Project Astra:

Large-scale continuous monitoring networks for detecting and quantifying methane emissions from oil and gas production operations

Vincent M. Torres, Field Ops Manager

David T. Allen, Principal Investigator

The University of Texas at Austin

Conducted by The University of Texas at Austin in collaboration with

- Chevron
- Environmental Defense Fund
- ExxonMobil
- Gas Technology Institute (GTI)
- Microsoft
- Pioneer Natural Resources
- SLB

Project Astra

www.projectastra.energy

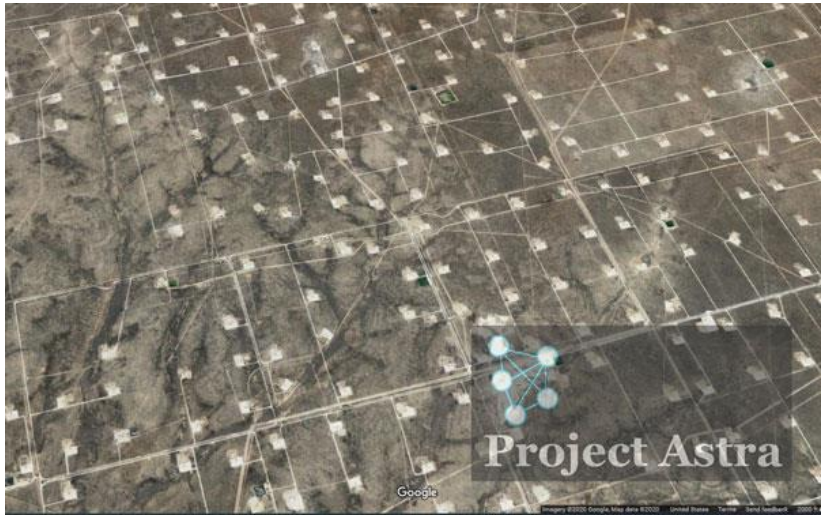
Objective: To demonstrate a novel approach to monitoring methane emissions from upstream oil and gas production sites, using advanced sensing technologies and data analytics.

Project Astra approach will:

- Transform methane emission detection from labor intensive OGI surveys, inefficient at finding and slow to repair emissions, into fixed, sensor intensive, continuous monitoring networks that use advanced data analytics to efficiently deploy operators
- And quickly find emission sources and repair leaks at the same cost (or less) as current survey methods

From →

To ↘



Project Astra Phases & Status

- Sensor inter-comparison - Completed;
- Design stage of Digital Methane Challenge - Completed;
- Pilot launched – In progress

1.

Methane Sensor Inter-comparison

An in-field assessment and selection of sensors for the Project Astra pilot network

3Q 2020-3Q 2021

2.

Digital Methane Challenge

Using a digital twin of the pilot area, determine the optimized design of the sensor mesh network and the data analytics required to identify unintended emissions

3Q 2020 – 4Q 2022

3.

Project Astra Pilot

A multi-month, operating pilot of the methane network in the Permian Basin

4Q 2021 - 2023

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Methane sensor field inter-comparison

Key questions assessed during sensor inter-comparison

Goal of Phase: Identify sensors able to operate remotely unattended on their own power for months, continuously making reliable measurements

- What precision and accuracy can be provided by low-cost methane sensors?
- What is their data capture rate?
- Does their performance change over time?

Key questions assessed during sensor inter-comparison

- What precision and accuracy can be provided by low-cost methane sensors?
- What is the data capture rate?
- Does performance change over time?

Methods:

- 9 months of testing (October 2020 – June 2021)
- Periodically compared the 7 sensors against multiple certified gas standards in single blind challenges
- Continuously compared the sensors to a collocated state of the art TILDAS (1 ppb precision at 1 Hz)

Key questions assessed during sensor inter-comparison

- What precision and accuracy can be provided by low-cost methane sensors?

Multiple sensors could acheive ~10 ppb sensitivity at 1 Hz; multiple sensors were able to detect ~500 ppb changes in concentration at 1 minute resolution as compared to the TILDAS

- What is the data capture rate?

Multiple high and moderate precision sensors had high data capture rates, > 80 – 90%

- Does performance change over time?

Multiple sensor systems were challenged by the dust

Result: At the conclusion of the sensor intercomparison, we had identified a number of viable high and moderate resolution sensors that could be deployed in the network.

Final report available as a preprint

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Network Design Questions:

How many sensors are needed over the entire area and on each pad site?

What temporal resolution is required of the sensors?

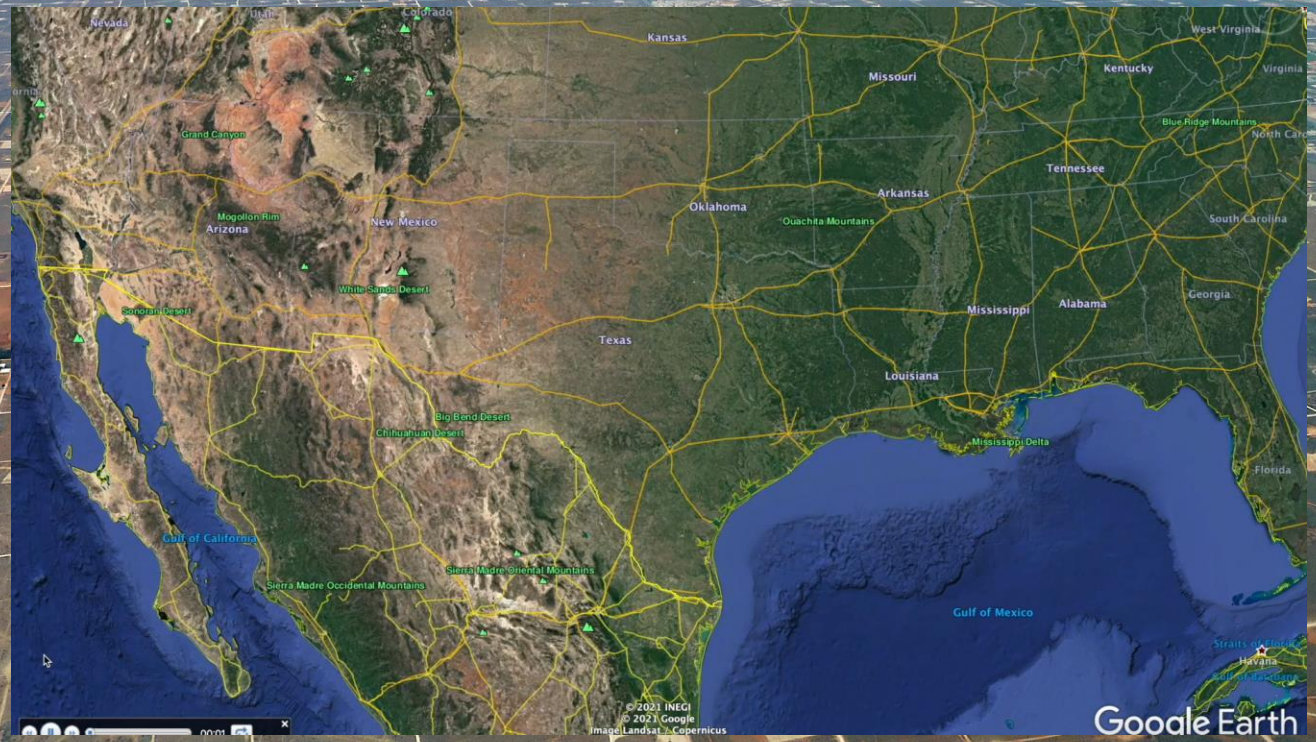
What accuracy is required?

Can low-cost sensors be used, i.e., would their resolution be adequate?

DIGITAL METHANE CHALLENGE – Used a fine spatial and temporal scale model of the pilot region with digital simulations of emissions in the atmosphere, and used the resulting concentrations of methane to design the network

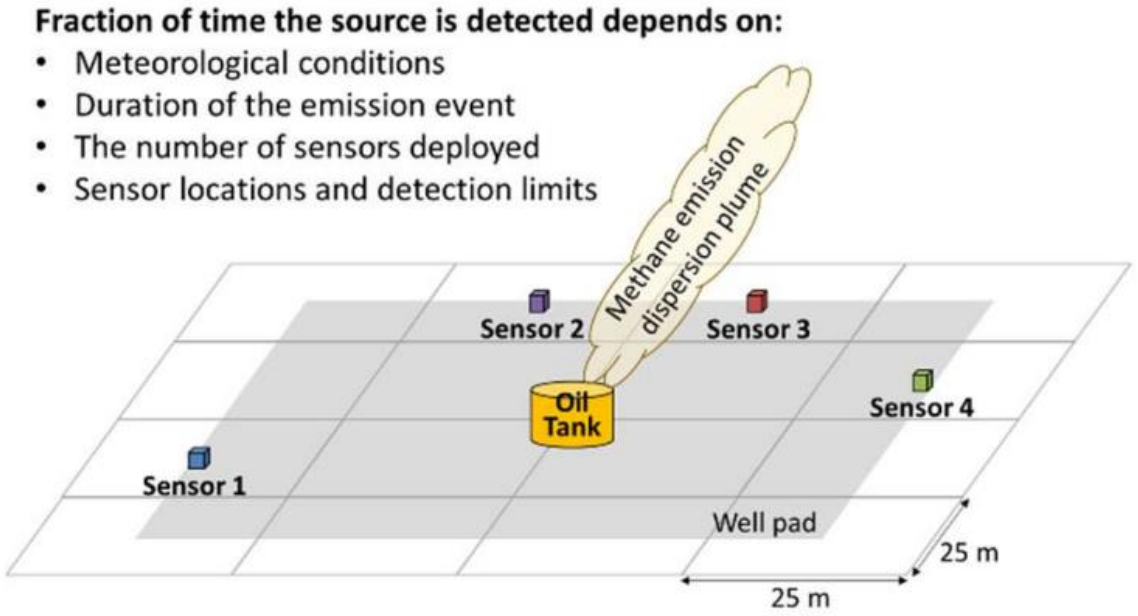
Using a digital twin to design detection networks for unintended methane emissions in oil and gas production regions

Simulate atmospheric dispersion



Network design problem

- For a single pad site, what numbers of continuous monitors, with what sensitivity are required to achieve a targeted design efficiency?

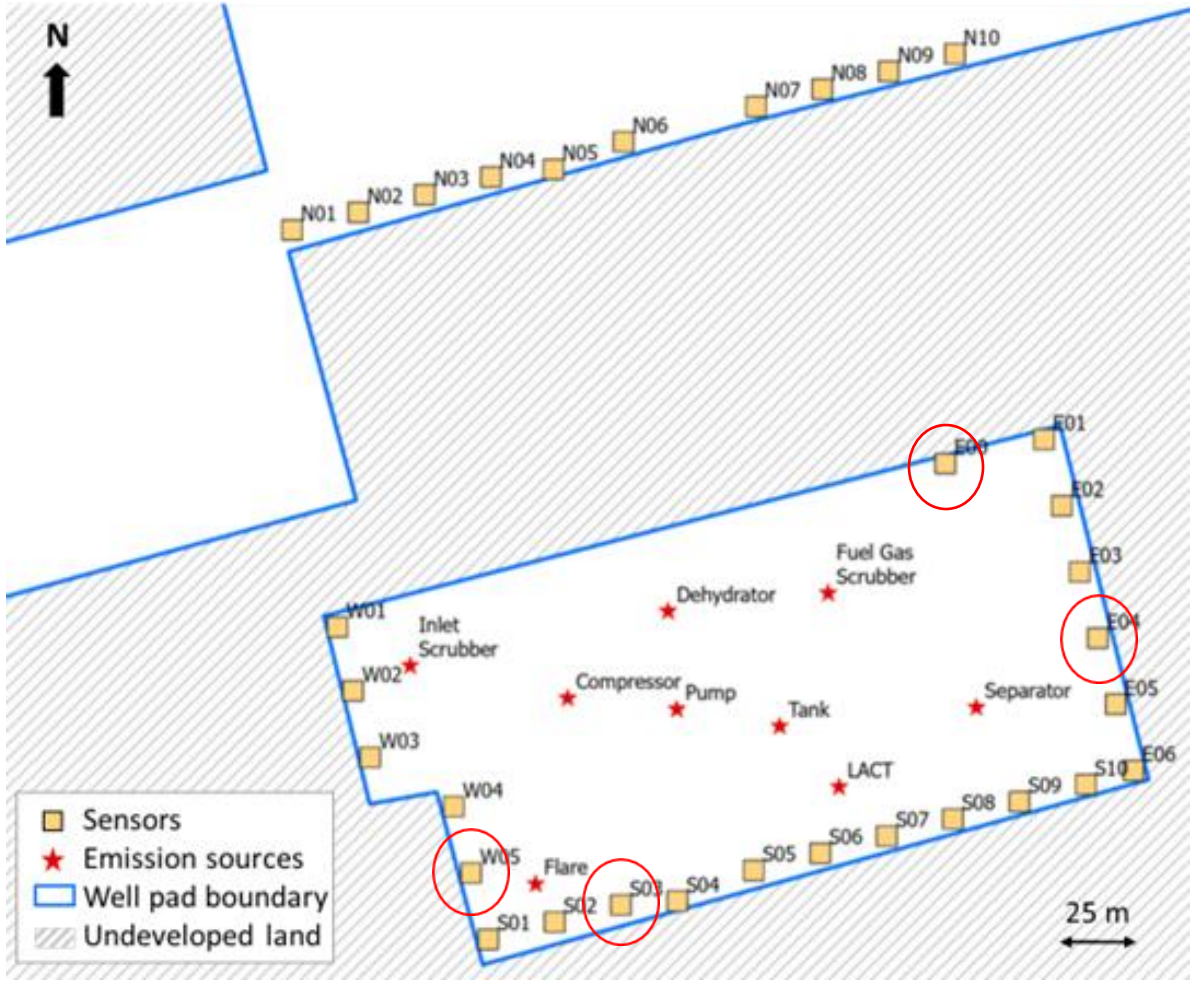


Prototypical single site configuration

Stack height of the equipment and plume rise parameters applied in dispersion modeling; temporal coverage of detection by source, with the optimized sensor network by maximizing averaged temporal coverage of detection among the nine simulated sources.

Equipment type	Stack height (m)	Plume rise (m)	Fraction of time with detection over 1000 ppb with the optimized sensor network
Compressor	6.9	5.0	5.0%
Dehydrator	2.0	0	21.6%
Flare	6.1	5.0	4.1%
Fuel gas scrubber	2.0	0	27.5%
Inlet Scrubber	2.0	0	10.7%
Lease Automatic Custody Transfer unit (LACT)	2.0	0	30.4%
Pump	2.0	0	22.0%
Separator	2.0	0	32.1%
Tank	5.5	0	21.9%

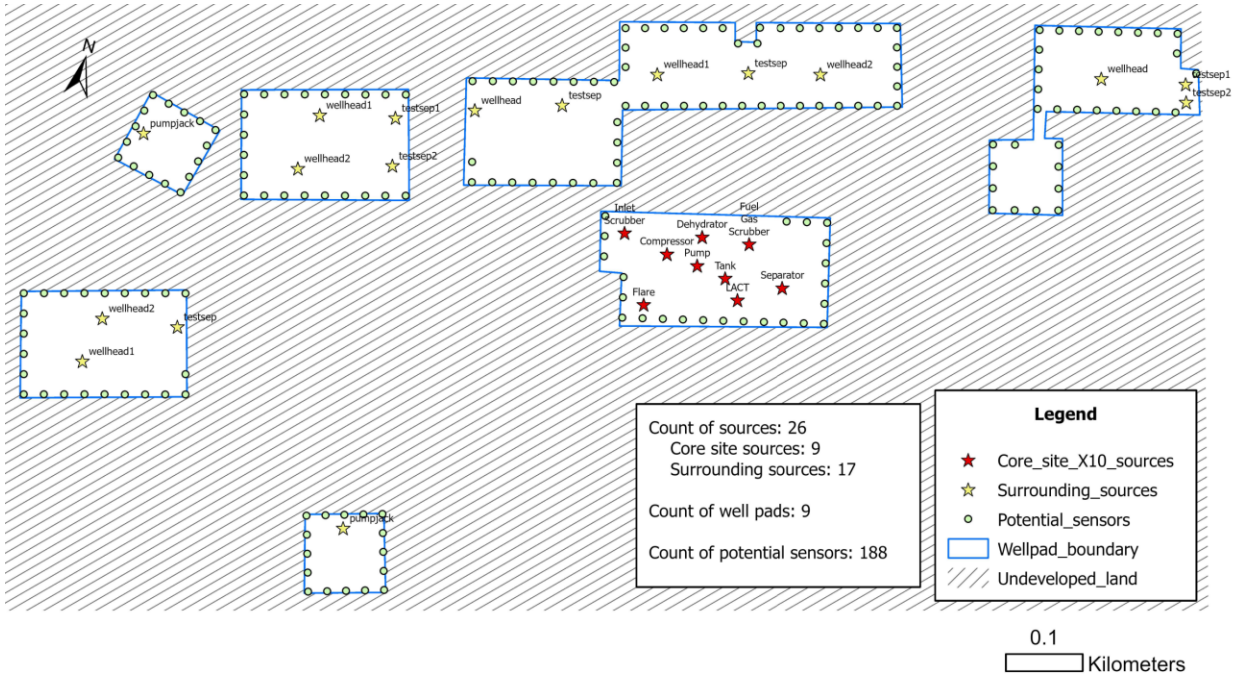
Established procedures to determine where to place sensors and how to interpret emissions detected to convert them to annual emission estimates.



Multi-site network design problem

- In a shared, multi-site network with sites of varying types, what numbers of continuous monitors are required to achieve a targeted design efficiency and where should they be placed?

- Constraint is the emission reduction efficiency at each site
- Optimize for minimum cost of sensors and responses, recognizing that detections may not occur on the same sites as emissions
- Use the digital twin to design and interpret emissions from the network



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Project Astra Pilot

Description

The initial period of the Project Astra pilot will run through 2023, for a network of approximately 50 sites; both moderate and high-resolution sensing systems are being run in parallel; emission events are being reported to operators and throughout the pilot, causes of the emission events detected by the network are determined to assess accuracy, and efficacy.

Outcome and next steps

Outputs from the pilot 1) support accelerated and enhanced emissions reductions by project participants; 2) inform a cycle of continuous improvement in the network design; 3) peer-reviewed publications, and 4) responses to EPA proposed rules and potentially enable a pathway to alternative compliance approval for the system. Project Astra findings will be summarized in a comprehensive report ("Playbook") scheduled to be released in late 2023, followed by an expansion of the network.

Project Astra
Summary of Conclusions To Date

- Current continuous emission monitoring systems (CEMS)
  - provide rapid emission detection
  - semiquantitative estimates of emission magnitude
  - can provide rapid communication of detections
  - challenges remain in source attribution and emission quantification
  - have some unique quantifiable advantages relative to other advanced emission measurement systems
- Multi-site networks have advantages in source attribution and emission quantification

More Information

Vincent Torres
(vmtorres@mail.utecas.edu)
David Allen
(allen@che.utexas.edu)

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