Methane Sources and Emissions

Photo: R. Jackson, USA Today

California Air Resources Board, June, 2016

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Energy-Water Interactions (not discussed today)

Global Carbon Project (globalcarbonproject.org)

GLOBAL CARBON PROJECT

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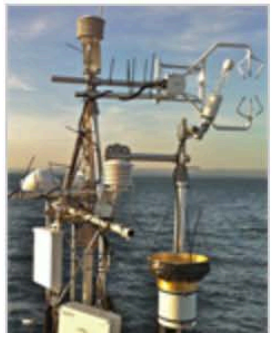
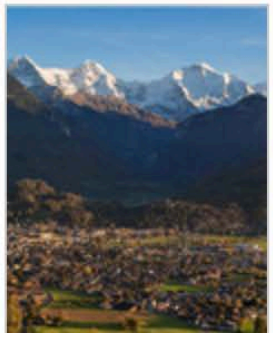
The Global Carbon Project

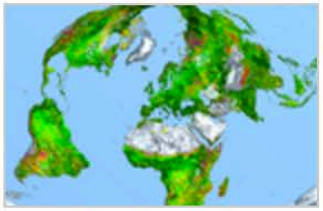
The Global Carbon Project (GCP) was established in 2001 in recognition of the large scientific challenges and critical nature of the carbon cycle for Earth's sustainability.

The scientific goal of the project is to develop a complete picture of the global carbon cycle, including both its biophysical and human dimensions together with the interactions and feedbacks between them.

Tribute to Mike Raupach	Managing the Carbon Cycle Requires Strong Science	10th International CO_2 Conference (ICDC) 21-25 August 2017
		

Science Highlights

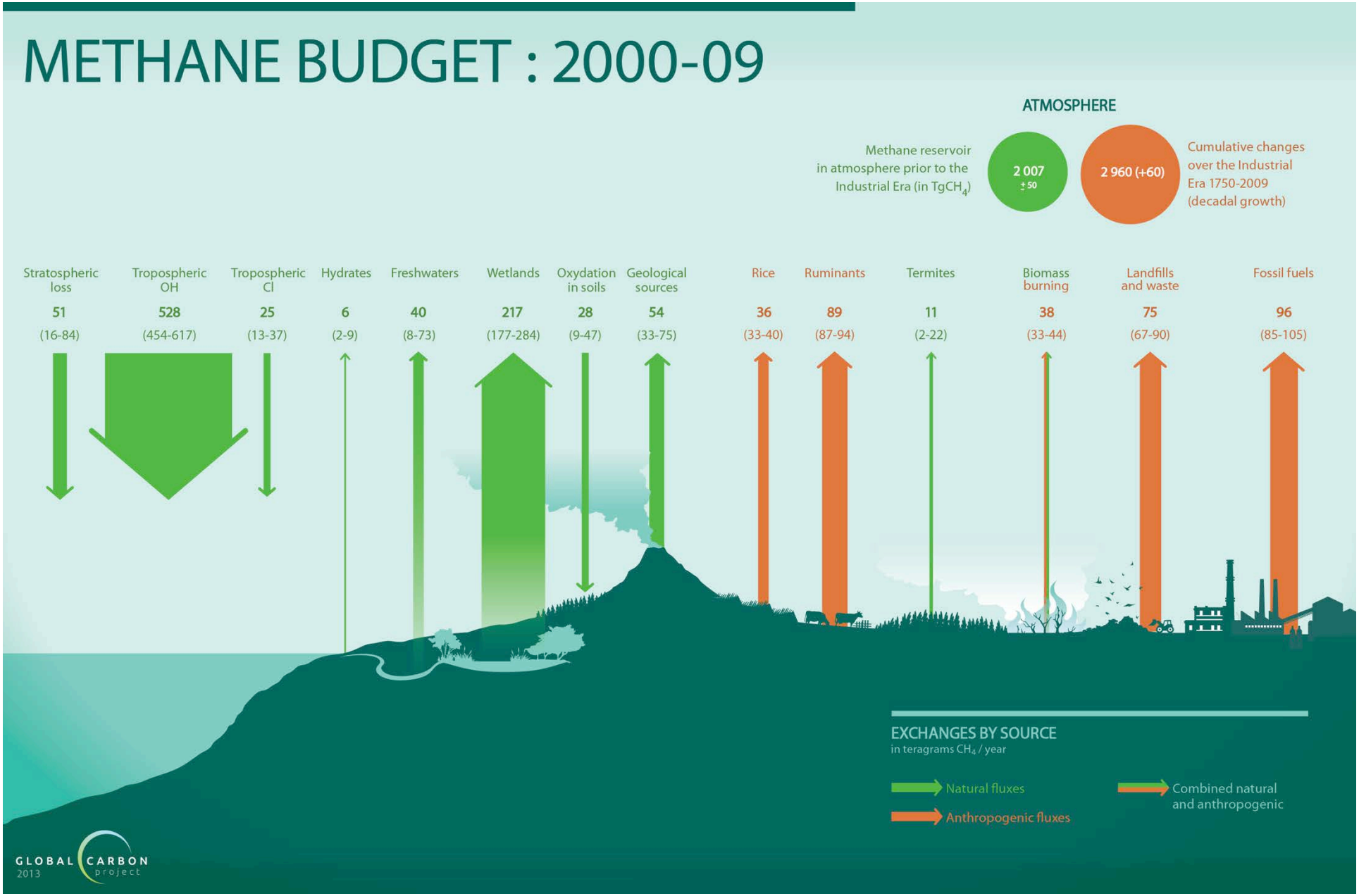
Carbon Budget 2015



Greening Earth

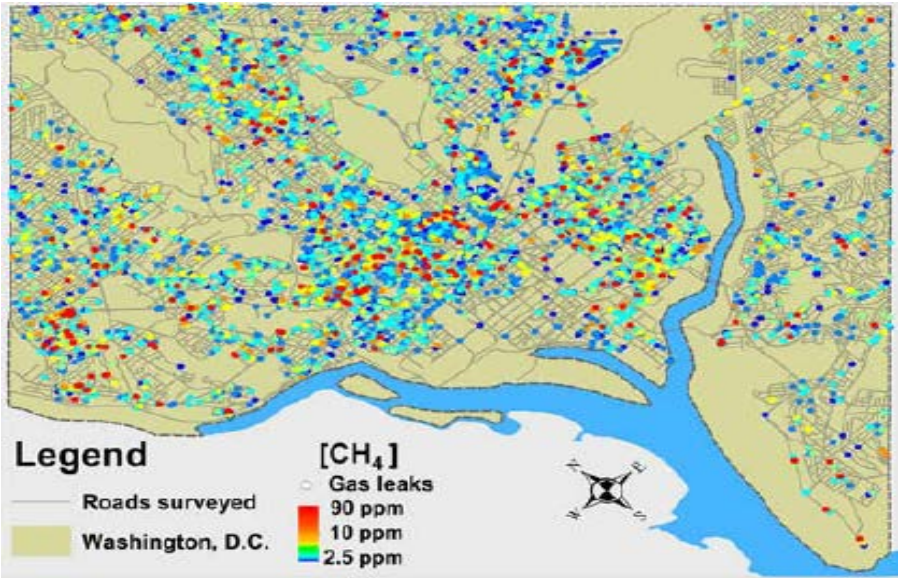
Land is a GHG source

Global Methane Budget (2nd budget just submitted)



Based on Kirschke et al. 2013, Nature Geoscience

Air Studies Upstream at Wellpads and Downstream to City Streets



Air Quality and Health Interactions

On-site Workers

Compressor Stations

Drilling & Well Completions

Holding Ponds

Winter Ozone Formation

How Common Are Large Emitters? Early Detection is Key

Flights across six regions and >8,000 wellpads (with EDF).

1) The % of sites with large emissions was 4% nationally, ranging from 1% in the Powder River (WY) to 14% in the Bakken (ND).

2) Emissions observed 3x more often in oil-producing plays & in oil-producing regions of mixed basins. In the Barnett, 21% of well pads producing oil emitted methane compared with <1% of gas sites.

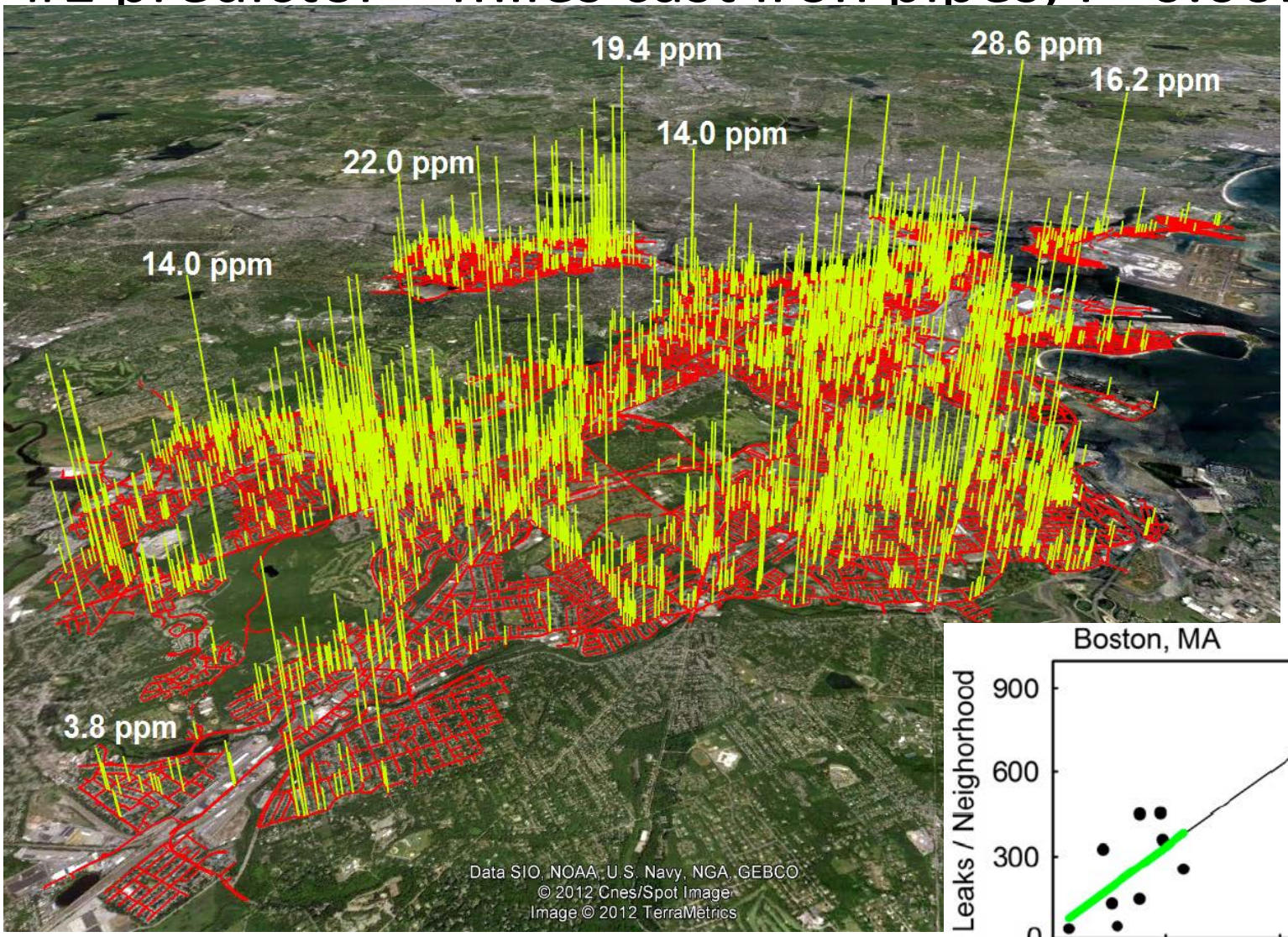
3) >90% of ~500 detected sources were from tank vents & hatches.

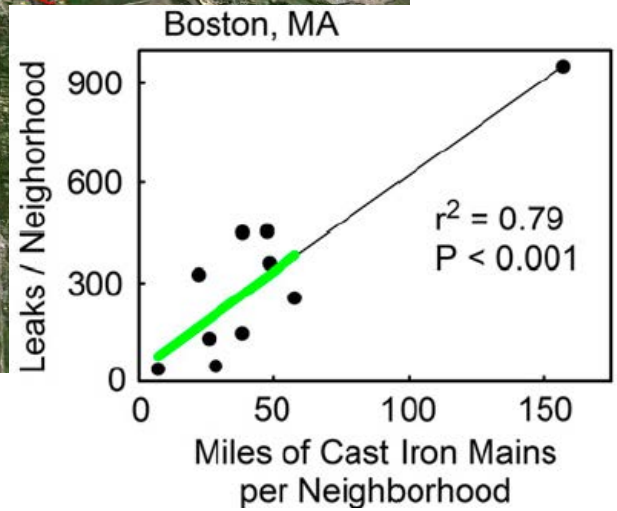
(Lyon et al. 2016 ES&T)

Legacy Wells : What Happens in 25 or 50 Years?

Methane losses from pipelines downstream

Boston overall (~3,400 leaks; 800 road miles)
#1 predictor – miles cast iron pipes; P<0.001





Red = roads driven; Yellow = leaks

Phillips et al. 2013 Env Pollution

Some Quick Responses

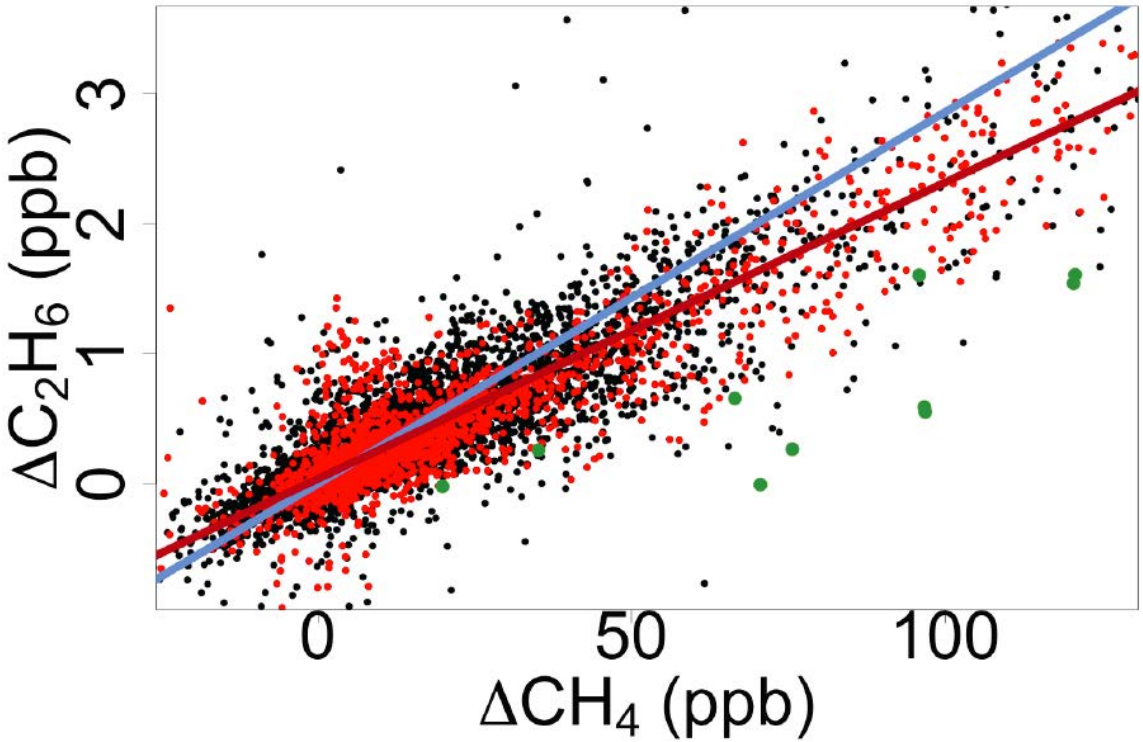
Boston Mayor Tom Menino
Mayor Menino has written a strongly worded letter to the state Department of Public Utilities urging its chairwoman to step up scrutiny of utilities following a story in today's Globe about more than 3,300 natural gas leaks from the vast pipeline system under Boston.

Congressman Ed Markey, MA 7th District
"This study shows that we need a plan to ensure leaks from aging natural gas pipelines in Boston and other cities and communities are repaired, so that we can conserve this important natural resource, protect the consumers from paying for gas that they don't even use, and prevent emissions of greenhouse gases into the environment," Markey wrote to the Pipeline and Hazardous Materials Safety Admin.

July, 2014: Massachusetts passes new pipeline safety bill that includes accelerated natural gas pipeline replacements.

How much natural gas is in the air of the Boston metroplex?

Top-down CH4 budget : 18.5 ± 3.7 g CH_4 m^{-2} yr^{-1}
~90% natural gas in winter, ~60% in summer
(**2.7% loss, ~ 2.5X higher than state inventory**)



McKain et al. 2015 PNAS

Published in 2014: Map of ~6,000 Methane Leaks in DC

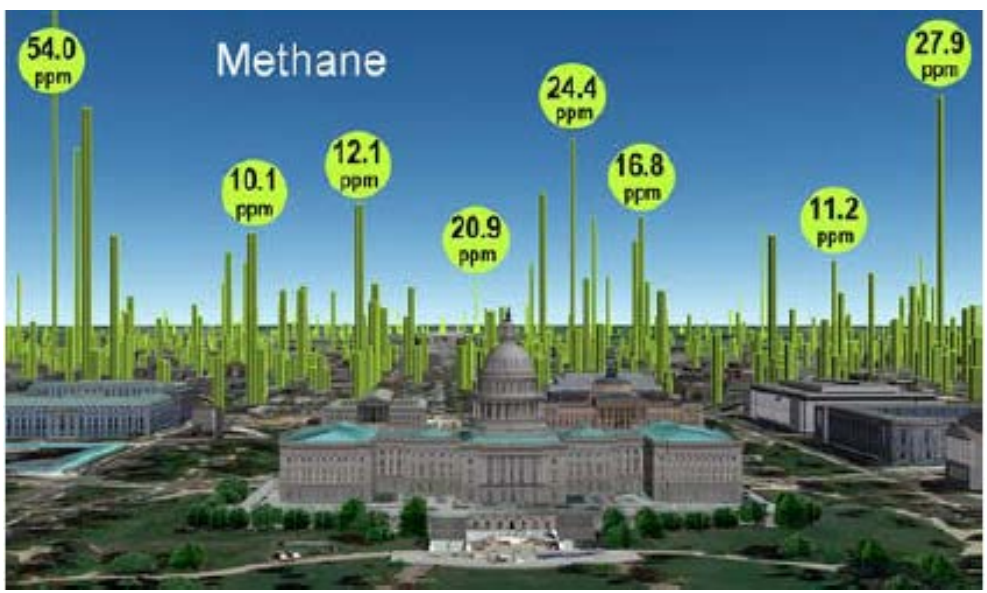
Environmental Science & Technology

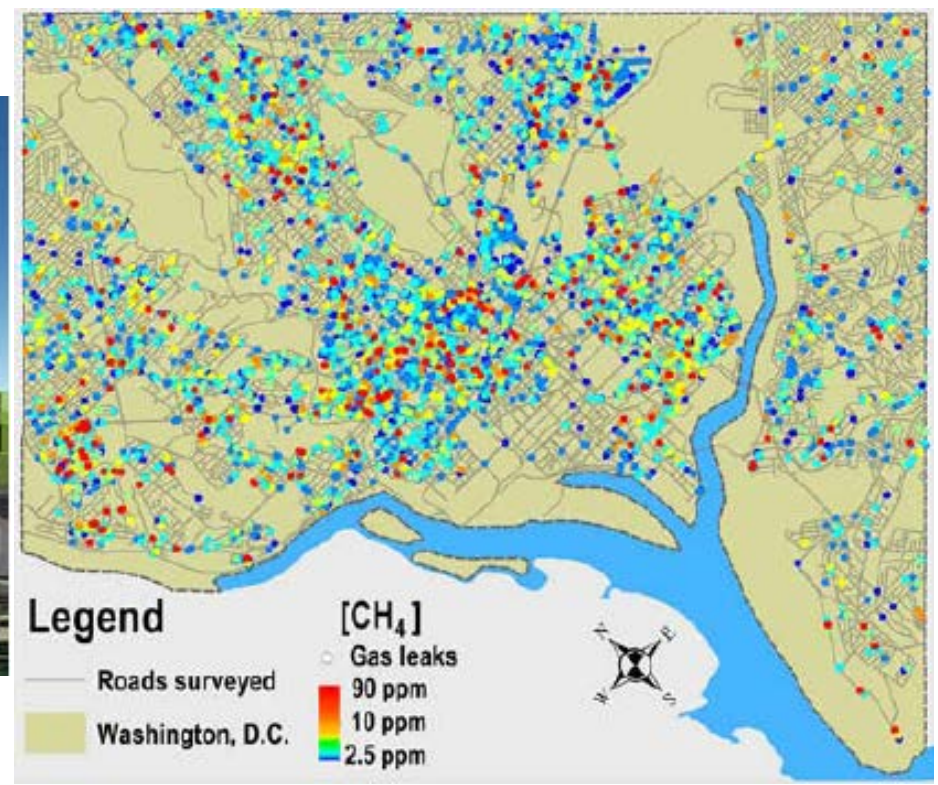
Article

pubs.acs.org/est

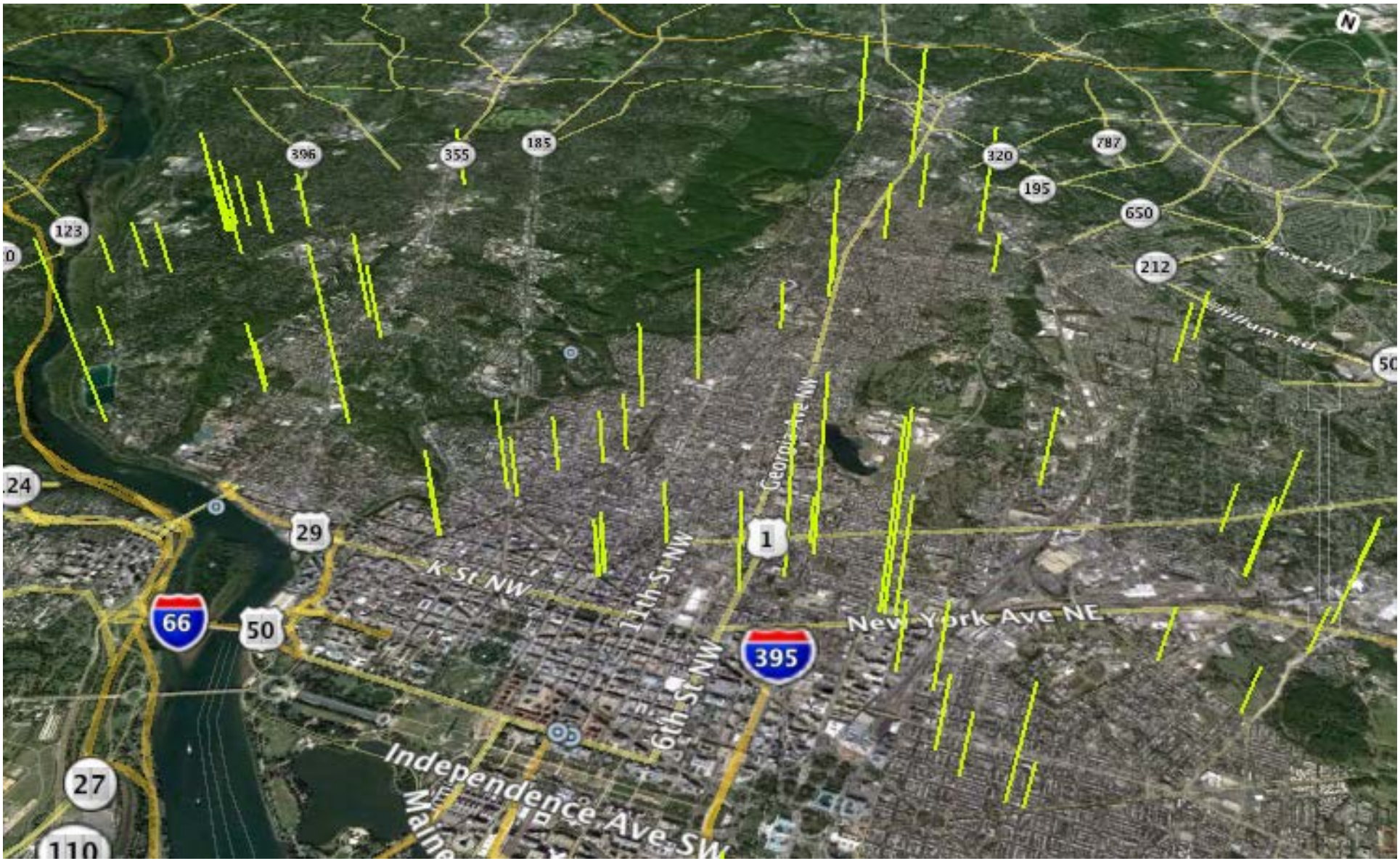
Natural Gas Pipeline Leaks Across Washington, DC

Robert B. Jackson,[†,‡,*] Adrian Down,[†] Nathan G. Phillips,[§] Robert C. Ackley,[∥] Charles W. Cook,[†] Desiree L. Plata,[⊥] and Kaiguang Zhao[†]



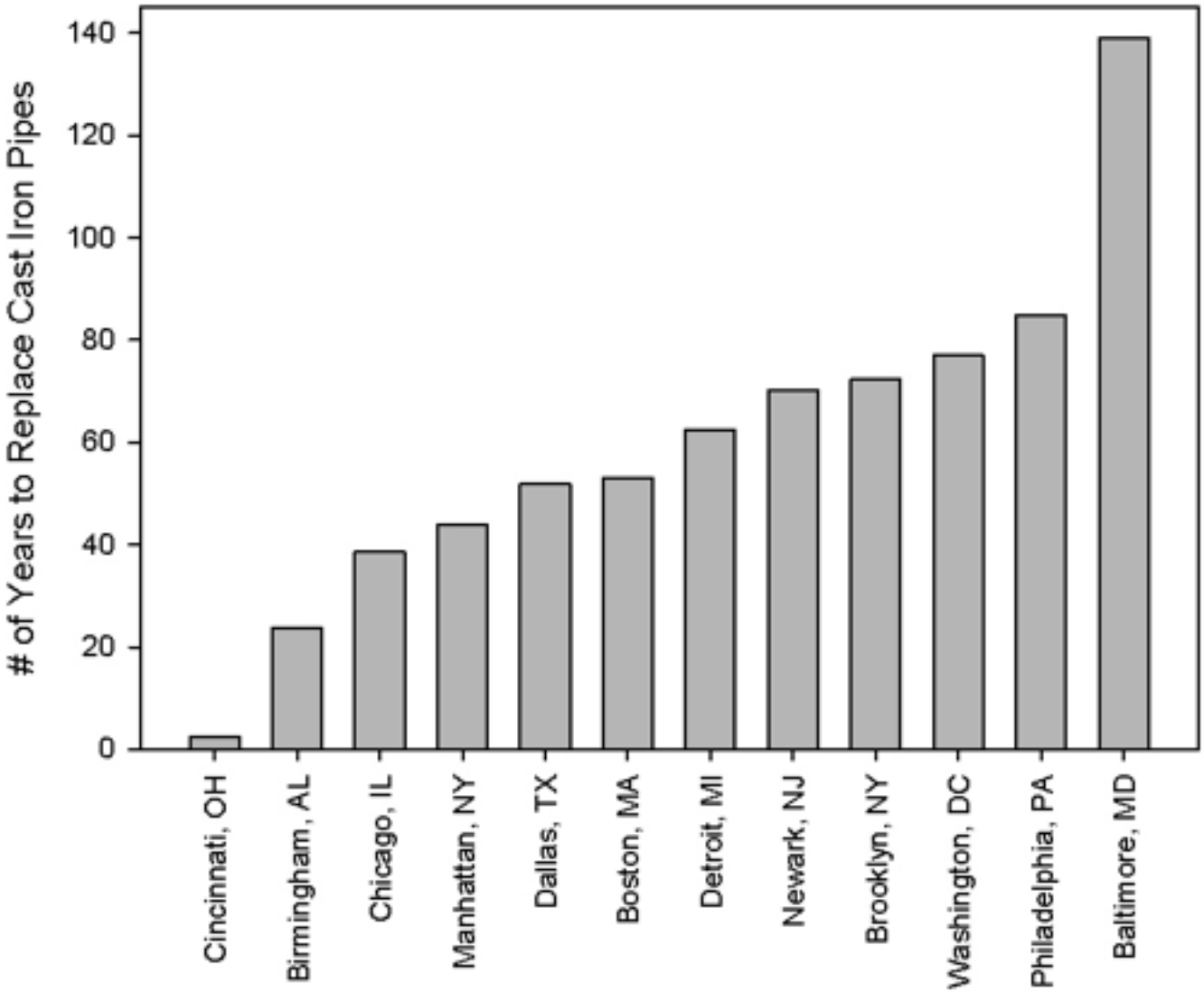


We can identify the top 50 leaks, for instance, all of them between 30 and 100 ppm methane (50-times background)



Jackson et al. 2014

Who's Doing a Good Job?
Years to Full Replacement of Cast-Iron Pipes



Estimates based on PHMSA data for 2004-2013

Jackson et al. 2014
Ann Rev Env Res

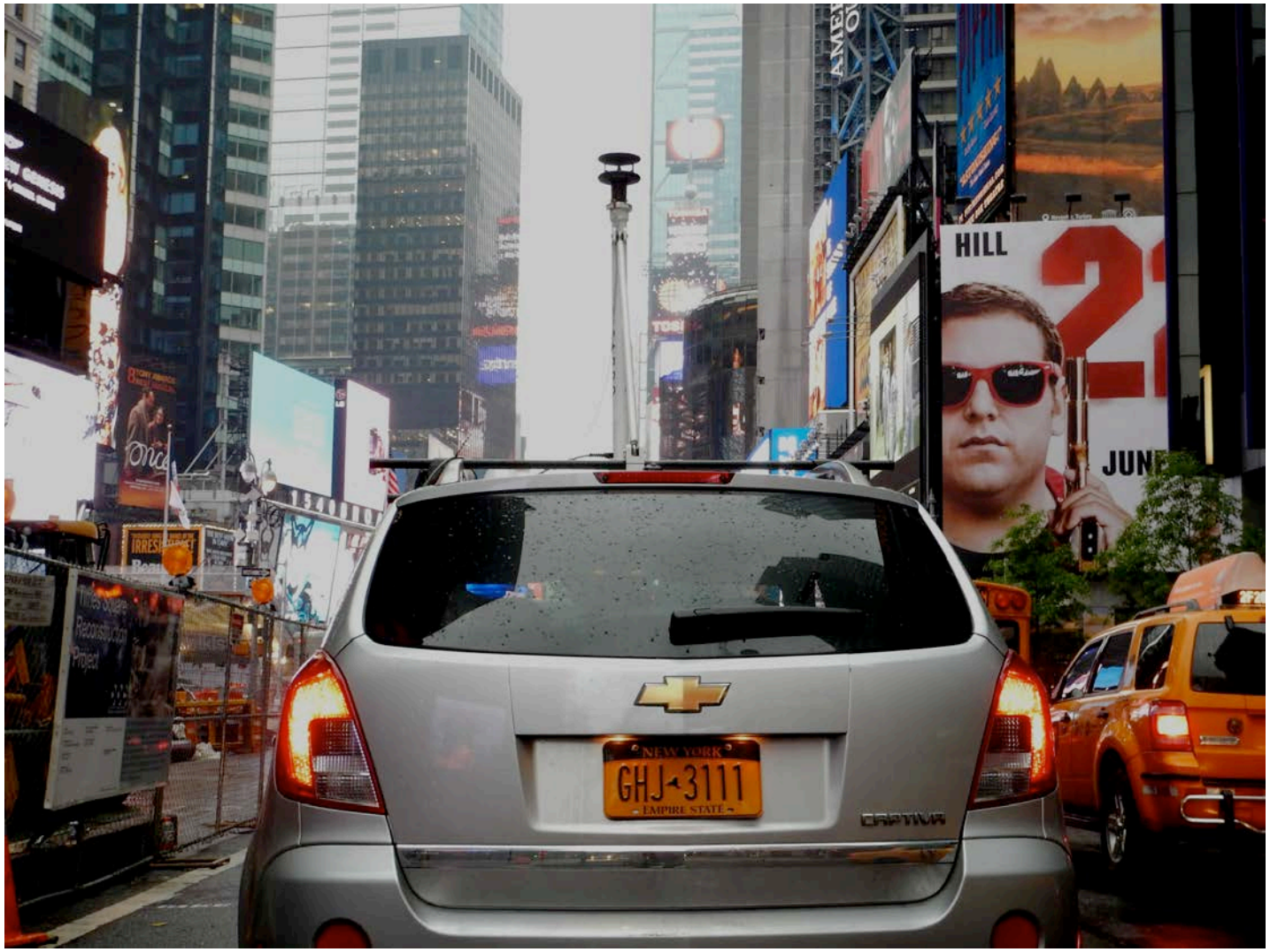
Natural Gas Pipeline Replacement Programs Reduce Methane Leaks and Improve Consumer Safety

Morgan E. Gallagher,[†,‡] Adrian Down,[§] Robert C. Ackley,[∥] Kaiguang Zhao,[⊥] Nathan Phillips,[#] and Robert B. Jackson[*,†,▽]

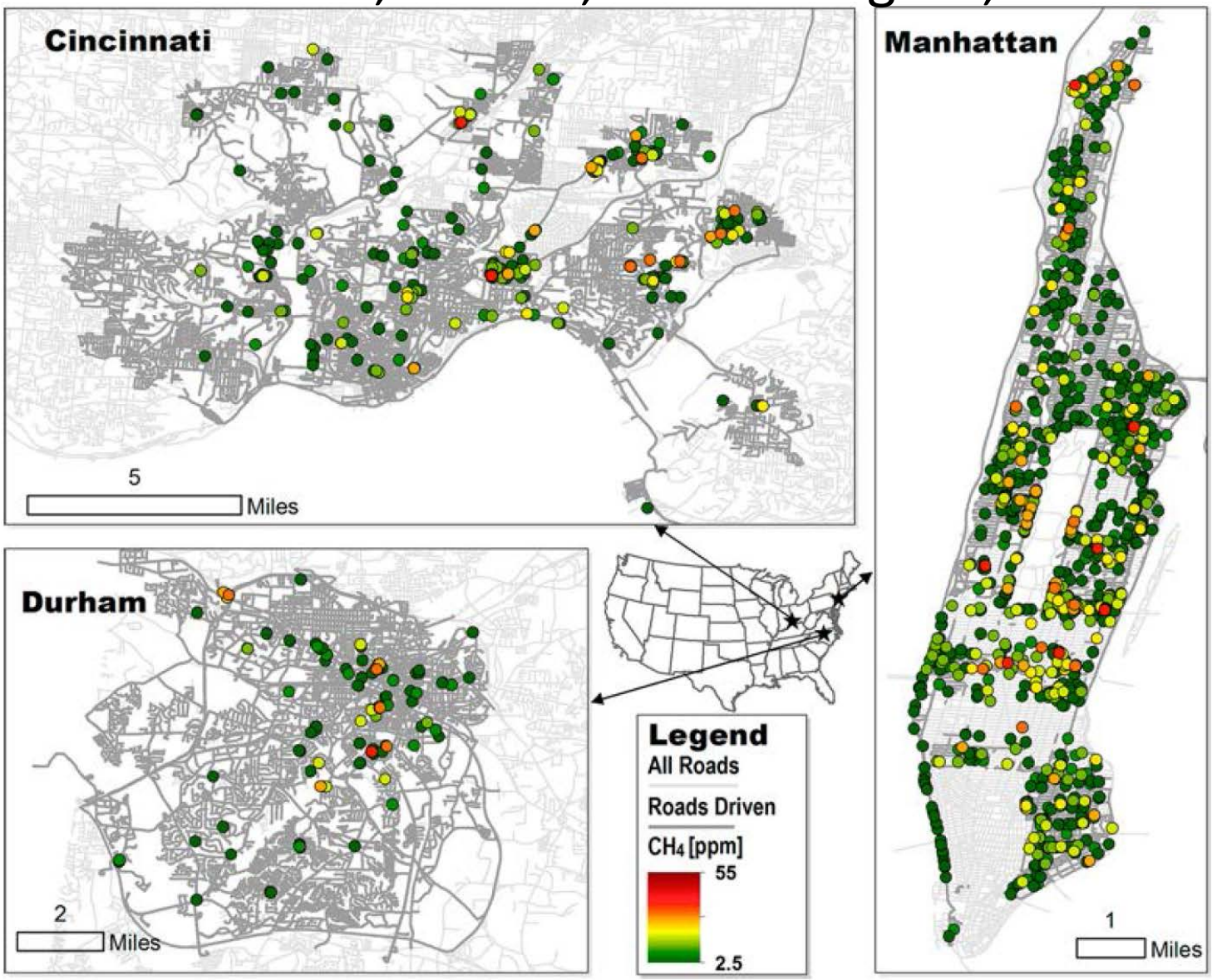
Environmental Science & Technology Letters

Published last fall

Mapped three new cities: Manhattan, Cincinnati, and Durham, NC.



90-95% fewer leaks in Cincinnati or Durham, NC, cities with completed pipeline replacement programs, than in Manhattan, Boston, or Washington, DC.



Gallagher et al. 2015

Justifications for Fixing Leaks:

1) Money: Consumers pay ~$2 billion each year in LAU gas
2) Jobs: Four unions benefit from repairing and replacing pipelines: UA (pipefitters), LIUNA, Operating Engineers, and Teamsters.
3) Consumer safety: ~15 fatalities and $130 M in property damage annually from incidents
4) Air Quality and Health: Volatile organics and ozone formation
5) Greenhouse gas emissions and climate change