Natural Gas Infrastructure: Field-based Methane Emissions Quantification

NETL FWP 1022424 Task 5

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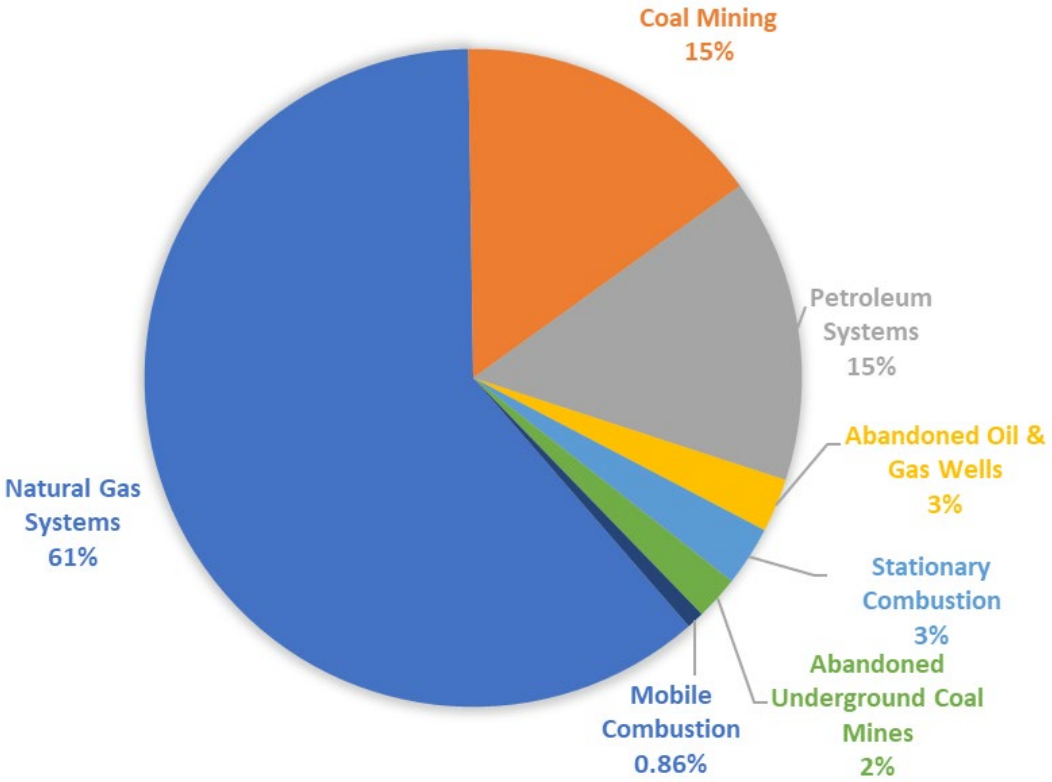
Geo-Analysis and Monitoring Team



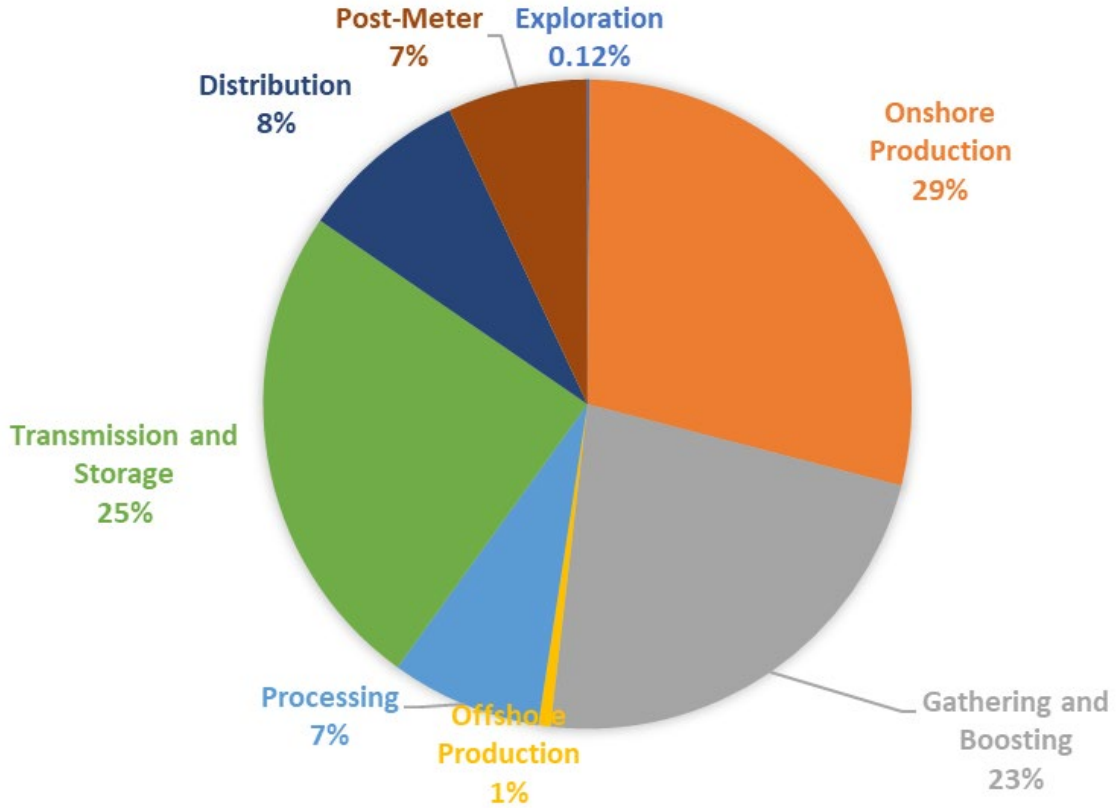


EPA's Estimate of Greenhouse Gas Emissions

Methane Emissions from Energy (2020)
Total Methane: 269.0 MMT CO2 Eq



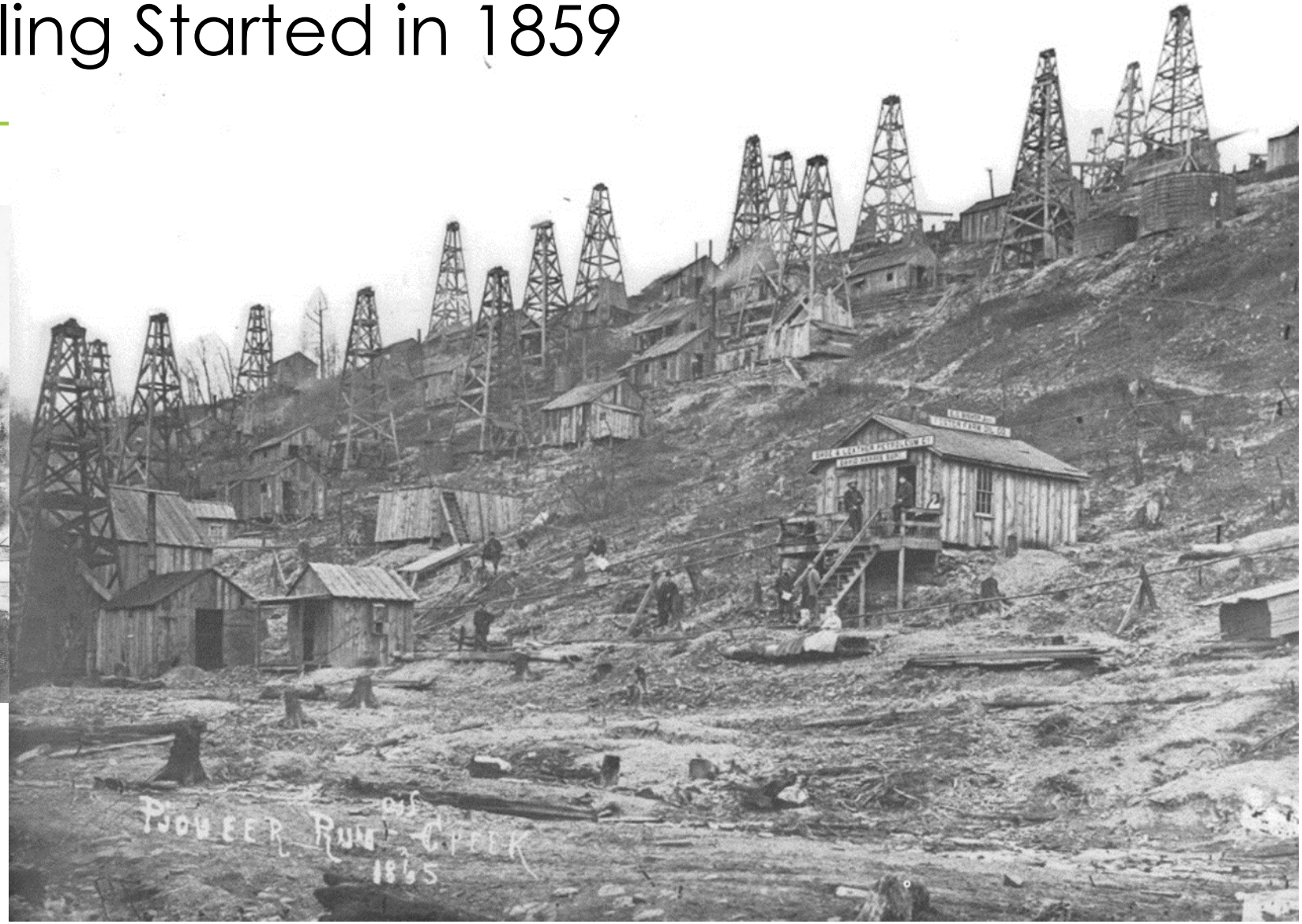
Methane Emissions from Natural Gas Systems (2020)
Total Methane: 164.6 MMT CO2 Eq



EPA. 2022. Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020. U.S. Environmental Protection 9 Agency, EPA 430-P-22-001. https://www.epa.gov/ghgemissions/draft-inventory-us-greenhouse-gas-emissions-and10 sinks-1990-2020.

U.S. Oil and Gas Drilling Started in 1859

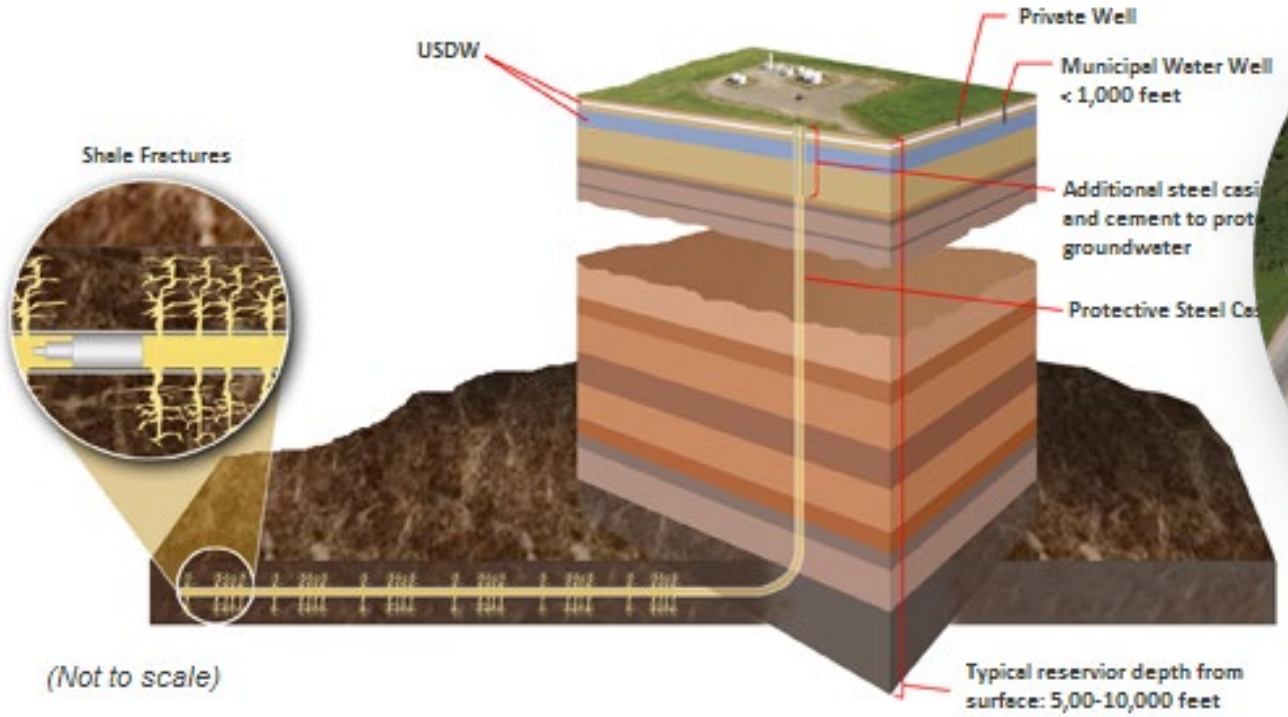
The Drake Well

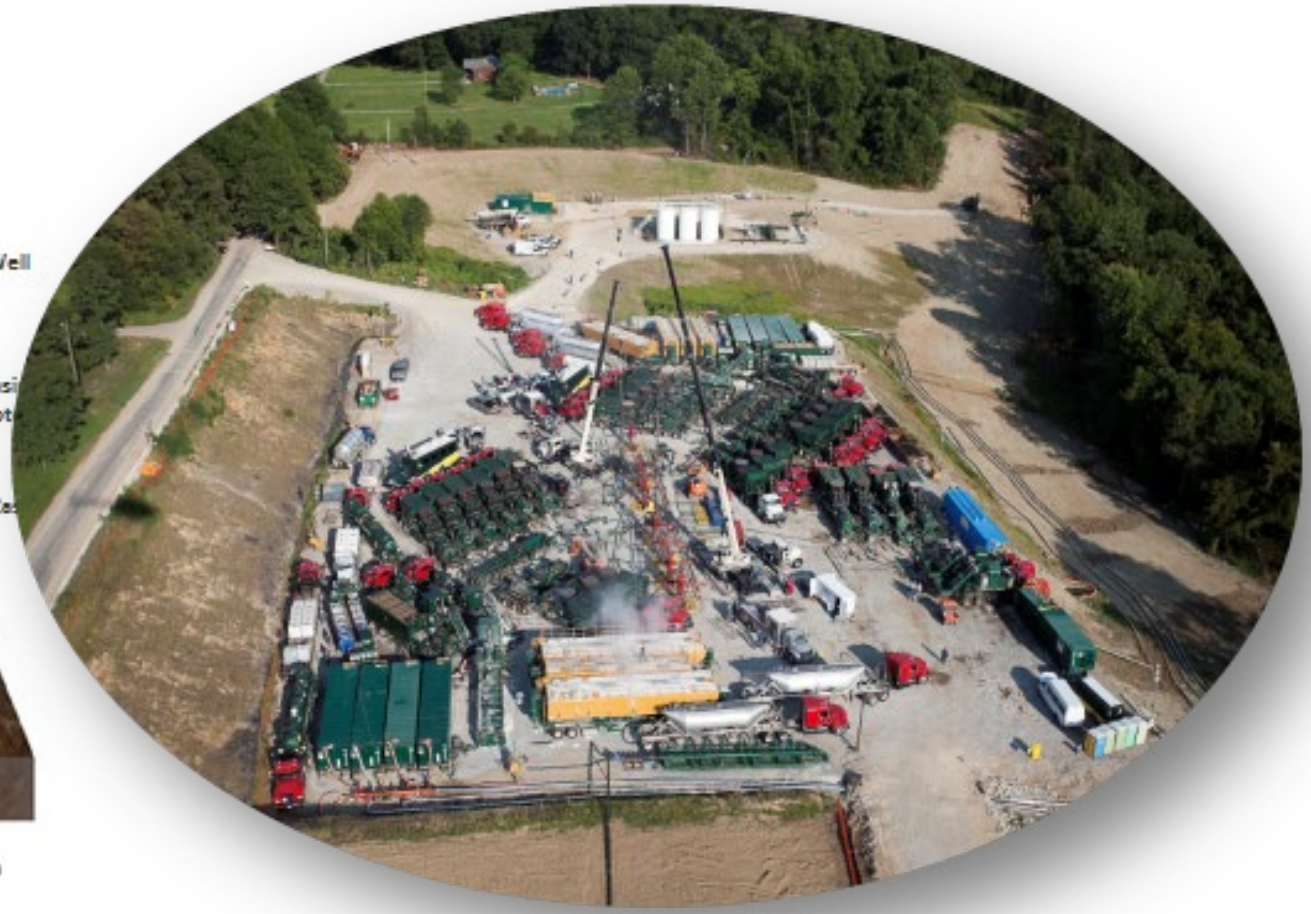


Photos Courtesy of the Drake Well Museum and Park Collection

Modern Natural Gas Production

Marcellus Shale Well Pad

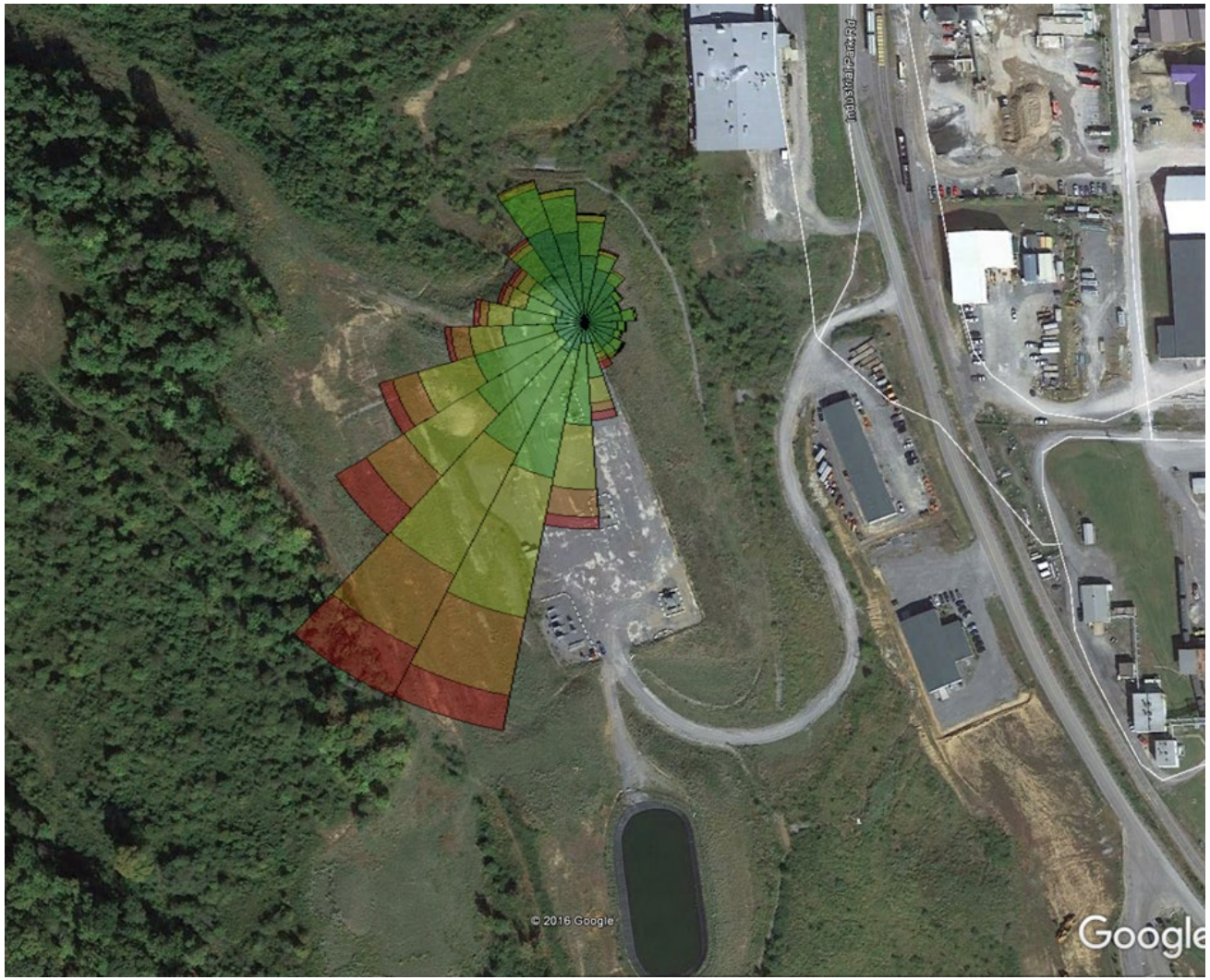




Ambient Air Monitoring

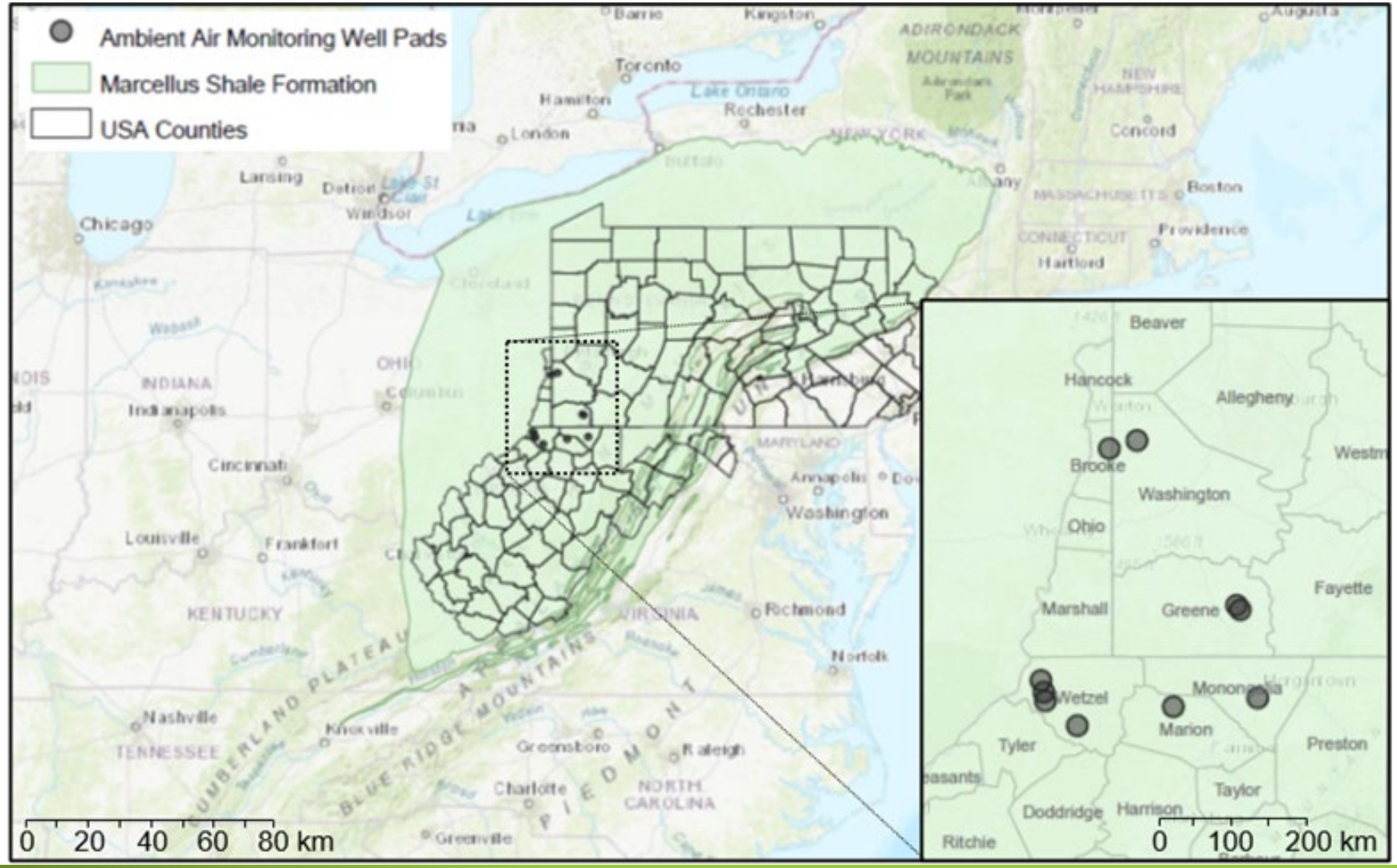
NETL's Mobile Air Monitoring Laboratory

Methane
Carbon Dioxide
Volatile Organic Compounds (VOCs)
Nitrogen Oxides (NOx)
Ozone
Particulate Matter (PM)



Monitoring Laboratory Deployments

Ten Marcellus Shale Well Pads in Southwest PA and North WV



Collaboration with site operators provided activity logs for activity phase dates and times at each location:

Drilling through Production

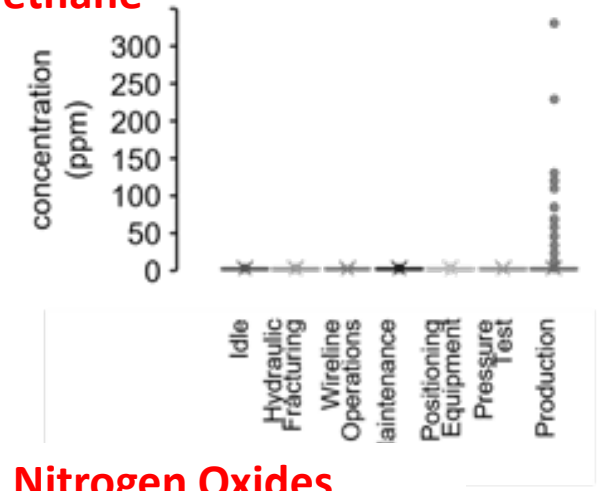
Evaluating Measurements by Well Pad Activity

Example of Summary Statistics for One Well Pad

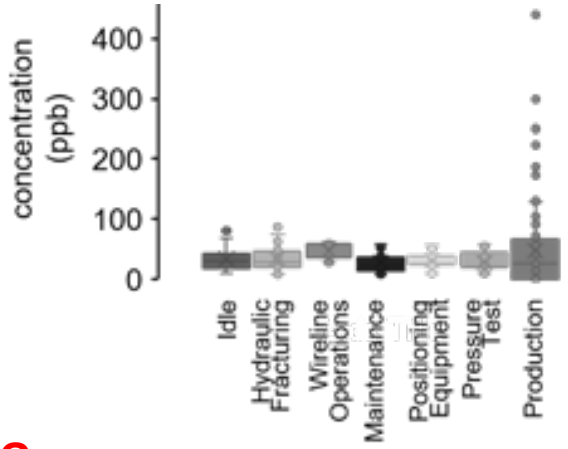
Phases of Operations:

- *Idle*
- *Hydraulic Fracturing*
- *Wireline Operations*
- *Maintenance*
- *Positioning Equipment*
- *Pressure Testing*
- *Production*

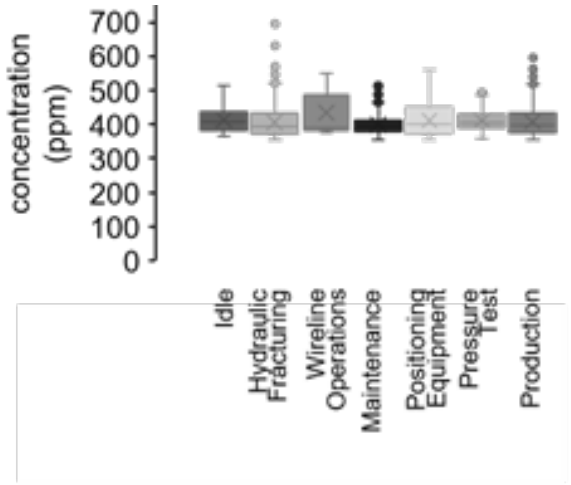
Methane



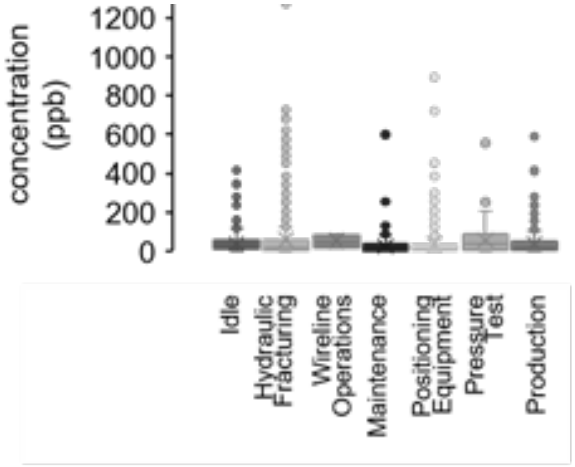
Ethane



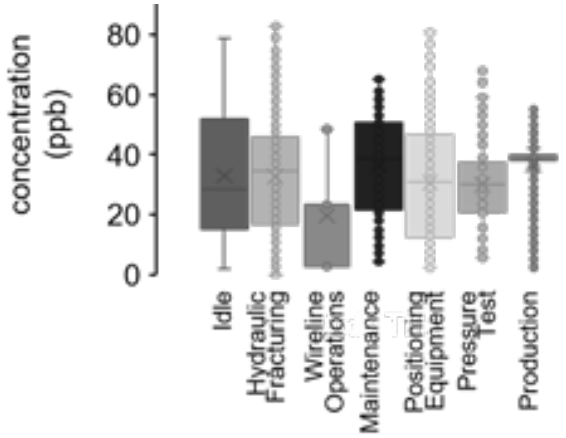
Carbon Dioxide



Nitrogen Oxides

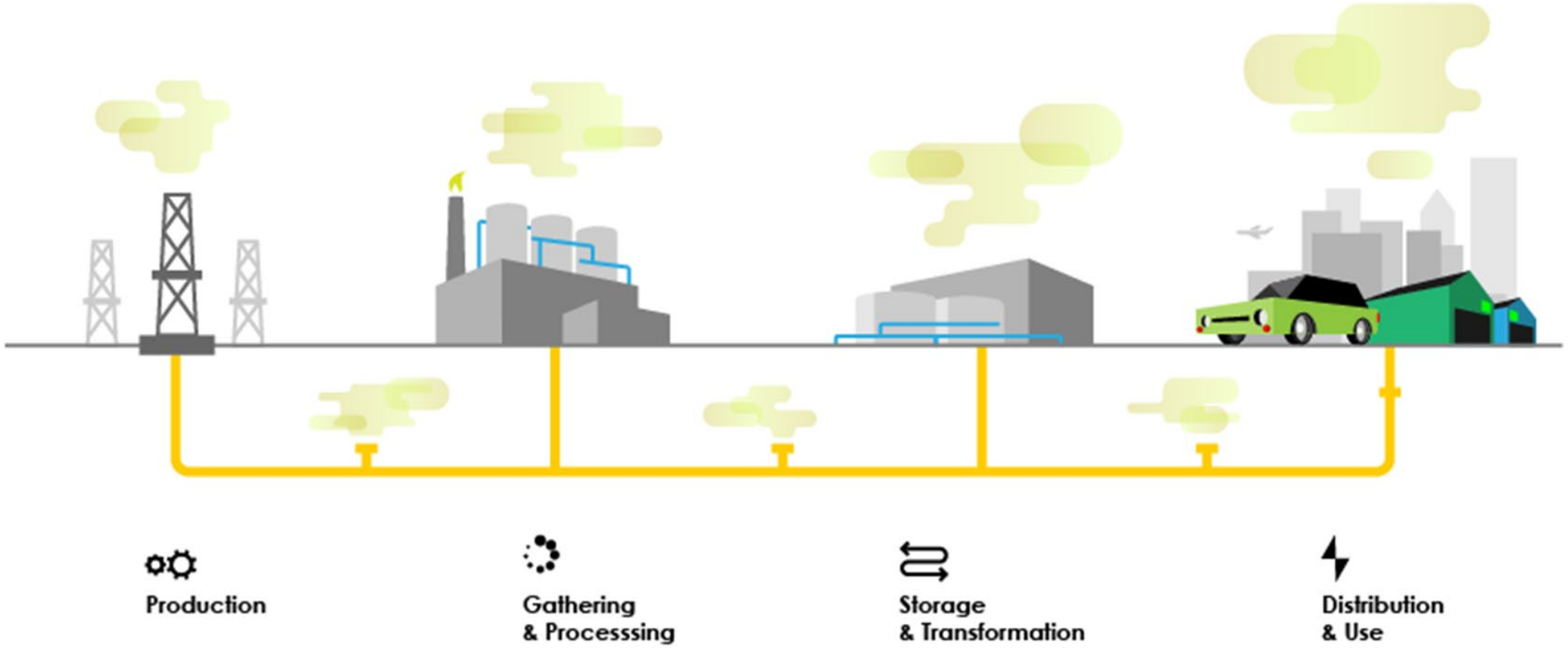


Ozone



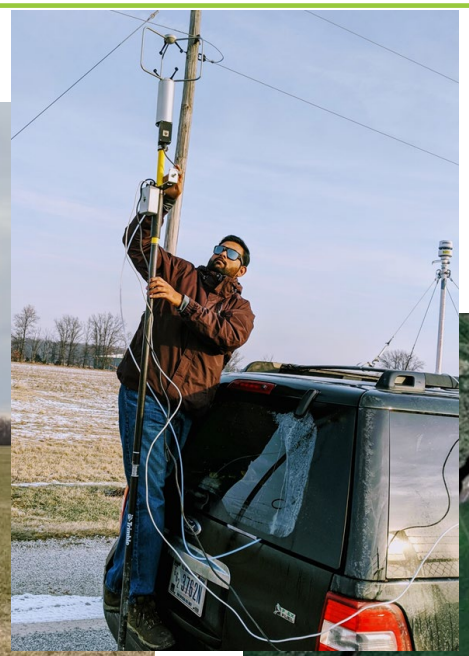
Emissions Quantification Throughout Natural Gas System

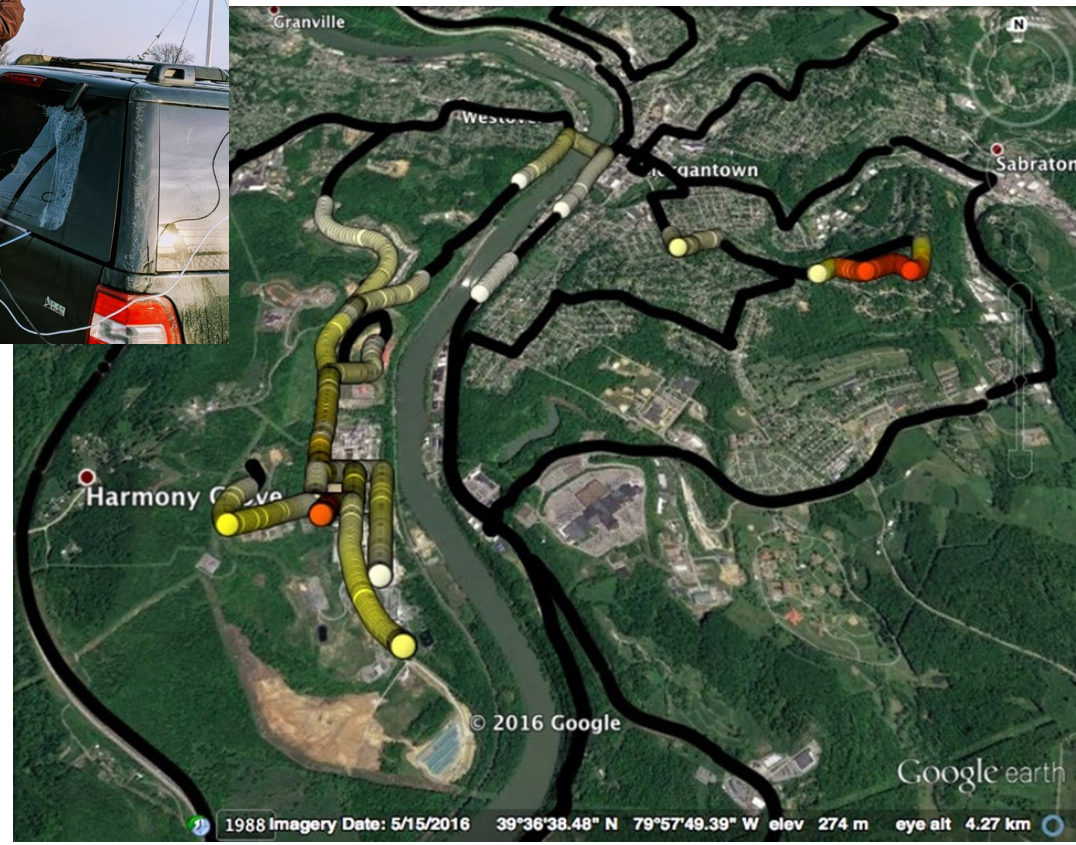
Source-specific, Targeted Monitoring Campaigns



Vehicle-based Surveys to Find Methane Leaks

Locating and quantifying leak rates



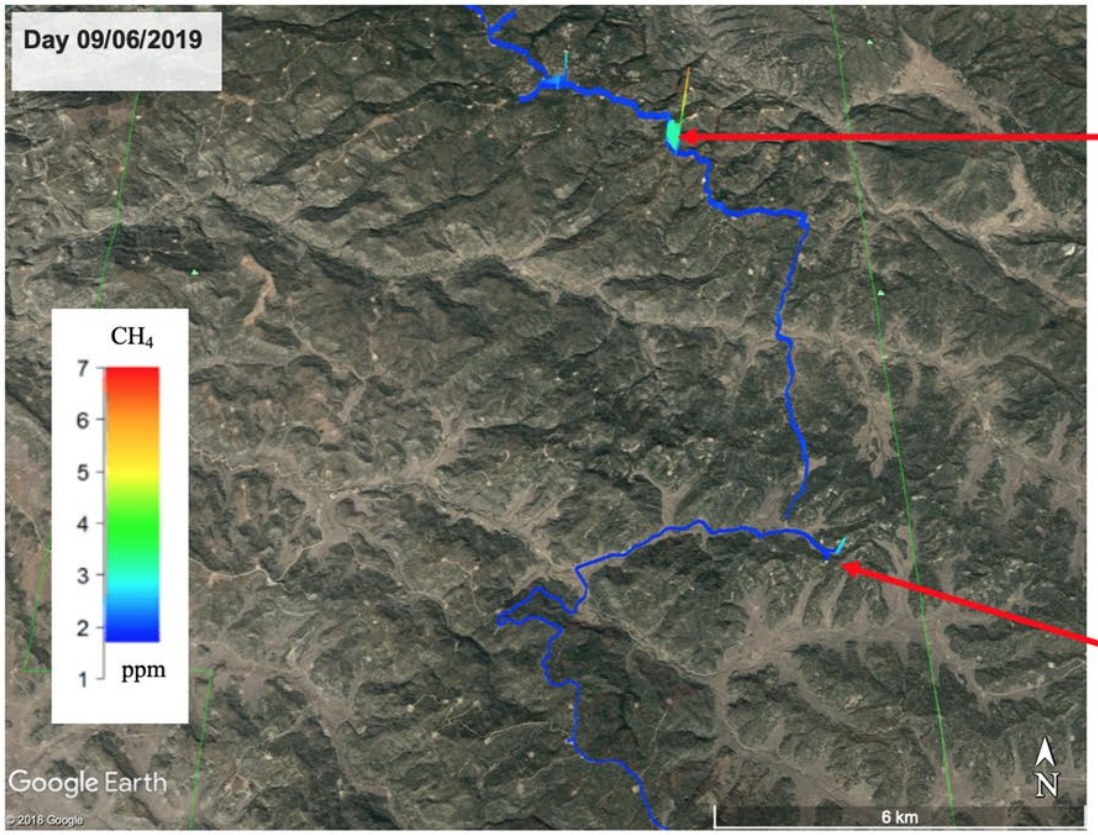


Using Vehicle-based Surveys to find Pipeline Leaks

Natural Gas Gathering Pipeline Emission Factor Improvement

- Field campaign in New Mexico
- Mobile survey platform is efficient in identifying methane hotspots and leak sources:
  - Leaks from aboveground pipeline infrastructure
  - 80% wells spud after 1980s
  - Most pipelines protected steel/plastic

(A)

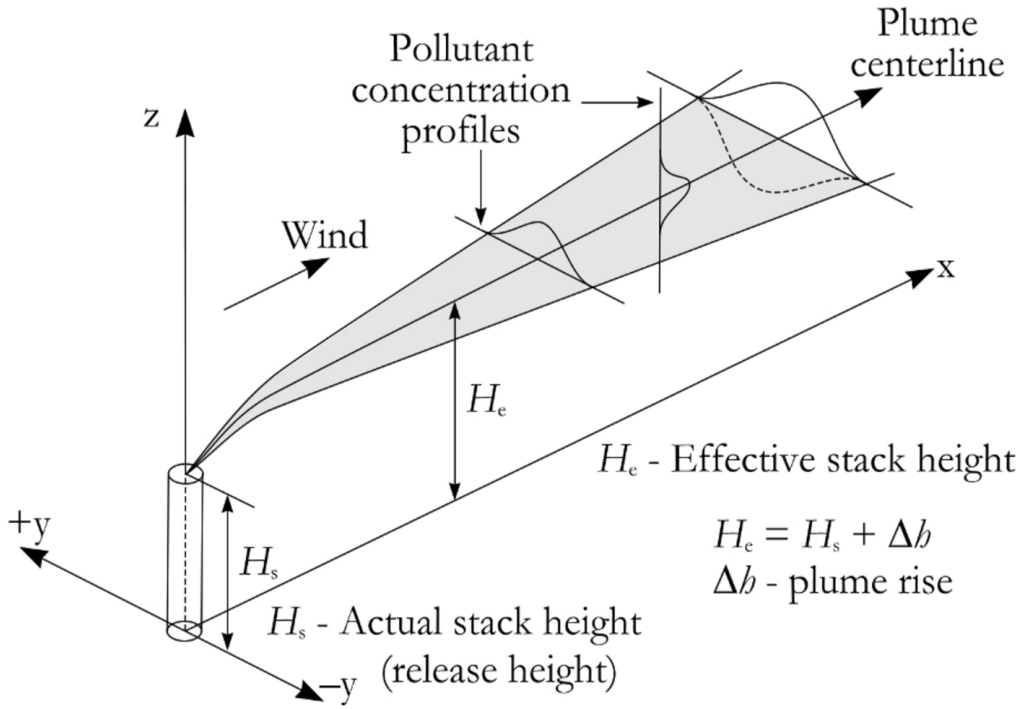


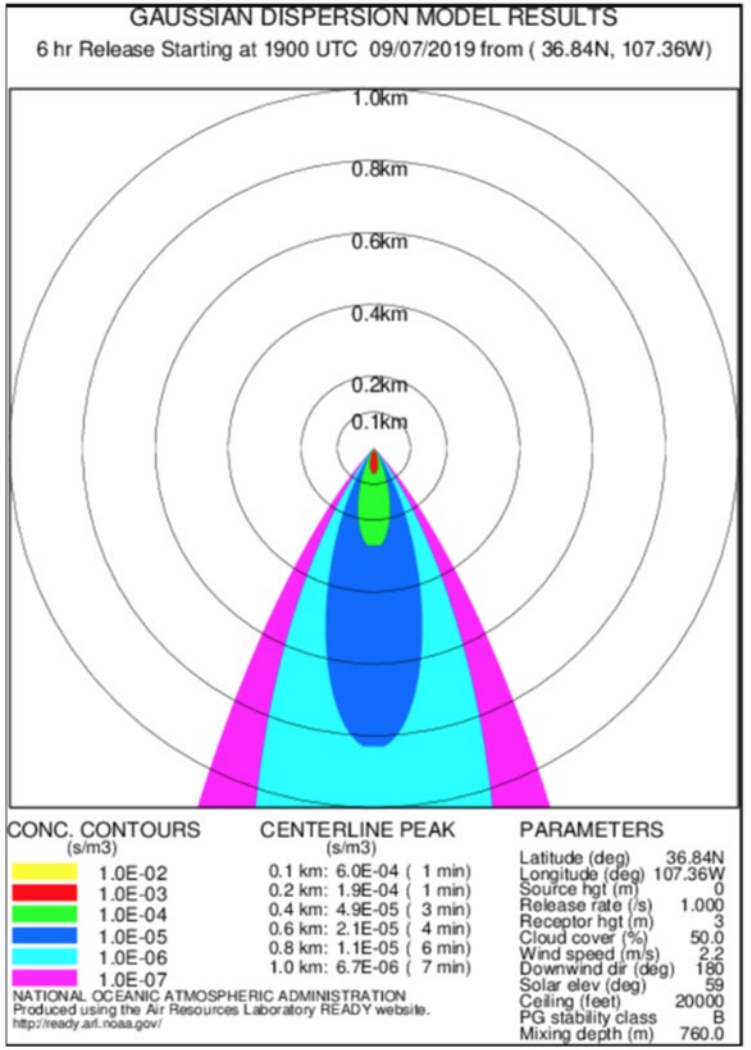
(B)

(C)

Using Vehicle-based Surveys to find Pipeline Leaks

Natural Gas Gathering Pipeline Emission Factor Improvement





Schematic figure of a Gaussian plume. Our mobile platform can detect small leaks ~1.5 LPM (0.02 g/s):

- Categorized as small leaks, ~94% of 230 leaks from a national distribution pipeline study

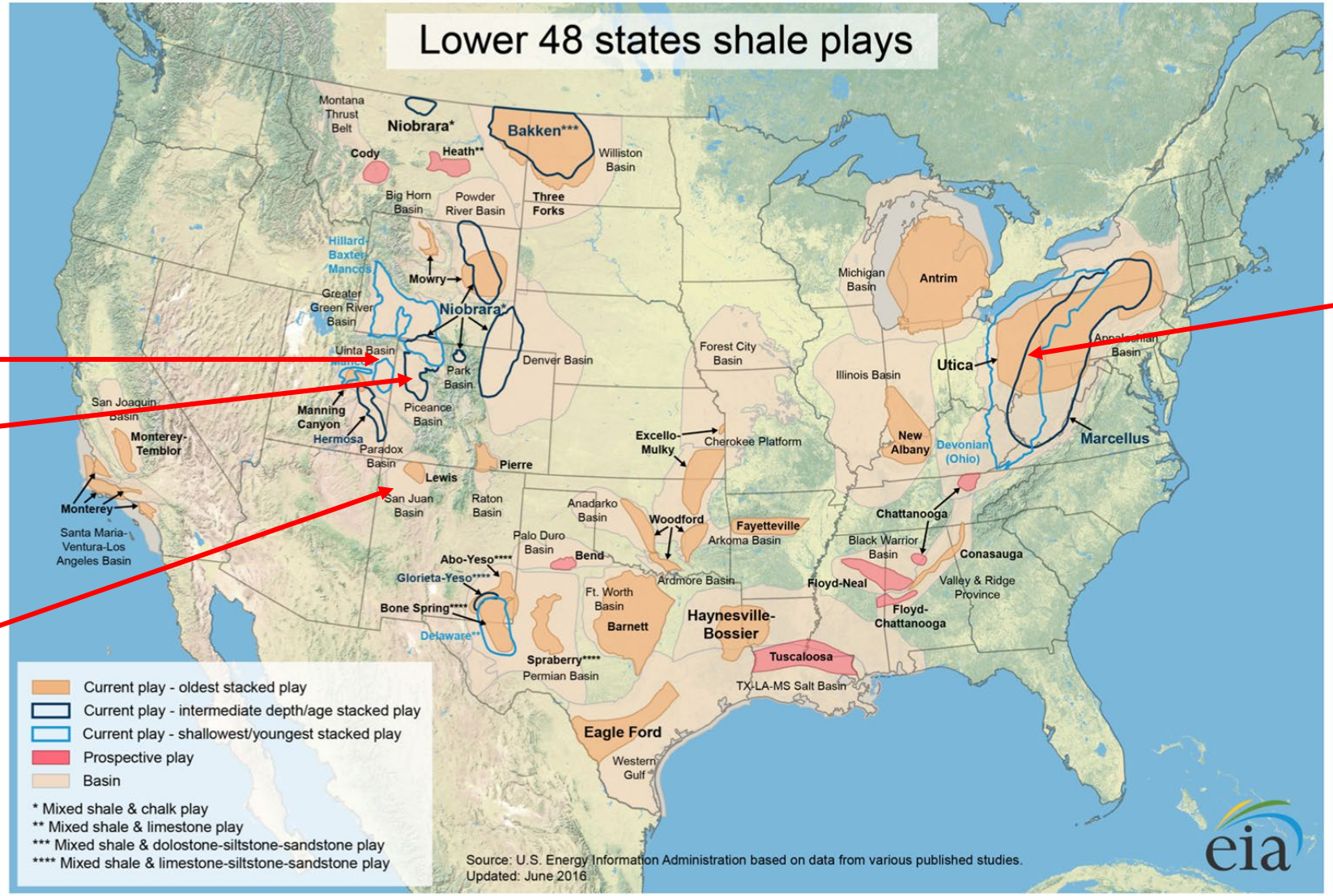
Using Vehicle-based Surveys to find Pipeline Leaks

Total mileage surveyed **~230 miles**

Utah, 50 mi
Feb. 2020

Colorado, 20 mi
Sep. 2019
Feb. 2020

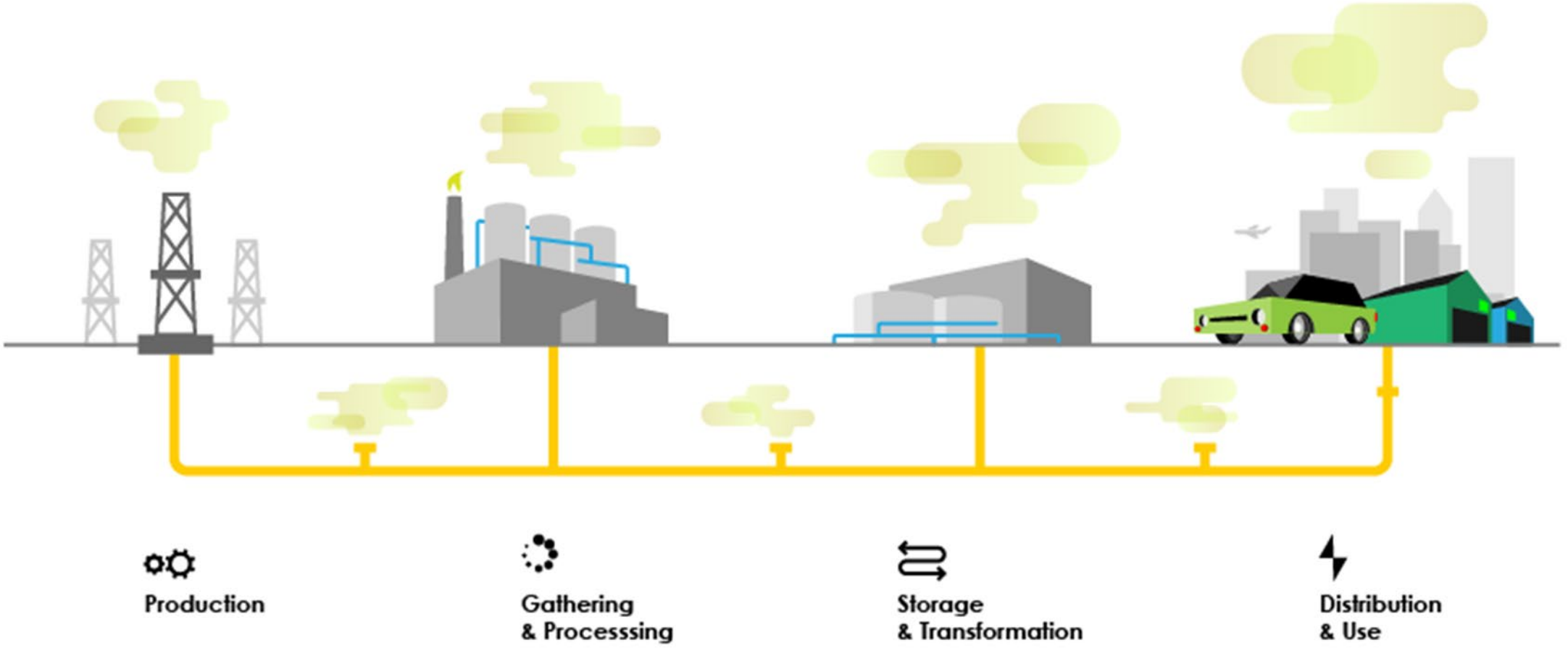
New Mexico, 116 mi
Sep. 2019



Ohio, 46 mi
Mar. 2019

Quantifying Methane Emissions from M&R Stations

Metering and Regulating Stations: Custody Transfer - Transmission to Distribution



Quantifying Methane Emissions from M&R Stations

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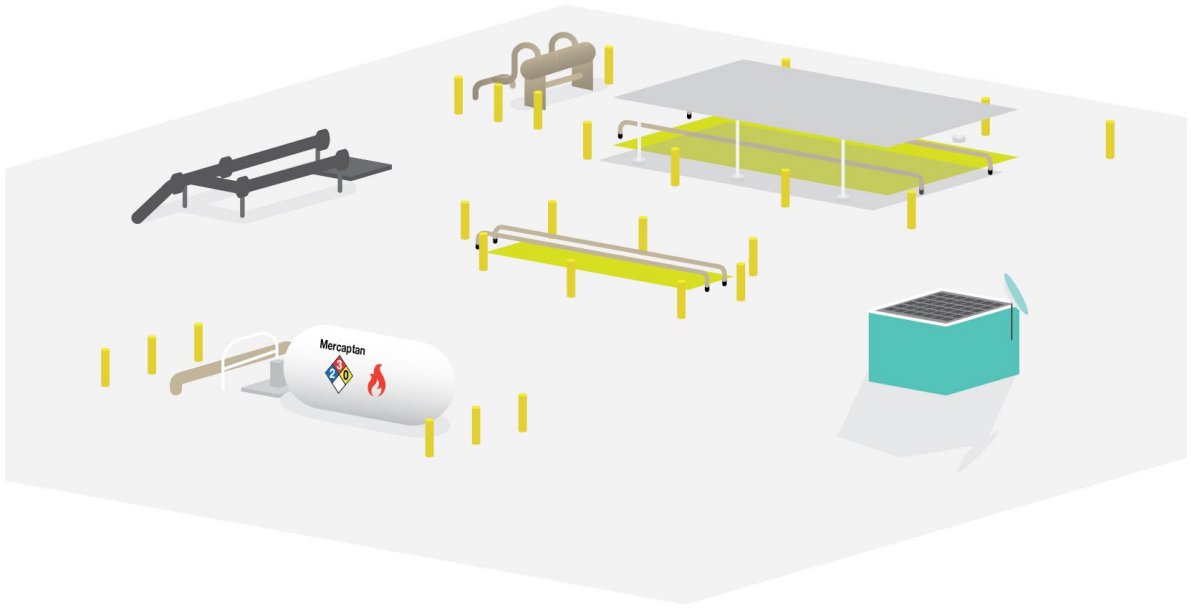
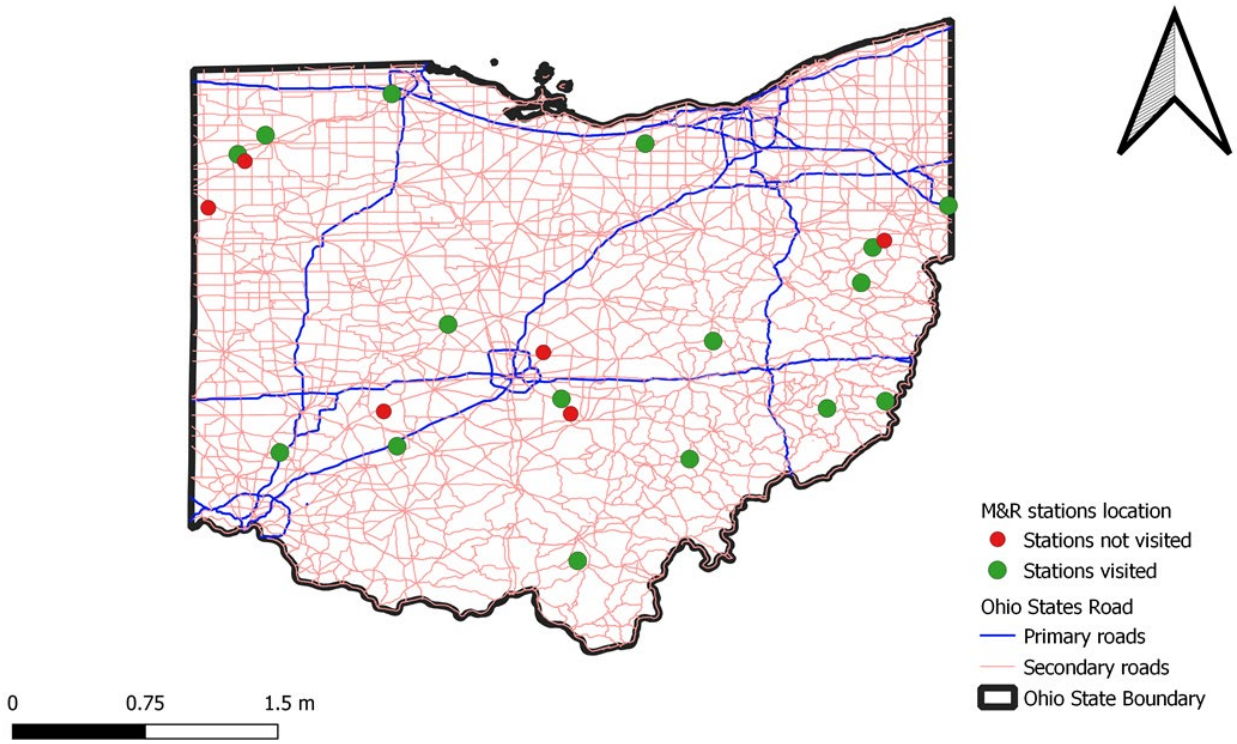
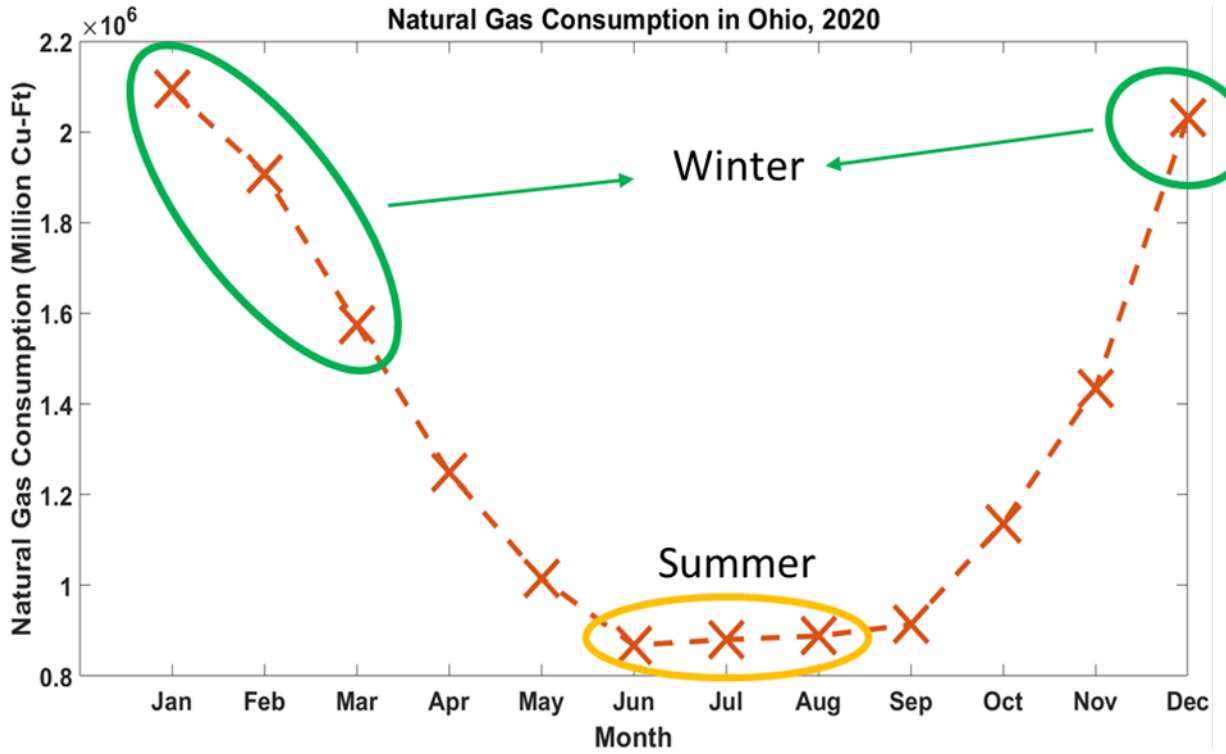


Quantifying Methane Emissions from M&R Stations

Case Study: 22 M&R Stations in Ohio

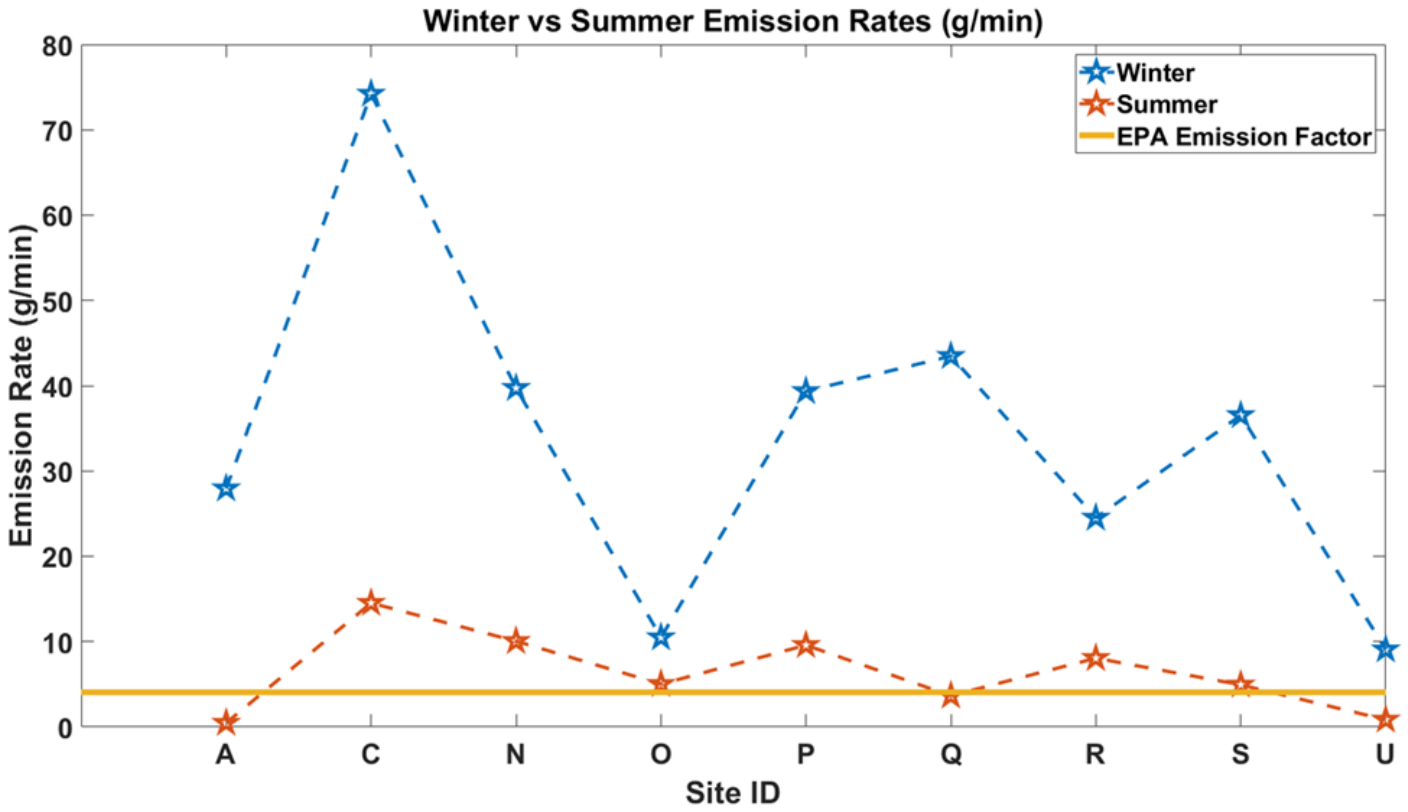




From Rextag Database: Identified 22 M&R Stations in Ohio
Conducted surveys in Winter and Summer months to compare seasonal variation

Quantifying Methane Emissions from M&R Stations

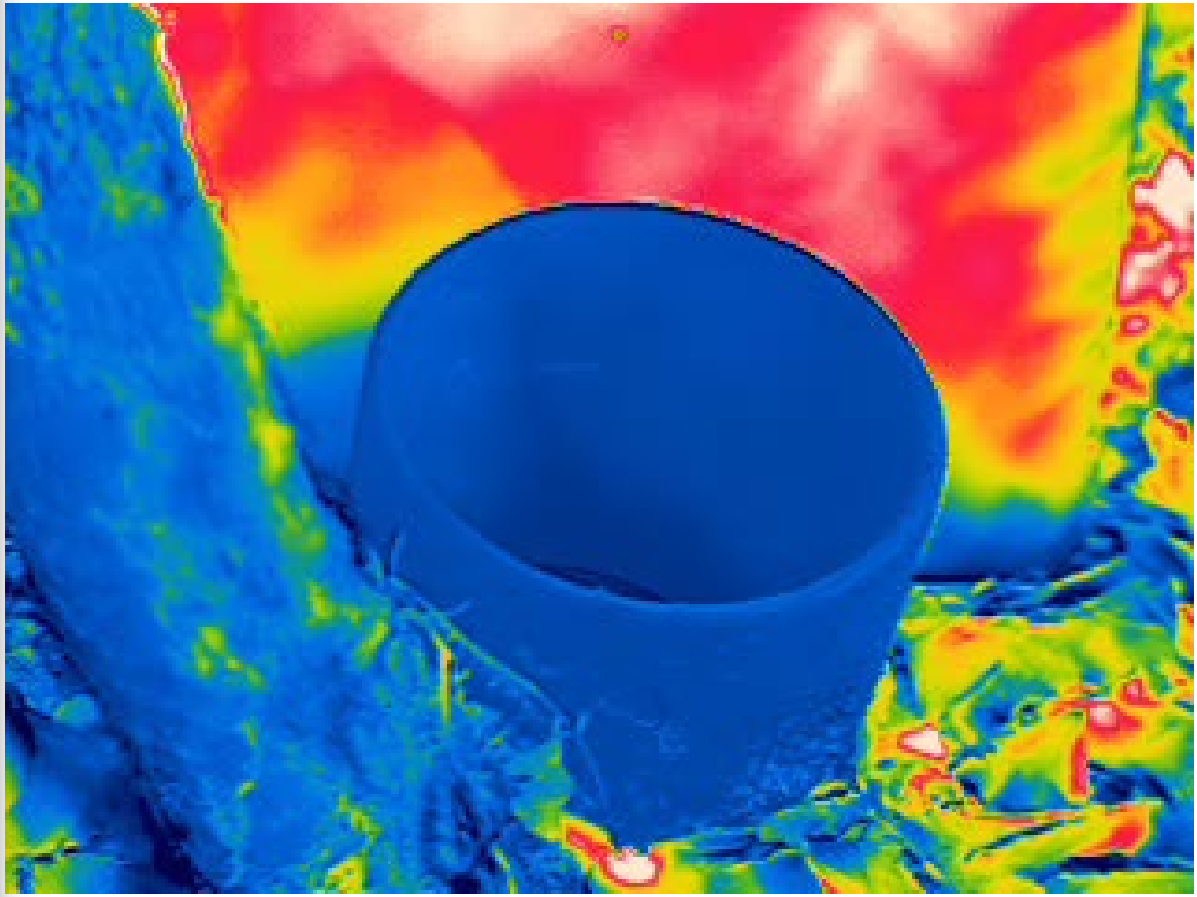
Case Study: 22 M&R Stations in Ohio - RESULTS



	Lamb et al. (2015) (EPA GHGI)	This Study	
Sample size, n	56	Winter	Summer
		9	9
Emission Rate (g/min)	**4.06**	**31.5**	**6.35**
Standard Deviation (g/min)	14.15	19.16	4.61

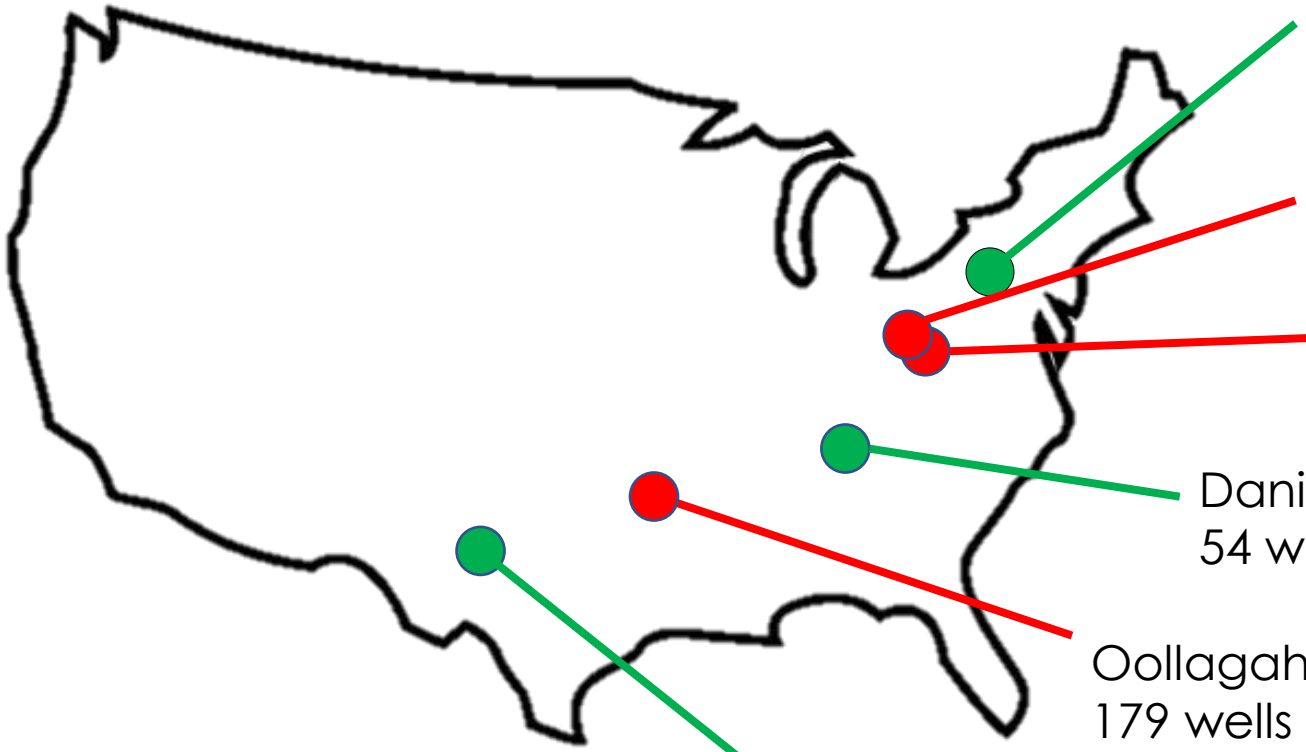
Methane Emissions from Orphaned Wells

Characterizing a Complex Legacy Environmental Problem using Advanced Sensor Technologies



Estimating GHG Footprint of Orphaned Wells

Completed (Red) and In-Progress (Green) Study Areas



Private Property near Olean, NY
Approx. 77 wells (21 unplugged/56 plugged)

Oil Creek State Park, PA
138 wells (67 unplugged/71 plugged)

Hillman State Park, PA
31 wells, all unplugged

Daniel Boone National Forest, KY
54 wells (53 unplugged/1 plugged)

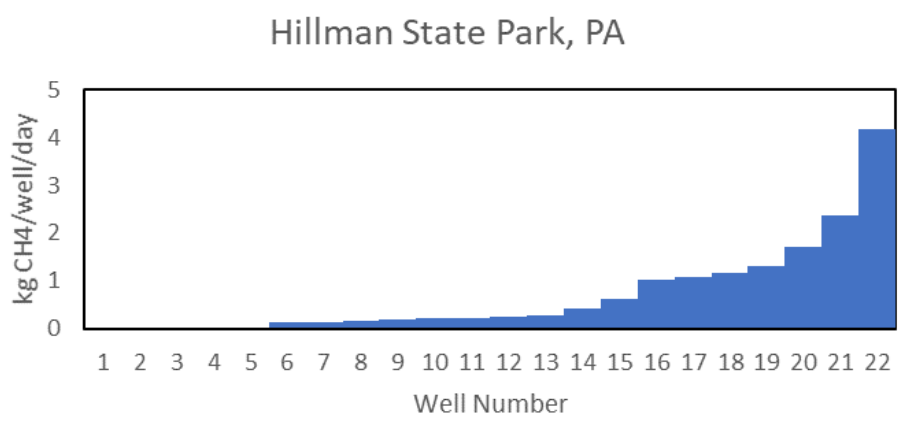
Oollagah Lake area, OK
179 wells (159 unplugged/20 plugged)

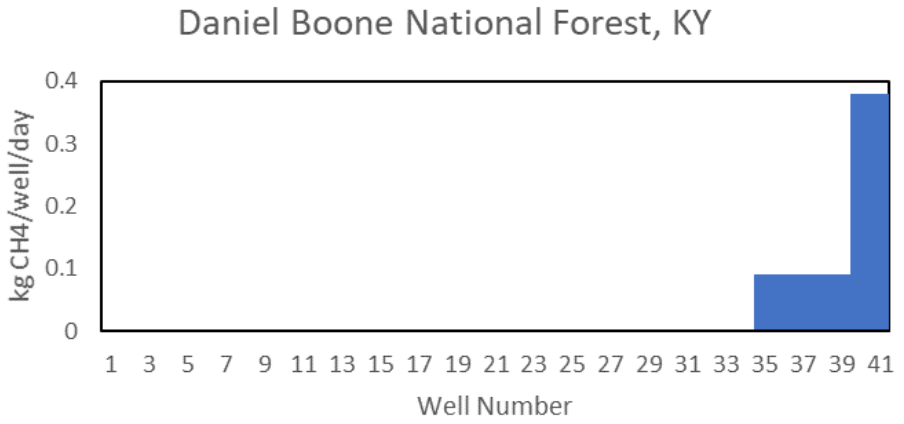
Private Property near Midland, TX
Approx. 100-200 wells, plugged

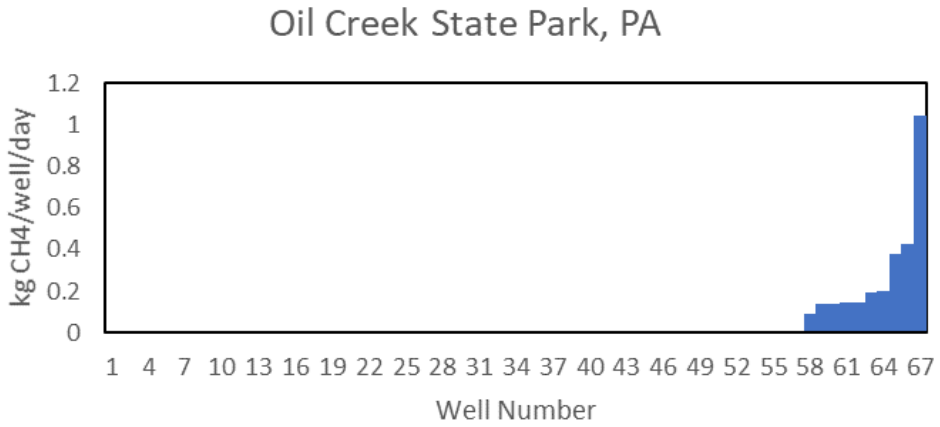
Estimating GHG Footprint of Orphaned Wells

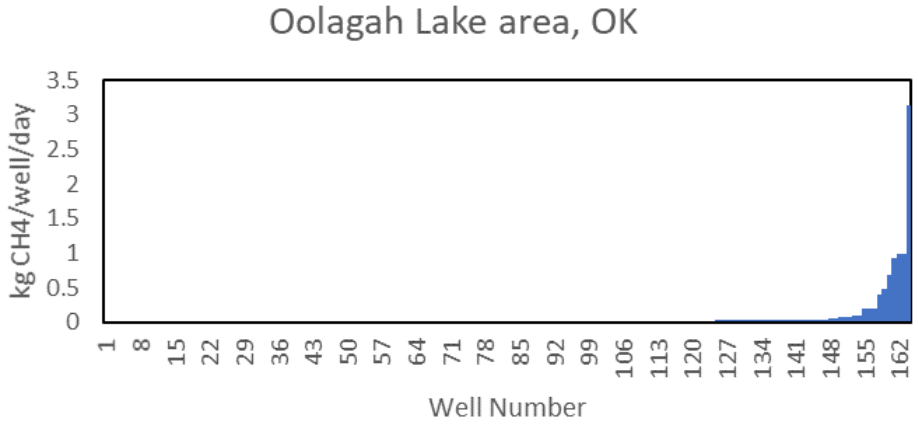
Methane Emission Factors: Fat-tailed Distribution Characterized by "Super Emitters"

UNPLUGGED WELLS



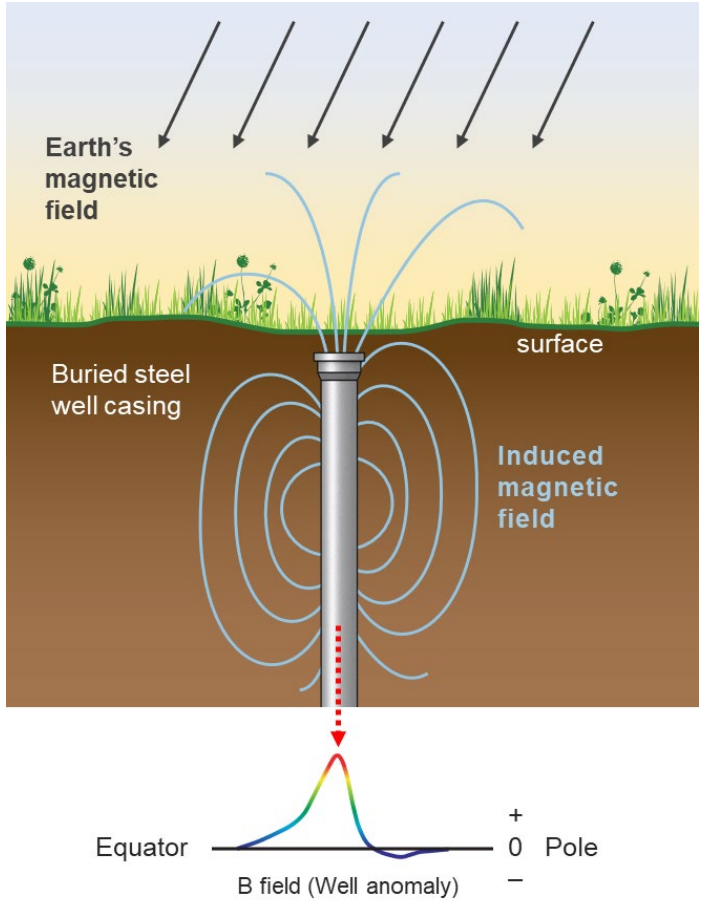


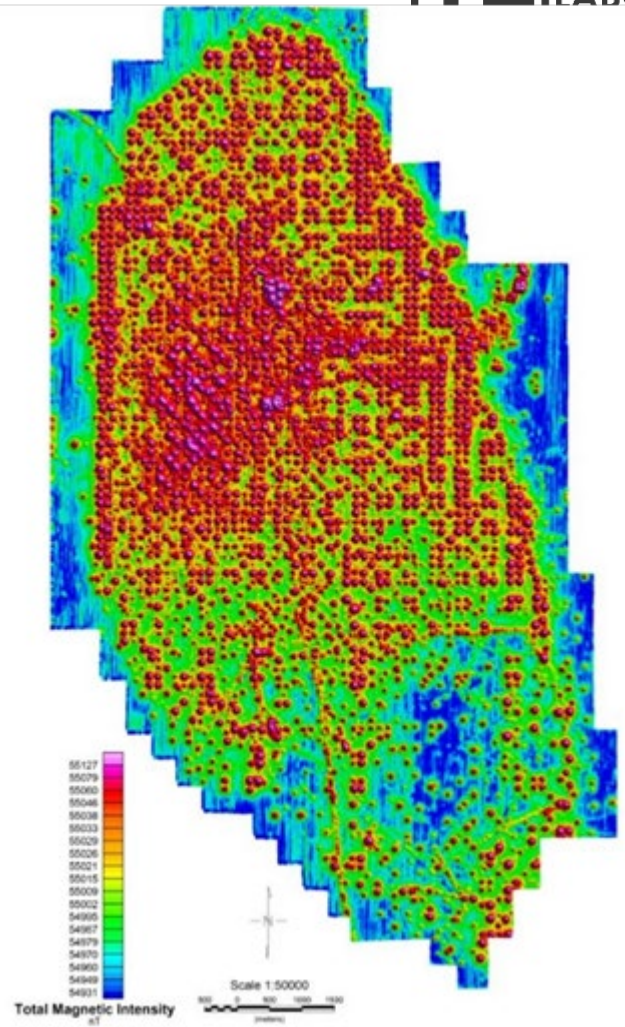




Major Challenge: Finding Orphaned Wells

Aerial Magnetic Surveying Techniques for Finding Wells





Thank you!
Questions?

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