Surface-based Methane Monitoring and Measurement Network Pilot Demonstration: Project Astra Phase II

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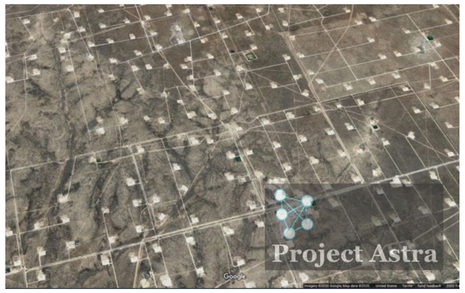
Project Astra: Advancing the Next Generation of Methane Emission Monitoring

- Project Astra is demonstrating a novel approach to monitoring methane emissions from oil and gas production sites, using a multi-operator, shared network with advanced sensing technologies and data analytics
- Project Astra:
  - Phase I (2020-2023, prior to DoE support): Design and deploy an initial network covering ~50 well sites
  - Phase II (2023-2027, with DoE support) Expand the network to gathering and boosting and gas processing sites; improve emission quantification accuracy



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Astra partners

TEXAS The University of Texas at Austin · GTI ENERGY · Chevron · Microsoft · EDF Environmental Defense Fund · PIONEER Natural Resources · ExxonMobil · Schlumberger

Phase 1.1. Sensor Inter-comparison

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

Methods

- 9 months of testing (October 2020 – June 2021)
- 7 sensors compared against multiple certified gas standards in single blind challenges
- Sensors compared 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 with ~10 ppb sensitivity at 1 Hz; multiple sensors able to detect ~500 ppb changes in concentration at 1 minute resolution

What is the data capture rate?

- Multiple high and medium precision sensors had high (>80%) data capture rates

Does performance change over time?

- Multiple sensor systems challenged by dust, but challenges were overcome

Figure: Project Astra methane sensor inter-comparison site in the Permian Basin

Phase 1.2 and 1.3. Digital twin/pilot

Using a digital twin of the pilot area, determine the optimized design of the network and the data analytics required to identify unintended emissions; network pilot was deployed in 2022.

Created simulations of emission dispersion to address network design questions:

How many sensors are needed?

- One sensor per site capable of detecting large events with short (<1 day) average detection times due to the close proximity of sites in the Permian Basin

What precision is required?

- Time to detection and other performance characteristics are not sensitive to event detection thresholds, however, having accurate background concentrations is important

Pilot

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

Outputs from the pilot support accelerated and enhanced emissions reductions by project participants; inform a cycle of continuous improvement in the network design; and potentially enable a pathway to alternative compliance approval for the system. Project Astra findings are summarized in a comprehensive report released in January 2024, followed by Phase II, expansion of the network, funded by the Astra partners and DoE.

Summary of Phase 1

A ~40-page summary of findings from Phase 1 is available from the PI.

Phase 2: Expansion and improved emission quantification

A four-year Phase 2 effort will expand the types of sites covered and will improve emission quantification capabilities

Objectives

1. Extend the Project Astra network to include gas gathering and boosting sites and gas processing sites.
2. Advance the detection and quantification capabilities of sensing technologies.
3. Support emission inventory improvements.
4. Demonstrate advanced data analytics and accelerate and automate responses to network emission detections.
5. Inform the development of Integrated Methane Modeling Platform Designs.

Phase 1 and 2 Publications

Sensor intercomparison

- Torres, et al. "Field inter-comparison of low-cost sensors for monitoring methane emissions from oil and gas production operations." *Atmospheric Measurement Techniques Discussions* (2022): 1-22. (preprint)

Sensor network designs and efficiency assessments

- Chen, et al. "Assessing detection efficiencies for continuous methane emission monitoring systems at oil and gas production sites." *Environmental Science & Technology* 57.4 (2023): 1788-1796.
- Schissel, et al. "Comparing the emission reduction effectiveness of continuous monitoring to periodic Optical Gas Imaging surveys for methane emissions at oil and gas production sites." *ChemRxiv* (2023). (preprint)
- Chen, et al. "Determining times to detection for large methane release events using continuously operating methane sensing systems at simulated oil and gas production sites." *ChemRxiv* (2023). (preprint)
- Chen, et al. "Simulated methane emission detection capabilities of continuous monitoring networks in an oil and gas production region." *Atmosphere* 13.4 (2022): 510.

Detection limits

- Chen, et al. "Defining detection limits for Continuous Monitoring Systems for methane emissions at oil and gas facilities, submitted to Atmosphere (2024)