

PICARRO

Identification of Methane Emissions in an Urban Setting

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Collaborators in this effort



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- Jocelyn Turnbull & Colm Sweeney – NOAA/ESRL
- Paul Shepson & Maria Obiminda Cambaliza – Purdue
- Eric Crosson, Chris Rella, & Sze Tan – Picarro, Inc.
- Robert Ackley – Gas Safety, Inc.



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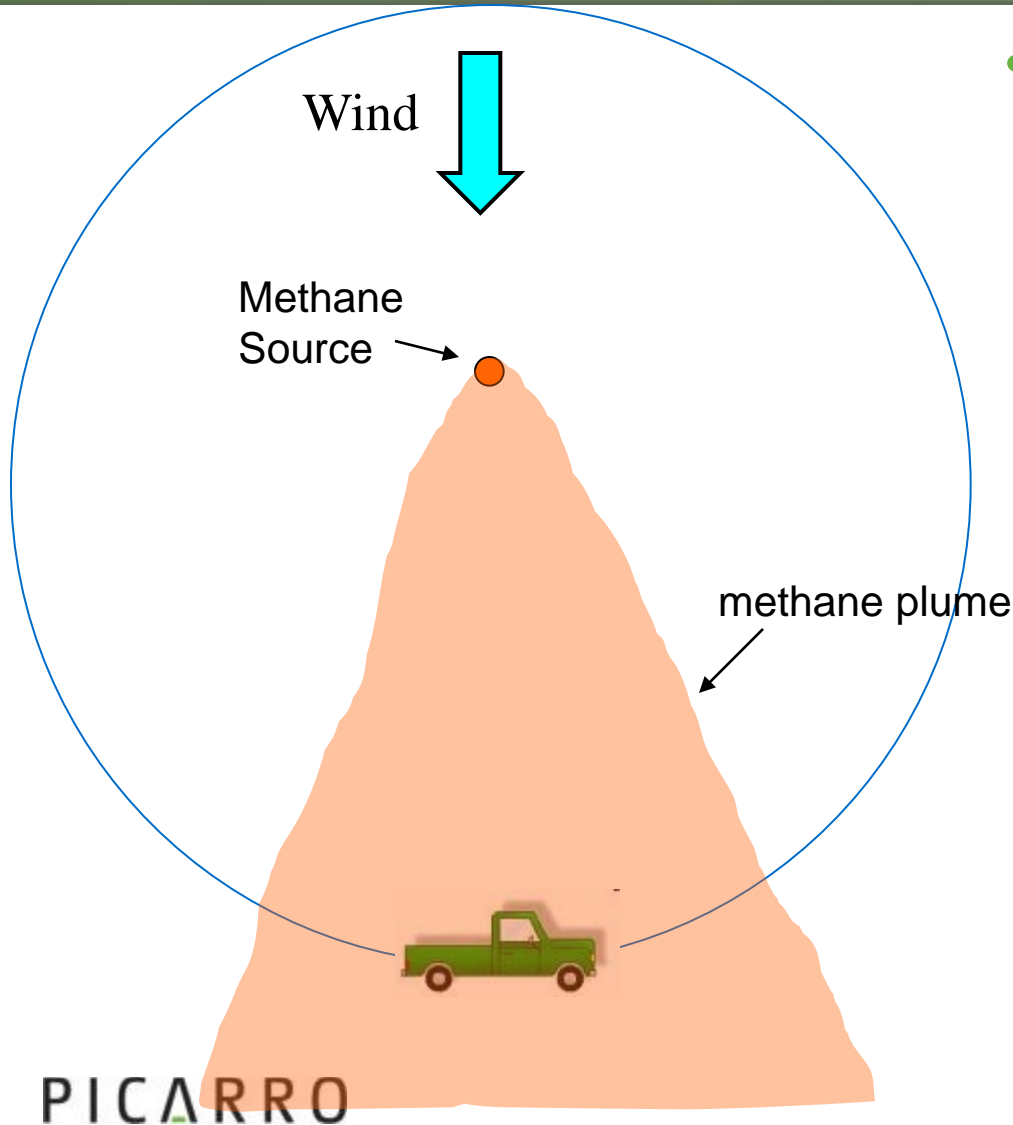
Objectives of this effort



- As an extension of the INFLUX work
 - Identify methane source locations and gather information on methane flux signals (relative magnitudes).
 - Provide prior knowledge for inversion models.
 - Data to help validate inversion model results.
 - Information to help improve flux measurements from aircraft.
 - Data could help to model cross-wind dispersion in an urban environment.



Method: Measuring Methane Plumes to Determine Source Locations



- Map out methane concentrations while driving along roads and highways.
 - CH_4 : 2 ppb precision at 0.5 Hz.
 - GPS data
 - Wind velocity

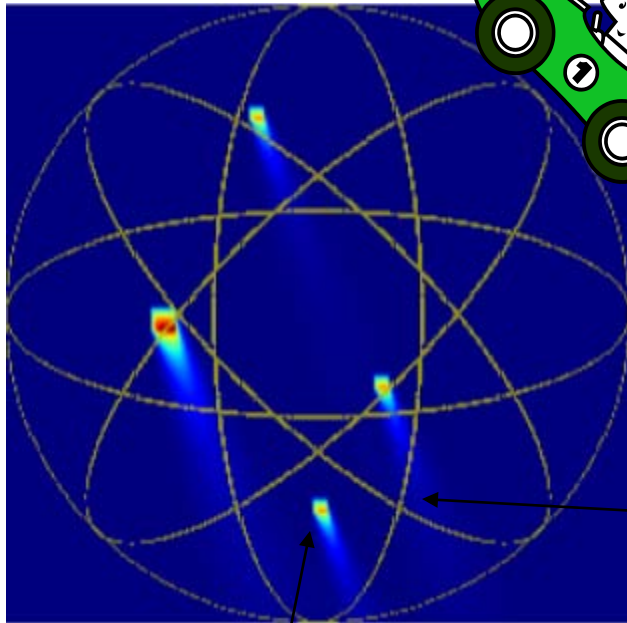


Method: Identifying methane source locations



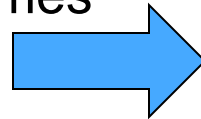
Guidance from Simple Gaussian Plume Model

Sources

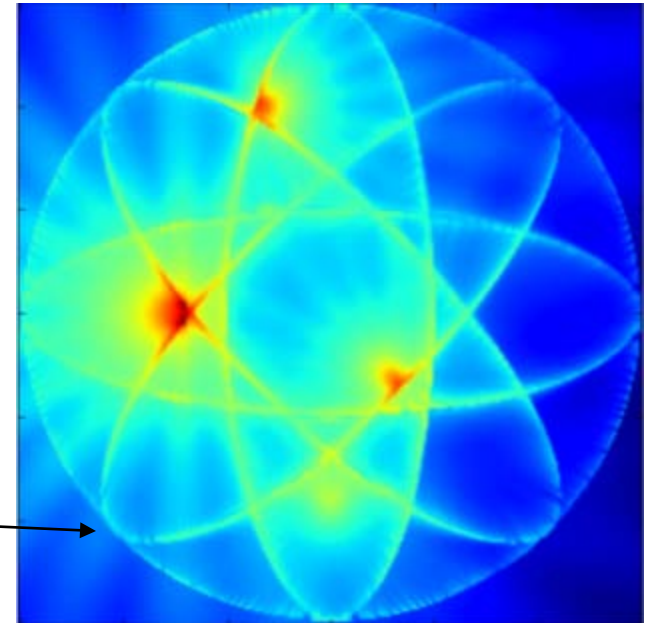


methane source and plume

Source locations
calculate from
plumes



Reconstruction



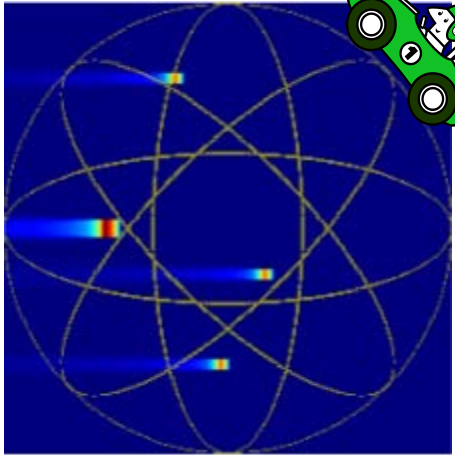
roads

Four source locations
Winds: 0 to 360° in 20° steps
Atmospheric stability class C

Model Results: Winds from only two orthogonal directions.....source location looks possible.

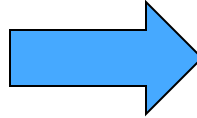


Sources

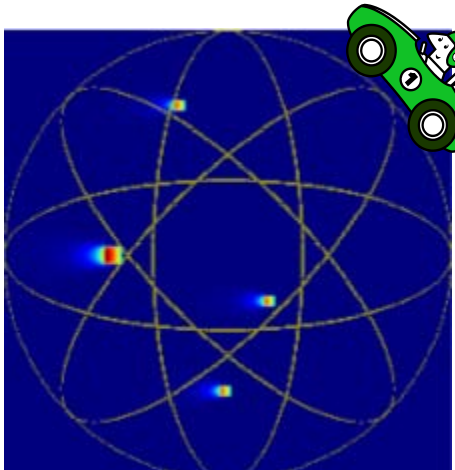
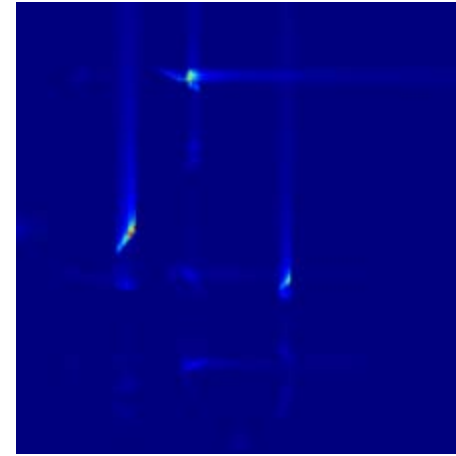


Atmospheric Stability

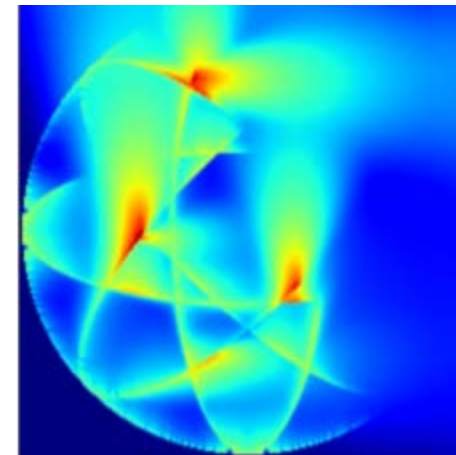
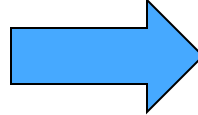
Class F



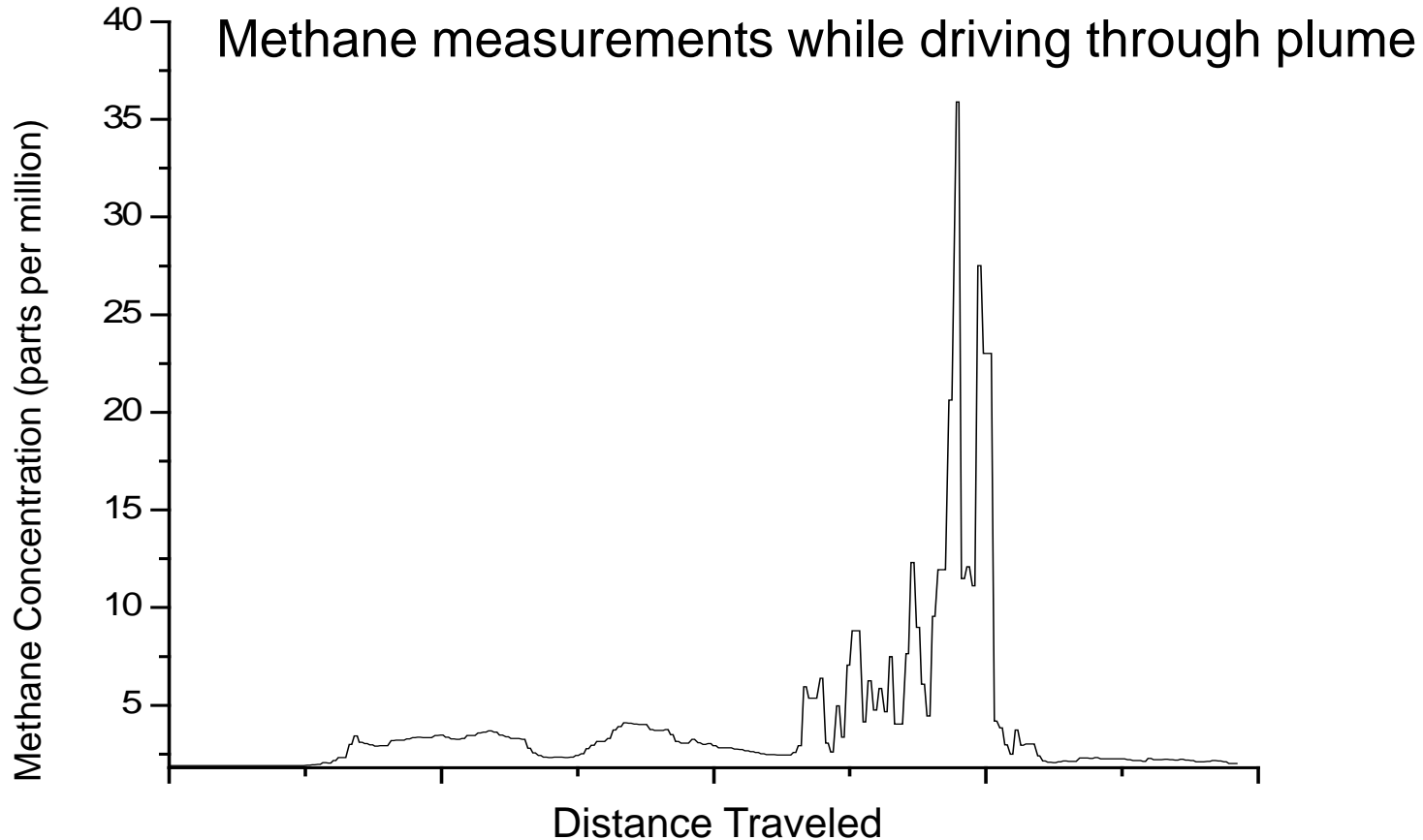
Reconstruction



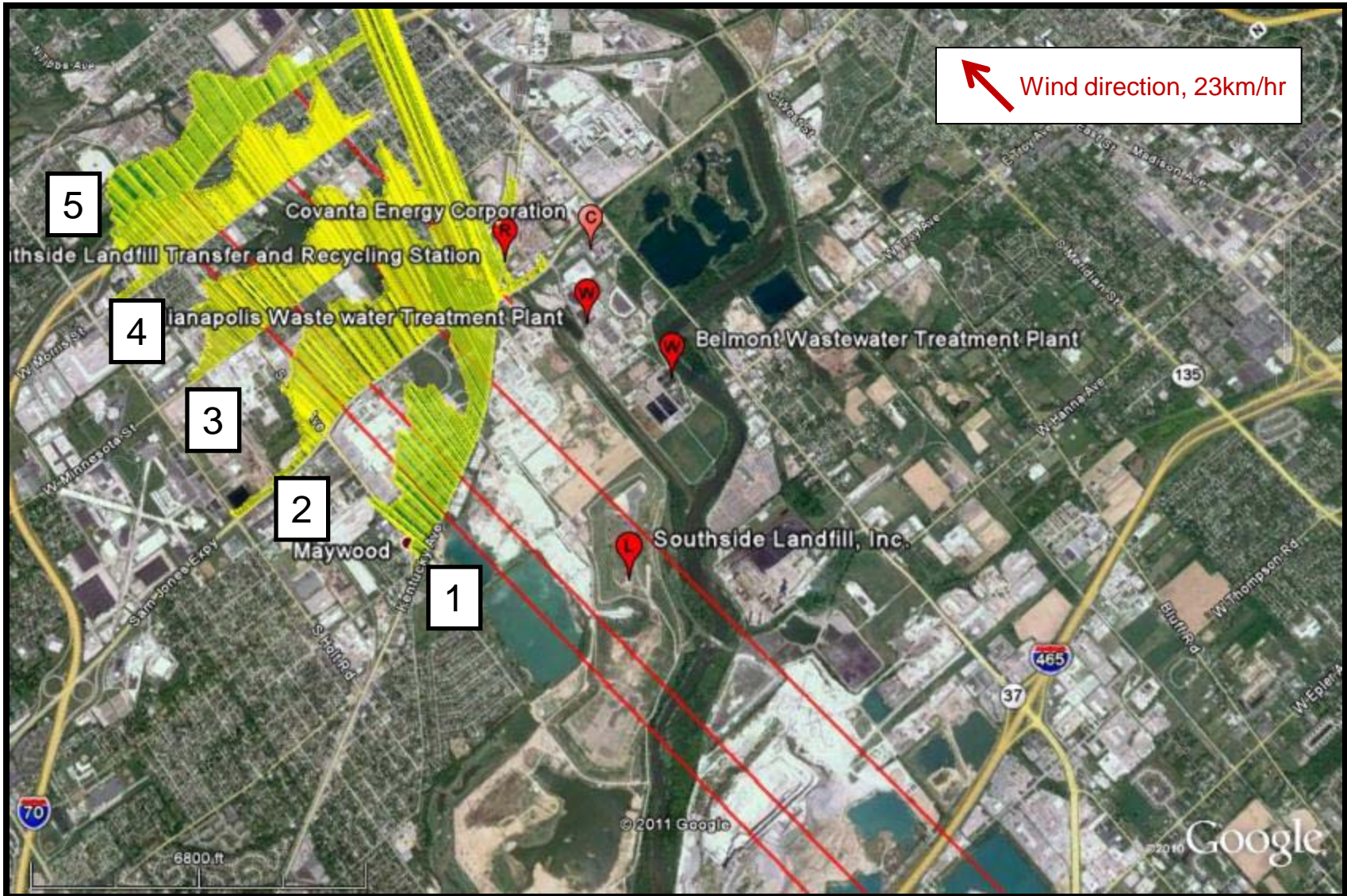
Class A



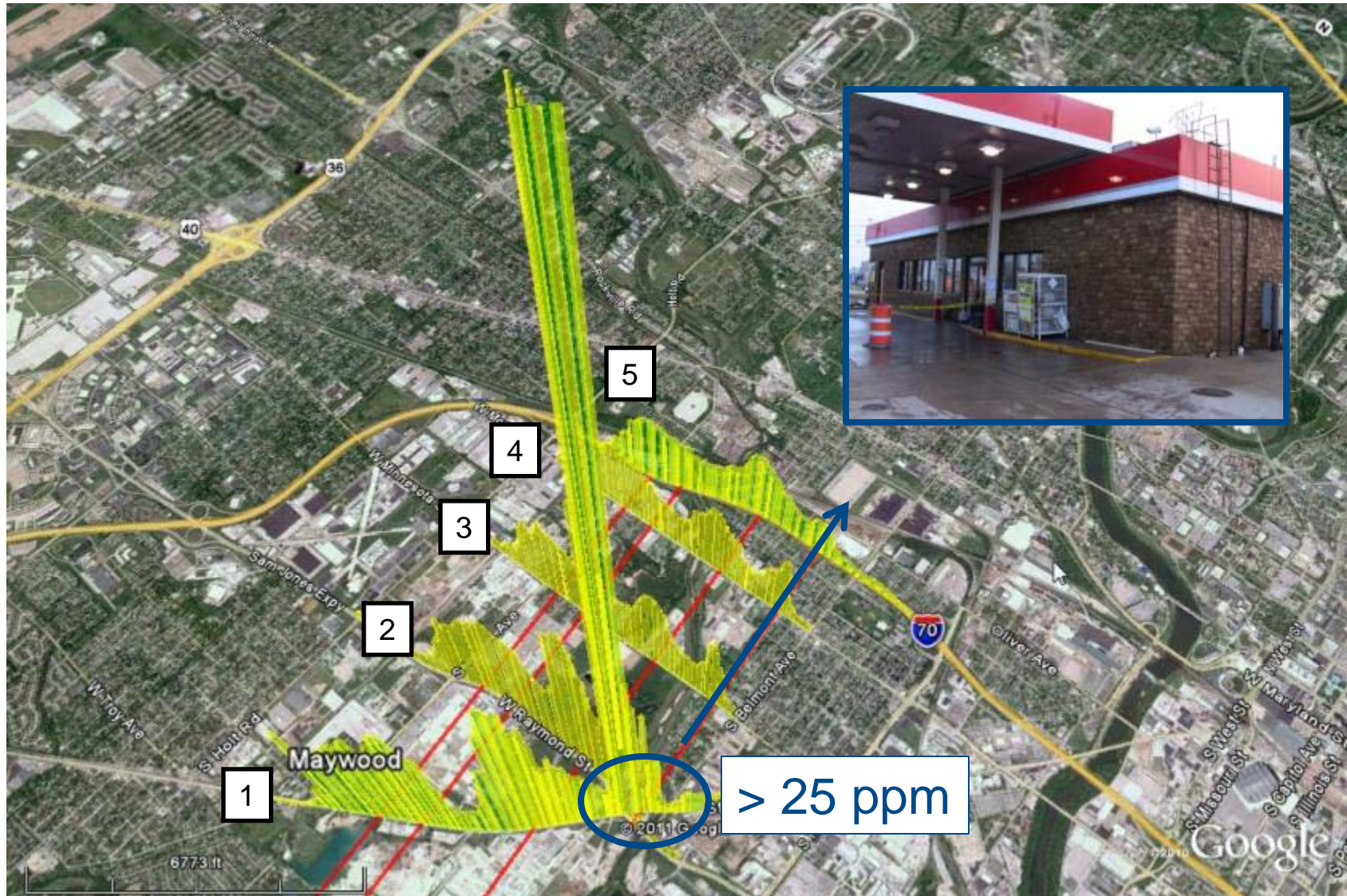
From Models to Reality: Measurements in Indianapolis



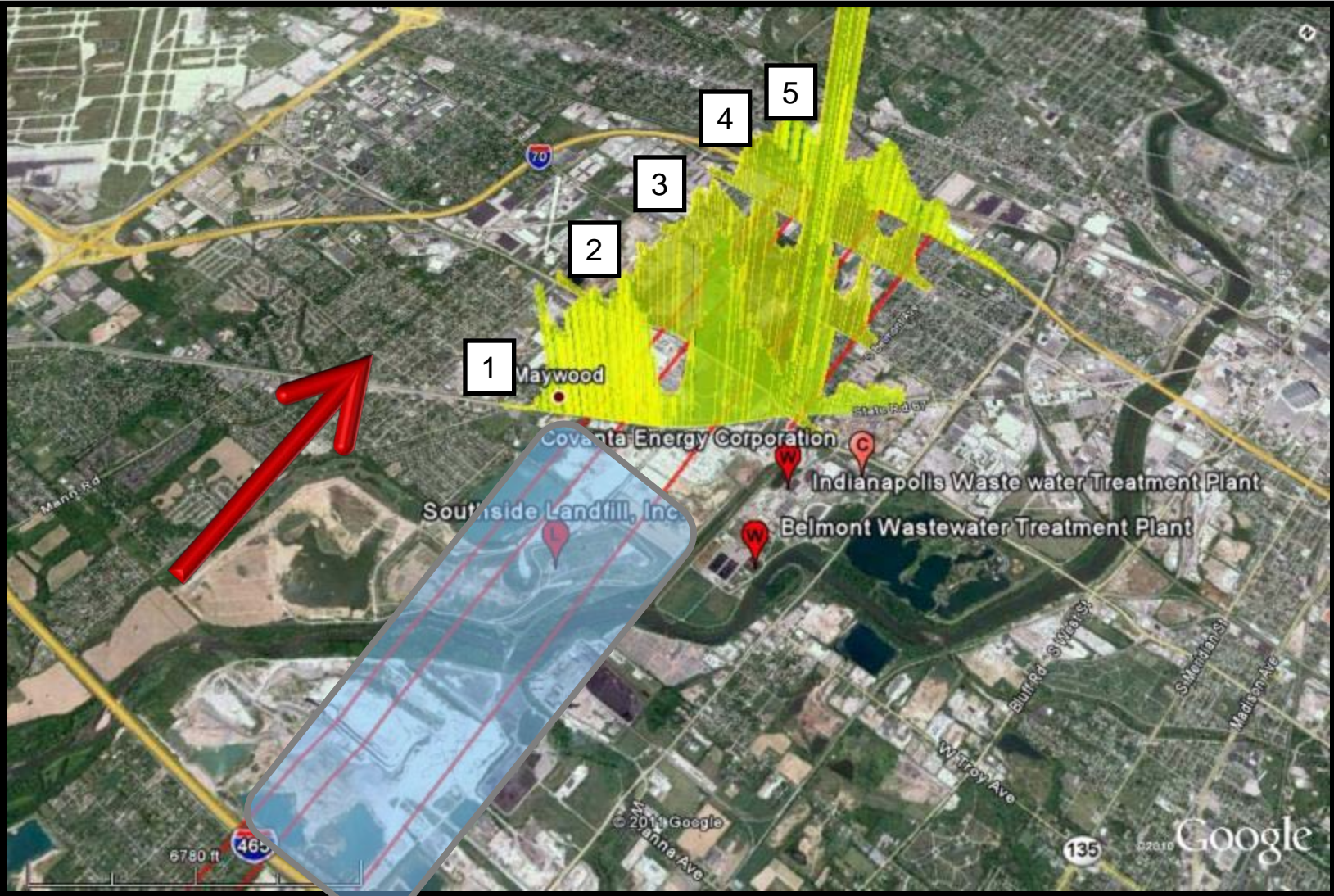
“Methane Maps” of Indianapolis



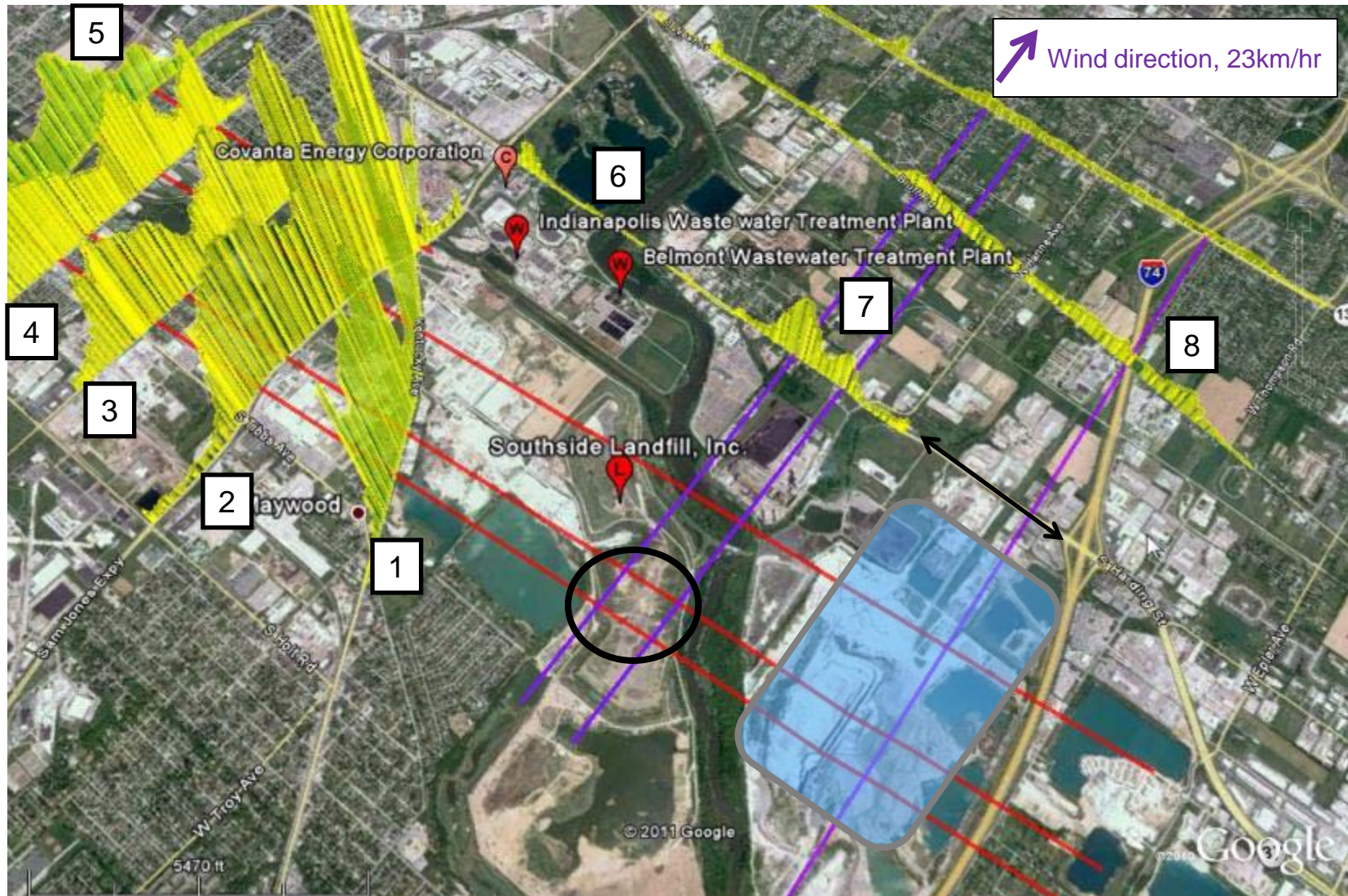
Some Sources are easy to Identify



Others are NOT so Easy



Methane Data Taken the Next Day

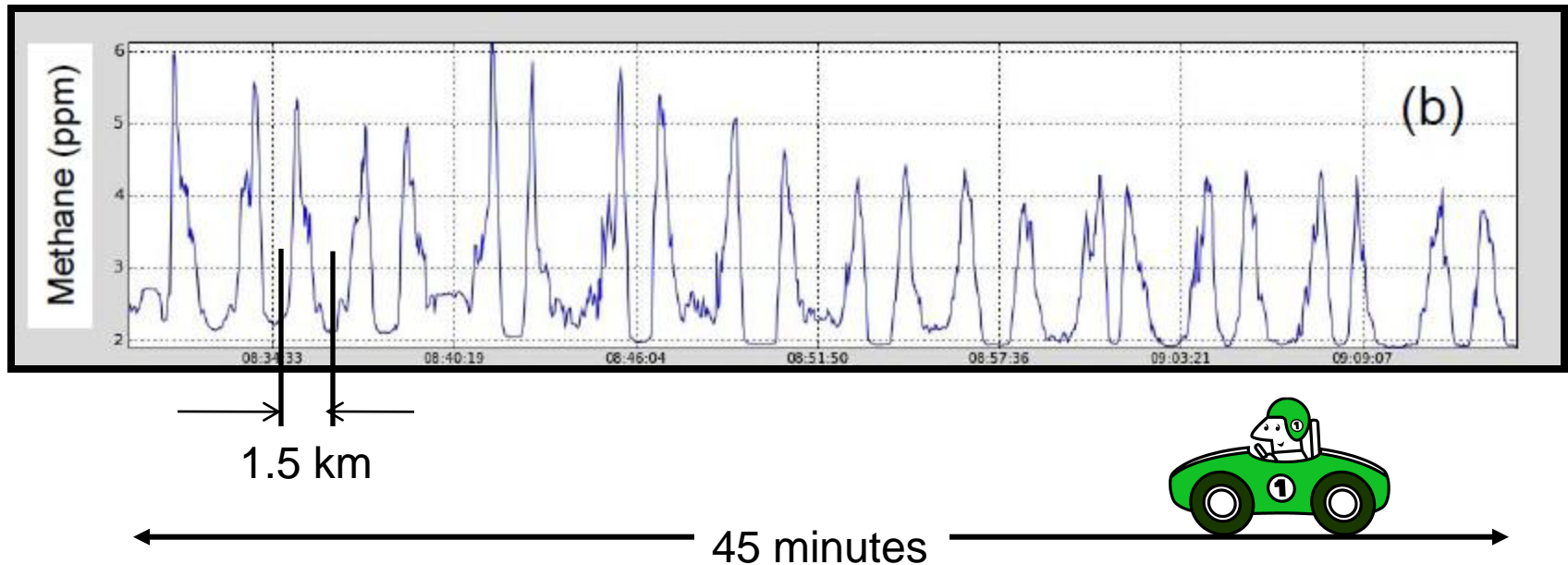


Reproducibility of Plume Measurements

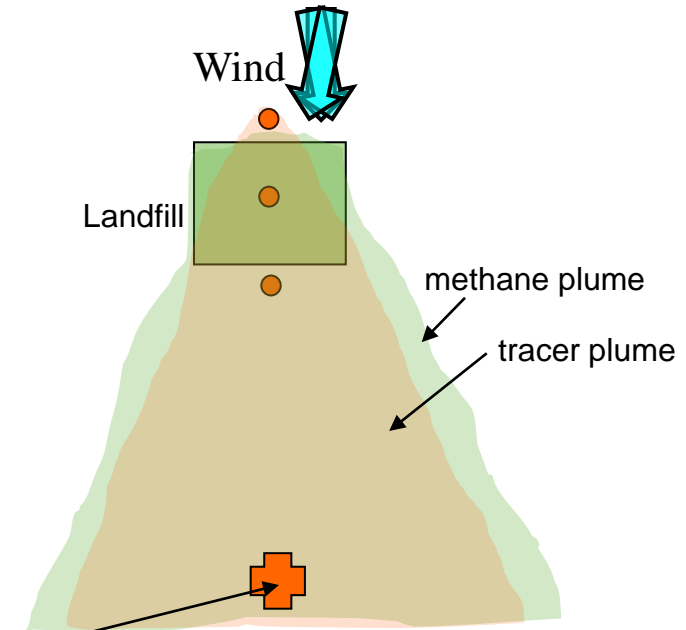
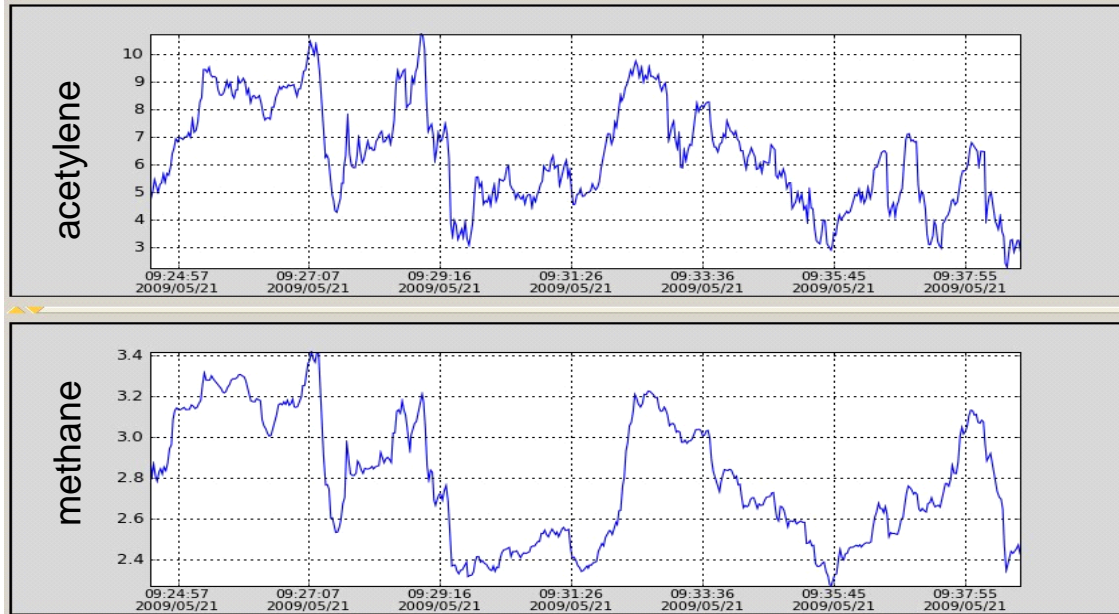


Repeated landfill plume measurements taken while driving 2 km from source. (Location: Danville, IN)

- Wind speed = 3.8 ± 1.2 km/hr
- Source Flux $\cong 7,000$ grams / minute



Stationary Tracer Method to Assess Fluxes

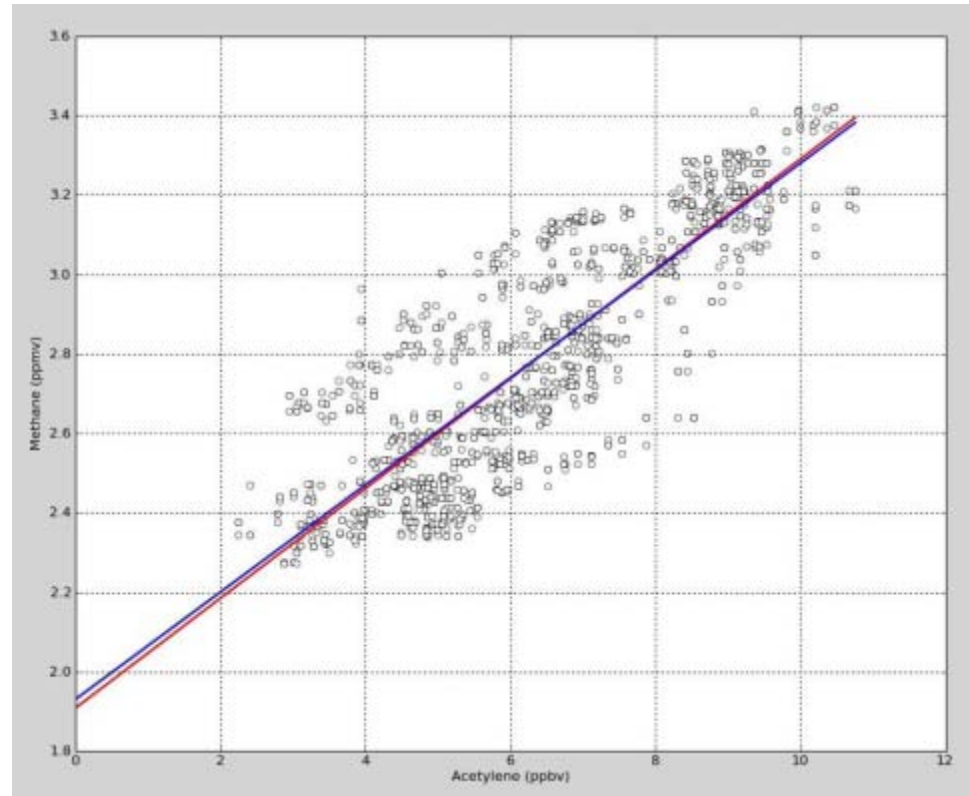


- Fixed location 1300 m downwind of landfill
- Natural variation in wind direction & wind speed will cause variability in signal as the plumes sweep across the detection point
- High correlation indicates good overlap between plumes

Methane Flux Determination (Location: Danville, IN)



- Plot methane vs. acetylene.
- Slope of line gives ratio of emission rates.



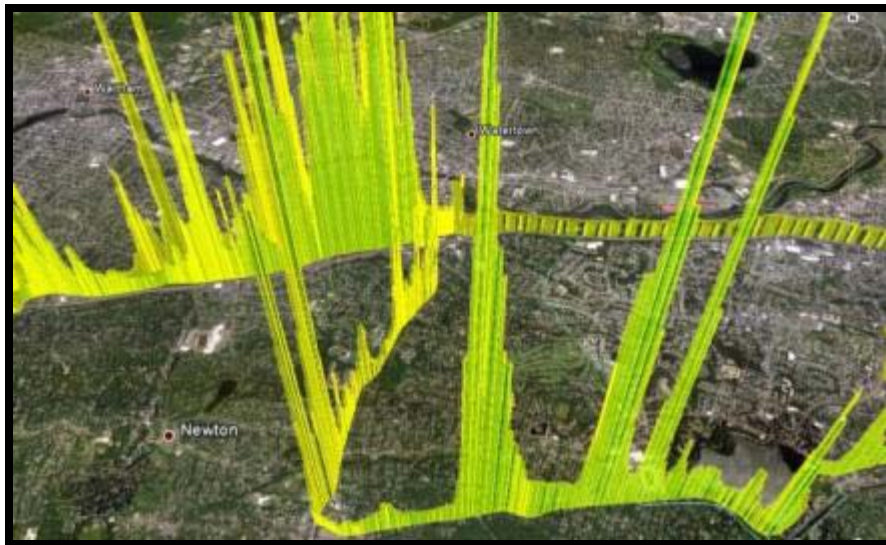
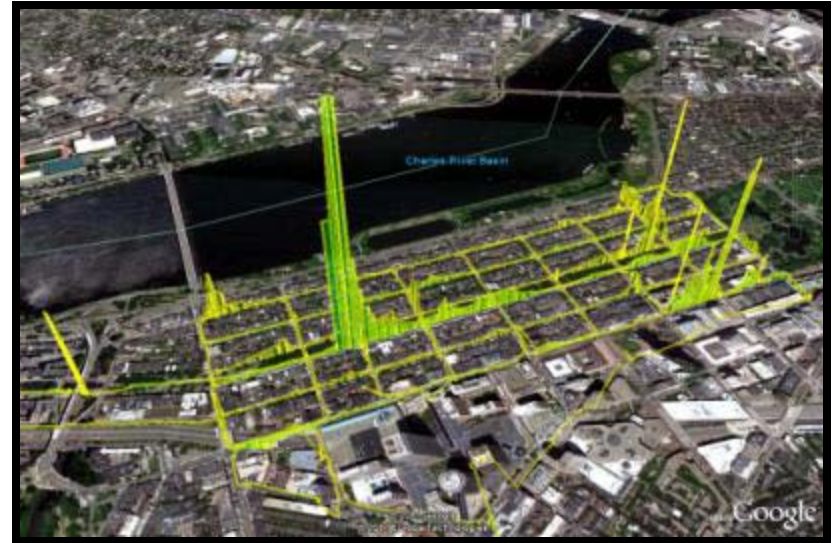
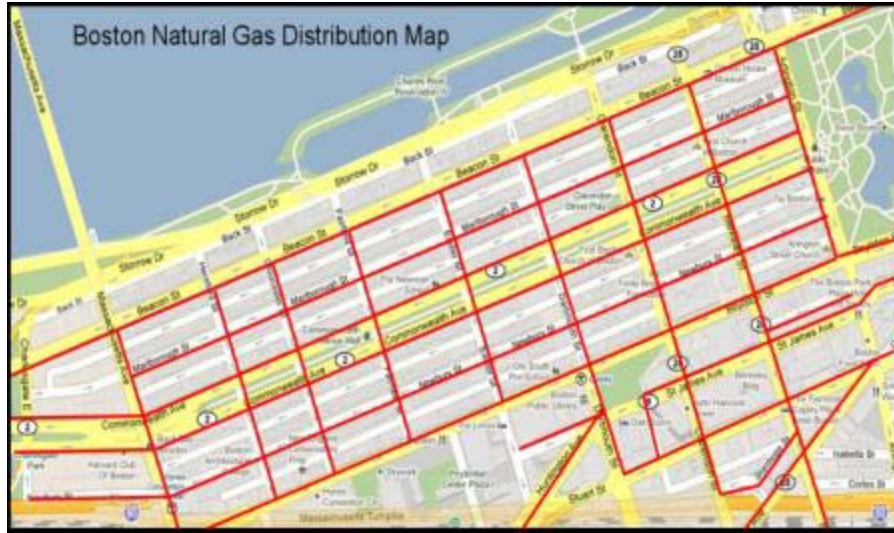
Type of linear regression	Slope of the line	Total Methane Emissions
Constrained	138.1	7,207 g / min = 7.5 moles / s

A Very Complex Methane Map: Boston



Play Video

Natural Gas Leaks in and around Boston



Natural Gas Leaks Destroying Vegetation



- Leaks in aging natural gas pipelines are killing trees all across the northeast.
 - Natural gas leaks can kill trees by displacing oxygen in the soil and drying out their roots.
 - 7,500 to 10,000 trees affected in Boston area alone.
- Several cities are asking for damages in excess of \$1M each.

Flux (cubic feet / m ² -day) at surface	Gas in air 8" below surface
0.237	26%
1.407	48%
1.007	80%
0.012	63%



Summary



- Identification of methane source locations by driving around looks possible.
- Flasks need to be analyzed.
- Need model to reconstruct methane probability distribution from plume data.
- Need to take more systematic data.