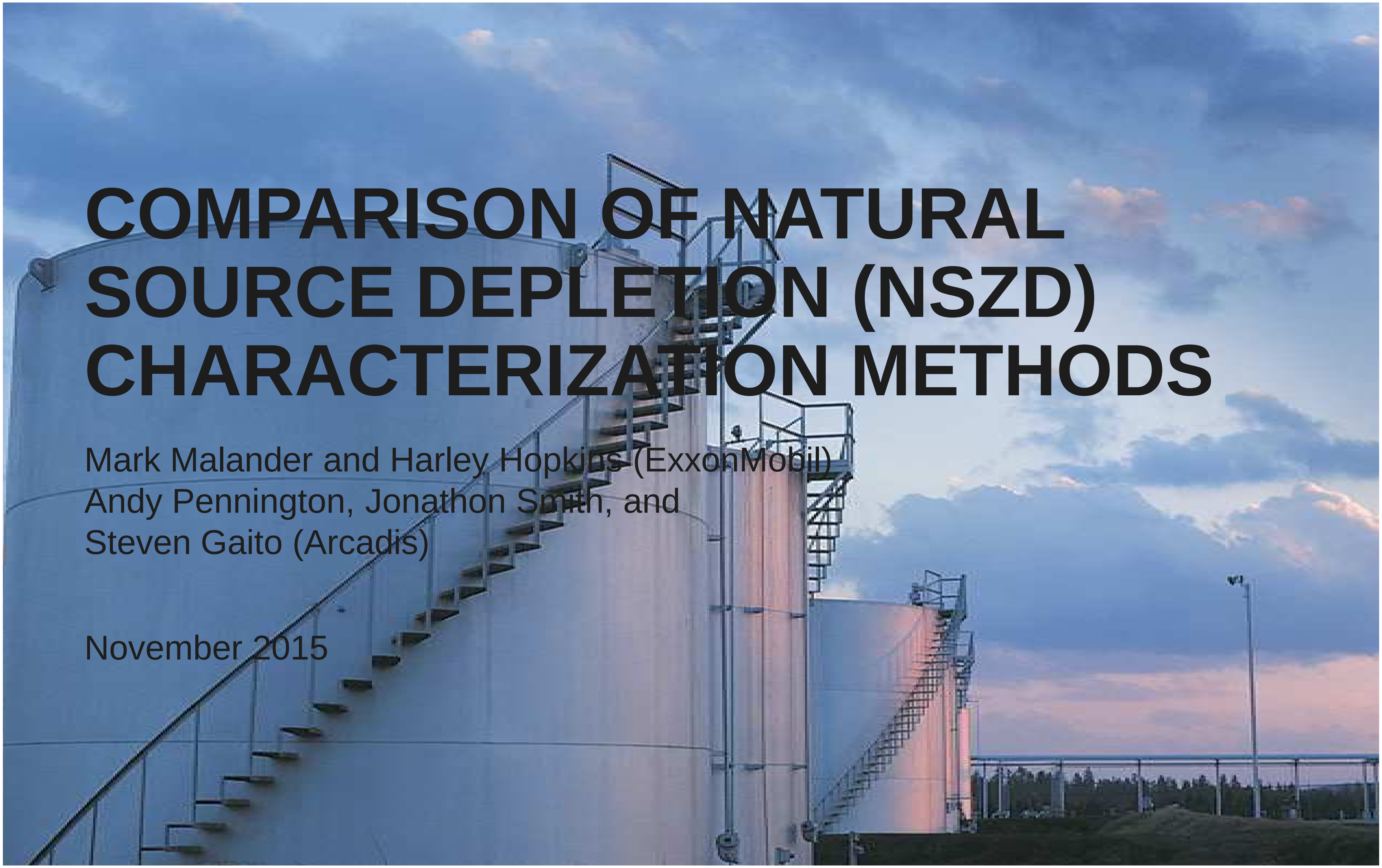

COMPARISON OF NATURAL SOURCE DEPLETION (NSZD) CHARACTERIZATION METHODS

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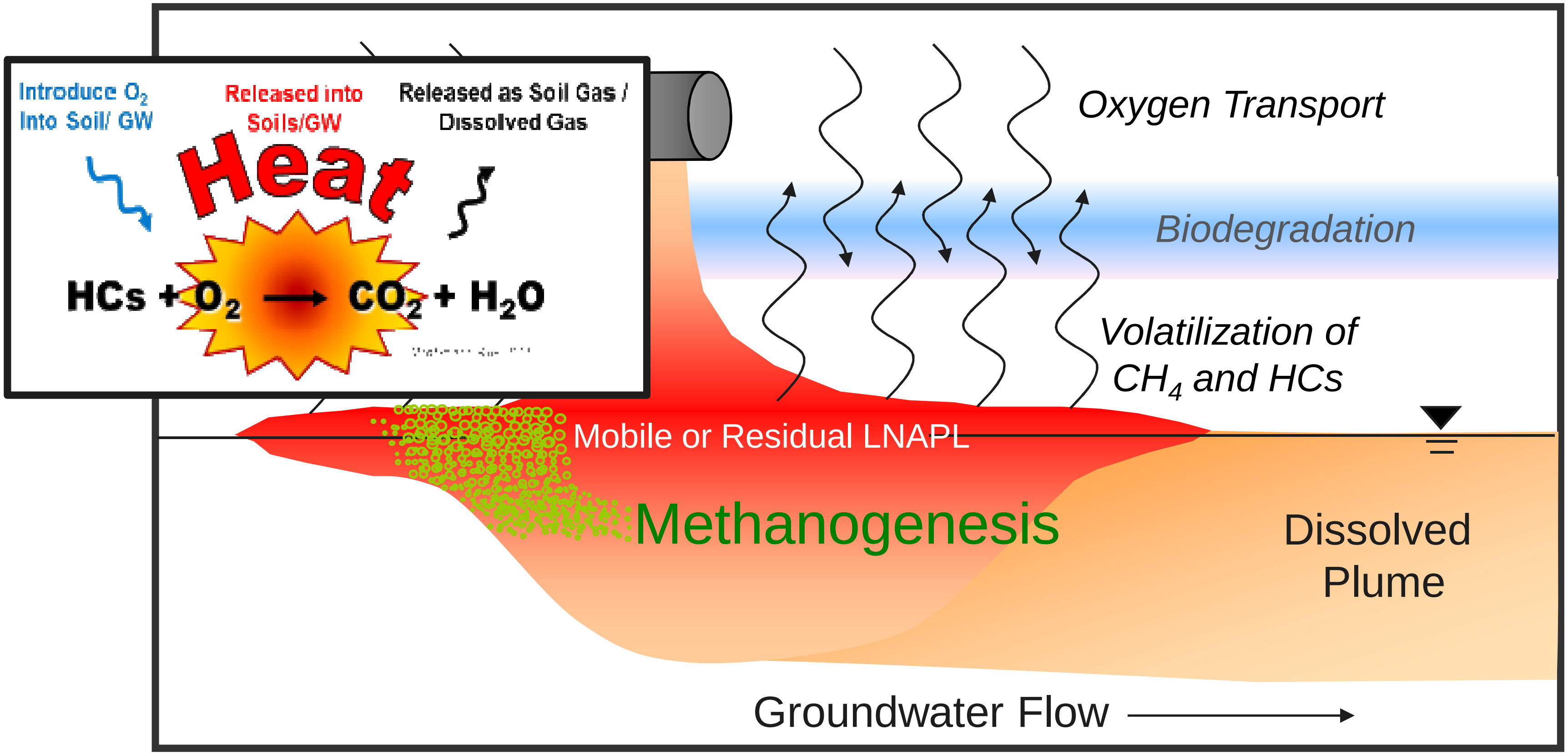
Agenda

- Study Objectives
- Findings from each Method
- Comparison of NSZD Rates
- Temperature Observations
- Summary

NSZD Processes in the Vadose Zone



Mass loss occurs from:
Volatilization: Observed from soil gas concentration data
Biodegradation: Inferred from oxygen, methane, and hydrocarbon soil gas depth profiles or CO_2 flux through groundsurface

NSZD Methodology Comparison: Study Objectives

CO_2 Trap

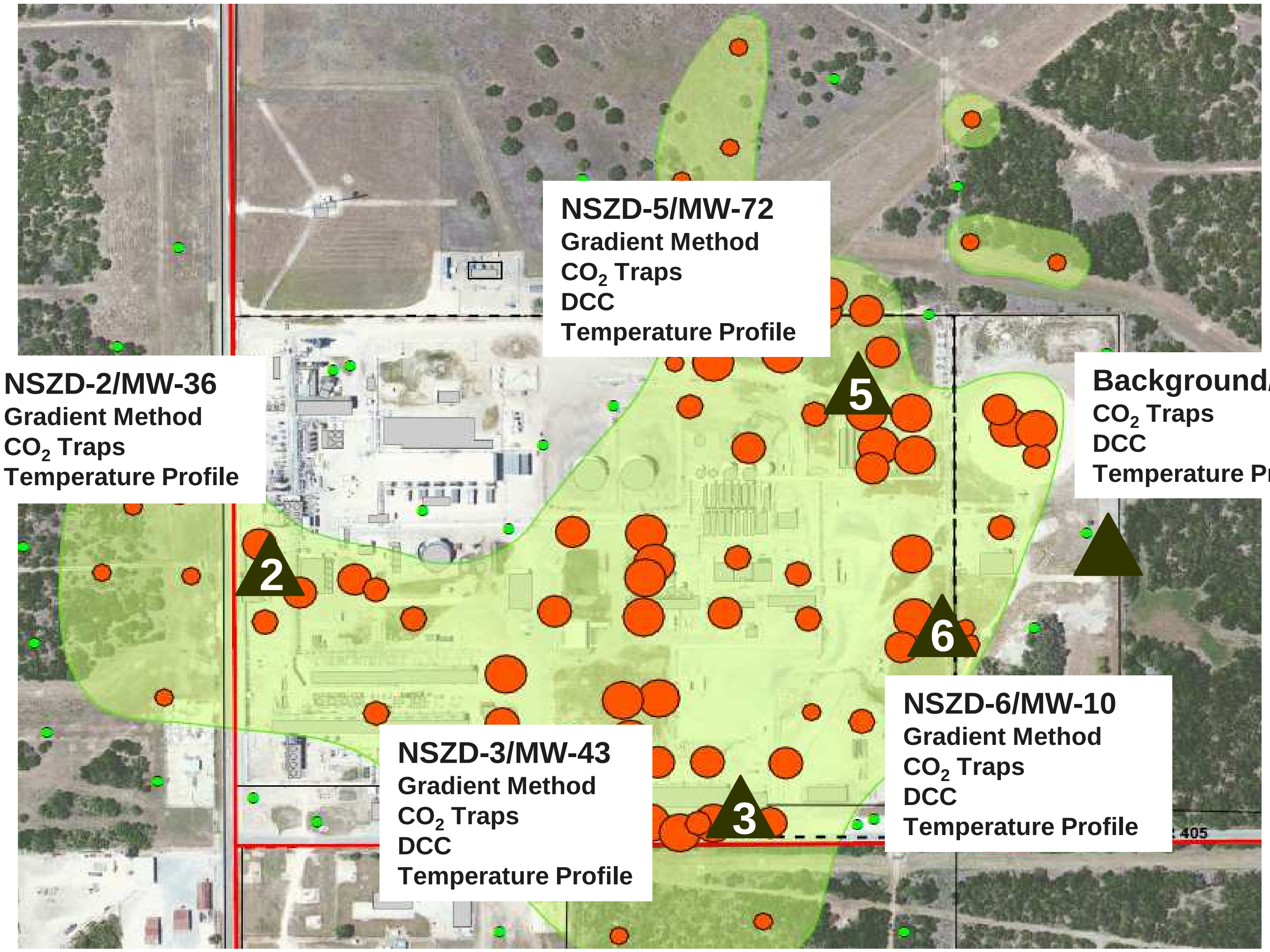
LI-COR Chamber and Analyzer

Temperature Datalogger

- Side-by-side comparison of NSZD quantification methods
- Gradient Method
- Dynamic Closed Chamber (DCC)
- CO_2 Traps

- Collect duplicate CO2 trap data to evaluate repeatability
- Collect ancillary data:
  - Soil moisture
  - Rainfall from airport
  - Barometric pressure
  - Temperature profiles

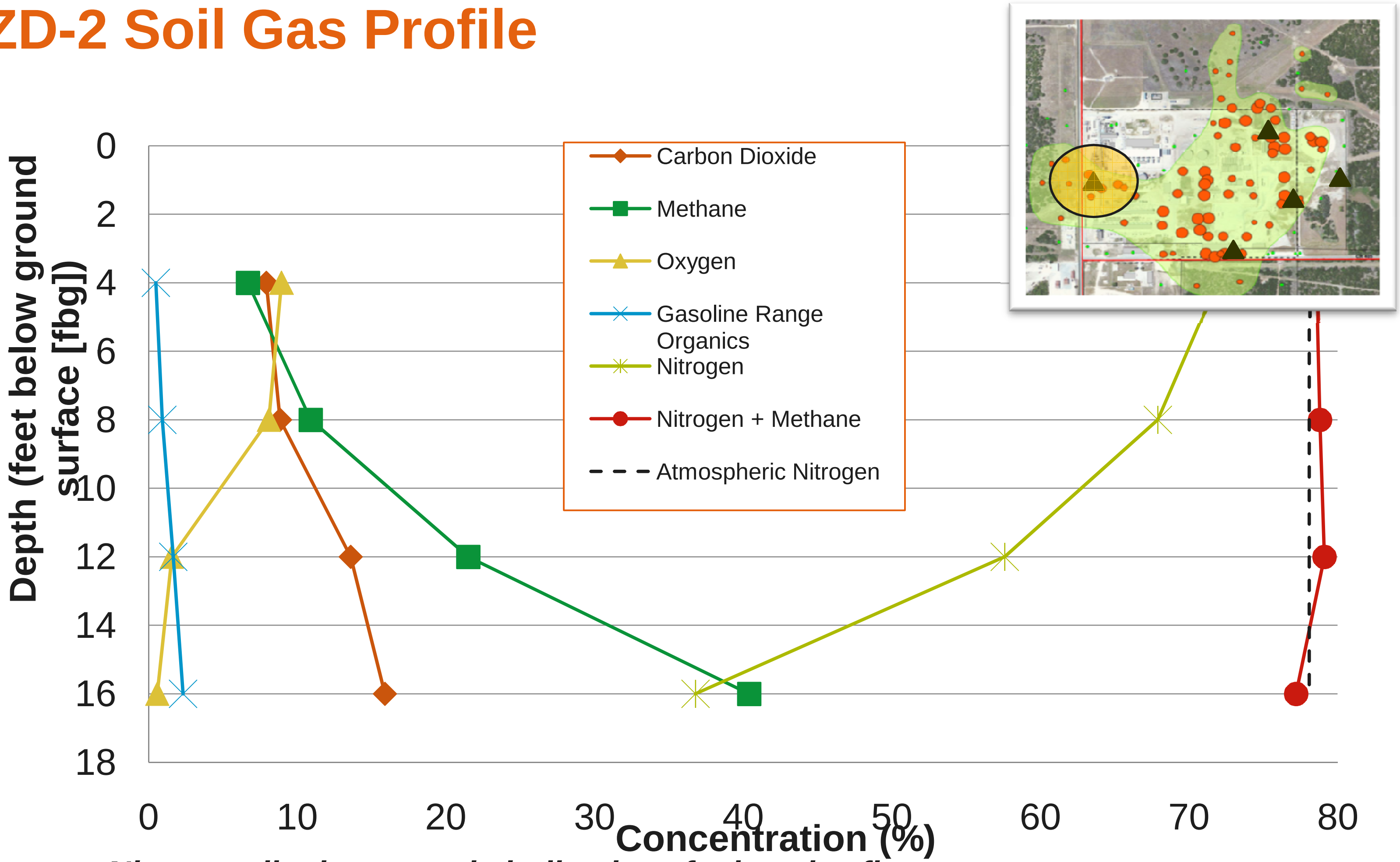
Method Comparison Study Locations



Gradient Method

Gradient Method

NSZD-2 Soil Gas Profile



Nitrogen displacement is indicative of advective flow

Vapor-Phase Porous Media Diffusion Coefficient

	D_{eff}, O_2 (cm^2/sec)		Ratio
Location ID	March 2014	Aug 2012	2014:2012
NSZD-2	0.0124	0.0071	1.75
NSZD-3	0.0084	0.0206	0.41
NSZD-5	0.0060	0.0085	0.70
NSZD-6	0.0042	0.0017	2.48

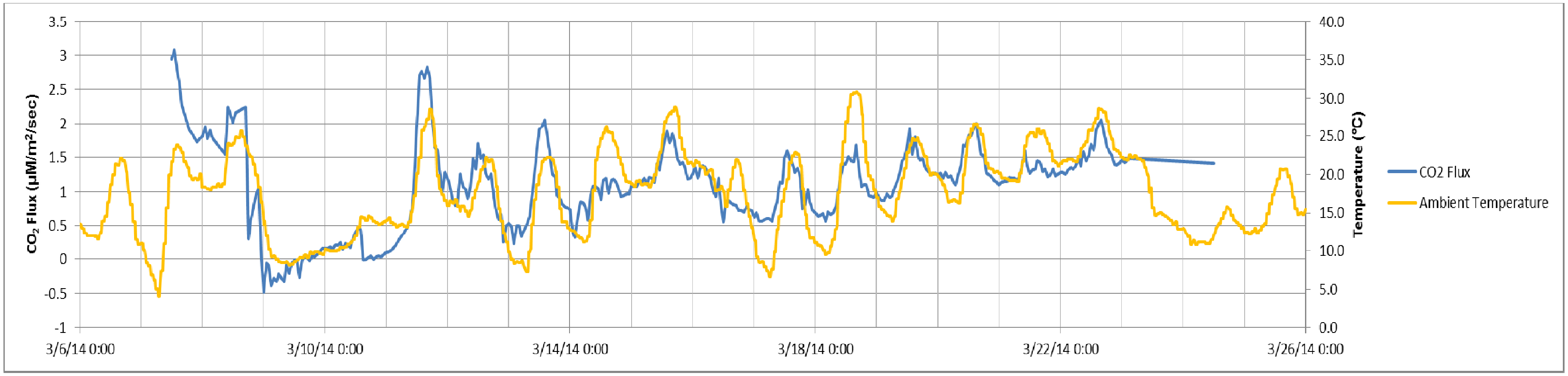
Diffusion coefficient is dependent on pore fluid saturation

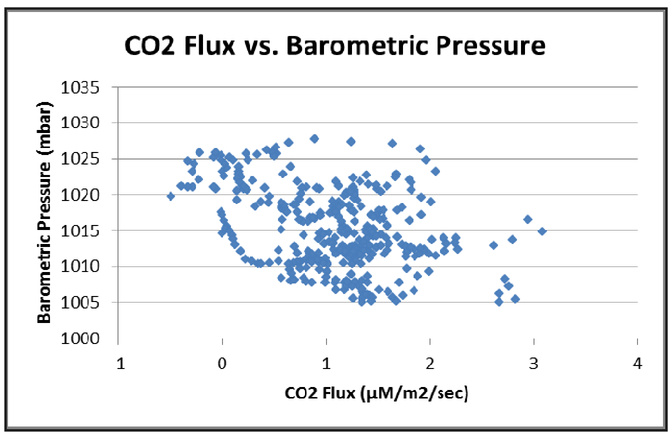
CO_2 Flux Methods

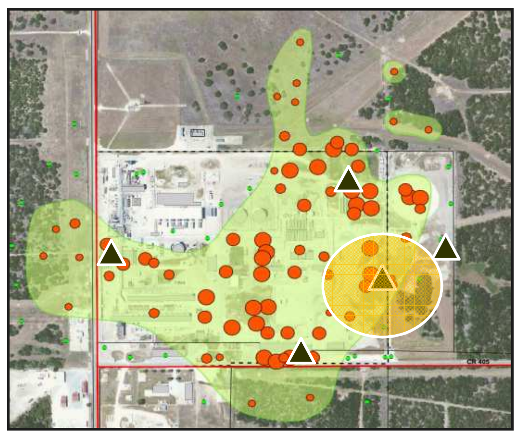
Dynamic Closed Chamber (DCC)

High-quality data, but demanding setup

CO_2 Flux Data (DCC): NSZD-6

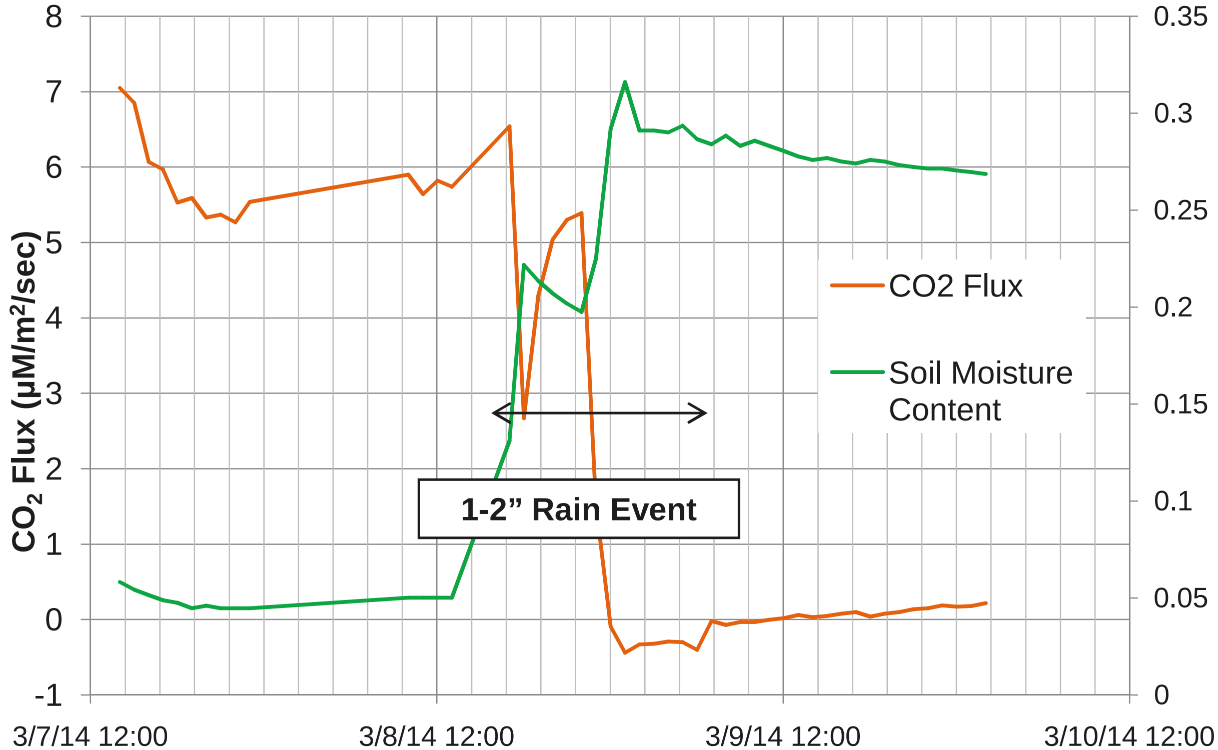




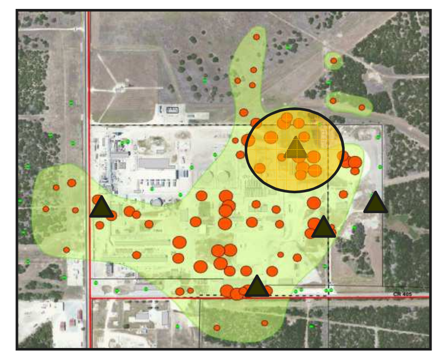


Strong correlation between atmospheric temperature and flux

CO_2 Flux Data (DCC): NSZD-5

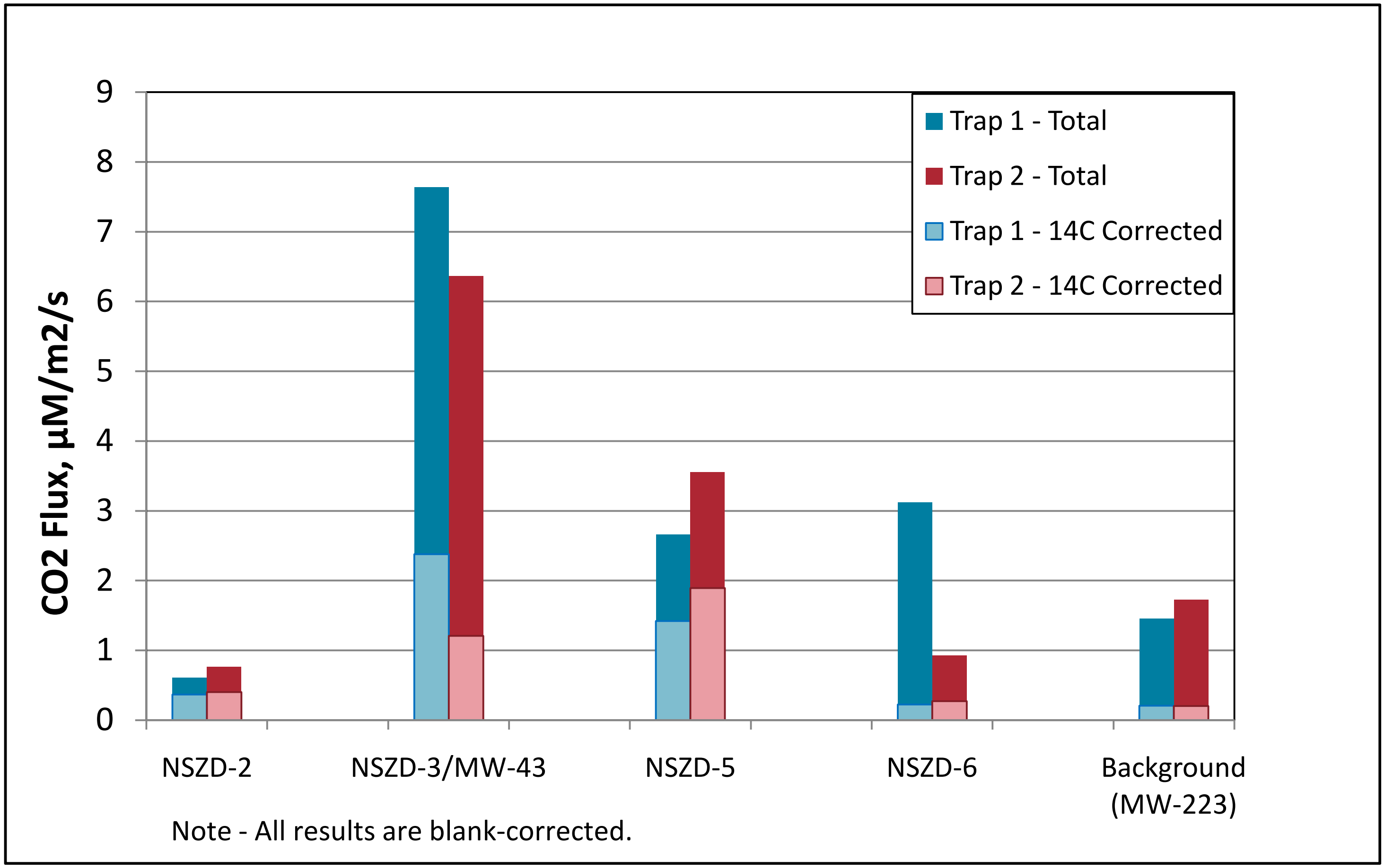


Effects of soil moisture/rainfall are significant



CO2 Traps

CO_2 Trap Results
Duplicate Comparison



CO_2 Trap Results
Modern Carbon Flux

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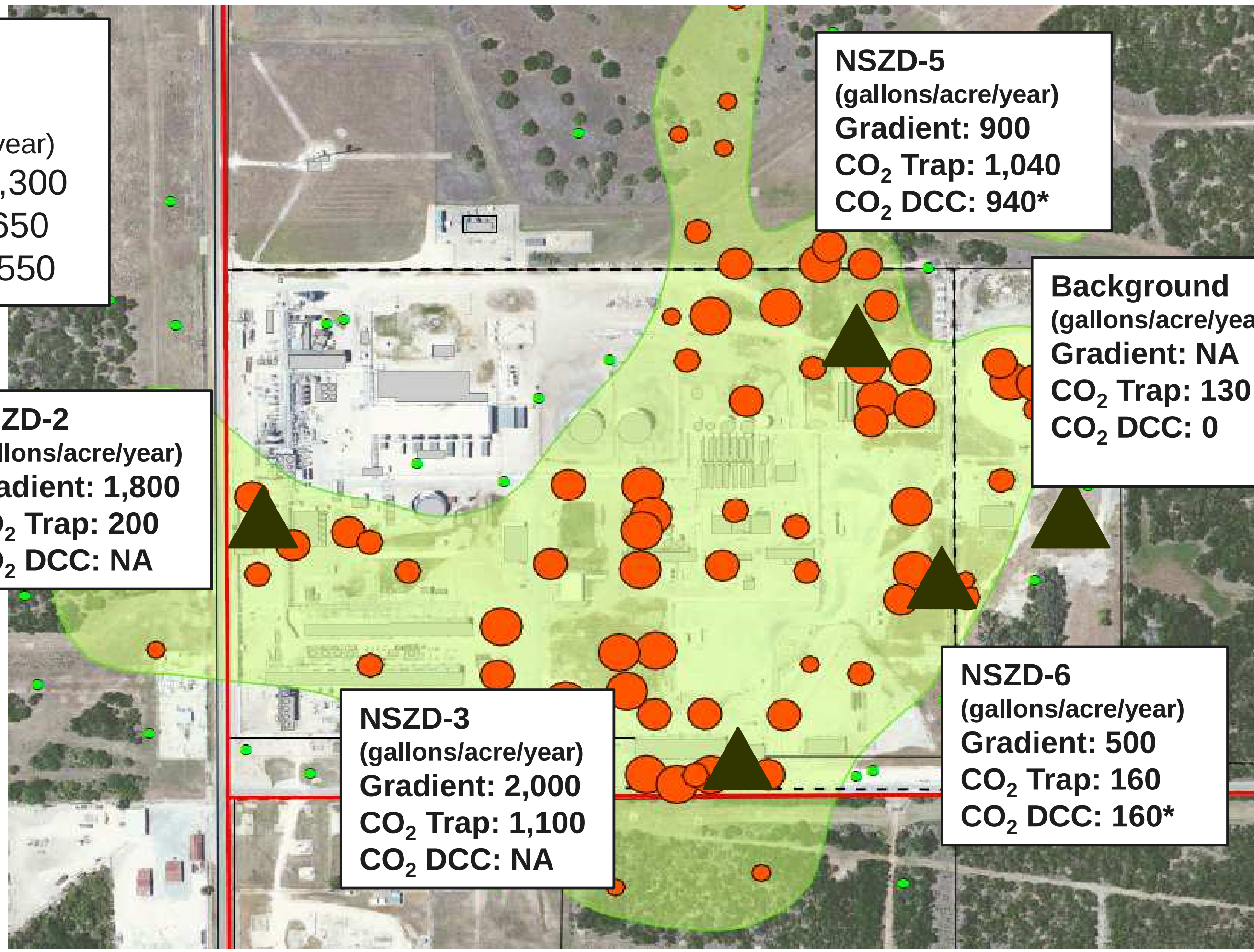
Method Comparison Site Wide Average

Site Wide Averages
(gallons/acre/year)
Gradient: 1,300
CO_2 Trap: 650
CO_2 DCC: 550



*DCC results are corrected using data from background location

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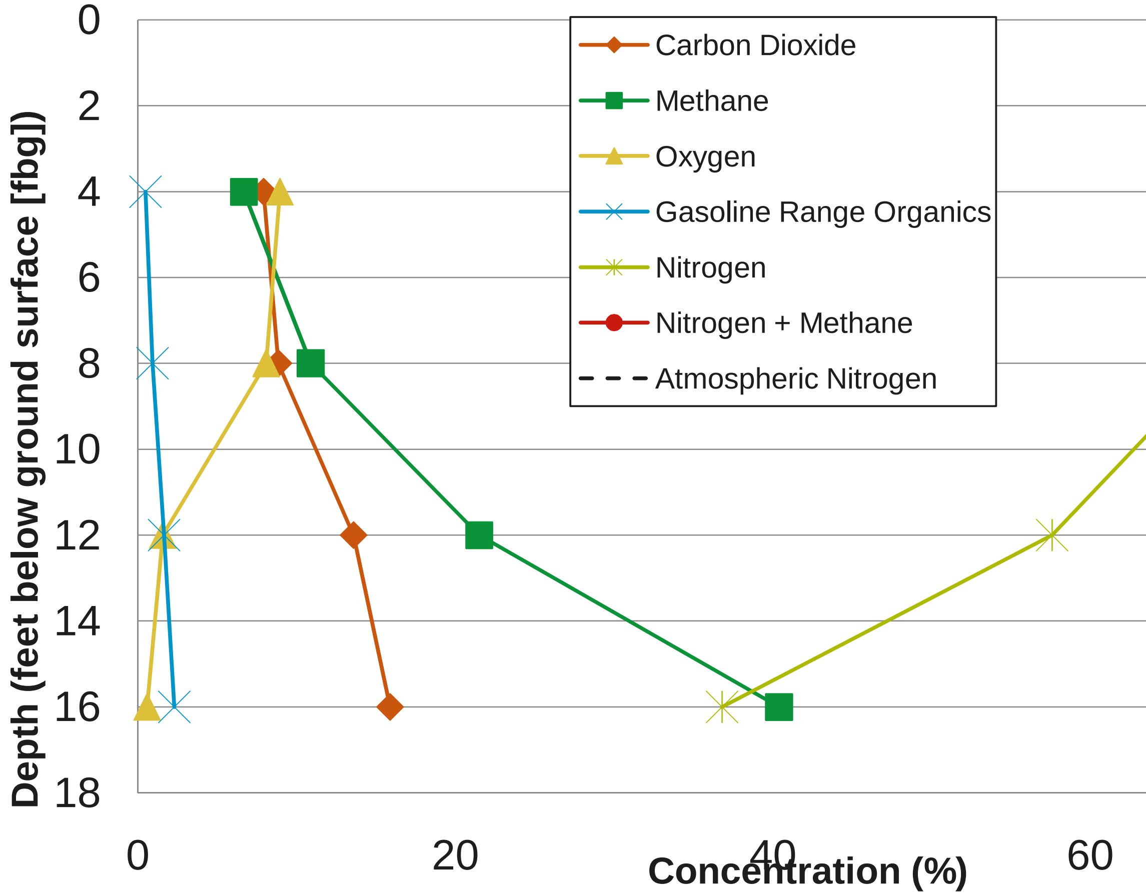
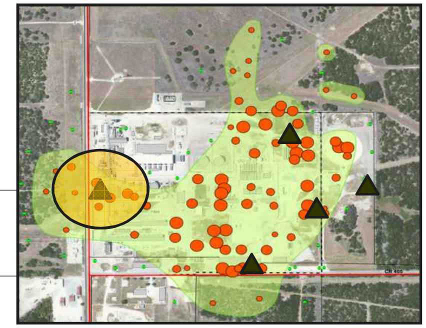
Gradient Method

NSZD-2 Soil Gas Profile





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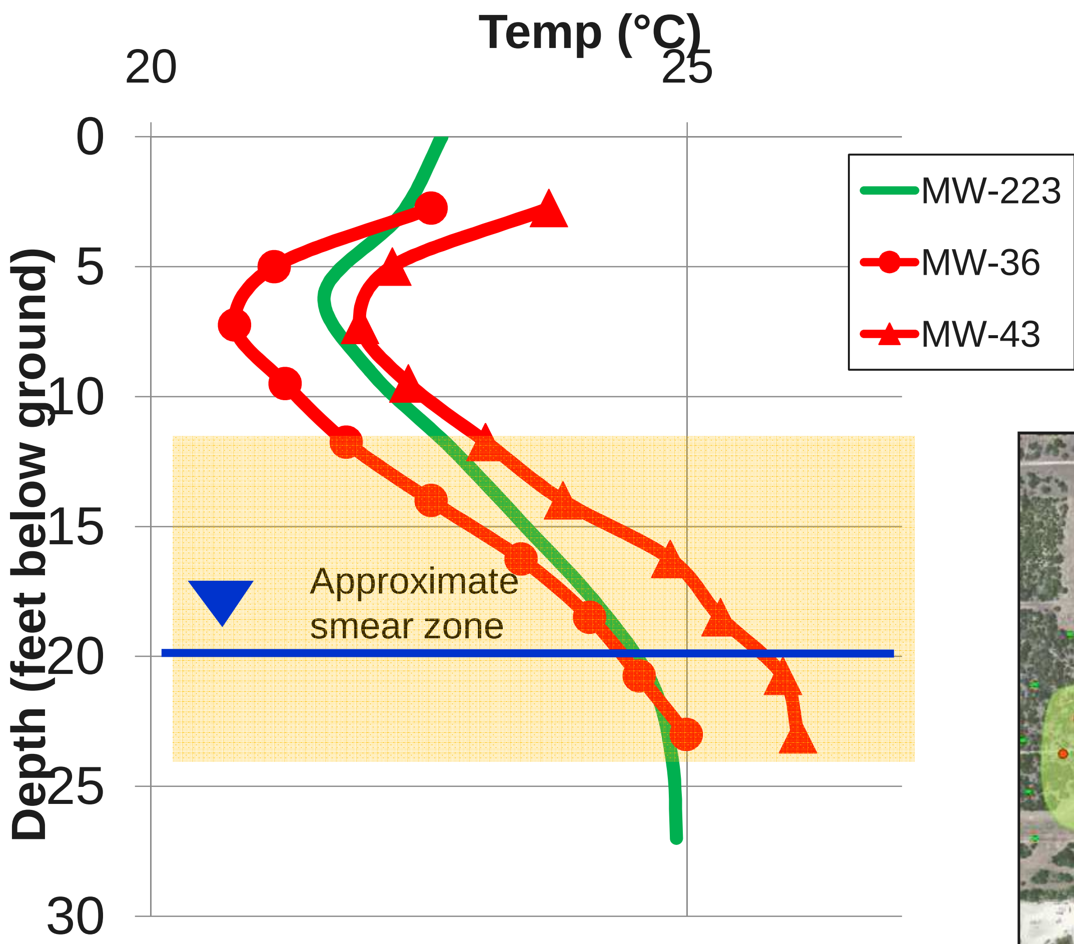
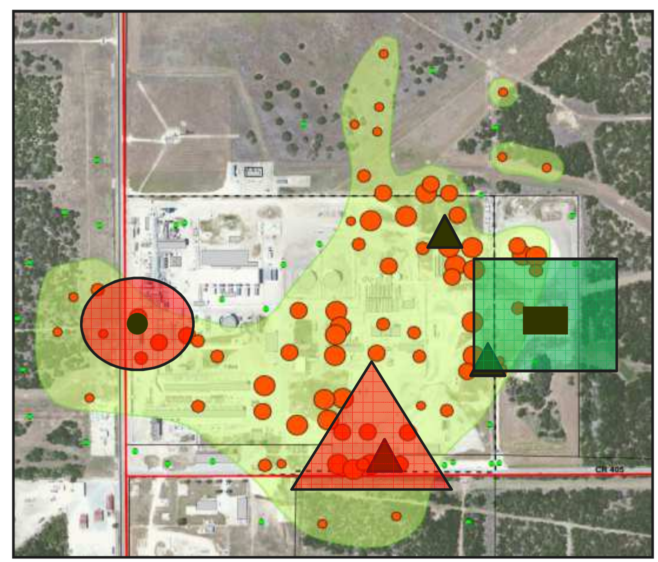
Temperature Observations

Temperature Observations

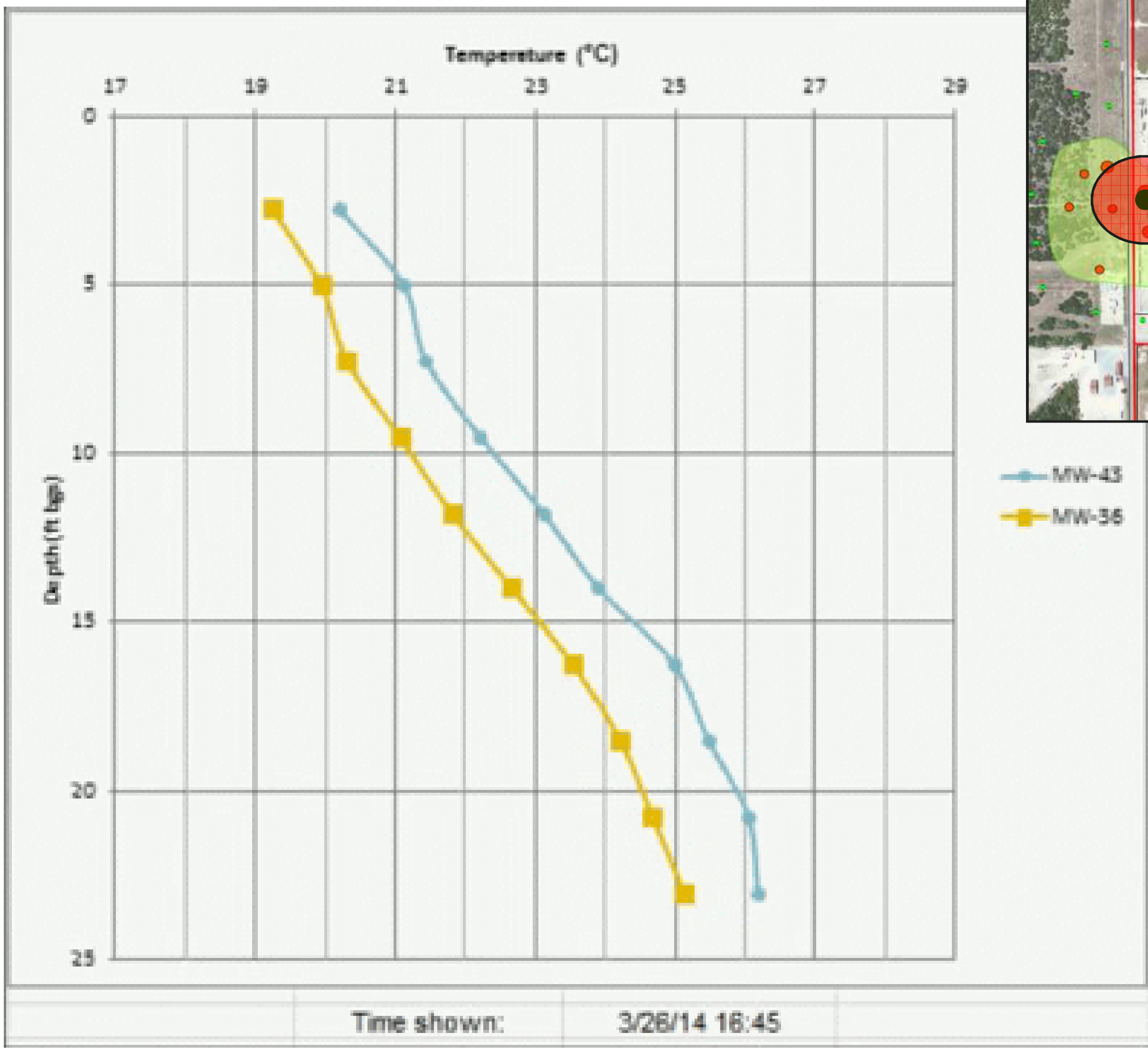
- Intrinsically safe temperature dataloggers set down-well at 2.5-foot to 3-foot intervals
- Temperature data logged every 15 minutes
- Data logging resolved downward propagation of temperature variation at surface

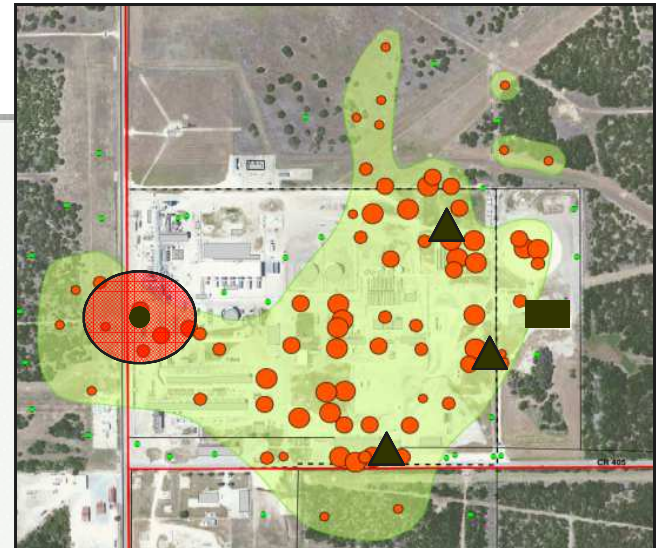
Temperature Observations





Temperature Profile





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Method Comparison Summary

	Capital Costs	Field Deployment Costs	Data Reliability	Qualitative Evidence	Data Density	Ease of Use	Best Application
Gradient Method	B	C	B	A	B	C	Sites with existing soil gas sampling infrastructure
CO_2 Traps	A	B	A	C	C	A	Well-understood sites with relatively uniform subsurface and climate conditions
LI-COR DCC	C	A	B	B	A	B	Initial screening of locations; Detailed rapid measurements; Investigating complex influences

Notes: Gradient method includes diffusion coefficient field measurement
Capital costs assume purchase of LI-COR DCC

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QUESTIONS AND COMMENTS

Thank you!