ORD Ambient Methods Research Update

National Ambient Air Monitoring Conference

Atlanta, GA

August 12, 2014

Tim Watkins

Office of Research and Development

Outline

- Federal Reference Method (FRM)/Federal Equivalent Method (FEM) Development and Evaluation Activities
- Next Generation Air Monitoring (NGAM) Research
- Additional Ambient Methods Research

Federal Reference and Equivalent Methods (FRM/FEM)

Ozone

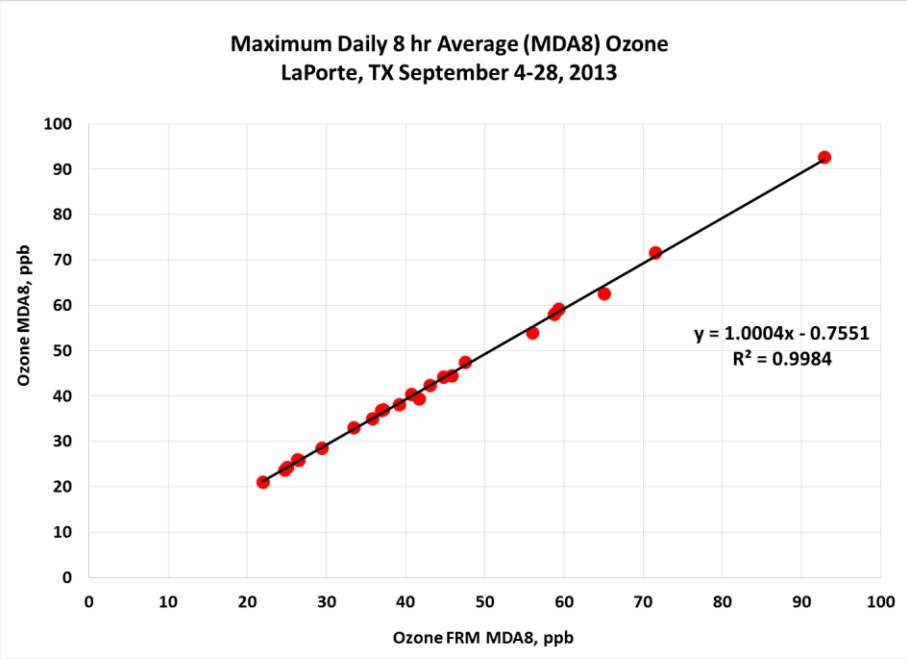
NO_2

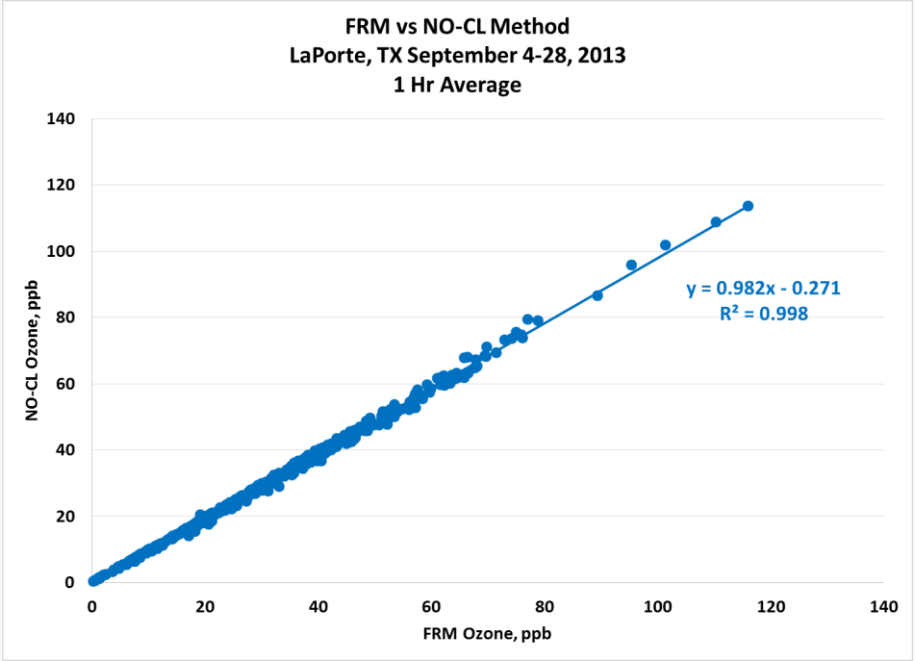
NOy

FRM/FEM Applications Review

FRM/FEM Methods Research: O3

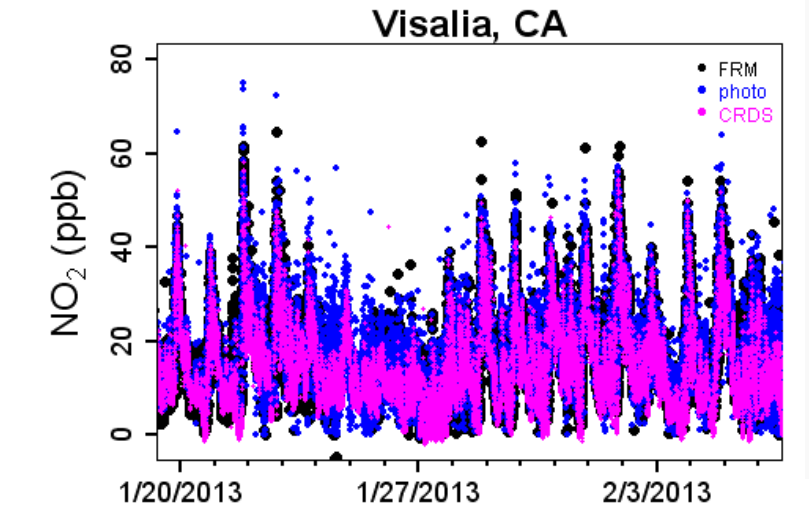
- **ORD has performed detailed laboratory and ambient evaluations of potential new FRMs/FEMs**
- **This methods research provides valuable state-of-the-science tools to help EPA and partners for use in NAAQS attainment monitoring**
- **ORD is currently evaluating a new O_3 FRM based upon NO-chemiluminescence (NO-CL)**





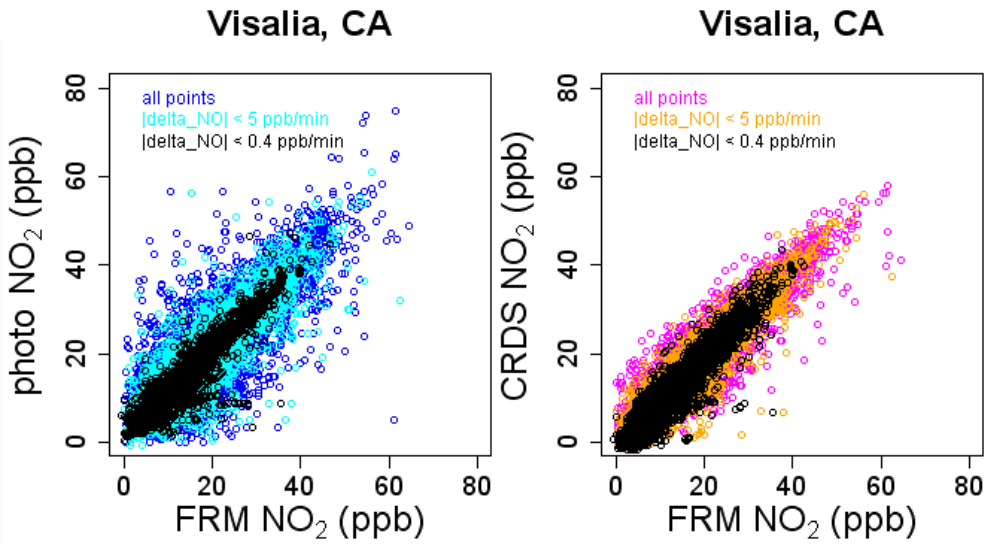
- **The proposed new FRM will mitigate many of the measurement issues associated with current methods (including measurement interferences by VOCs during wintertime ozone exceedance events in western states)**
- **ORD's plan for new Ozone FRM was presented to and endorsed by CASAC AMMS.**
- **The new O_3 FRM will be submitted as part of the proposed O_3 NAAQS rulemaking package on December 1, 2014**

FRM/FEM Methods Research: NO_2



- **ORD is currently evaluating the current NO_2 FRM against more selective NO_2 methods**
- **ORD collected ~4 weeks of ambient data in a near roadway setting during the CA DISCOVER-AQ study**
- **There is a near roadway (I-25) component to the Denver DISCOVER-AQ study**

- **Rapid changes in NO concentration which occur in near roadway environments challenge the indirect (difference) methods such as the FRM**
- **Direct optical (spectroscopic) NO_2 methods are better suited for near roadway NO_2 monitoring**
- **NO_2 direct optical and photolytic methods may be preferable due to their lack of interference from higher oxides of nitrogen (NO_z)**



FRM/FEM Methods Research: NOy

- ORD drafted an NOy FRM in 2011 to support the NOx/SOx secondary NAAQS proposal.
- ORD is conducting research needed in order to finalize the NOy FRM.
- Evaluating commercial NOy analyzers in laboratory and ambient settings to determine:
  - Accuracy and precision
  - Reliability and stability
  - Calibration procedures
  - Potential differences amongst convertors
  - Convertor efficiency checks (iPN and nPN vs NO2)
- Working with OAQPS, Regions, and State and local agencies to ensure applicability of work.
- Result will be a technical summary of the data and operational recommendations.

FRM/FEM Application Review

- Review Response Time
  - New applications: 120 days
  - Modifications to existing designations: 30 days
- The AMTIC list was recently updated (6/18/2014) to announce new designations and approved modification requests
- 11 application reviews are currently in progress
- At least 15 new applications are expected within the next 12 months

Program Activity (last 12 months)

	O_3	SO_2	NO_2	CO	Pb	PM
New Designations	**2**		**1**		**1**	**1**
Modifications to Existing Designations	**4**	**2**	**8**	**2**	**4**	**9**

Next Generation Air Monitoring Research

Remote Sensing (Satellite) Measurements

Sensor Evaluations and Guidance

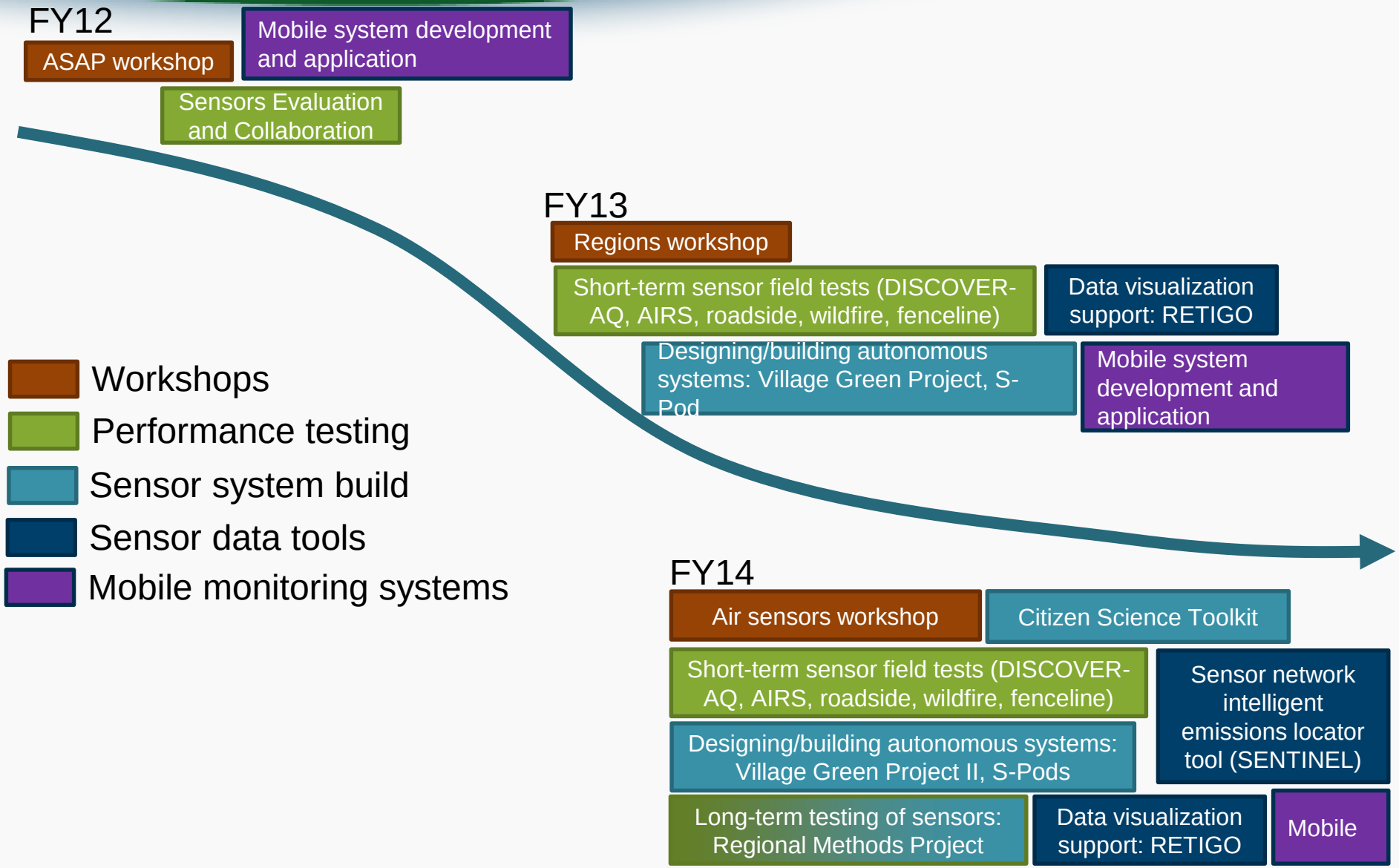
Mobile Monitoring Systems

Village Green Monitoring Stations

The Changing Paradigm of Air Monitoring

Snyder et al., ES&T, August 2013
http://pubs.acs.org/doi/abs/10.1021/es4022602

ORD NGAM R&D has been a rapidly moving area



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:
  - NAAQS compliance monitoring methods
    - Federal Reference (FRM) and Equivalent (FEM) methods
  - 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

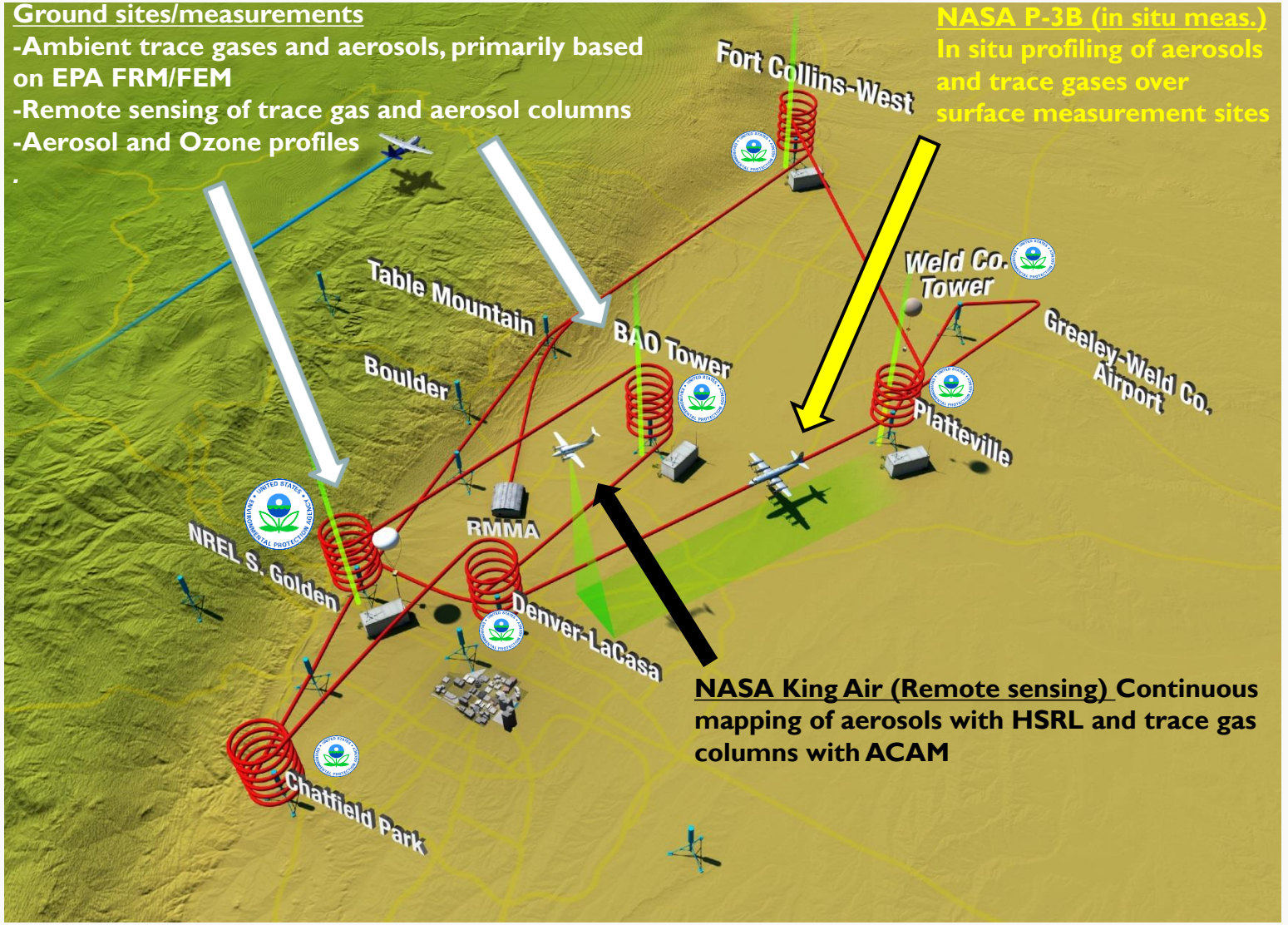
	DISCOVER-AQ Field Mission Locations and Timeframes			
	Baltimore, MD July 2011	San Joaquin Valley, CA Jan-Feb, 2013	Houston, TX Sep 2013	Denver, CO Jul-Aug, 2014
Federal Reference Methods (FRM)/Federal Equivalent Methods (FEM)				
Ozone – ambient evaluation of new FRM for NAAQS	■		■	■
NO_2 – ambient 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			■	■

“Other Duties as Assigned”

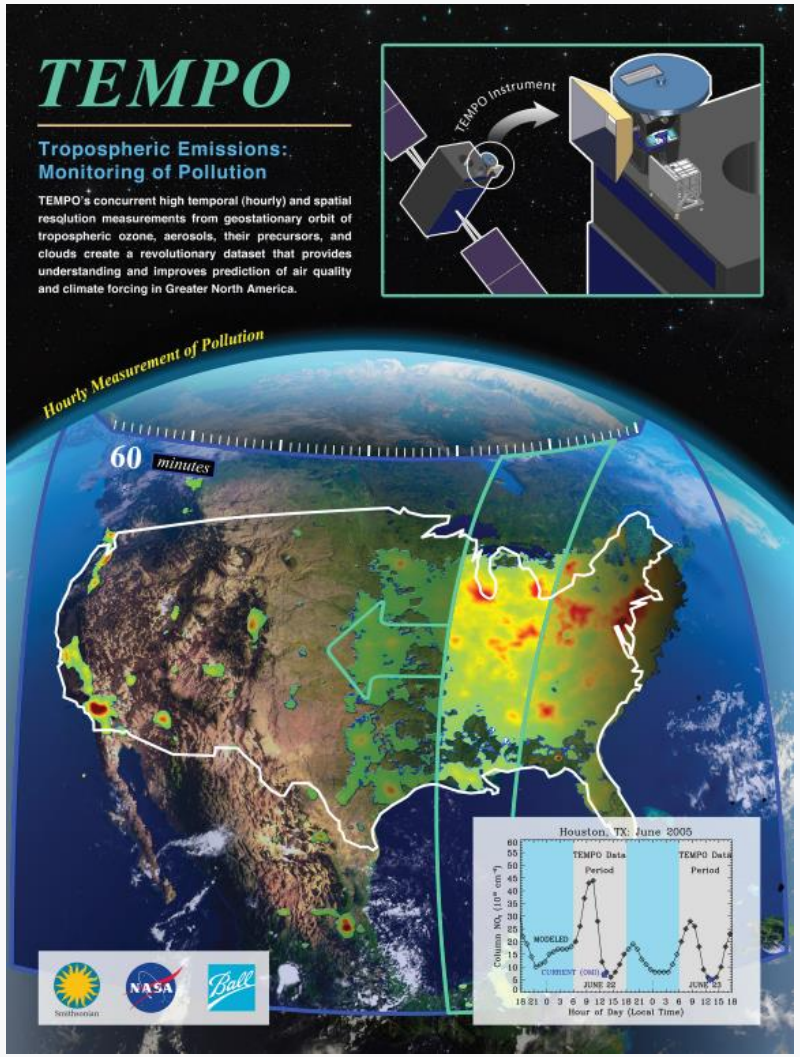
Denver, CO Observation Strategy (July-August 2014)

Systematic and concurrent observation of column-integrated, surface, and vertically-resolved distributions of aerosols and trace gases relevant to air quality as they evolve throughout the day.

Three major observational components:



From DISCOVER-AQ to TEMPO



Selected Nov. 2012 as NASA's first Earth Venture Instrument

- Instrument delivery September 2017, with expected ~2018 launch

Provides hourly daylight observations to capture rapidly varying emissions & chemistry important for air quality

- UV/visible grating spectrometer to measure key elements in tropospheric ozone and aerosol pollution
- North American component of a constellation for air quality observations

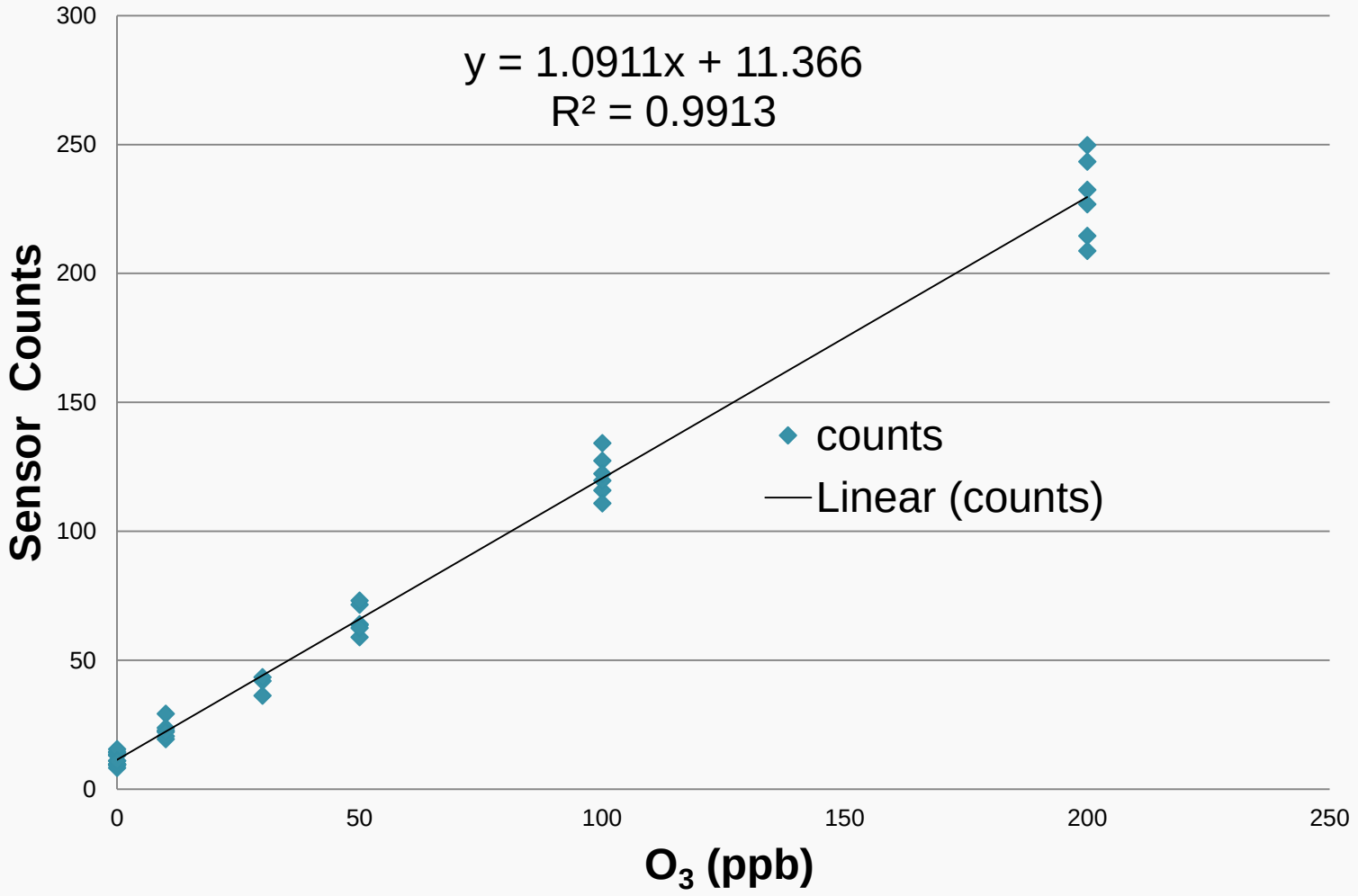
TEMPO data and potential application areas within EPA and the Air Quality Management Community

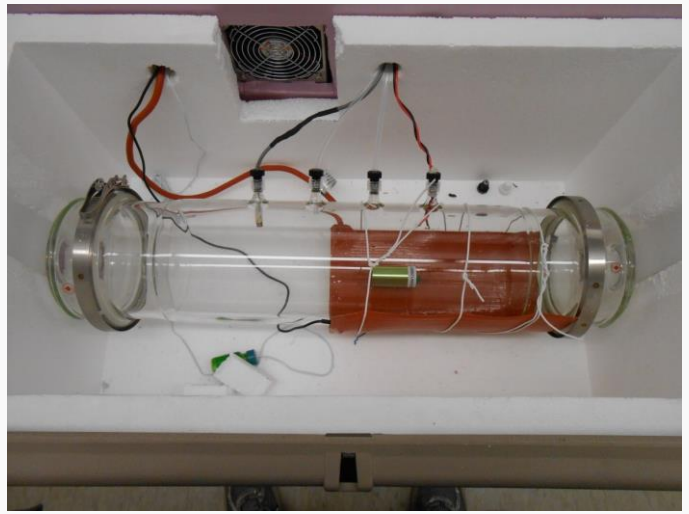
- Emissions Inventories (improve or develop new methods, including mobile sources and area sources such as soil NOx)
- Inform air quality model development and evaluation
- Evaluation of impact of short term climate forcers (ozone, chemically produced aerosols) and climate-chemistry connections
- Data on smaller spatial scales better supports AQ assessment and planning activities: Source attribution, Exceptional Event Evaluations (Wildfires and Strat. Intrusions) and Trends
- Intercontinental transport of air pollution (HTAP and other activities

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)	

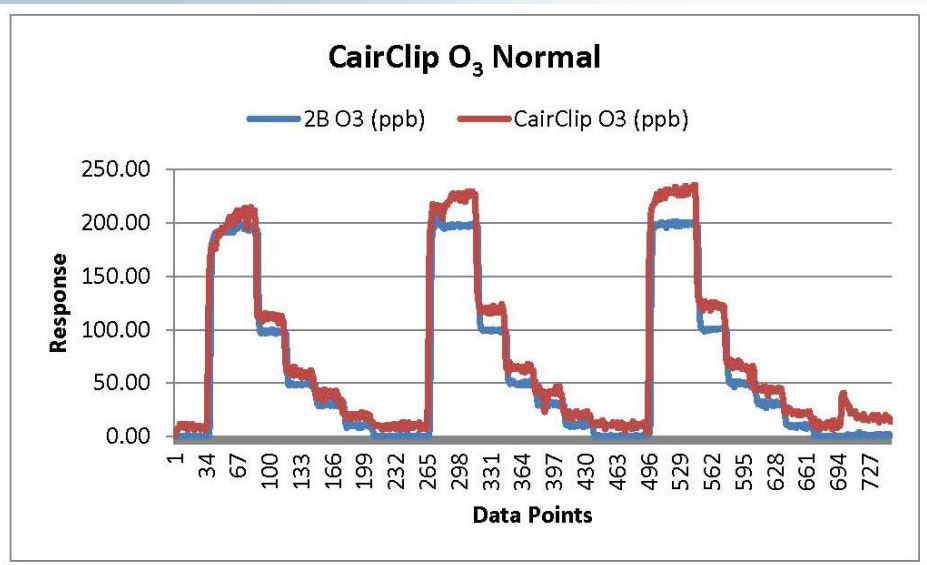
Example Results from Laboratory Evaluation



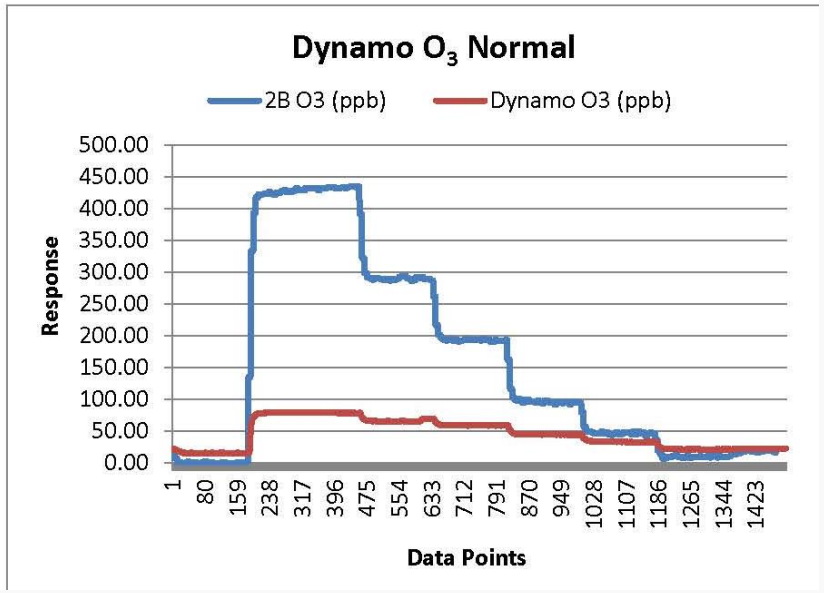


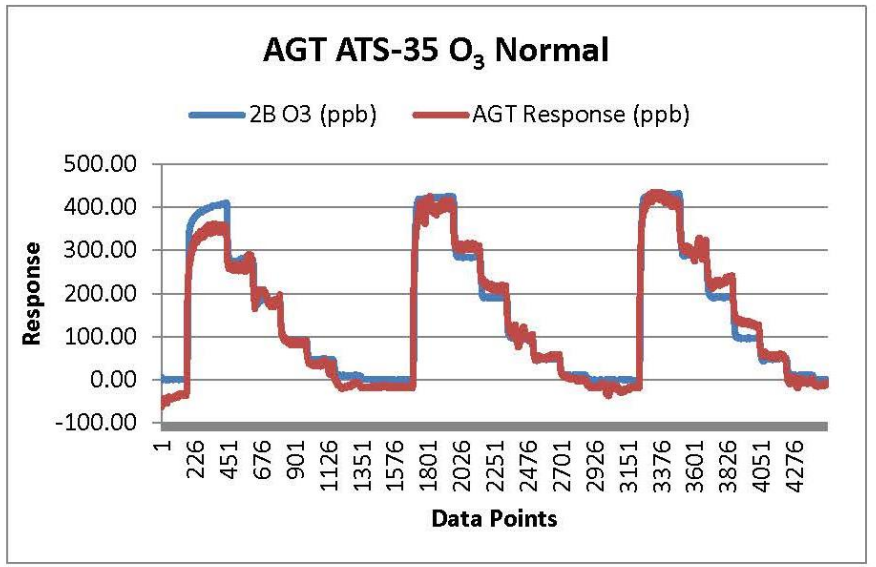
Example: Cairpol CairClip sensor

Example Results from Laboratory Evaluation: Ozone



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





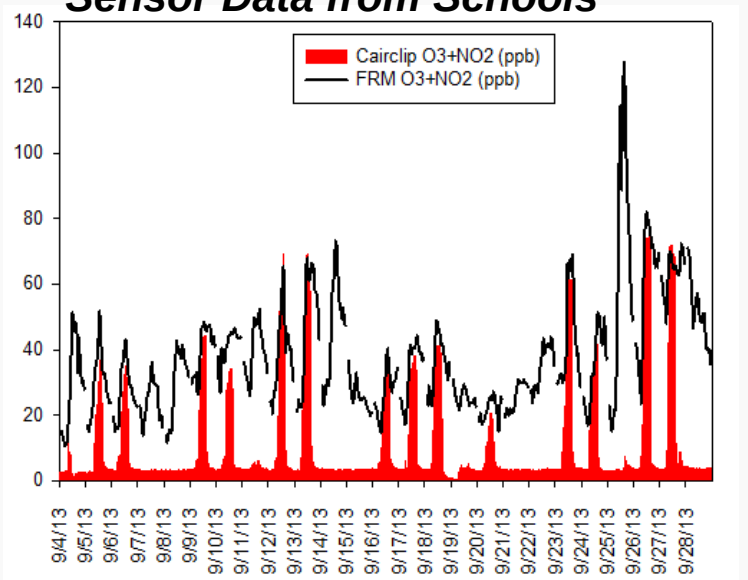
Example Field Test Results

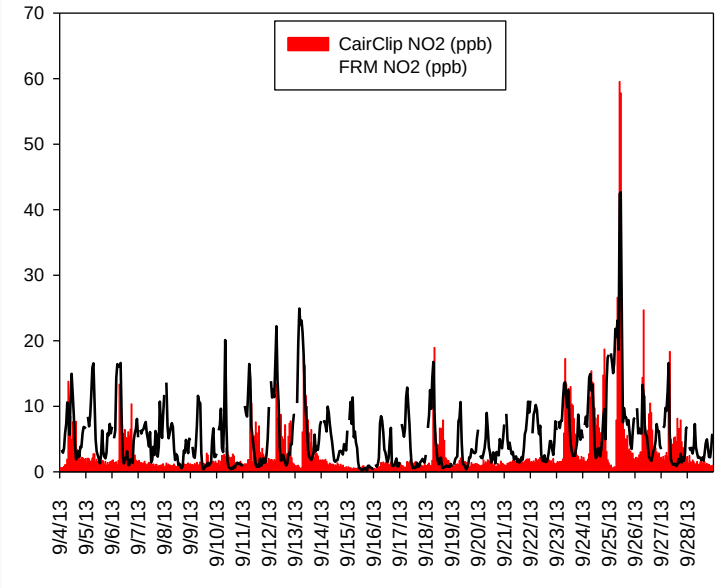
DISCOVER-AQ Study Houston, TX (Sept. 2013)

- 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





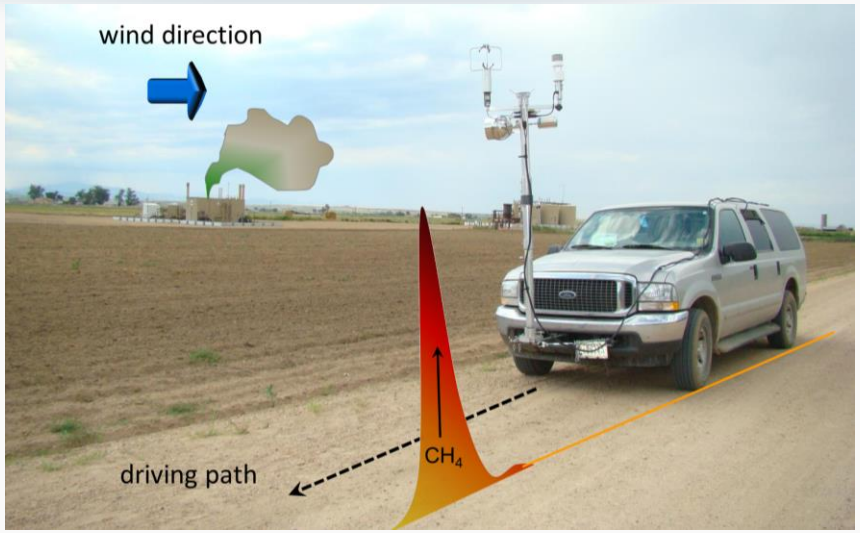
Air Sensor Citizen Science Toolbox

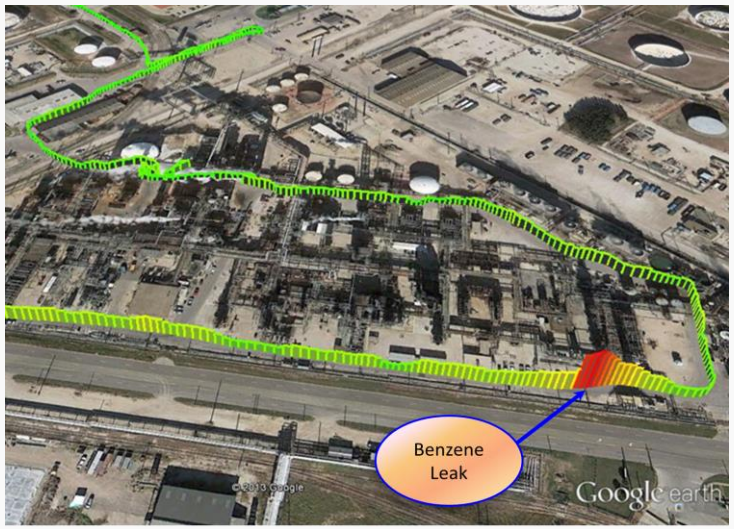
- The Toolbox provides information to help citizens more effectively and accurately collect air quality data in their community, including information on;
  - Sampling methodologies
  - Generalized calibration/validation approaches
  - Measurement methods options
  - Data interpretation guidelines
 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

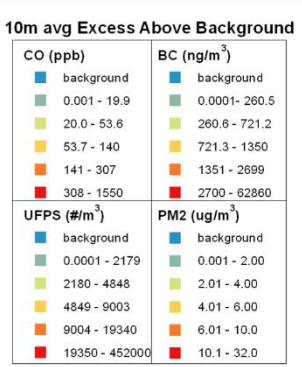
- Available Resources include
  - Air Sensor Guidebook
  - Sensor Evaluation Reports
  - EPA Presentation: Sensor Technology
  - Citizen Science Funding Resource Guide

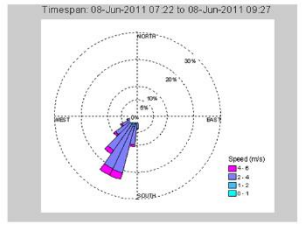
http://www.epa.gov/heasd/airsensortoolbox/index.html

Mobile System Development and Application

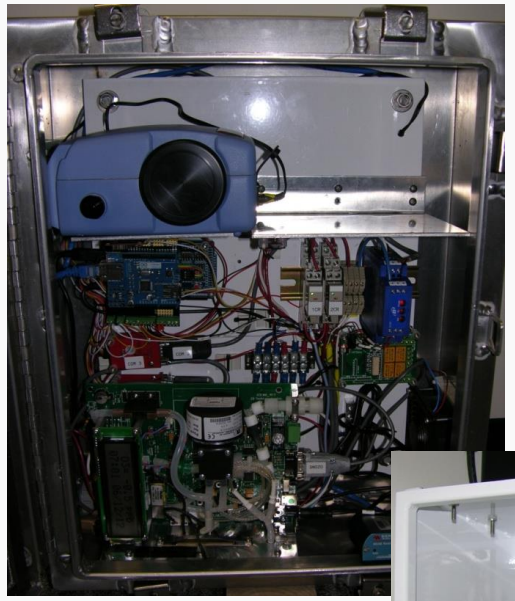


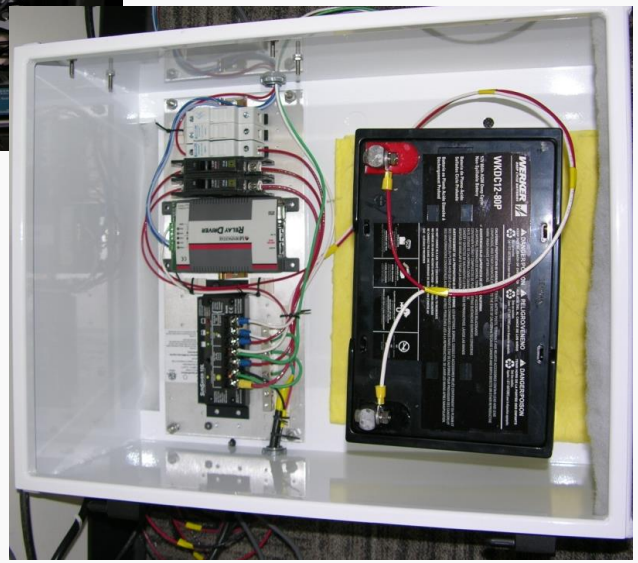






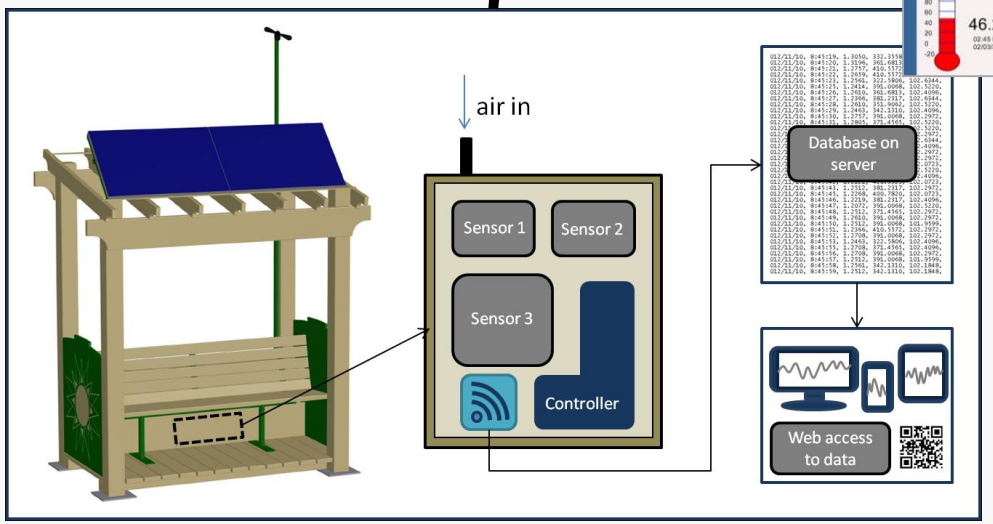
Village Green Project



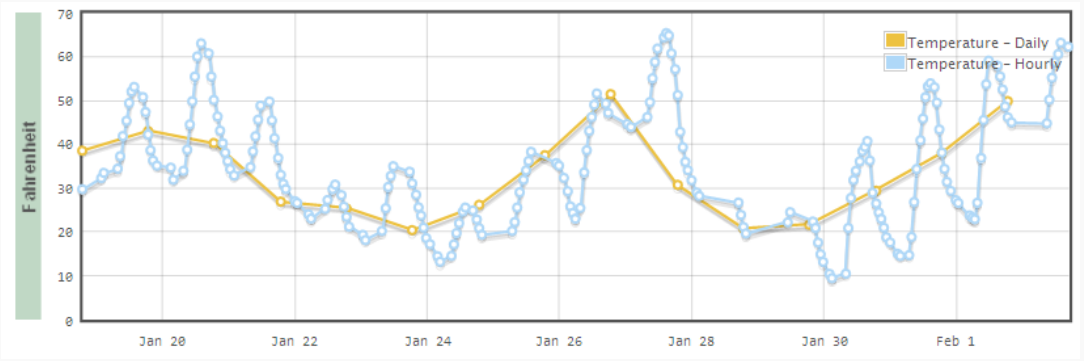


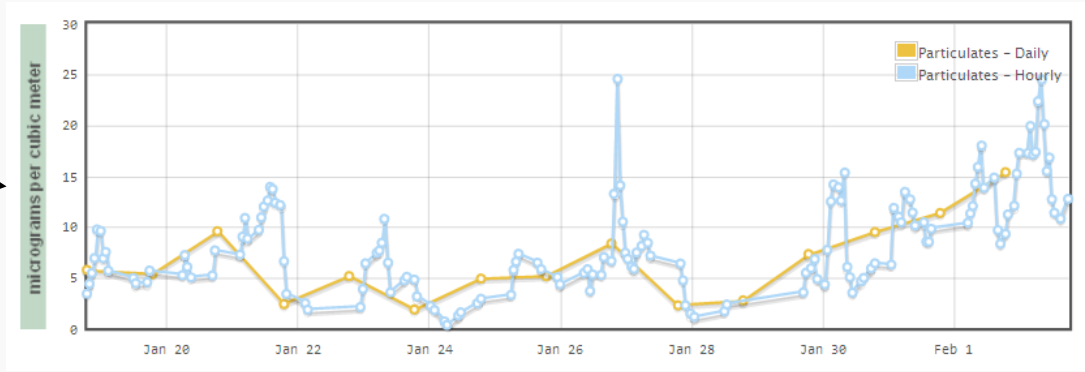
Air instruments (PM, ozone), power system and communications components stored securely behind bench

Village Green Communications/Website



Public website updated minute-by-minute

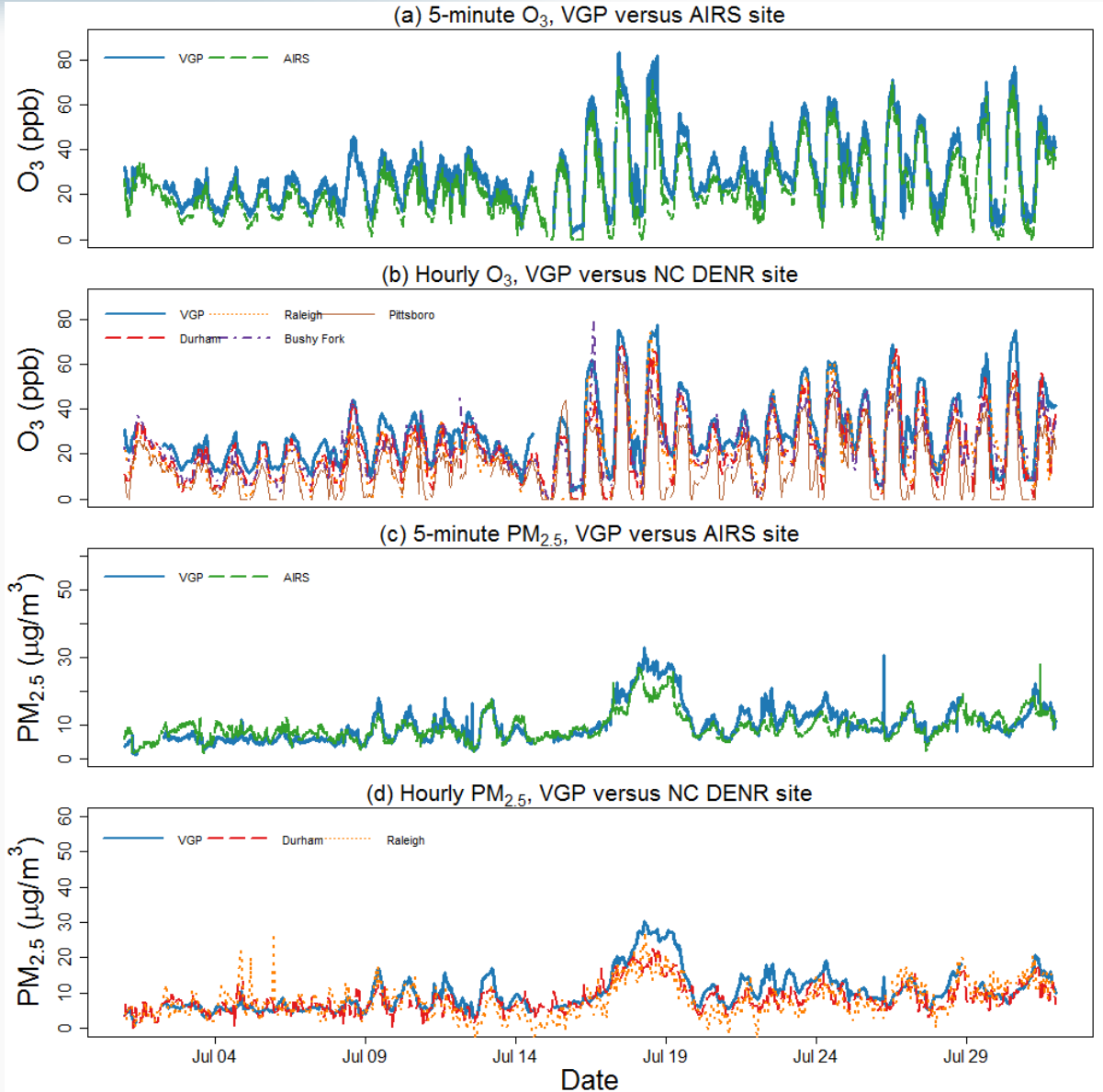




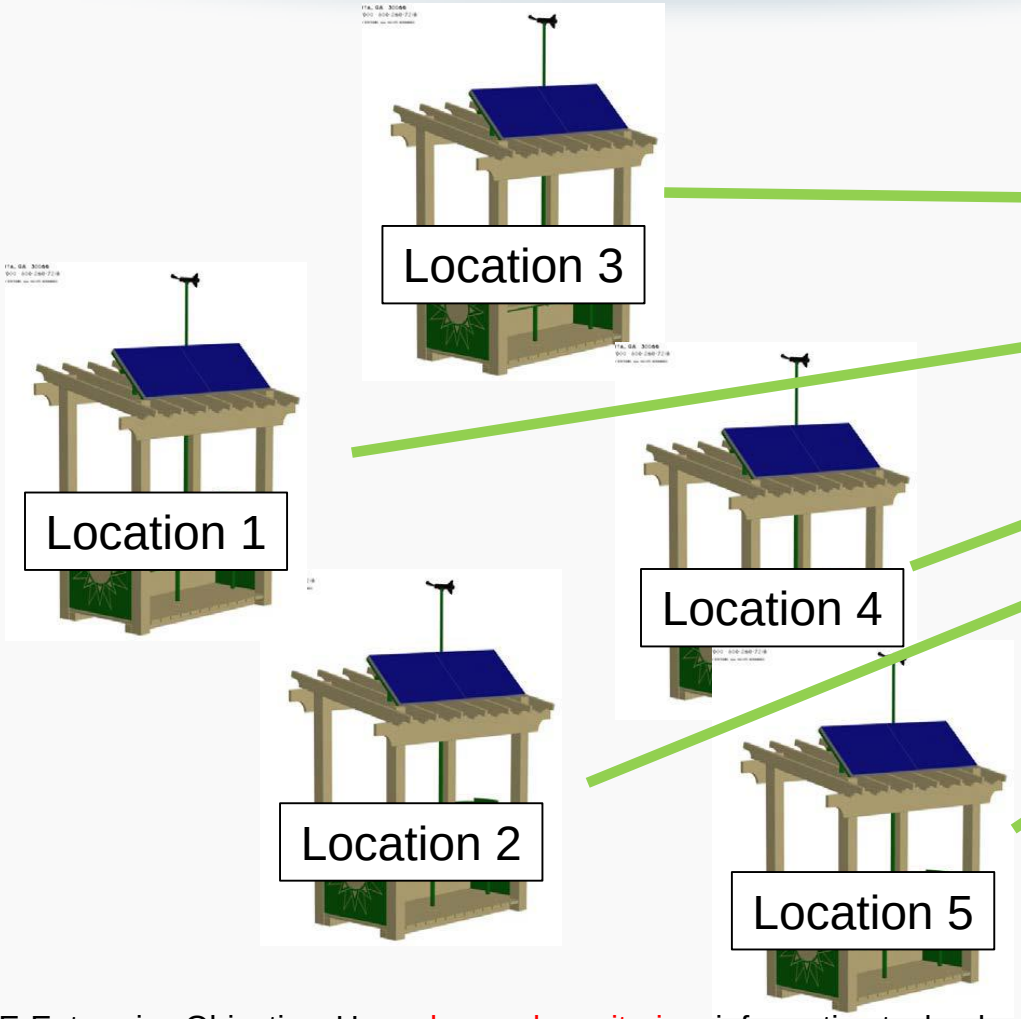
- Data transmitted via cellular modem to HTTP server
- Data screened on SQL server for various diagnostic indicators, averaged to desired interval (e.g., hourly, daily)
- Data available to web browser interface

http://villagegreen.epa.gov/

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.

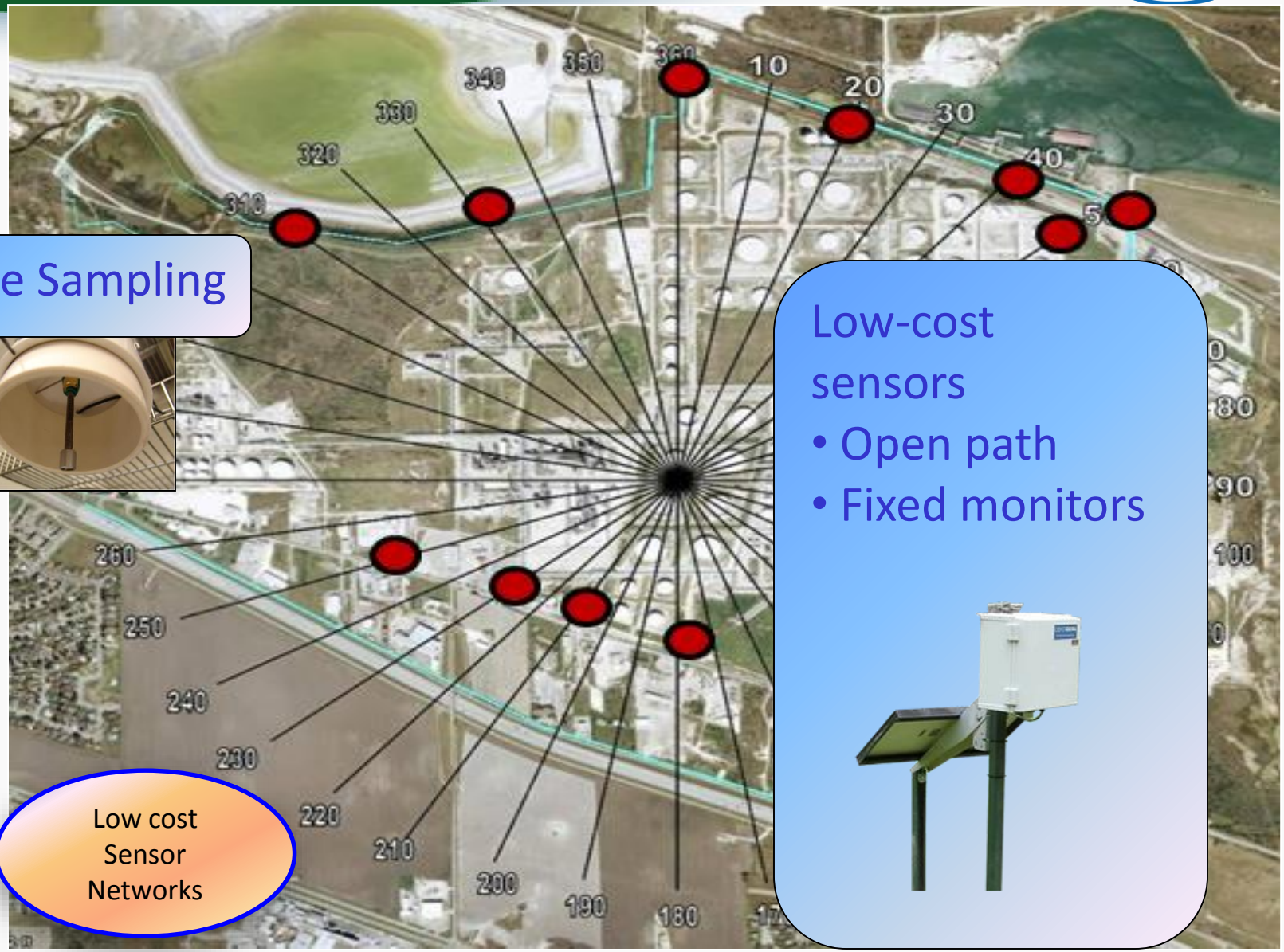
Village Green/E-Enterprise Timeline

- Summer 2014:
  - Hardware development (ORD): develop new VGP system for northern climates (combined solar/wind)
  - Publish Village Green Project prototype design
  - Website development (OAQPS): develop data stream process for multiple VGP stations to transmit data to the AirNowserver; redesign website to show data for multiple stations (future URL may be airnow.gov/villagegreen)

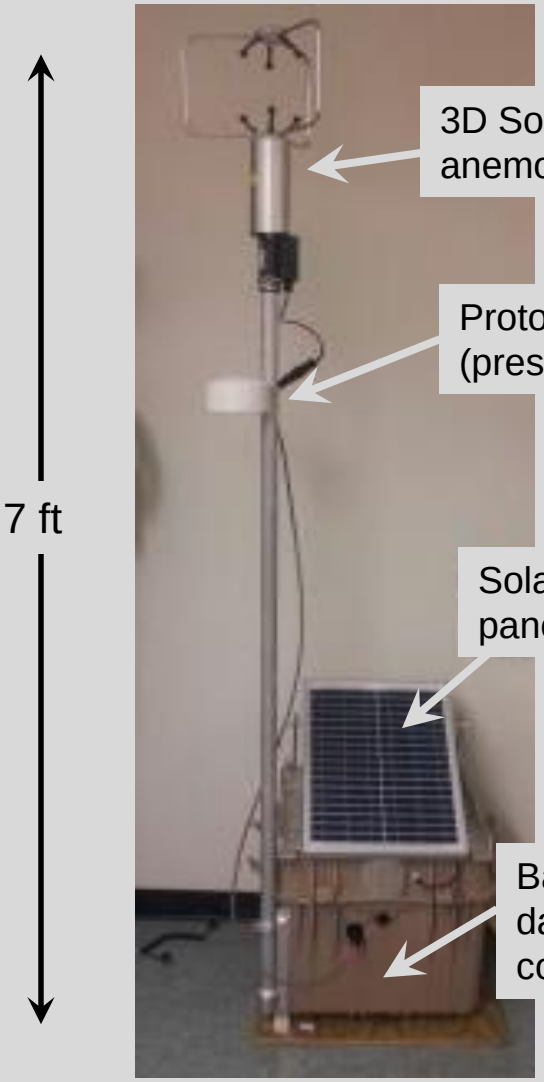
- Fall-Winter, 2014:
  - Determine state partners for new stations
  - Build and deploy approximately 4 VGP stations

- E-Enterprise team is also connecting with others interest in self-funding to obtain stations and would allow the data stream to be hosted on the new website.

Sensor Networks In-plant and Along Facility Fence Line



Portable/Solar Powered System



Drop-in-place Sensor Pod (SPod)

Inside of battery box

Additional Ambient Methods Research

EPA Regional Methods Projects

Acrolein Measurement

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

Acrolein Measurement

- Current ORD efforts are directed at improvements in the TO-15 canister method to develop best practices for recovery of acrolein from canisters

- Evaluating and optimizing the following parameters relative to the recovery of acrolein
  - Current and new canister passivation technology (fused silica and new generation fused silica)
  - Pressure effects
  - Humidity effects
  - Cleaning processes
  - Acrolein degradation/formation in canisters containing ambient air matrix
  - Holding times

- Results will be available in FY 15

Acknowledgements and Key Points of Contact

- Melinda Beaver (FRM, DISCOVER-AQ)
- Rachelle Duval (Community Sensor Applications, DISCOVER-AQ)
- Gayle Hagler (Village Green, Mobile Systems)
- Amanda Kaufman (Air Sensor Citizen Science Toolbox)
- Russell Long (FRM, DISCOVER-AQ)
- Robert Vanderpool (FRM/FEM)
- Eben Thoma (Fenceline Monitoring, SPod, Mobile Systems)
- Jim Szykman (DISCOVER-AQ, Remote Sensing)
- Don Whitaker (Acrolein Measurement)
- Ron Williams (Sensor Evaluation, Village Green, Air Sensor Citizen Science Toolbox)

For additional information: Tim Watkins (watkins.tim@epa.gov)