# The California Satellite Methane Project:

## GHGs Source Identification and Emissions Reduction

**2025 Yangtze River Delta Clean Air Forum**

***August 28, 2025***


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Research Division

California Air Resources Board


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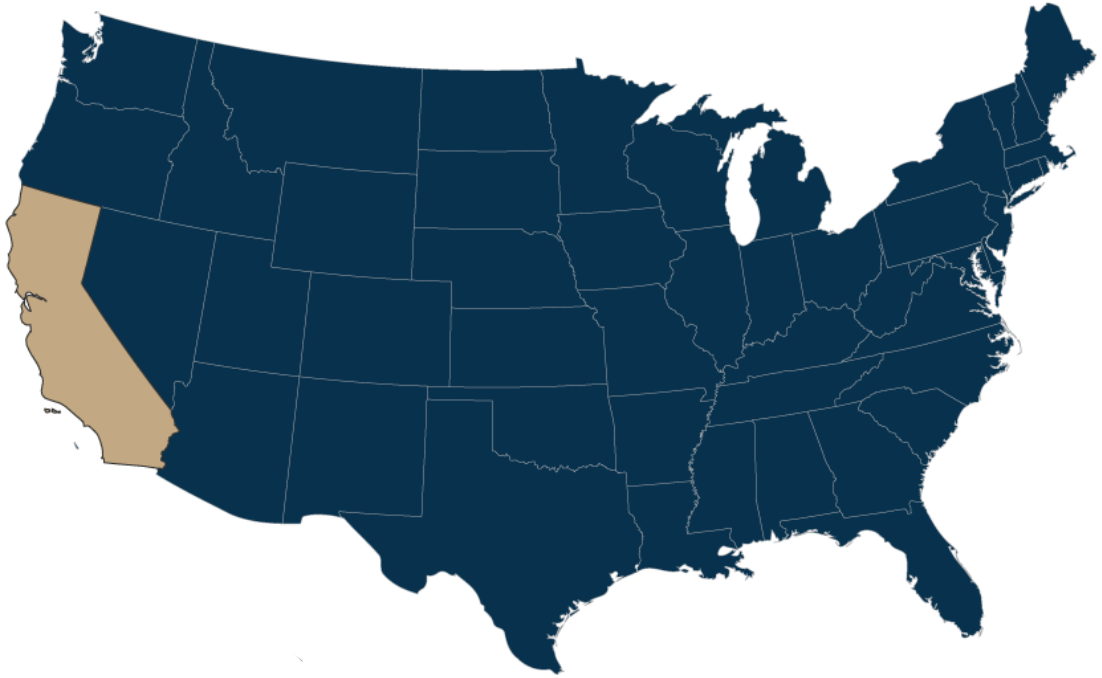
# California




*California is a collection of farmers, surfers, factory workers, outdoor enthusiasts, tech geeks, truckers, world-class researchers, celebrity actors, and many more—who come from all around the world to live and work in one of the most beautiful, vibrant, and ecologically and culturally diverse places on Earth. We are sustained, in more ways than one, by the mountains, deserts, rivers, streams, forests, farmlands, rangelands, coastline, and temperate climate that form our natural environment and characterize our great State.*

*California Scoping Plan 2013*

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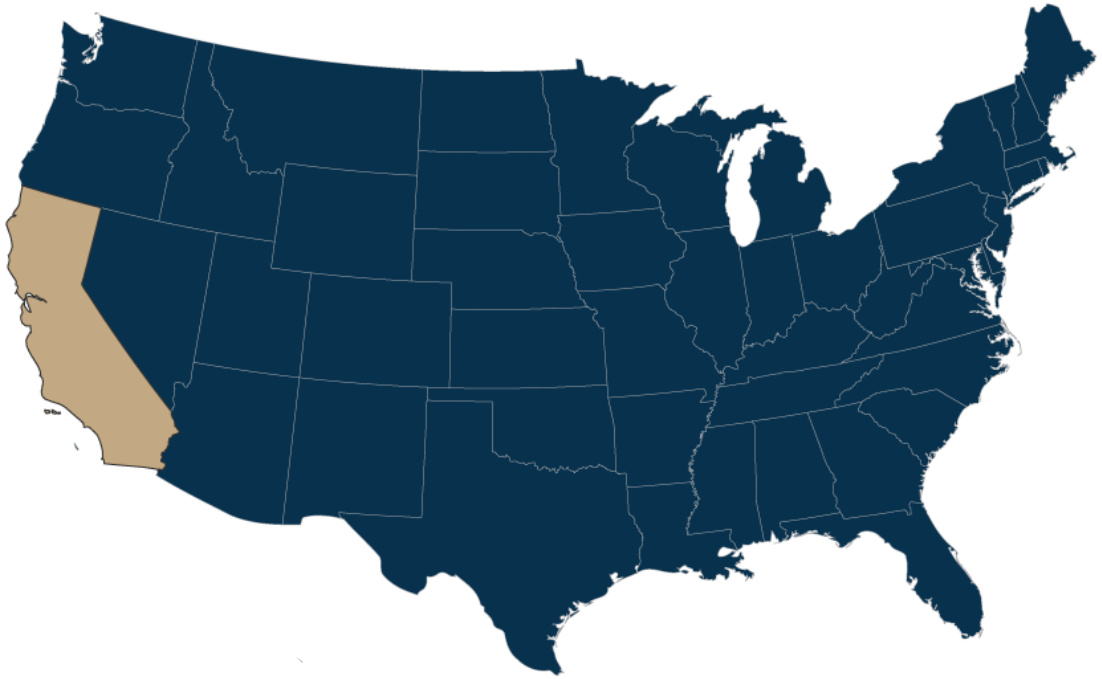

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*California Scoping Plan 2013*

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# California in the 1960'ties

## no stranger to poor air quality

# California Air Resources Board

**On August 30, 1967**, California's elected leaders came together to unify statewide efforts to address severe air pollution. Governor Ronald Reagan approved the Mulford-Carrell Air Resources Act to create the State Air Resources Board, committing California to a unified, statewide approach to aggressively address the serious issue of air pollution in the state.

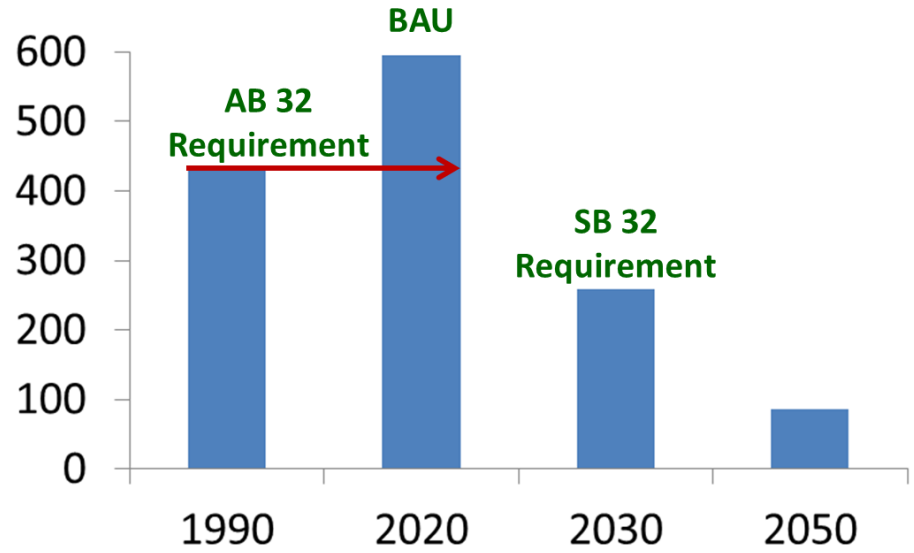
**In 2006**, Assembly Bill 32, also known as the Global Warming Solutions Act of 2006, was signed by Gov. Arnold Schwarzenegger, giving CARB this new role. AB 32 established a first-in-the-world comprehensive program of regulatory and market mechanisms to achieve real, quantifiable, cost-effective reductions in greenhouse gases

# California's Climate Requirements

Reduce Total Greenhouse Gas Emissions
- 1990 Levels by 2020
- 40% below 1990 levels by 2030
- 80% below 1990 levels by 2050

Reduce Short Lived Climate Pollutants
- 40% below 2013 levels by 2030 for $CH_4$ and HFCs
- 50% below 2013 levels by 2030 for BC

Electricity
- 50% renewables by 2030
- Carbon Free by 2045




Transportation
- Zero Emission Requirements for both cars and trucks
- By 2035 *all new cars and passenger trucks sold in California must be zero-emission vehicles*

Carbon Neutrality by 2045

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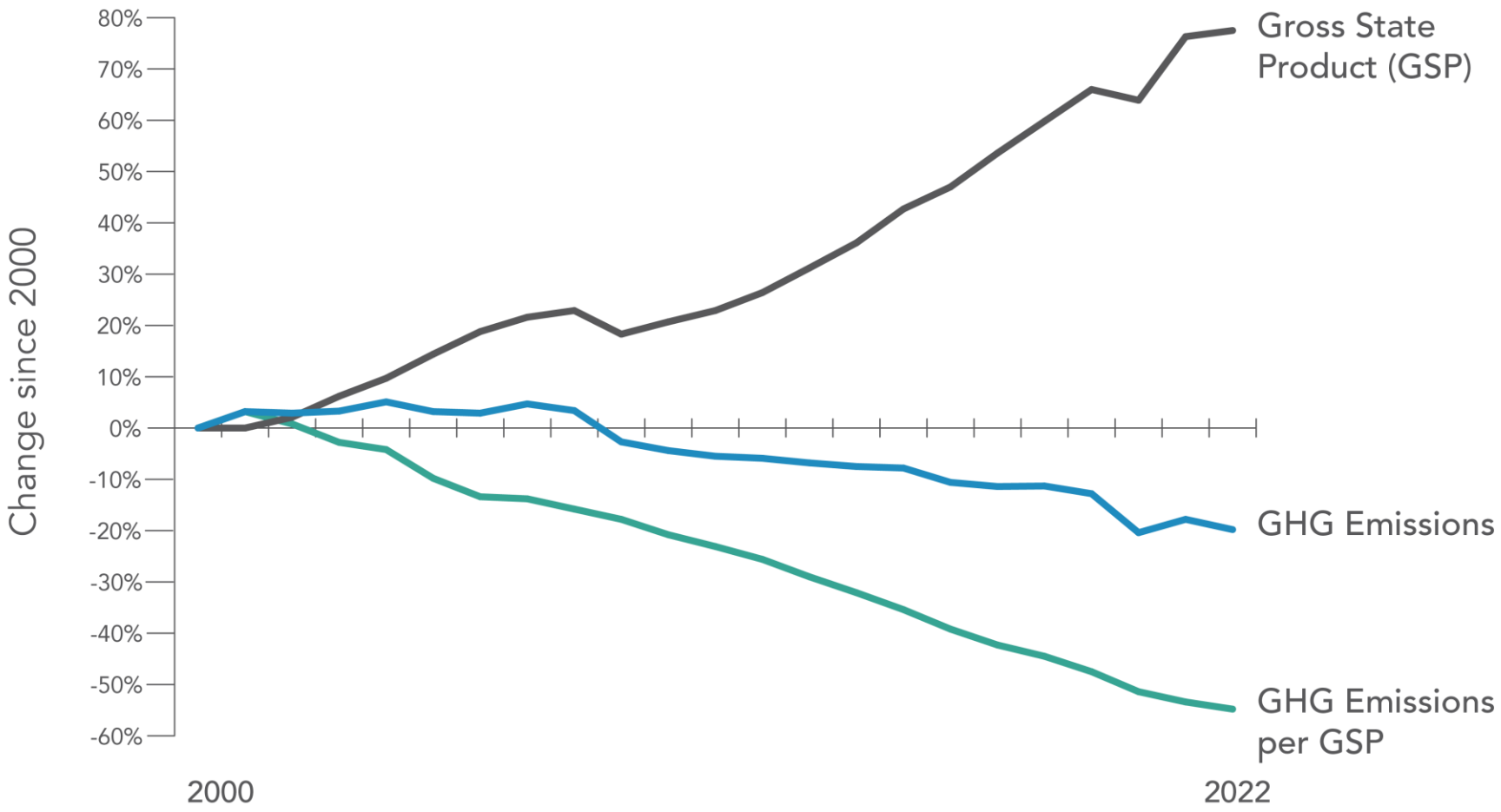
# Progress to date - decoupling

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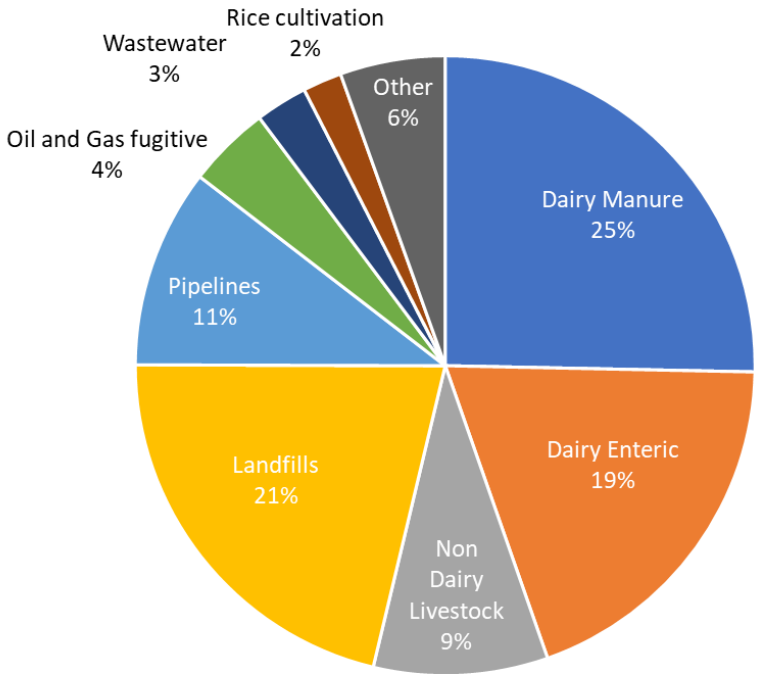
# More about Methane?

**California 2019 Methane**

**39 MMTCO$_2$e**

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Methane is an important GHG, and a Short Lived Climate Pollutant

- Odor- and color-less
- Is the main component (~90%) of natural gas
- Organic waste + anerobic conditions = methane
- About 11% of both California and US total GHG emissions
- But has accounted for 30% of global warming since pre-industrial times

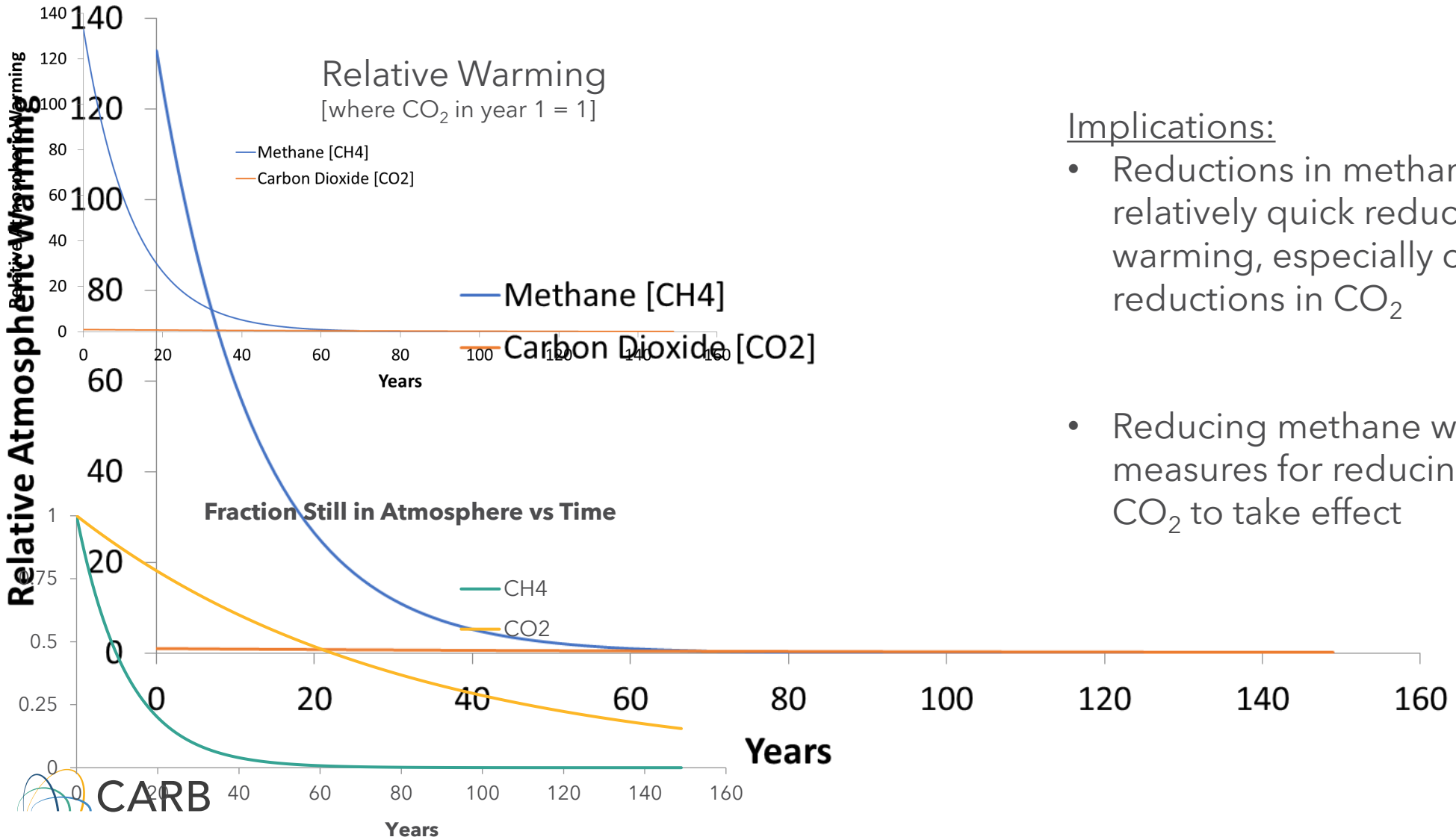
Global Warming Potentials (GWPs):

- 100 year – 25
- 20 year – 86

Atmospheric removal times:

- Methane – 50% removed every 8 years
- Carbon Dioxide – 50% removed every 53 years

# How much heat does $CH_4$ absorb compared to $CO_2$ and when




Implications:

- Reductions in methane will lead to relatively quick reduction in warming, especially compared to reductions in $CO_2$
- Reducing methane will allow measures for reducing effect of $CO_2$ to take effect

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# Chinese Methane Emissions Control Action Plan

*November 2023*


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# Methane Monitoring In California

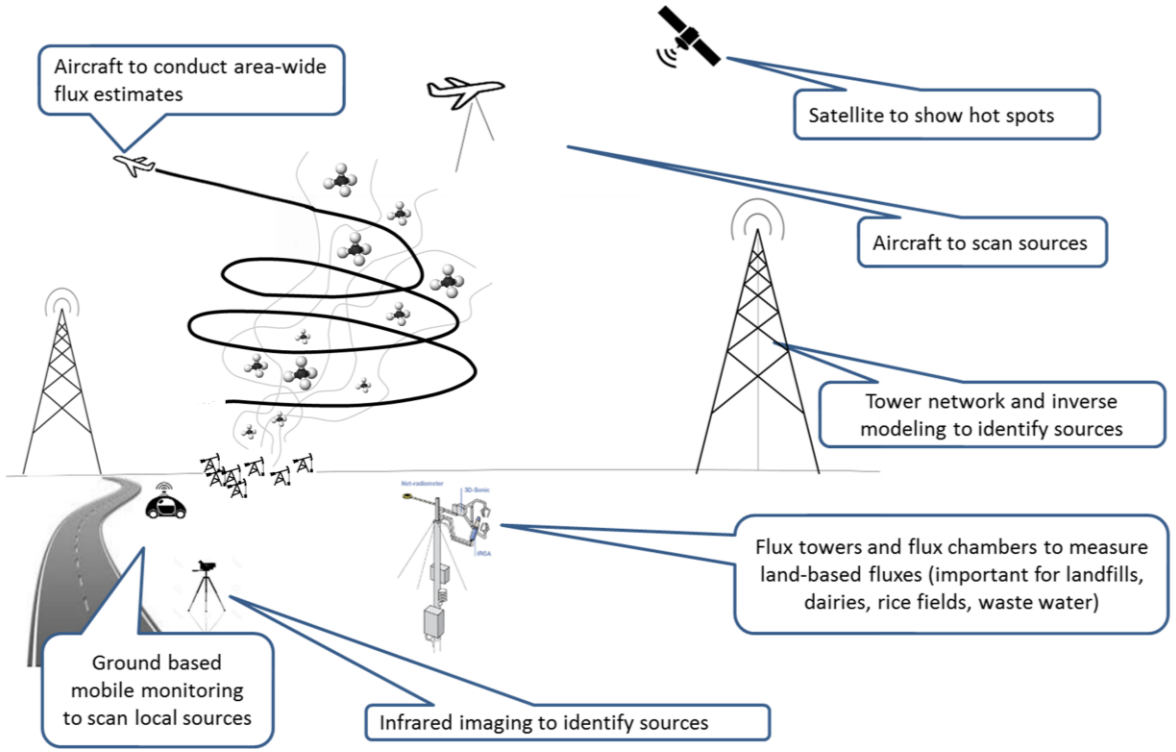
*You Can't Manage What You Don't Measure*
- Peter Drucker

Each measurement has its own purpose and limitations

- For detecting plumes or informing emissions
- Point in time or space

Need to consider all measurements for complete understanding

- Measurements to quantify emissions - stocktake
- Measurements to locate and fix leaks - mitigation

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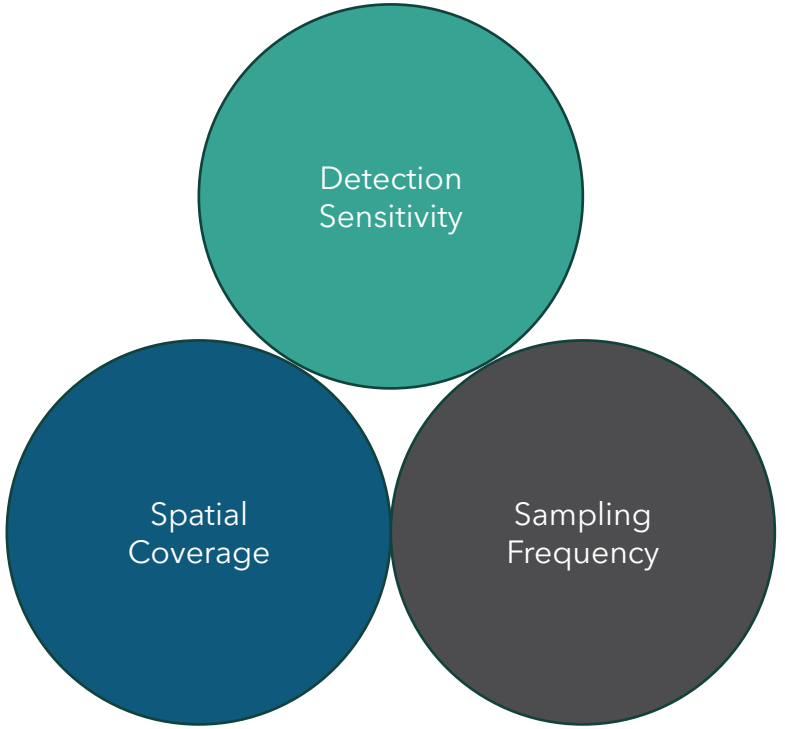
# Measuring Methane with Satellites

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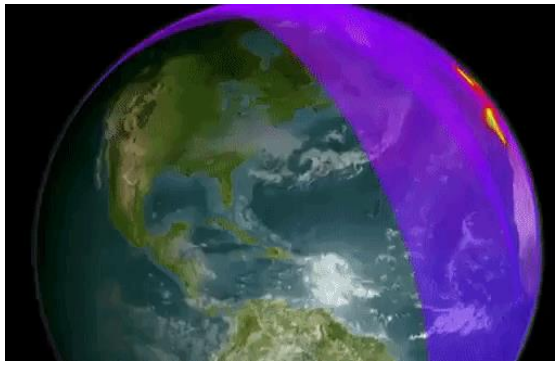
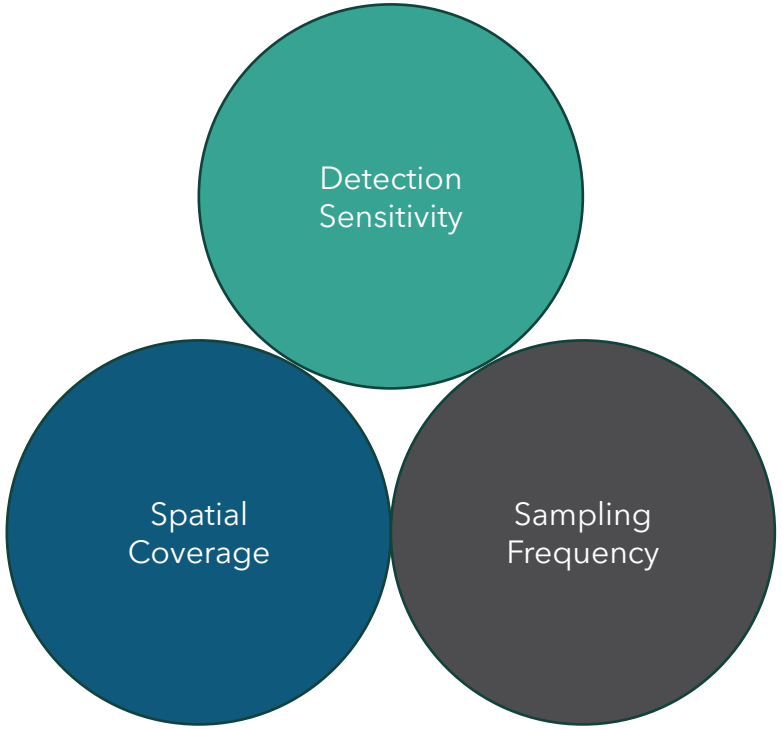
# Measuring Methane with Satellites

## Regional Mappers

- TROPOMI



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# Measuring Methane with Satellites

**Regional Mappers**

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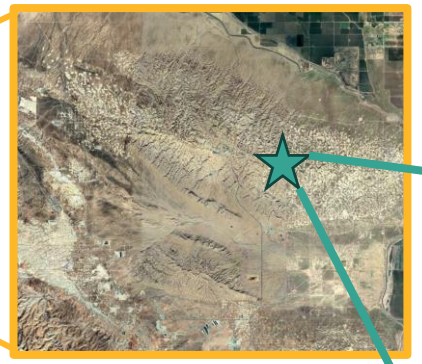
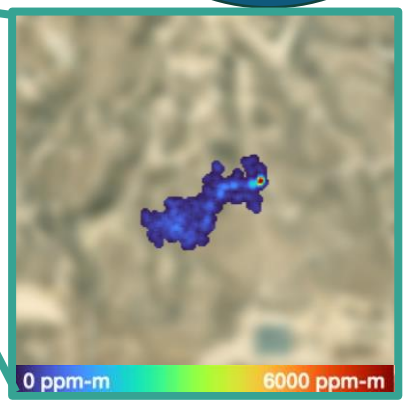


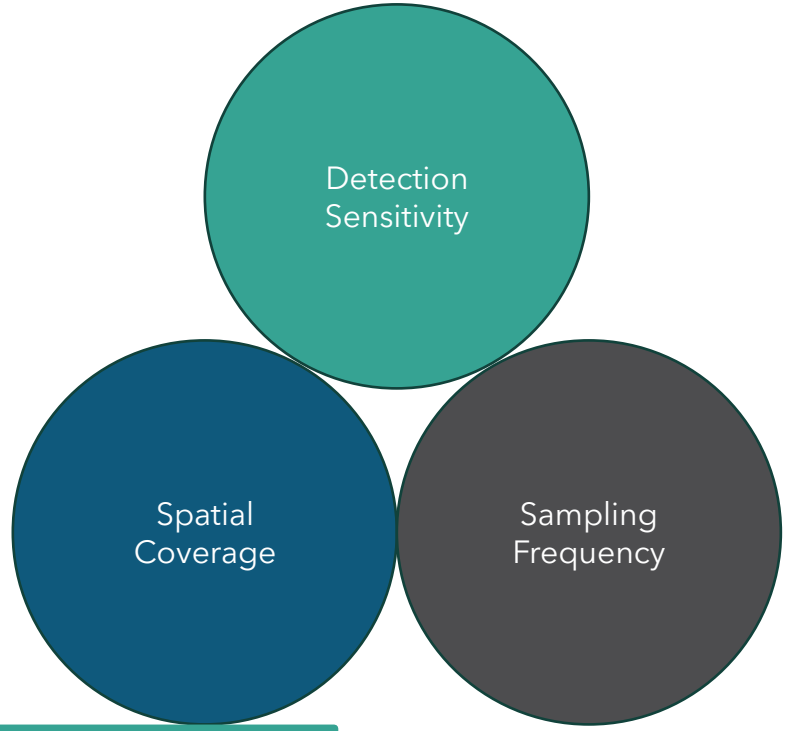
**Plume Mappers**

- Satellite *constellations*




**Methane *plume***

*A large, localized enhancement of methane*

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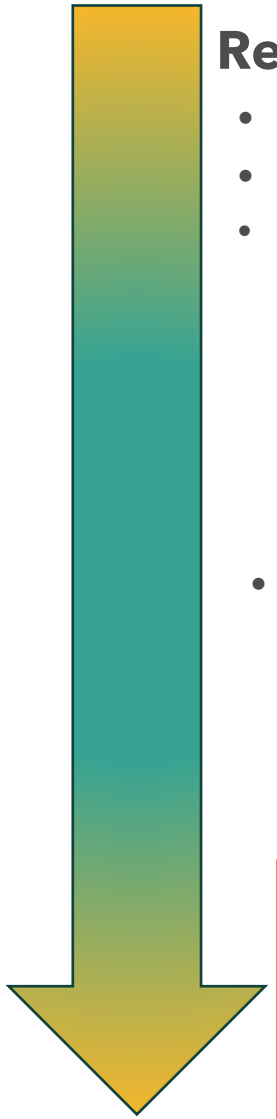

**Regional Mappers**

- Government-operated
- Free data
- TROPOMI

- MethaneSat

**Plume Mappers**

- Commercial companies
- Data can be purchased
- *New*
- Carbon Mapper, GHGSat, Maxar, etc.

Focus of this talk

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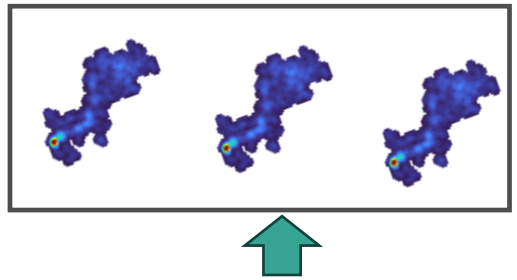
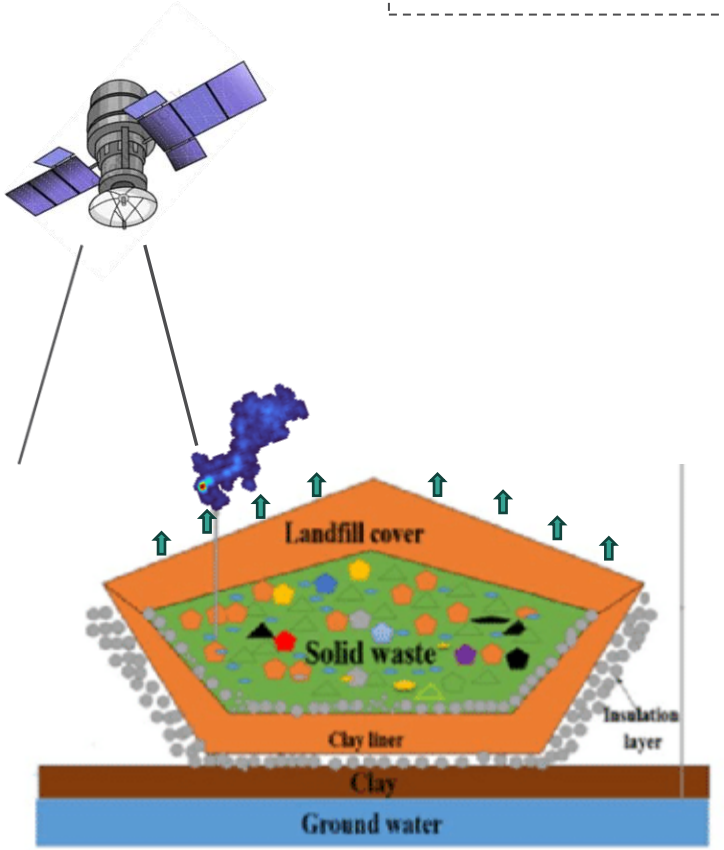
# Technology only sees large concentrated plumes

***For Illustrative Purposes Only***

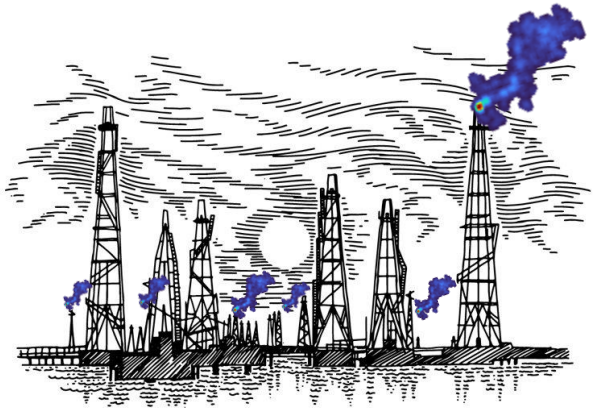
Plume mappers are not a tool for measuring *all* methane emissions, but can be useful for finding large, localized sources of methane emissions



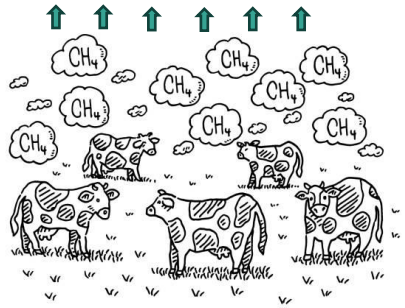
California sees plume mappers as a tool to support *mitigation*, not *inventory* development



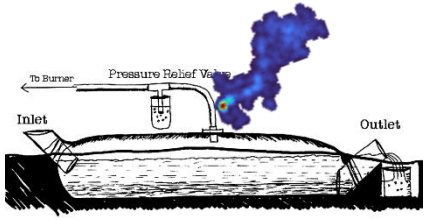

***Landfills***



***Oil and Gas***




***Dairy***




***Digester***

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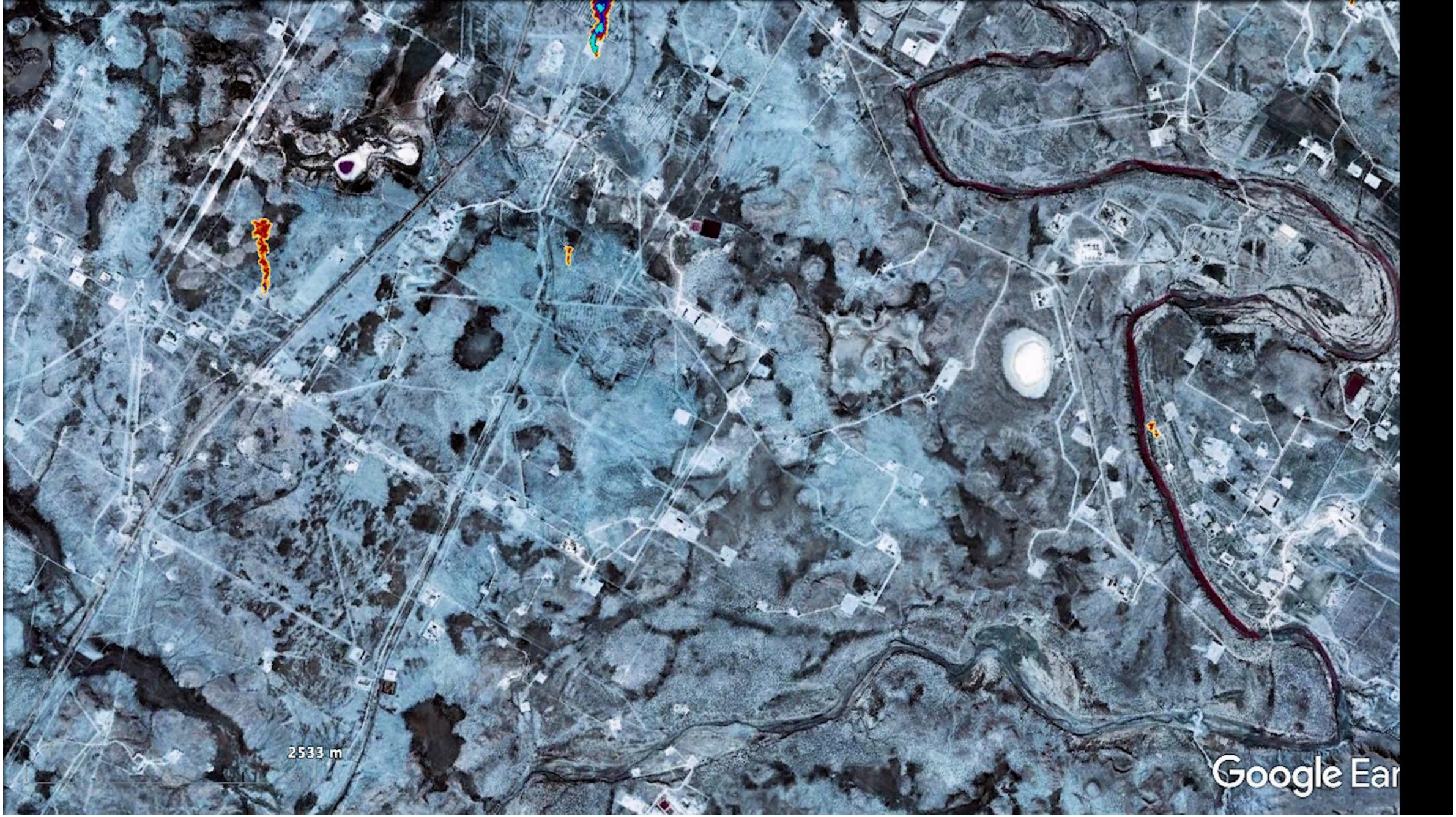


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Source: https://www.youtube.com/watch?v=8xxCvdw_IS0

# California Satellite Methane Project (CalSMP)


*Based on a decade of research on feasibility of using remote sensing to mitigate methane*

- In 2022 CA Government allocated $100 million for methane satellite data
- $95 million to purchase satellite data- awarded to Carbon Mapper though competitive RFP process
- $5 million for community engagement
- Goals:
  - Detect methane leaks and **mitigate** their emissions
  - Raise global awareness about methane emissions – **make worldwide data public**
- First satellite launched in 2024

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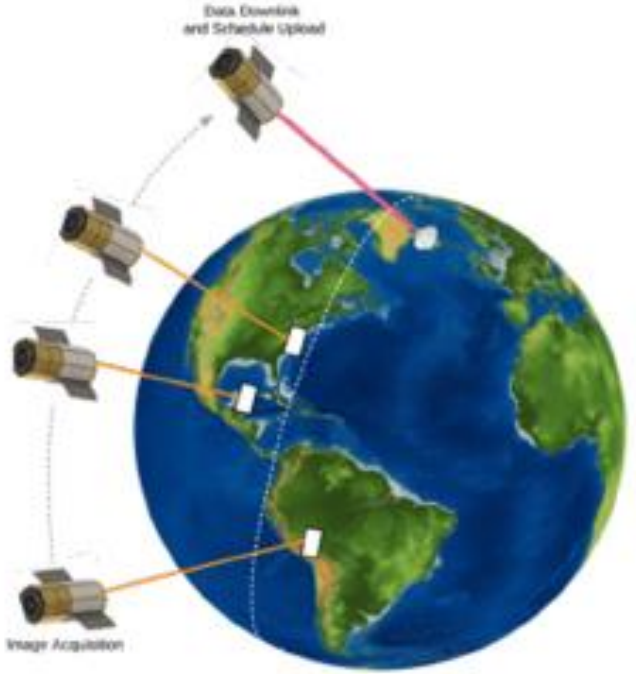
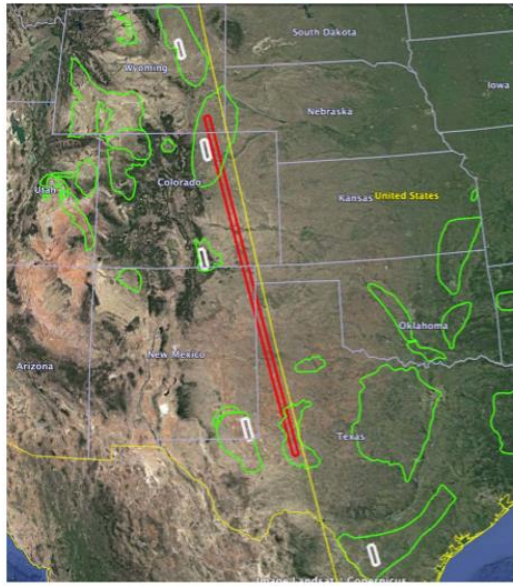
*https://ww2.arb.ca.gov/our-work/programs/california-satellite-methane-project*

# Satellites as Observation Platform




***Approximate specifications:***

- Satellite in a polar orbit – about 400 km above earth
- Satellites will 'take pictures' of landmass below it
- 'Size' of picture approximately 18x50 km (adjustable, satellite specific)
- Goes around the planet 15 times per day, or every 95 min
- Each satellites can collect approximately 45 tiles per day




Coverage figure: comparing coverage between Carbon Mapper pushbroom (red) and strip-collect (white) observing modes in selected US gas basins (green). Basemap source: Google Earth

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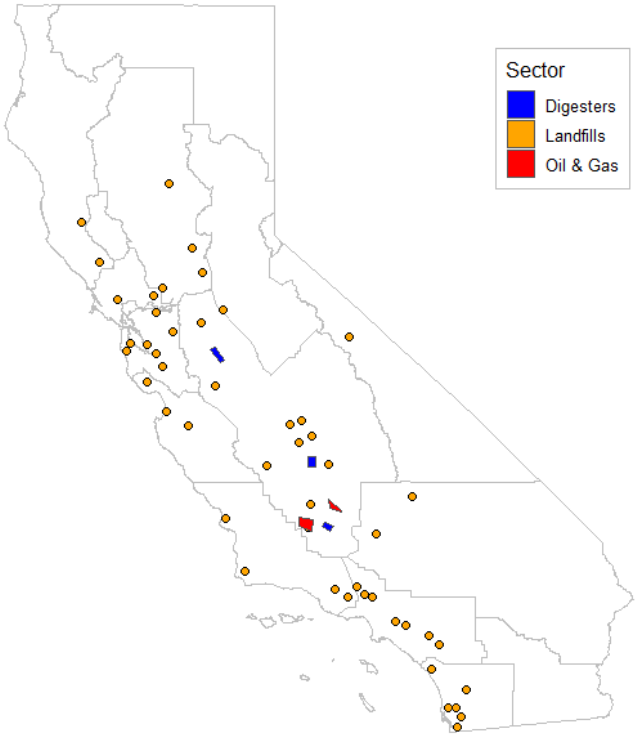
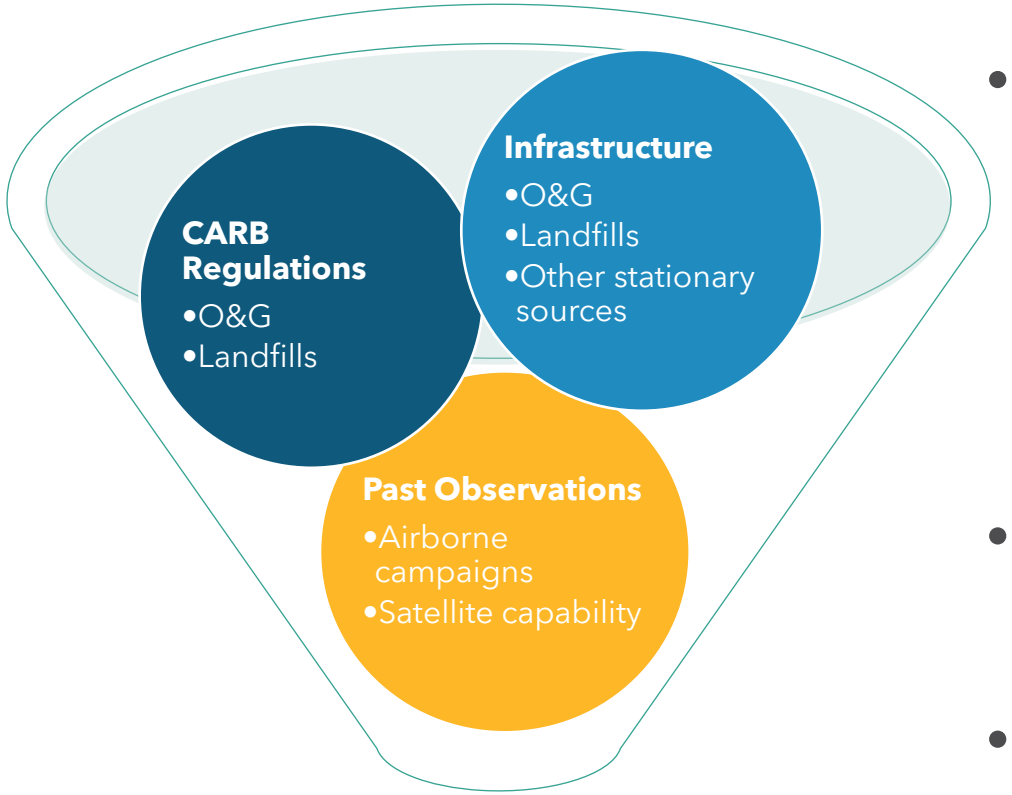
# Example of Satellite Making Observations in CA

*for illustrative purposes only*




Areas of Interest (AOI's) In California

# Determining Observation Targets




**Targets**

- Determine priority areas based on:
  - CARB programs:
    - California Oil & Gas Regulation
    - Landfill Methane Regulation
  - Enforcement and monitoring efforts
- Used detailed infrastructure databases
- Considered locations of previously detected plumes from past airborne campaigns
- Considered the satellite observational capacity over California

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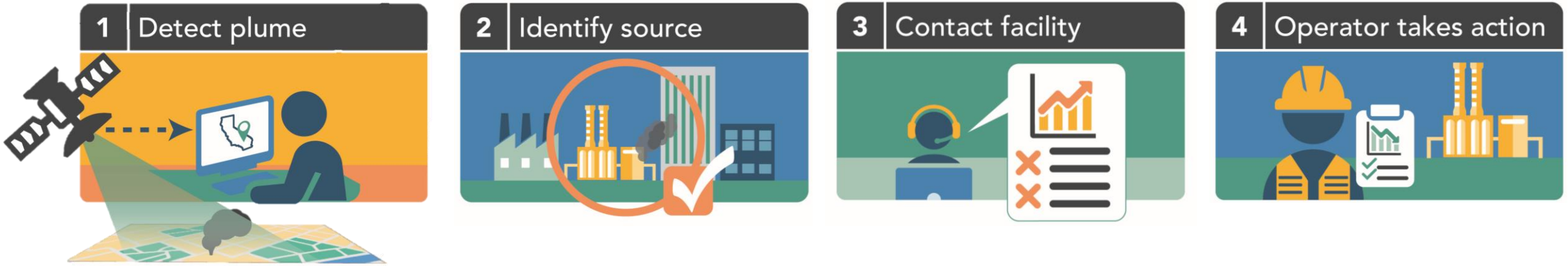
# Mitigation Procedure




Plume data is sent to CARB 24-72 hours after detection

Processing:

- Plume QA/QC
- Determine source and operator

Send email to operator

Operator communicates findings to CARB

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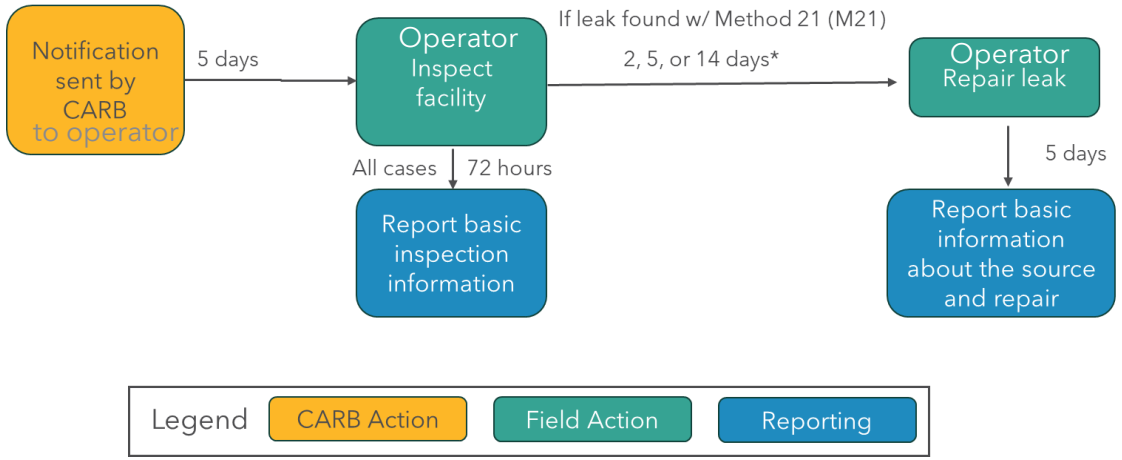
# Relevant California Methane Regulations

CARB's Oil and Gas Methane Regulation (COGR)

- In 2023, COGR was amended to include § 95669.1, which includes requirements for remotely detected methane plumes
- § 95669.1 prioritizes owner/operator inspection, repair, and reporting
- § 95669.1 does not require an agency field inspection

Example when source is an unintentional emission

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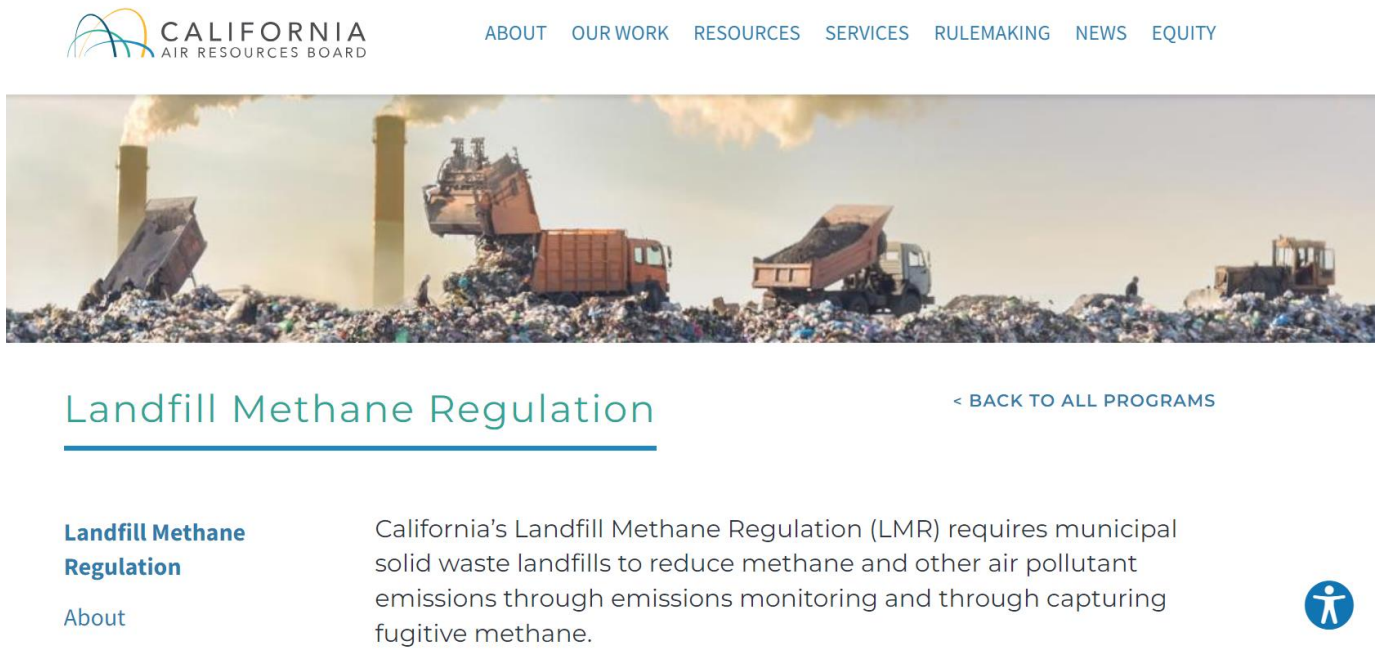
# Relevant California Methane Regulations

Landfill Methane Regulation (LMR)

- Adopted in 2010
- Requires quarterly surface methane and component leak monitoring
- Future regulatory updates may add requirements that operators take certain actions (e.g., inspect, repair, and report findings) if notified of a plume detection
- This concept was first presented at a LMR Workshop on 5/18/2023
- Additional details and request for comments solicited at LMR Workshop on 12/18/2024

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# Early Results – Since May 2025

| | Oil and Gas | Landfill | Other |
|---|---|---|---|
| Event Notifications | 12 | 33 | 3 |
| Responses | 10 | 5 | 2 |
| Mitigations | 4 | 2 | 1 |

- Mitigations are plumes that were unknown to operator and have been repaired since notification
- Very early in the project- many plumes are still in process
- Next step: quantify methane mitigation

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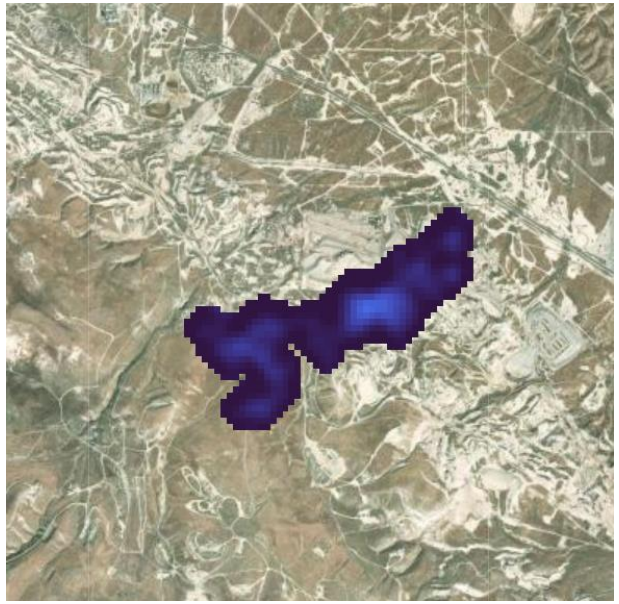
# Example - Oil and Gas Mitigation

**Approximate Point of Origin**

**Plume Image**



Sector: **Oil and Gas**
Leak type: **Unintentional**
Cause: **Stuffing box**
Mitigation type: **Repair**

Next step: **Follow up observation**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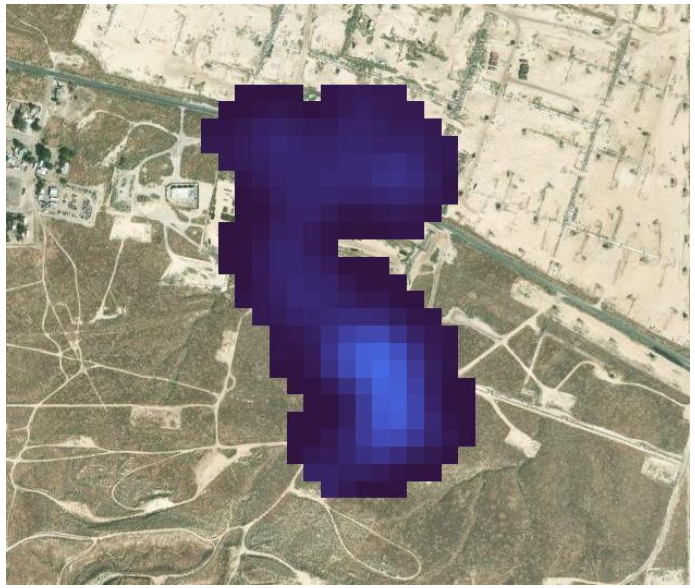
# Example - Oil and Gas Mitigation

**Approximate Point of Origin**

**Plume Image**



Sector: **Oil and Gas**
Leak type: **Unintentional**
Cause: **Tank hatch**
Mitigation: **Tank repair and pressure reconfigured**

Plume observed
June 7, 2025

Email sent to operator
June 10, 2025

Inspection and leak detection
June 11, 2025

Initial response received
June 13, 2025

Repair made
June 23, 2025

Final response received
June 25, 2025

Follow up observation- no plume detected
July 5, 2025

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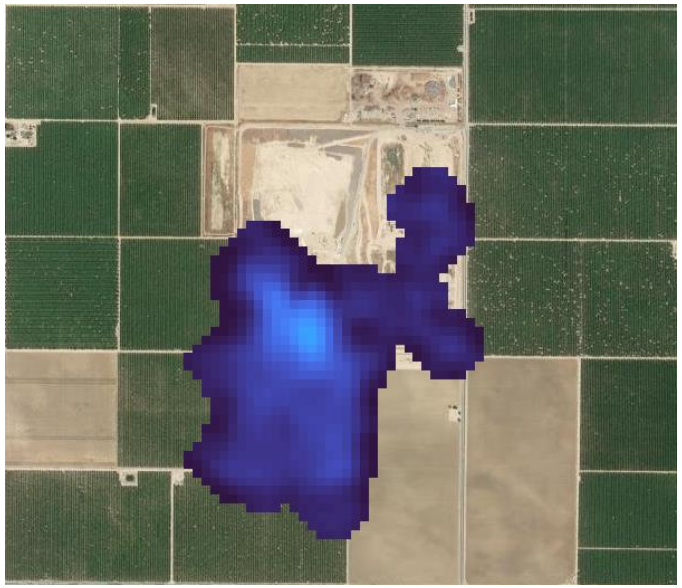
# Example - Landfill Mitigation

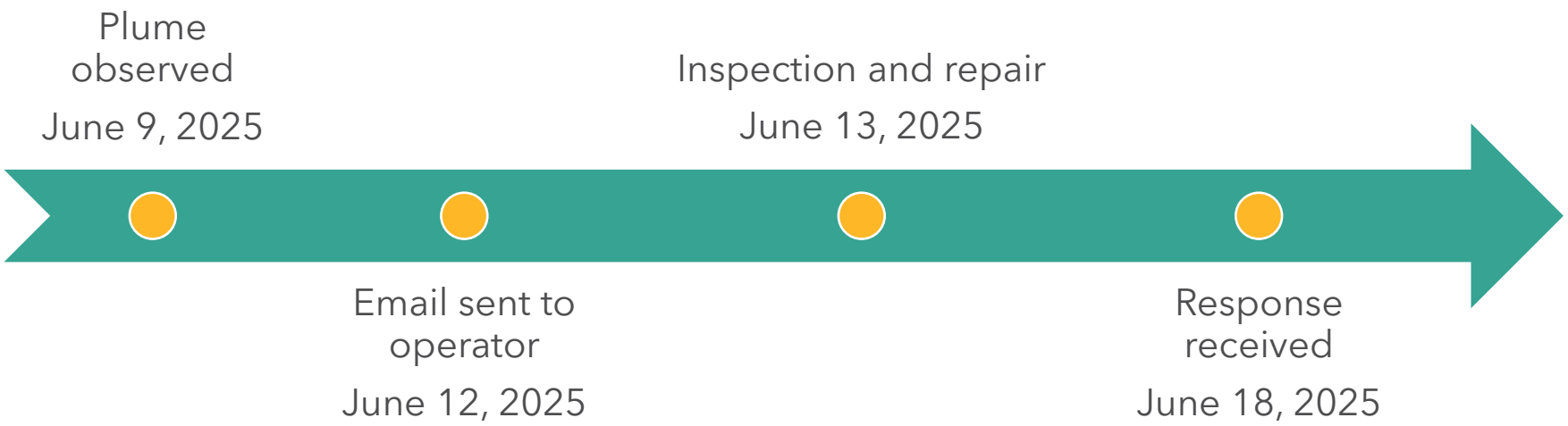
**Approximate Point of Origin**

**Plume Image**



Sector: **Landfill**
Leak type: **Unintentional**
Cause: **Insufficient vacuum at the intermediate cover**
Mitigation type: **Replaced belts on blower**

Next step: **Follow up observation**

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# Summary and Next Steps

- The California Satellite Methane Project is still in the early stages
- Already have shown the potential for mitigation
- Mitigation of methane emissions through satellite observation is best when
  - Plumes are from concentrated point source
  - There is a strong infrastructure database to determine sources
  - Backed by regulation
- Will continue to build program components and share our experience online and through published reports.
  - Data management system
  - QA/QC procedures
  - Regulations

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# Summary and Next Steps

- Plan to launch more satellites to improve observational capacity in 2025 and 2026
- Continue to automate and streamline data pipeline
- Will continue to work with other partners to improve and expand on the program
  - US Climate Alliance
  - Subnational Methane Pledge
  - National and International partners

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# Subnational Methane Pledge

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## California launches methane-cutting effort with subnational governments at COP28

*The new Subnational Methane Action Coalition expands its signatories as governments around the world gather to discuss climate action*

The Subnational Methane Action Coalition SMAC
https://www.smacmethane.org/

SMAC members represent more than 200 million people and have a combined GDP of $7 trillion USD.

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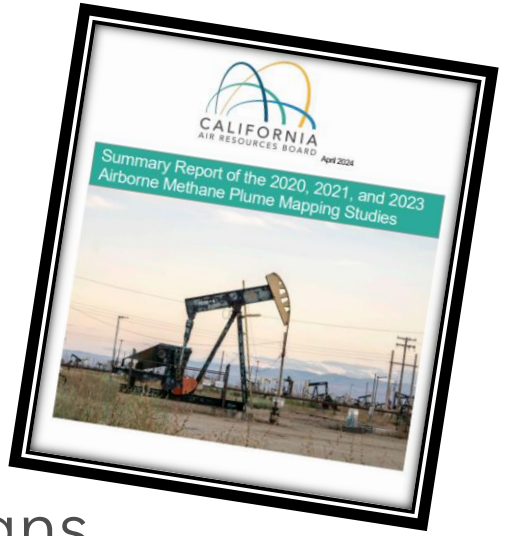
Initial Signatories at COP28

# Useful Resources

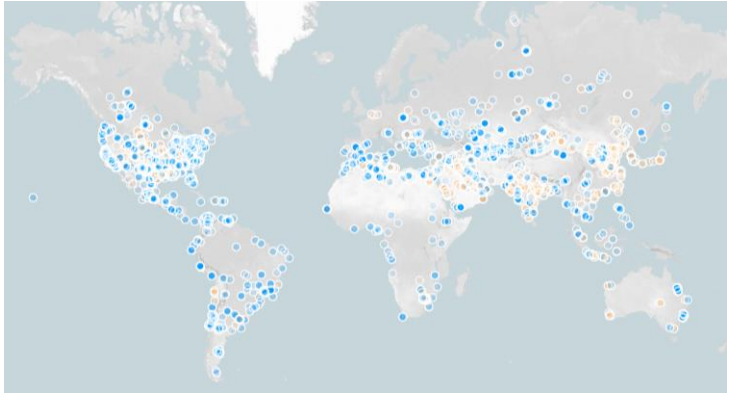
- California Satellite Methane Project home page
  https://ww2.arb.ca.gov/our-work/programs/california-satellite-methane-project




- Report demonstrating mitigation - airborne campaigns
  https://ww2.arb.ca.gov/resources/documents/summary-report-2020-2021-and-2023-airborne-methane-plume-mapping-studies

- The Subnational Methane Action Coalition SMAC
  https://www.smacmethane.org/


- The Carbon Mapper worldwide data portal
  https://www.carbonmapper.org/



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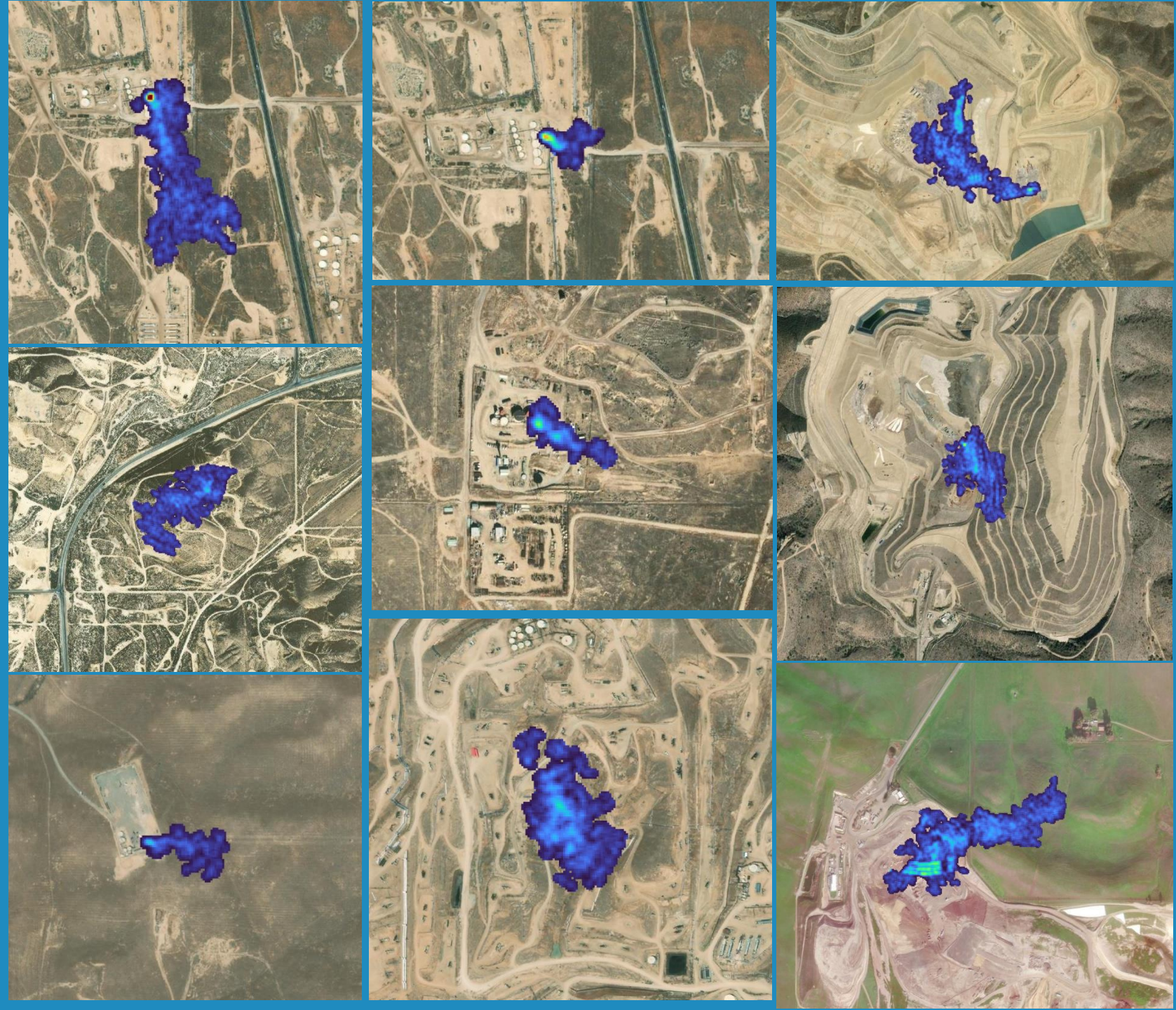
# Thank you

Contact:
Jorn Herner at
jorn.herner@arb.ca.gov



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