# Update on Next Generation Air Monitoring Research at EPA

NACAA Joint Permitting and Enforcement Workshop

Chicago, IL

December 10, 2014

# The Changing Paradigm of Air Monitoring


Snyder et al (Oct 2013)
Environmental Science & Technology
2013 47 (20), 11369-11377
DOI: 10.1021/es4022602

# The Role of Sensor Technology in the Changing Paradigm

**How data is collected?**

Limited Mostly to Governments, Industry, and Researchers

**Who Collects the data?**

Compliance Monitoring, Enforcement, Trends, Research

**Why data is collected?**

Government Websites, Permit Records, Research Databases

**How data is accessed?**

Sensor Technology

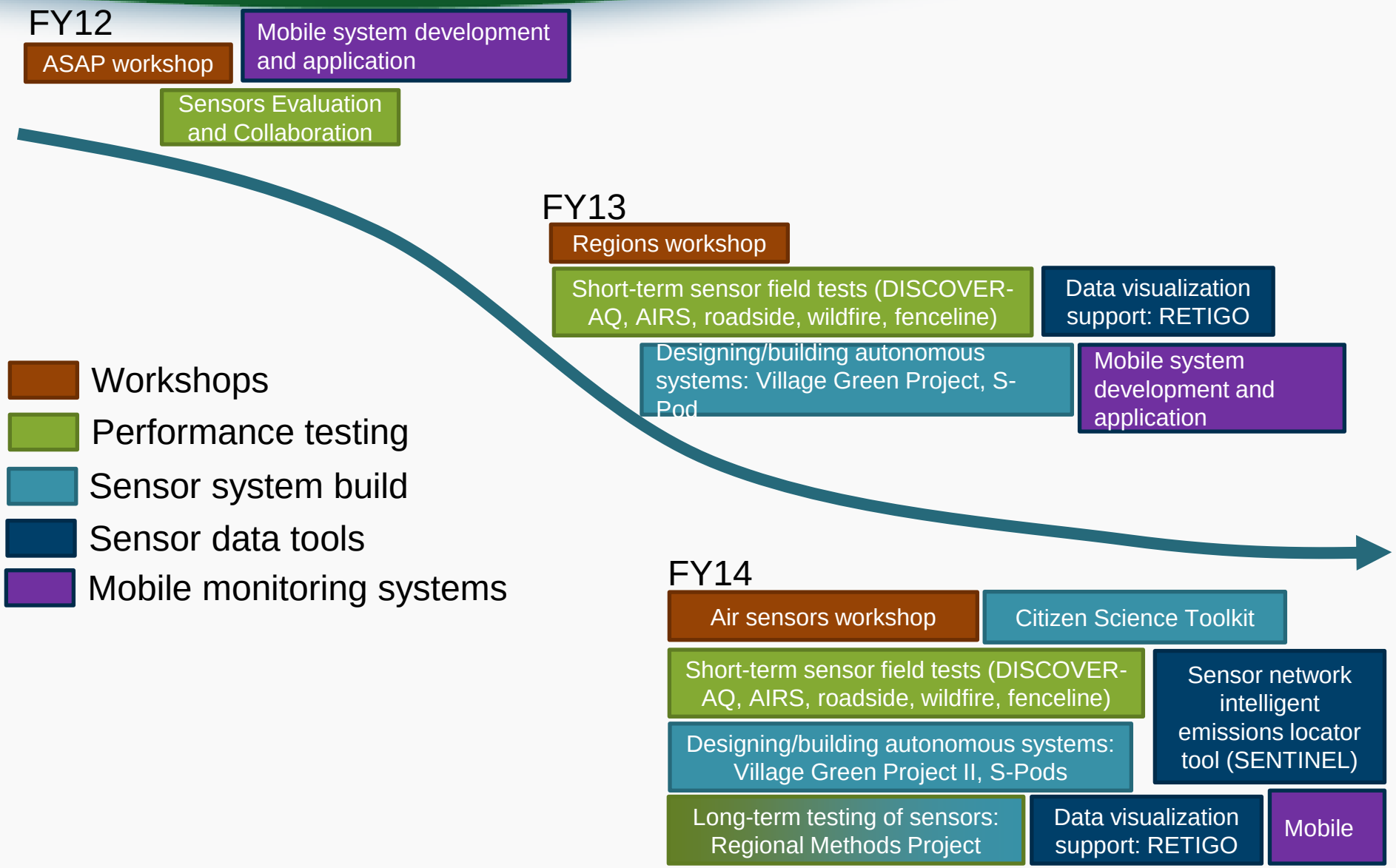
Expanded Use by Communities and Individuals

New Applications and Enhancement of Existing Applications

Increased Data Availability and Access

Snyder et al., 2013

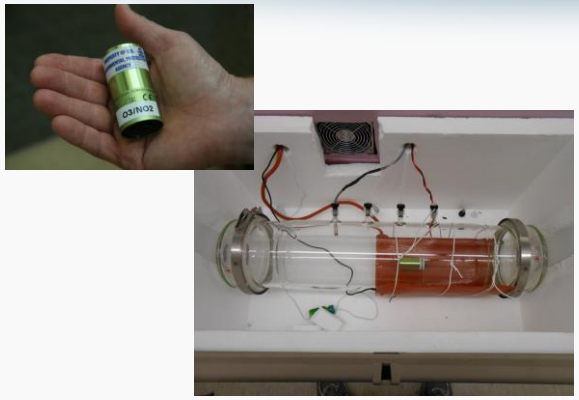
# ORD NGAM R&D has been a rapidly moving area



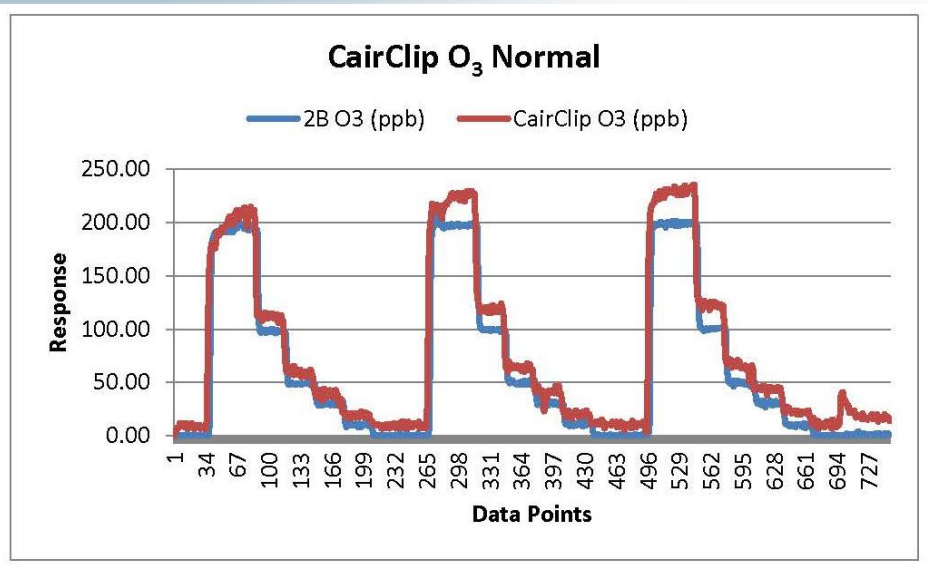
# Sensor Performance Evaluation

| Pollutant | Laboratory controlled test | Short-term field test | Long-term field test |
|---|---|---|---|
| PM | n/a | Near-road, ambient (2013-2014) | Regional methods (2014-2016) |
| Ozone | Completed (2013) | DISCOVER-AQ (2013-2014) | Regional methods (2014-2015) |
| Nitrogen dioxide | Completed (2013) | DISCOVER-AQ (2013-2014) | Regional methods (2014-2015) |
| VOCs | Ongoing | Near-road, ambient (2013-2014) | Regional methods (2014-2015) |
| Carbon monoxide | Ongoing | DISCOVER-AQ (2014) Forest fire study (2014) | Regional methods (2014-2015) |
| Sulfur dioxide | | DISCOVER-AQ (2014) | |

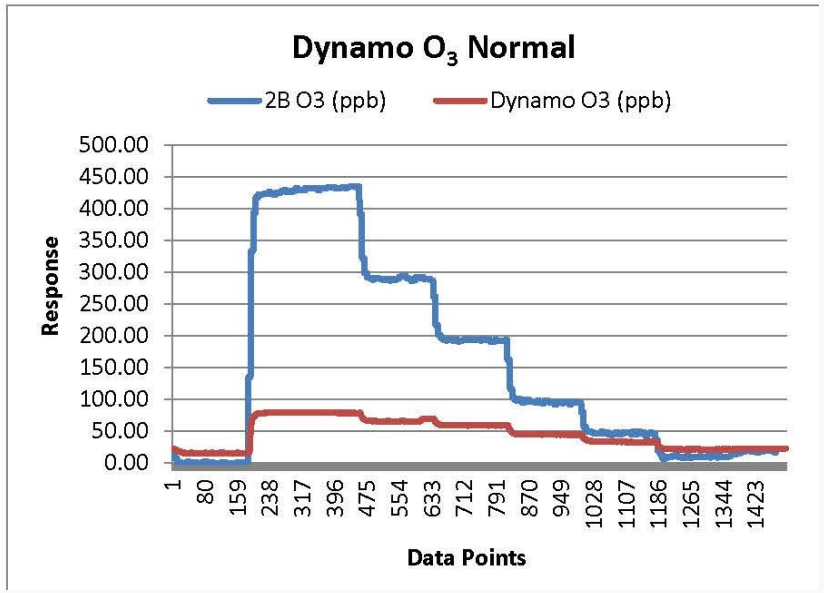
# Example Results from Laboratory Evaluation: Ozone

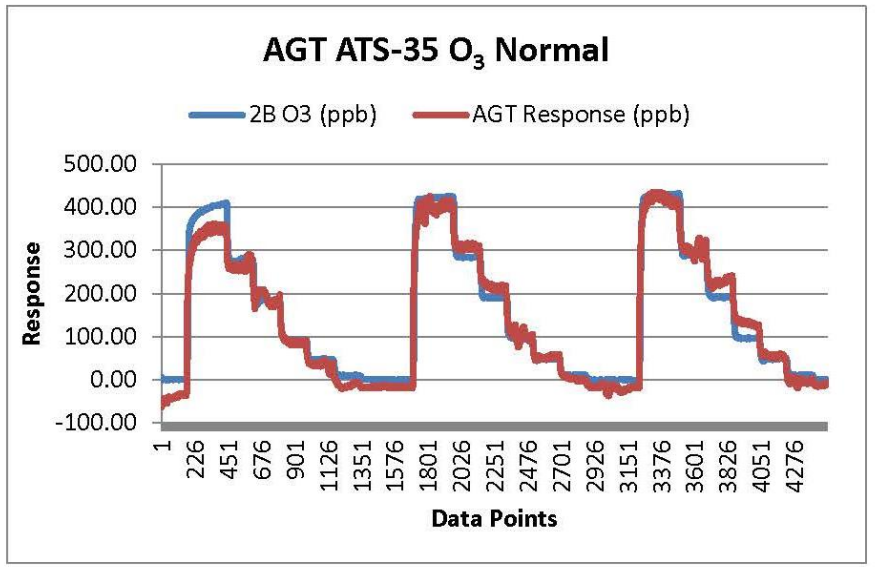


Example: Cairpol CairClip sensor




Source: EPA Sensor Evaluation Report
EPA 600/R-14/143 | May 2014



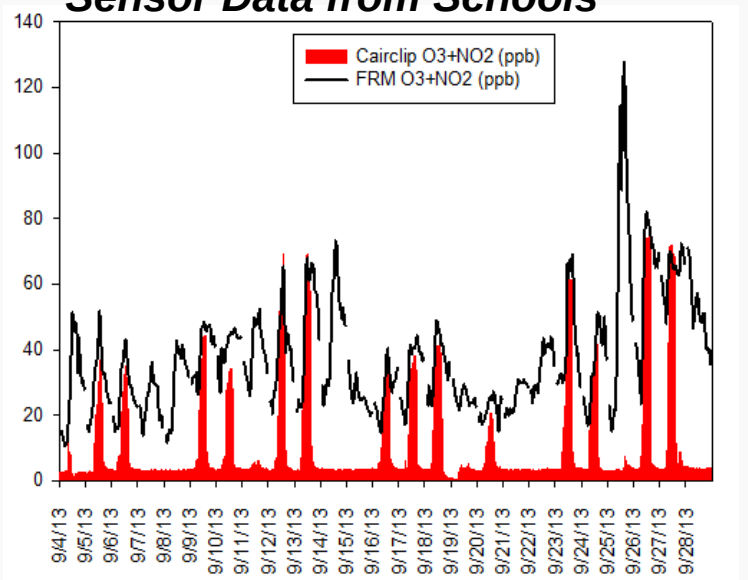
# Example Field Test Results

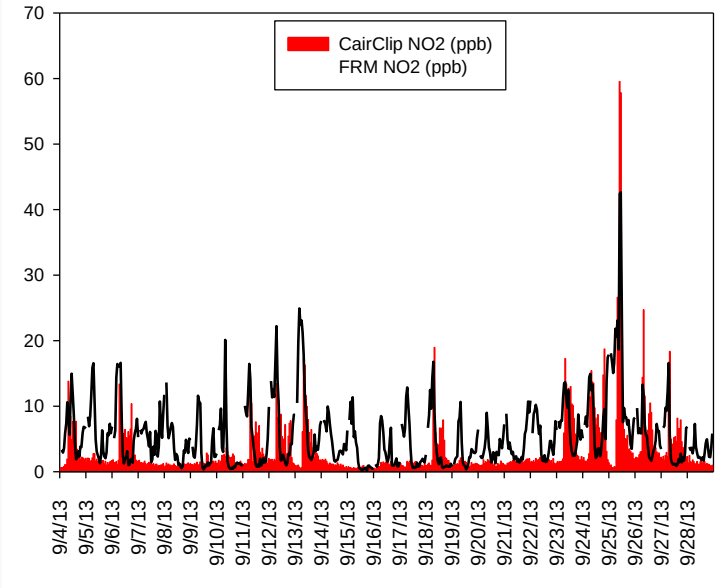
DISCOVER-AQ Study Houston, TX (Sept. 2013)

- Citizen science: small $NO_2/O_3$ and $NO_2$ sensors deployed at 7 schools
- Sensor data compared to reference analyzer data
- Low-cost sensors performed well

**CairClip Sensor**

***Sensor Data from Schools***



# EPA Regional Methods Projects

- Collaborative evaluation/validation of low-cost volatile organic compound passive sampling methods (FY13 Project)
  - Multi-Region Project (R8 lead, R3, R5, and R6)

- Field evaluation of lower cost, continuous measurement of air pollutants (FY 14 Project)
  - Multi-Region Project (R4 lead, R1, R5, and R8)
  - Community Air Sensor Network (CAIRSENSE) Project

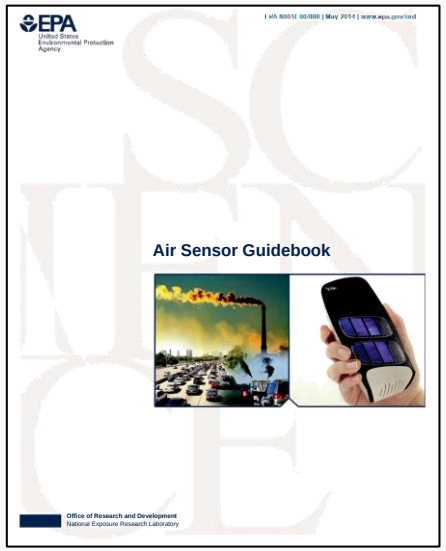
# Air Sensor Citizen Science Toolbox

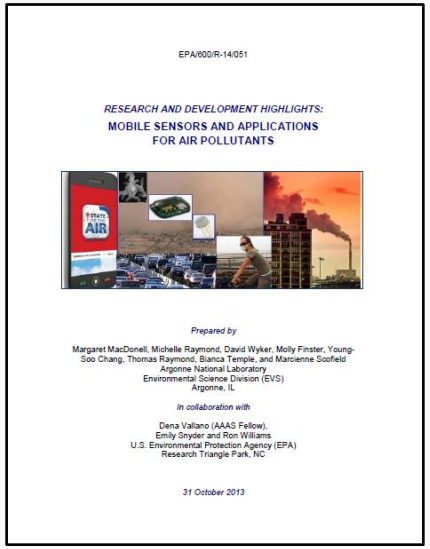
- The Toolbox provides information to help citizens more effectively and accurately collect air quality data in their community, including information on;
  - Sampling methodologies
  - Generalized calibration/validation approaches
  - Measurement methods options
  - Data interpretation guidelines
  - Education and outreach
  - Low cost sensor performance information

- Available Resources include
  - Air Sensor Guidebook
  - Sensor Evaluation Reports
  - EPA Presentation: Sensor Technology
  - Citizen Science Funding Resource Guide

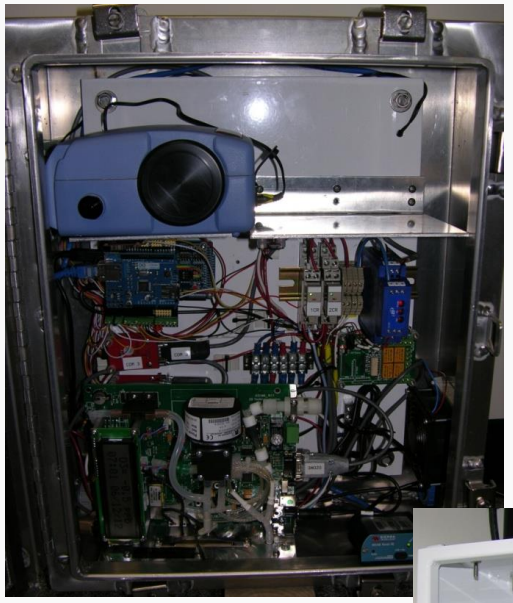
Air Sensor Citizen Science Toolbox
EPA
Measure • Learn • Share

http://www.epa.gov/heasd/airsensortoolbox/

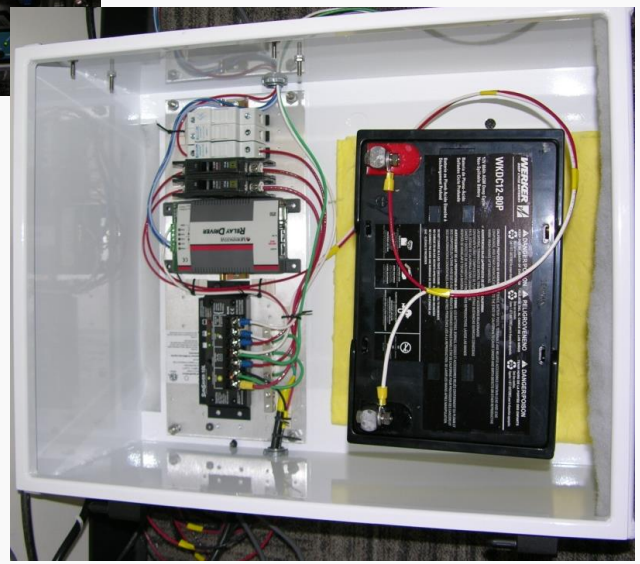


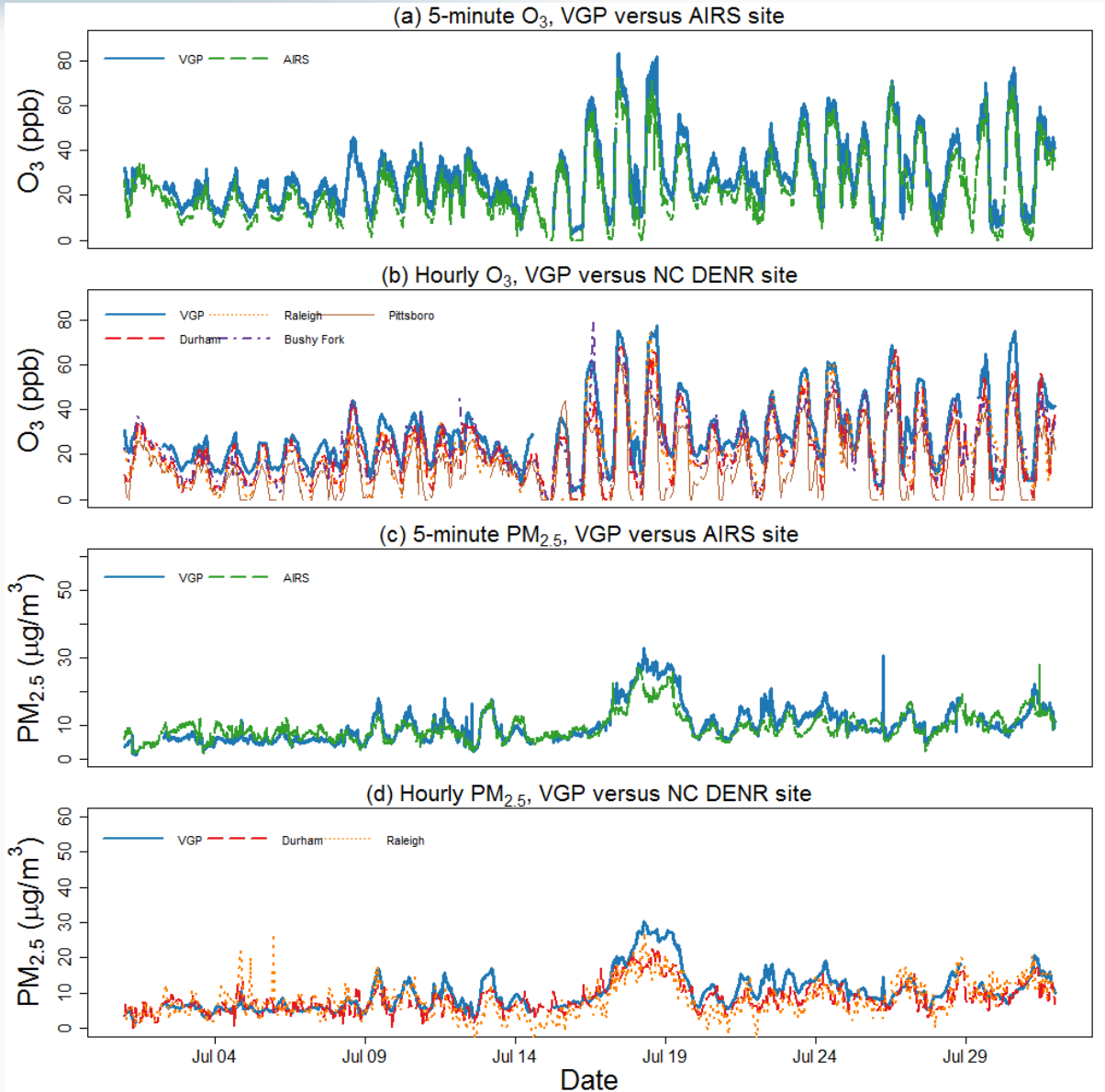
# Village Green Project



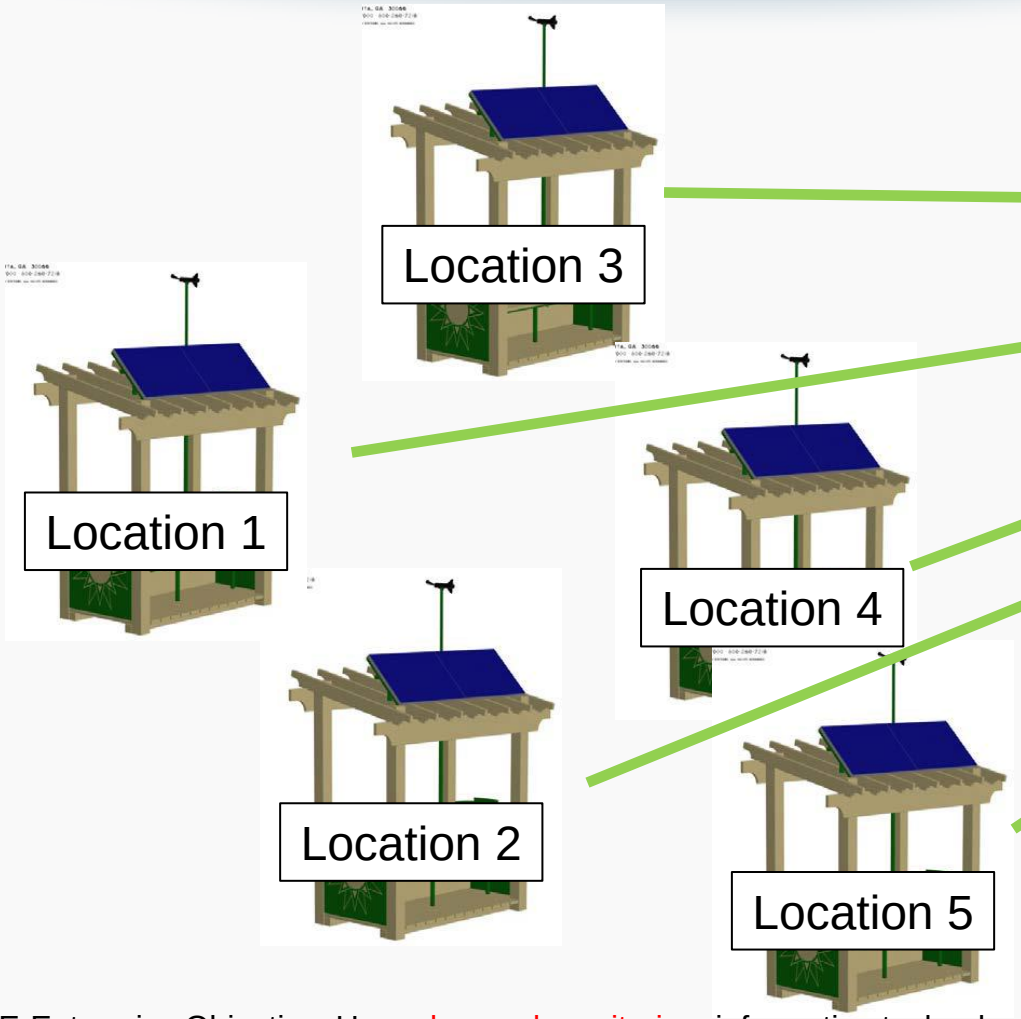
Air instruments (PM, ozone), power system and communications components stored securely behind bench.



# Village Green Evaluation



# Village Green Expansion through the EPA E-Enterprise Program

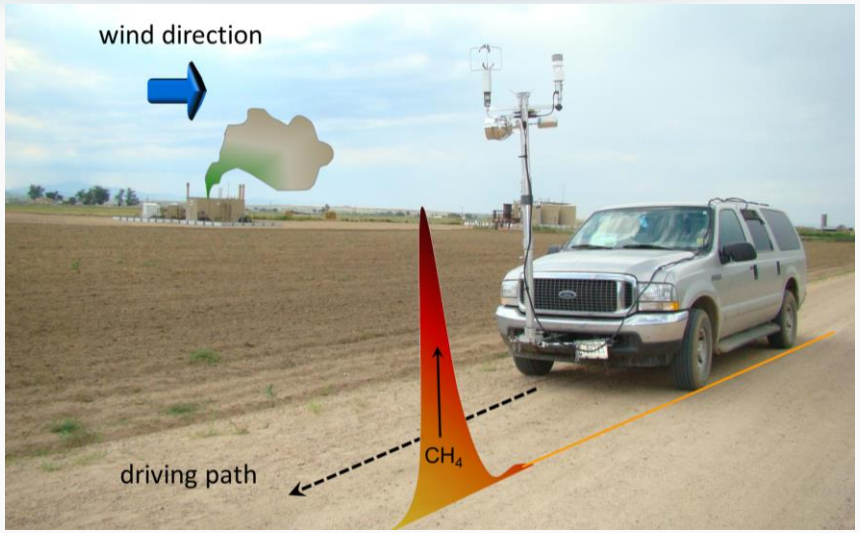


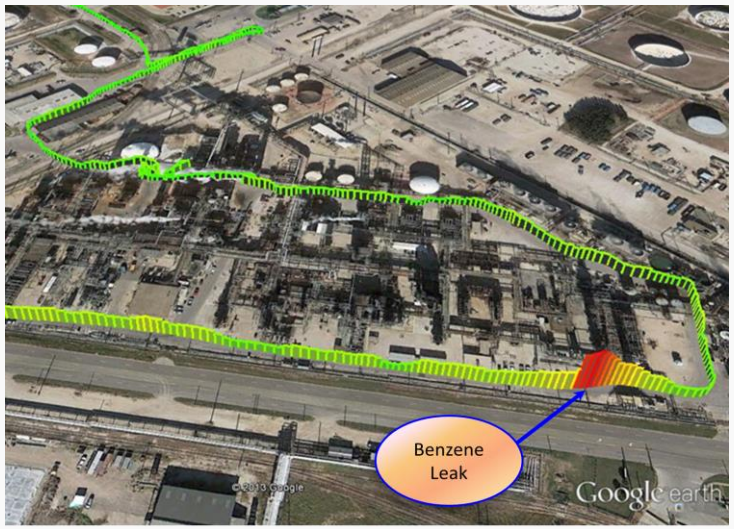

New back-end support by AirNow, with development underway to support high time-resolution data.

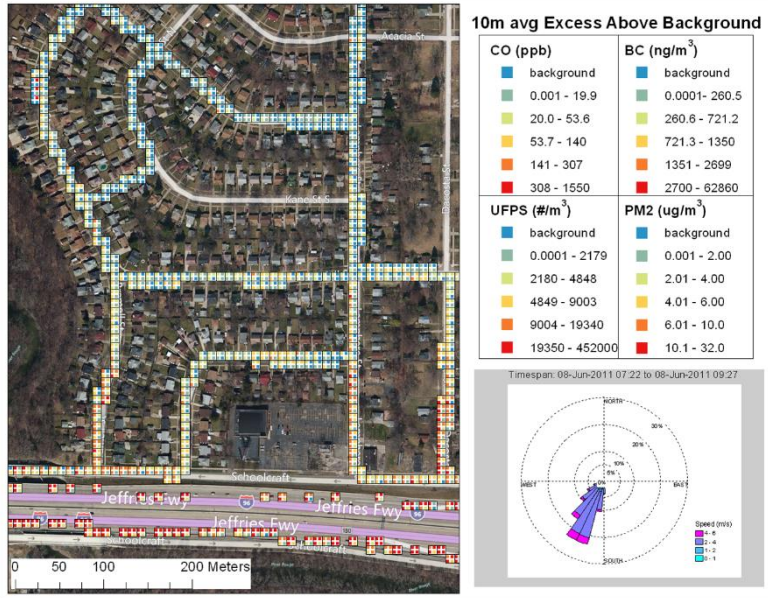

Website re-design to support real-time data viewing for multiple locations

E-Enterprise Objective: Use advanced monitoring, information technologies, optimized business processes, and increased transparency to improve environmental outcomes and enhance service to the regulated community. By September 30, 2015, provide real-time environmental data to at least two communities.

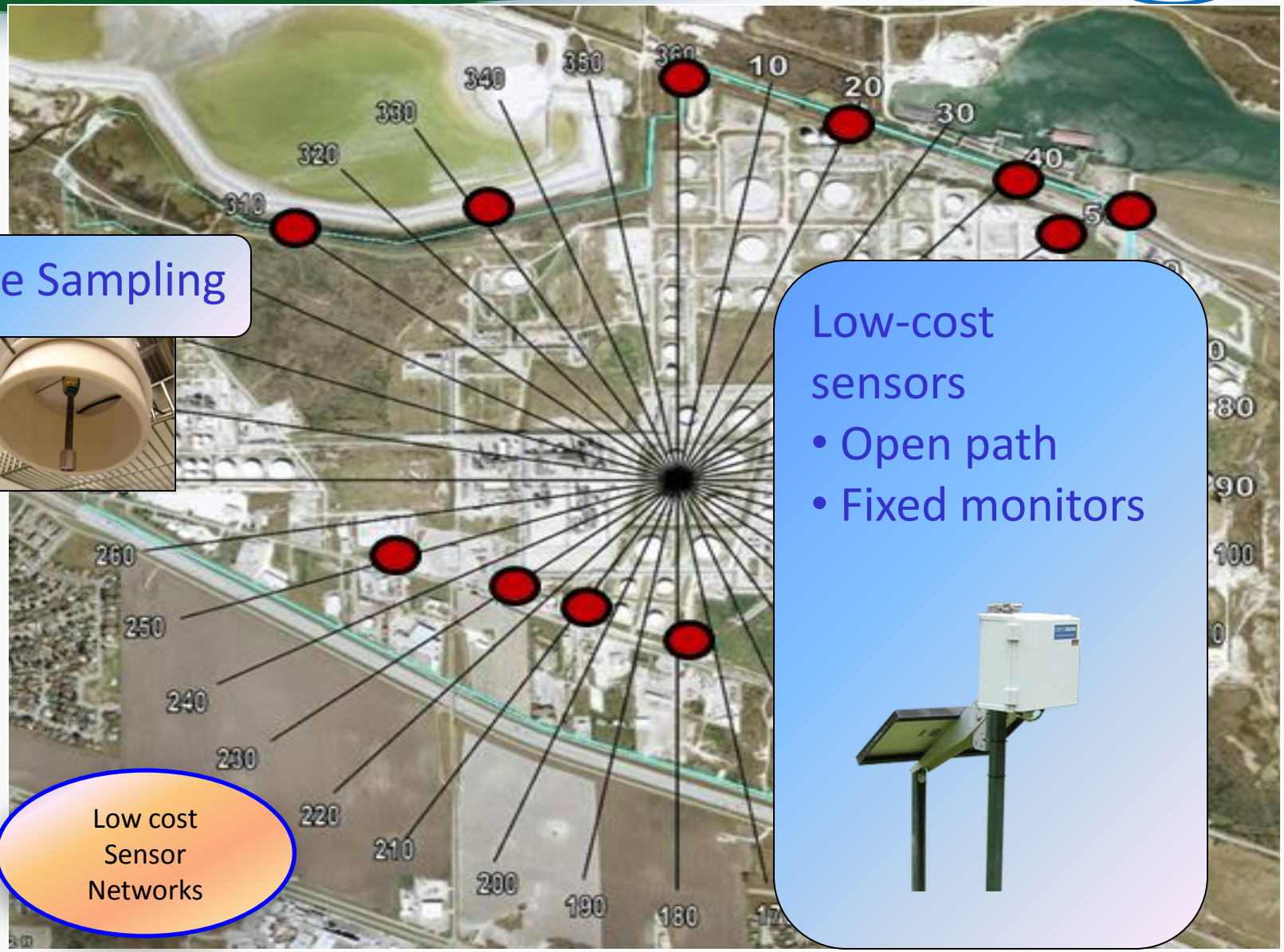
# Mobile System Development and Application



# Sensor Networks In-plant and Along Facility Fence Line




Passive Sampling

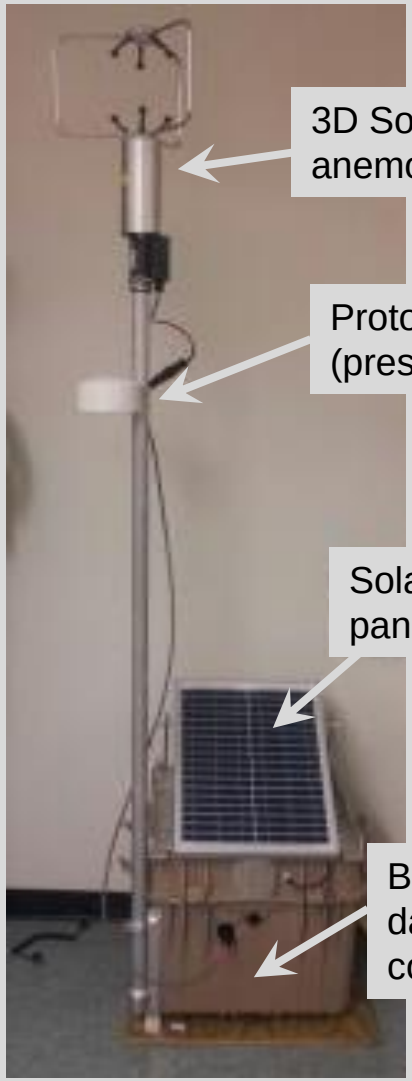


Low-cost sensors
- Open path
- Fixed monitors



Low cost Sensor Networks

# Portable/Solar Powered System




Drop-in-place Sensor Pod (SPod)

Inside of battery box

# DISCOVER-AQ

- How can ambient air quality be reliably informed using non-traditional approaches, such as satellite remote sensing?

- Collaboration with NASA to explore temporal and spatial relationships between column and surface measurements at locations with differing air quality.
  - *Maryland, July 2011*
  - *California, January 2013*
  - *Texas, September 2013*
  - *Colorado,  July 2014*

- Unprecedented 3-dimensional characterization of pollutants and precursors.
  - Result is an expansive database of satellite, aircraft, ground-based measurements for gaseous air pollutants (i.e., $NO_2$, $NO_y$, $O_3$, …) and particulate matter over urban areas with persistent air quality problems – final data in publicly accessible archive within 6 months.

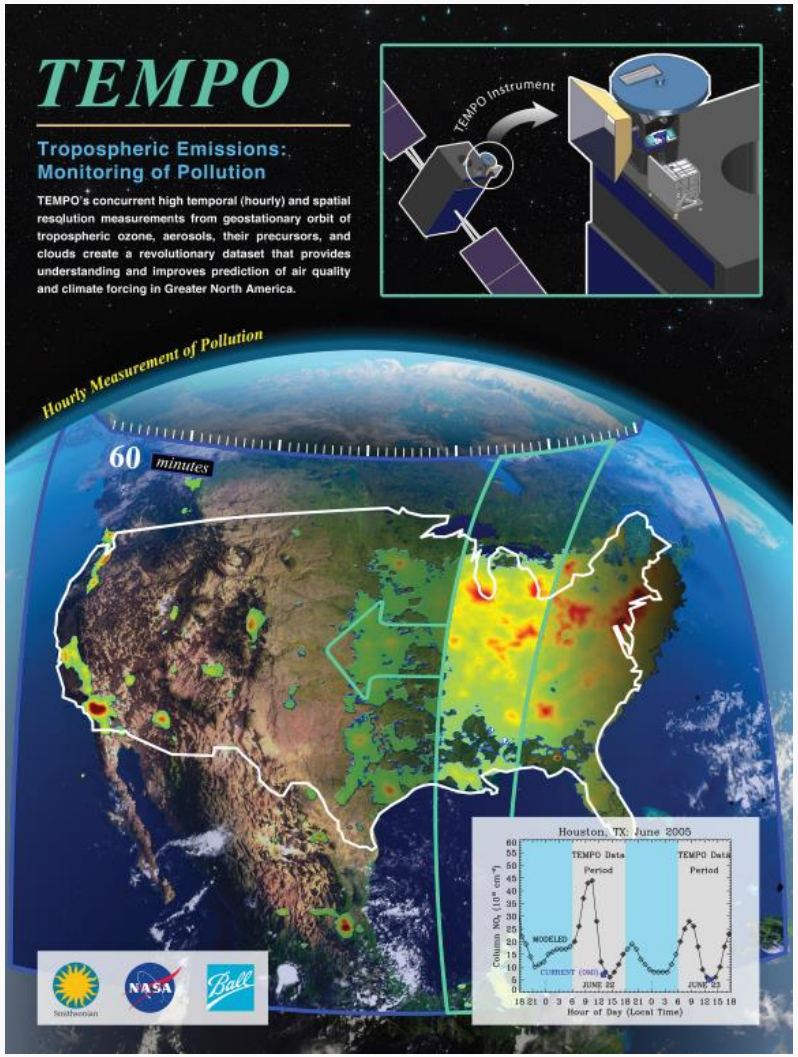
- EPA research is being use to inform:
  - Federal Reference (FRM) and Equivalent (FEM) methods for NAAQS compliance
  - Value of new monitoring approaches (in-situ, small sensors, and remote sensing)
  - Evaluation and improvements for Community Multiscale Air Quality (CMAQ) fine-scale modeling




# ORD's DISCOVER-AQ Field Campaign Objectives

| | DISCOVER-AQ Field Mission Locations and Timeframes | | | |
|---|---|---|---|---|
| | Baltimore, MD July 2011 | San Joaquin Valley, CA Jan-Feb, 2013 | Houston, TX Sep 2013 | Denver, CO Jul-Aug, 2014 |
| **Federal Reference Methods (FRM)/Federal Equivalent Methods (FEM)** | | | | |
| Ozone – ambient evaluation of new FRM for NAAQS | ■ | | ■ | ■ |
| $NO_2$ – ambient evaluation of new direct measurement methods for FEM | ■ | ■ | ■ | ■ |
| $NO_y$ – ambient evaluation of method compared to NOx for $NO_x/SO_x$ secondary standard | ■ | ■ | | ■ |
| **Remote Sensing Methods** | | | | |
| Evaluation of column-to-surface measurements ($NO_2$, AOD/$PM_{2.5}$) | ■ | ■ | ■ | ■ |
| Evaluation of aerosol lidar (ceilometer) for continuous mixing heights in support of PAMS | | | | ■ |
| **Small Sensor Technology** | | | | |
| Evaluation with collocated FRM/FEM measurements | | | ■ | ■ |
| Understand vertical distribution of pollutants | | | | ■ |
| Citizen science and educational outreach activities | | | ■ | ■ |

# From DISCOVER-AQ to TEMPO




- First geostationary satellite dedicated to air quality applications
- Selected in 2012 as NASA's first Earth Venture Instrument with anticipated launch in 2018
- To provide hourly daylight observations to capture rapidly varying emissions & chemistry important for air quality
- Potential air quality applications include:
  - Air quality concentrations
  - Emissions Inventory
  - Air quality model evaluation
  - Global and regional transport
  - Atmospheric processes/chemistry

# Summary

- The emergence of Next Generation Air Monitoring (NGAM) technologies presents new opportunities and challenges
  - Opportunity to enhance exposure assessment to better protect public health
  - Challenge in understanding data quality and interpretation

- The US EPA is working to address challenges to promote the responsible and reliable use of these technologies, while also exploring new applications to support federal, state, local, and community-level air quality management activities, including potential applications for permitting and enforcement.