Methane Plume Satellites:
What can they see and how can they be useful in mitigation

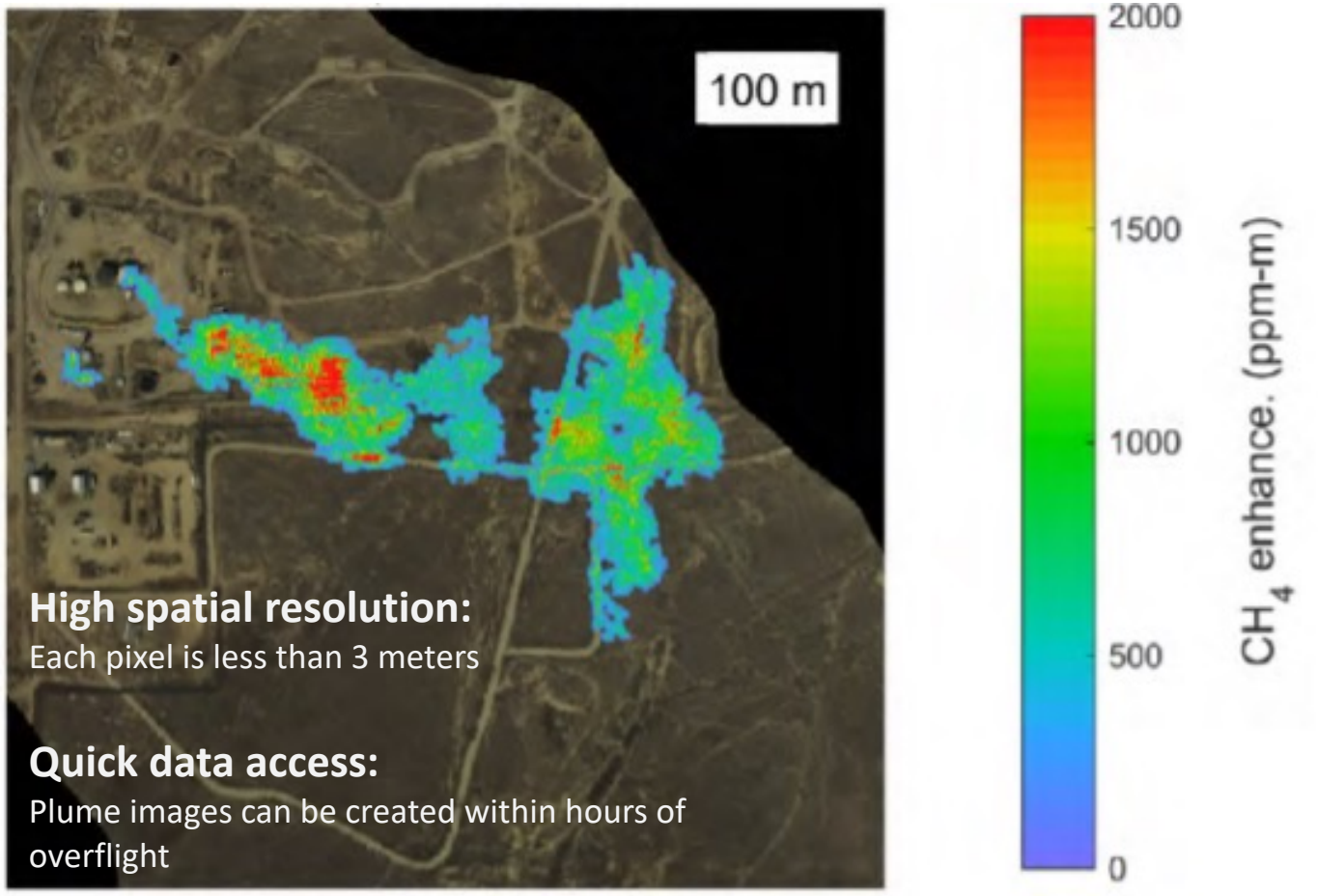
CALIFORNIA
AIR RESOURCES BOARD

Where did this start and how did CARB get involved?

In the mid 2010's, new research demonstrated the ability of *hyperspectral imagers* to detect localized sources of methane

"Hot spot" over San Joaquin Valley at coarse regional level resolution

Can we use the hyperspectral imagers to learn more about the "hot spot" and other large methane emissions?

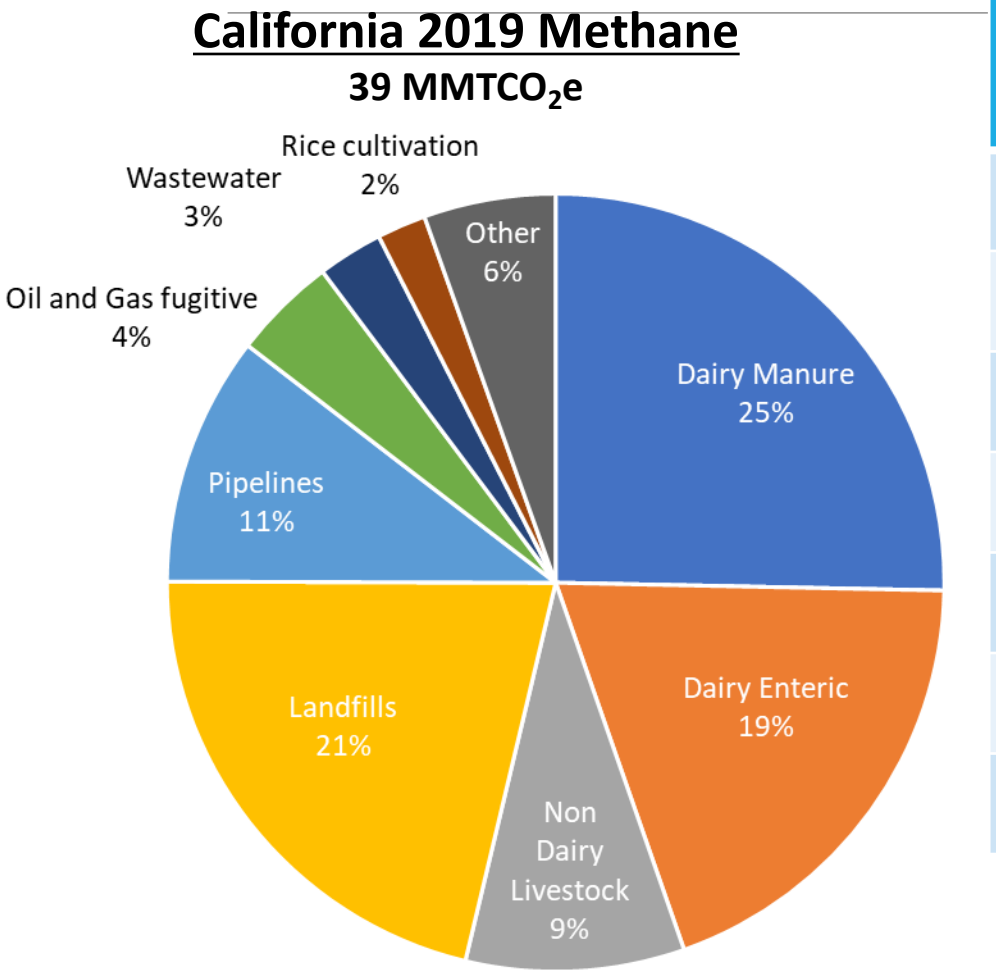


“Seeing” Methane Plumes

- Hyperspectral Instrument can accurately identify location of individual plumes (high spatial resolution)
- Only sees methane when it is highly concentrated.
- Does not see diffuse area sources
- It is a not a stock take or inventory tool but can be used to spot plumes for follow up

- Leaking natural gas compressor station

Which *Types* of Sources are best-served by this technology?



Diffuse Area Source/ Small Plumes - *generally, will not see*	Highly Concentrated Plumes *"Find and Fix" potential*
Oil and Gas Fugitive	Oil and Gas Fugitive
	Pipelines
Landfills	Landfills
Dairy Manure	Dairy Digesters
Enteric Fermentation	
Rice Cultivation	
Wastewater	

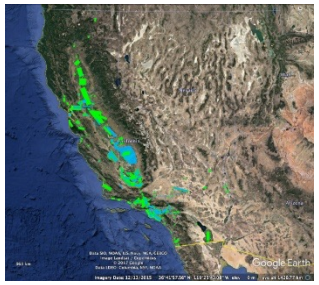
Airborne Surveys: Piloting Instrument Use

Research

Mitigation

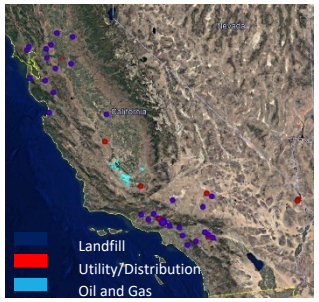
2016-2017 – California Methane Survey

- Surveyed 272,000 facilities and component, 10% of CA Landmass with multiple revisits.
- A significant number of individual plumes in all sectors



2020

- Worked with industry prior to 'enroll' their infrastructure.
- Approximately 50% of found plumes could be mitigated
- Industry voluntarily provided feedback on what was leaking and why



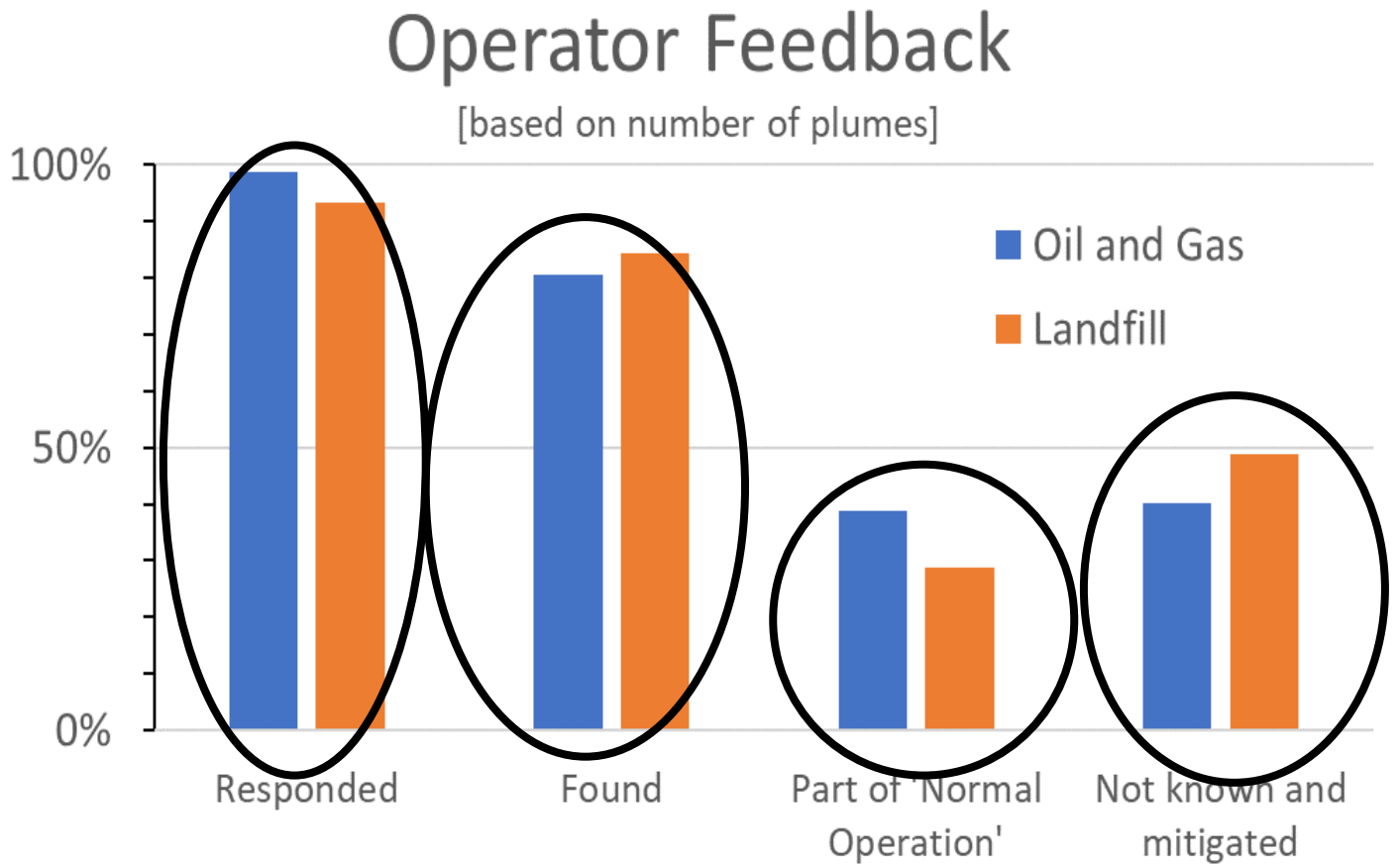
2021

- Funded by Carbon Mapper
- Let industry know we were flying but did not 'enroll' volunteers.
- Used internal databases to identify owners of infrastructure with plumes
- Worked closely with regulatory and enforcement staff, local air districts for communication and other actions

2023 – data available later in 2023

What Did we Learn?
High Response Rate, Most Plumes Found and "Fixed", Quickly Overall

- For leaks, Oil and gas "fixed"/ mitigated within 4 days on average



And A Lot More: CARB Summary Report

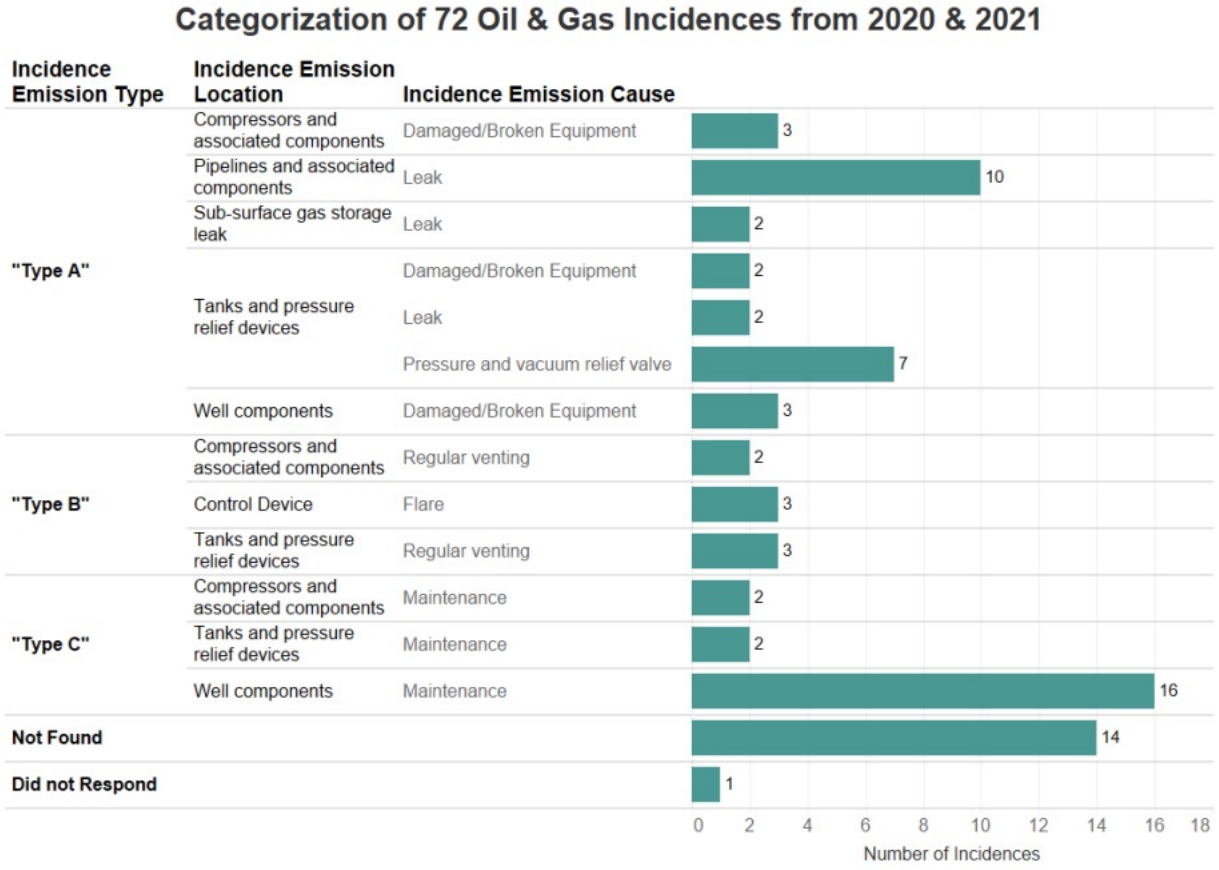


Figure 7. A graphic depicting the results of oil & gas operator feedback from the 2020 and 2021 airborne campaigns. Note that the Incidence classifications (Emission Type, Emission Location, and Emission Cause) were assigned by CARB staff based on operator responses.

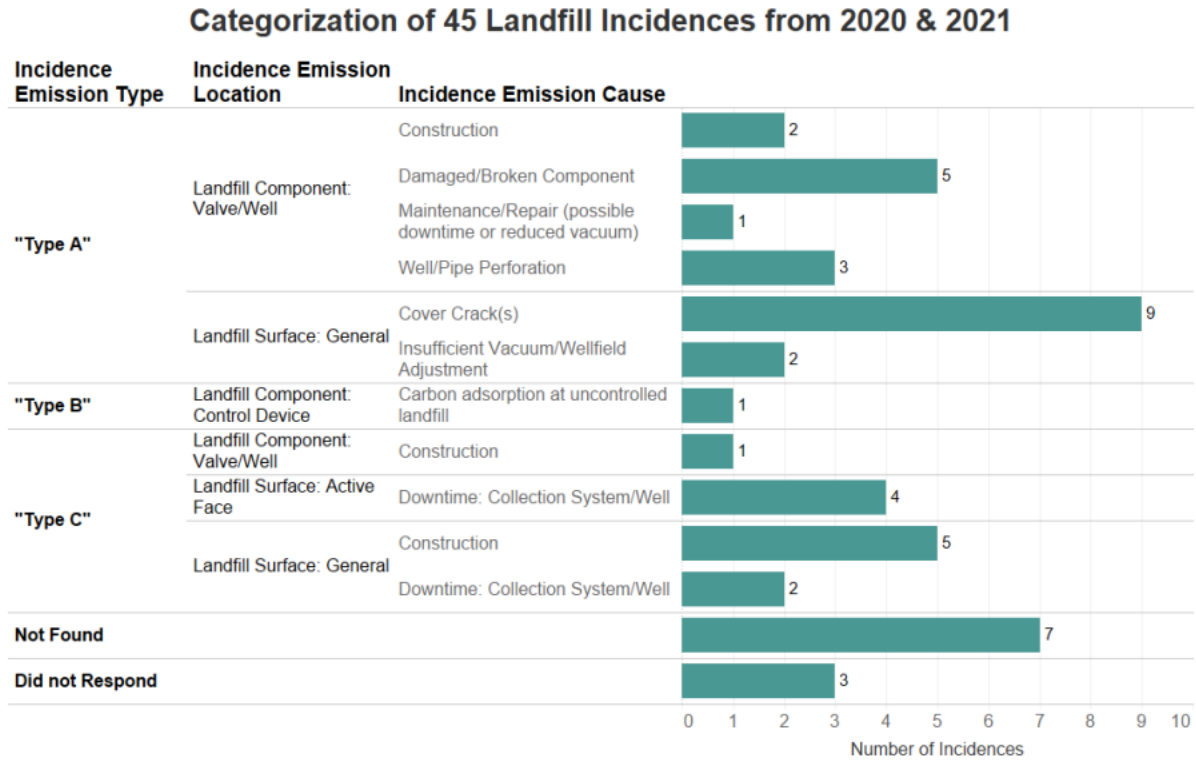


Figure 8. A graphic depicting the results of landfill operator feedback from the 2020 and 2021 airborne campaigns. Note that the Incidence classifications (Emission Type, Emission Location, and Emission Cause) were assigned by CARB staff based on operator responses.

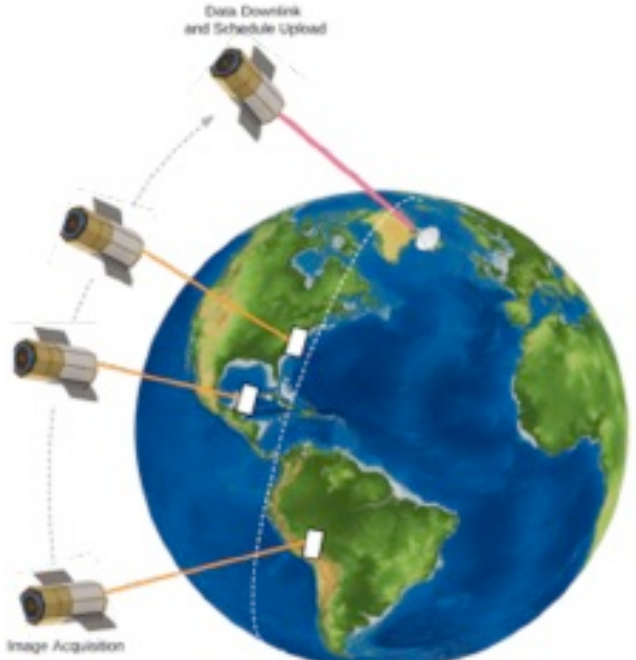
Summary report available at: https://ww2.arb.ca.gov/resources/documents/summary-report-2020-and-2021-airborne-methane-plume-mapping-studies

Airplanes vs Satellites as Observation Platform

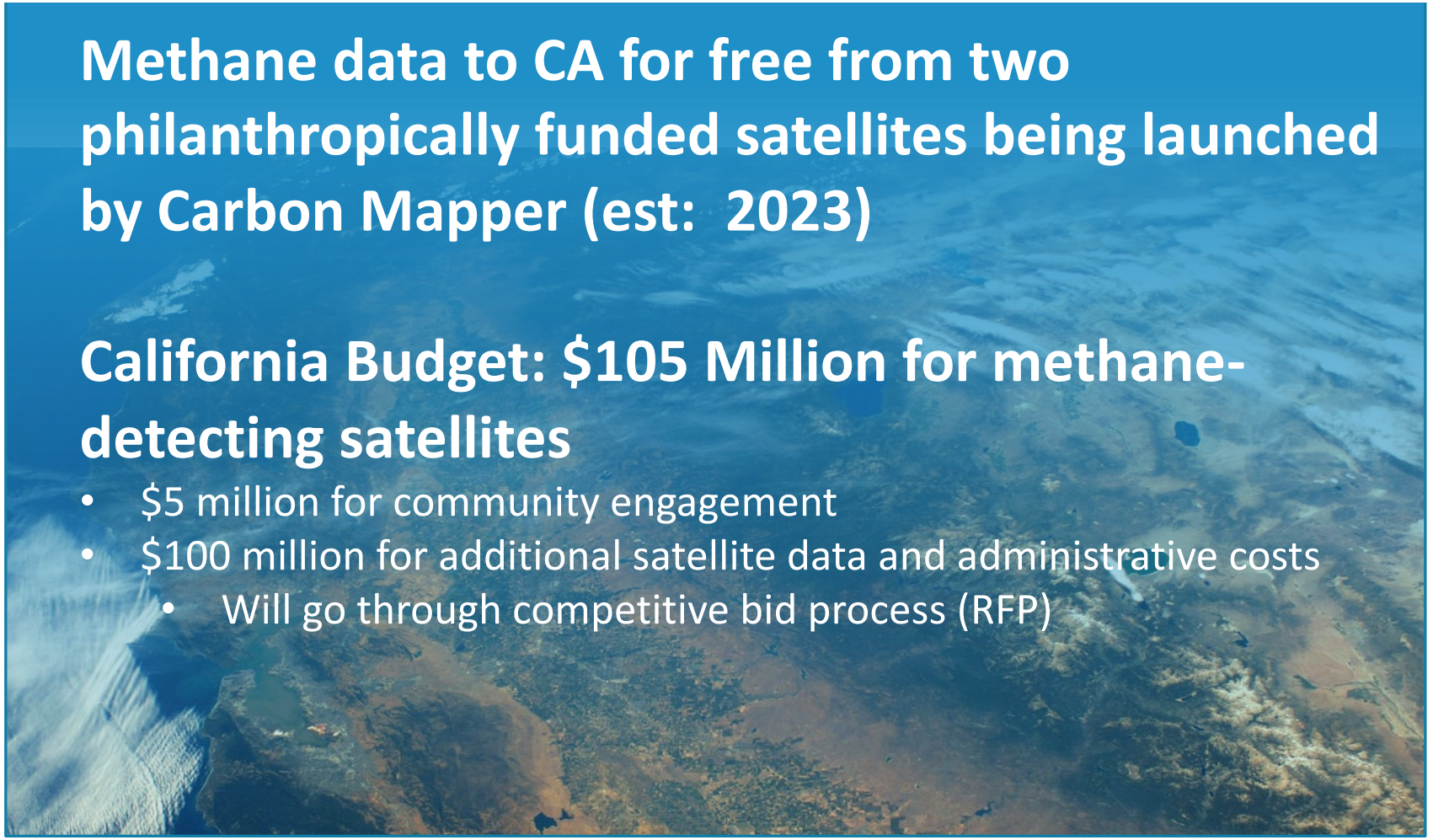
- Airborne campaigns:
  - Flexible coverage, Great spatial resolution
  - Can cover main targets in California in ~15 days of flight

However, flights are not well suited for routine monitoring due to cost and overall coverage, such as beyond California

- Satellite:
  - More frequent - could increase with more satellites
  - Detection limit expected to be 50-100 $kgCH_4/hr$ under ideal conditions for upcoming satellites
  - Can use different types of collection modes that concentrate on an area for lower detection limit or cover more area with higher limit



What's Next?



Methane data to CA for free from two philanthropically funded satellites being launched by Carbon Mapper (est: 2023)

California Budget: $105 Million for methane-detecting satellites

- $5 million for community engagement
- $100 million for additional satellite data and administrative costs
  - Will go through competitive bid process (RFP)

Expected Schedule for RFP and Project

Remotely Detected Emissions Plumes And Regulations

Role

- Support early detection, improve understanding of emissions

Benefits of regulatory inclusion

- Earlier detection of large plumes = quicker emission reductions

Potential Applications in CA

- Oil and gas infrastructure; landfill gas collection systems; dairy digesters

Implementation

- Access to data, responsiveness/timelines, operator identification, technology capabilities, coordination across regulators, ongoing costs

Ex: Oil and Gas Methane Regulation

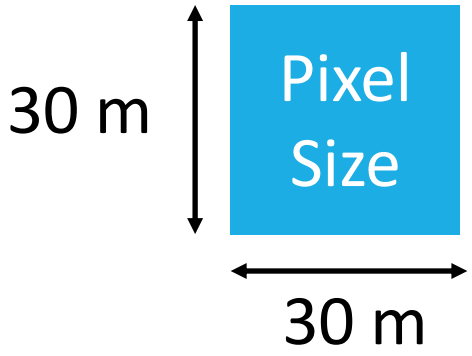
New Remote Plume Detection Provision

- Amendments adopted in June 2023; not yet final

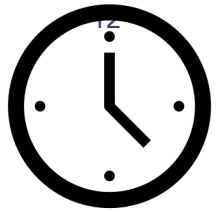
CARB to notify operators of satellite-detected plumes

Technology pre-approved by CARB

- Must meet specifications such as:



Data available in



72 hours

Ex: Notification to O&G Operator

Notified by email within seven business days of CARB receiving the satellite data

Includes at least the following:

- ID Number
- Plume imagery
- Coordinates of plume origin
- Date and time of detection

Ex: O&G Notification

Inspect facility or report venting — Within 5 days of notification

Report results of inspection — Within 3 days of inspection

Repair discovered fugitive leaks — Varies by leak characteristics

Report outcome of repairs — Within 5 days of repair

Remote Sensing Path Forward

Evaluate use of satellite data for landfill gas collection systems and dairy digesters

Increase coordination among regulators

Implement feedback/response management

Evaluate other technologies

Ensure long-term viability

Thank you