A multi-scale methane monitoring system for enhancing emission detection, quantification, and prediction

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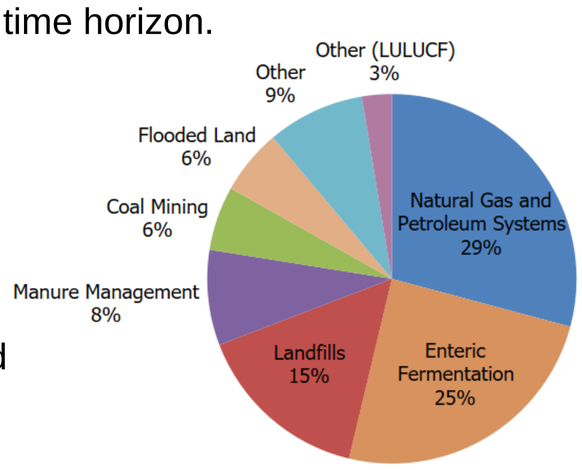
Project Summary

- The goal of this project is to *create a comprehensive plan to develop and deploy an integrated continuous methane monitoring and reporting system to locate methane emissions and inform near real-time mitigation decisions*.
- This system is expected to integrate traditional, state-of-the-art, and cutting-edge *sensor technologies* and *inverse modeling* to identify and characterize methane emissions from both chronic and super-emitters.

Background and Motivation

- CH_4 is a powerful greenhouse gas with a global warming potential 28 times that of CO_2 over a 100-year time horizon.
- Globally, natural gas and oil sectors represent 63% of total fossil fuel related CH_4 emissions (80 Tg CH_4 yr^{-1}) for the 2008–2017 decade.
- In the U.S., natural gas and petroleum systems are the second largest source of CH_4 emissions, accounting for 29% of total CH_4 human-caused emissions.

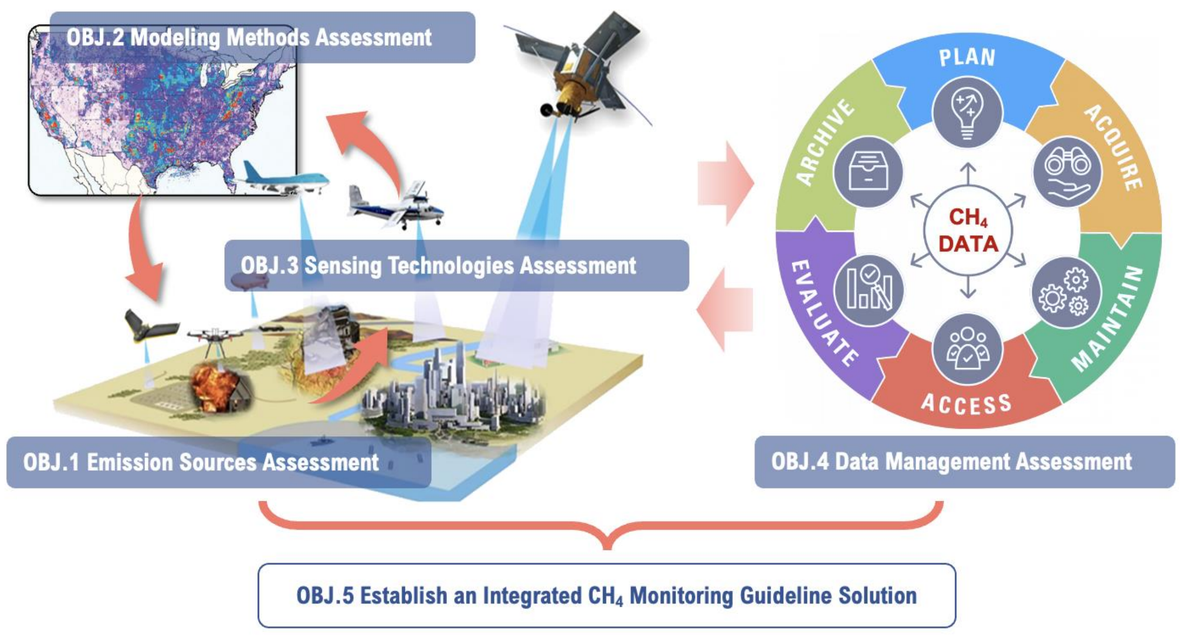


EPA inventory (1990–2021)

- The ability to rapidly and accurately assess the amount of location of chronic and super-emitting CH_4 releases, which may vary greatly in space and time, plays a great role in facilitating effective emission mitigation actions.
- **Technological gap:** we lack standardized approaches for effectively integrating **multiscale observation/detection platforms** and **inverse modeling methods** to accurately estimate and reduce methane emissions.

Project Objectives

- Summarize existing anthropogenic CH_4 emission sources
- Evaluate top-down and bottom-up CH_4 inverse modeling methods
- Assess existing, novel, and emerging CH_4 detection methods
- Evaluate data management practices for an integrated platform
- Establish design and specification for an integrated platform



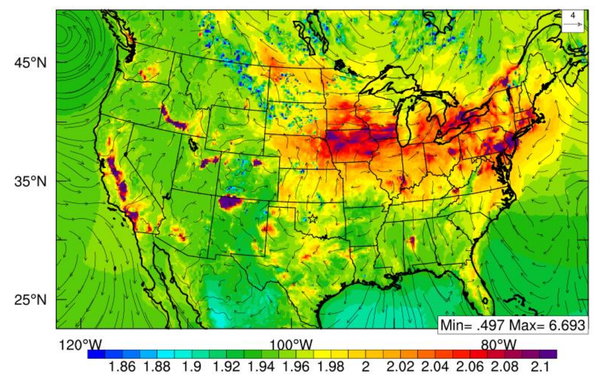
Collaborators and Industrial Partners

devon · ENLINK MIDSTREAM · COTERRA · Oklahoma Geological Survey 1908

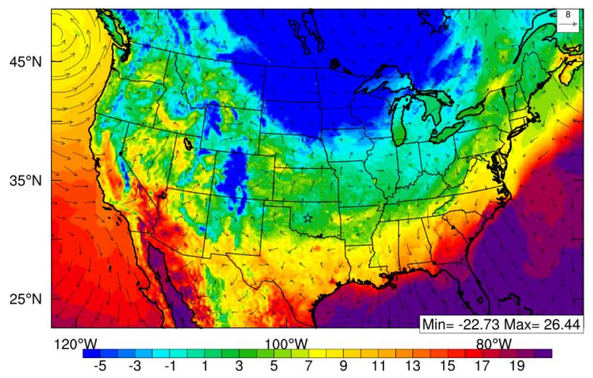
- Project PI: David Ebert (ebert@ou.edu)
- Check out a related OU-led project – **AIMNet: A Showcase of An Integrated Methane Sensing Network in Anadarko Basin (FE0032285)**

Assessment of CH_4 Inverse Modeling

- Deployment of real-time weather and CH_4 modeling framework for the continental U.S.
- Comparison of existing CH_4 inverse modeling approaches across various scales (advantages and limitations).



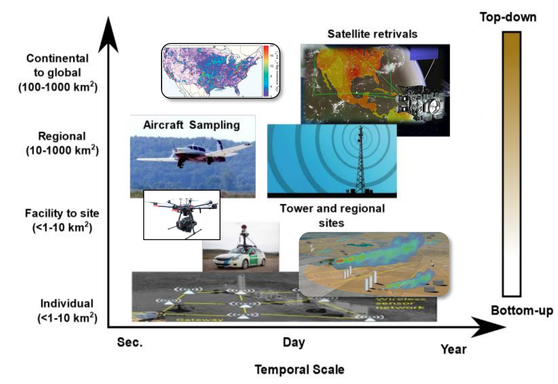
CH_4 concentration (ppmv)



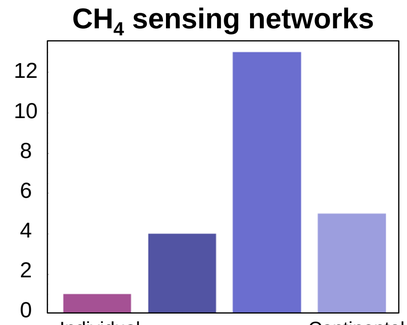
2-m air temperature (°C)

Intercomparison of CH_4 Sensing Technologies

- Intercomparison of CH_4 sensor technologies, platforms, and monitoring networks globally (fixed, mobile, aerial-based, remote sensing, and integration), including cost assessment.

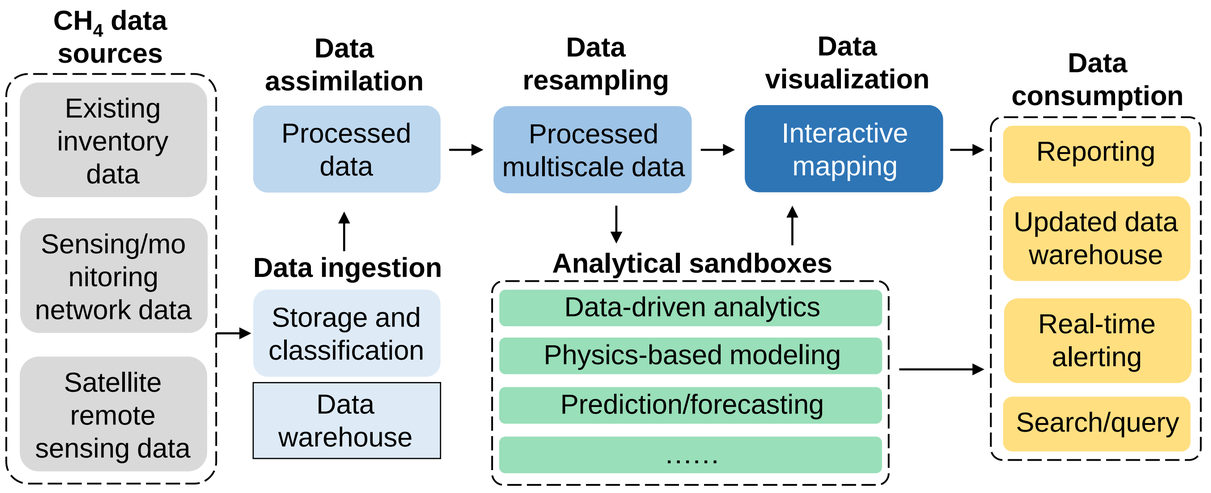


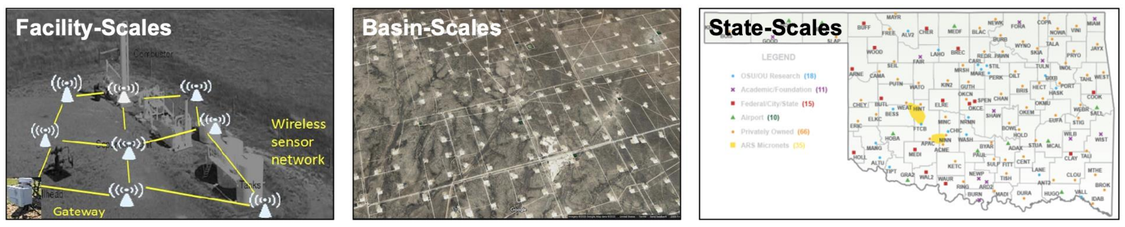
CH_4 sensing networks



Key Attributes	Surface-based Platforms				Airborne/Spaceborne Platforms		
Continuous	✓	✓	✗	✗	✗	✗	✗
Autonomous	✓	✓	✗	✓	✗	✗	✓
Spatial coverage	Facility's-scale	Facility/ regional-scale	Facility/ regional-scale	Facility/ regional-scale	Facility/ regional-Scale	regional-Scale	regional/continental-Scale

Design Parameters for an Integrated Platform





- Iterative design of an integrated methane monitoring platform across different spatial scales.
- Engagement with industry and government stakeholders to ensure an effective system design.
- Interactions with various external experts through monthly **Methane Emissions Lecture Series**.
- OU Symposium "Closing the Gap: Strategies for Effective Methane Emissions Reduction" in August 2024.

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Refs: Saunois et al. (2020). The global methane budget 2000–2017. *ESSD*, 12, 1561–1623. U.S. EPA (2023). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2021.