Environmental intelligence
for people and the planet

Harnessing sensor networks and big data to measure and manage our environment

September 2017
"Making Sense of Sensors" Conference
Melissa Lunden, Chief Scientist, Aclima, Inc.

Problem

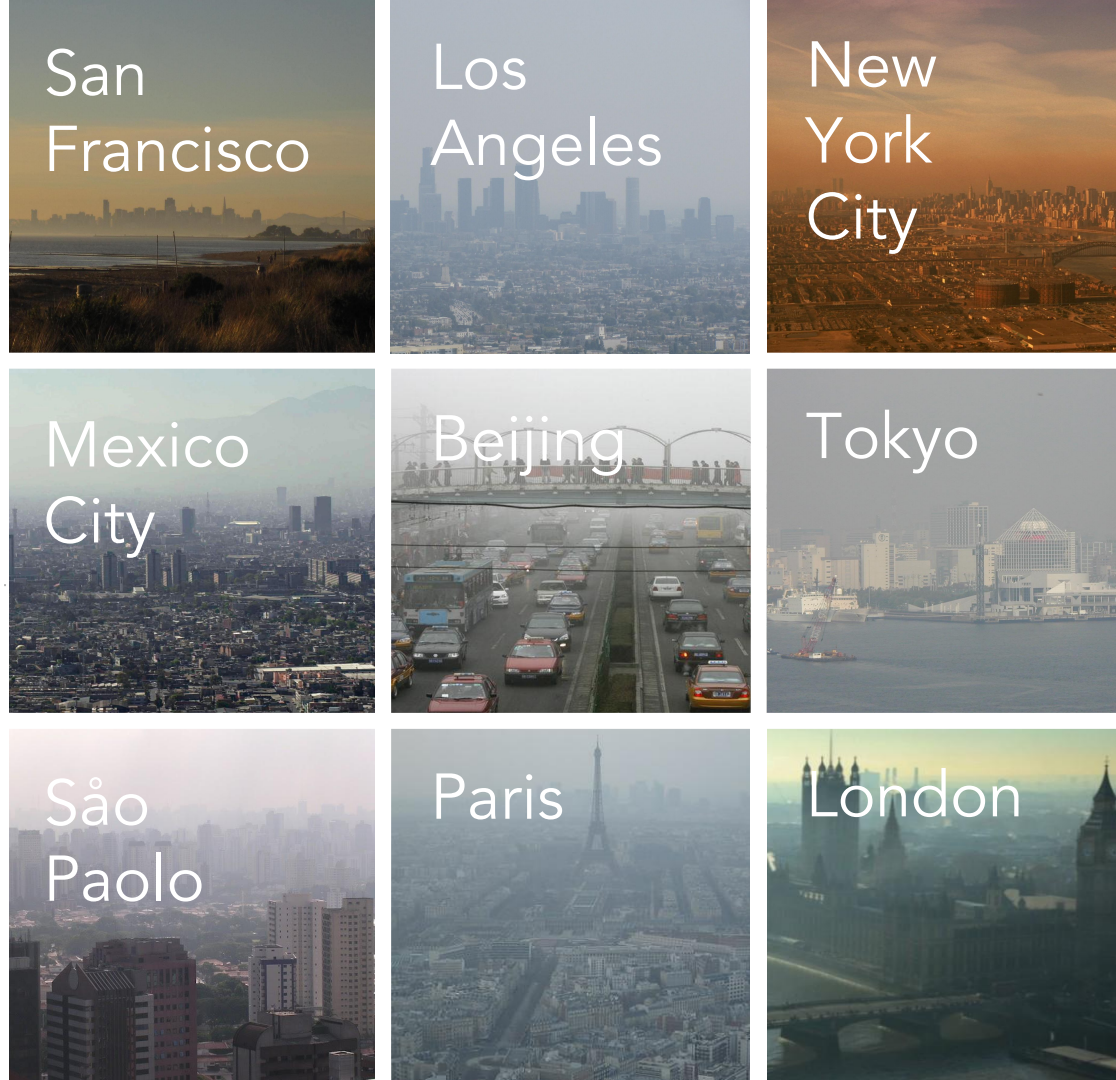
You can't manage what you don't measure.

In the face of increasing pressures on our environment, we need high-resolution and localized measurement to manage the quality of our most valuable natural resources.

Billions of people and trillions of dollars in assets are exposed to unmanaged risk.

"Measure the treasure – it resonates with me because at Google, we say 'what gets measured, gets improved.'"

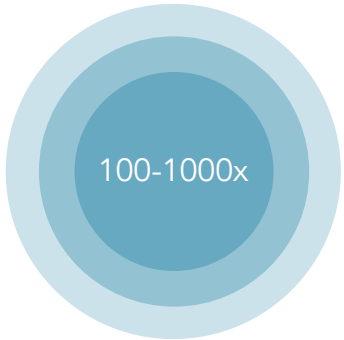
— Luc Vincent
Creator of Google Street View
Vice President of Engineering, Lyft
Special Technology Advisor, Aclima



Aclima Solution

Ubiquitous, real-time sensor networks fused with Ai hold the key to unlocking a new relationship with our environment.

The Aclima platform creates a ubiquitous data lake that powers 'environmental intelligence' – a new paradigm in environmental resource management that transforms decision-making and policy.



Aclima technology reduces the cost of measuring air pollutants by 100-1000x, enabling ubiquitous scale.

Aclima Platform for Environmental Intelligence

- Government
- Manufacturing
- Real Estate
- Retail
- Smart Cities+Transport
- Infrastructure+Industry
- Energy Production
- Public Health
- Utilities+Telecom
- Agriculture
- Insurance
- Consumer Products

We combine leading-edge sensing technology, cloud computing, and artificial intelligence to take the real-time pulse of the invisible world around us.

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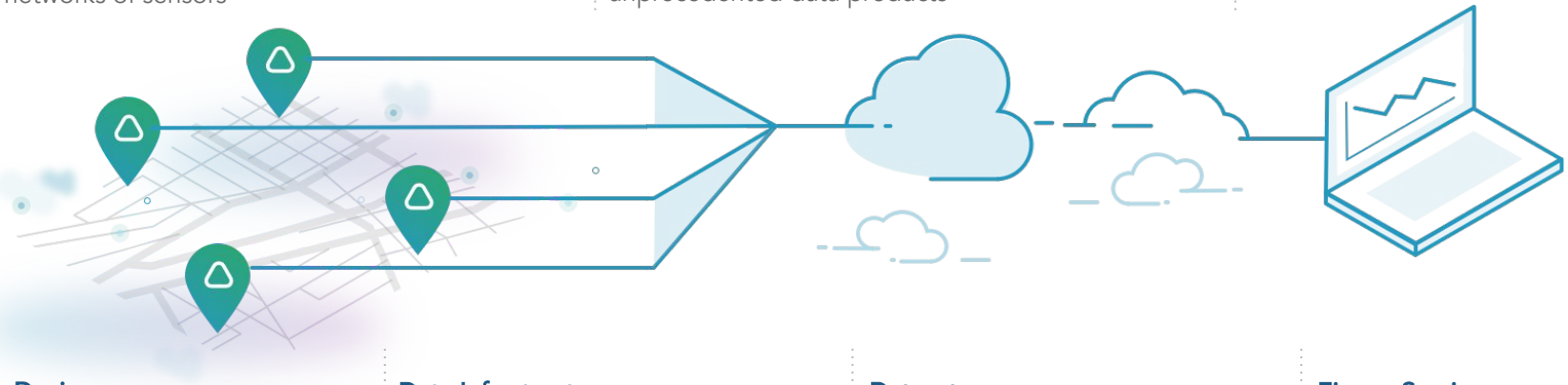
Aclima Technology Platform

Network
Technology architecture connects + calibrates distributed networks of sensors

Analytics + Ai
Big-data, geo-spatial analytics and artificial intelligence unlocks unprecedented data products

Interfaces
Powerful tools to visualize + communicate data insights



Devices
Modular sensing devices to measure an expanding range of parameters indoors and outdoors, across settings.

Data Infrastructure
Cloud-based architecture collects, organizes and computes large amounts of streaming real-time data

Datasets
Proprietary, sensor-generated data sets on indoor + outdoor environments power machine learning models

Ei-as-a-Service
Subscription to data products provides access to continually improving insights and predictions

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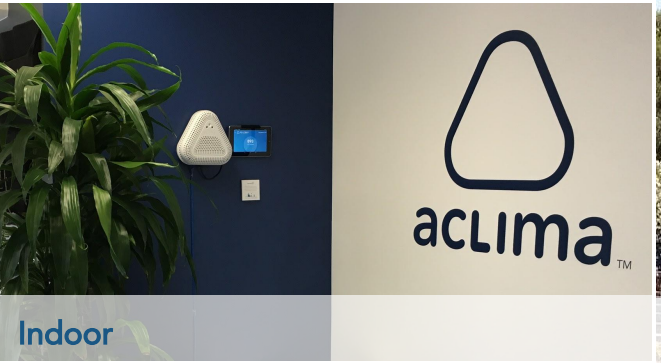
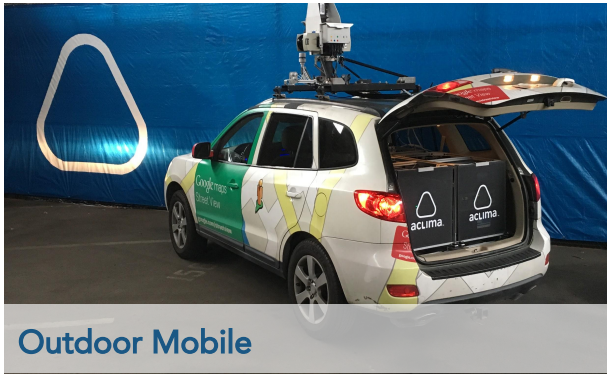
Current Deployment Platforms



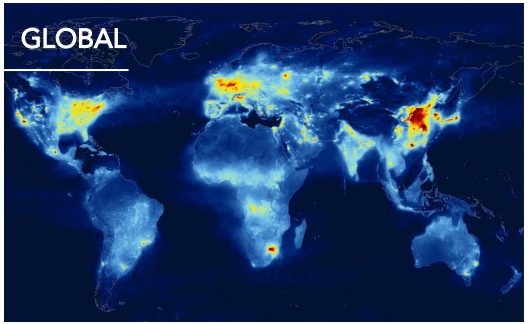
Indoor

Outdoor Stationary

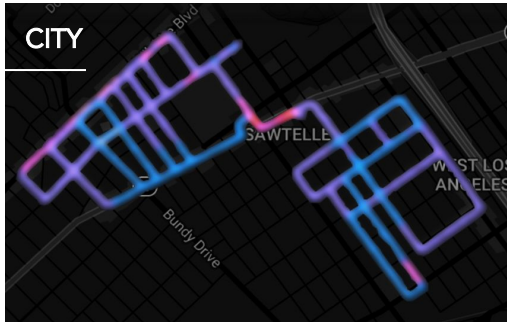


Outdoor Mobile

Impact Across Multiple Scales



Urban populations are disproportionately exposed to unhealthy conditions.

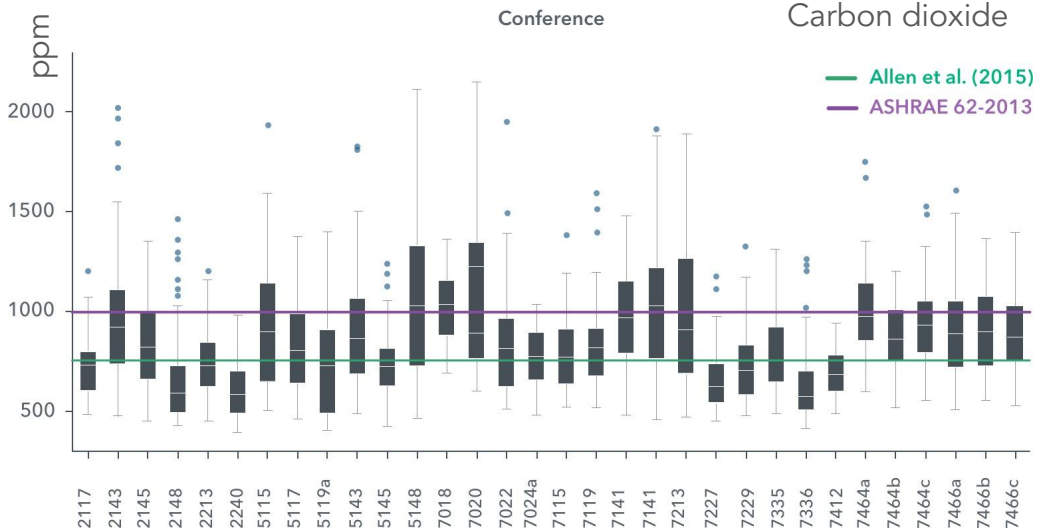


Environmental conditions vary across, within and between neighborhoods and sites.

Environmental condition varies within and between buildings and spaces.

GLOBAL IMPORTANCE → PERSONAL RELEVANCE

Mapping the Indoors



We spend ~90% of our time indoors

Indoor pollution levels can be much higher than outdoors

Sensor networks provide a map of environmental conditions indoors that affect our health, comfort, and productivity

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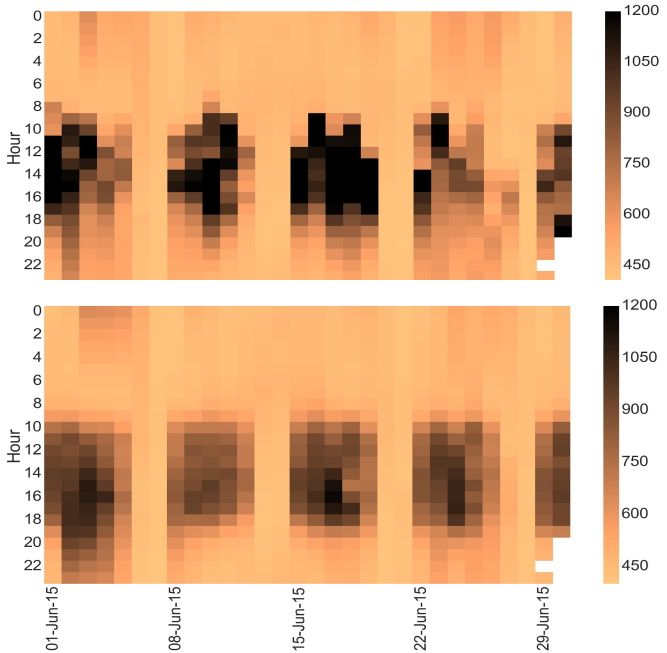
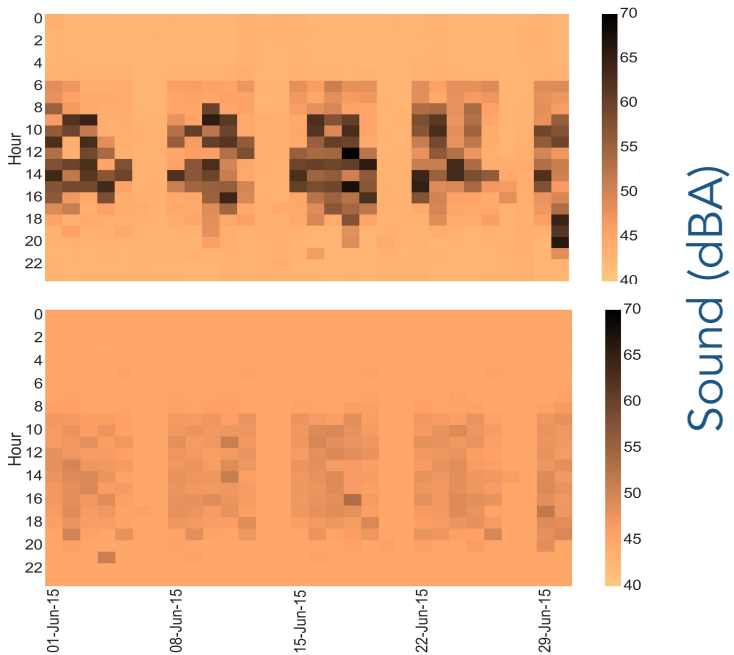
Conveying valuable information in space and time



Conference room



Open office

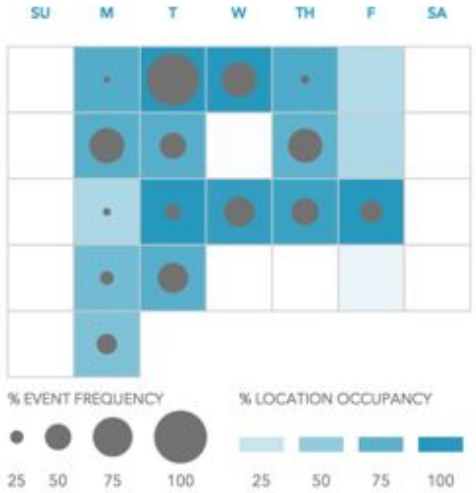
Complicating Factors

Comparison of two conference rooms

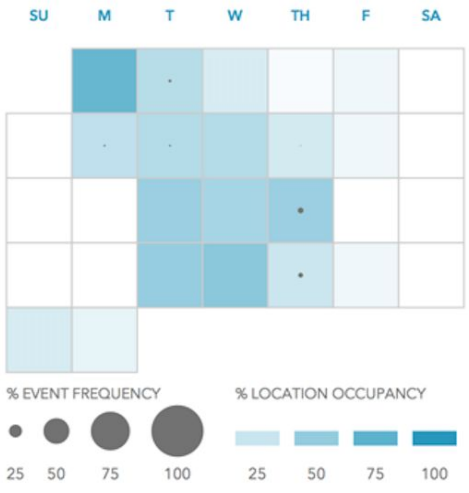
Space utilization matters

People can upset even the most well designed buildings

Conference room A

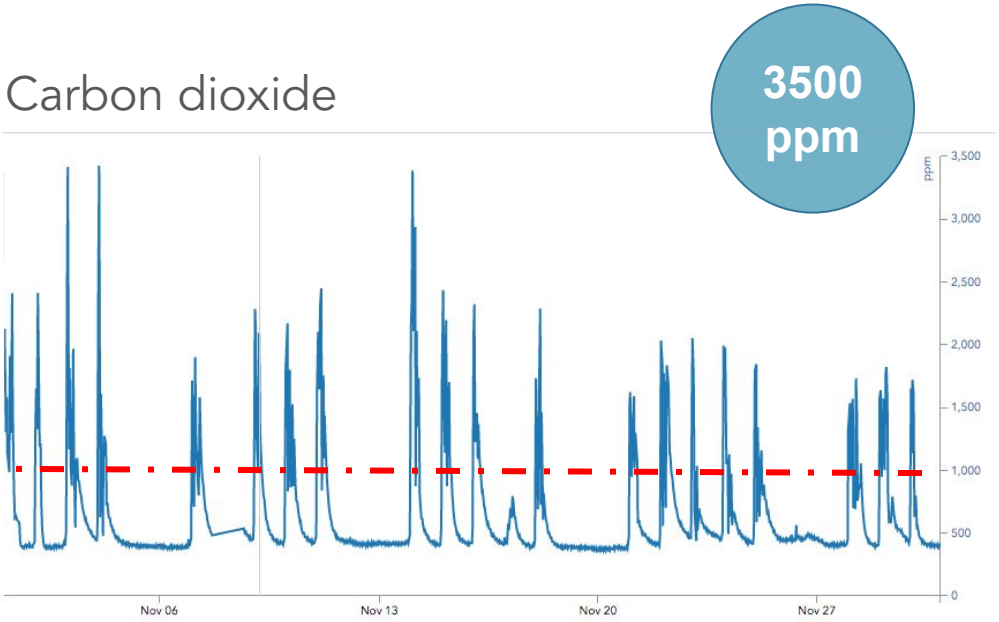


Conference room B



Capturing Problem Spaces

Carbon dioxide



Poor IAQ has proven to be a particular problem in schools, with likely impacts on cognition and learning

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Urban Mapping: Driving Science, Health and Urban Planning

Environmental Science & Technology

Article

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High-Resolution Air Pollution Mapping with Google Street View Cars: Exploiting Big Data

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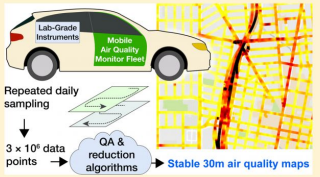
Supporting Information

ABSTRACT: Air pollution affects billions of people worldwide, yet ambient pollution measurements are limited for much of the world. Urban air pollution concentrations vary sharply over short distances (≪1 km) owing to unevenly distributed emission sources, dilution, and physicochemical transformations. Accordingly, even where present, conventional fixed-site pollution monitoring methods lack the spatial resolution needed to characterize heterogeneous human exposures and localized pollution hotspots. Here, we demonstrate a measurement approach to reveal urban air pollution patterns at 4−5 orders of magnitude greater spatial precision than possible with current central-site ambient monitoring. We equipped Google Street View vehicles with a fast-response pollution measurement platform and repeatedly sampled every street in a 30-km^2 area of Oakland, CA, developing the largest urban air quality data set of its type. Resulting maps of annual daytime NO, NO_2, and black carbon at 30 m-scale reveal stable, persistent pollution patterns with surprisingly sharp small-scale variability attributable to local sources, up to 5−8× within individual city blocks. Since local variation in air quality profoundly impacts public health and environmental equity, our results have important implications for how air pollution is measured and managed. If validated elsewhere, this readily scalable measurement approach could address major air quality data gaps worldwide.



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Mobile Platform

Location + Meteorology

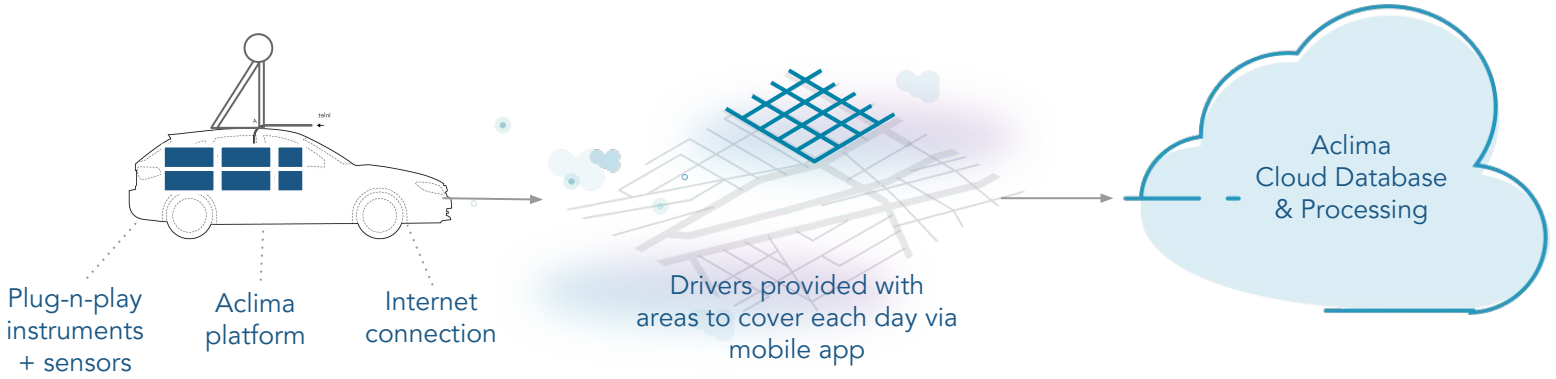
Latitude & Longitude
Vehicle Speed and Heading
Wind Direction
Wind Speed
External Temperature
External Pressure

Reference Equipment

Ozone
Nitrogen Dioxide
Nitric Oxide
Black Carbon
PN 2.5
UFP

Sample rate = 1 Hz

Platform Operation



Data Acquisition

- Reference equipment plug-n-play into Aclima platform
- Data uploaded in real time to Aclima cloud backend
- On-board data storage system ensures no data loss

Data Quality Control

- Gas phase instruments calibrated weekly
- Particle instrument zero check daily

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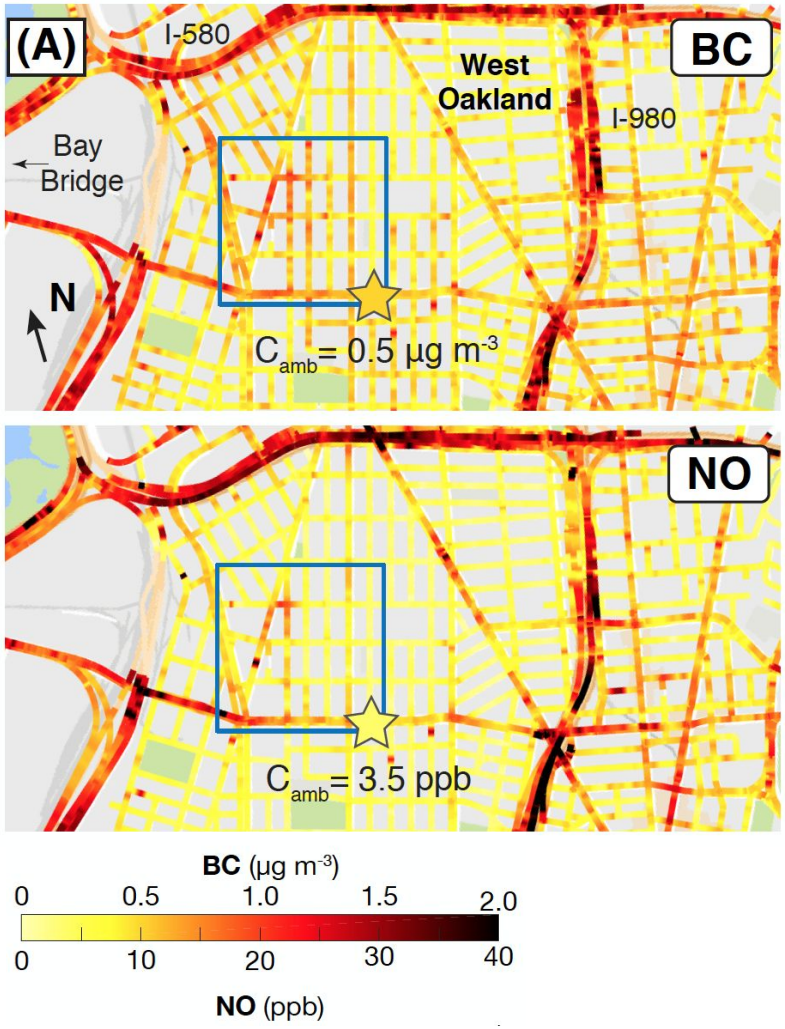
Pollutants vary sharply in space

Variability attributable to local emission sources

Observed variation of up to 5-8x within individual city blocks

Levels at ambient sites are most representative of concentrations on lower-traffic streets



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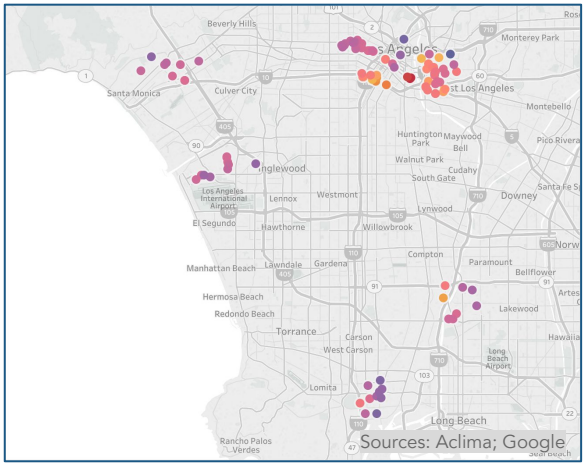
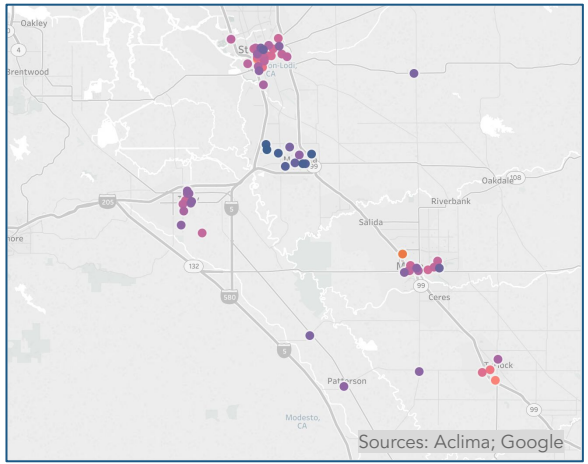
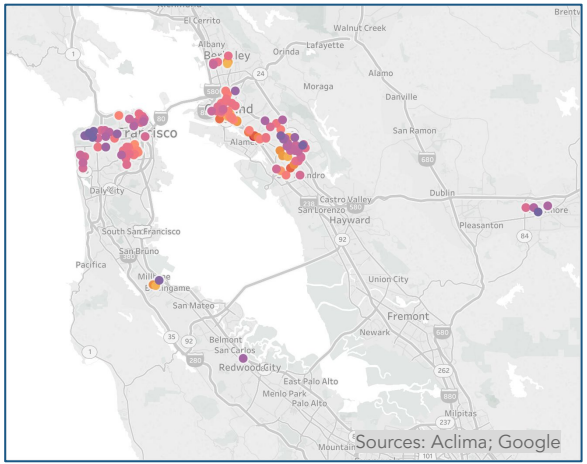
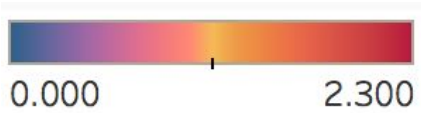
Mapping insights: BC variability around schools





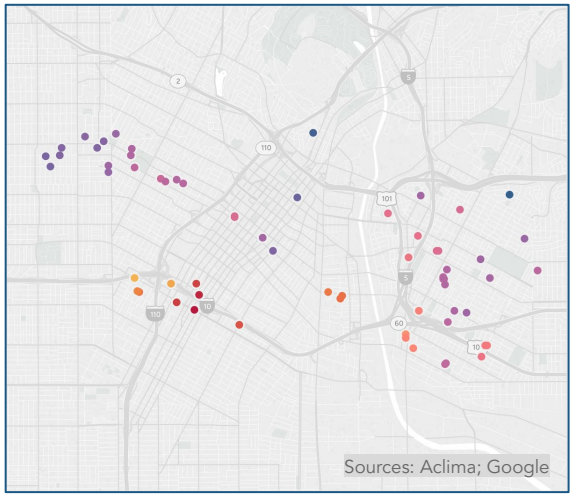


Median BC ($\mu g/m^3$)



Mapping insights: Variation as a function of pollutant

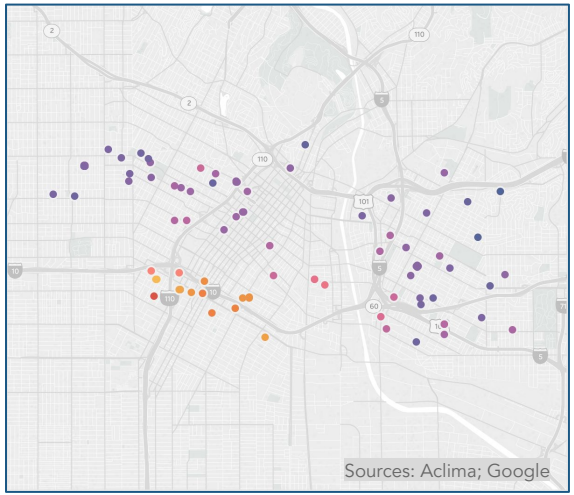
Black Carbon



Mean BC, µg/m^3

0.266 3.318

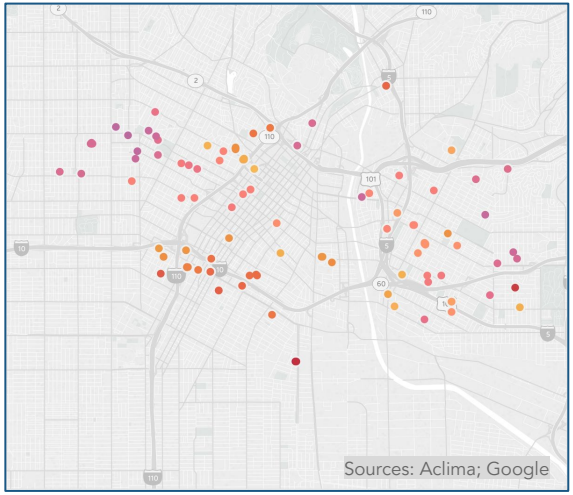
NO



Mean NO (ppb)

4.14 48.23

NO_2



Mean NO2 (ppb)

2.8 111.8

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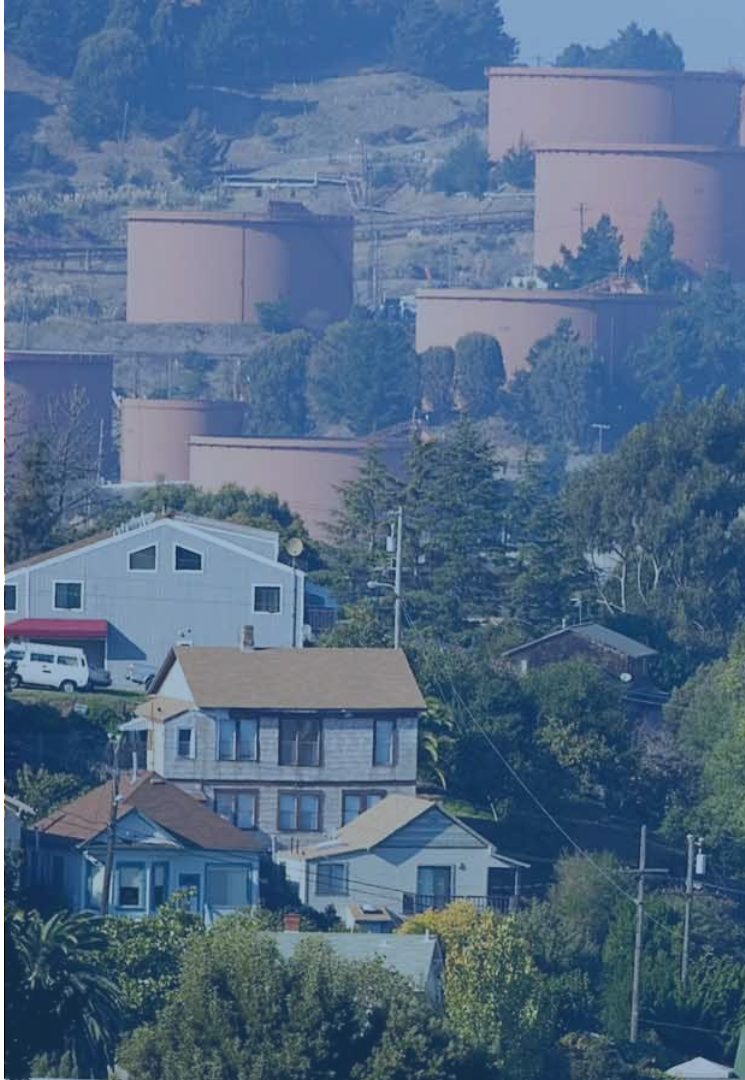
Moving forward

Success!

- Results verify thesis that pollution is highly variable in space and time
- Robust operation of indoor and mobile measurement platforms

What next?

- Sensor validation of mobile platform nearing completion
- Moving to outdoor stationary platform sensor validation and third party validation



Thank You