Methane Overflight Study Overview

Air Quality Technical Advisory Committee
March 9, 2023
Harrisburg, PA and Microsoft Teams

Josh Shapiro, Governor

Richard Negrin, Acting Secretary
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.
What is Carbon Mapper?

https://youtu.be/5NzPnZ9f6BE

https://youtu.be/LzB3dR6zRyU
How the Technology Works
Overflight Target Areas
Overflight Target Areas

2019 AIMS Emission Inventory

UC Climate Alliance

Proposed Flight Areas

2019 Methane Sources (tons per year)

- 0 - 100
- 100 - 500
- 500 - 1000
- 1000 - 2500
- 2500 and Up
Overflight Target Areas

End of 30 day window date: 2020-08-01

Source: Engelen et al, ECMWF
• 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
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.
Preliminary vs. Actual Flight Locations
Actual Flight Locations vs. Methane Detection Locations
Plume Source Attributions
Attribution by Plume vs. Source

153 Distinct Plumes

91 Distinct Sources
Total vs. Average Emission Rate

Total Emission Rate by Attribute Type Using Persistence Factor

Average Emission Rate by Attribute Type Using Persistence Factor
Compressor Station
• Plumes all align with prevailing wind (out of SW)
• Several large sources dominate the region
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
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
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
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

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