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Bureau of Air Quality

Methane Overflight Study Overview

Air Quality Technical Advisory Committee

March 9, 2023

Harrisburg, PA and Microsoft Teams

Josh Shapiro, Governor

Richard Negrin, Acting Secretary

Methane Overflight Study

- The Pennsylvania Department of Environmental Protection (DEP), in collaboration with Carbon Mapper, Inc. (Carbon Mapper) and the U.S. Climate Alliance, conducted a research study to better understand the capabilities of airborne methane detection technology and to gather data on methane emission sources and rates.
- This study intended to evaluate the effectiveness of Carbon Mapper's airborne technology as a methane emission data measurement tool to detect methane-emitting sources and measure their corresponding emission rates.
- The data obtained by Carbon Mapper was used to evaluate and compare methane emissions across different facilities and industries across PA.

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What is Carbon Mapper?

https://youtu.be/5NzPnZ9f6BE

https://youtu.be/LzB3dR6zRyU

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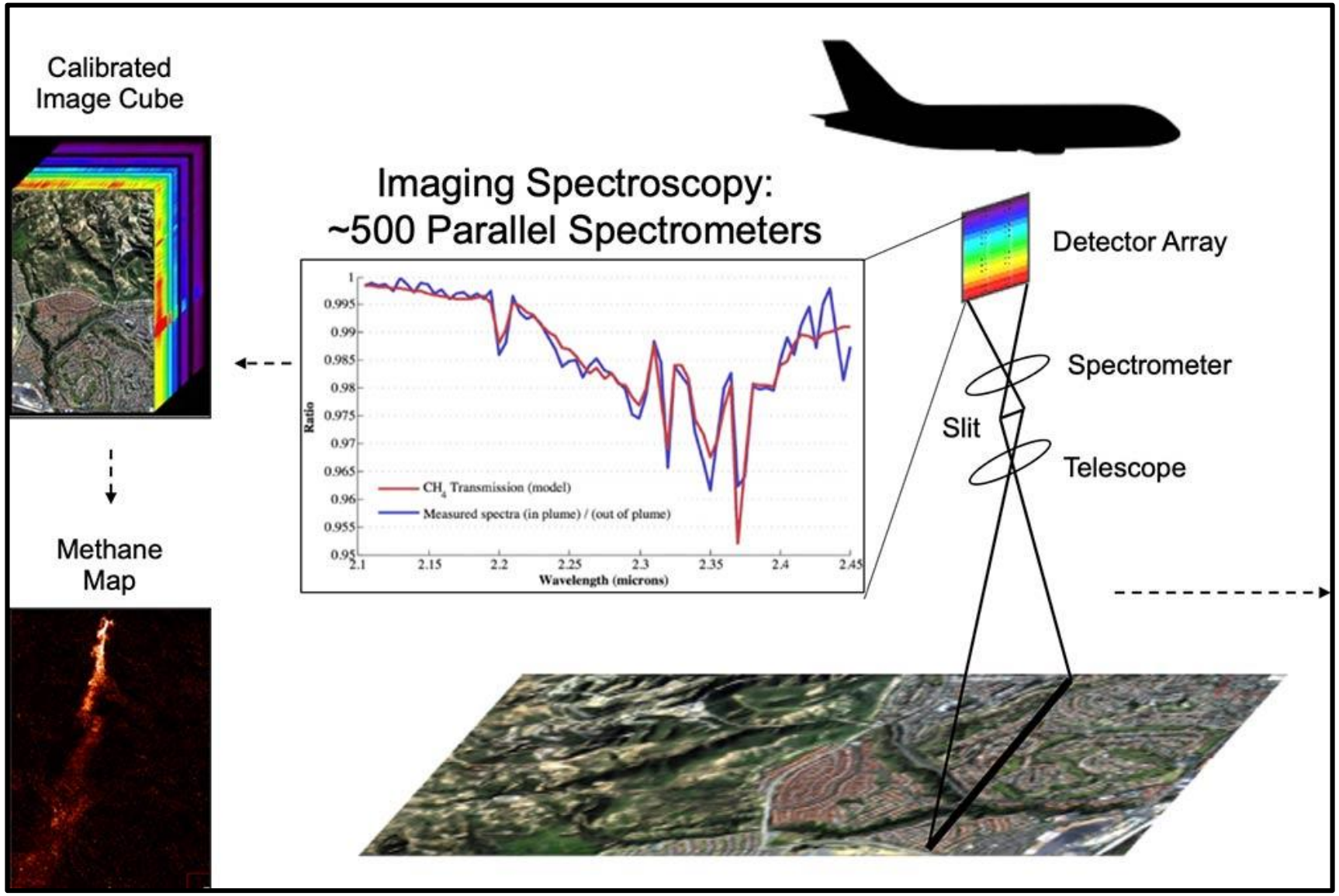
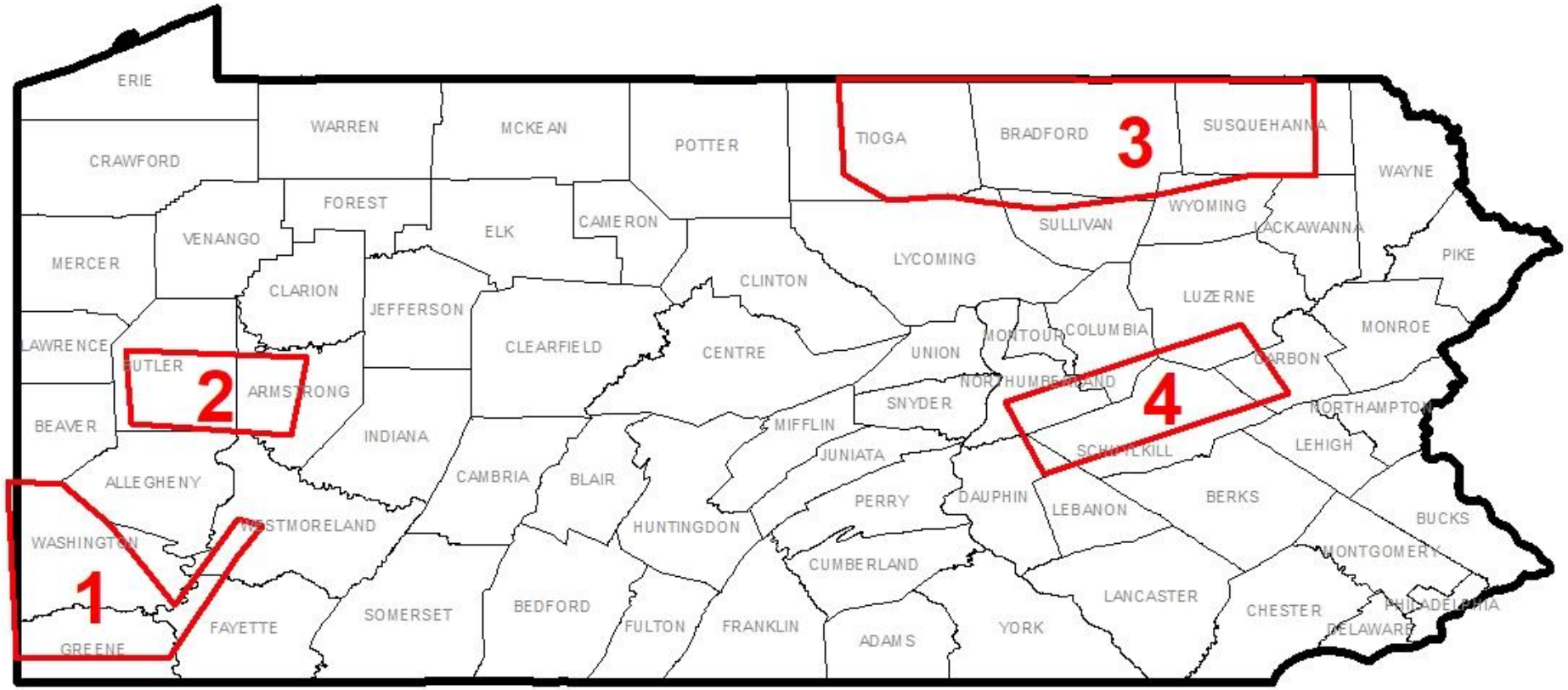
How the Technology Works



Overflight Target Areas



UC Climate Alliance

Proposed Flight Areas

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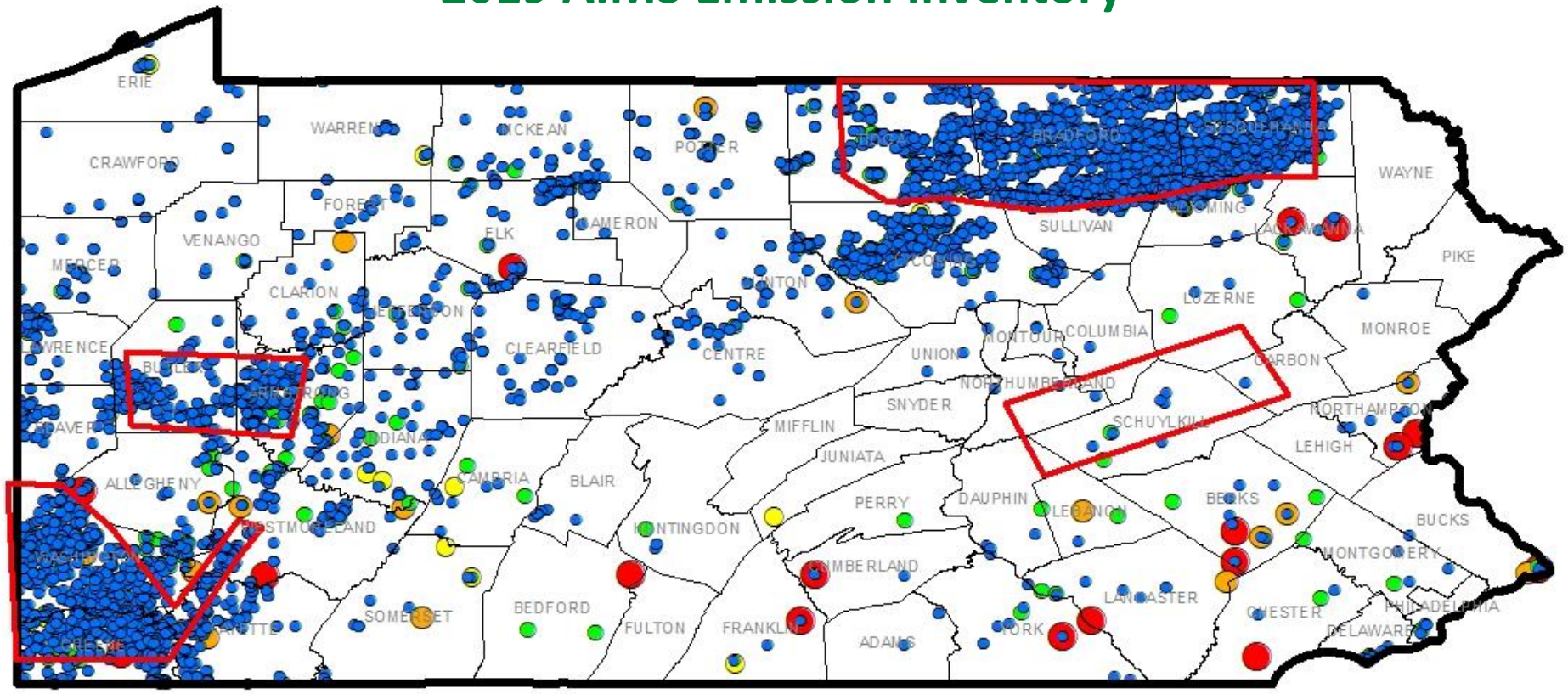
Overflight Target Areas

2019 AIMS Emission Inventory



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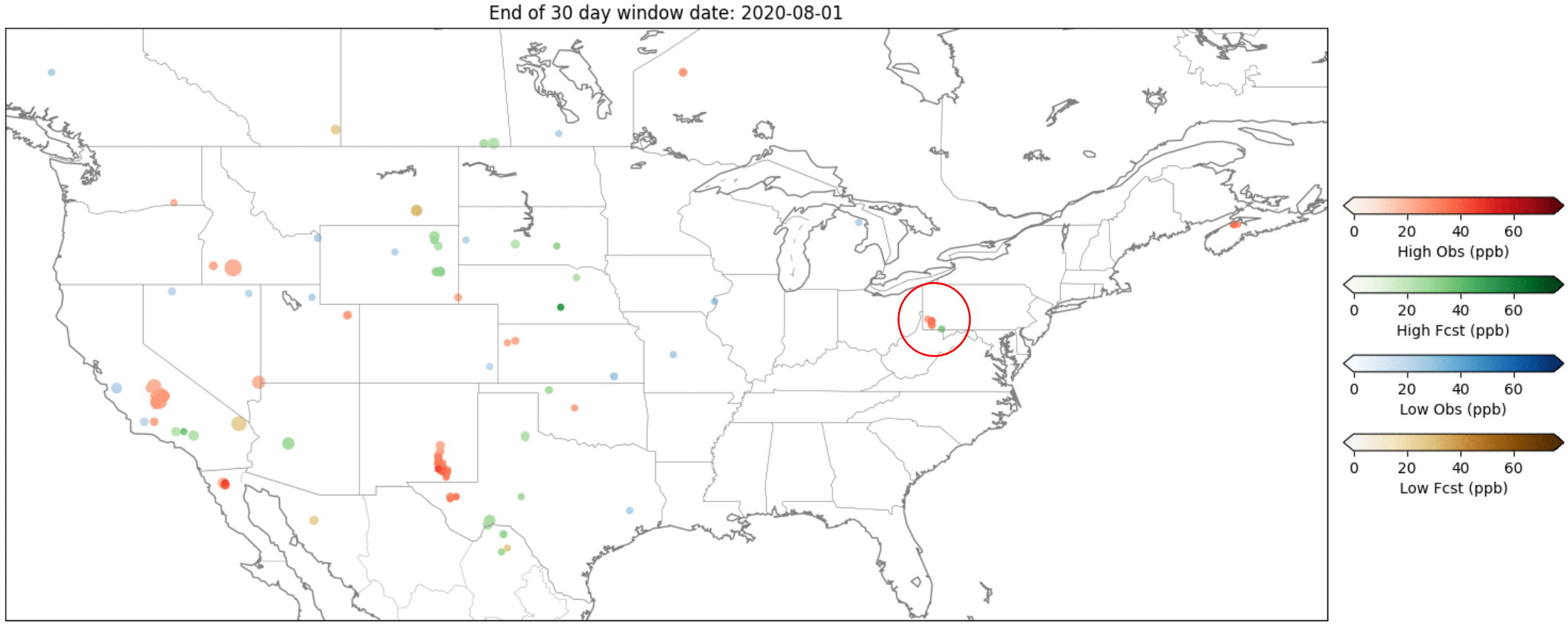
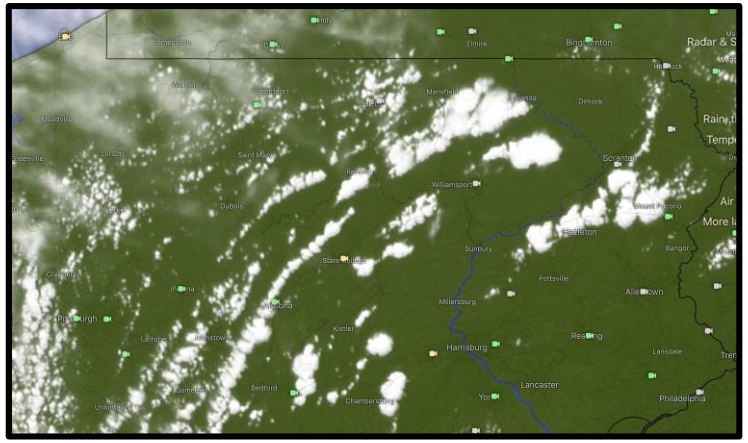
Overflight Target Areas



Source: Engelen et al, ECMWF

Methane Overflight Study - Results

- Global Airborne Observatory (GAO) plane was based at State College from May 11-30, 2021
- Coverage of target areas ~ 90% complete
  - Significant impacts from clouds (50% down time)
  - Includes 4 samples over Southwestern PA
- Flights occurred nine times over the approximate 3-week period, on the following days in May:
  - 11, 12, 13, 14, 15, 17, 18, 21, and 26
- During the campaign, 153 total plumes were detected from 91 individual sources



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Plume Detection Method

Carbon Mapper followed the following method to complete its plume analysis:

1. Calibrated and orthorectified image cube data.
2. Retrieved methane column mixing ratio-lengths and generated methane plume data.
3. Performed automated methane plume extraction and quality control.
4. Geolocated methane plumes with latitude/longitude coordinates.
5. Calculated methane plumes' integrated enhancement and length.
6. Acquired and processed High Resolution Rapid Refresh (HRRR) reanalysis wind fields.
7. Estimated emissions and quantified uncertainty for each individual methane plume.
8. Attributed each methane plume to the nearest infrastructure or facility and classified its emission sector.
9. Generated a source list and methane plume images.

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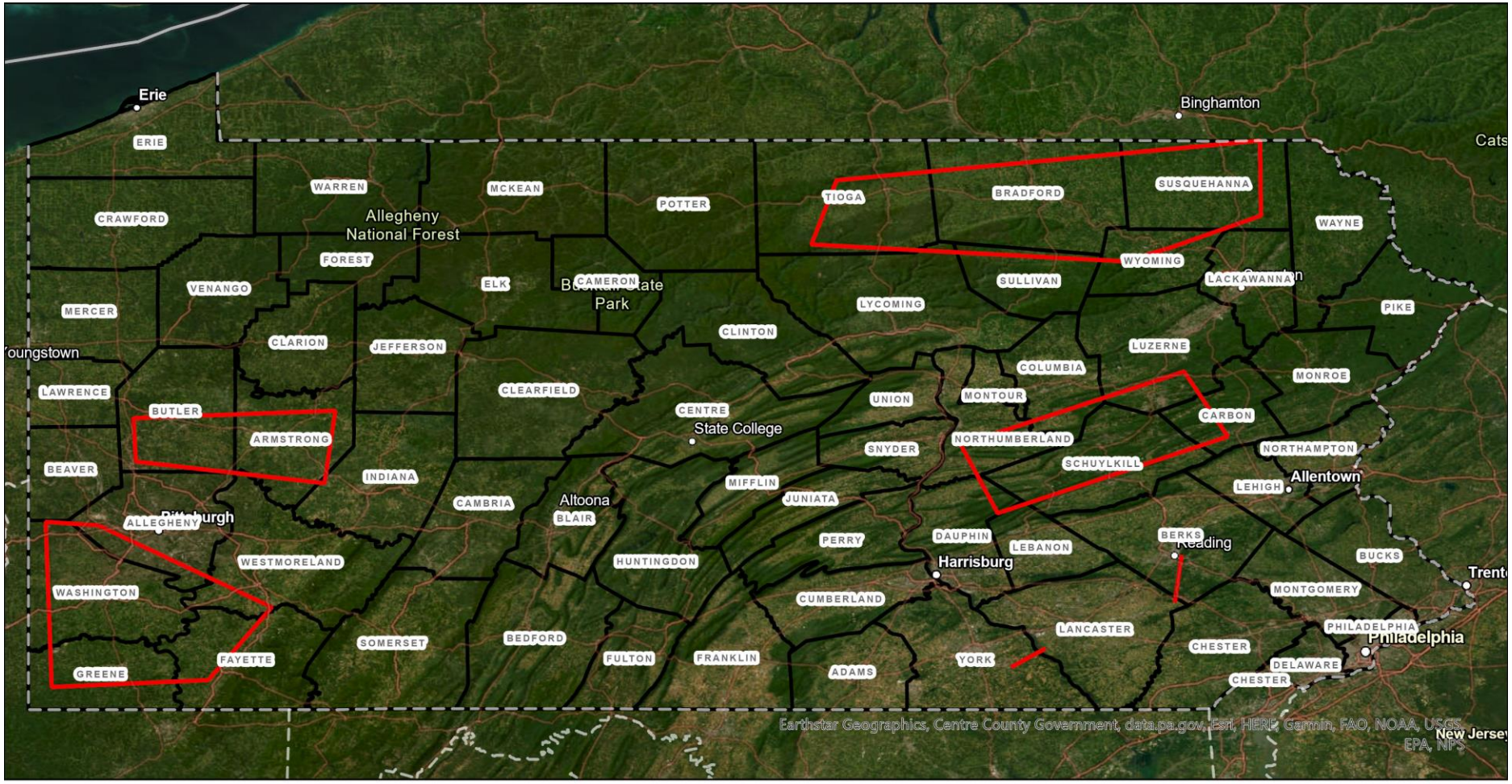
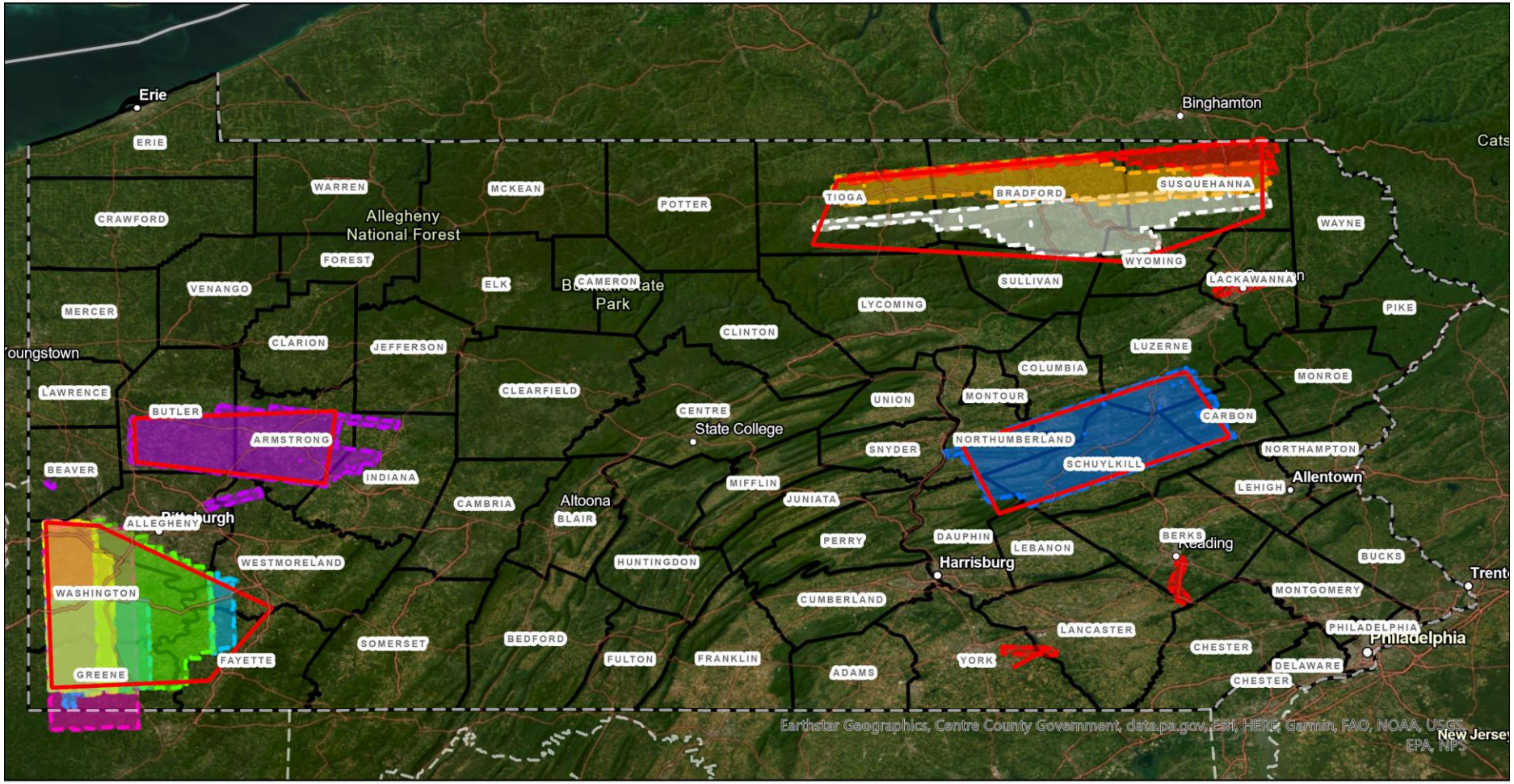
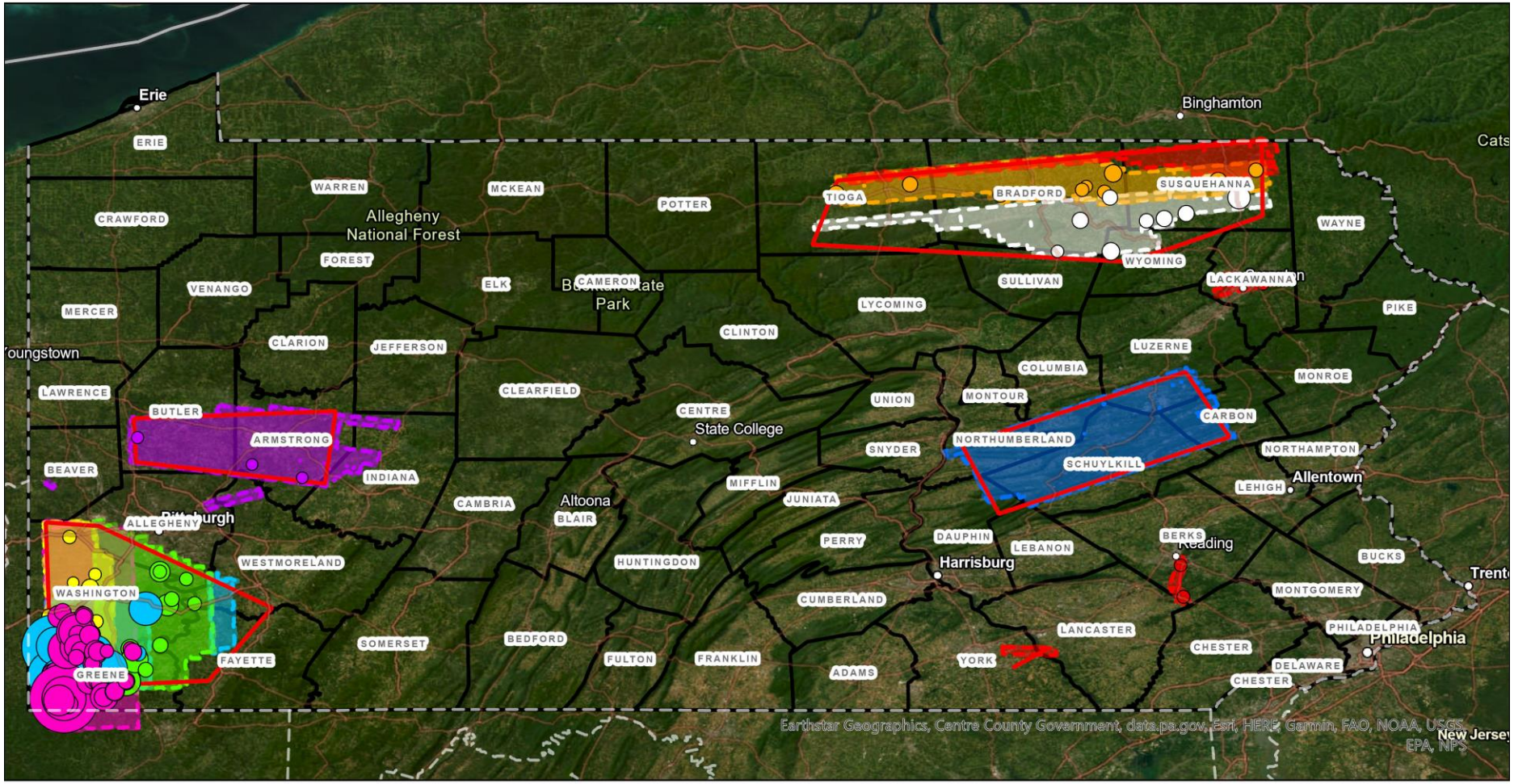
Preliminary Flight Locations



Preliminary vs. Actual Flight Locations



Actual Flight Locations vs. Methane Detection Locations

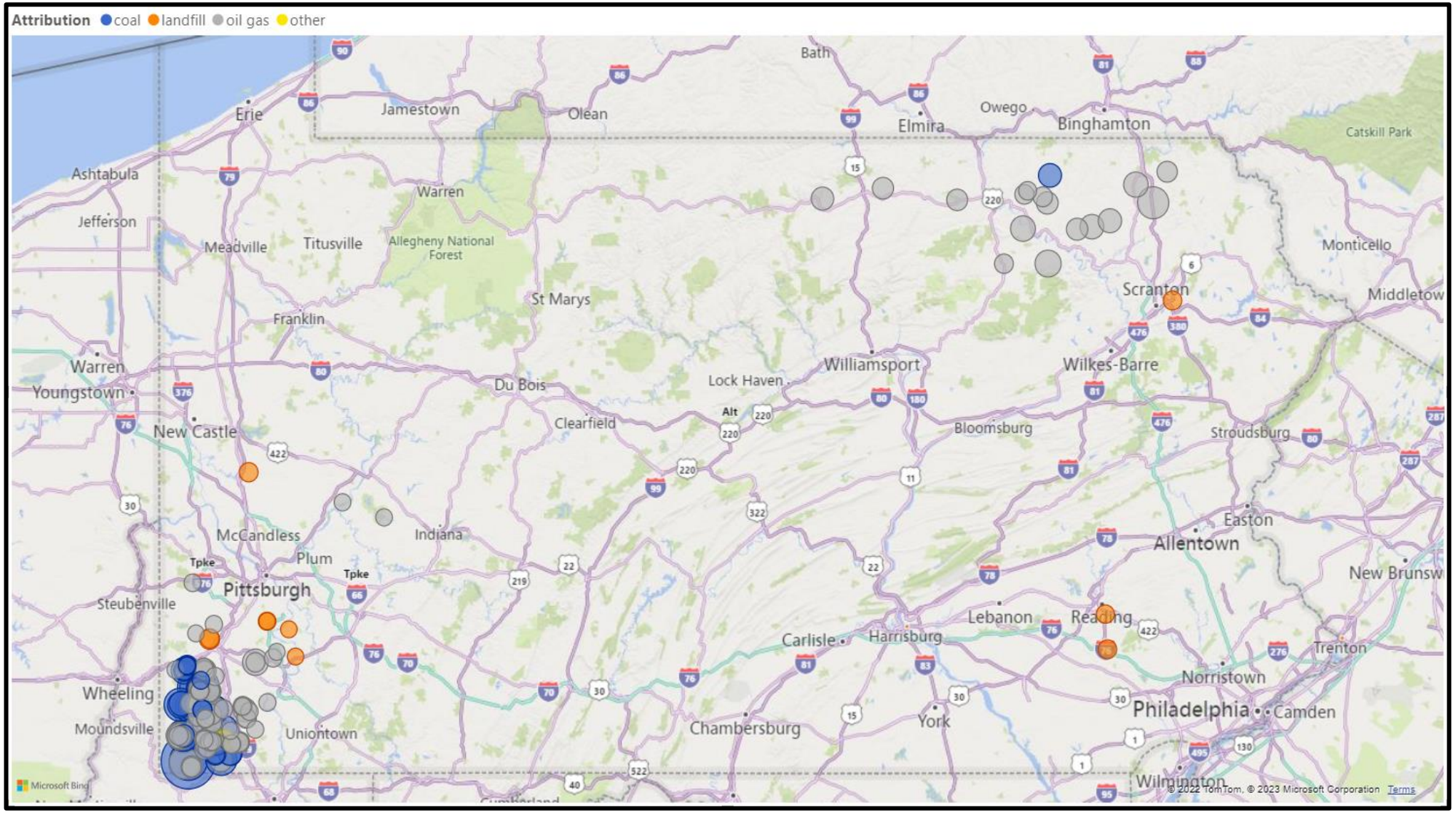


05/11/2021 05/12/2021 05/13/2021 05/14/2021 05/15/2021 05/18/2021 05/21/2021 05/26/2021

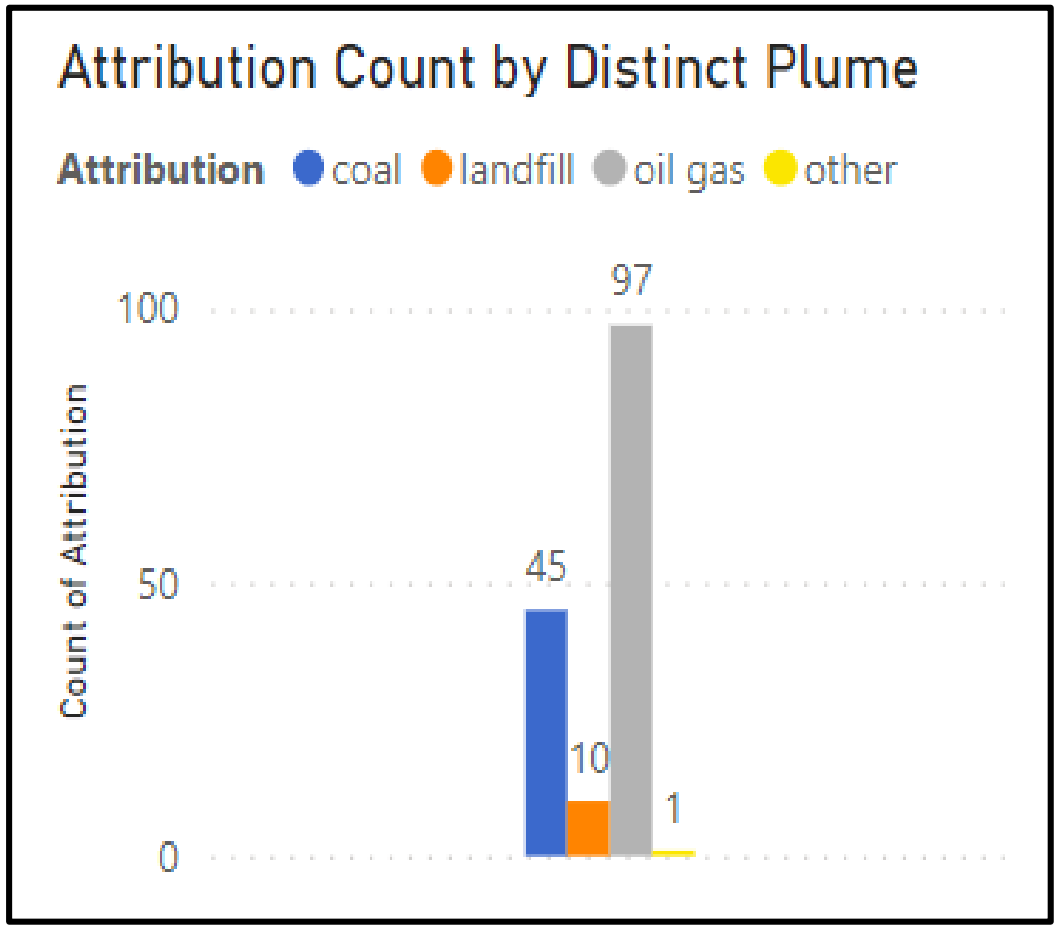
0 9 18 36 54 72 Miles

N W E S

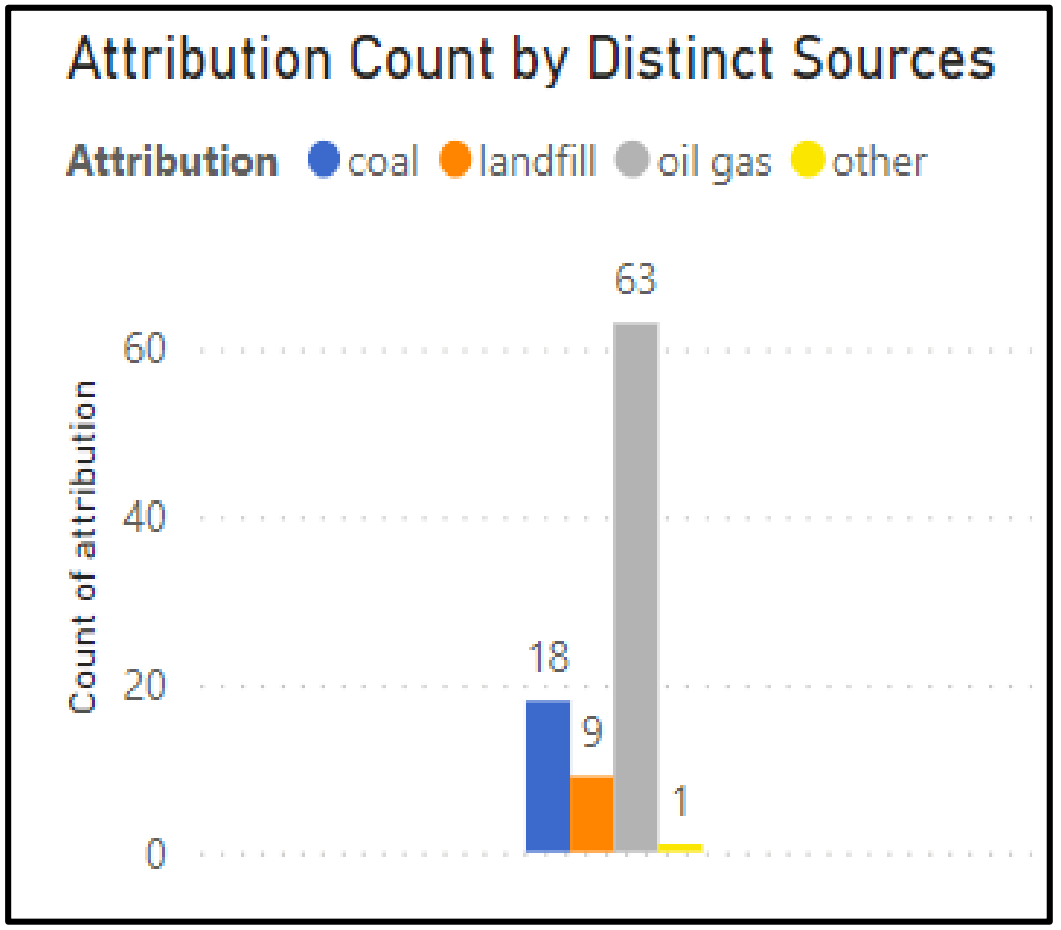
Plume Source Attributions



Attribution by Plume vs. Source

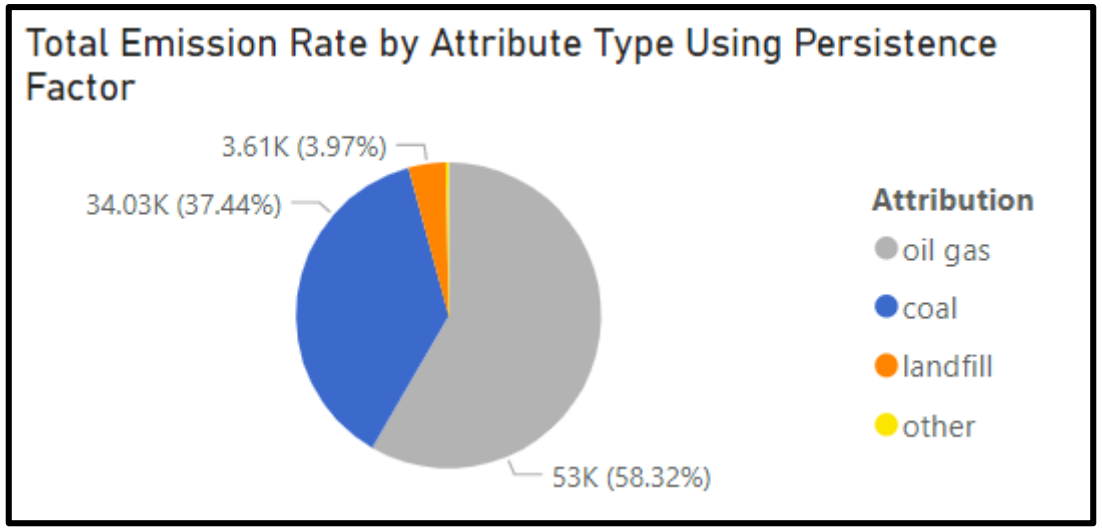


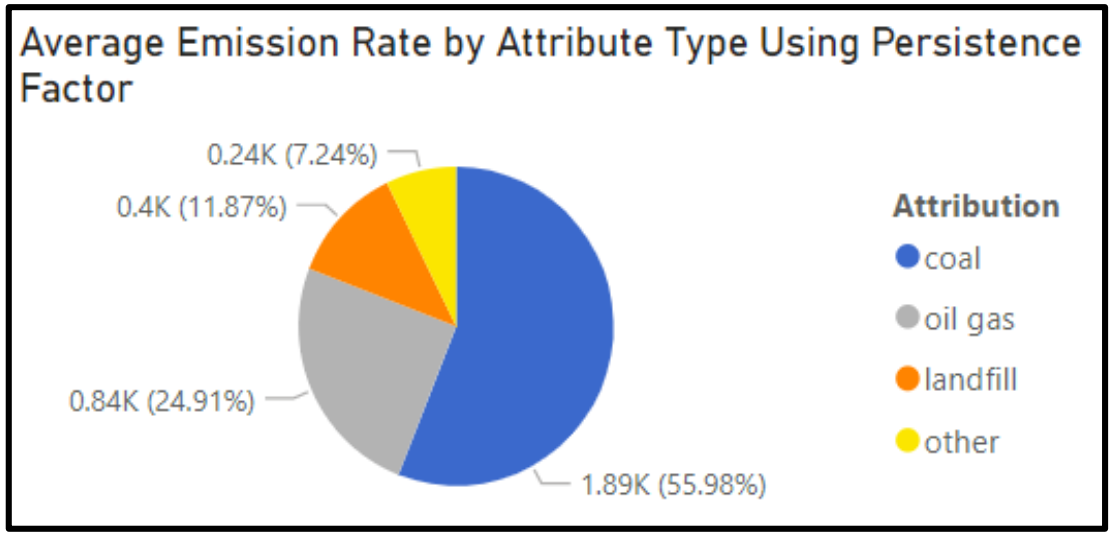
153 Distinct Plumes



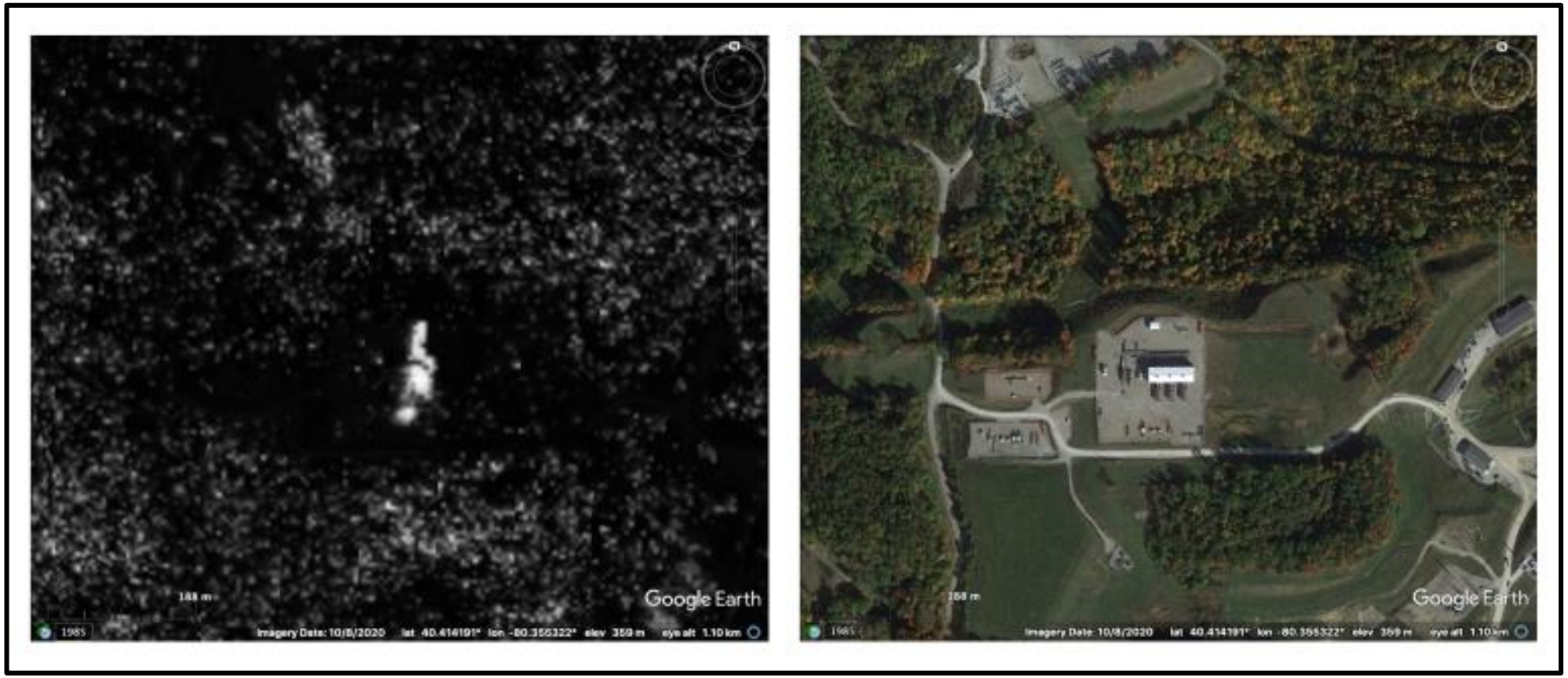
91 Distinct Sources

Total vs. Average Emission Rate

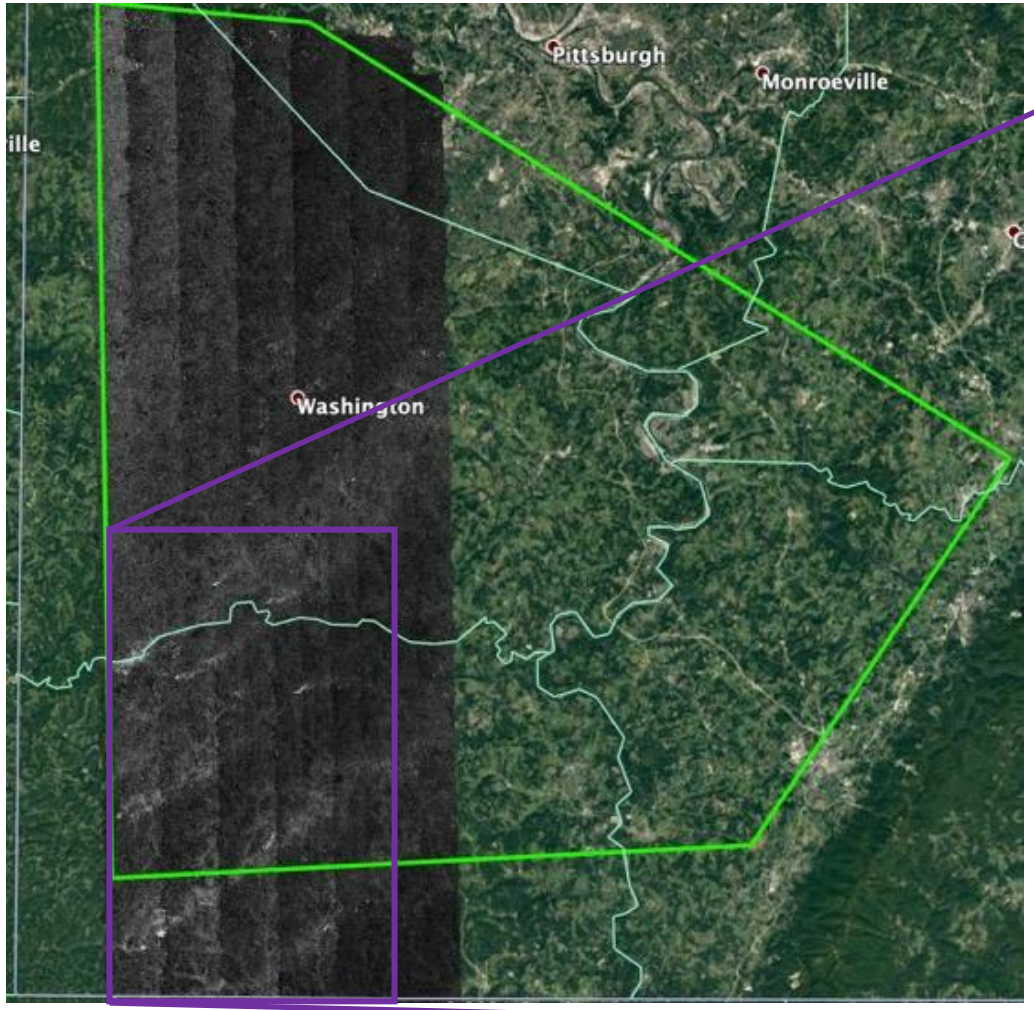


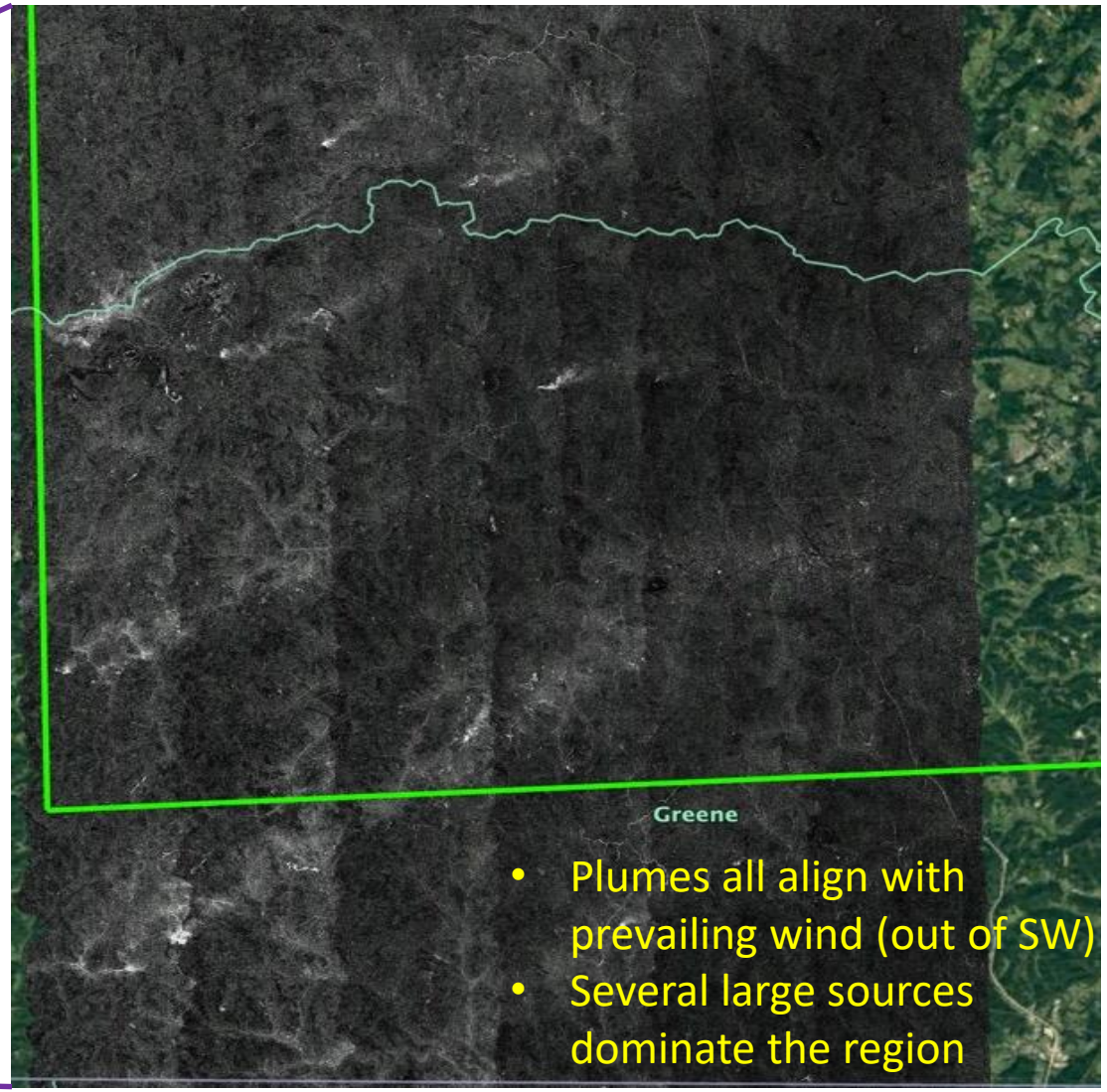


Compressor Station



Raw Images of Methane Emissions – May 21 Flight



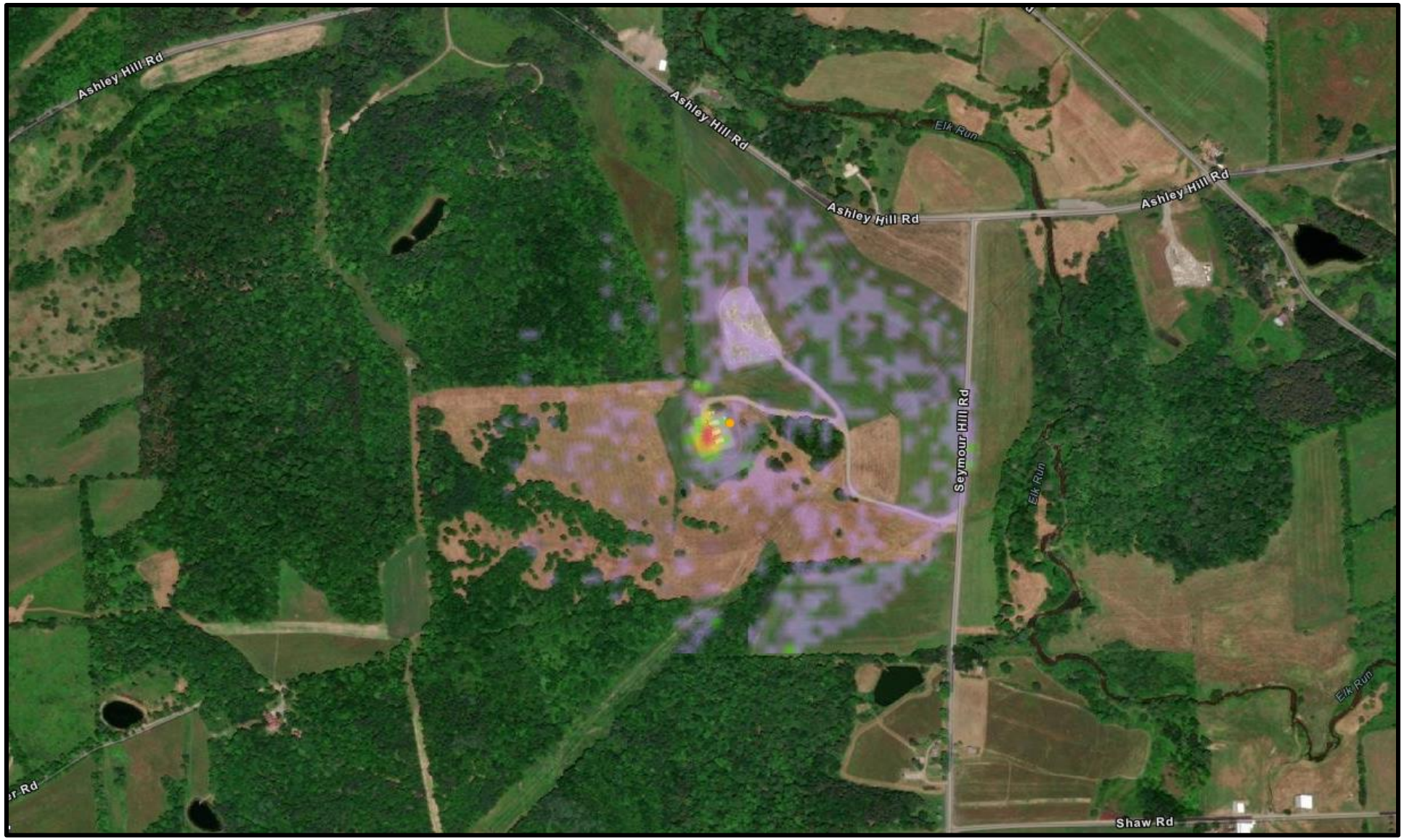


- Plumes all align with prevailing wind (out of SW)
- Several large sources dominate the region

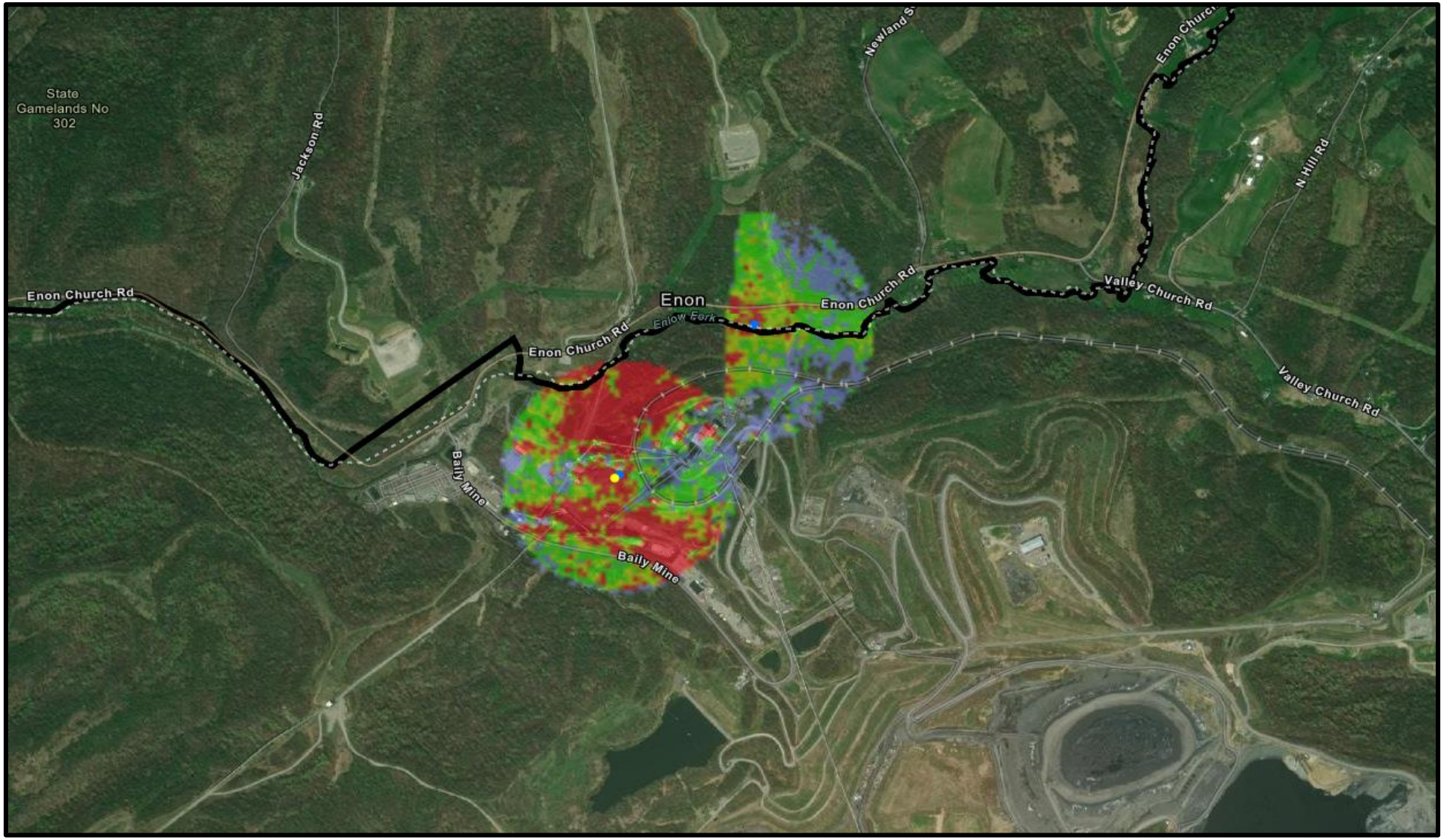
Initial Plume Examples – Landfills

Initial Plume Examples – Coal Mine Vents

Initial Plume Examples – Natural Gas Production

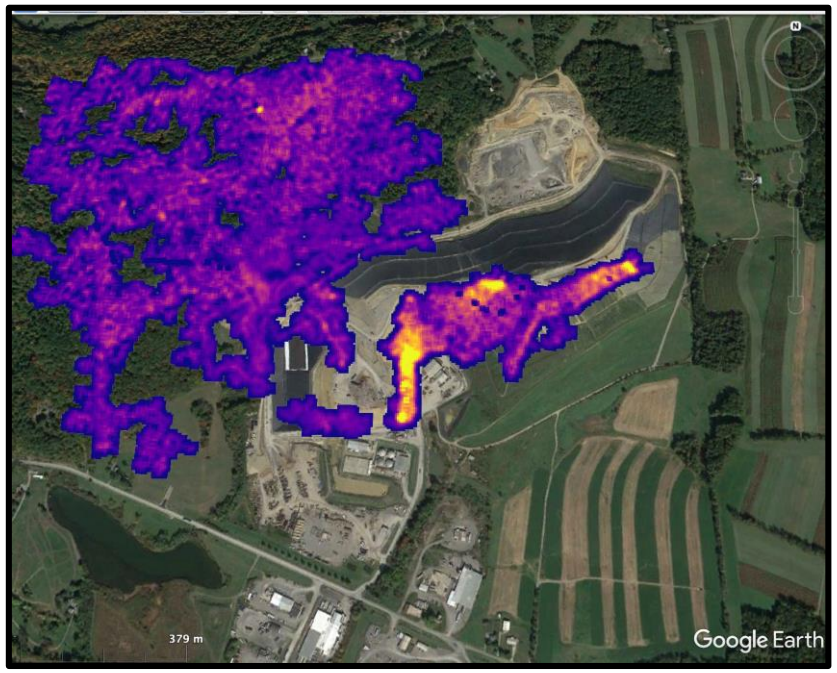


Initial Plume Examples – Coal Mines



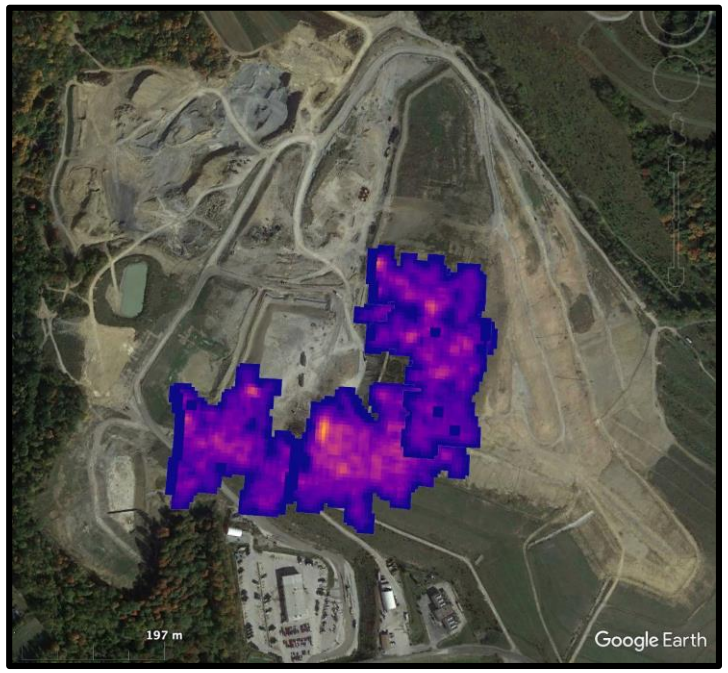
Final Plume Examples - Landfills

Seneca



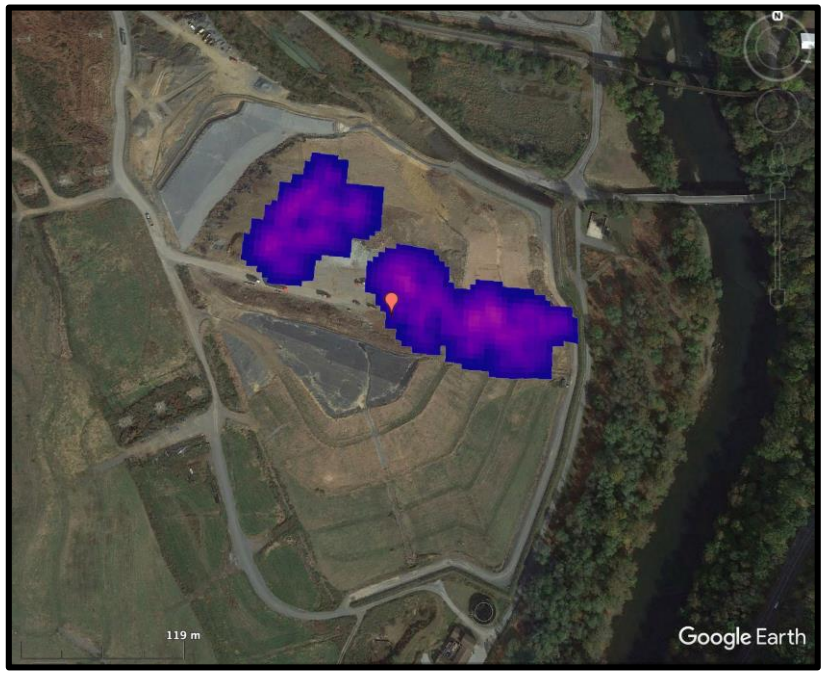
671 +/- 524 kgCH4/hr

Arden



561 +/- 122 kgCH4/hr

Western Berks



296 +/- 140 kgCH4/hr

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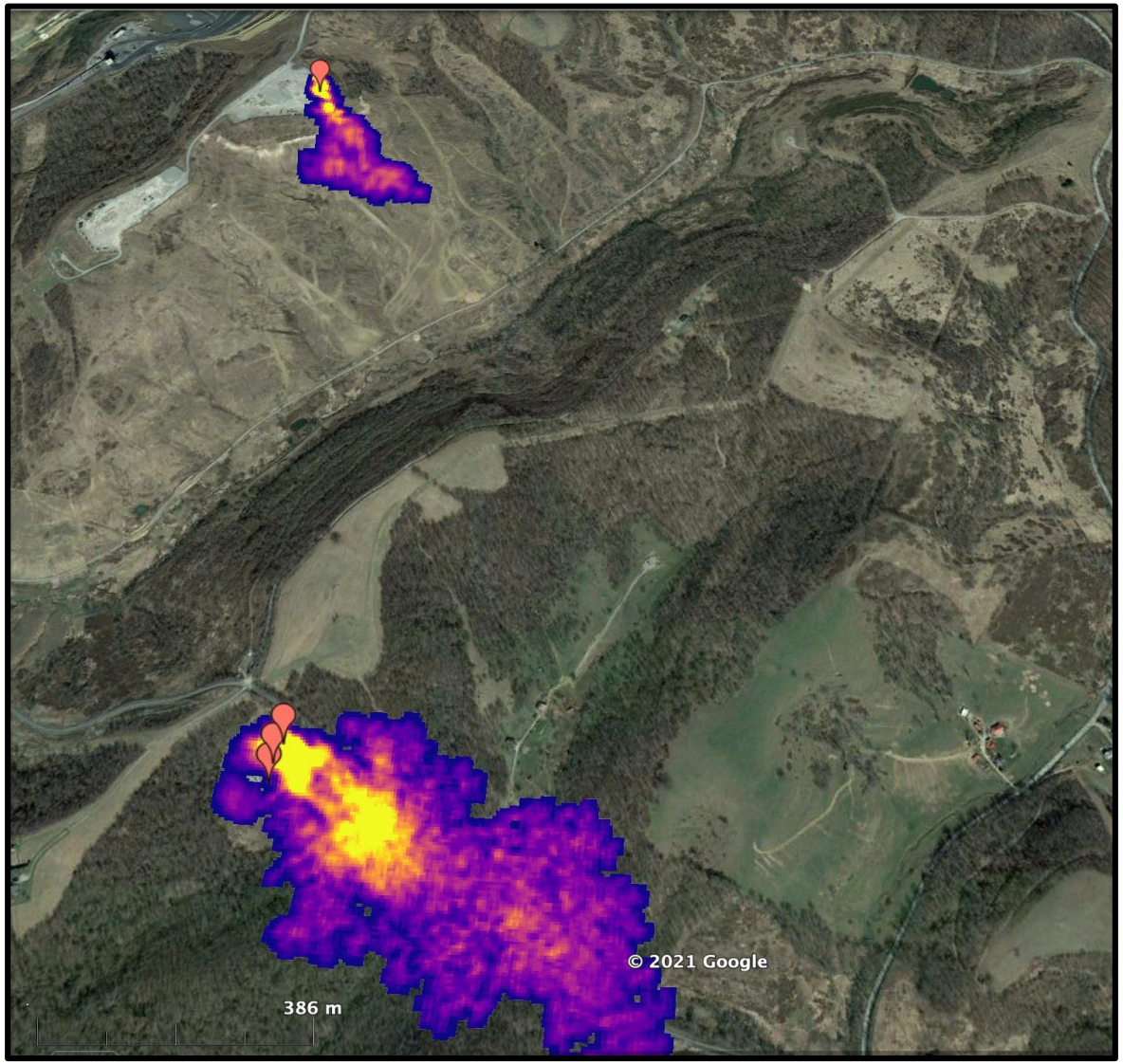
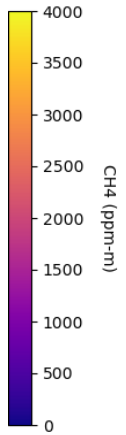
Final Plume Examples – Coal Mines and Natural Gas Production



1000+ kgCH4/hr from tank battery/well pad



5000+ kgCH4/hr from coal mine vent

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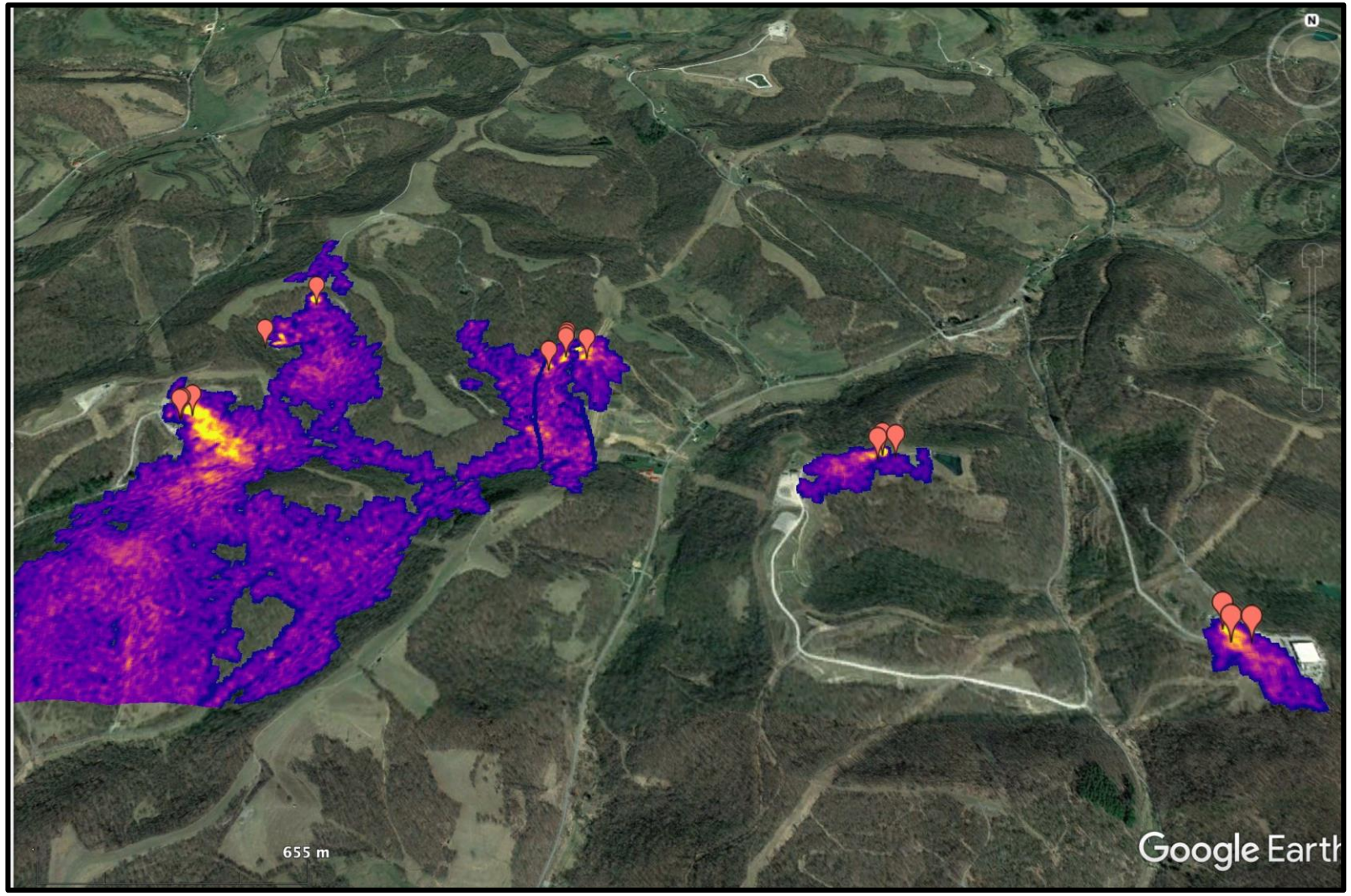
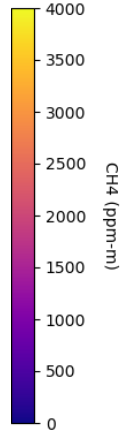
Final Plume Examples – Coal Mine Vents





5500+ kgCH4/hr from this complex

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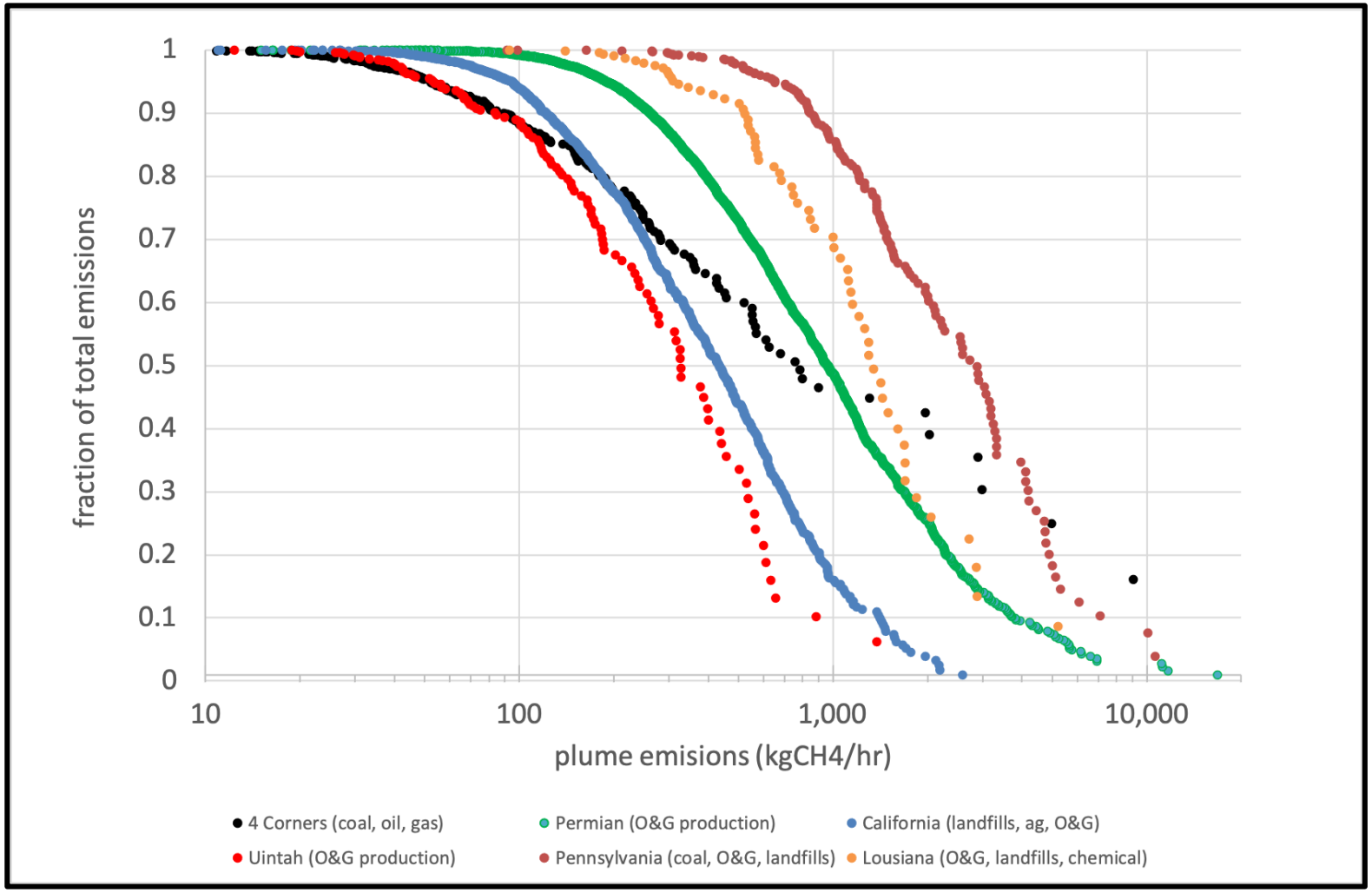
Pennsylvania vs. Other Regions



- This graphic displays the cumulative distributions of individual plume emissions.
- Caveat: Plot developed with initial emission rate estimate using 2.5 m/s
- Will be refined with HRRR winds

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Actual Methane Reductions Achieved

- Actual methane reductions were realized from this campaign.
- 12 facilities instituted a mitigation technique to combat methane at their location.
- This led to an approximate 10% reduction in the emission from sources identified as part of this campaign.
- “Other” Source Category – Represents an unverified source.

Methane Emission Reductions Estimates by Persistence Factor

Source Category	Emission Rate (kg/hr)	Sum of Amount Reduced (kg/hr)	Percent Reduction
Coal mining	34,025	0	0.0 %
MSW landfill	3,609	1,341	37.2 %
Oil and gas	53,004	7,268	13.7 %
Other	244	0	0.0 %
Total	**90,882**	**8,609**	**9.5 %**

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Potential Future Projects

- Carbon Mapper's work continues. There is potential for future projects like this to occur near or over Pennsylvania.
- Further investigation is needed to understand and rectify the variation between aerial and terrestrial emission estimations.
- Ways to improve this type of project include the following:
  - More intensive monitoring over the same area to delineate constant versus intermittent releases of methane.
  - Fly over agricultural rich areas of Pennsylvania to determine potential methane being released into atmosphere.
- Similar technology to the one used on this campaign will be installed on satellites to complete daily methane monitoring of the atmosphere.

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