National Ambient Air Quality Data

An Overview and Future Directions

Many Voices - One Vision.
Environmental Public Health Tracking Conference

March 24-26, 2004

Agenda

- Describe Existing Air Quality Networks
  - State/Local and Federal Roles
  - What is measured ?
  - Where do the data go ?
  - Changes in Monitoring Program
- Outline Remote Sensing (Satellite)
  - What’s measured ?
  - What’s happening with the data ?
- Next Steps

Ambient Air Monitoring

- 20+ years of available information with recent emphasis on “real time” data
- Most ambient air monitoring networks operated by States via EPA grants
- Uses
  - NAAQS attainment
  - Public Information
  - Air Quality Trends and Program Accountability
  - Air Quality Forecasting
  - Risk/Exposure Characterization
  - Research/Science Support

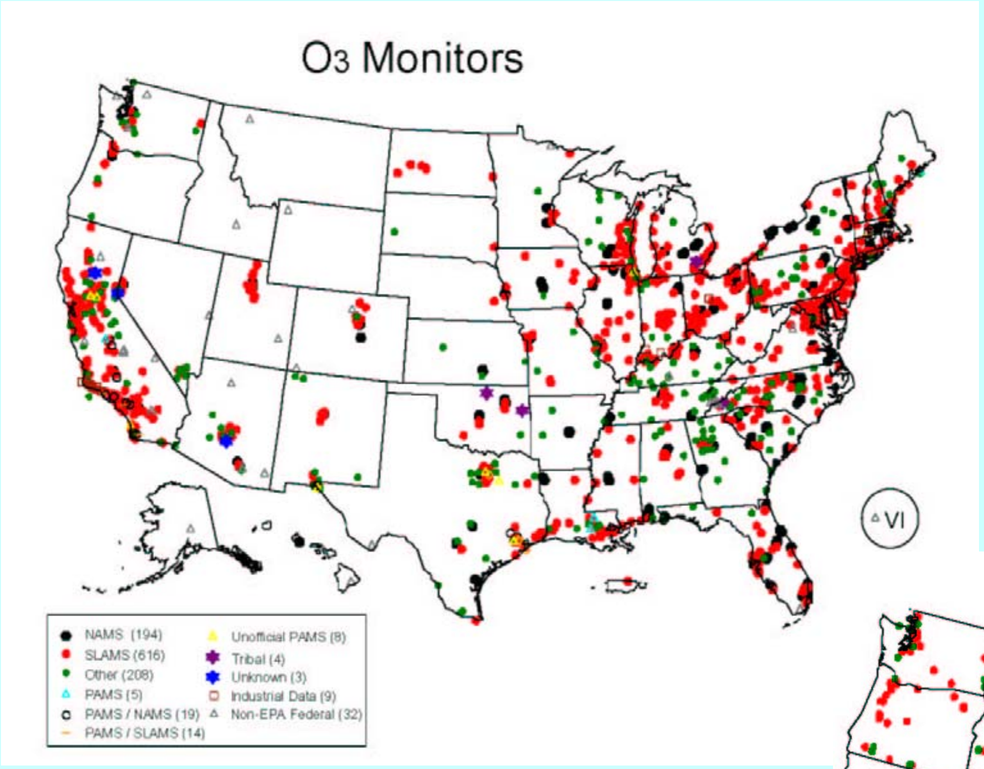
Federal-State-Local Air Monitoring Partnerships

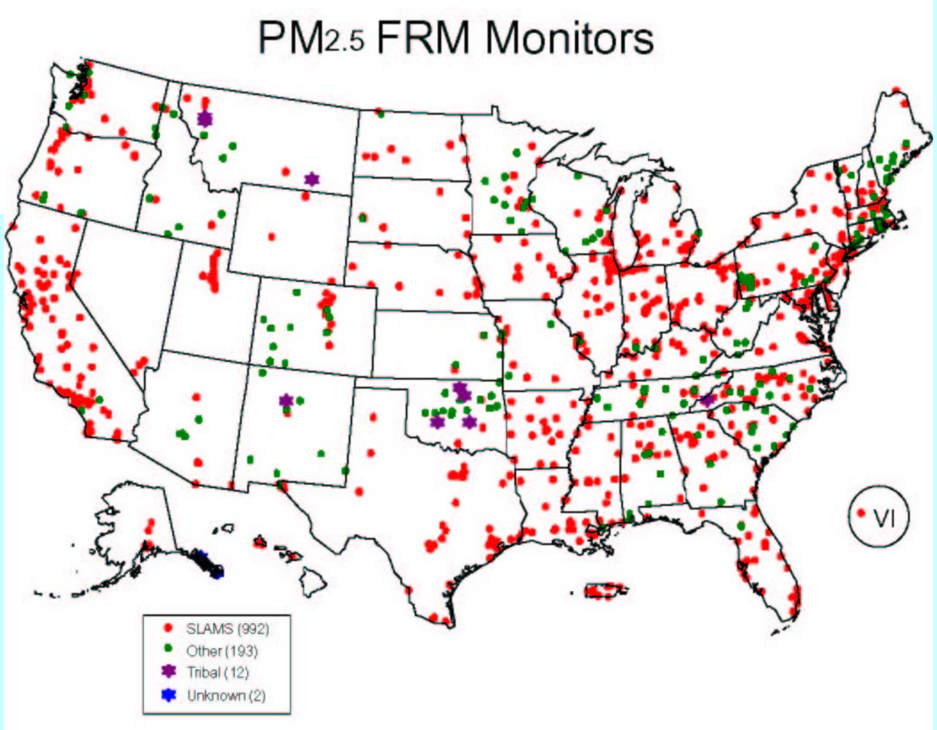
- Attainment (or not) Designations
- Air Quality Forecasting
- Air Quality Analysis/National Trends
- <u>National Oversight/Rules/Guidelines</u>
- <u>Quality Assurance Support</u>
- <u>Methodology Support/Research</u>
- <u>National Data Storage/Management</u>
- Grant Funds

- Attainment (or not) Designations
- Air Quality Forecasting
- <u>Monitor Operation</u>
- <u>Special Studies</u>
- <u>Raw Data Management</u>
- <u>Quality Assurance</u>
- Data Analysis

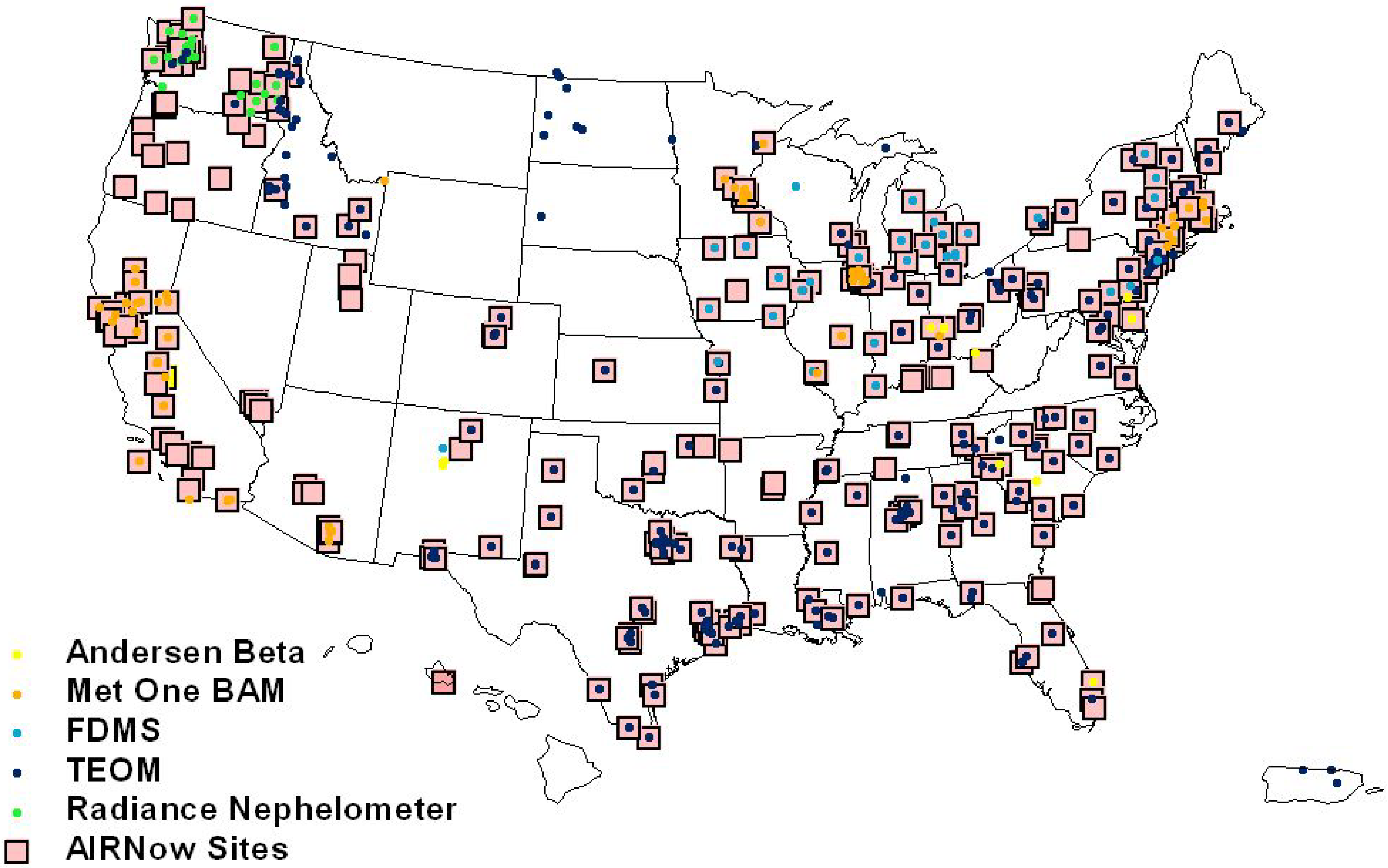
Ambient Air Monitoring Networks

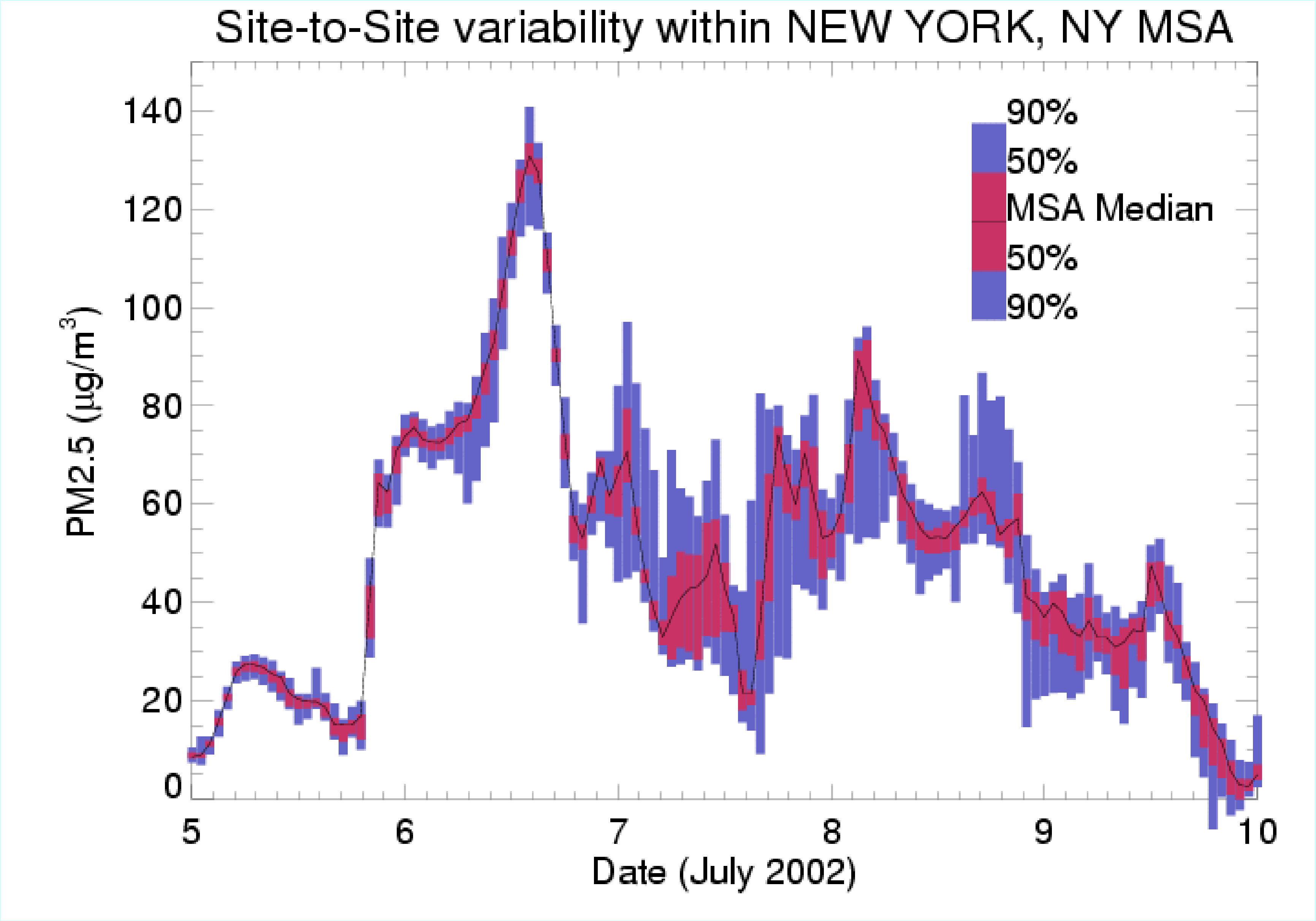
- Criteria Pollutant monitoring
  - Emphasis on PM and Ozone
  - Less emphasis for CO, NO_2, SO_2, Lead
- Detailed Monitoring for Ozone and Particulate Matter
  - Photochemical Assessment Monitoring Stations (PAMS)
    - Precursor Organic Compounds and NOx (background/urban sites)
  - Speciated Fine Particle Network
    - Operated by States (urban/metropolitan sites)
  - IMPROVE
    - Operated by National Park Service (background/rural sites)
- Air Toxics monitoring
  - Small number of trends sites (State/local and EPA networks)
  - Community-based efforts


O3 Monitors
VI
NAMS (194)
SLAMS (616)
Other (208)
PAMS (5)
PAMS / NAMS (19)
PAMS / SLAMS (14)
Unofficial PAMS (8)
Tribal (4)
Unknown (3)
Industrial Data (9)
Non-EPA Federal (32)


PM2.5 FRM Monitors
VI
SLAMS (992)
Other (193)
Tribal (12)
Unknown (2)

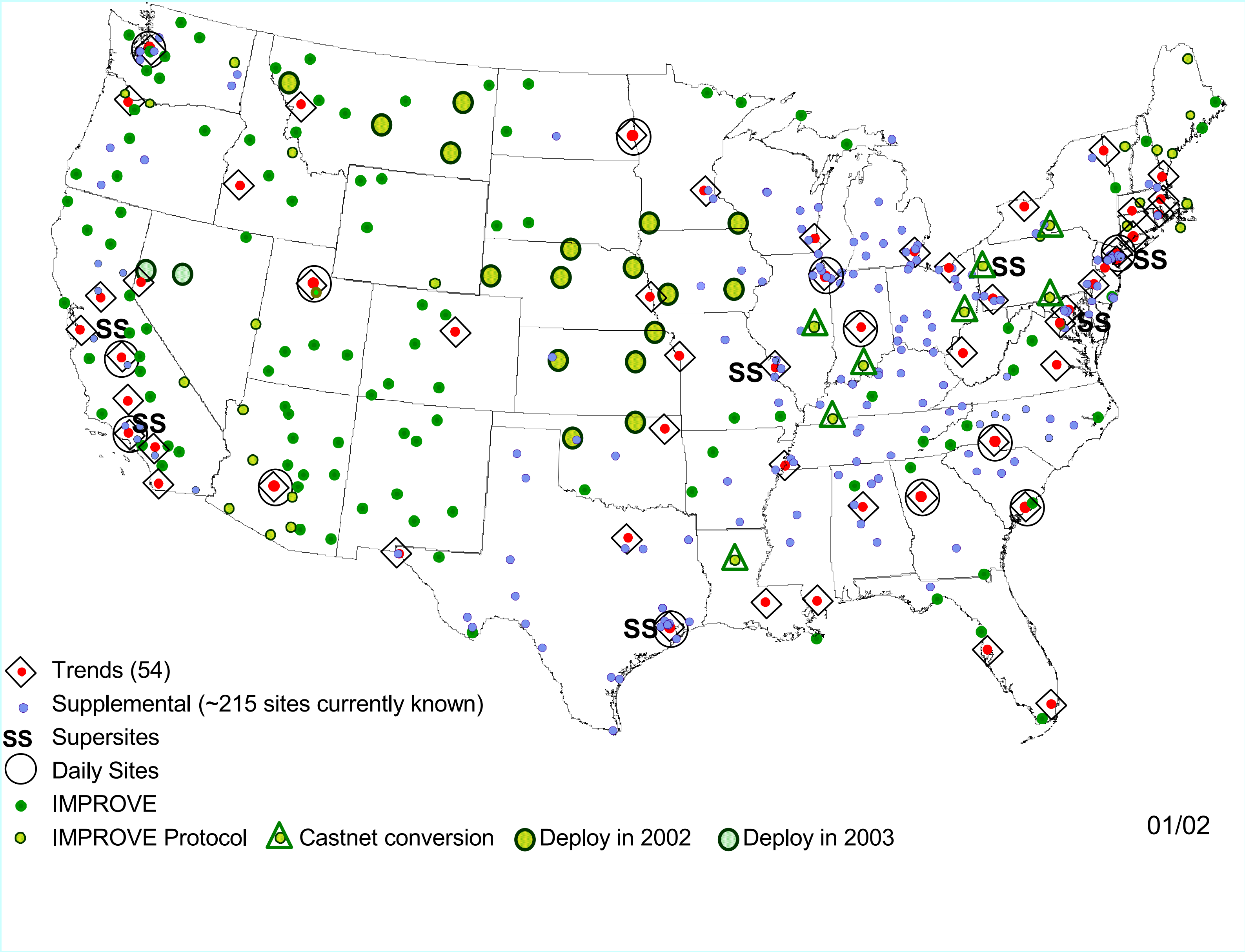
PM2.5 Continuous Monitoring Sites Reporting to AIRNow and AQS - February 2004





Site-to-Site variability within NEW YORK, NY MSA
PM2.5 (µg/m3)
140
120
100
80
60
40
20
0
5
6
7
8
9
10
Date (July 2002)
90%
50%
MSA Median
50%
90%

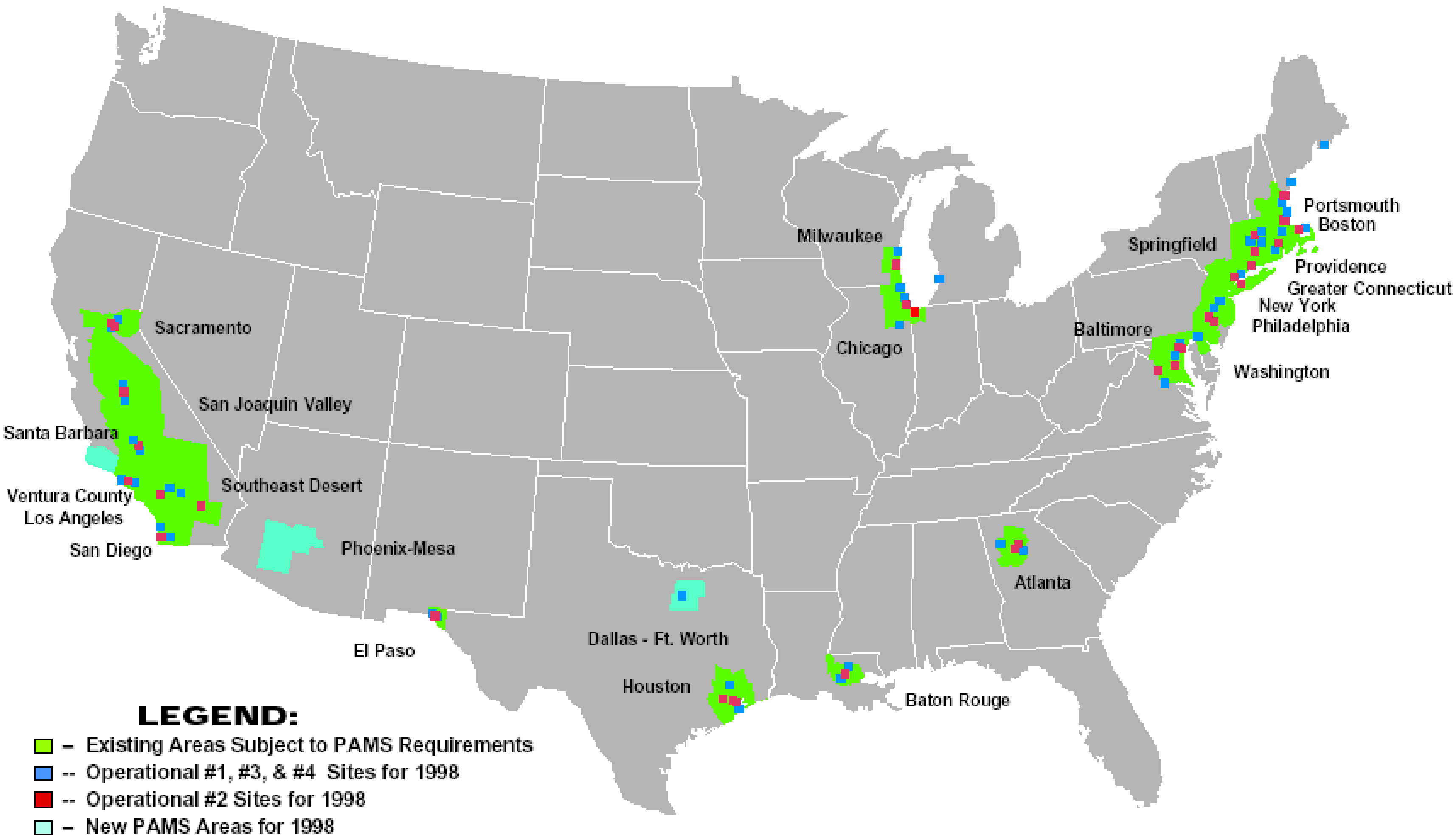
Urban & Rural PM2.5 Speciation Networks



Species Measured in EPA's Fine Particle Monitors

Arsenic	Gold	
Aluminum	Lanthanum	
Barium	Niobium	
Bromine	Phosporus	Ammonium
Cadmium	Selenium	Sodium, by X-Ray Flourescence
Calcium	Tin	Potassium by X-Ray Flourescence
Chromium	Titanium	Measured Organic Carbon
Cobalt	Samarium	OC adjusted by sampler-specific blank
Copper	Scandium	OC_adj multiplied by 1.4 factor (to convert carbon t
Chlorine	Vanadium	Nitrate
Cerium	Silicon	Measured Elemental Carbon
Cesium	Silver	Carbonate Carbon
Europium	Zinc	Volatile Nitrate
Gallium	Strontium	Non-Volatile Nitrate
Iron	Sulfur	Adjustement Factor for making EC_NIOSH and OC_
Hafnium	Tantalum	Sulfate
Lead	Terbium	Total Carbon Mass (sum of OCM_adj and EC)
Indium	Rubidium	Total Carbon (sum of OC_adj and EC)
Manganese	Potassium, by IC	Calculated Sulfate
Iridium	Yttrium	Using IMPROVE Definition: 2.2[Al]+2.49[Si]+1.63[Ca
Molybdenum	Sodium, by IC	
Nickel	Zirconium	
Magmesium	Wolfram (same as Tungsten)	
Mercury		

Operating PAMS Sites, 1998

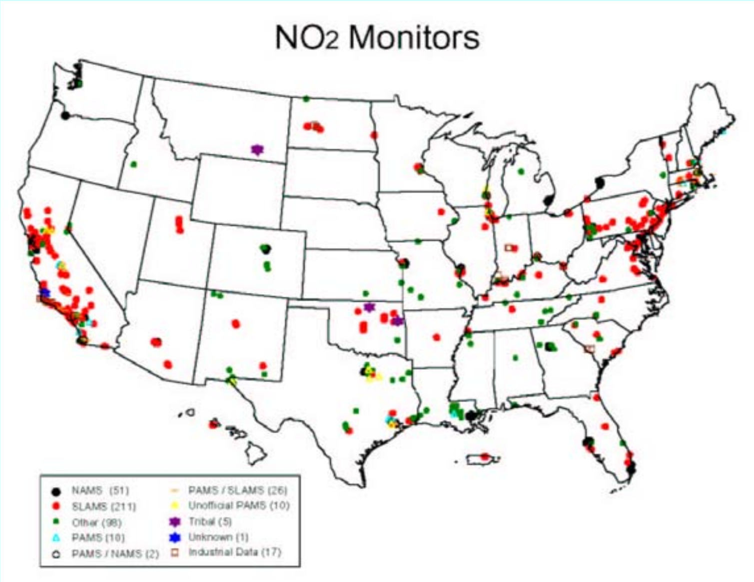


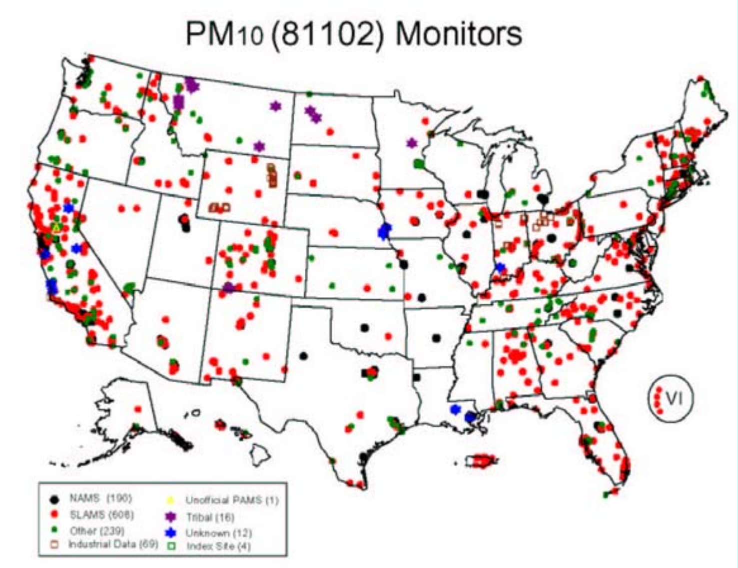
Ozone Precursors – PAMS Measures

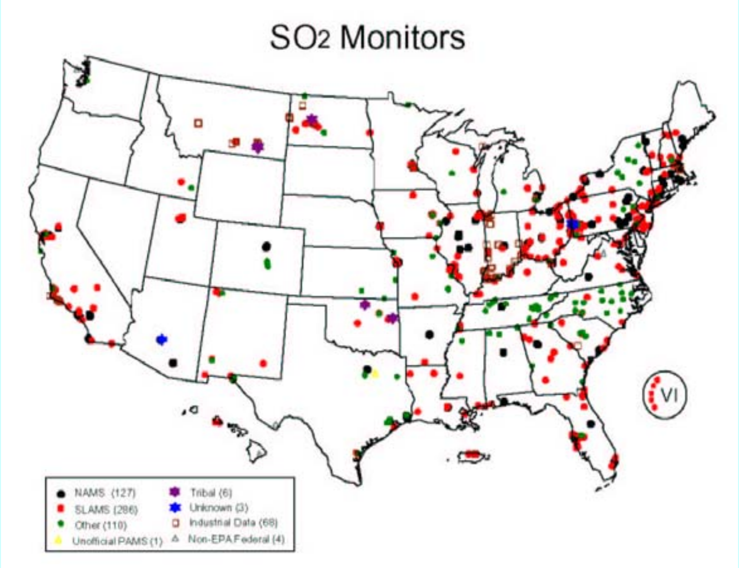
Ozone, nitrogen oxides, VOC sums			***Surface Meteorological***	
Ozone	44201		Temperature	62101
			Wind Speed	61101/3
Nitric Acid	42601		Wind Direction	61102/4
Nitrogen Dioxide	42602		Relative Humidity	62201
Oxides of Nitrogen	42603		Solar Radiation	63301
			uv Radiation	63302/4
Total NMOC	43102		Barometric Pressure	64101
Sum of Targeted	43000		Precipitation	65102

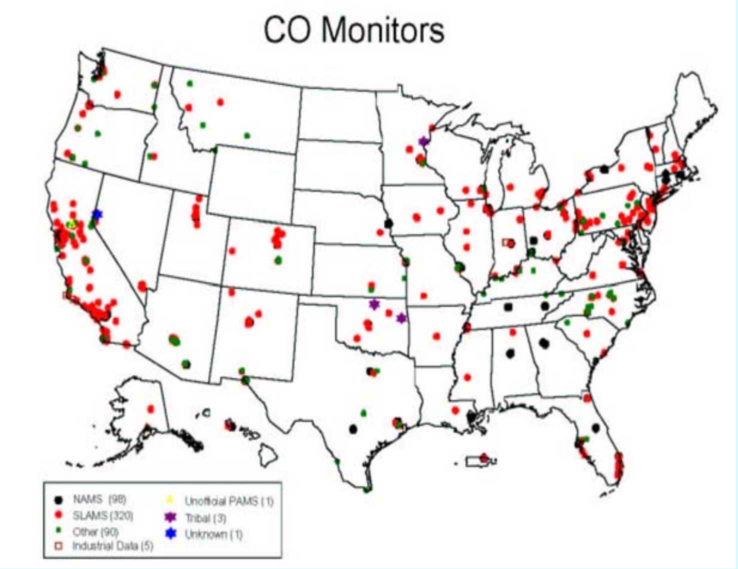
Hydrocarbons (HCs) - listed in elution sequence				
Ethylene	43203		2,3-dimethylpentane	43291
Acetylene	43206		3-methylhexane	43249
Ethane	43202		2,2,4-trimethylpentane	43250
Propylene	43205		n-Heptane	43232
Propane	43204		Methylcyclohexane	43261
Isobutane	43214		2,3,4-trimethylpentane	43252
1-Butene	43280		Toluene	45202
n-Butane	43212		2-methylheptane	43960
t-2-Butene	43216		3-methylheptane	43253
c-2-Butene	43217		n-Octane	43233
Isopentane	43221		Ethylbenzene	45203
1-Pentene	43224		m&p-Xylenes	45109
n-Pentane	43220		Styrene	45220
Isoprene	43243		o-Xylene	45204
t-2-pentene	43226		n-Nonane	43235

Hydrocarbons (HCs) - listed in elution sequence				
c-2-pentene	43227		Isopropylbenzene	45210
2,2-Dimethylbutane	43244		n-Propylbenzene	45209
Cyclopentane	43242		m-Ethyltoluene	45212
2,3-dimethylbutane	43284		p-Ethyltoluene	45213
2-methylpentane	43285		1,3,5-Trimethylbenzene	45207
3-Methylpentane	43230		o-Ethyltoluene	45211
2-Methyl-1-Pentene	43246		1,2,4-trimethylbenzene	45208
n-hexane	43231		n-Decane	43238
Methylcyclopentane	43262		1,2,3-trimethylbenzene	45225
2,4-dimethylpentane	43247		m-Diethylbenzene	45218
Benzene	45201		p-Diethylbenzene	45219
Cyclohexane	43248		n-Undecane	43954
2-methylhexane	43263			
Carbonyls				
Formaldehyde	43502			
Acetone	43551			
Acetaldehyde	43503			

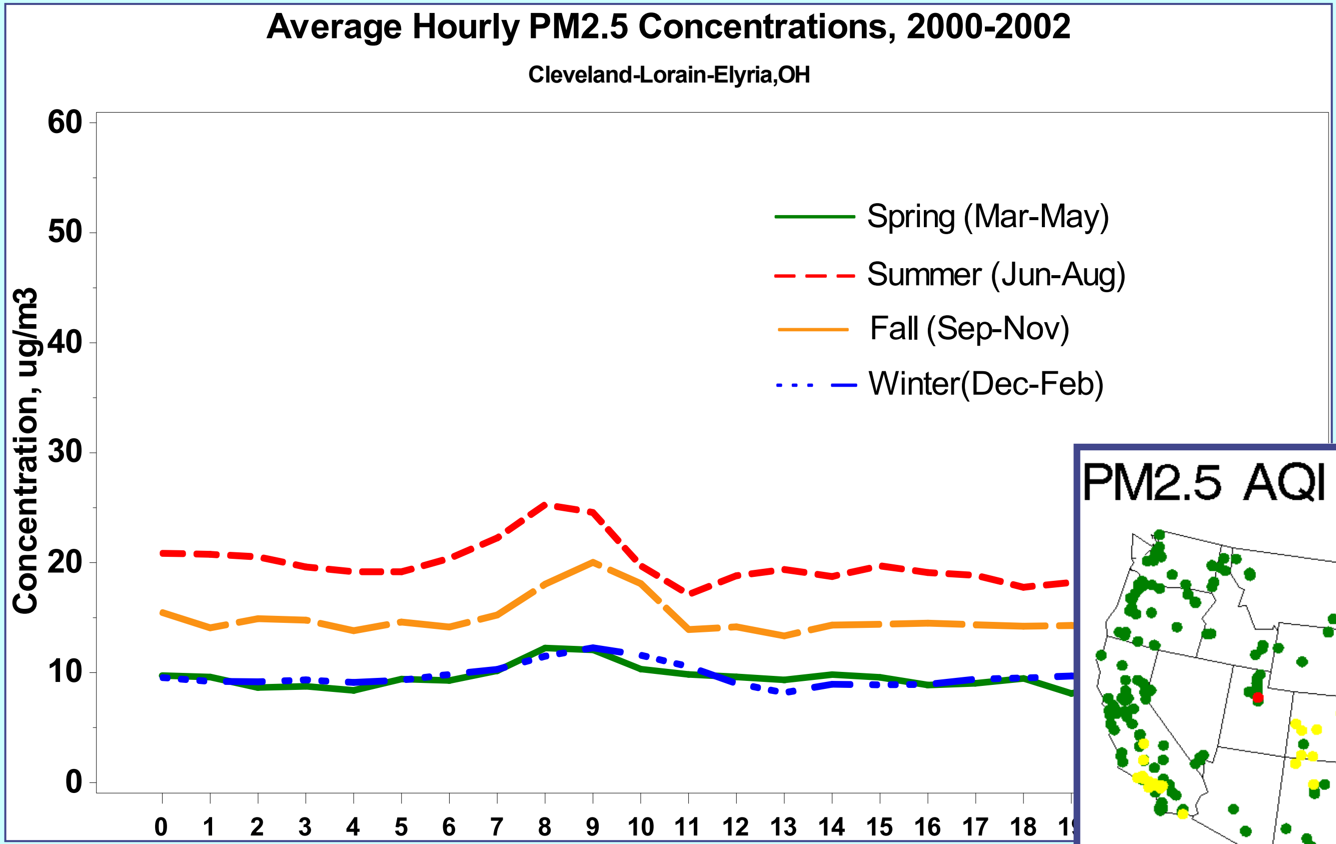

NO2 Monitors
NAMS (51)
SLAMS (211)
Other (98)
PAMS (10)
PAMS / NAMS (2)
PAMS / SLAMS (26)
Unofficial PAMS (10)
Tribal (5)
Unknown (1)
Industrial Data (17)

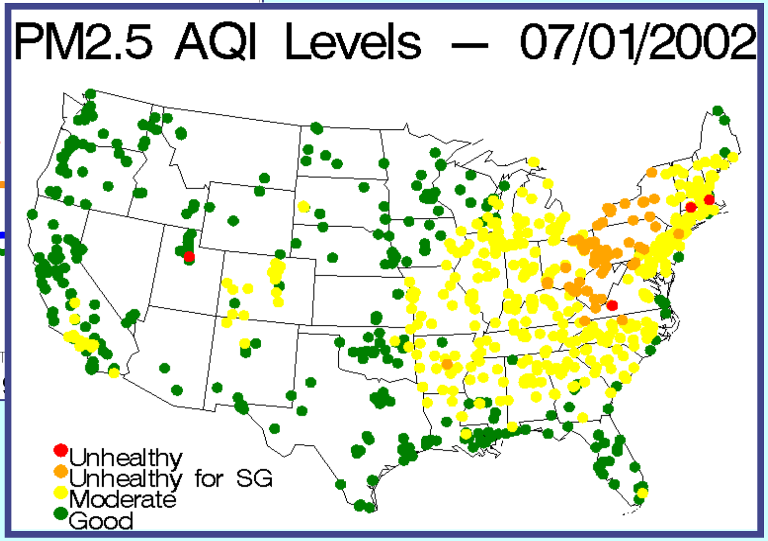

PM10 (81102) Monitors
VI
NAMS (190)
SLAMS (608)
Other (239)
Industrial Data (69)
Unofficial PAMS (1)
Tribal (16)
Unknown (12)
Index Site (4)


SO2 Monitors
VI
NAMS (127)
SLAMS (286)
Other (110)
Unofficial PAMS (1)
Tribal (6)
Unknown (3)
Industrial Data (68)
Non-EPA Federal (4)


CO Monitors
NAMS (98)
SLAMS (320)
Other (90)
Industrial Data (5)
Unofficial PAMS (1)
Tribal (3)
Unknown (1)

We assess spatial and temporal patterns; perform exploratory analyses





Trends summaries and special studies are available at
www.epa.gov/airtrends

Air quality agencies participating in AIRNow

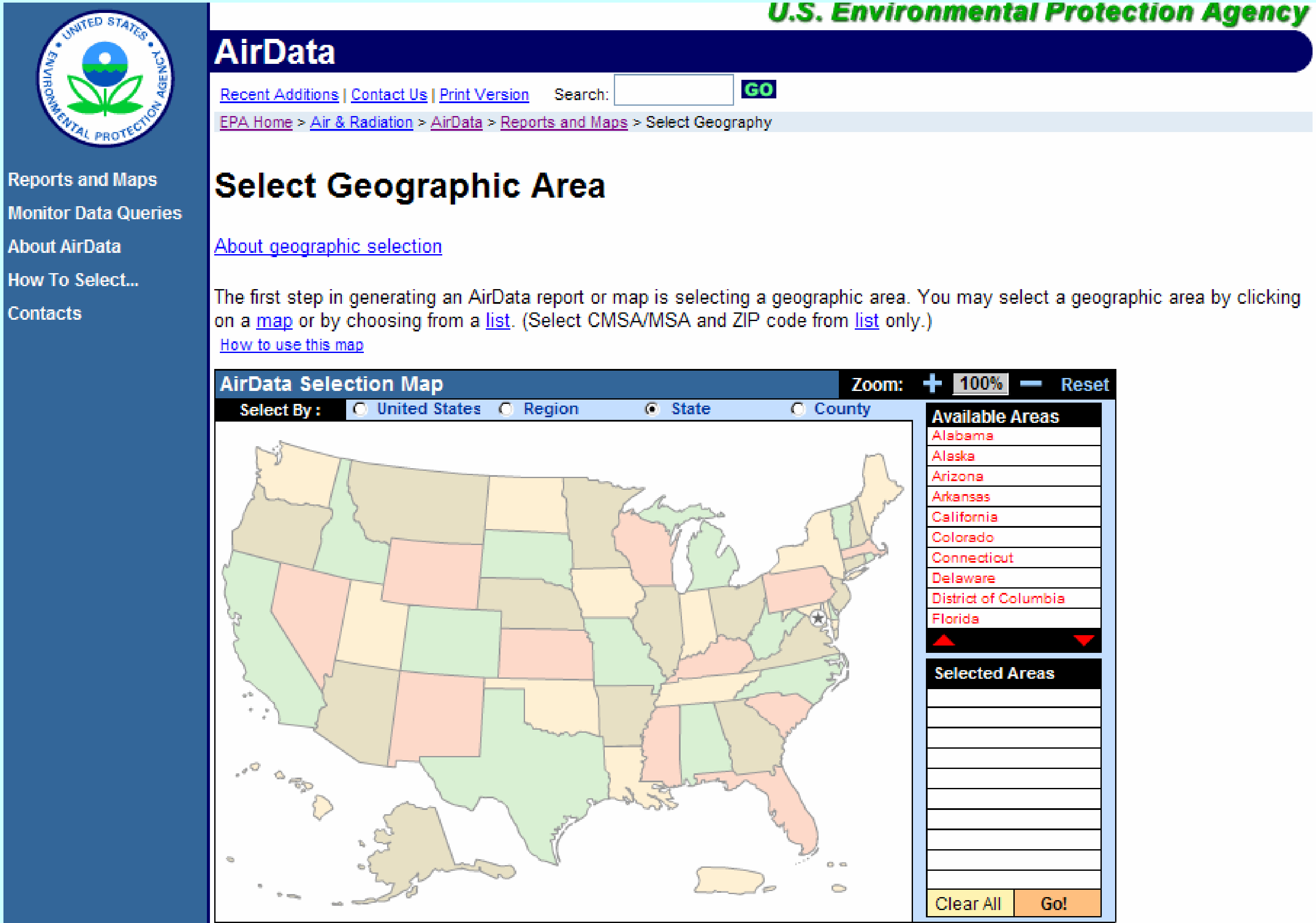
www.epa.gov/airnow

- Local agencies perform the data collection, QA, and forecasting
- Data generally collected hourly
- 300 cities forecasting for ozone
- 150 cities forecasting for $PM_{2.5}$
- Variety of forecasting techniques

AQI Values	AQI Category (Descriptor)	AQI Color
0 - 50	Good	Green
51 - 100	Moderate	Yellow
101 - 150	Unhealthy for Sensitive Groups	Orange
151 - 200	Unhealthy	Red
201 - 300	Very Unhealthy	Purple
301 - 500	Hazardous	Maroon

- Peak daily concentration reported as AQI value
- Forecasted data reported as AQI value or AQI category
- Both hourly and daily peak data are archived
- Forecasted information archived as well

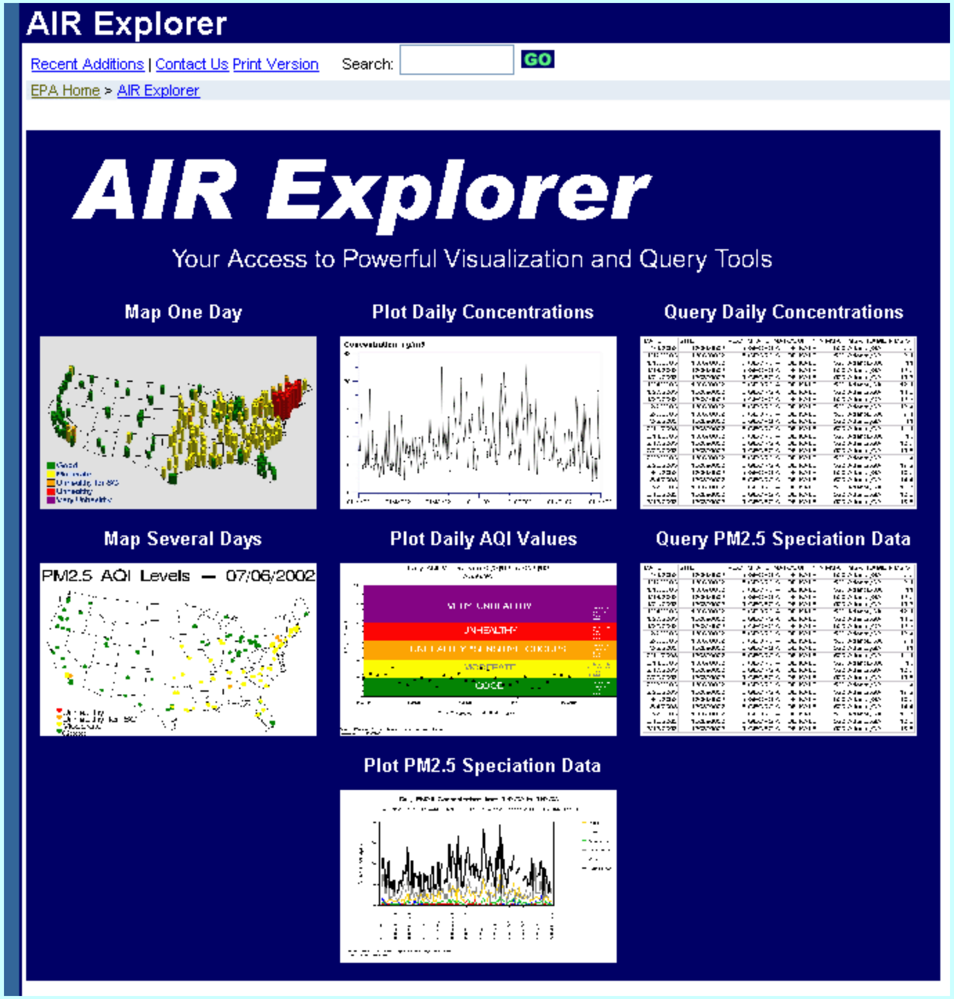
AIR Data provides data for general public



http://www.epa.gov/air/data/

Large data sets at: http://www.epa.gov/ttn/airs/airsaqs/archived%20data/downloadaqsdata.htm

We're Developing Web-based Tools for Air Quality Analysis

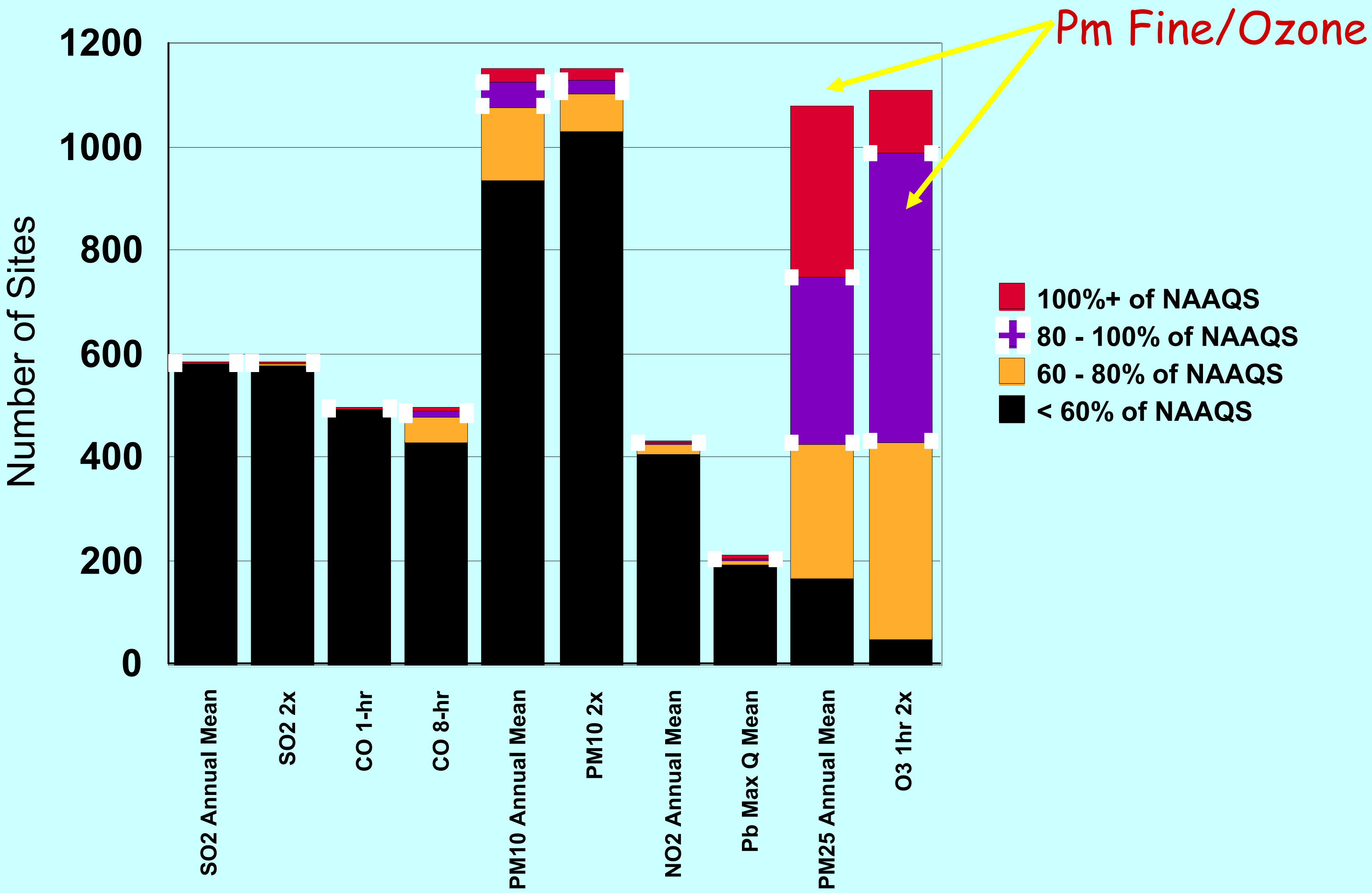


- Powerful Web-driven analytical tools
- Generates output dynamically
- Only need a Web browser
- Currently available on EPA's Intranet...
  intranet.epa.gov/airexplorer
- Plan to provide broader access later in 2004

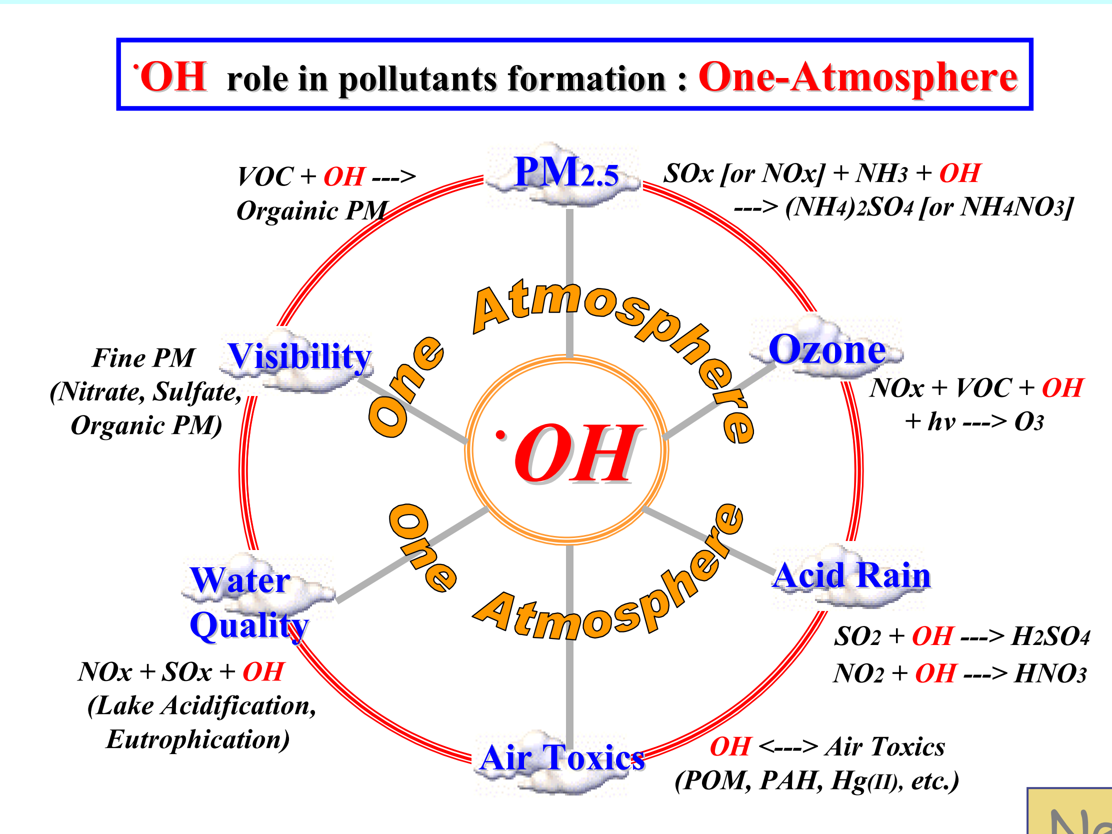
EPA effort to “redesign” national monitoring networks

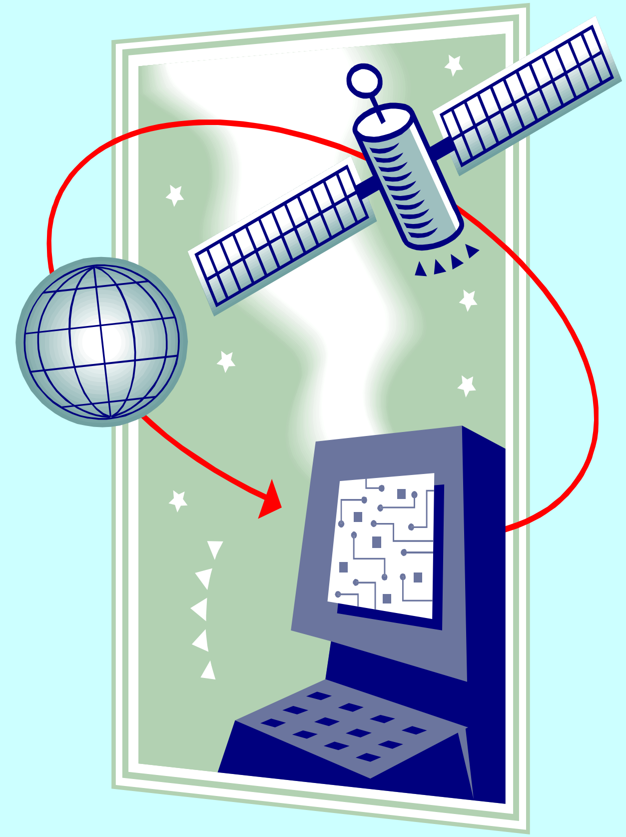
- Reduce redundant, “low-value” monitors and realign resources to address current or emerging monitoring priorities
- Multi-pollutant measurements
- Real-time measurements
- Improvements in information transfer
- Support multiple monitoring objectives
- Integration and leveraging among monitoring programs

Most measurements (except O3, PM2.5) are well below NAAQS



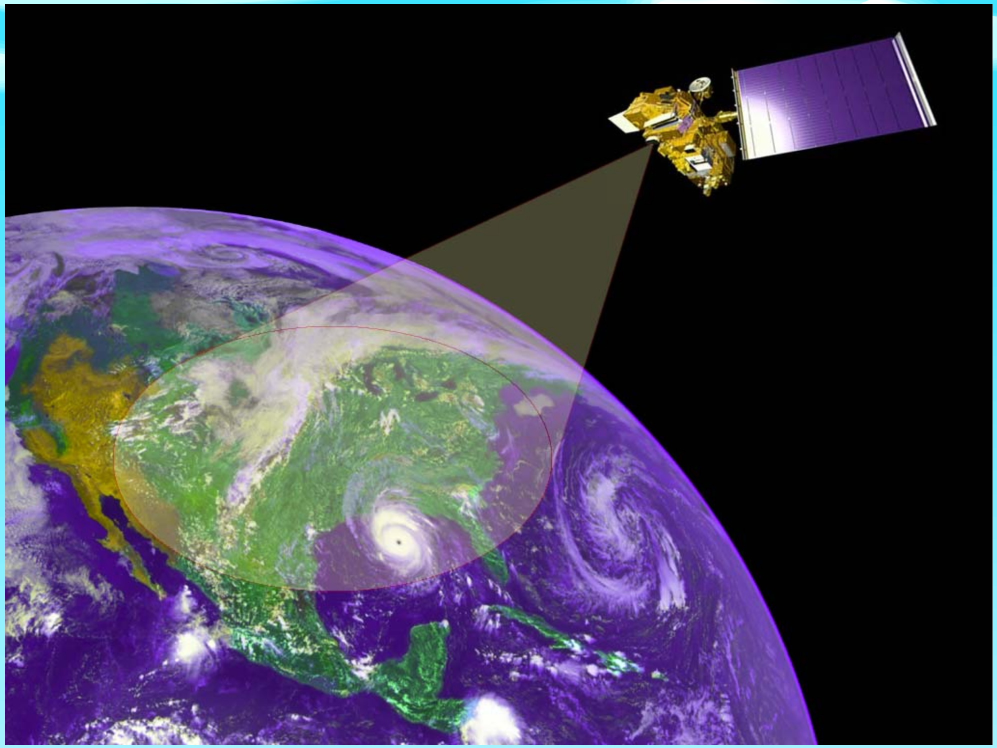
Progress in science/technology to address this complex work.



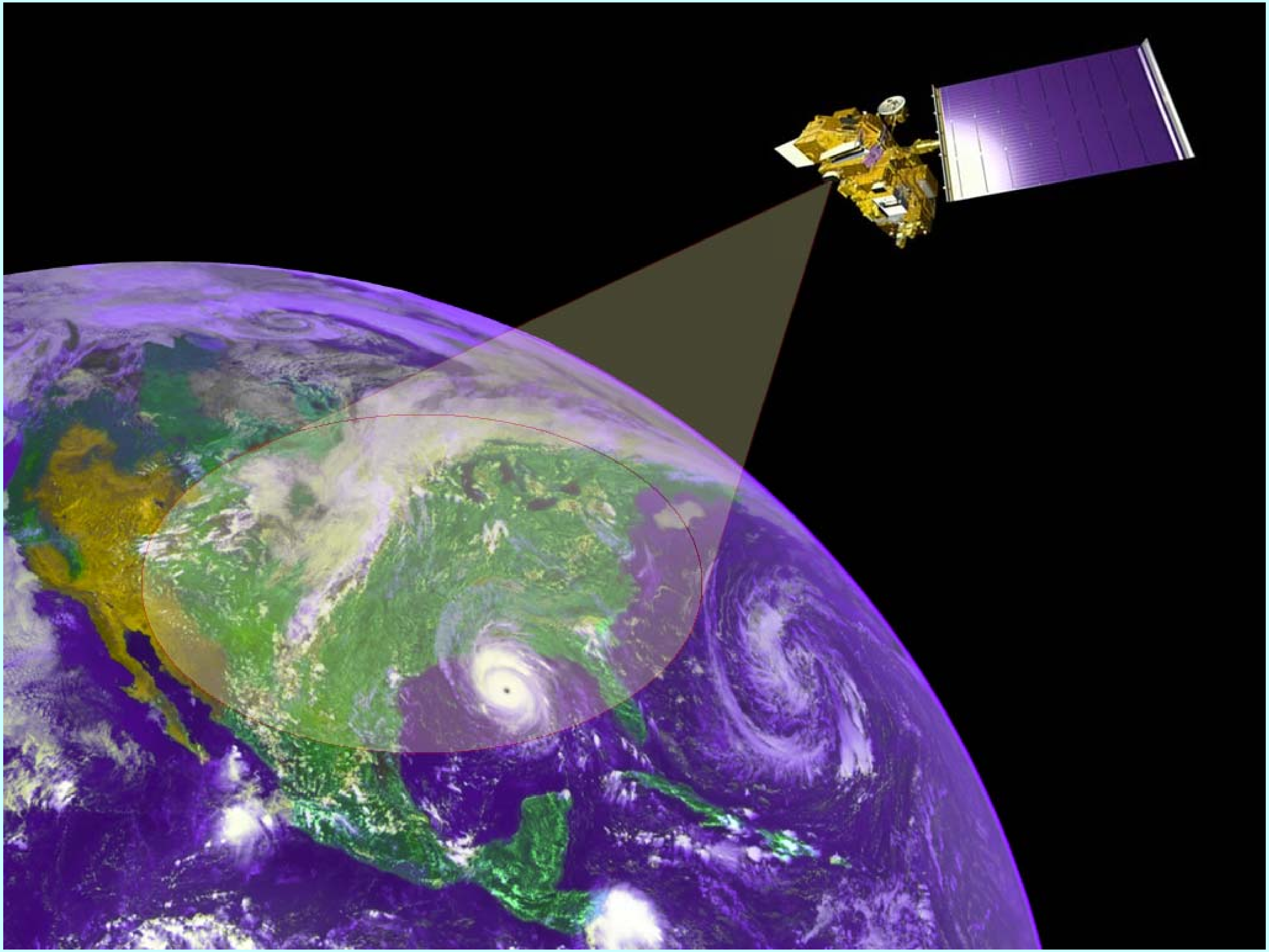


Air Pollution === Complex Problem

New Monitors --
Linked to Wireless Networks,
Data Systems & Models



Satellite Monitoring for Air Quality

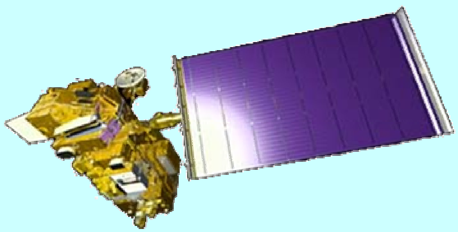


Target Observables for Air Quality

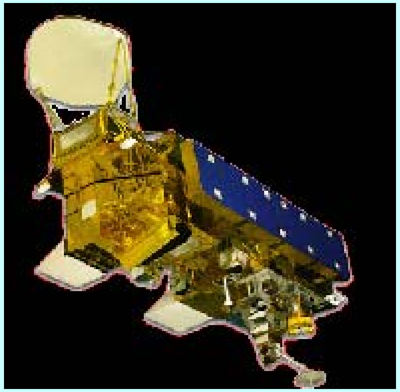
Pollutant	Current Sensors	Measurement
Sulfur dioxide (SO_2)	GOME	Column
Formaldehyde (H_2CO)	GOME	Column
Carbon monoxide (CO)	MOPPIT, AIRS	Column
Nitrogen dioxide (NO_2)	GOME	Column
Ozone (O_3)	TOMS/SBUV, AIRS	Column, Profile
Particulate Matter (PM2.5) (as aerosol optical depth)	TOMS, AVHRR, MODIS, SeaWIFS, GOME, SCIAMACHY, GOES	Column

The MODIS Sensor Sees Aerosols

- **MOD**erate-Resolution **I**maging **S**pectroradiometer
- Designed for mapping land, ocean and atmospheric characteristics



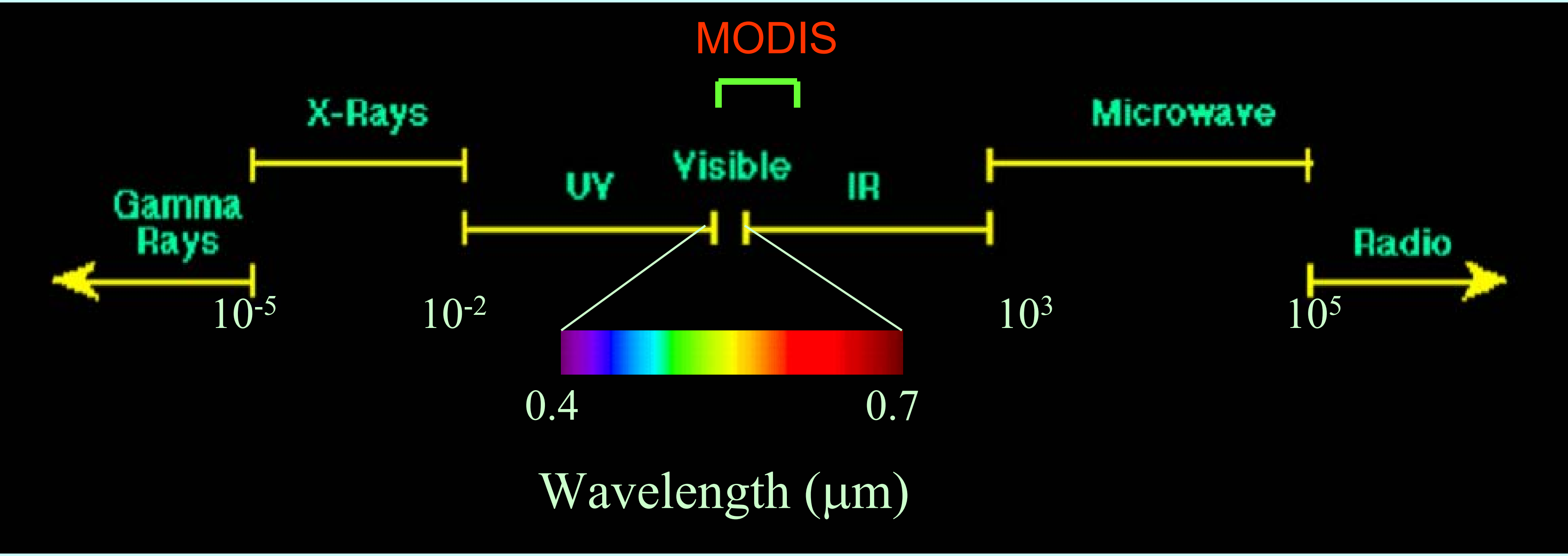
TERRA
- Launched 18 Dec 1999
- ~10:30 AM Equatorial Crossing (Descending)
- First image acquisition – April 2000



AQUA
- Launched 4 May 2002
- ~1:30 PM Equatorial Crossing (Ascending)
- First image acquisition – July 2002

What Does MODIS Do?

MODIS measures a portion of the electromagnetic spectrum from 0.4 to 14.5 µm that is reflected and radiated back to space. This includes the visible and the thermal infrared spectrums.



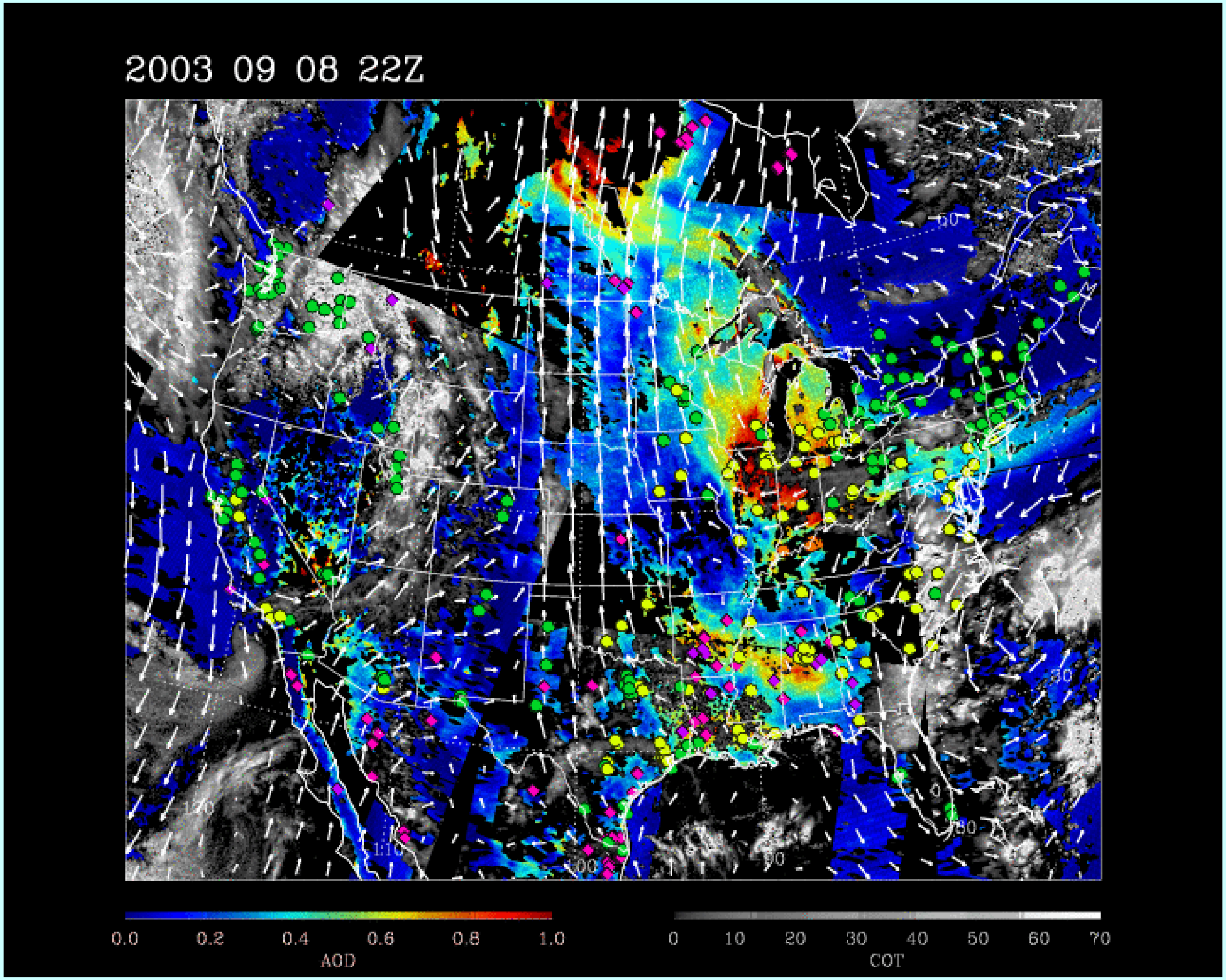
MODIS data collection results in 44 data products describing many of Earth's vital signs, from ocean/land surface temperatures to the properties of clouds.

Some Details of MODIS “Aerosol Optical Depth”

- Spatial resolution of pixels - 10 km x 10 km
- AOD is a total column product, limitations exist due to lack of vertical distributions of aerosols.
- Can not “see” through clouds. .
- Competing processes of surface reflection and aerosol backscatter prevent consistent data retrievals over areas with high surface albedo.

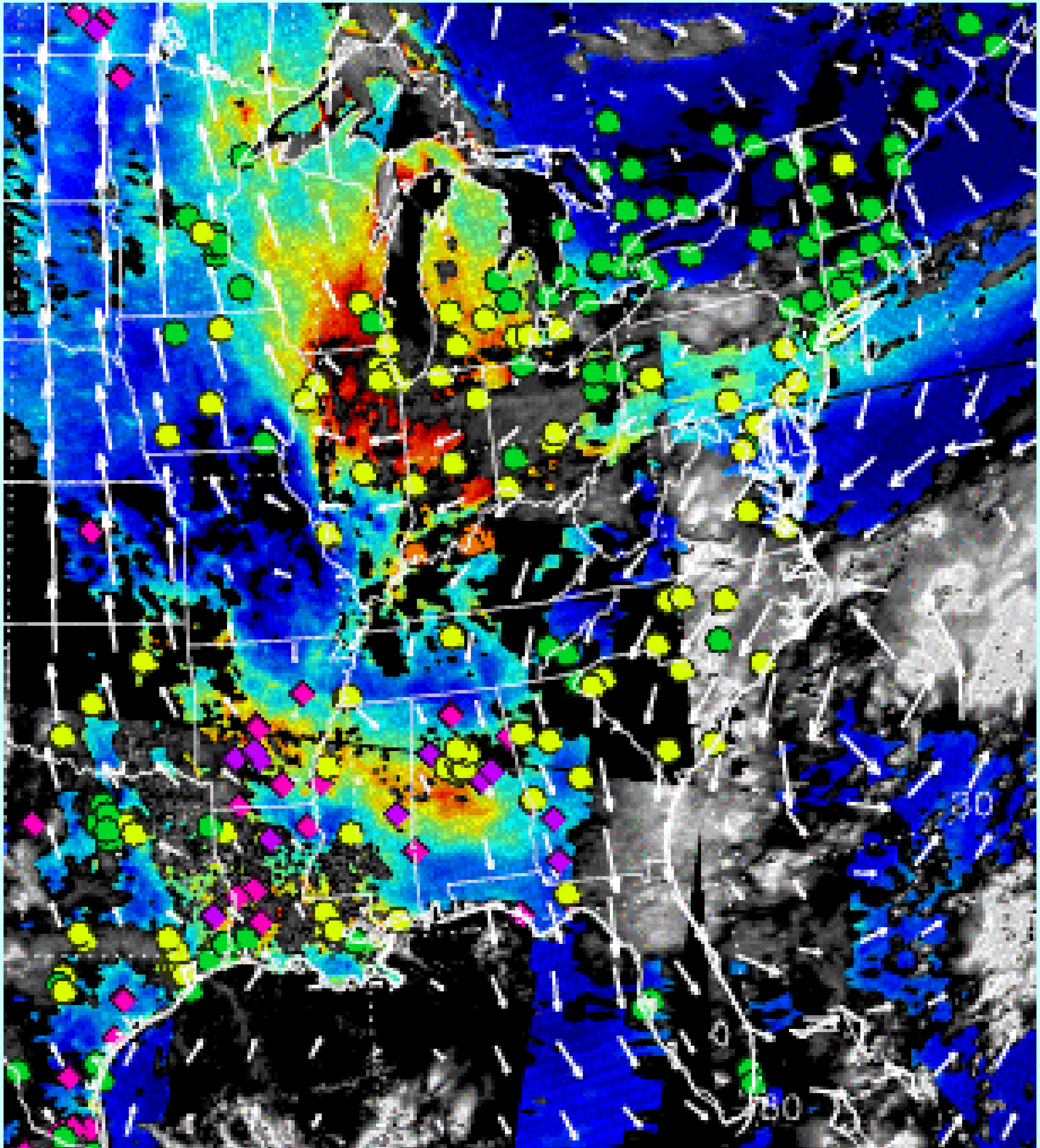
< Back

Composite PM2.5/MODIS Aerosol Optical Depth Data Fusion



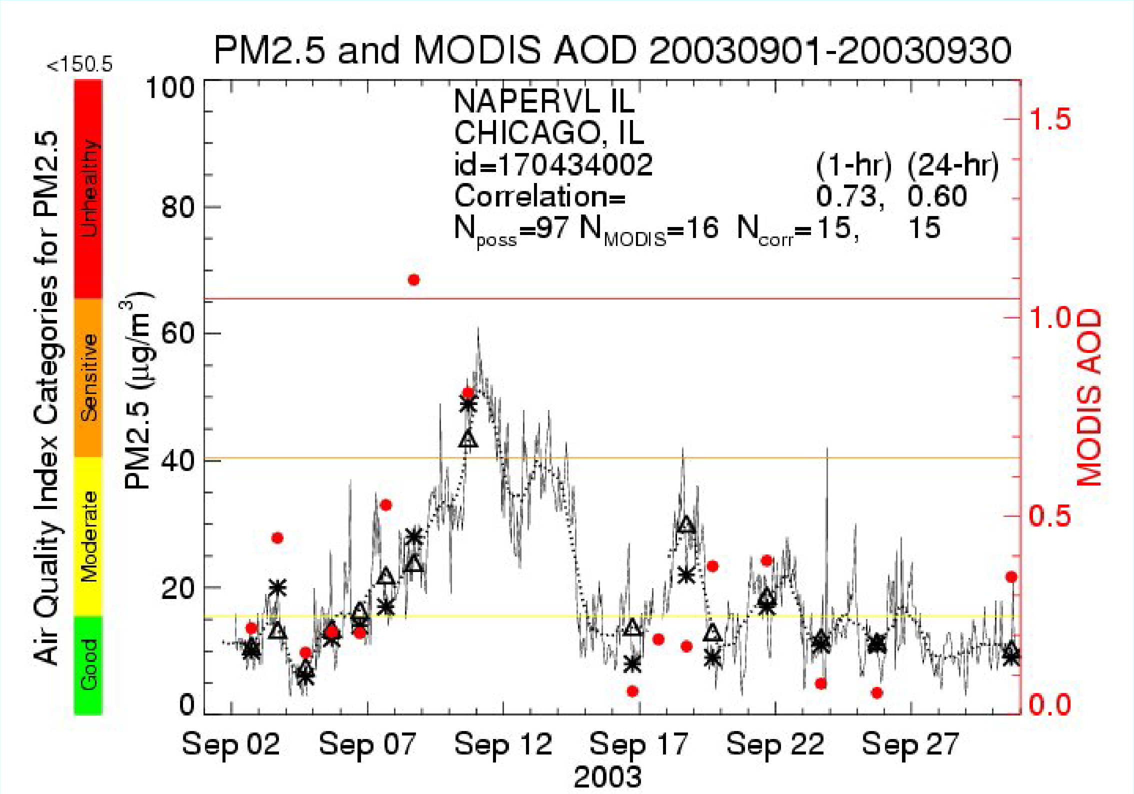
MODIS AOD captures spatial extent of large scale aerosol events during cloud free conditions (US EPA, 2003, Kittaka, C. 2004, and Engel-Cox, J. et. al. 2004).

A closer look …



Evaluation of MODIS AOD/PM2.5

Chicago, IL September 2003 Time series



MODIS AOD shows strong correlations with PM2.5 mass concentrations during large scale aerosol events (US EPA, 2003 and Engel-Cox, J. et. al. 2004).

MODIS AOD predicts correct AQI level >90% (regional AL study) (Wang, J. et al., 2003).

Where do we go from here ?

- Evaluate Existing Air Quality Networks for Use in Public Health Tracking
- Develop “Pilot” Projects to Understand Usefulness of Air Quality Data and Learn About Public Health Tracking Needs
- Consider Network Assessment and Updates as Way to Improve Usefulness
- Expand Use of New Technology
  - Remote sensing (satellite)
  - Analytical Tools