Strengths and limitations of current PM and O_3 monitoring data

Tim Hanley
EPA - Office of Air Quality Planning and Standards

EPA and CDC Symposium on Air Pollution Exposure and Health
Tuesday September 19, 2006
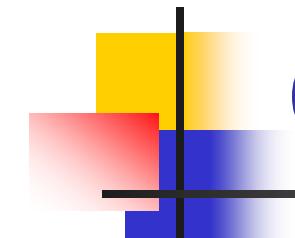
Overview of PM and O_3 Networks

- **Large robust networks**
    - $PM_{2.5}$
        - Most sites in locations to capture community-wide population exposure, (i.e., neighborhood scale).
        - Background and transport sites for each State
    - PM_{10}
        - Most sites at middle and neighborhood scale
    - $PM_{10-2.5}$
        - Proposal from this past January; Final rule expected next week.
    - O_3
        - Downwind sites designed to capture high concentrations
        - Urban sites designed to capture high-density population-exposure
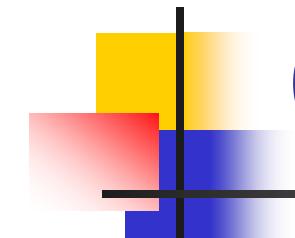
Ozone Monitoring Network

- Objectives
  - Primary - support NAAQS attainment/non-attainment decisions
  - Secondary - trends, development of emission control strategies, support for health studies, and public reporting through Air Quality Index.
- Strengths
  - Sites
    - O_3 is well characterized in almost all urban areas, via 1226 active sites
  - Sampler and Methods
    - Consistent Method – almost all use UV method
    - Hourly data available in near real-time
  - Data Quality - robust QA/QC program
    - Precision – National estimate is that 90% sites controlled to within 3%
    - Bias – National bias estimate is that 90% of sites between (-4.79) and (+5.76) percent.
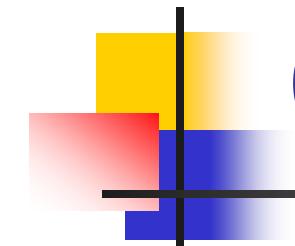
Ozone Monitoring Network

- Limitations
    - Limited ozone season in most areas typically only covers warm weather months
    - Growth in VMT's/highways may be causing some sites to be more susceptible to titration by NOx.
    - Limited rural coverage; NPS and CASTNET sites can help
- Comment
    - Site characteristics may require individual research, if important.

PM$_{2.5}$ FRM/FEM and Ozone Monitoring Sites

- • PM2.5 FRM/FEM Sites
- ■ Ozone Sites
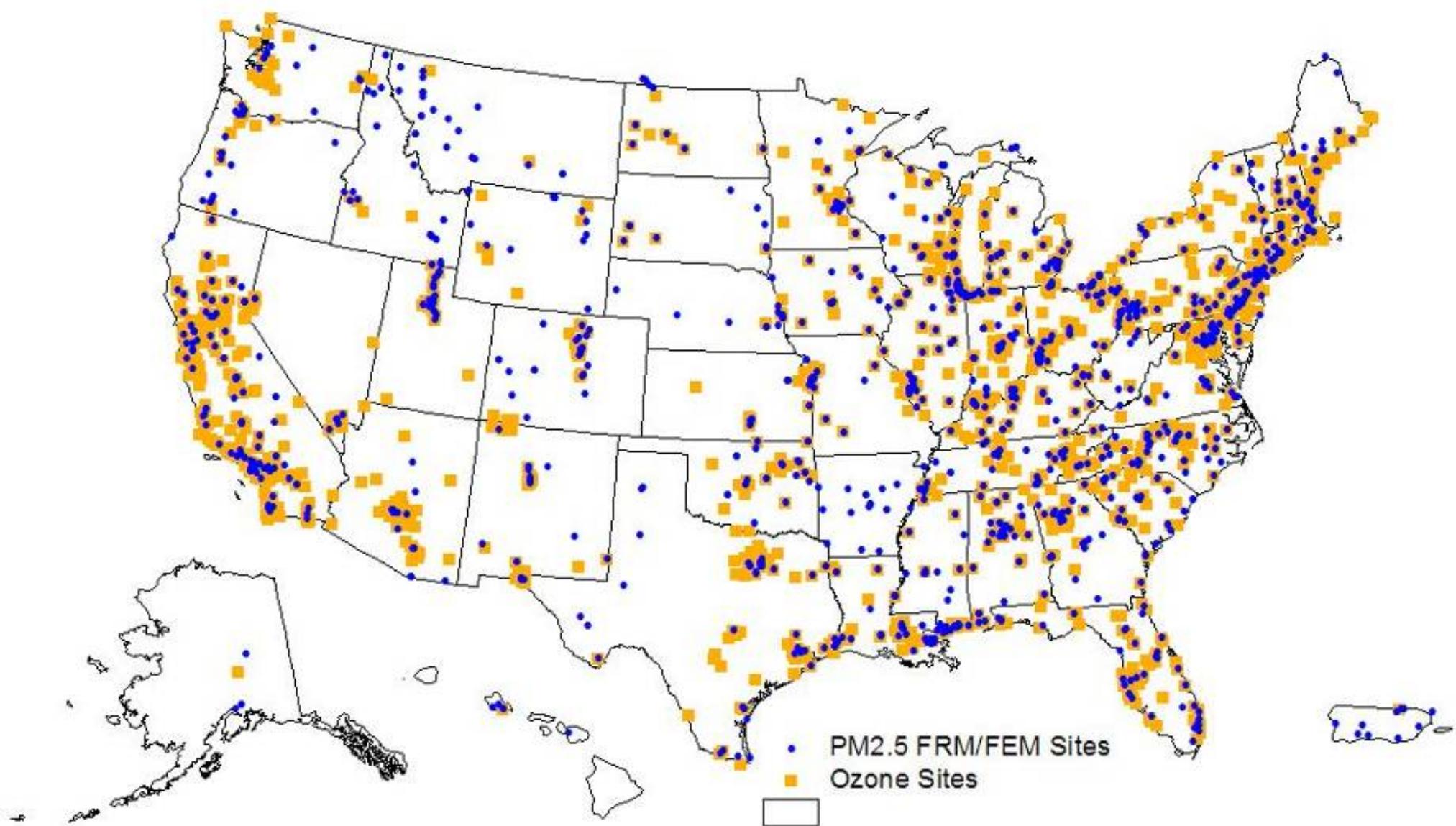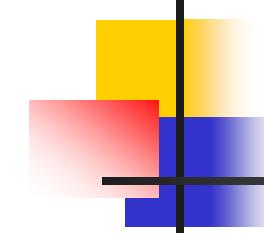
PM$_{2.5}$ Federal Reference Method (FRM) /Federal Equivalent Method (FEM)

- **Objectives**
  - Primary - support NAAQS attainment/non-attainment decisions;
  - Secondary - trends, development of emission control strategies, support for health studies, and public reporting through Air Quality Index.

- **Strengths**
  - Sites
    - PM$_{2.5}$ is well characterized in most areas with fine particle issues
      - 933 active Federal Reference Method (FRM) and filter-based Federal Equivalent Method (FEM) sites
      - ~ 125 sites operate every day
  - Sampler and Methods
    - All sites use one of three instrument manufacturer series of samplers; consolidation will leave two series of samplers in next few years.
    - Consistently implemented methods according to 40 CFR part 50, Appendix L
    - Gravimetric mass measured in well controlled laboratories for temperature and RH
  - Data Quality - robust QA/QC program
    - Precision – National estimate is that 90% of sites controlled to within 7.3%
    - Bias – National bias estimates, compared to independently operated FRMs, of (-2%)

6
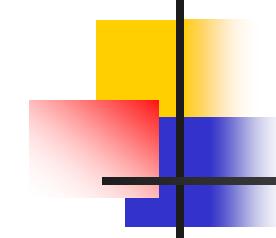
PM$_{2.5}$ FRM/FEM

- Limitations
  - Sample frequency
    - Over 600 sites operate on a 1:3
    - Another 100+ sites operate on 1:6
  - Time resolution – 24 hour integrated samples.
  - Lag in data availability due to post-sampling laboratory analyses and data validation of ~1-3 months.
  - Recently proposed standards may necessitate moving a small number of sites.
  - May not have many sites to evaluate gradients in some areas, especially medium and small cities, modeling can help.
  - Sampling occurs at ambient conditions; therefore, some of the semi-volatile species are lost, especially on warmer days.
  - Near roadway sites are pretty limited.
- Comment
  - Site characteristics may require individual research, if important.

PM$_{2.5}$ Chemical Speciation Program

- **Strengths**
  - **Sites**
    - 216 Chemical Speciation sites plus IMPROVE (110 sites + 35 State operated and CASTNET sites).
      - 54 Speciation Trend Network (STN) sites are for long-term trends
      - Additional 162 Speciation State and local Air Monitoring Stations (SLAMS)
    - Some rural sites exist which allow for estimates of background and urban bump.
    - Good coverage for current and expected PM2.5 non-attainment
  - **Sampler and Methods**
    - Most (>80%) STN and SLAMS Speciation sites use Met One Sampler
    - All States use national contract lab for STN sites
  - **Chemical Species**
    - Anions – Particulate sulfate, nitrate
    - Cations – Particulate ammonium, sodium, and potassium
    - Trace elements - ~35 key elements.
    - Total carbon – sum of organic, elemental and carbon (measured separately)
    - Gravimetric mass

PM$_{2.5}$ Chemical Speciation and IMPROVE Monitoring Sites

Legend:
- Speciation SLAMS
- IMPROVE
- Speciation Trends Sites
- Continuous Speciation Sites with Multiple Measurements
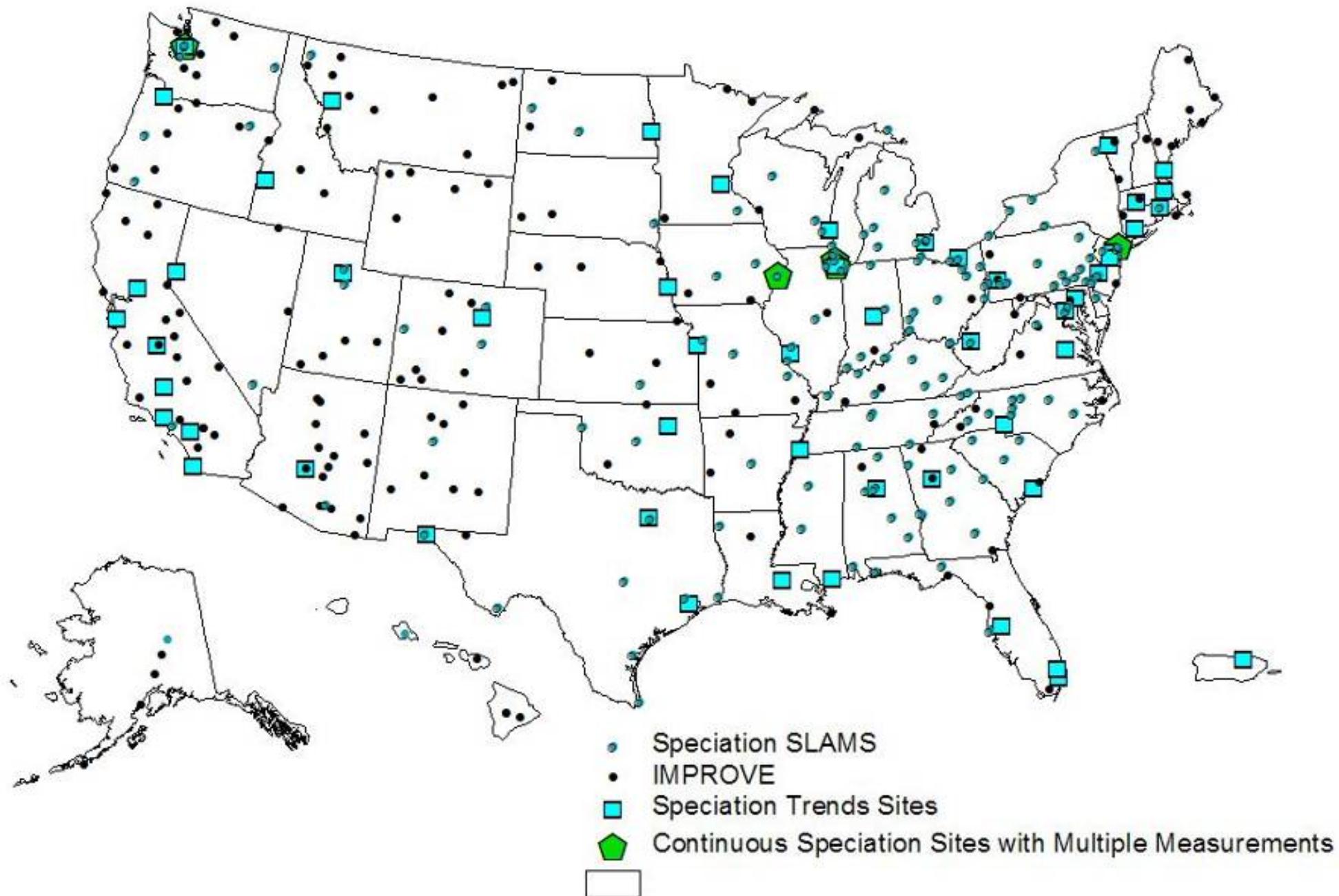
# PM$_{2.5}$ Chemical Speciation Program

- Limitations
  - Sample frequency of 1:3 for STN and IMPROVE; mostly 1:6 for SLAMS speciation
  - Time resolution – 24 hour integrated samples. Only a handful of continuous (1 hour) monitoring sites.
  - ~ 3 month time lag in data availability for National Contract lab
  - Large costs have potential for some sites to be at risk.
    - SLAMS speciation previously cut by ~40 sites
    - IMPROVE evaluating its program now
  - Comparability of STN/SLAMS speciation carbon method to IMPROVE carbon method.
    - Implementation of IMPROVE approach for carbon measurement (sampling and laboratory) at STN/SLAMS speciation is about to begin.
- Other
  - Blank corrections are made based on estimates of field blank values.
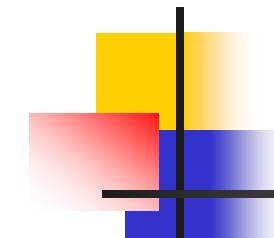
PM$_{2.5}$ Continuous Mass Sites

- **Strengths**
  - Sites
    - Good coverage in most areas with fine particle issues
    - 514 Continuous Mass Sites
  - Sampler and Methods
    - Reporting monitors are correlated to FRM/FEMs
    - No post-sampling laboratory analysis
  - Data Reporting
    - Everyday monitoring with hourly data reports updated nationally on AIRNow and AIRNowTech
    - Data support forecast reports for most large and many other cities each day
    - Reporting of current AQI uses last 12 hours of data with weighting for more recent hours for estimate of "mid-point" 24 hour AQI.
    - Reporting of previous days AQI based on average of midnight-to-midnight mass concentration.

PM$_{2.5}$ Continuous Mass Sites by Method

- ▲ Andersen BAM
- ▲ Correlated Radiance Nephelometer
- ▲ Met One BAM
- ▲ FDMS
- ▲ TEOM
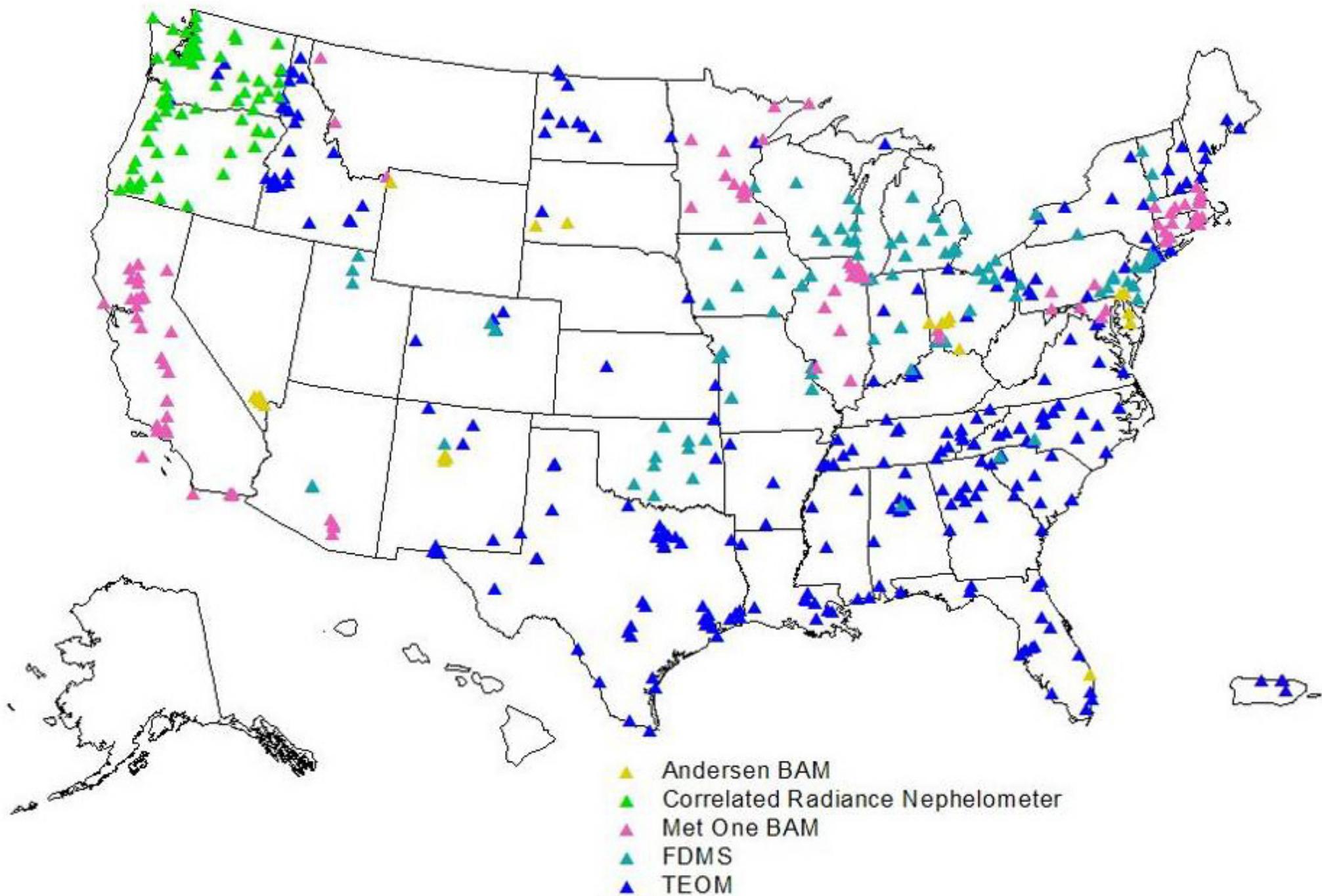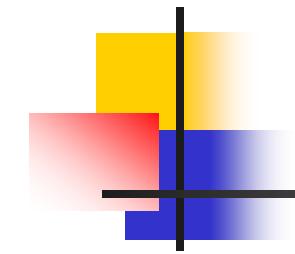
PM$_{2.5}$ Continuous Mass Sites

- **Limitations**
  - Methods
    - No methods have been approved as equivalent methods
    - Various methods have been implemented based on selection of State, local, and tribal agencies
  - Data Transformations
    - Although many states have statistically correlated their PM$_{2.5}$ continuous methods; its often difficult to track down what these are and how often they are updated
  - Data Quality
    - Some methods have seasonal biases as compared to FRM/FEM
    - Some methods have better/worse precision than others, especially for short-term (1-3) hour data
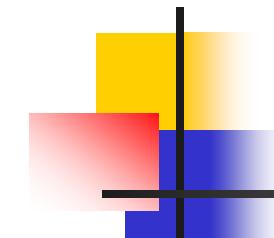
PM$_{10}$ Monitoring Sites

- **Strengths**
  - Sites
    - Large, long-term operational network
    - Large number of sites in most large cities with coarse particle problems
  - Sampler and Methods – Special Notes
    - 146 samplers are the same make and model as a PM$_{2.5}$ FRM without the second-stage separator.
    - 220 continuous monitors, with 86 sites reporting to AIRNowTech in near real-time

Current PM10 Network
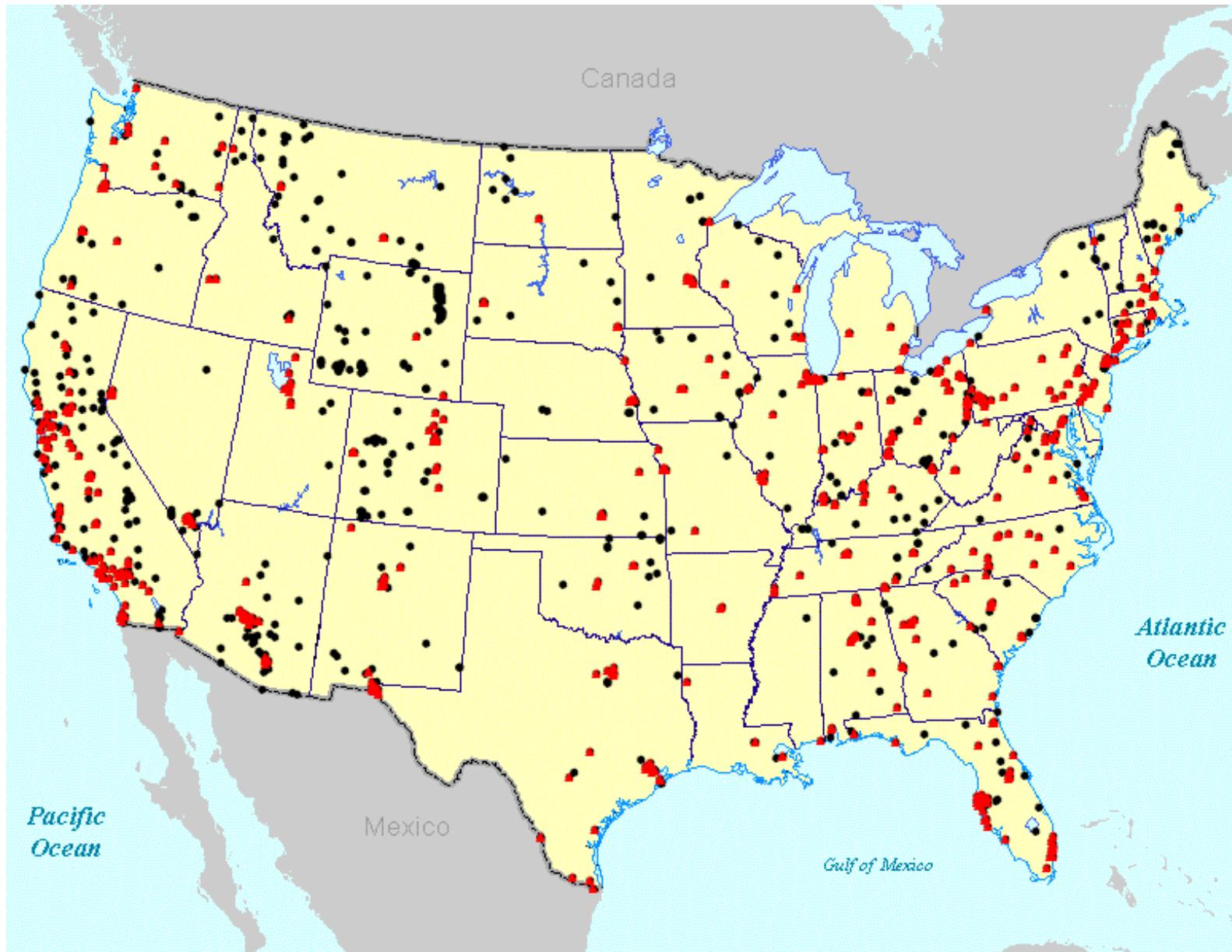
1206 – Monitors reporting data in 2005

835 – Monitors within CBSAs (whole counties)

647 – Monitors within urbanized areas >50,000 population
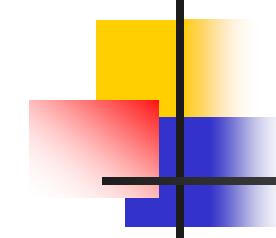
PM$_{10}$ Monitoring Sites

- **Limitations**
  - **Similar to PM$_{2.5}$**
    - Sample frequency – most filter sites operate on 1:6 or 1:3 sample frequency.
    - Time resolution – 24 hour integrated samples.
    - Lag in data availability due to post-sampling laboratory analyses and data validation of ~1-3 months.
    - May not have many sites to evaluate gradients in some areas, especially medium and small cities.
    - Gravimetric method has similar sampling issues to PM$_{2.5}$ FRM.
  - **Unique to PM$_{10}$**
    - Recently proposed standards may result in changes to network.
    - Hi-volume method used at majority of sites is less precise than low-volume method.
    - Virtually no speciation data for PM$_{10}$
    - No independent QA program to assess method bias.
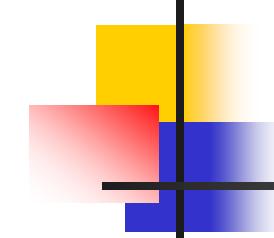
PM$_{10-2.5}$

- Complex proposal in January 2006
- Stay tuned for final, expected September 27.
- Looking backwards
  - Substitution of PM$_{2.5}$ from PM$_{10}$ has best precision when samples are the same make/model at the same station. At most 146 of these.
  - Data users have relaxed this restriction to get large geographical and temporal data set.

EPA has proposed adding new Multi-pollutant Monitoring Stations

- National Core (NCore) Multi-Pollutant Network
  - Network plans due July 1, 2009
  - Full network operational by January 1, 2011
    - ~75 Stations Nationally
    - ~55 Urban Sites at Neighborhood to Urban Scale
    - ~20 Rural Sites at Regional Scale
    - 1-3 sites per State
    - 50 States, plus, DC, VI, and PR
    - States with 2-3 sites – CA, FL, IL, MI, NY, NC, OH, PA, TX.
    - Additional rural sites negotiated with States, NPS, Tribes, CASTNET
- Pollutants
  - Particles
    - $PM_{2.5}$ filter-based and continuous, speciated $PM_{2.5}$, PM10-2.5 FRM/FEM or continuous $PM_{10-2.5}$ FEM
  - Gases
    - O_3; high-sensitivity - CO, SO_2, NO/NO_y
  - Meteorology
    - Minimally - Ambient Temperature, WS, WD, RH

**Working Draft of
NCore Multi-pollutant Stations**

NCore Multi-pollutant Site Tool

- Web-based tool is being developed to provide information and seek input on design of NCore
- Includes
  - Site metadata
  - Site pictures
  - Satellite and street maps
  - Networks station is being leveraged with
  - Links to information on NCore
  - **Ability to review and post comments on each station**
- Expect to roll-out tool in late fall 2006
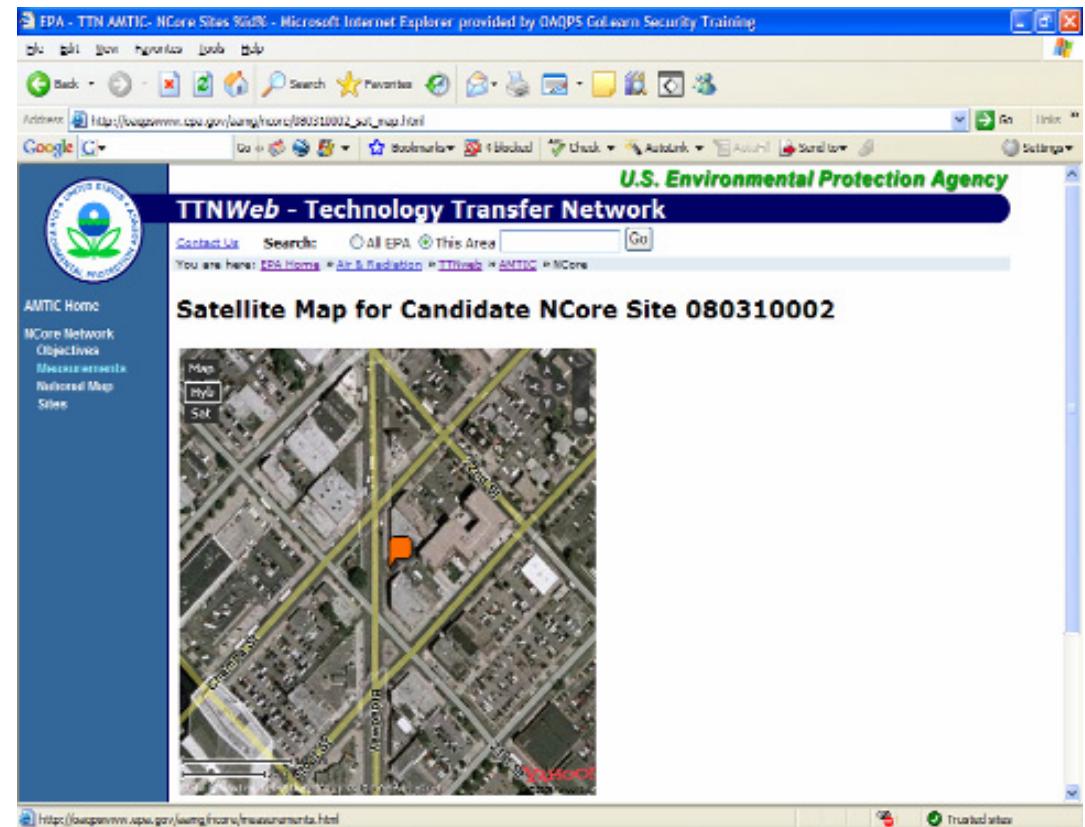
Ambient Air Monitoring Data Flow

PM$_{2.5}$ Data Issues that may be of interest

- PM$_{2.5}$ site meta data improvements
  - EPA is working with monitoring agencies to ensure every PM$_{2.5}$ site has the appropriate monitoring objectives properly recorded on AQS (e.g., population exposure, regional transport...)

- New parameter codes for PM$_{2.5}$
  - EPA is working with monitoring agencies to store PM$_{2.5}$ continuous monitoring data into 4 major bins:
    - **PM$_{2.5}$ Local Conditions** - 88101**–** data to be used in NAAQS decision making.
    - **PM$_{2.5}$ Total Atmospheric –** 88500 - For methods measuring total PM$_{2.5}$ aerosols in the atmosphere, including those that can be volatilized from the FRM. Volatile channel stored as 88503.
    - **PM$_{2.5}$ Raw Data** – 88501 - For continuous methods that have produced validated data <u>without</u> respect to whether it reasonably match the FRM
    - **Acceptable PM$_{2.5}$ AQI & Speciation Mass –** 88502 - Valid data that <u>does</u> reasonably match the FRM with or without data transformations, but is not to be used in NAAQS decisions.
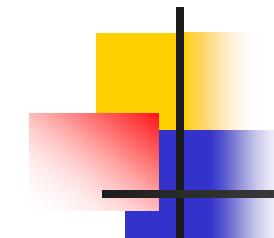
Web Sites of Interest

- **Real-time air pollution data and maps**
  - http://airnow.gov/
    - AIRNOW - Ozone and PM2.5 maps, State/local Air Quality forecasts
  - http://airnowtech.org
    - Recent real-time maps and data
  - http://idea.ssec.wisc.edu/
    - Uses MODIS Satellite data and AIRNow observations

- **Historical AIR Monitoring Data**
  - http://www.epa.gov/ttn/airs/airsaqs/
  - http://www.epa.gov/air/data/
  - http://vista.cira.colostate.edu/views/
    - IMPROVE
  - http://www.epa.gov/airexplorer/

- **Ambient Monitoring Technology Information Center (AMTIC)**
  - http://www.epa.gov/ttn/amtic/
    - Ambient Monitoring Technology Information Center
    - Program information, methods, links to regulations
  - http://www.epa.gov/ttn/amtic/supersites.html
    - Supersites Research