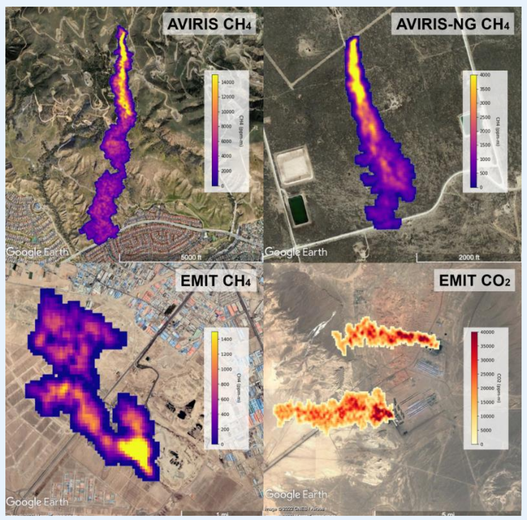
National Aeronautics and Space Administration

MISTRAL (Multiscale Intelligent System for TRAcking and Localization of Emissions)

Exploring persistent, multimodal monitoring and source identification of greenhouse gas emissions

Challenge

- At reported greenhouse gas (GHG) emission levels, the amount of equivalent CO_2 global society can emit and keep a 50% chance of holding temperature rise to 1.5°C is ≈ $25x10^{10}$t, running out in less than 6 years.
- Actual emissions of GHG, especially CH_4, are significantly higher than reported.
- Low atmospheric concentration of GHG prevents scaling of direct removal.
- Prevention of emissions—the most effective method of GHG reduction—is severely impeded by heterogeneity of emission sources and paucity of localization.

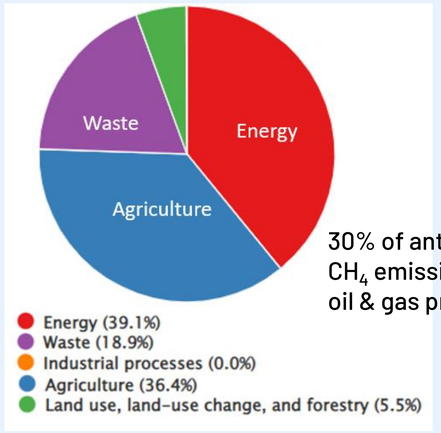


Massive CH_4 emissions observed with JPL spectrometers over Aliso Canyon and Permian Basin. Credit: NASA JPL

Objective

- Develop affordable, ecologically sustainable, persistent, multiscale, autonomous airborne system for monitoring and localization of emissions over large areas of heterogeneous emitters, with primary focus on oil and gas production sites, such as the Permian Basin, with the area of 86,000 mi^2.

Notional concept of multimodal localization system



30% of anthropogenic CH_4 emissions are from oil & gas production sites

US Emissions of CH_4 by source. Credit: EPA

Expected Impacts

- Persistent monitoring/localization radically curtails release of GHG in large oil-and-gas production and other focused release area because many emissions are due to failure in equipment, such as leaks and undetected cessation of burn-off.
- Inform emitters ⇒ enable optimal solution to GHG emission: prevention at the source.
- Dynamic: No expensive ground installations; no cost of dismantling; in place on time.
- Versatile: Handle a broad range of emitters, human-made and natural; operate at optimal proximity; autonomous system uses state-of-the-art components.

Results

- Multidisciplinary team assembled.
- Stakeholders and SME interviewed.
- Preliminary analysis of desirability, viability, and feasibility conducted.
- Generated preliminary system concepts for tradeoff studies.

Next Steps

- Conduct high-fidelity system analysis of the system analysis and tradeoffs for candidate concepts.
- Continue monitoring state of the art in satellite-based localization for hybrid solutions.
- Continue engagement with stakeholders and potential users.

Partners and/or Participants

- NASA LaRC, ARC, AFRC: concepts and systems analysis, autonomous systems, sensors, controls, atmospheric sciences, V&V, flight testing
- NIST: sensors, controls
- Exxon Mobile: Oil and Gas production site SME
- Aurora Flight Sciences: potential autonomous vehicles for flight tests
- UIUC: intelligent systems
- EPA, AFRL, DOE, FEMA, FAA: SME and stakeholders

IMAGINAVIATION

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