EPA United States Environmental Protection Agency

Next Generation Emission Measurements

Protect the environment and save companies money

EnviroTech Summit, Raleigh NC, April 26, 2018

E. Thoma: *EPA Office of Research and Development (ORD), Durham, NC 27711*

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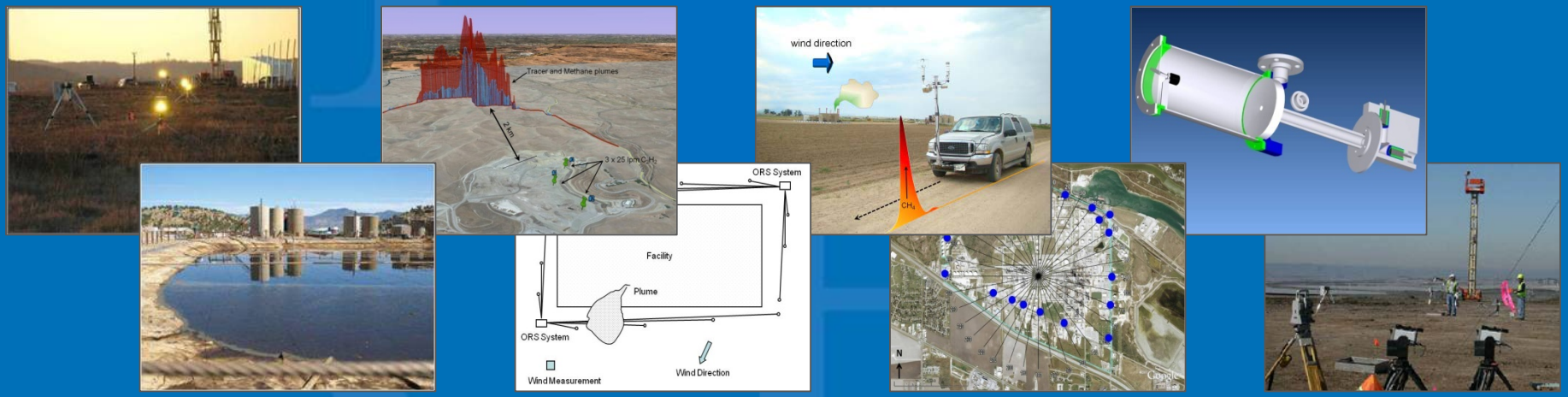


Office of Research and Development
National Risk Management Research Laboratory, Air and Energy Management Division

NRMRL Fugitive and Area Source Group
Source and Fenceline Measurements
Methods and Technology Development

EPA ORD NGEM Core Team

Focus: industrial / energy gas-phase air pollutants

Rachelle Duvall - *Sensors and citizen science*

Ingrid George - *Next gen volatile organic compound (VOC) methods*

Don Whitaker - *VOC and hazardous air pollutant (HAP) passive samplers*

Karen Oliver - *VOC and HAP passive samplers / methods*

Tai Wu - *NGEM data management*

Halley Brantley - *Data analysis and inverse forms (ORISE Fellow)*

Shaibal Mukerjee - *Community impact analysis*

Bill Mitchell - *Sensor communications and design*

Edgar Thompson - *Optical spectroscopy*

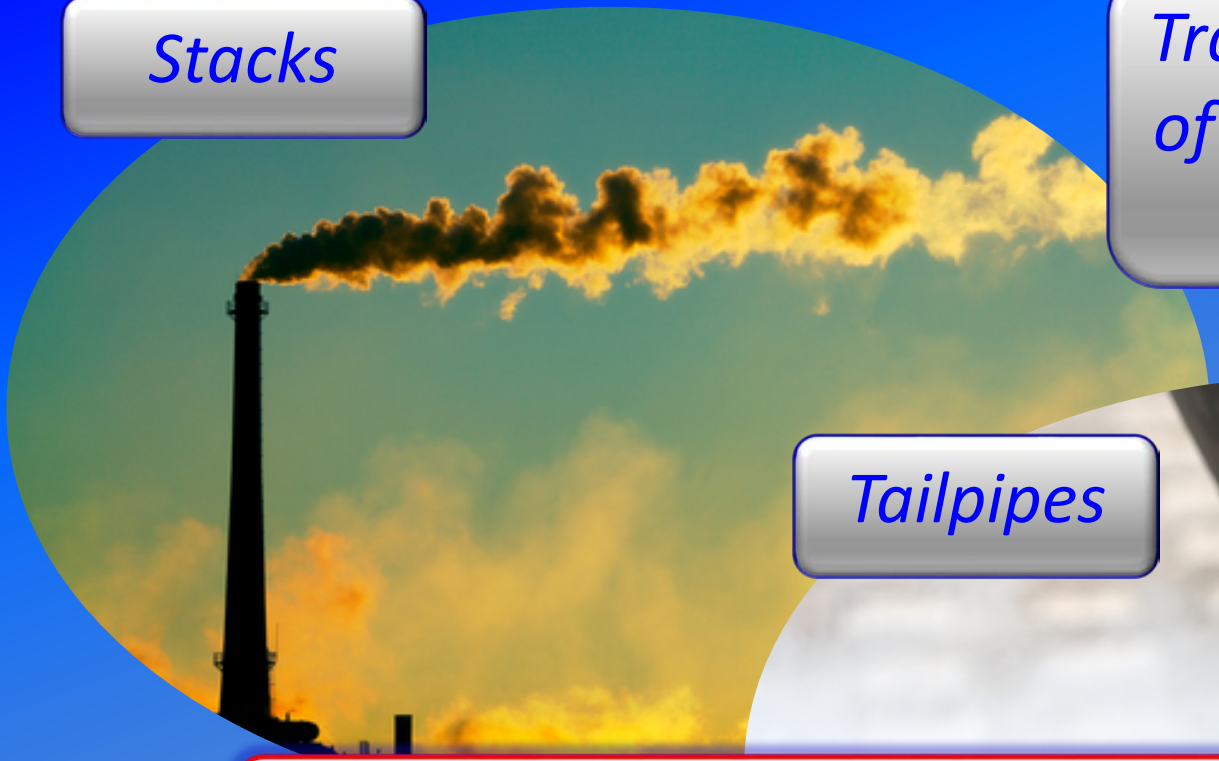
Tamira Cousett - *VOC/HAP analysis support (Jacobs Technology)*

Jacob Cansler - *NGEM field and analysis support (Jacobs Technology)*

Parik Deshmukh - *NGEM EPA contractor support lead (Jacobs Technology)*

Eben Thoma - *NGEM fugitive, area source, and fence line applications*

Stacks



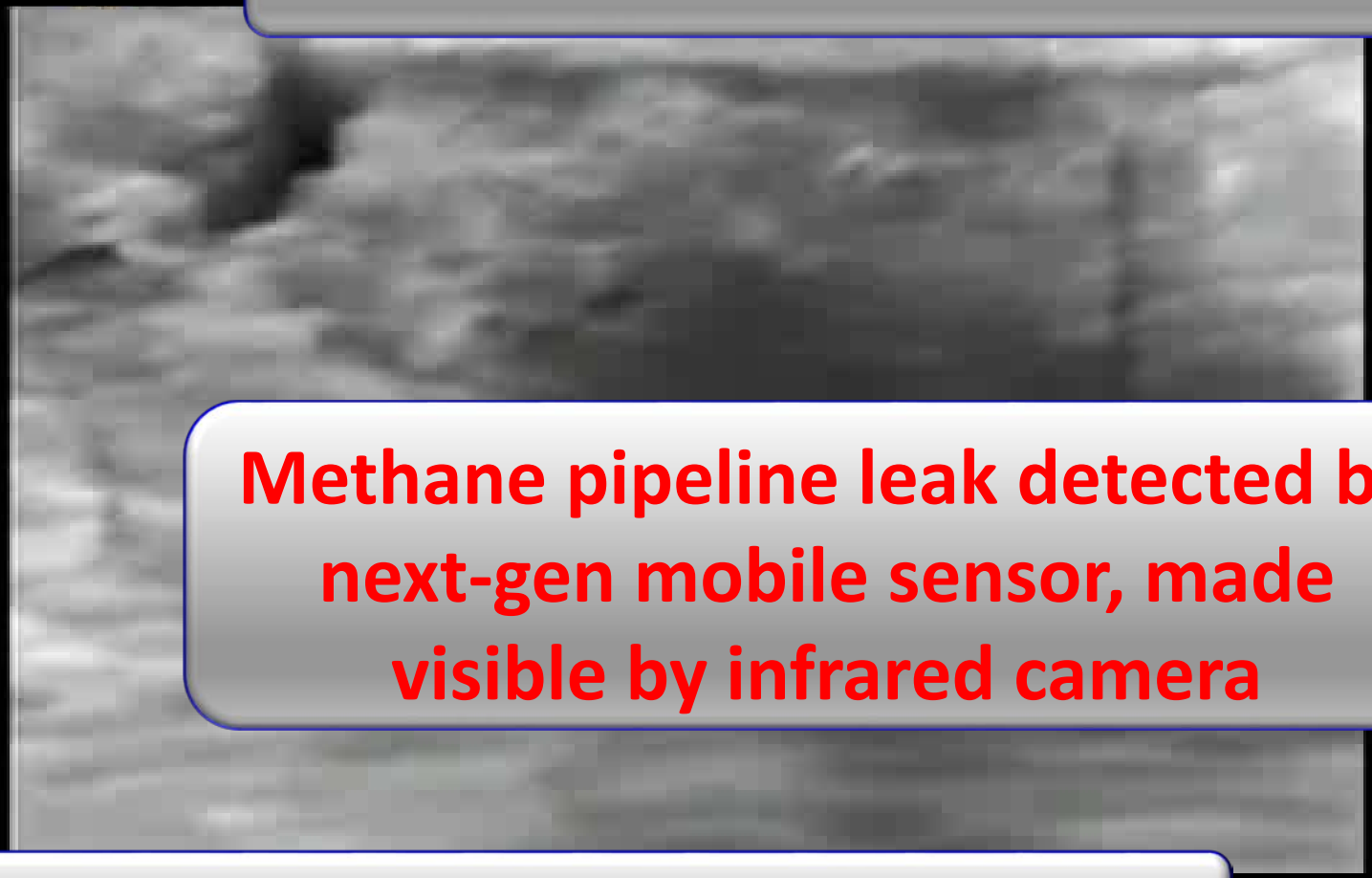
Traditional sources of air pollution are well-studied

Tailpipes

Known Source Location

Easy to measure and model
Regulatory framework is mature

Fugitive sources are another matter



Methane pipeline leak detected by next-gen mobile sensor, made visible by infrared camera

Unknown location or existence (stochastic)


The intersection of industry and community can be tense
Odors and air pollution fears make it worse
© 2014 Microsoft Corporation
Pictometry Bird's Eye © 2012 Pictometry International Corp

Traditional air monitoring > $200,000

…..a non-starter

Enter…
Next Generation Emission Measurements (NGEM)

http://www.aamjiwnaangenvironment.ca/monitoring.html

Stochastic source emissions *where and when?.....*

<u>An air pollutant source that can be:</u>

- Spatially distributed, unknown location
- Temporally episodic, difficult to predict
- Unexpected or unintended
- Not monitored or well understood
- Affected by meteorology

Next Generation Emission Measurements (NGEM)

<u>Examples</u>:

Fugitive leaks, malfunctions, process upsets, waste water/area sources, vented liquids storage, drains/sumps, startup/maintenance events, etc.

Stochastic fugitive and area sources

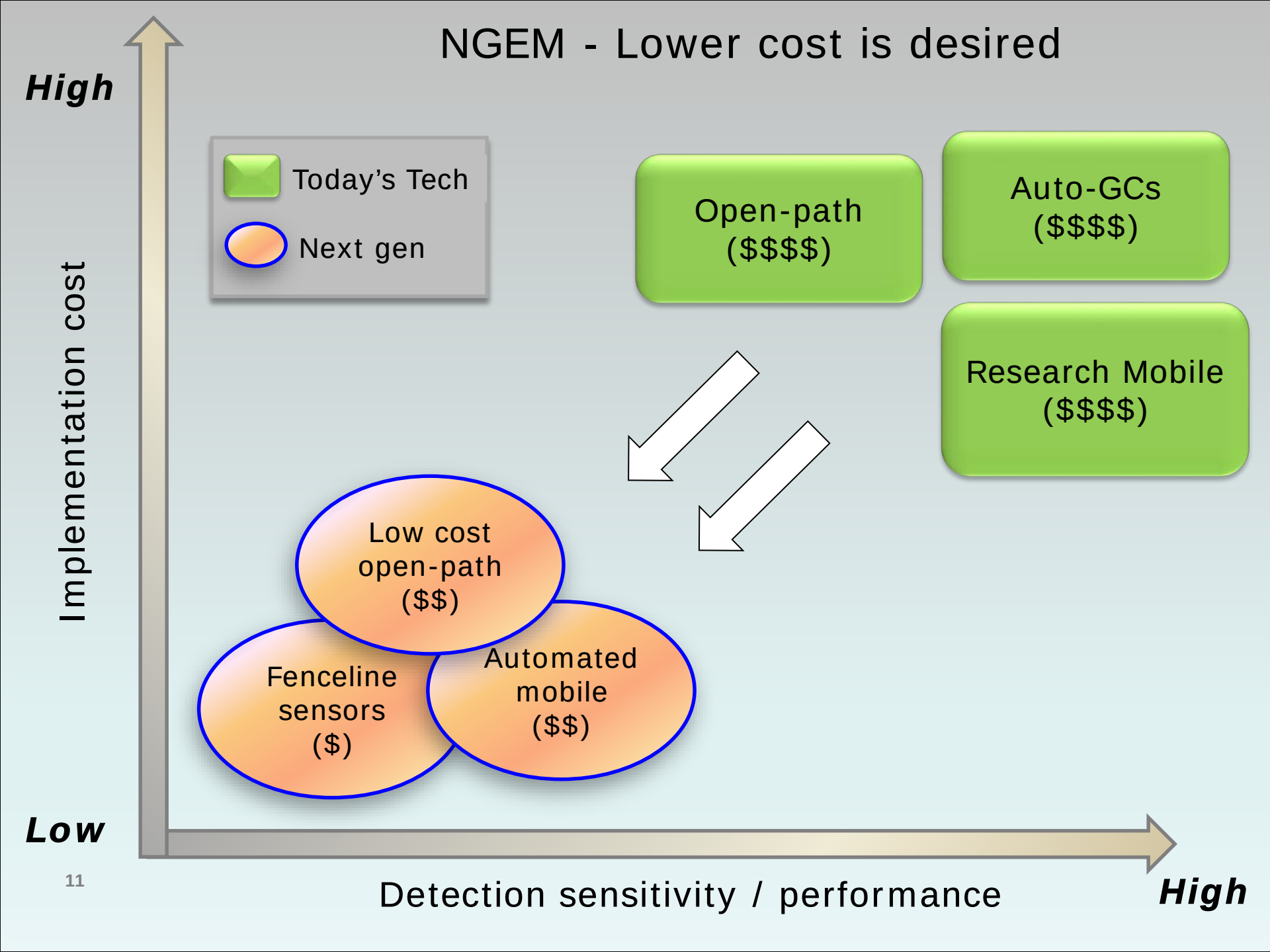
- Energy production
- Energy refining / distribution
- Industrial facilities
- Commercial operations
- Agricultural operations
- Landfills
- Waste water treatment
- Local odor sources


VOC and HAP emissions?

The NGEM Question?

How can "we" use emerging measurement and information systems to better protect the environment, save companies money and improve community wellbeing?

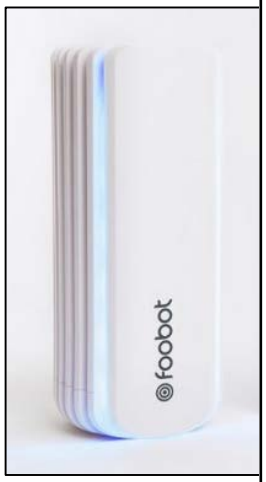
We = industry, regulators, 3rd parties, citizens

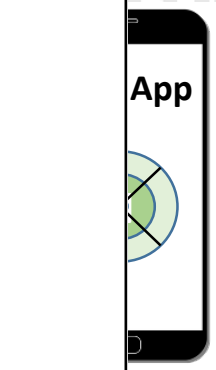

NGEM - Lower cost is desired
High
Implementation cost
Low
Today's Tech
Next gen
Open-path
($$$$)
Auto-GCs
($$$$)
Research Mobile
($$$$)
Low cost
open-path
($$)
Fenceline
sensors
($)
Automated
mobile
($$)
Detection sensitivity / performance
High

Next Generation Emissions Measurements (NGEM)

What is NGEM?

- Sensors in facilities and in communities
- Crowdsourcing odor and other observations
- Hybrid measurement / model systems
- Predictive and transparent informetrics



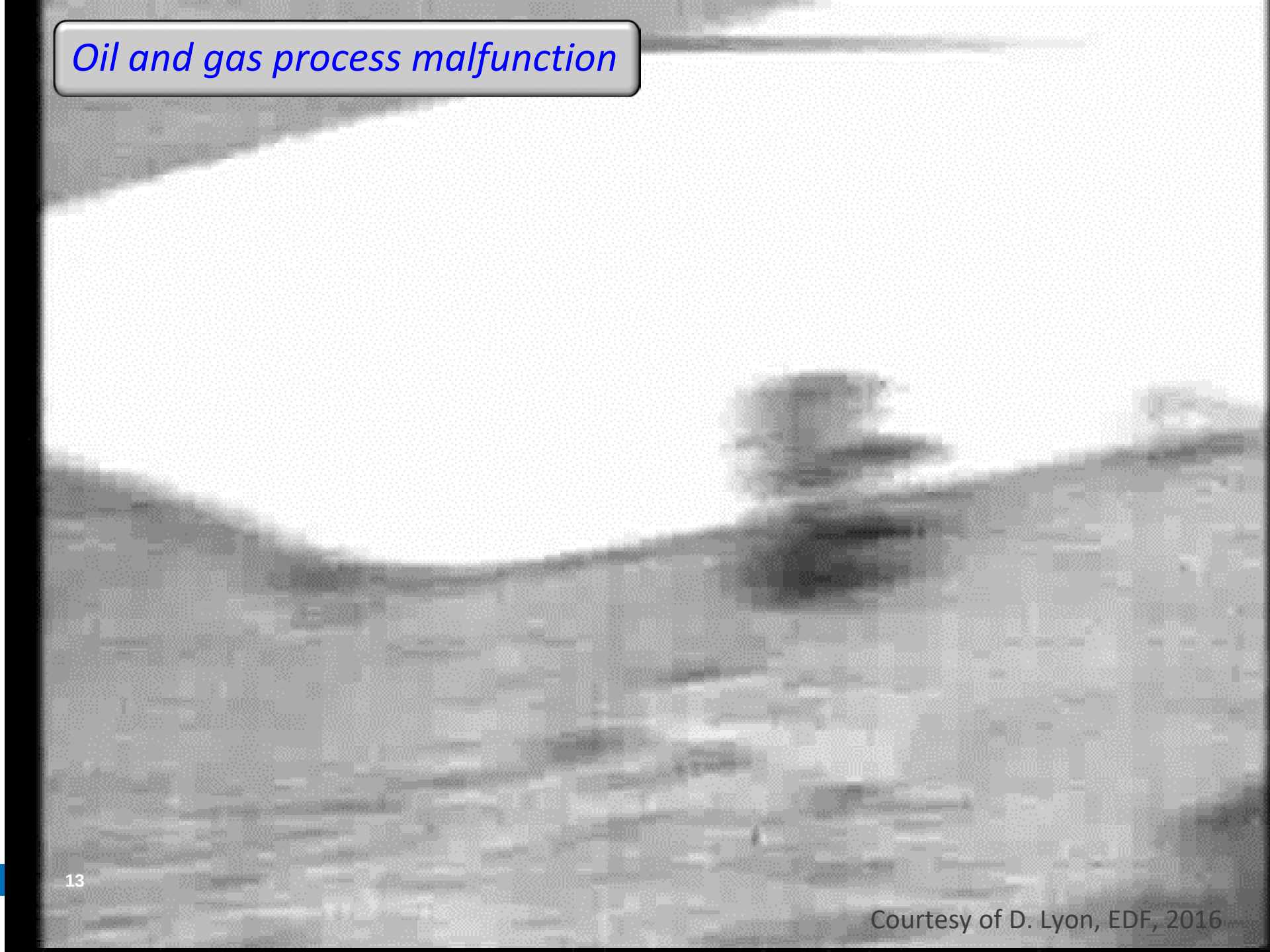


Facility Sensors

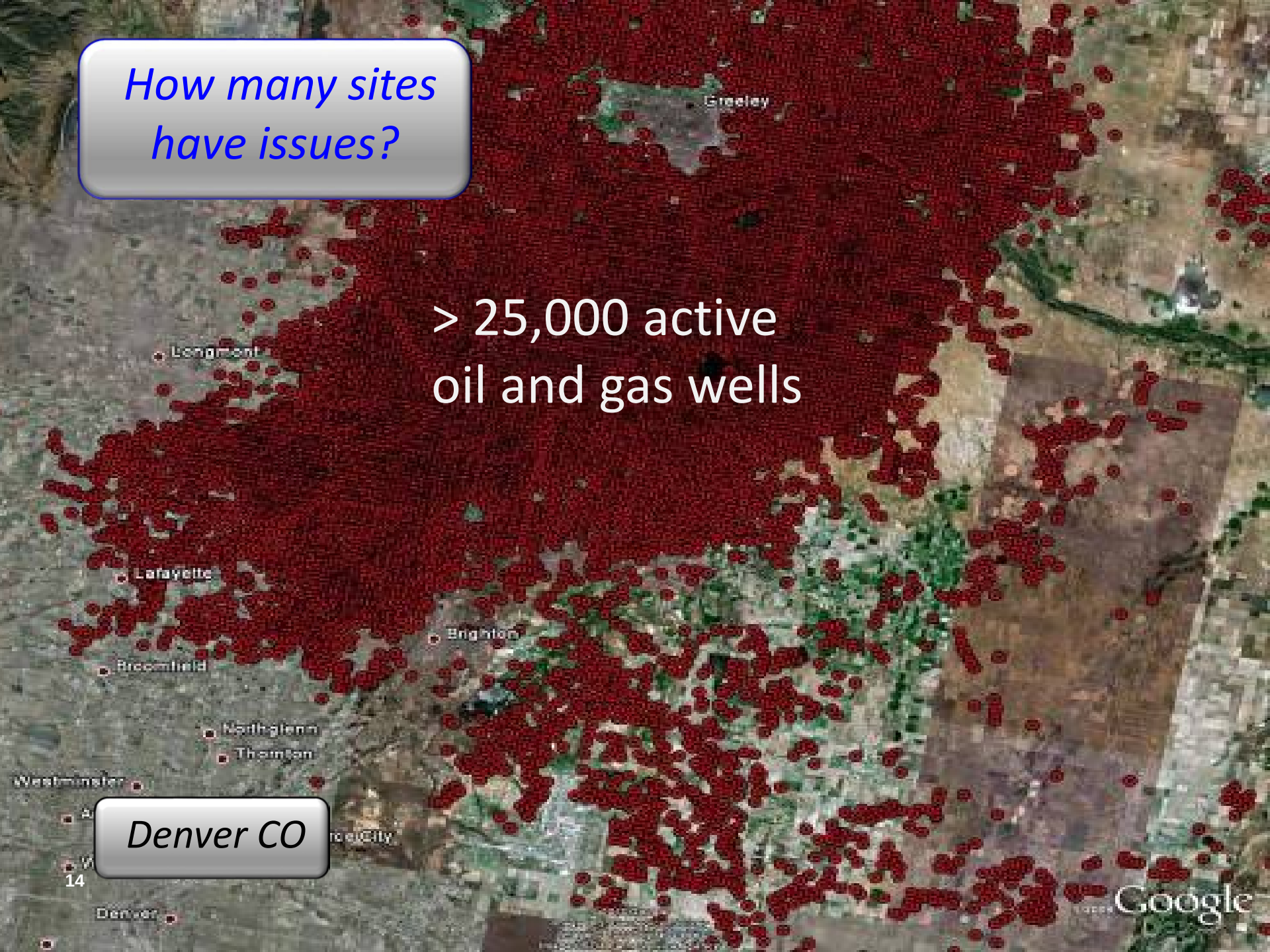
Personal and community Sensors

Metadata

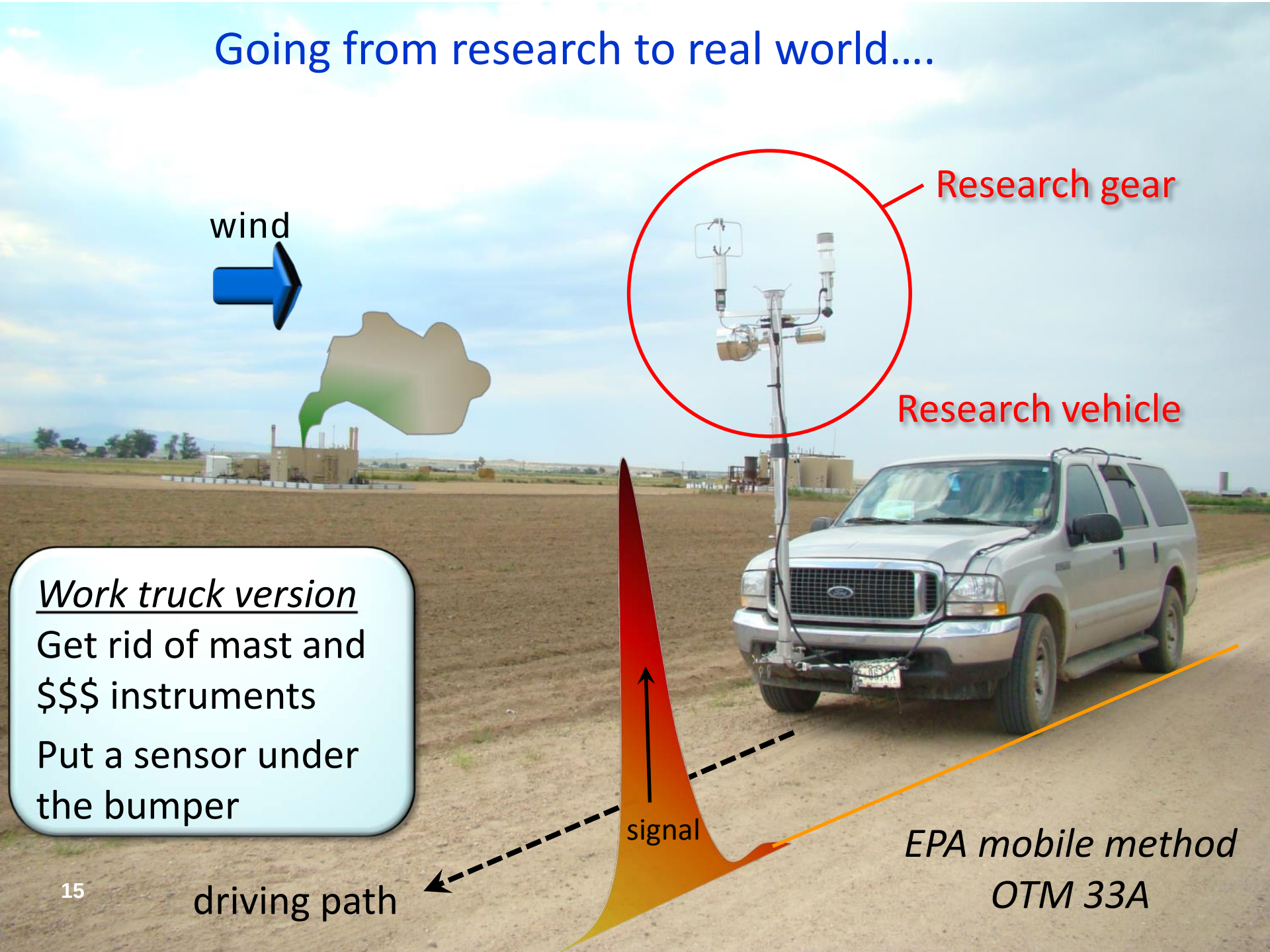
Oil and gas process malfunction



Courtesy of D. Lyon, EDF, 2016


How many sites have issues?
> 25,000 active oil and gas wells
Denver CO
Greeley
Longmont
Lafayette
Brighton
Broomfield
Northglenn
Thornton
Westminster
Denver
Google

Going from research to real world….



Work truck version

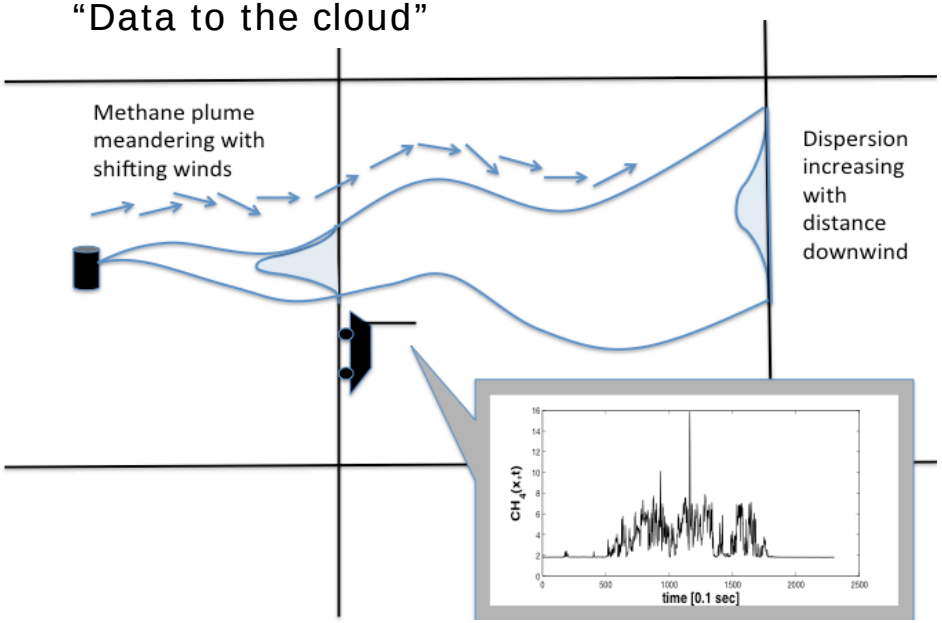
Get rid of mast and $$$ instruments

Put a sensor under the bumper

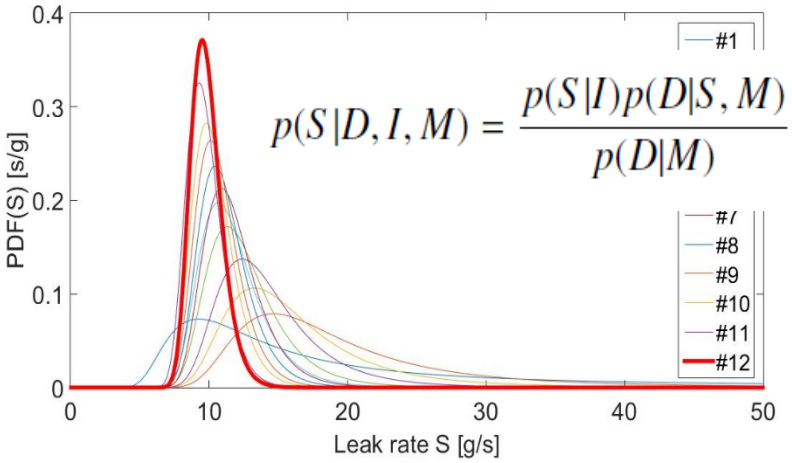
2018… Simplified mobile sensing

Automated Work Truck Sensing

"Data to the cloud"



Bayesian forms



Near and mid-field inverse models

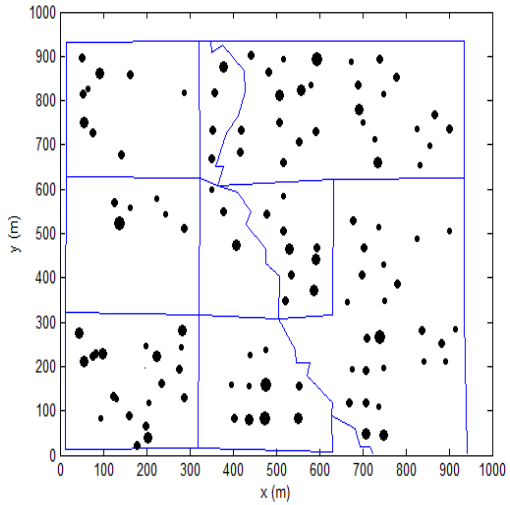
$$\bar{C}(x_v, y_v, z_m) = \frac{D_y(x', y', \vec{m}) D_z(x', z_m, \vec{m})}{U(x')} S(x', y')$$

$$D_z(x', z_m, \vec{m}) = \frac{A}{\bar{z}} \exp\left(-\left(\frac{B z_m}{\bar{z}}\right)^s\right)$$

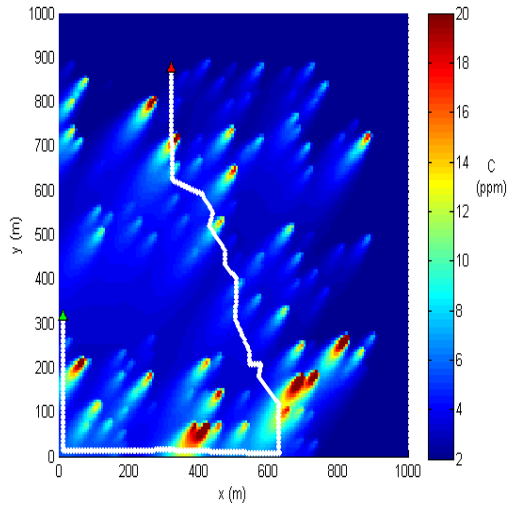
$$D_y(x', y', \vec{m}) = \frac{1}{\sqrt{2\pi}\,\sigma_y} \exp\left(-\frac{1}{2}\left(\frac{y'}{\sigma_y}\right)^2\right)$$

$$\sigma_y = a z_o \frac{\sigma_v}{u_*} \left(\frac{x'}{z_o}\right)^p$$

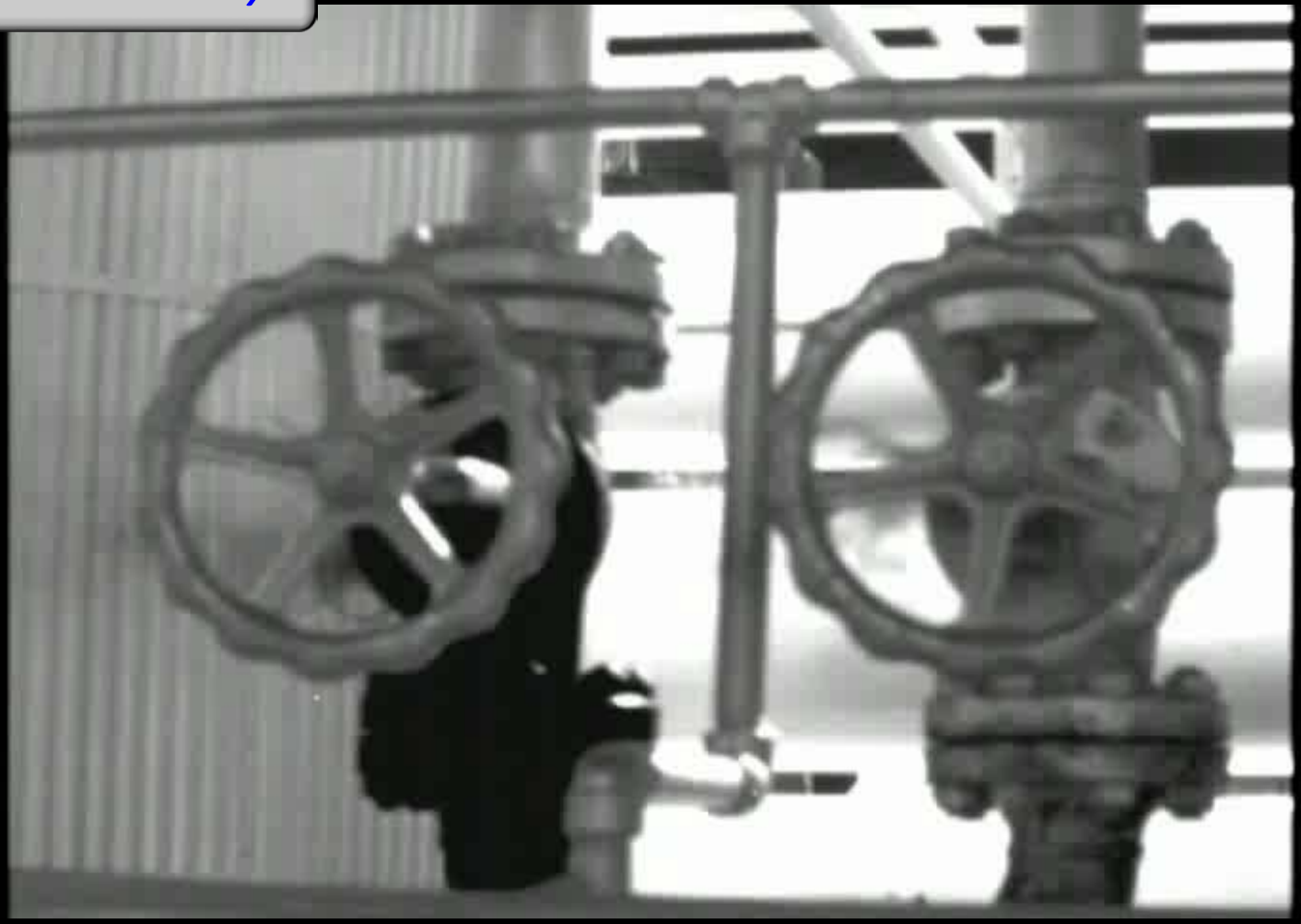
Well pad locations and production levels



Opportunistic and planned path



Leak in a Facility



Where's the leak?

Pickup truck

$1MM - 3MM yr. / facility

SPod FENCELINE SENSO

Secure | https://www.epa.gov/sites/production/files/2016-04/documents/spod_fact_sheet.pdf

Apps | Suggested Sites | Awaiting Action | Log in to Concur | National Locator | ORD@Work | Quality Assurance | Scientific, Technical, | SBIR Relevancy Revie | Imported From IE

EPA

www.epa.gov/research

science in ACTI

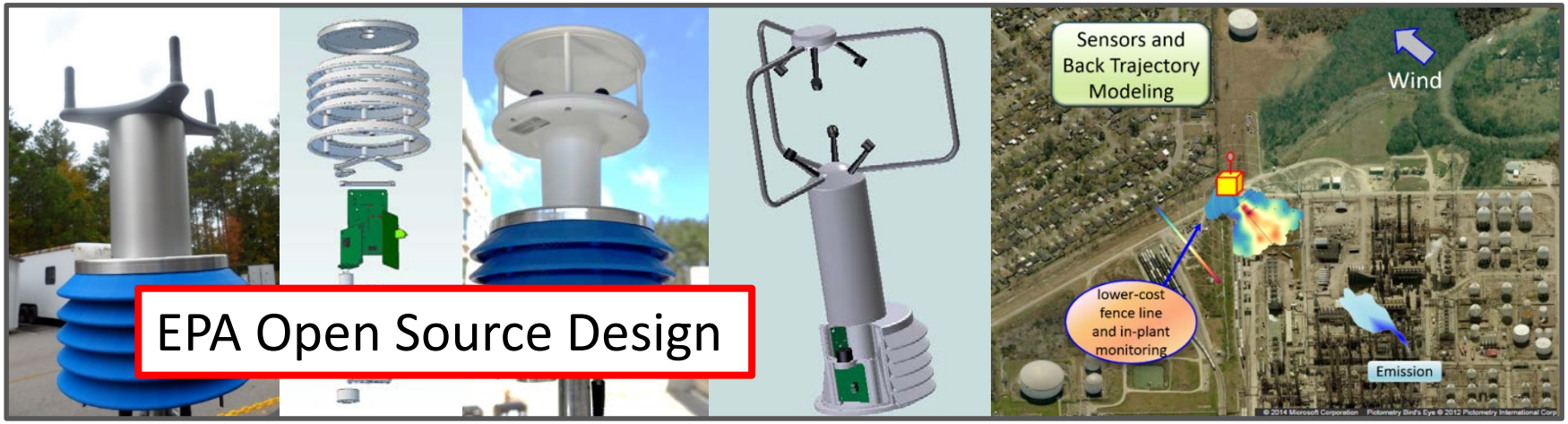
INNOVATIVE RESEARCH FOR A SUSTAINABLE

SPod FENCELINE SENSORS UNDER DEVELOPMENT

Next Generation Emission Measurements

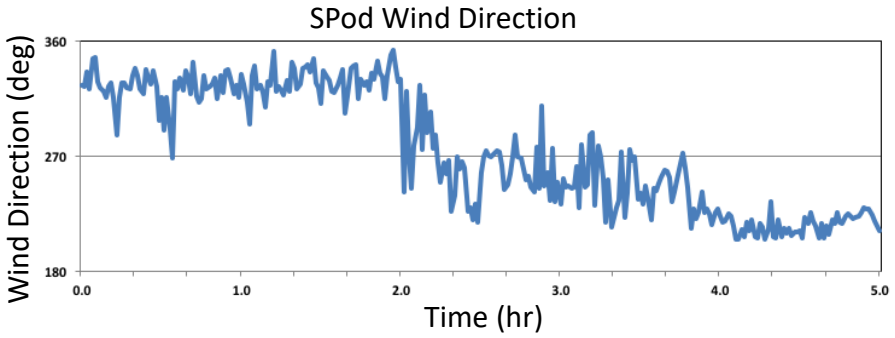
U.S. Environmental Protection Agency (EPA) researchers are helping to develop and test new air pollutant sensors and inverse modeling approaches that can improve facility leak detection and repair and source emissions inventories. The commercialization of cost effective, implementable sensor systems that meet desired performance goals will help bring

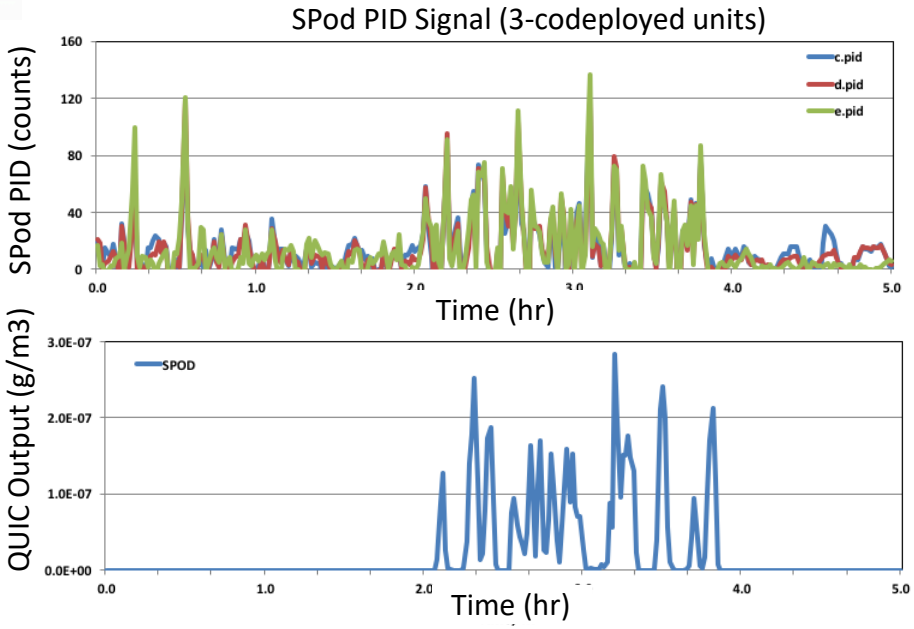
SPod-class sensors produce fast measures of emissions and wind direction, ready for inverse models



Combining sensor data and wind flow models

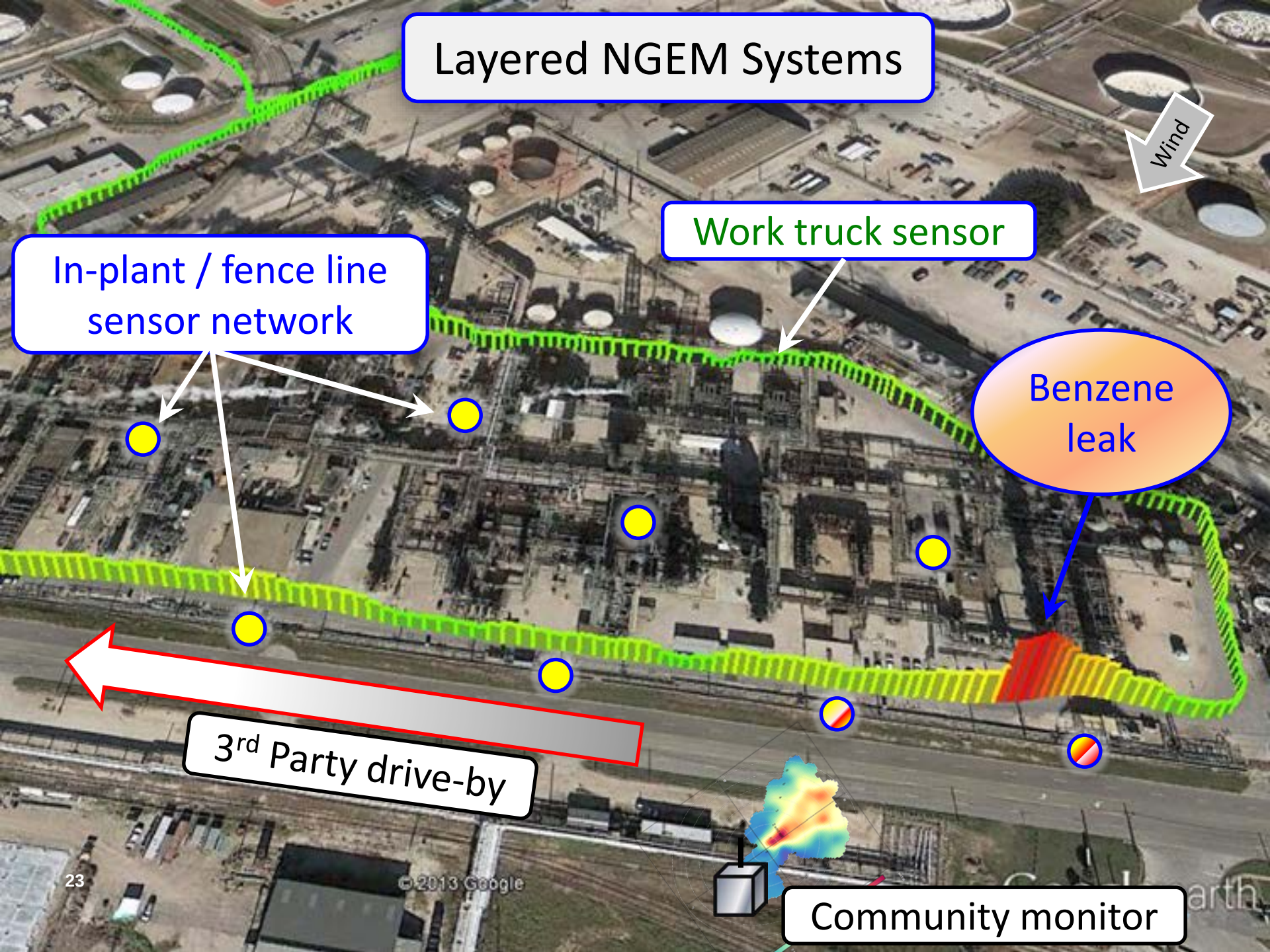
Helps understand concentration fields and source locations





Los Alamos Quick Urban & Industrial Complex (QUIC) Dispersion Model
http://www.lanl.gov/projects/quic/
Easy to setup, runs on a laptop!

In-facility leak detection sensor network testing, cooperative research with U.S. industries


Layered NGEM Systems
Wind
Work truck sensor
In-plant / fence line sensor network
Benzene leak
3rd Party drive-by
Community monitor
23
© 2013 Google

Drivers for NGEM

What is the data worth?

How we will mange sources in the future?

arpa·e
CHANGING WHAT'S POSSIBLE

ABOUT | ENGAGE | PROJECTS | MEDIA | FAC

https://arpa-e-foa.energy.gov/

PROJECT LISTING

- Aeris Tech - More information on Aeris Tech's project is coming soon!
- CU Boulder - More information on CU-Boulder's project is coming soon!
- Duke - More information on Duke's project is coming soon!
- GE - More information on GE's project is coming soon!
- LI-COR - More information on LI-COR's project is coming soon!
- PARC - More information on PARC's project is coming soon!
- PSI Corp - More information on PSI's project is coming soon!
- Rebellion - More information on Rebellion's project is coming soon!

HOME

MONITOR

Methane Observation Networks with Innov

EDF ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

www.edf.org/methanedetectors

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Climate and energy

The problem

Methane Detectors Challenge

Catalyzing next generation air emissions monitors to tackle methane pollution

TECH TIMES

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Google Equips Street View Cars With Aclima Sensors To Map Air Pollution

By Nicole Arce, Tech Times | July 29, 8:57 AM

Google Street View Cars Want to Scan Your City for Gas Leaks

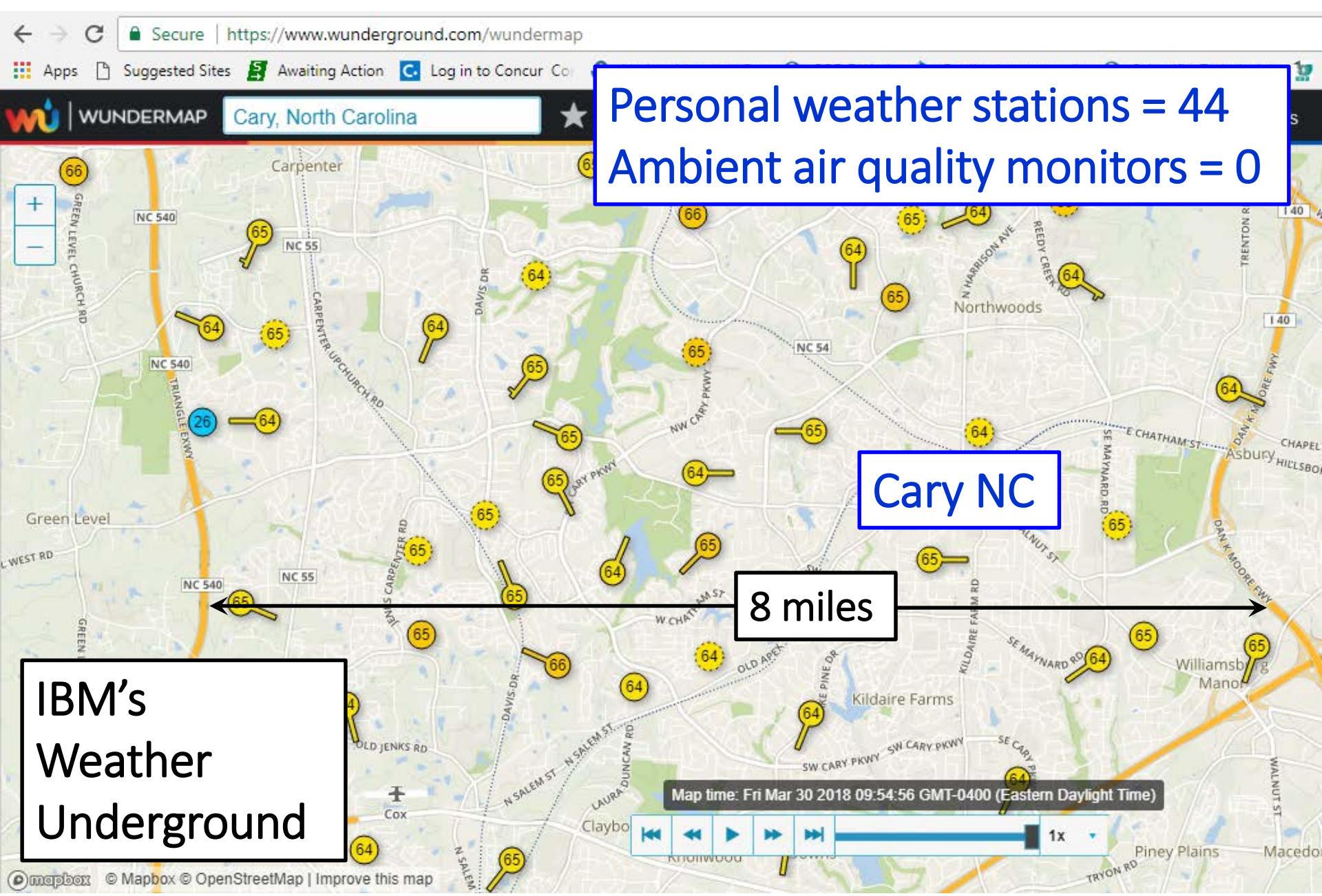
By *Zoë Schlanger*

Filed: *7/16/14 at 1:21 PM*

A Google Street View car is driven in Sundsvall, northern Sweden September 13, 2011.
Fabrizio Bensch / Reuters

http://www.newsweek.com/google-street-view-cars-want-scan-your-city-gas-leaks-259212

http://www.techtimes.com/articles/72698/20150729/google-equips-street-view-cars-with-aclima-sensors-to-map-air-pollution.htm


Secure | https://www.wunderground.com/wundermap
Apps
Suggested Sites
Awaiting Action
Log in to Concur
WUNDERMAP
Cary, North Carolina
Personal weather stations = 44
Ambient air quality monitors = 0
Cary NC
8 miles
IBM's Weather Underground
Carpenter
Northwoods
Green Level
Kildaire Farms
Cox
Asbury
Williamsburg Manor
Piney Plains
Map time: Fri Mar 30 2018 09:54:56 GMT-0400 (Eastern Daylight Time)
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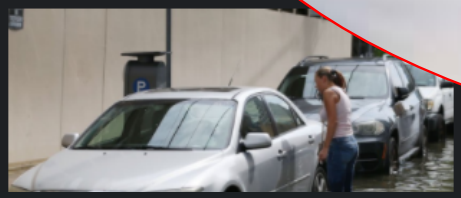
Let's Clear the Air

There aren't enough air quality sensors in the United States, so it's hard to track air pollution. Please help collect this data to keep your family and neighbors healthy.

Get an Air Quality Monitor



Disruptive tidal flooding ... year will strike as often as 80 to 180 days a year by the 2040s, according to a major report from

https://www.wunderground.com/

Let's Clear the Air

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Get an Air Quality Monitor

NGEM = More Information

New measurement tools

New modeling tools

New information tools

New generators of data

New ways to combine data

New users of data

What will NGEM deliver?

- Improved source understanding
- Reduced air shed impacts
- Safer working environments
- Reduced product loss
- More efficient work practices
- Lower regulatory burden
- Improve transparency and community relations
- Future source management and trading strategies