

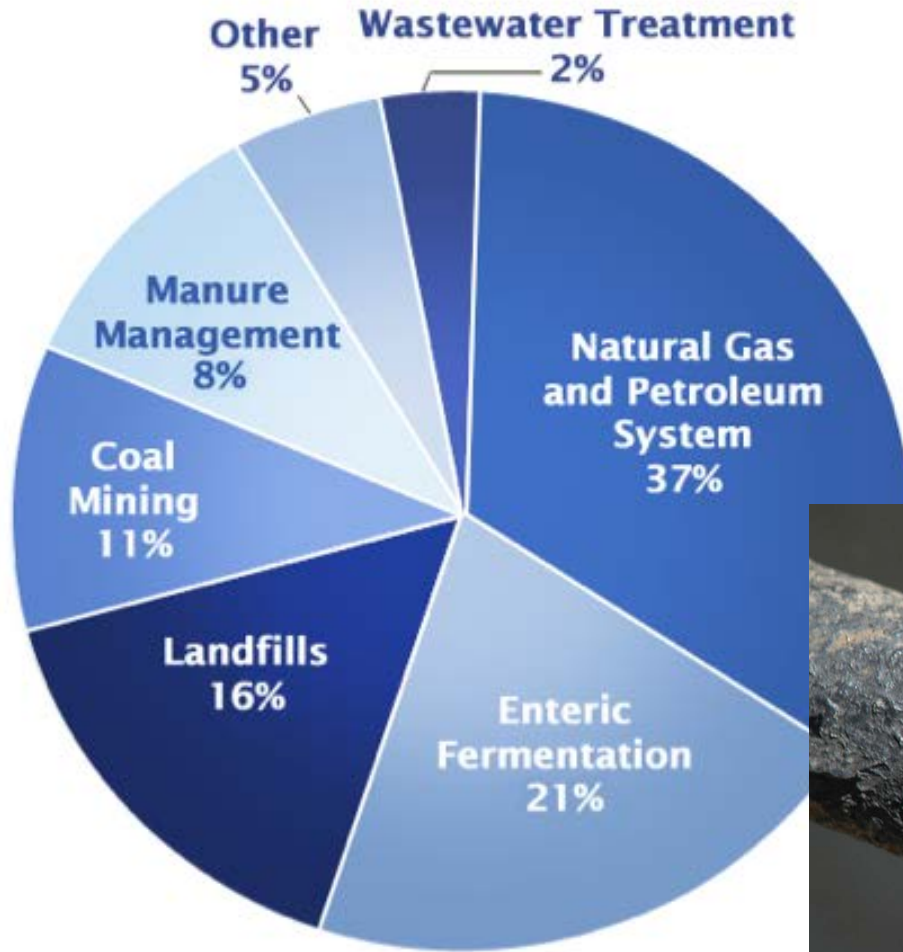
Rapid Identification of location and magnitude of urban natural gas leaks

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U.S. Methane Emissions from Human Activities

Note: Emission estimates from the EPA *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010*.



New sensor technology



Los Gatos UGGA

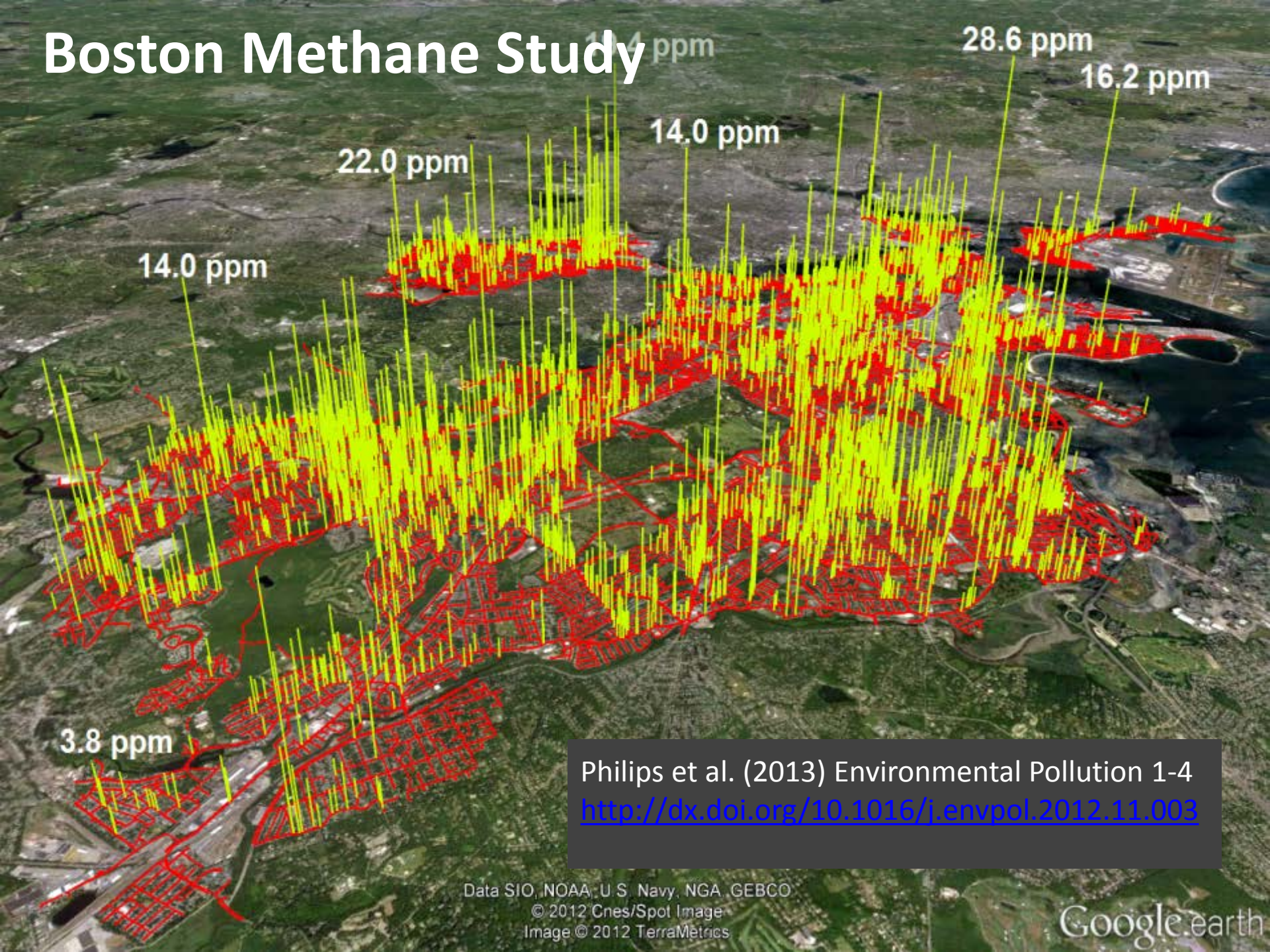


LiCor 7700



Picarro TGA

Boston Methane Study



Philips et al. (2013) Environmental Pollution 1-4
<http://dx.doi.org/10.1016/j.envpol.2012.11.003>

Sonic Anemometer

Gill Windmaster

CH₄ analyzer

LiCor 7700

GPS

Hemisphere A100

***Data @ 10Hz
= readings 0.9m @ 30 km/h***



GSV Car Instrumentation

Closed-path CH₄ analyzer

- 2Hz data = 4.5m @ 30 km/h

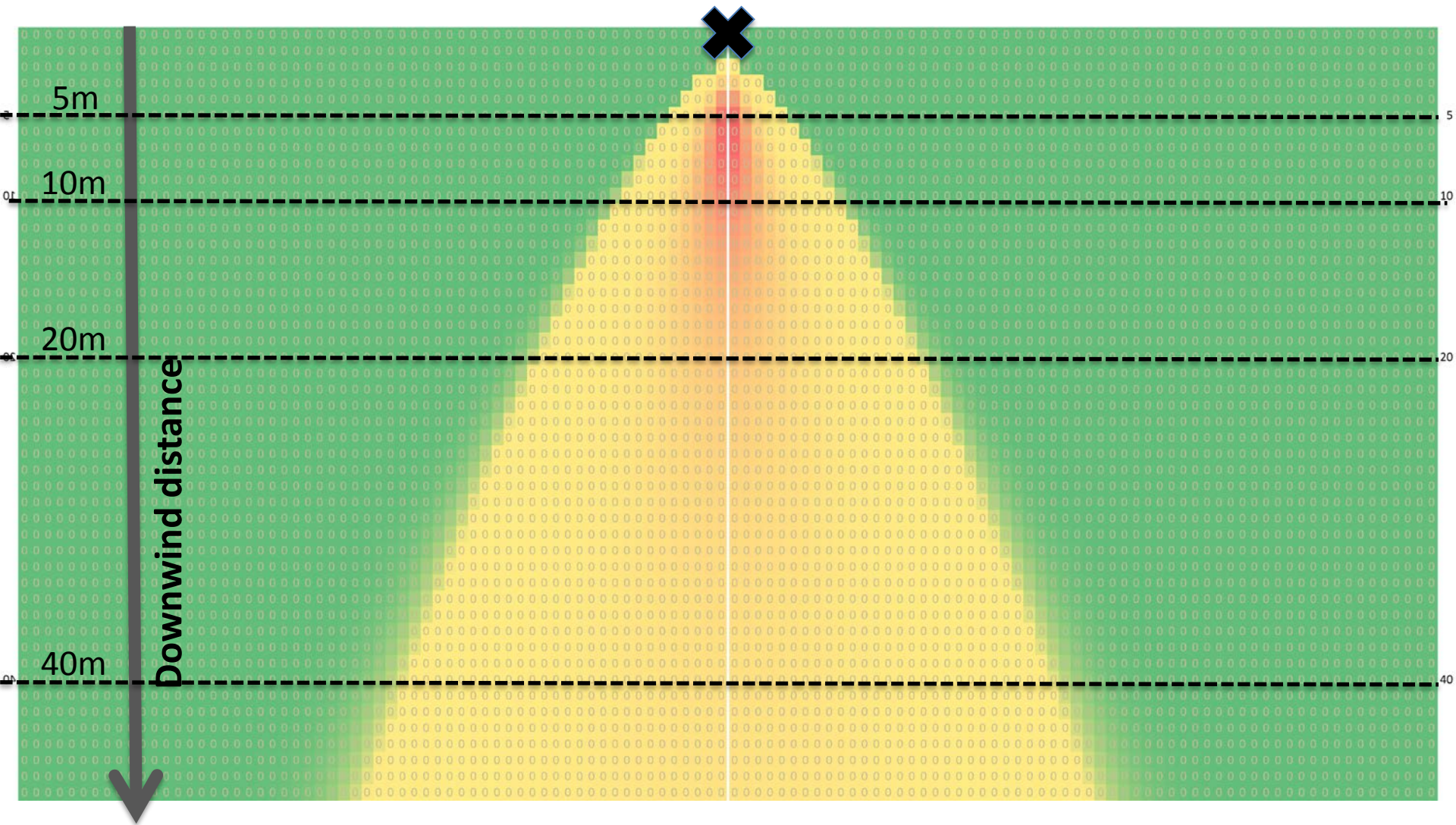


GPS unit

Each component reports performance data that were used in QAQC screening

Sample intake

**Theory: view from above of [CH₄] at 1m.
Leak source at point X.**



Reality

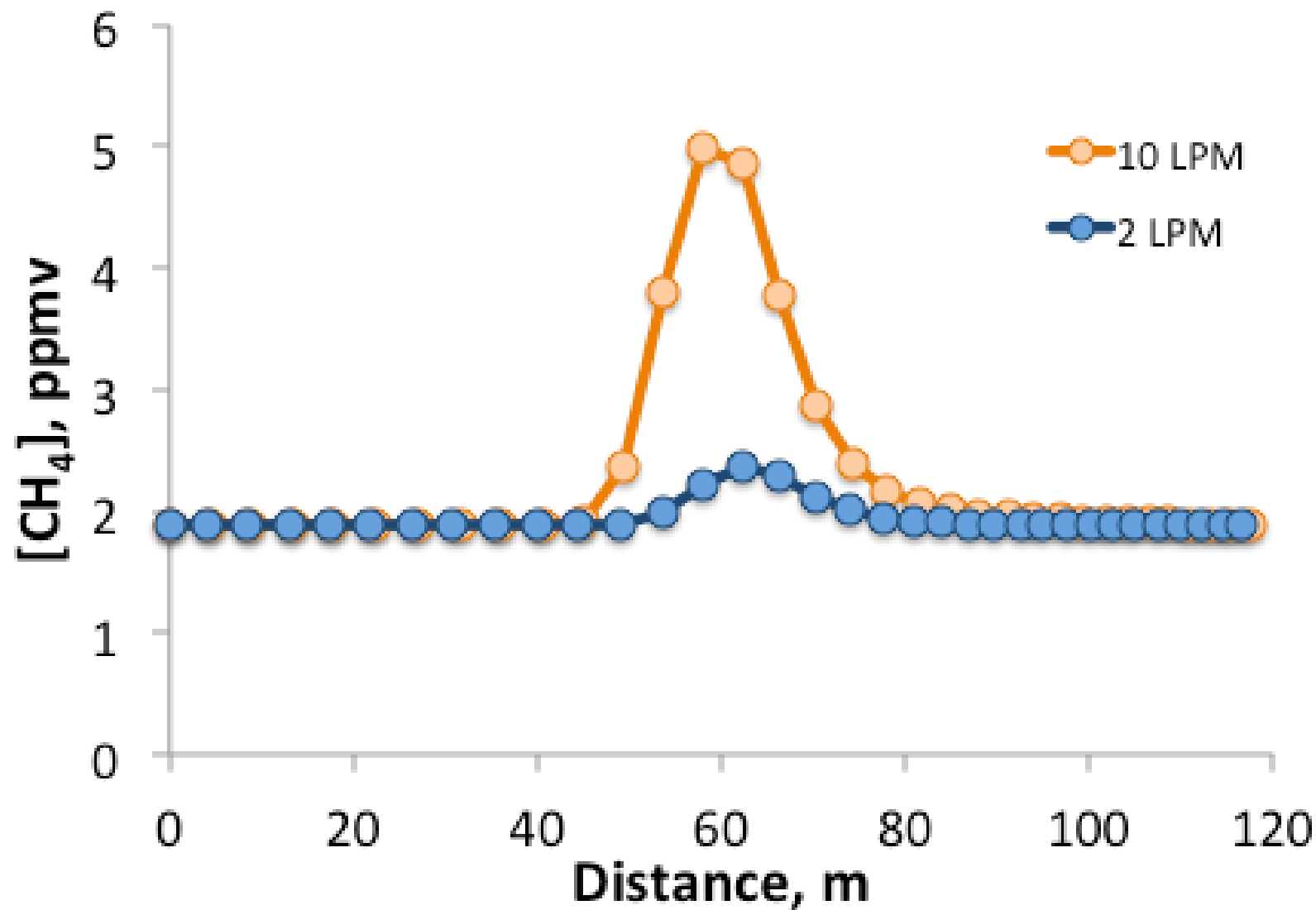


Controlled release experiments



Allowed us to vary:
release rate: 2, 5, 10 & 40 L/min
Distance 5, 10, 20 and 40m

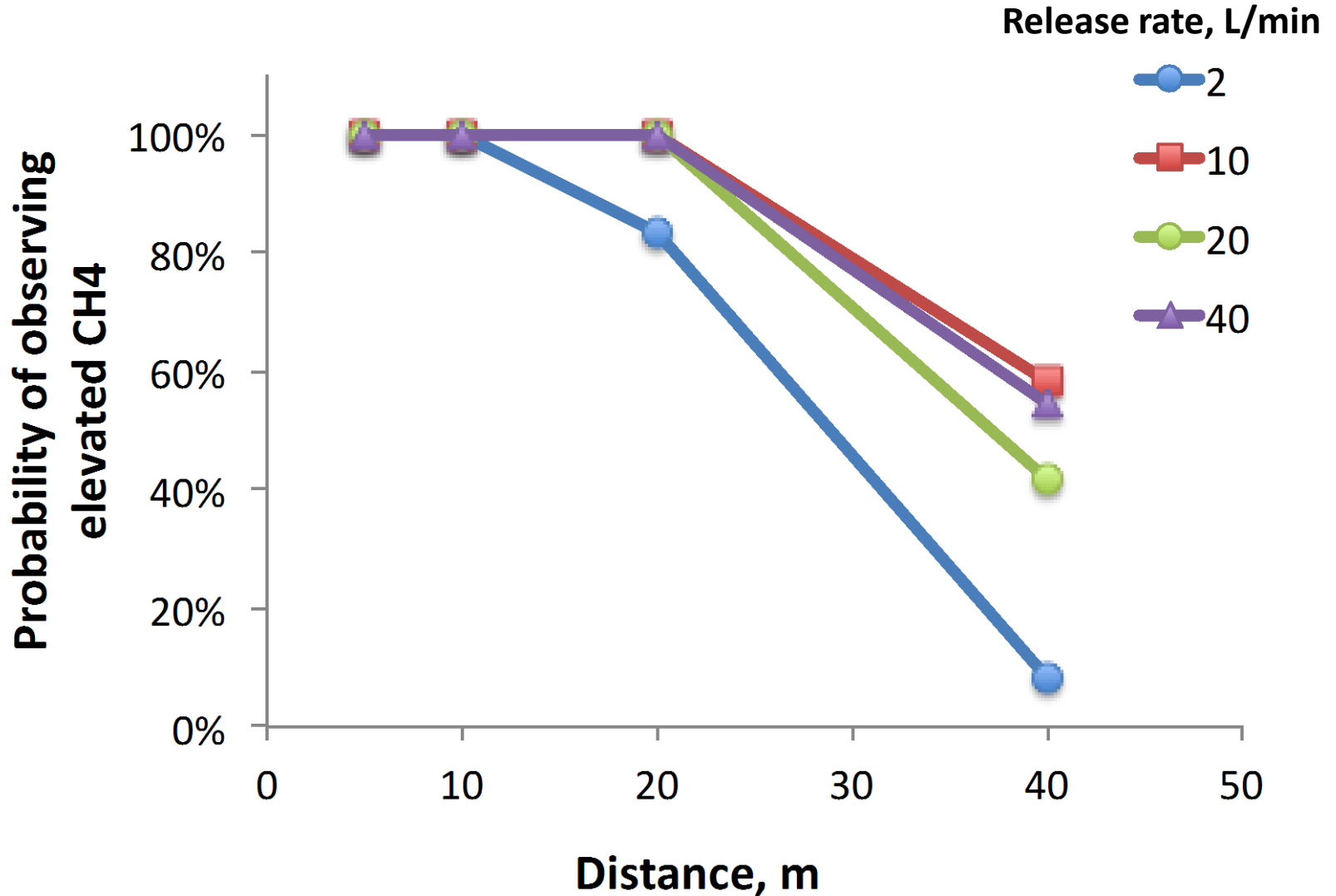
Example data



What is an “elevated CH₄ reading?”

- “Background” CH₄ calculated as 2-minute moving average
- A reading is elevated if it is:
 - 10% above background (more common)
or
 - 4x the standard deviation
(usually <3% above background; less common)

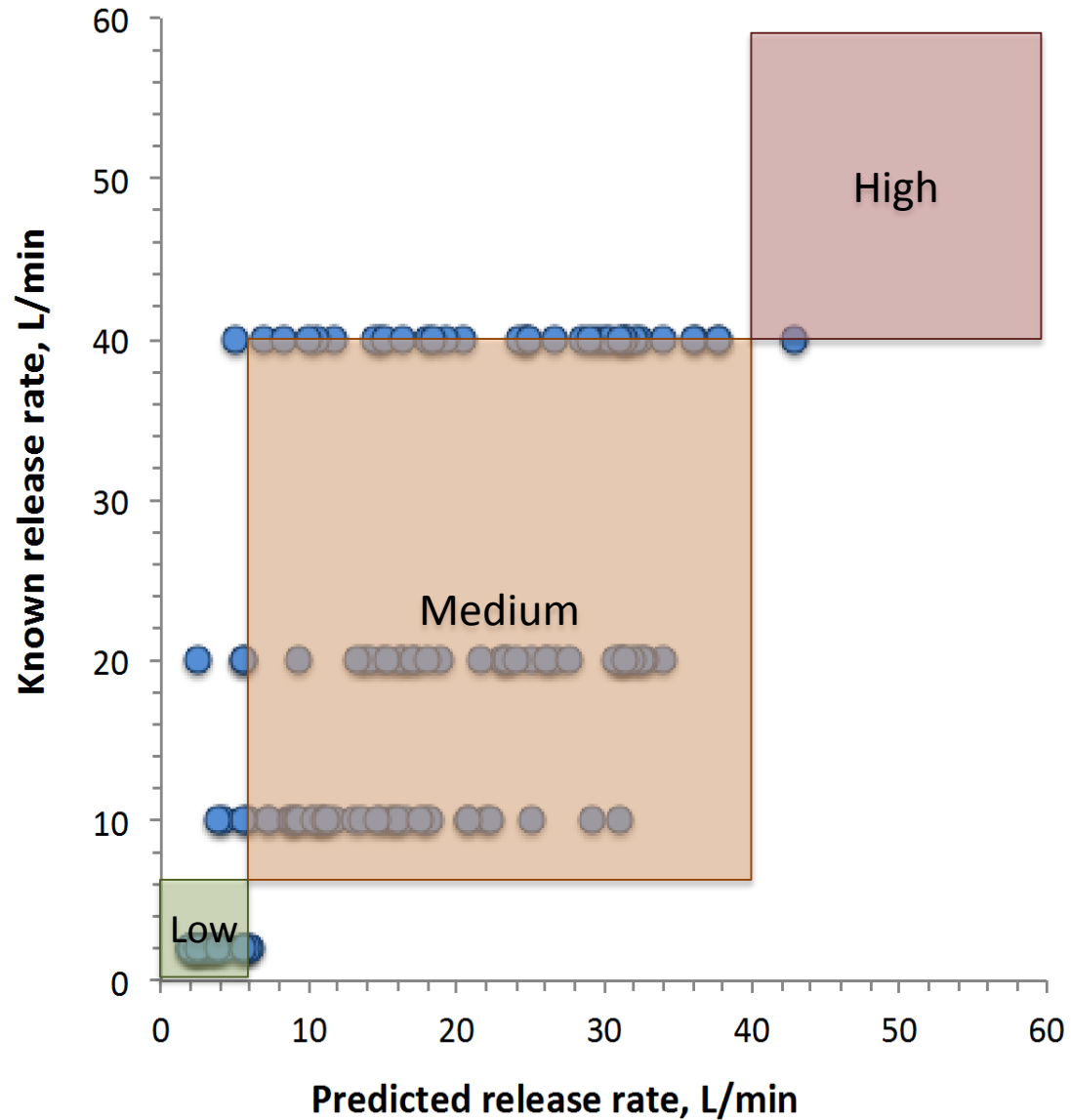
Reliably detect leaks 20m away



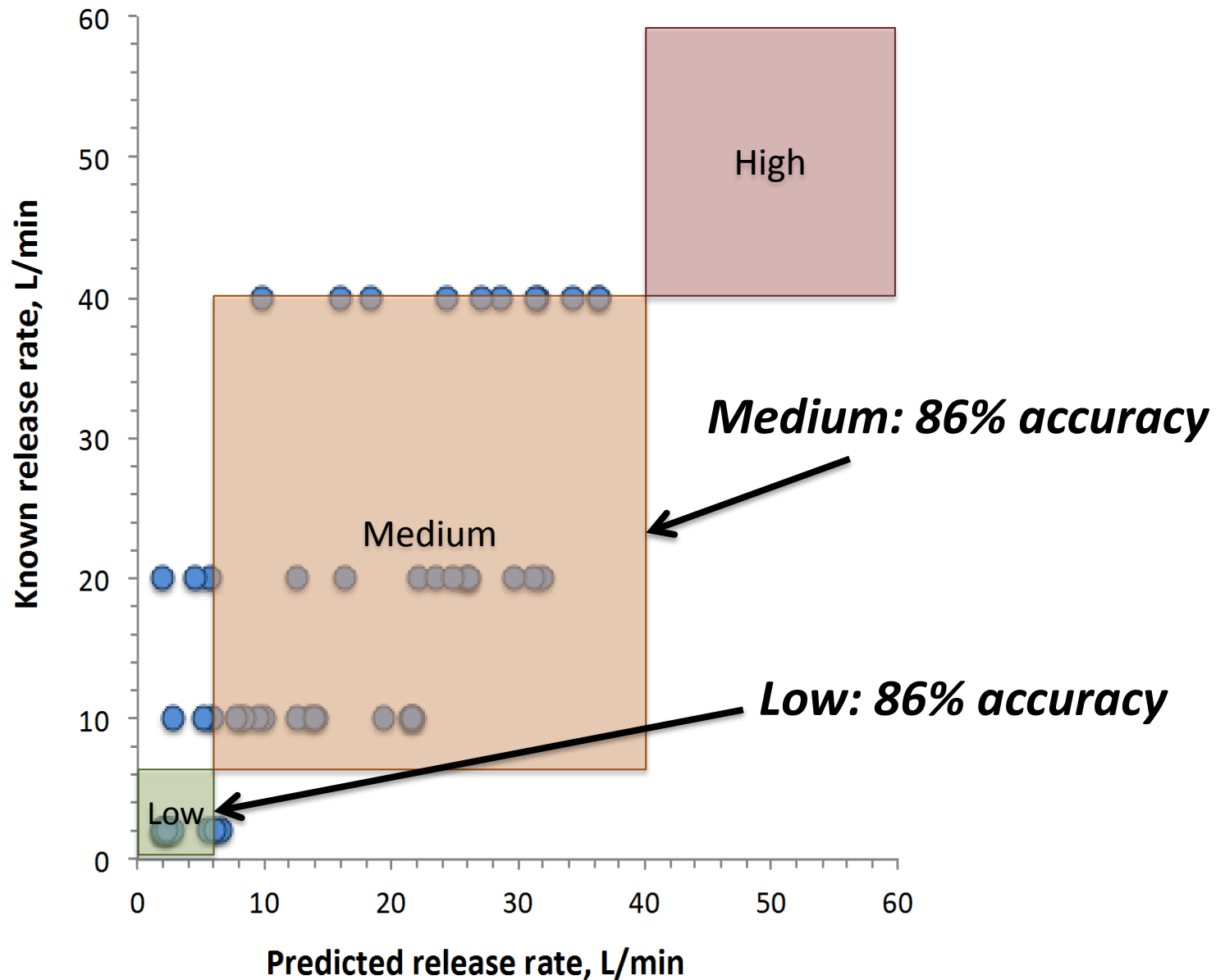
Leak size algorithm

- Because we would not know distances in the field, we binned data from all controlled releases $\leq 20\text{m}$.
- Our leak size algorithm statistically combines properties of the peak size and shape to estimate the leak magnitude
- We created bins (low/medium/high) to account for uncertainty.

Calibration data



Validation data

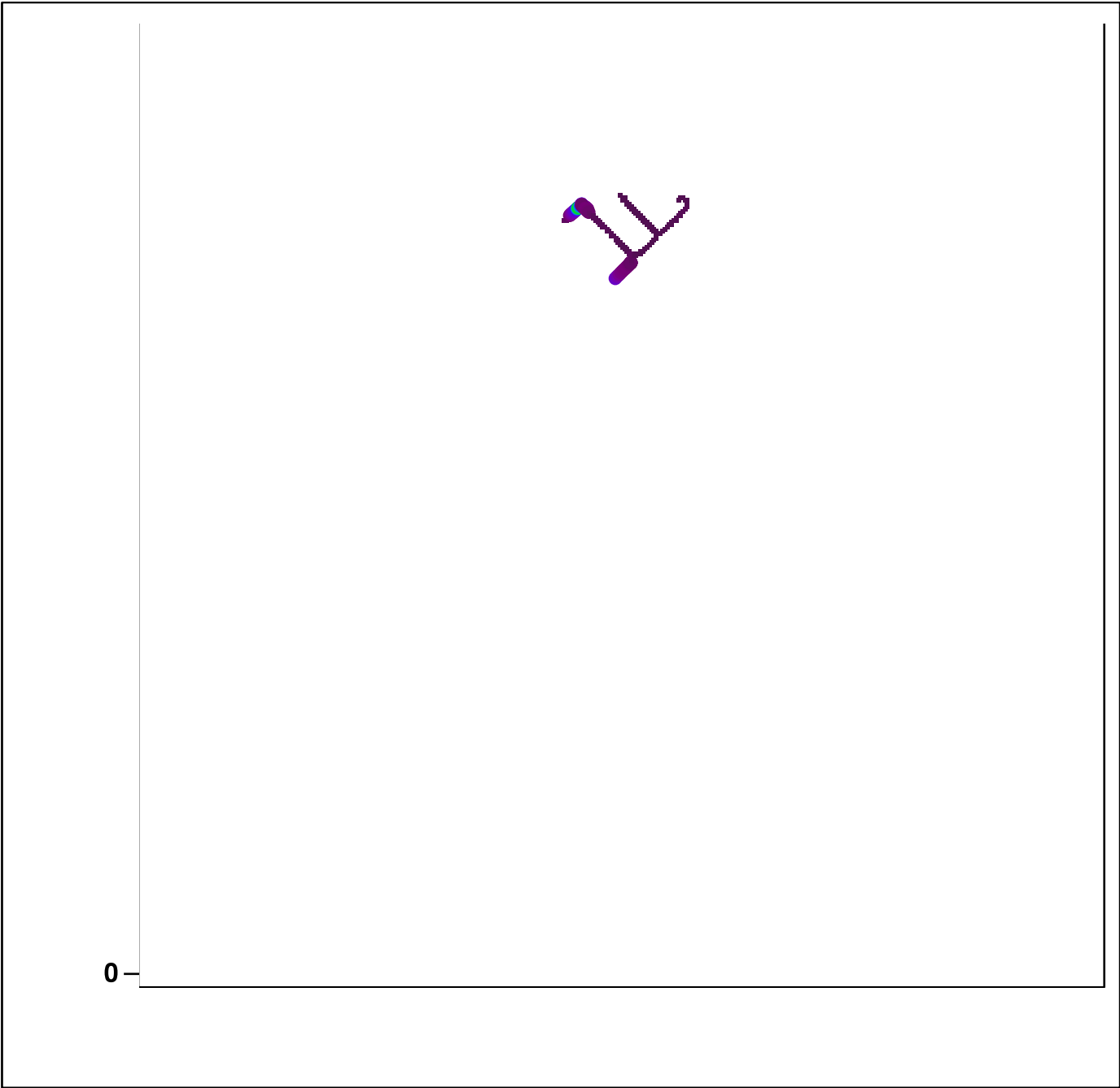


Field validation vs. high-flow

- WSU-CRA group measured 13 leaks in areas where we also mapped.
- We found 6 of those leaks (46%)
- We correctly categorized 5 of 6 (84%) as Low; one we incorrectly assigned Medium

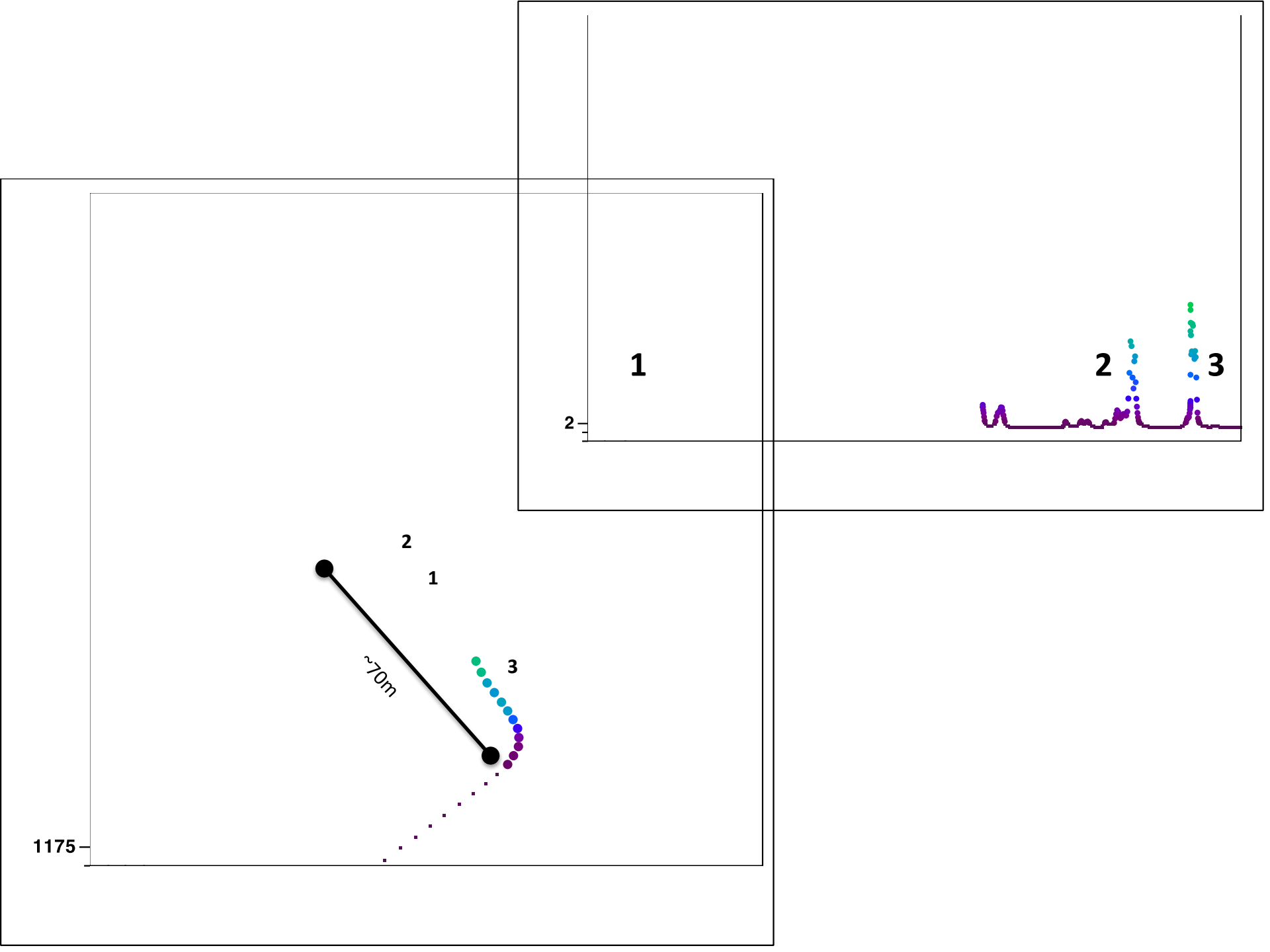
Driving & Data Analysis Strategy

- **Multiple drives:** GSV car drivers drove every public road in the study area at least two times.
- **Quality control:** excluded elevated readings for roads and driving speeds $>45\text{mph}$ due to poor spatial resolution (also greater influence by CNG vehicle exhaust)
- **Peaks vs. areas:**
 - “observed peaks” $< 100\text{m}$. Candidate NG leaks.
 - “observed areas” $>100\text{m}$. Presumed other source.



2

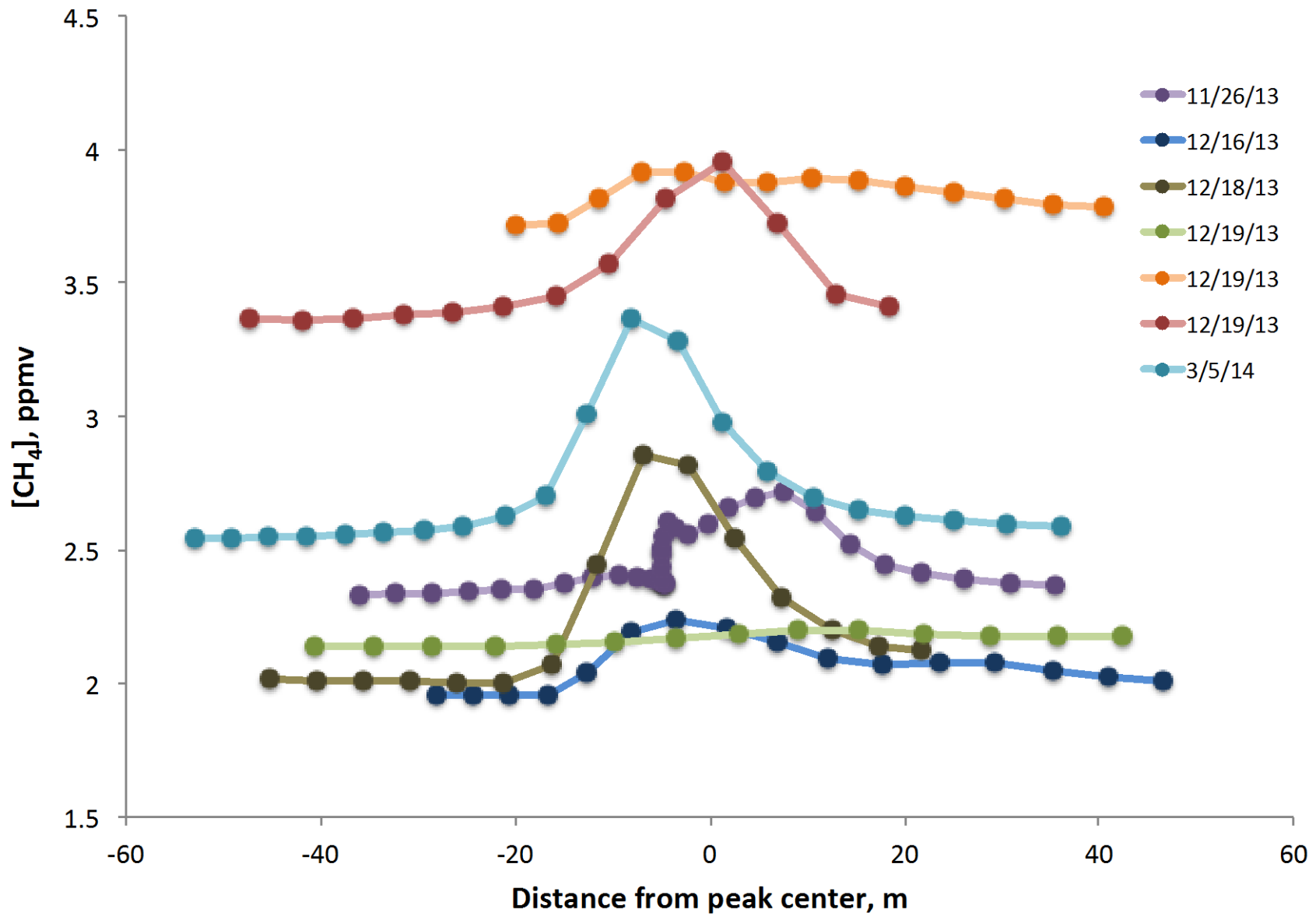




Driving & Data Analysis Strategy

❖ **Multiple observations:** We designated “verified peaks” for any location where an observed peak was found more than once.

This required a GIS analysis to identify where the midpoint of observed peaks were within 100m of each other.



Boston

[About leaks in Boston](#)

Methane leak indicator

● Low ?

● Medium ?

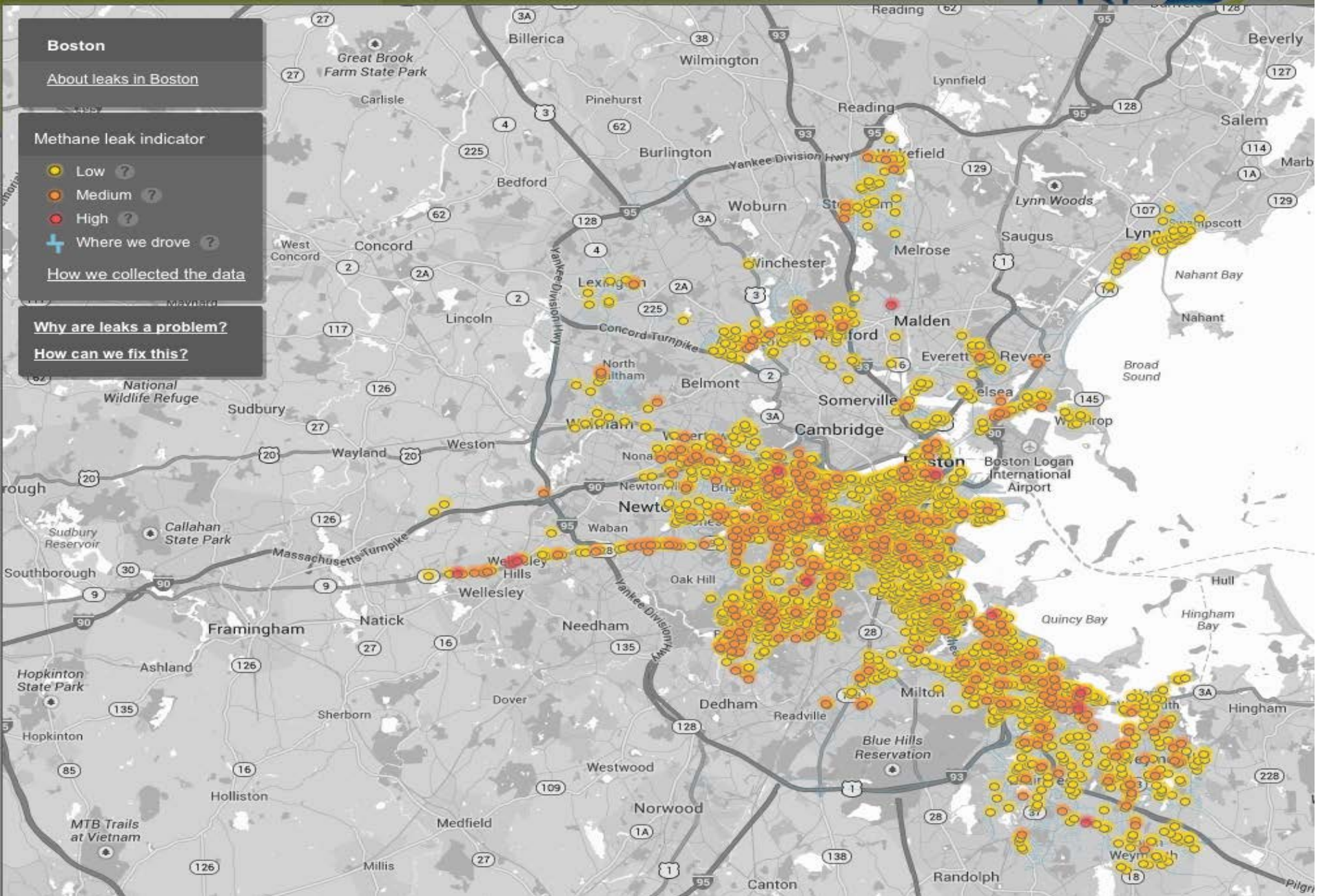
● High ?

⊕ Where we drove ?

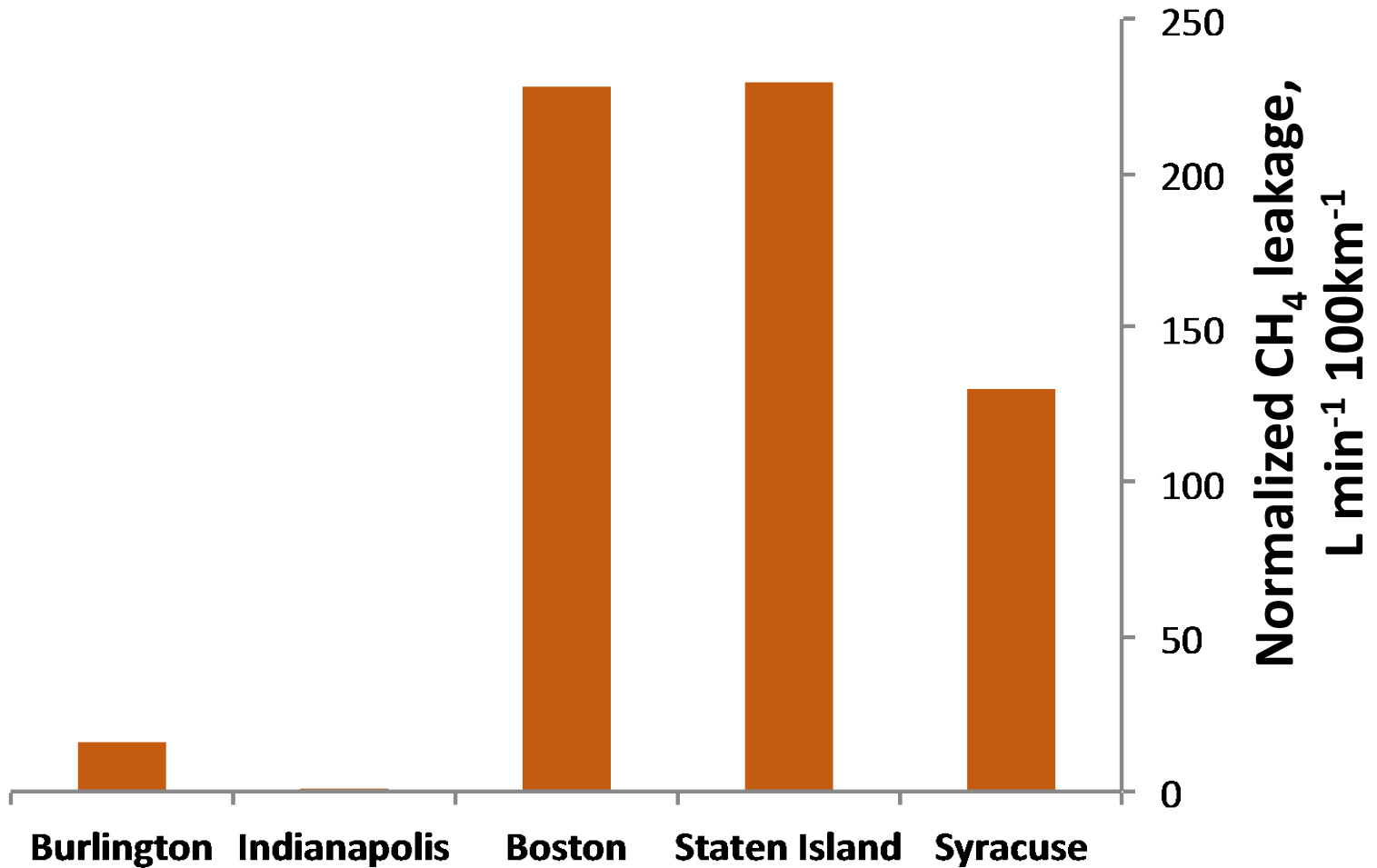
[How we collected the data](#)

Why are leaks a problem?

[How can we fix this?](#)



City-wide leakage rates: consistent with pipeline replacement



Thanks. Questions?

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