US EPA AirNow Program

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CSE Air Quality Conclave, April 2016

Outline

- AirNow and AirNow International
  - The "NowCast" reporting methodology
- Next Generation Air Monitoring (NGAM)
  - Small sensors
  - Village Green
- State Dept Embassy Monitoring
- Satellite fusion

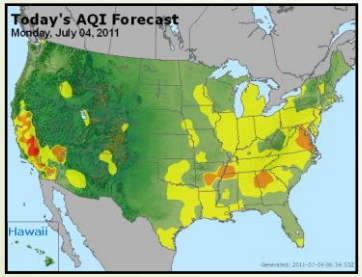
AirNow History

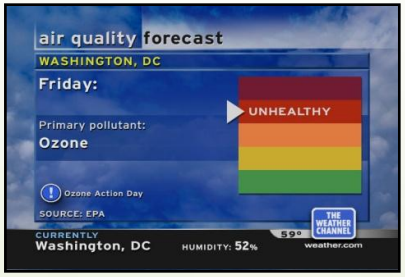
- State of Maryland developed a daily ozone animation in the early 1990s
- US EPA Region 1 (Northeast US) and several Non Government Organizations (NGOs) built the "Ozone Mapping System", covering 13 states
- Phil Dickerson and a team from US EPA headquarters moved Region 1's system to EPA HQ in North Carolina and began expanding it nationally
- In 1997, AirNow debuted on the EPA web site
- By 1998, some agencies were beginning to forecast next day air quality
- By 2007, all 50 states were participating, as was Canada and some parts of Mexico
- In 2008, began developing AirNow-International, to be used by our first partner – Shanghai Environmental Monitoring Center (SEMC)

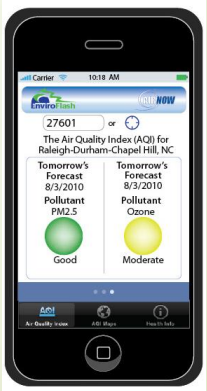
AirNow

AirNow System Today

- Year Round 24/7 coverage/delivers real-time data (ozone & particles) for 50 States, Puerto Rico, 6 Canadian Provinces and 24 U.S. National Parks
- Next-day AQI forecasts for over 400 cities (summer) and over 300 cities (year-round)
- Successful iPhone and Android apps
- State-of-the-science information about air pollution health effects for the public, media and stakeholders
- Public/Private partnerships with The Weather Channel, USA Today, CNN, weather service providers, NOAA National Weather Service

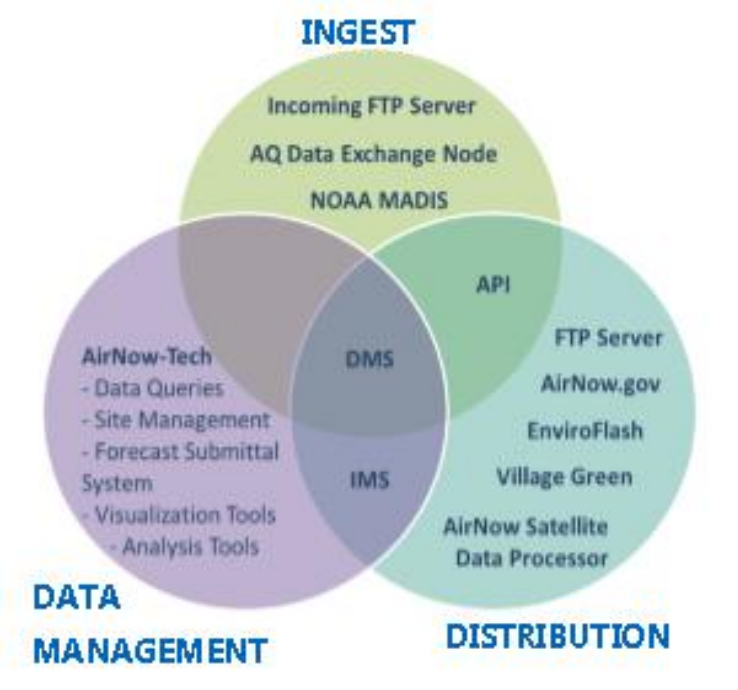






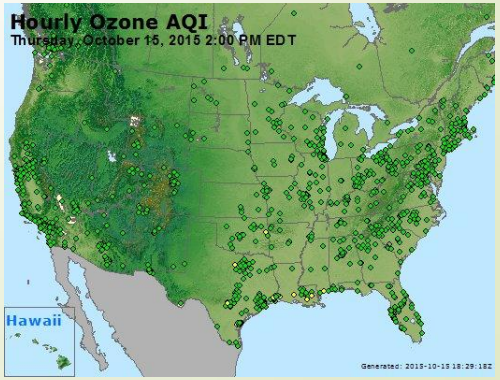
AirNow System: Main Elements

- Monitoring and Acquisition of Data
- AirNow Data Flow
- AirNow-Tech
- Forecasting
- Community

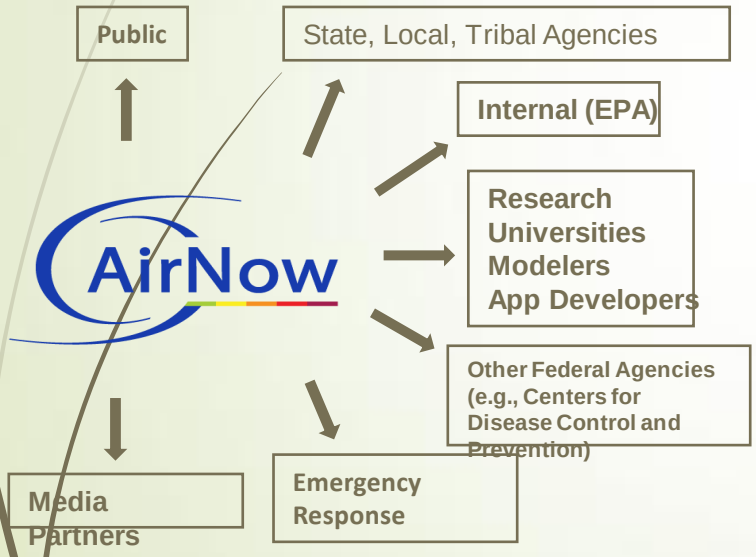


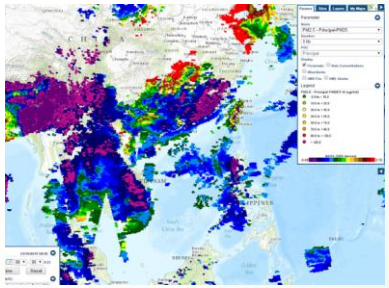
Monitoring and Acquisition of Air Quality Data in the U.S.

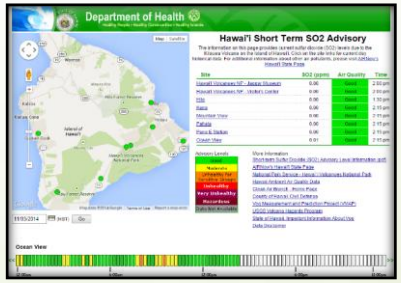
- EPA provides resources to our State, Local and Tribal partners to monitor air quality in their jurisdictions
- Partners are responsible for the monitoring and quality of the data
- Partners report data to EPA Air Quality System (AQS) for regulatory decision making
- Partners voluntarily report data to EPA AirNow for Air Quality Index (AQI) and public health protection
- Data reported from around 1600 ozone sites, 1150 PM2.5 sites and 380 PM10 sites
- Forecasts are submitted by partners – EPA does not alter them!
- AQS data is the official data of record, certified and available months after being collected.
- **AirNow data is available immediately!**

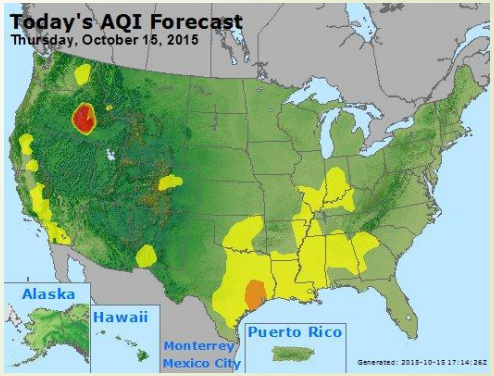


Data Flow: AirNow Outputs





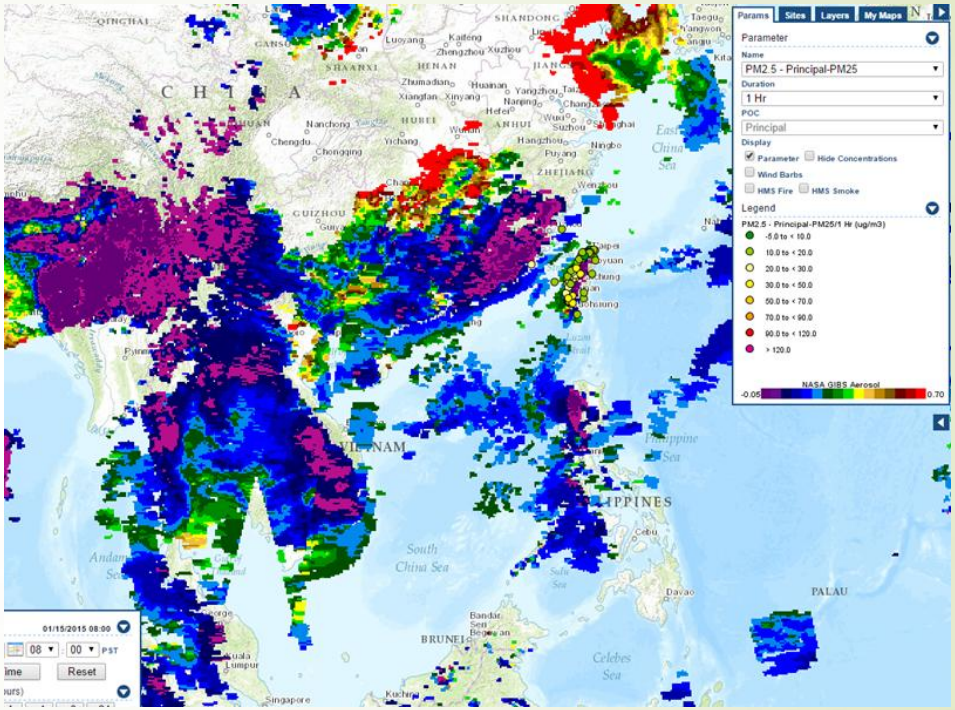




AirNow

AirNow-Tech

- Decision Support System – management and analysis tool for the AirNow and AirNow-I Program
- GIS functions – HYSPLIT trajectory tool, satellite, and smoke products
- Data queries, personalized tools, preferences, and services
- Ability to view meteorological and air quality data
- Worldwide satellite data
- Password-protected user accounts



Forecasting

- State, Local and sometimes city officials submit their forecasts
- Numerical, statistical, even neural network models are used
- AirNow distributes the provided forecast
- AirNow provides some forecasting support
- NOAA Model output is available
- Many resources for forecasters on AirNow.Gov and AirNowTech
- Forecast verification system in AirNowTech allows agencies to evaluate their forecast accuracy
- AirNow provides national consistency and a national data product for the media

AirNow Community

- AirNow-I Community Webinars
- Quarterly webinars
- Alternating times
- Program and technical topics
- Community news segment

2015 Webinars

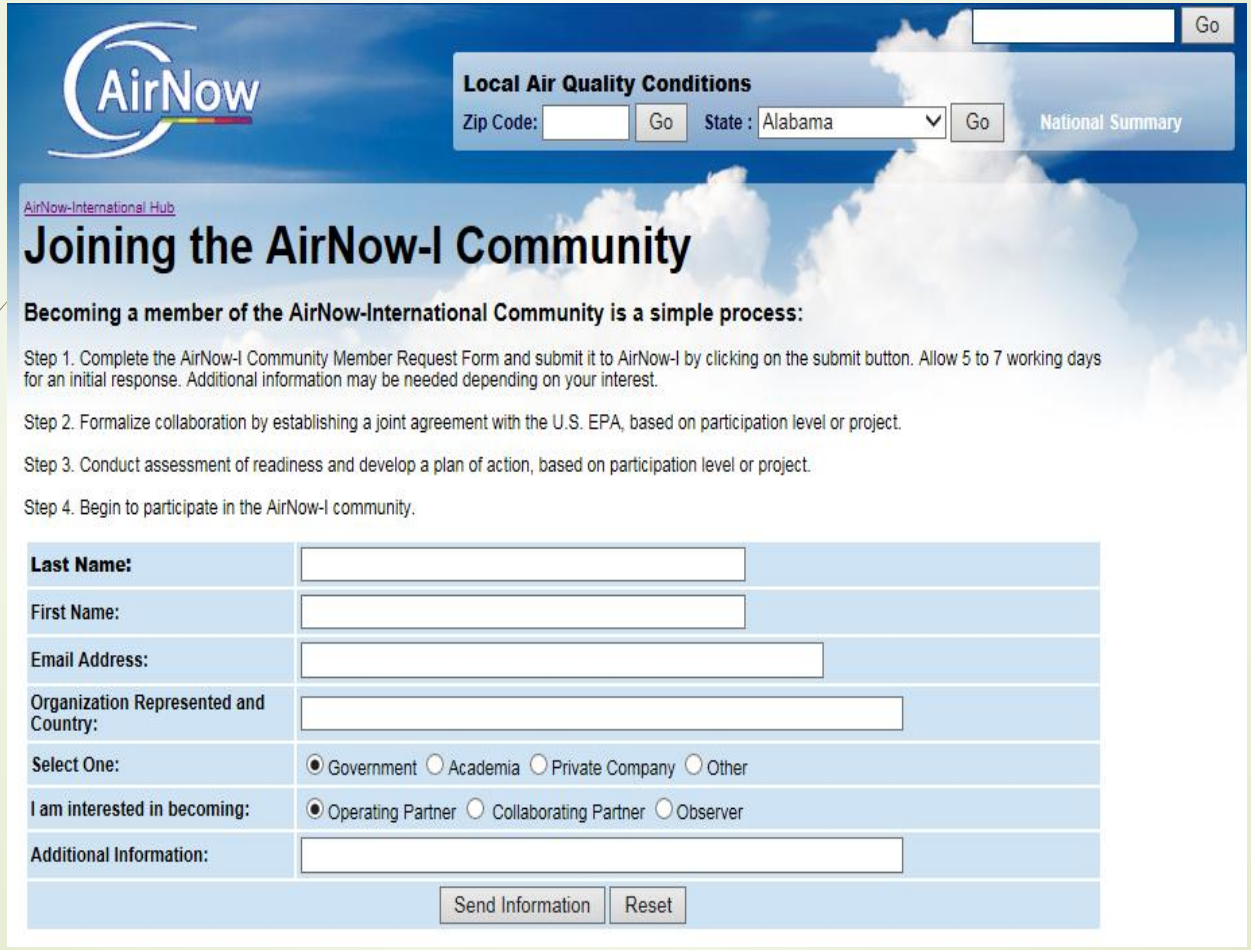
- January: AirNow and Air Quality Management; Are you ready for AirNow-Tech?
- May: AirNow-I Program Overview & Data Sharing Basics
- September: Involving the Community in Air Quality: Kids Making Sense & Village Green
- October 29: AirNow (USA) and SAFAR (India) systems discussion

AirNow-I Community

- Operating Partners
  - China: Shanghai 2010, Zhejiang Province 2013
  - Mexico: Monterrey 2012; Mexico City 2014; Guanajuato, Jalisco and Guadalajara 2015
- Collaborating Partners
  - Canada 2000
  - Taiwan 2014 (AirNow-Tech)
- AirNow Program Support Organizations
  - Technical Support - STI
  - Other US Agencies - DOS, NASA, NOAA, CDC, USFS
  - International Organizations – CEC, CAA

AirNow training for Mexico's Guanajuato [illegible] environmental protection agencies
Photo from CEC Facebook Page: www.facebook.com/CECconnect

Join us!


AirNow
Go
Local Air Quality Conditions
Zip Code:
Go
State : Alabama
Go
National Summary
AirNow-International Hub
Joining the AirNow-I Community
Becoming a member of the AirNow-International Community is a simple process:
Step 1. Complete the AirNow-I Community Member Request Form and submit it to AirNow-I by clicking on the submit button. Allow 5 to 7 working days for an initial response. Additional information may be needed depending on your interest.
Step 2. Formalize collaboration by establishing a joint agreement with the U.S. EPA, based on participation level or project.
Step 3. Conduct assessment of readiness and develop a plan of action, based on participation level or project.
Step 4. Begin to participate in the AirNow-I community.
Last Name:
First Name:
Email Address:
Organization Represented and Country:
Select One:
Government
Academia
Private Company
Other
I am interested in becoming:
Operating Partner
Collaborating Partner
Observer
Additional Information:
Send Information
Reset

Challenges and Future Plans

Challenges

- Citizen Science: how do we measure data quality and how do we deal with "hot spots"?
- Program growth versus funding

Future Plans

- Encourage data sharing in southeast Asia
- Move more of AirNow operations into the cloud
- Continue to explore the fusion of satellite air quality data with in-situ monitoring

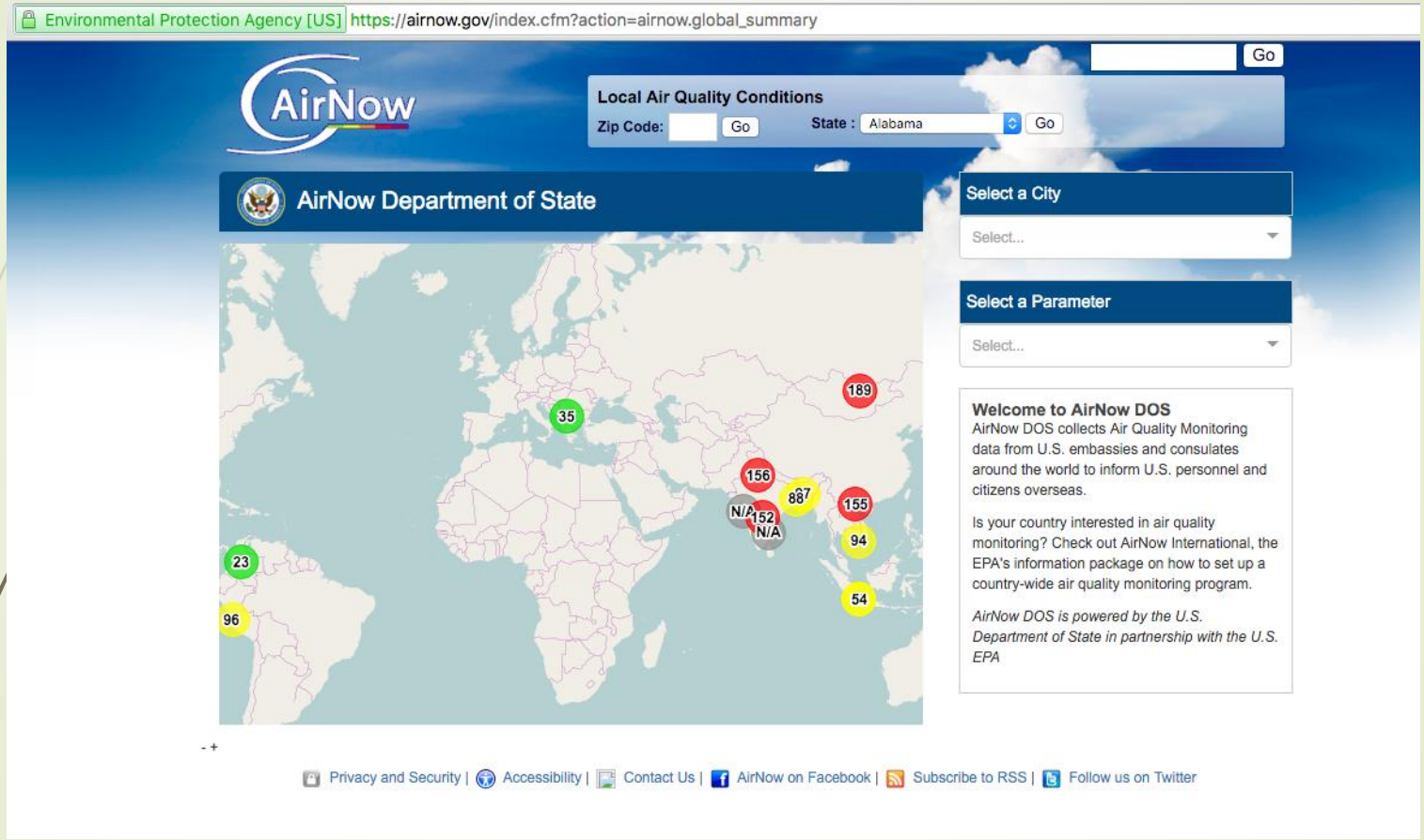
AirNow

The NowCast Method

- An average of the previous 8 -12 hours
- If air quality is less variable, the hours are weighted more evenly (approaching the NAAQS averaging period of 8 hours for ozone and 24 for PM2.5)
- If air quality is more variable, recent hours are weighted more heavily

AirNow

US Department of State



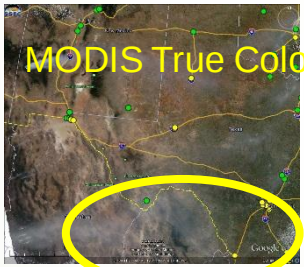
Currently 14 monitors around the world, 29 planned this year

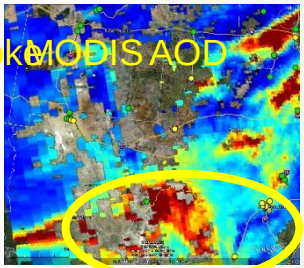
Why Satellite Data?

- Spatial coverage of current AirNow maps is limited. There are significant data gaps resulting in over 36 million American (~40% of the area) not covered by a monitoring network.
- Satellite data, specifically AOD can provide information to "fill-in" these gaps.

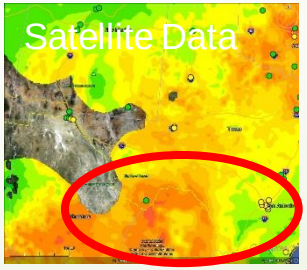
Example: New Mexico and Mexican Fires 5/24/2012

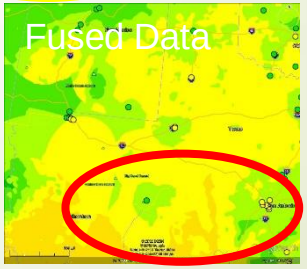
Current continuous AirNow $PM_{2.5}$ monitoring sites

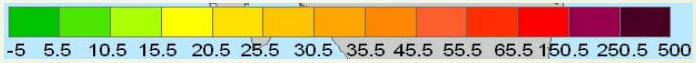




Satellite data captures the smoke and observed aerosols not in the AirNow data.

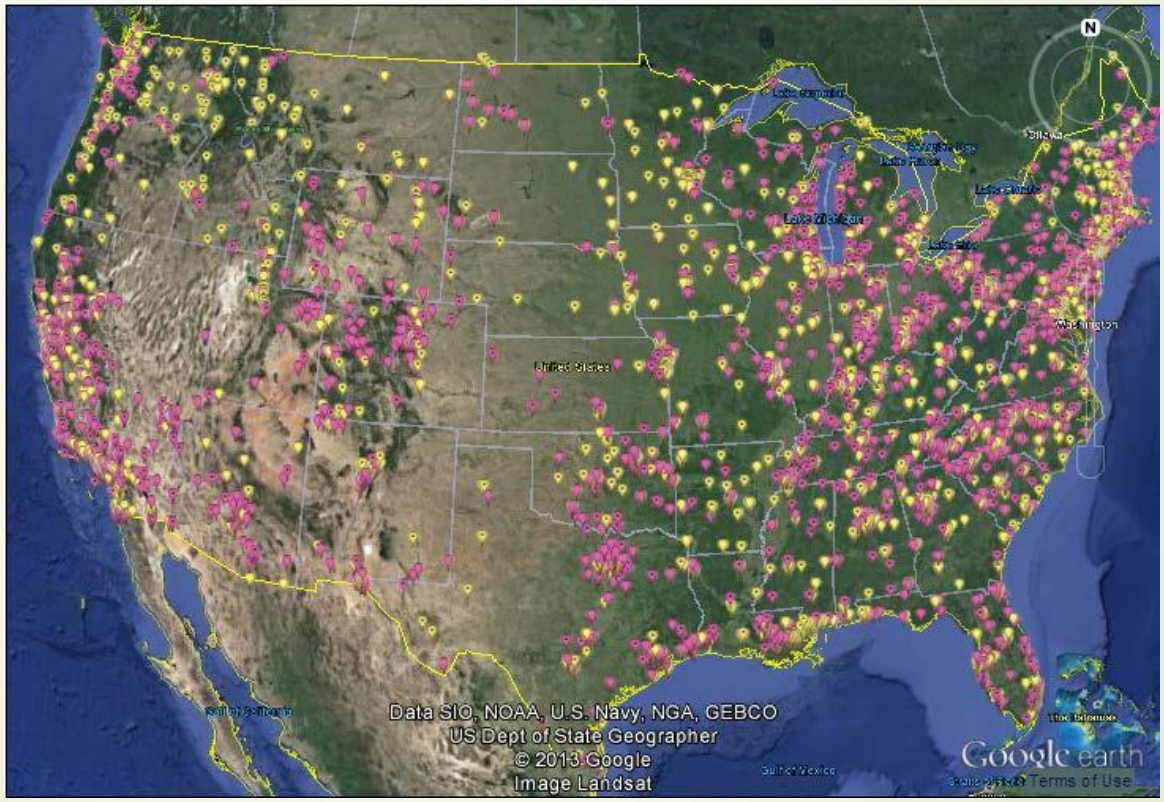






Concentration ($\mu g/m^3$)

Continuous Ozone and PM Monitors

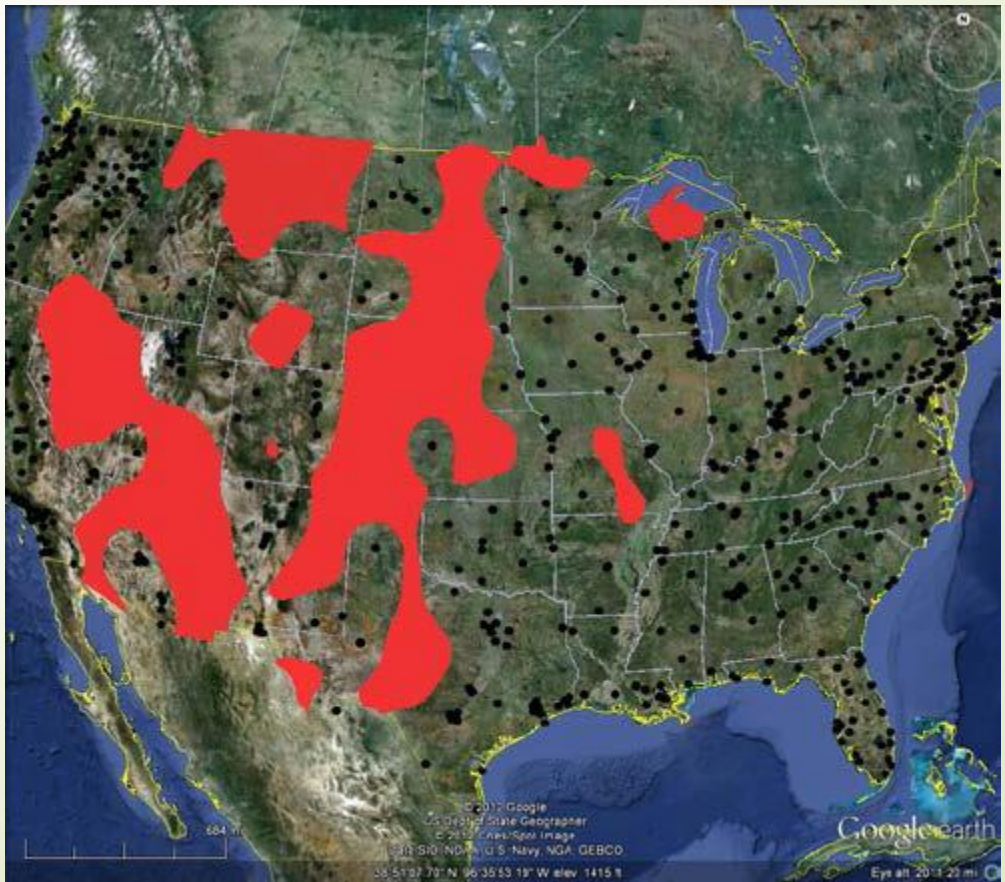


Ozone (pink balloons) and PM2.5 (yellow balloons) monitor locations, as of September 2013

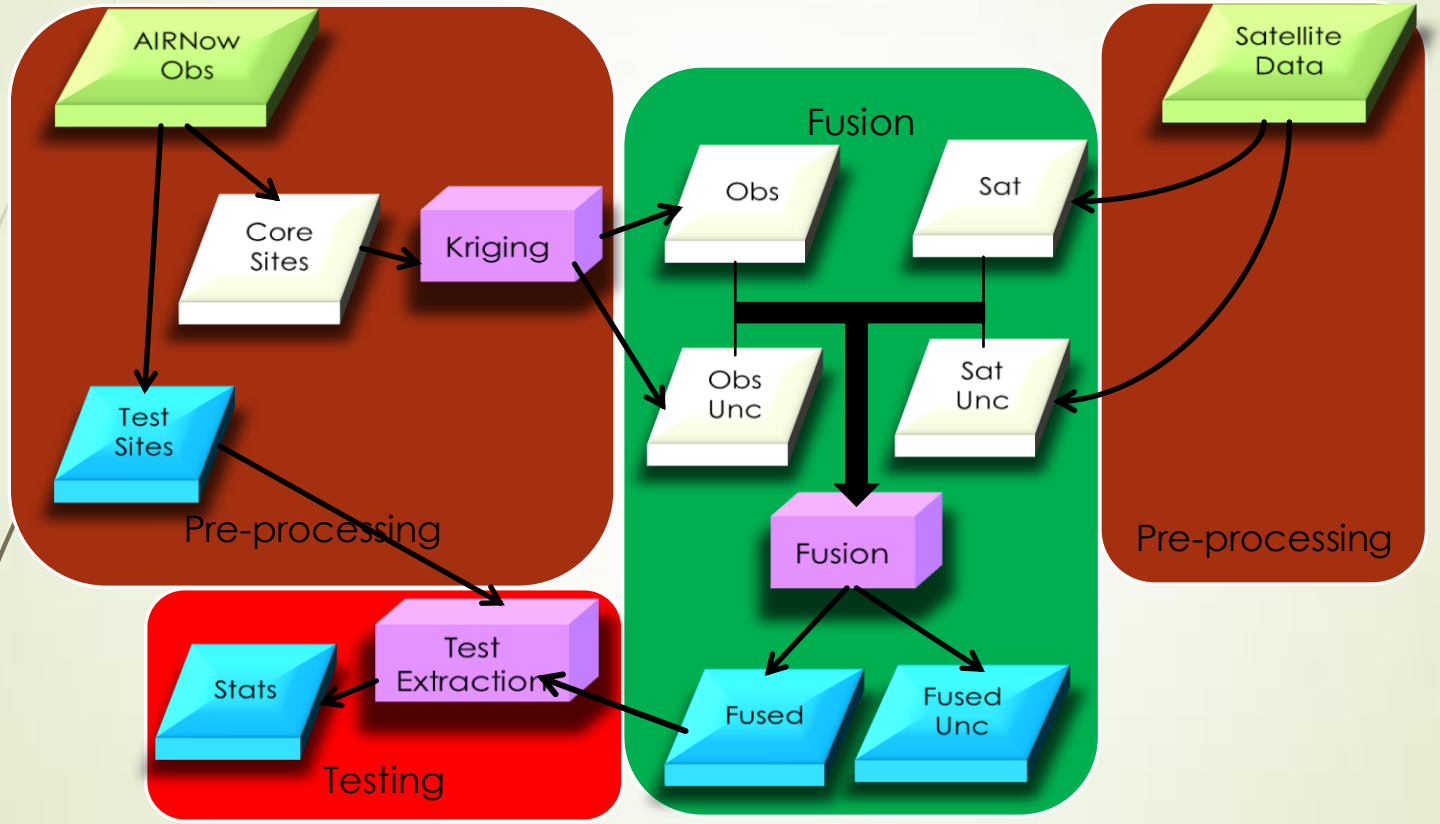
AirNow

Estimating Coverage of PM 2.5 Network

- Areas shaded in red represent locations with no PM2.5 monitors nearby

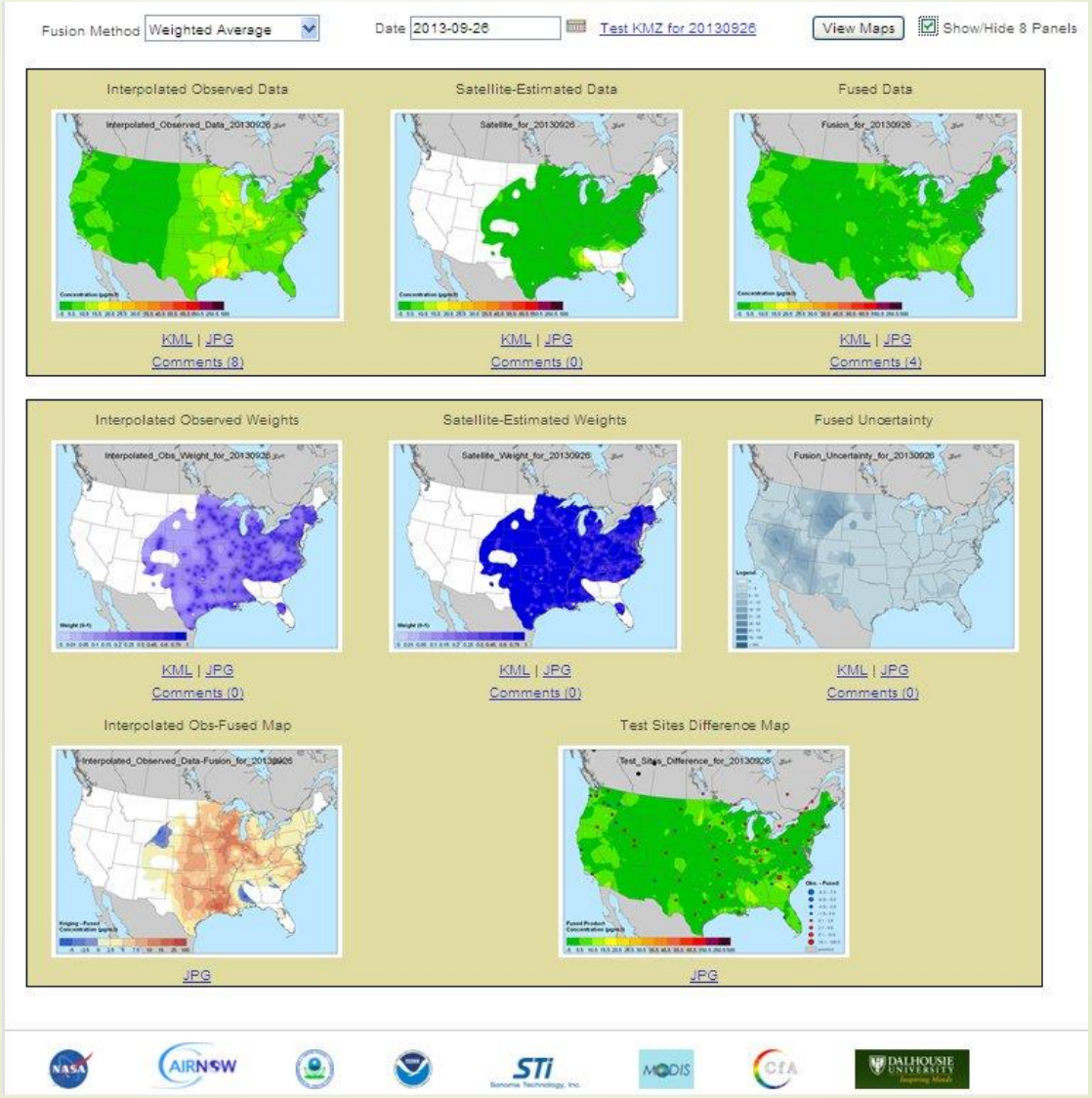


How We Incorporated Satellite Data

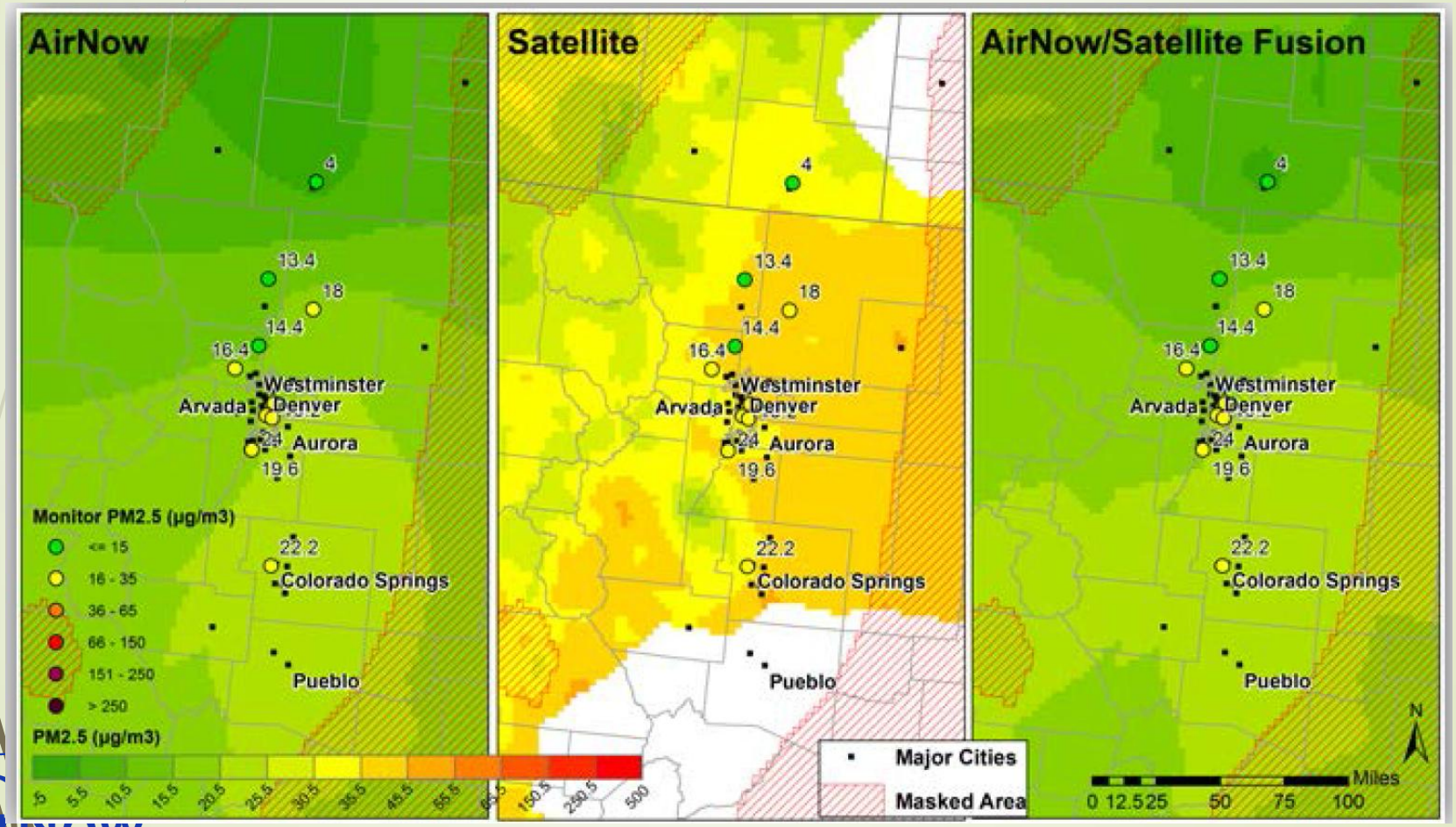


AirNow Satellite Data Processor (ASDP) Overview)

Individual Products from ASDP



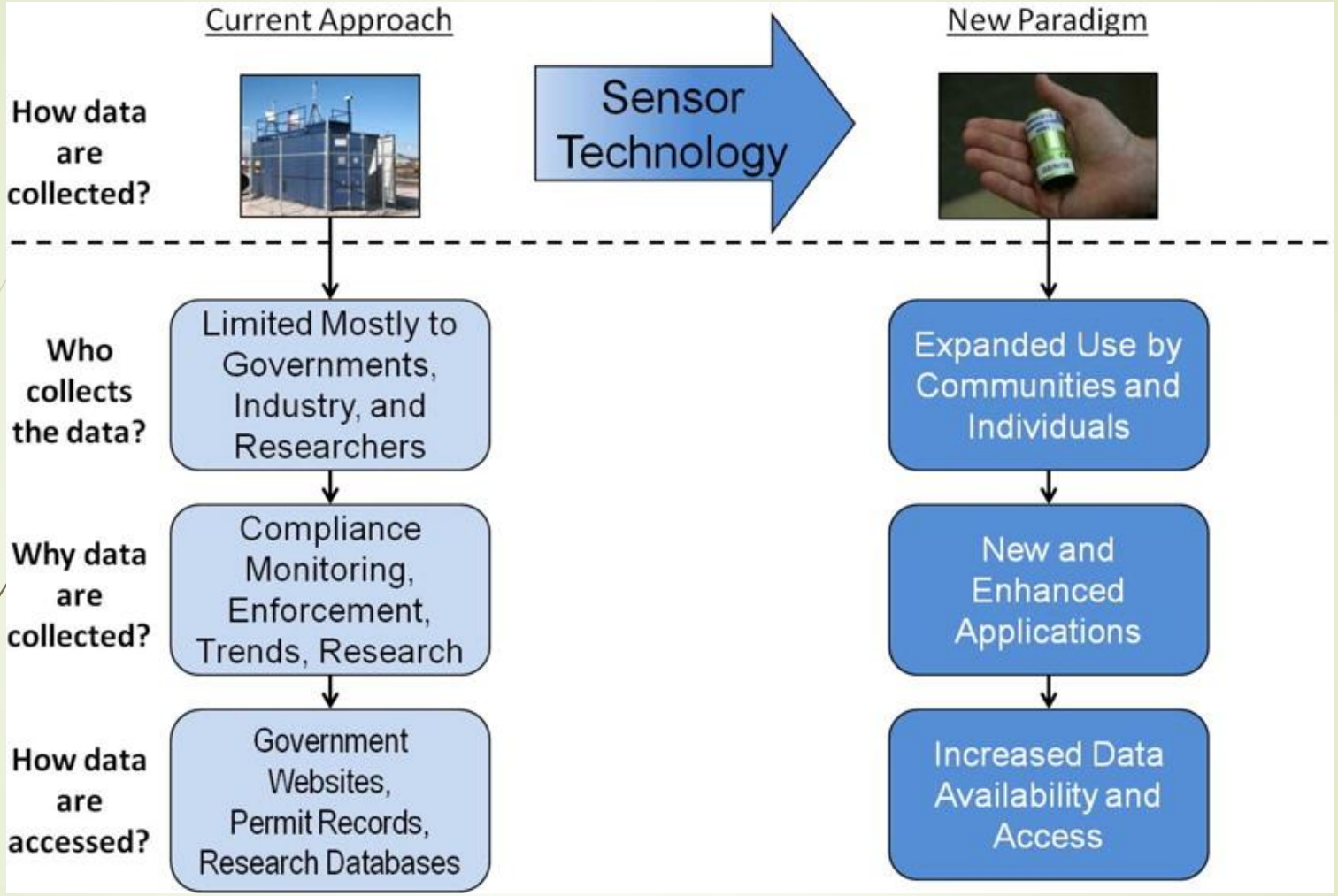
Case Study: Data Fusion in Colorado



Next Generation Air Monitoring

- Traditionally, air pollution is measured by expensive, stationary and complex air-monitoring instrumentation. Only a few organizations, like federal, state and some industries, typically collect data of such high quality. As air quality management problems become more complex, there is a need for enhanced air quality and exposure monitoring capabilities.
- The main areas of air sensor research at EPA include:
- Apps and Sensors for Air Pollution (ASAP)
- Mobile Monitoring
- Passive Fenceline Monitoring
- Enhanced National Ambient Air Quality Standards (NAAQS) Federal Reference Methods
- Satellites
- Data Fusion Approaches

AirNow



Published in: Emily G. Snyder; Timothy H. Watkins; Paul A. Solomon; Eben D. Thoma; Ronald W. Williams; Gayle S. W. Hagler; David Shelow; David A. Hindin; Vasu J. Kilaru; Peter W. Preuss; *Environ. Sci. Technol.* **2013,** 47, 11369-11377.
DOI: 10.1021/es4022602
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Background: Village Green Pilot Project

- Partnership between EPA and state and local agencies
- State/local solicitation
- 22 proposals submitted
- Five selected
- Selected Sites
  - Washington, DC – installed in March 2015
  - Philadelphia, PA – installed in March 2015
  - Kansas City, KS – installed in April 2015
  - Oklahoma City, OK – installed in July 2015
  - Hartford, CT – installed in November 2015

AirNow

VG Pilot Status: Deployment

Small sensors in action: Inside a Village Green Bench

Power module:
Power inputs from solar and/or wind
Rechargeable battery

Instrumentation module:
PM2.5 and ozone instruments
Microprocessor
Cellular modem
Internal temperature sensor
Heater (new stations)

Village Green after one year

- Initial assessment in Durham, NC indicated agreement within ~15% with nearby reference instruments (Jiao et al., 2015).
- Ozone from both the Village Green (VGR) monitor and the reference monitor (LAB) have been in close agreement towards each other from the time Village Green started.
- Particulate Matter (PM2.5): Comparison of the station (VGR) against nearby stations (CHS and LAB) for one day selected per month had disagreement in values for April and May, but close agreement in June.
- Met data looks fine.
- With only one quarter so far, we need further investigation. To prepare a comparison of daily averages for the full time span.

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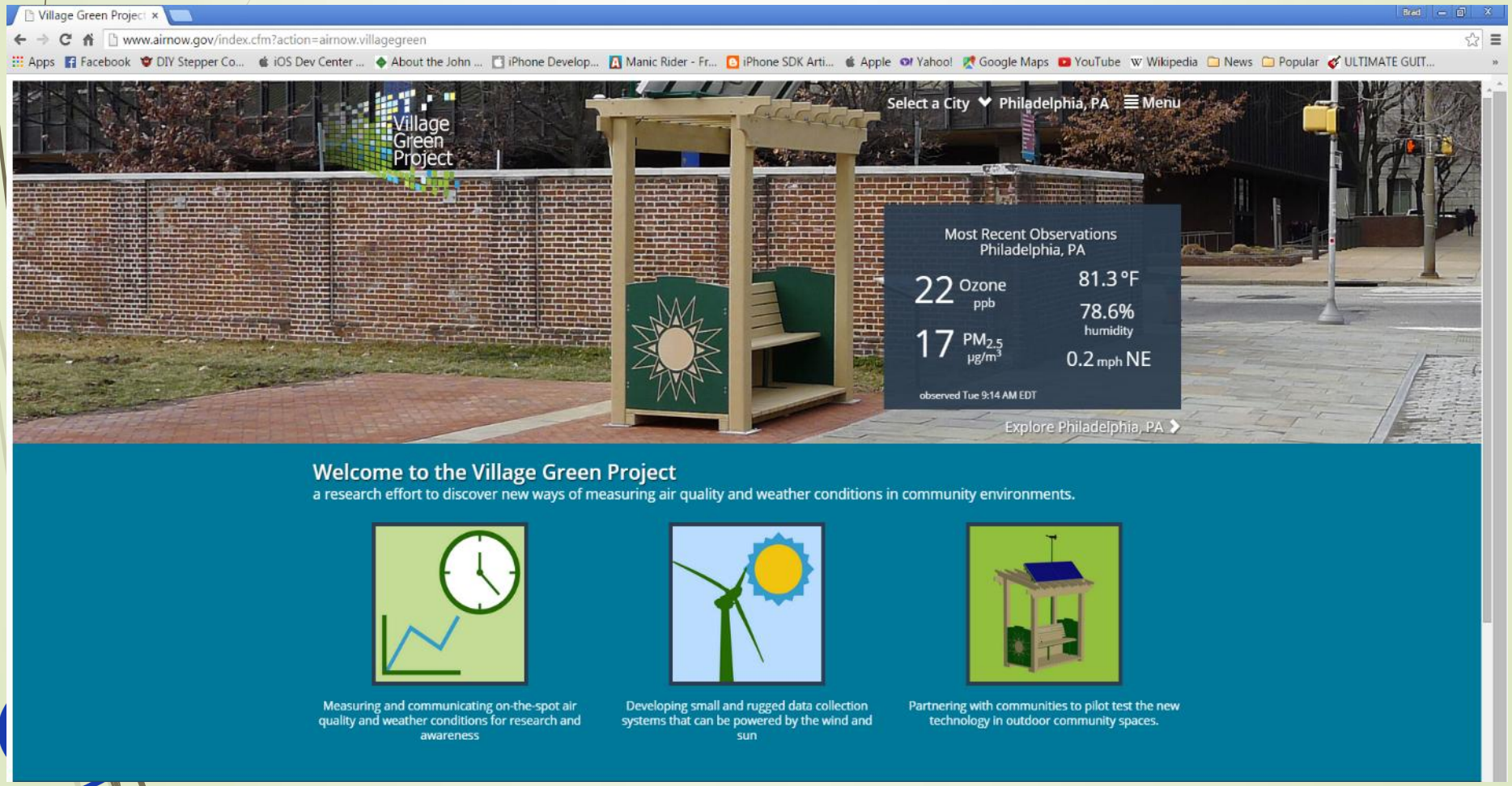
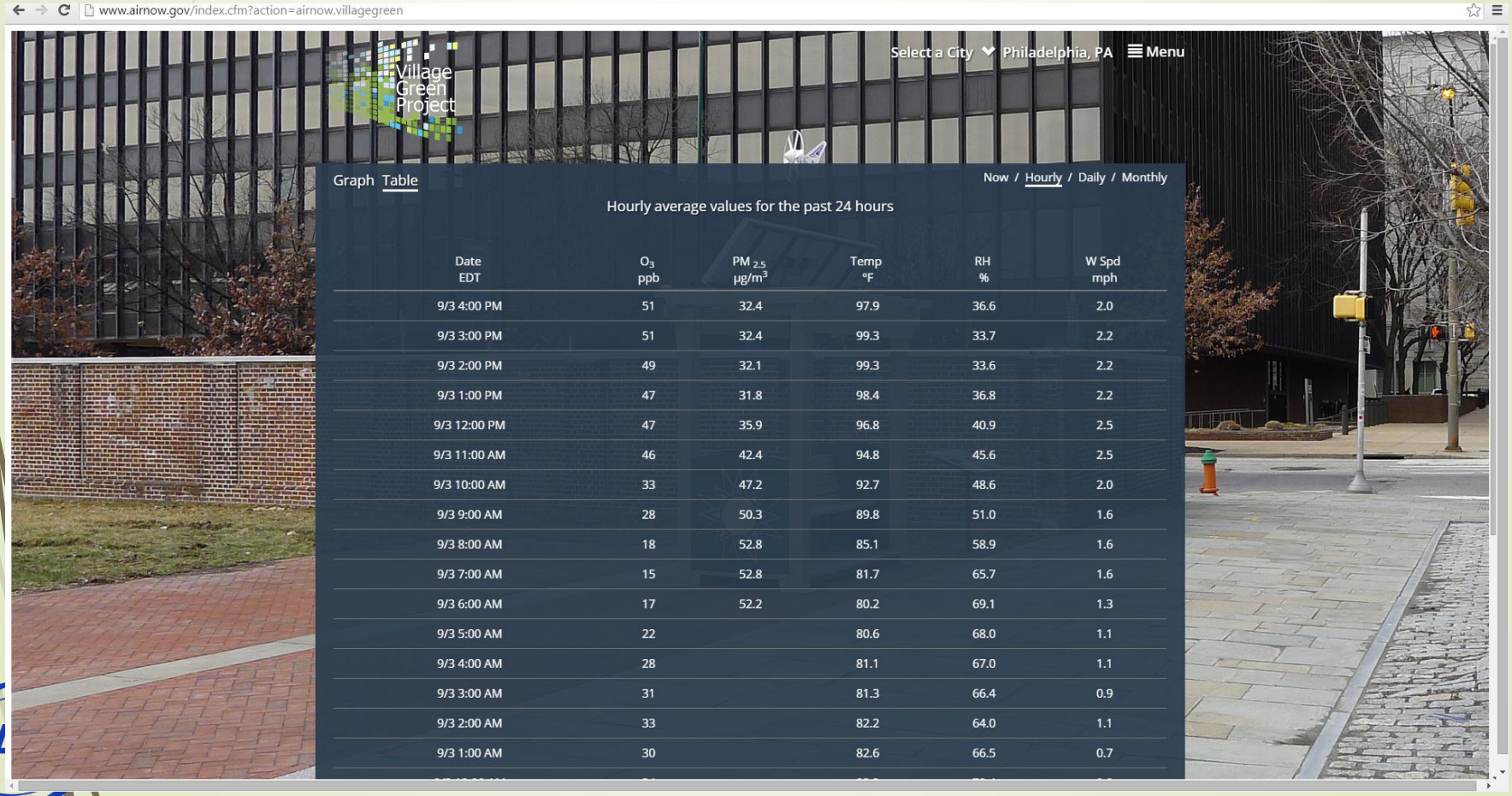
SNAPSHOT OF AIR NOW WEBSITE



SNAPSHOT: Hourly Average Values (24 hrs)



Date EDT	O_3 ppb	$PM_{2.5}$ $\mu g/m^3$	Temp °F	RH %	W Spd mph
9/3 4:00 PM	51	32.4	97.9	36.6	2.0
9/3 3:00 PM	51	32.4	99.3	33.7	2.2
9/3 2:00 PM	49	32.1	99.3	33.6	2.2
9/3 1:00 PM	47	31.8	98.4	36.8	2.2
9/3 12:00 PM	47	35.9	96.8	40.9	2.5
9/3 11:00 AM	46	42.4	94.8	45.6	2.5
9/3 10:00 AM	33	47.2	92.7	48.6	2.0
9/3 9:00 AM	28	50.3	89.8	51.0	1.6
9/3 8:00 AM	18	52.8	85.1	58.9	1.6
9/3 7:00 AM	15	52.8	81.7	65.7	1.6
9/3 6:00 AM	17	52.2	80.2	69.1	1.3
9/3 5:00 AM	22		80.6	68.0	1.1
9/3 4:00 AM	28		81.1	67.0	1.1
9/3 3:00 AM	31		81.3	66.4	0.9
9/3 2:00 AM	33		82.2	64.0	1.1
9/3 1:00 AM	30		82.6	66.5	0.7

SNAPSHOT OF AIR NOW WEBSITE

Sensor Messaging

- Focus group testing indicated "high – medium – low" messages were desirable.
- Both the breakpoints and messages should be based on our understanding of the broad body of health evidence.
- Should consider what is the population we want to advise (e.g., sensitive subpopulations) and how early do we want to advise them (e.g., when air quality is in the "moderate" or "unhealthy for sensitive groups").
- Sensor category breakpoints and messages should minimize:
  - LOW messages when the AQI indicates that the air quality concentration is unhealthy (e.g., in the "unhealthy for sensitive groups" or "unhealthy" categories).
  - HIGH messages when the AQI indicates that the air quality concentration is in the "good" or "moderate" categories.

AirNow

Draft PM2.5 approach

PM2.5	
!	Your sensor may not be working properly, check the Air Quality Index (AQI).
Low 0-(30-40) ug/m3	Enjoy your outdoor activities.
Medium (30-40) - (70-100) ug/m3	If medium readings continue, use the Air Quality Index (AQI) to plan outdoor activities.
High >(70-100) ug/m3	You may be near a sources of particle pollution like dust, smoke, or exhaust. Move to a different location where the readings may decrease. Check the AQI for your area.

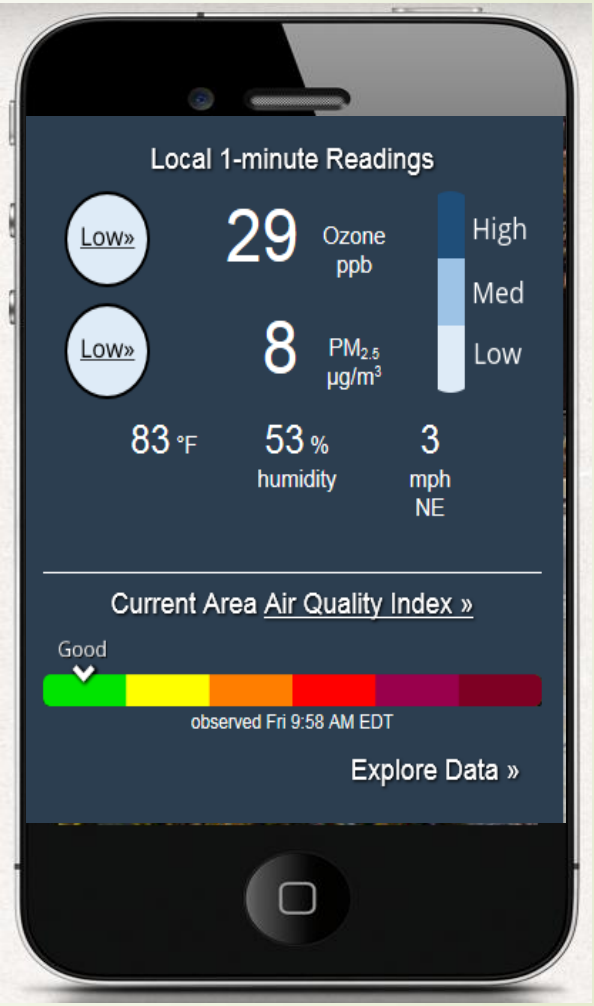
AirNow

Draft Ozone approach

Ozone	
!	Your sensor may not be working properly, check the Air Quality Index (AQI).
Low **0-59 ppb**	Enjoy your outdoor activities.
Medium **60-89 ppb**	If medium readings continue, use the Air Quality Index (AQI) to plan outdoor activities
High **90-149 ppb**	If high readings continue, consider adjusting your outdoor activities, especially if you are sensitive to ozone. Check the AQI to find out.
Very High **>150 ppb**	If high readings continue, consider adjusting your outdoor activities. Check the Air Quality Index (AQI) for your area to find out. Note that very high ozone readings may indicate that your sensor is not working properly. Check your sensor instructions.

Going public

- Planning to release prototype mobile app and website during Air Quality Awareness Week in early May 2016
  - Website will include FAQs and other information
- Will display the 6 (and counting) Village Green data streams



AirNow

Resources for further study

- https://airnow.gov/international
- https://www.epa.gov/air-research/air-sensor-toolbox-citizen-scientists
- https://www.epa.gov/air-research/village-green-project
- http://pubs.acs.org/doi/abs/10.1021/es4022602 (changing paradigm)