Integrating Point-Source Methane Emissions from Imaging Spectroscopy Data into the Multi-scale Methane Analytic Framework (M2AF) Information System

E. Natasha Stavros[1], Riley Duren[2], Andrew Thorpe[3], Daniel Cusworth[4], Brian Bue[3], Joseph Jacob[5], Winston Olson-Duvall[3], Robert Tapella[3], Kevin Gill[5], John Worden[6], Daniel Jacob[4], Vineet Yadav[5], and Elizabeth Yam[1]

[1]NASA Jet Propulsion Laboratory
[2]University of Arizona
[3]Jet Propulsion Laboratory
[4]Harvard University
[5]Jet Propulsion Laboratory, California Institute of Technology
[6]JPL / Caltech

November 24, 2022

Abstract

The Surface Biology and Geology global imaging spectrometer is primarily designed to observe the chemical fingerprint of the Earth's surface. However imaging spectroscopy across the visible to shortwave infrared (VSWIR) can also provide important atmospheric observations of methane point sources, highly concentrated emissions from energy, waste management and livestock operations. Relating these point-source observations to greenhouse gas inventories and coarser, regional methane observations from sensors like the European Space Agency (ESA) TROPOMI will contribute to reducing uncertainties in local, regional and global carbon budgets. We present the Multi-scale Methane Analytic Framework (M2AF) that facilitates disentangling confounding processes by streamlining analysis of cross-scale, multi-sensor methane observations across three key, overlapping spatial scales: 1) global to regional scale, 2) regional to local scale, and 3) facility (point source scale). M2AF is an information system that bridges methane research and applied science by integrating tiered observations of methane from surface measurements, airborne sensors and satellite. Reducing uncertainty in methane fluxes with multi-scale analyses can improve carbon accounting and attribution which is valuable to both formulation and verification of mitigation actions. M2AF lays the foundation for extending existing methane analysis systems beyond their current experimental states, reducing latency and cost of methane data analysis and improving accessibility by researchers and decision makers. M2AF leverages the NASA Methane Source Finder (MSF), the NASA Science Data Analytics Platform (SDAP), Amazon Web Services (AWS) and two supercomputers for fast, on-demand analytics of cross-scale, integrated, quality-controlled methane flux estimates.

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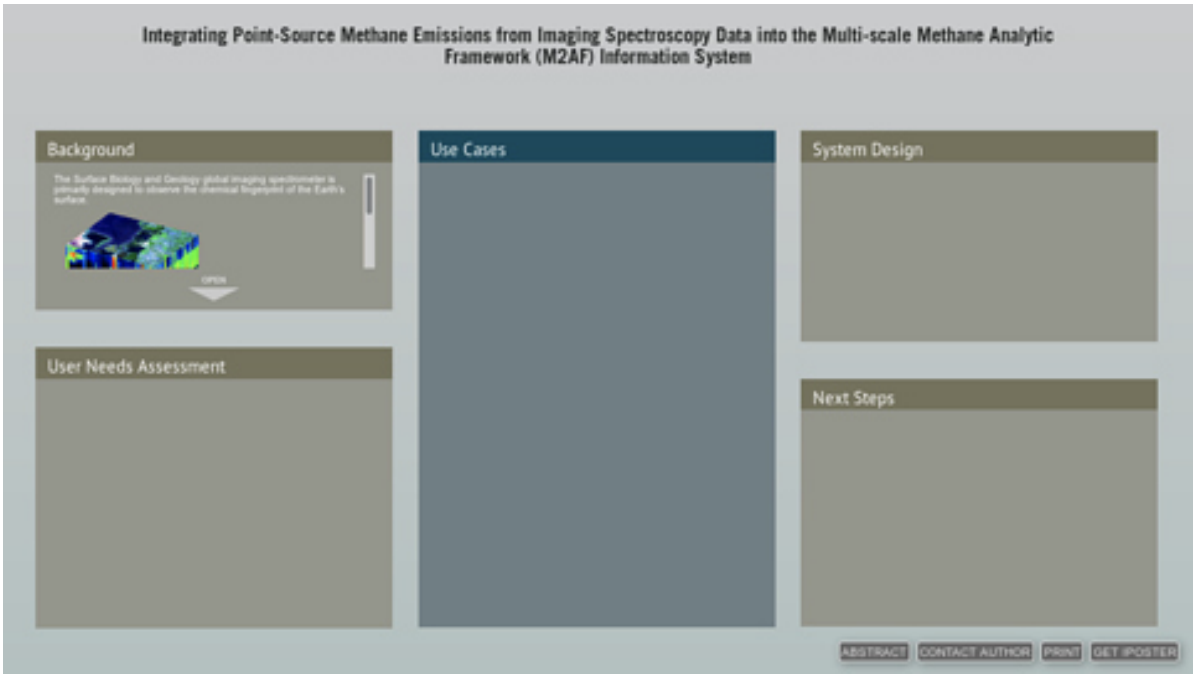


E. Natasha Stavros -1; Riley Duren - 2/1; Andrew Thorpe - 1; Dan Cusworth - 1; Brian Bue - 1; Joe Jacob - 1; Winston Olson-Duvall -1; Rob Tapella - 1; Kevin Gill - 1; John Worden - 1; Daniel Jacob - 3; Vineet Yadav - 1; Elizabeth Yam - 1

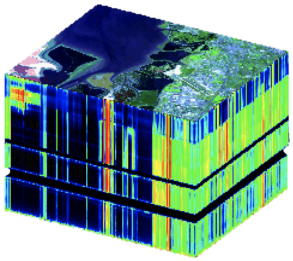
1 - Jet Propulsion Laboratory, California Institute of Technology; 2 - University of Arizona; 3 - Harvard University

PRESENTED AT:

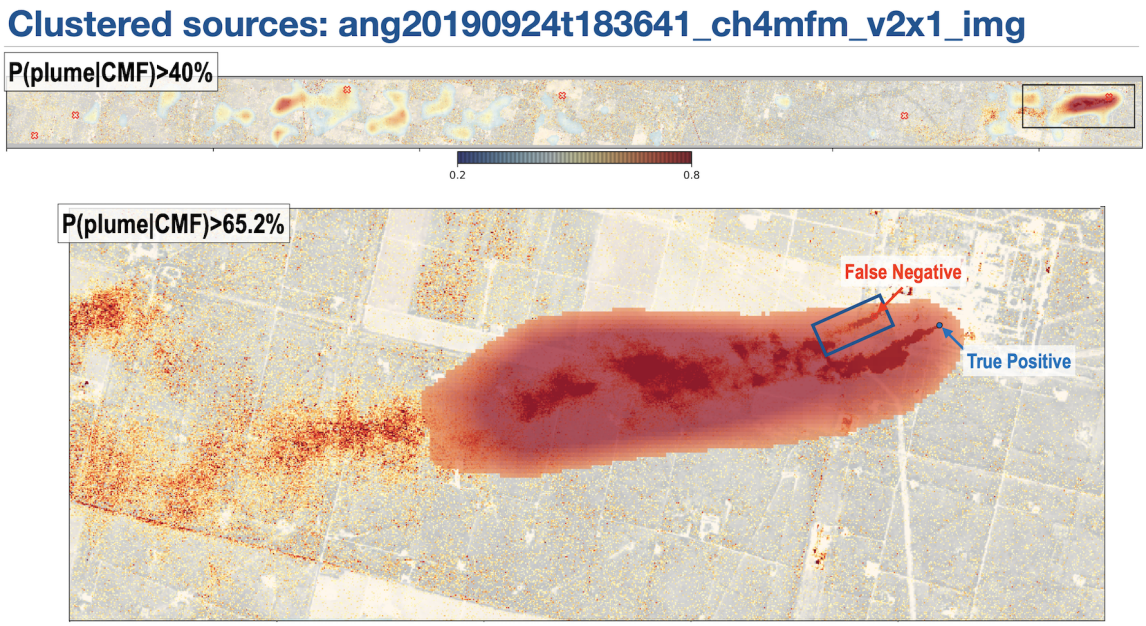
AGU FALL MEETING
Online Everywhere | 1–17 December 2020

BACKGROUND

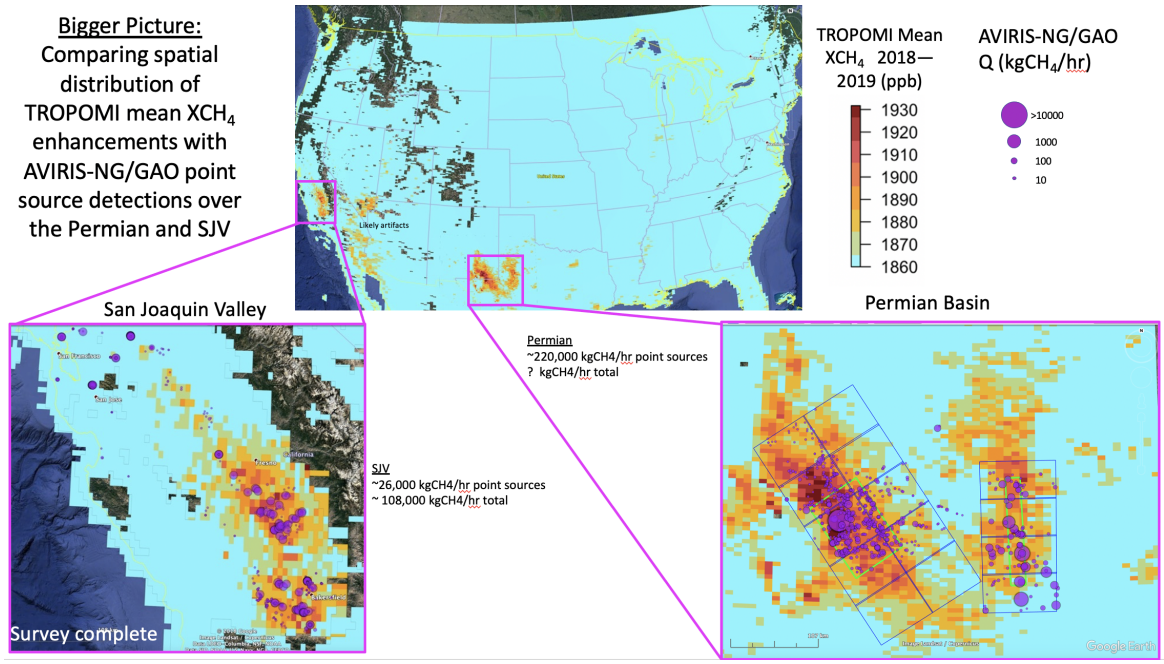
The Surface Biology and Geology global imaging spectrometer is primarily designed to observe the chemical fingerprint of the Earth's surface.



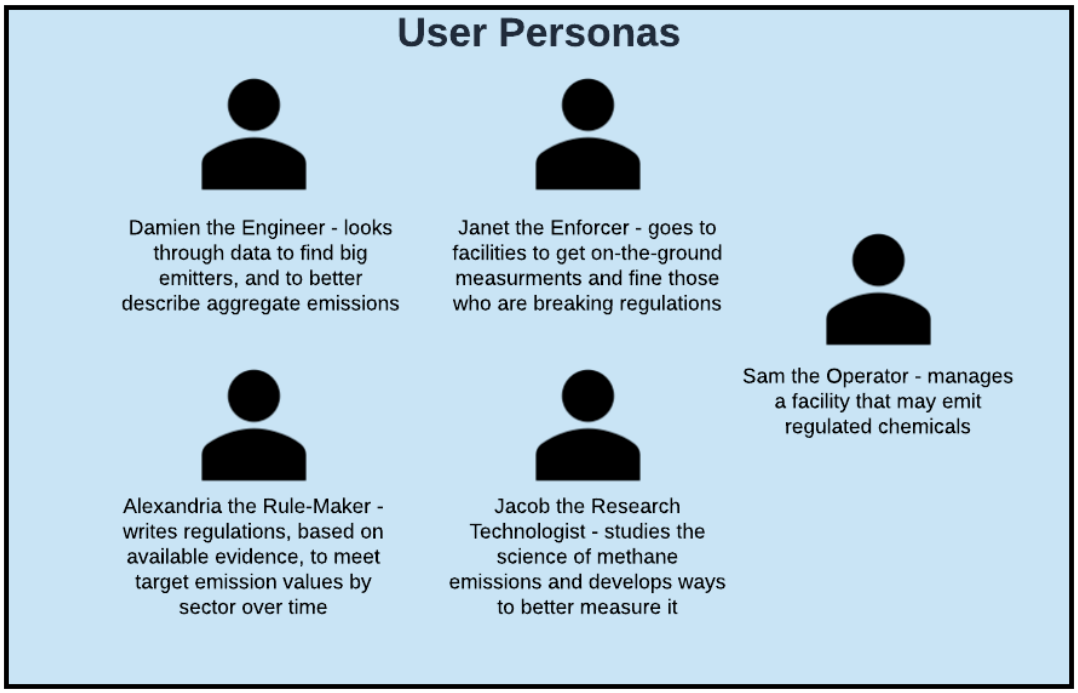
But visible to shortwave infrared imaging spectroscopy can also provide important atmospheric observations of methane point sources, highly concentrated emissions from energy, waste management and livestock operations.



Relating these point-source observations to greenhouse gas inventories and coarser, regional methane observations from sensors like the European Space Agency (ESA) TROPOMI will contribute to reducing uncertainties in local, regional and global carbon budgets:


Bigger Picture:
Comparing spatial distribution of TROPOMI mean XCH_4 enhancements with AVIRIS-NG/GAO point source detections over the Permian and SJV
TROPOMI Mean XCH_4 2018—2019 (ppb)
1930
1920
1910
1900
1890
1880
1870
1860
AVIRIS-NG/GAO Q ($kgCH_4/hr$)
>10000
1000
100
10
Likely artifacts
San Joaquin Valley
Permian Basin
Permian
~220,000 kgCH4/hr point sources
? kgCH4/hr total
SJV
~26,000 kgCH4/hr point sources
~ 108,000 kgCH4/hr total
Survey complete
Google Earth

TARGET USERS



USE CASES

Use Case 1: Connect Plume Observations to Infrastructure

End Points

- Scan a large area for hotspots to look at in more detail
- Search for a specific facility
- Search for the largest fugitive emissions (largest methane plumes)

Objectives

- Look at plume flux and location versus facility location
- Gather more details about a facility to determine whether any action needs to be taken
- See methane data-over-time for this facility to understand plume persistence

Use Case 2: Chart and Download Data for Further Analysis

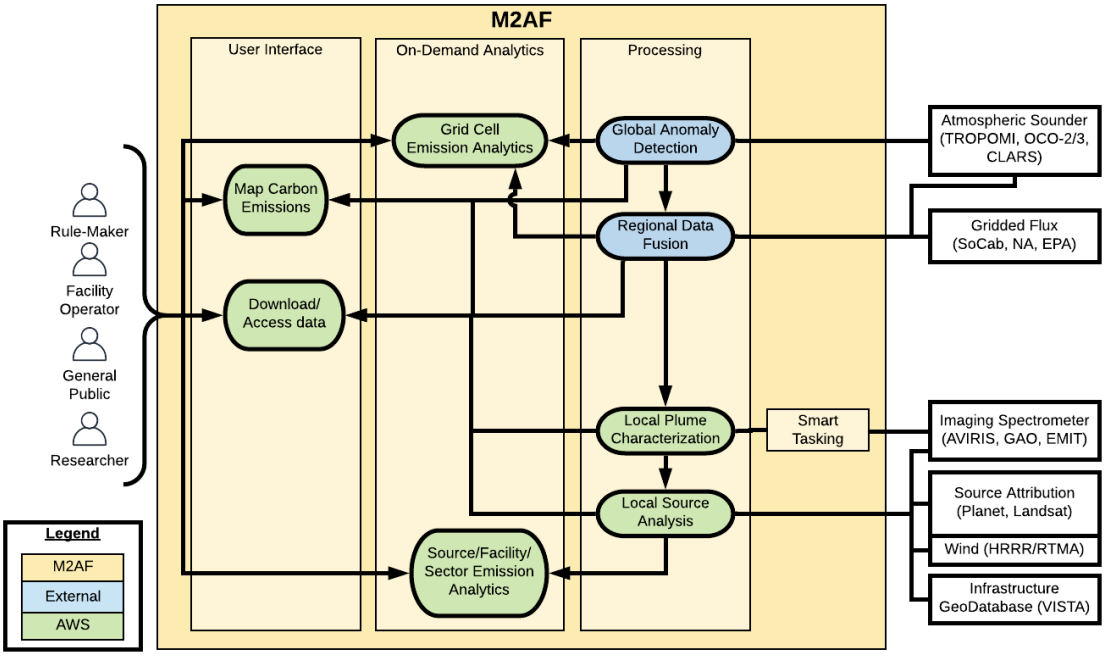
End Points

- View and find an interesting part of the map
- Look at summary histograms or tabulations of methane emissions of regions or sectors

Objectives

- Understand emissions by sector
- Evaluate concentration of super-emitters in a particular sector or region
- Download full or partial dataset (depending on what is seen int he charts) for custom analysis

To meet these Use Cases, the Multi-scale Methane Analytic Framework (M2AF) enables users to perform the following functions (ovals) in a hybrid cloud-on premise data platform:


M2AF
User Interface
On-Demand Analytics
Processing
Grid Cell Emission Analytics
Global Anomaly Detection
Map Carbon Emissions
Regional Data Fusion
Download/ Access data
Local Plume Characterization
Smart Tasking
Local Source Analysis
Source/Facility/ Sector Emission Analytics
Rule-Maker
Facility Operator
General Public
Researcher
Legend
M2AF
External
AWS
Atmospheric Sounder (TROPOMI, OCO-2/3, CLARS)
Gridded Flux (SoCab, NA, EPA)
Imaging Spectrometer (AVIRIS, GAO, EMIT)
Source Attribution (Planet, Landsat)
Wind (HRRR/RTMA)
Infrastructure GeoDatabase (VISTA)

SYSTEM DESIGN

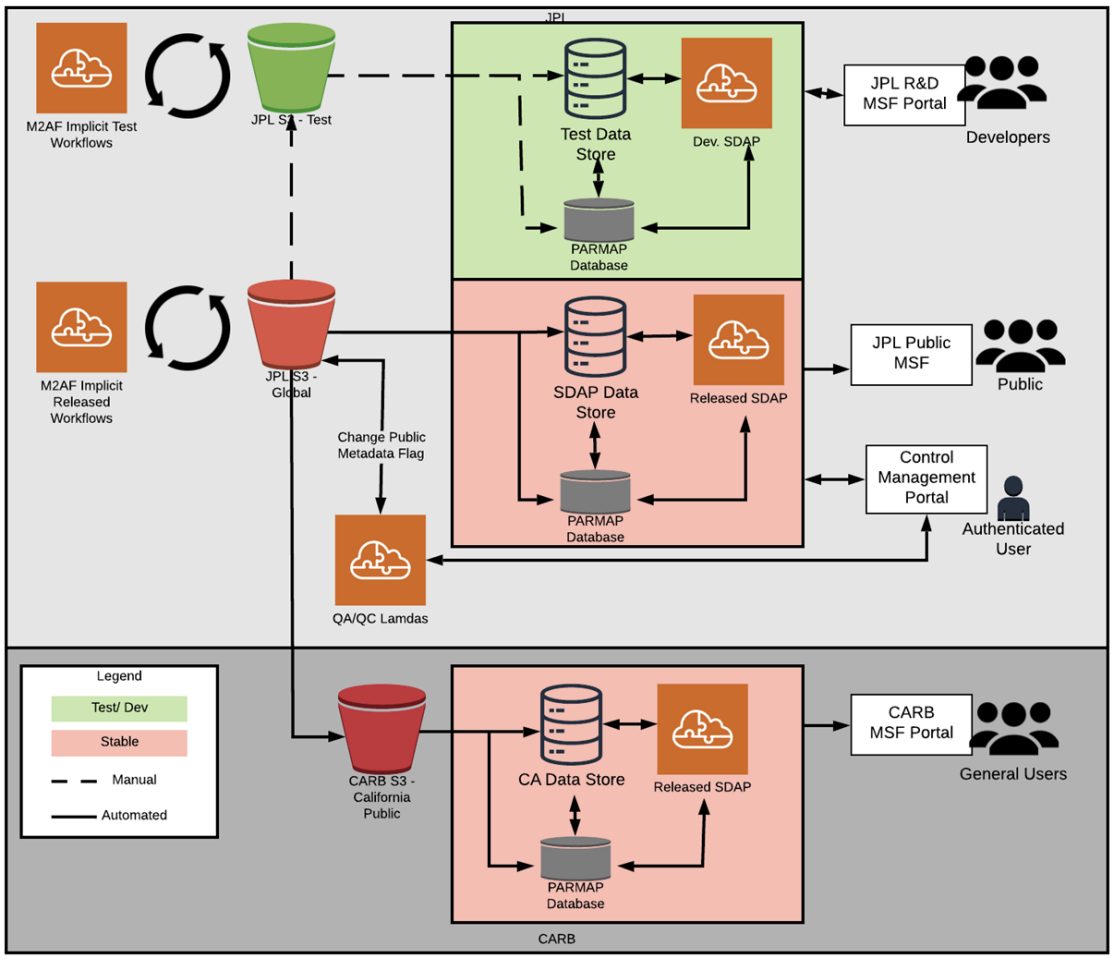
Our system is a collaboration with the California Air Resource Board (CARB)

As we develop in a quasi-agile management framework using research and development funds

We have multiple builds that are integrated and synced.

The analytics platforms leverage the best of the open-source Apache innovator Science Data Analytics Platform (SDAP) and its light-weight derivative Parmap

We leverage the well-established Methane Source Finder (MSF) at https://methane.jpl.nasa.gov (https://methane.jpl.nasa.gov) as our User Interface



NEXT STEPS

December 2020

- Deploy SDAP,
- Integrate with MSF, and
- Define Quality Assurance/ Quality Control portal use cases
- Test plume point source statistics through MSF

June 2021

- Integrate regional implicit workflow and interface with super computer
- Develop Control Management Portal - QA/QC integration, super computer deployment, user authentication
- Test regional forward model and inversion statistics through MSF

December 2021

- Integrate global datasets
- Refine MSF and Control Management Portals based on user feedback
- Test global data layer statistics through MSF

February 2022

- Finish documentation
- Public, open-source release

ABSTRACT

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