

ORD Research Activities as the “6th PM Center”

**Dan Costa
Air Research Program
Office of Research and Development
US Environmental Protection Agency**

**PM Centers Kick-off-RTP
November 30, 2005**

EPA PM Research Program



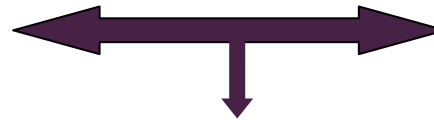
Epidemiology



Molecular

Clinical and Animal
Toxicology Studies

Intramural Program



EPA STAR Program
(PM Centers)

EPA Partners:

- *Other Federal Agencies*
- *Health Effects Institute*
- *National Research Council*
- *Academia*
- *Industry laboratories*

Emission Source
Characterization



Exposure, Atmospheric
Measurement and
Models



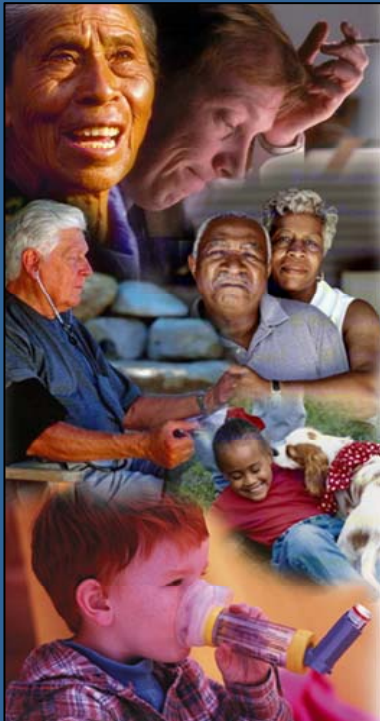
Supersites and EPA
Monitoring Network

RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions

PM Program Must be Responsive

Clean Air -- EPA Goal 1



“Protect and
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OMB PART

OAR, Regions, States, Tribes

Scientific Community

Public

“An Assessment of Tropospheric Ozone Pollution — A North American Perspective”

NATIONAL RESEARCH COUNCIL

Research Priorities for Airborne Particulate Matter

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Research Priorities for Airborne Particulate Matter

IV

Continuing Research Progress

Board on Ozone Science and Criteria

April 14, 2005
Revised August 11, 2005

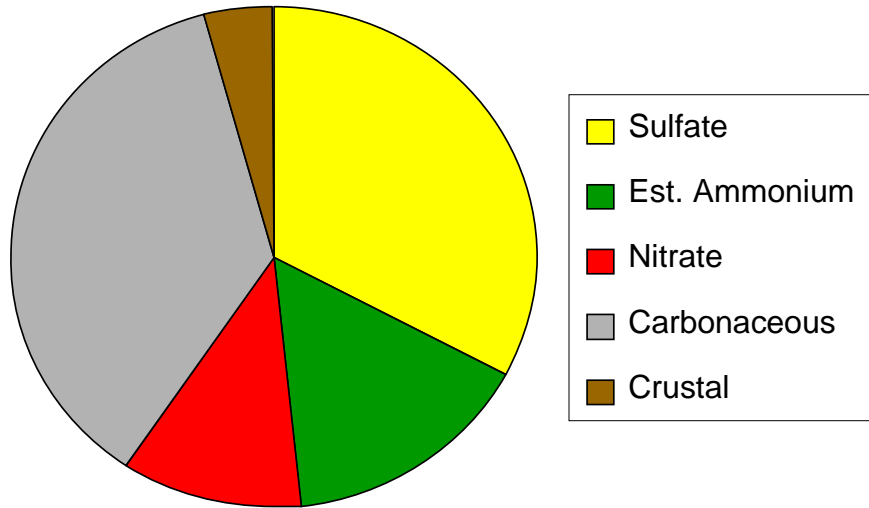
2003 2004 2005

RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions

Reality: Multiple Sources & Pollutants

► PM/O₃/AT



Pollutants contributing to PM_{2.5} and Ozone

SO₂ – Sulfate particles

NO_x – Nitrate PM, acid gases, formation of ozone and organic PM

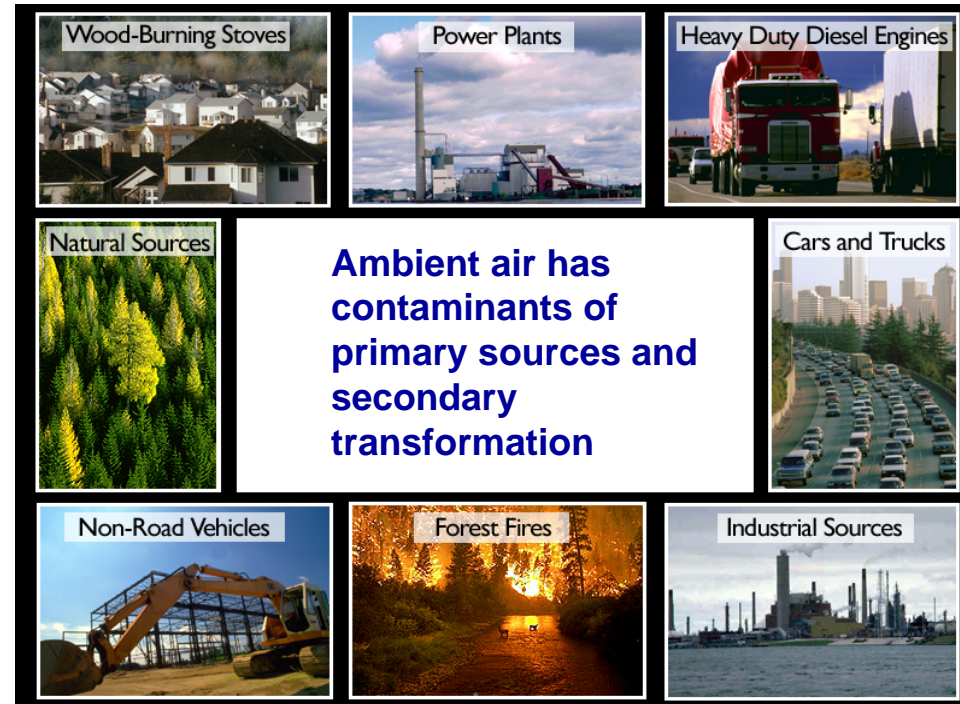
VOC – formation of ozone and organic PM

VOC(C6unsat) – secondary organic PM

NH₃ – Ammonium

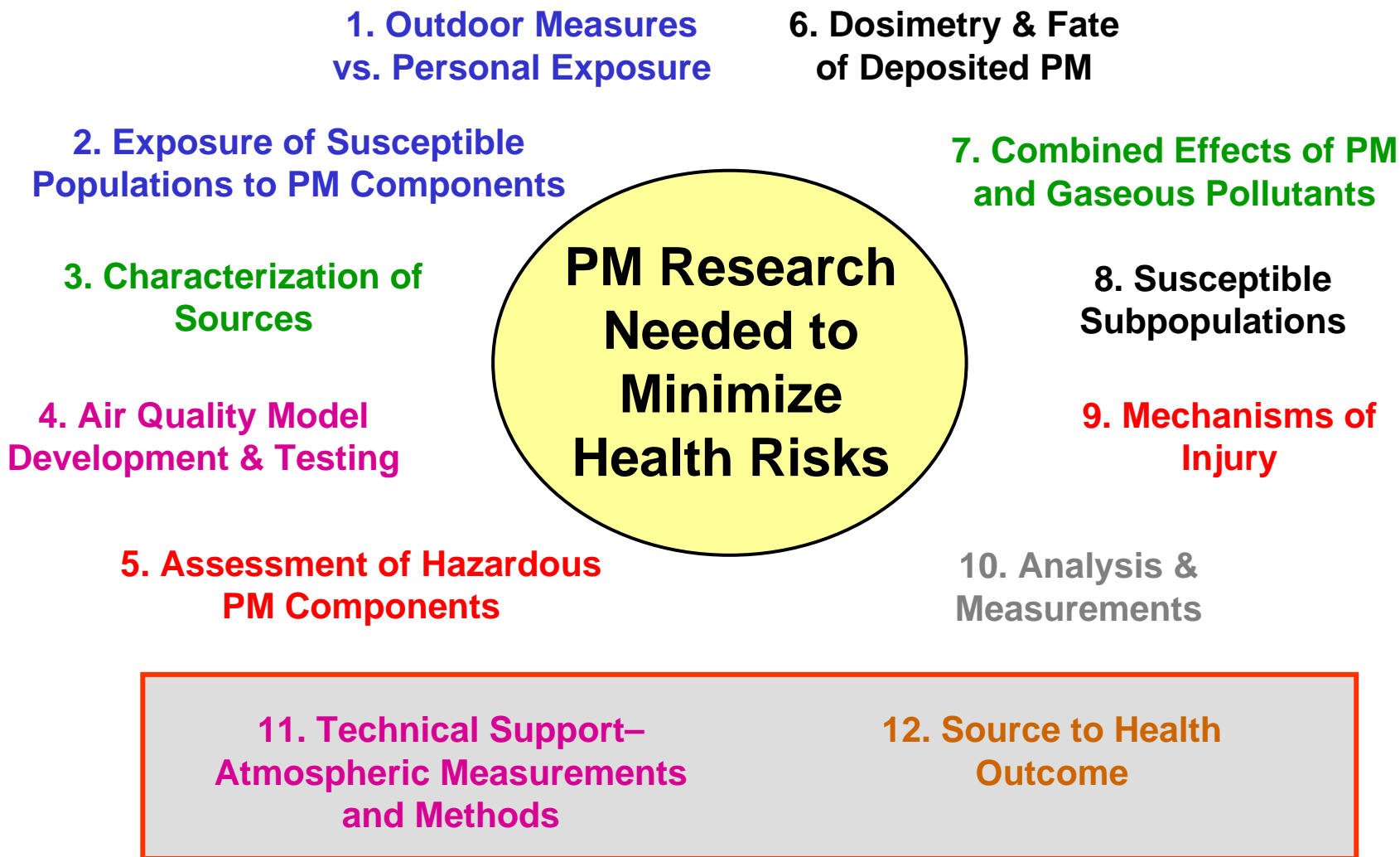
Direct emissions of carbonaceous PM, crustal materials, metals

CO – weak contribution to ozone formation



Overlap of source types, VOC/PM components and 'toxic' air pollutants

NRC Guides EPA's Research Priorities for PM



Focus on Long Term Goals

Long-term Goal 1

- Progress toward reducing uncertainty in standard setting and air quality management decisions due to advances in understanding in the air pollution sciences.

Long-term Goal 2

- Progress in assessing source to health linkages and reducing uncertainties that obscure these linkages.

Major In House Research Areas Tied to the LTGs

- **Health Research**
 - Hazardous components
 - Susceptible subpopulations
 - Exposure-dose-response
- **Exposure Research**
 - Data and models to bridge source to effects
- **Atmospheric Science Research**
 - Emissions characterization
 - Measurement and modeling tools

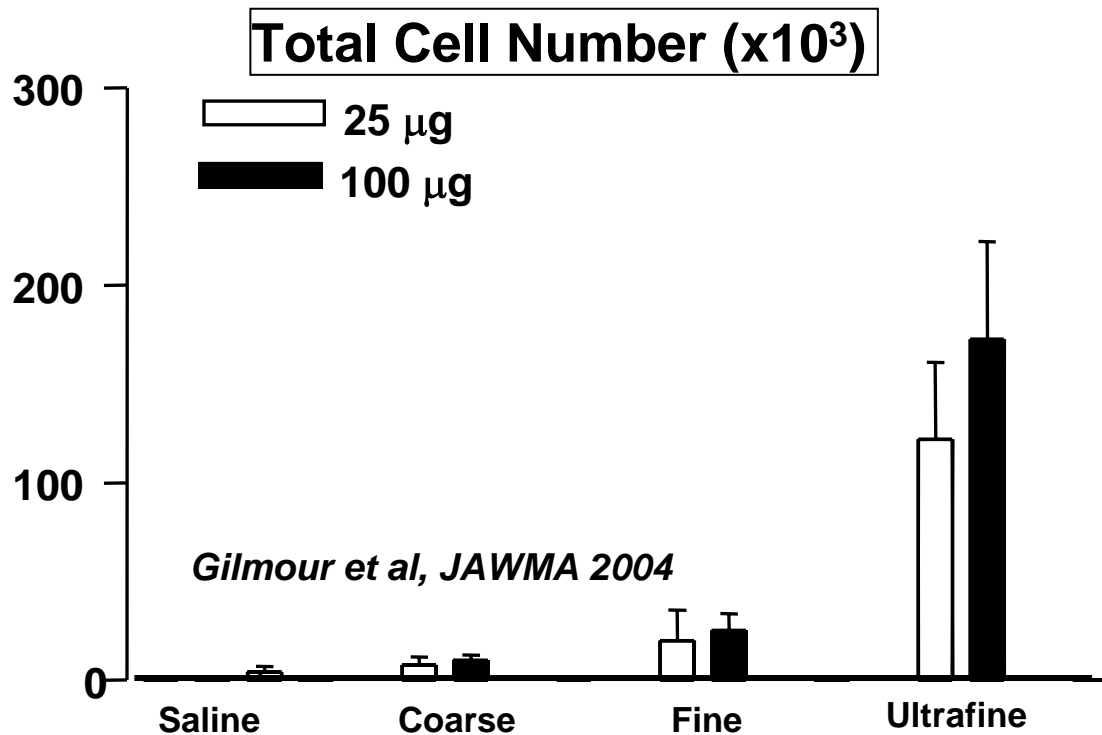
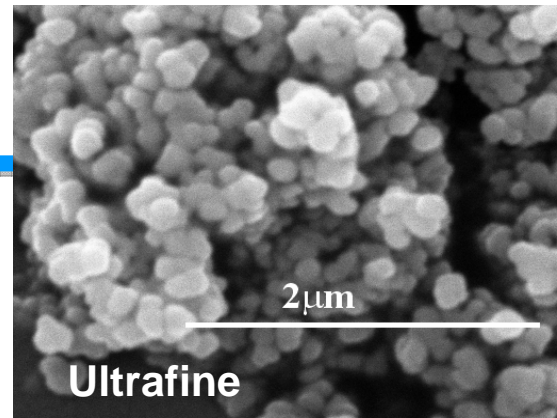
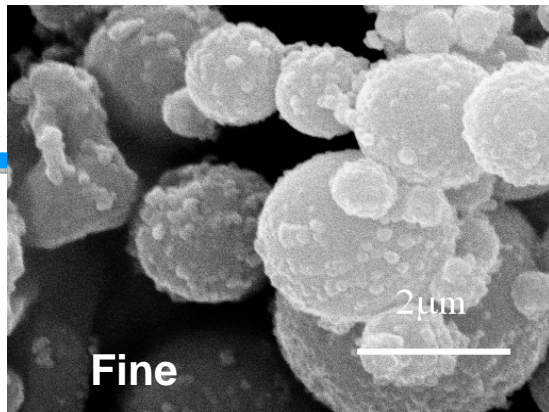
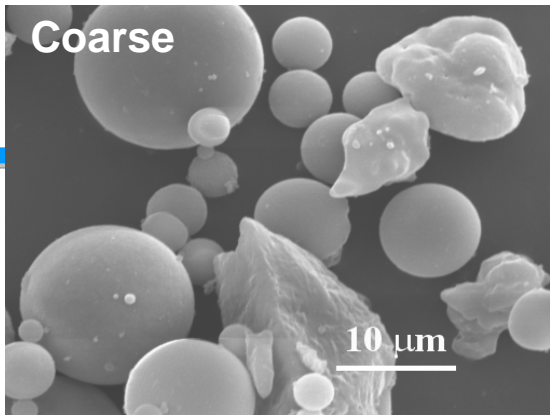
So What are the Research Issues?

- **Develop a systematic approach (NRC) - “Hazardous Components”**
 - Link - PM attributes to sources thru to health effects
 - Multicity-multipollutant approaches (e.g., NCore proposal)
- **Support OAR and clients – emerging NAAQS issues**
 - Near Highway (pressing client need)
 - Tool and model development (implementation)
 - Coarse PM – sources to health (urban vs non-urban)
 - Accountability (Are we making a difference?)
 - Emission Inventory development (update current databases and novel sources: open-burning, aircraft)

So What are the Research Issues?

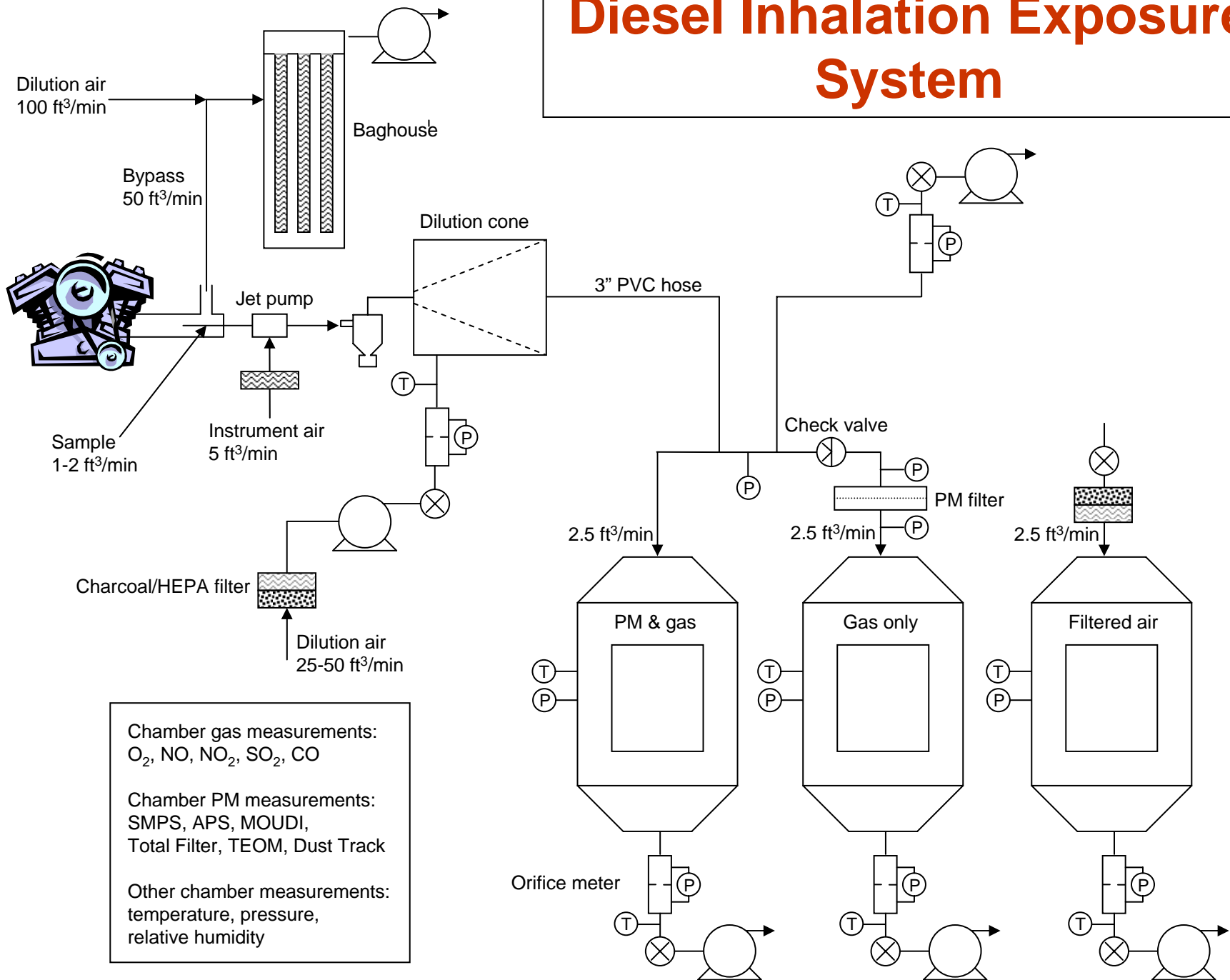
- **Apply advanced cutting-edge technologies (e.g., ‘omics)**
- **Assess long-term health implications of PM**
- **Improve exposure models: components (1°/2°) & sources**
- **Refine of atmospheric models – for SIP use and as predictive tools for public health application**
- **Develop remote sensing technologies**
- **Broaden PM-Ozone Program to “one-atmosphere”**
 - Integrate AT field program
 - Leverage AT toxicology with PM & HH (e.g., asthma)

Examples of ORD Research Program Efforts to Address These Issues

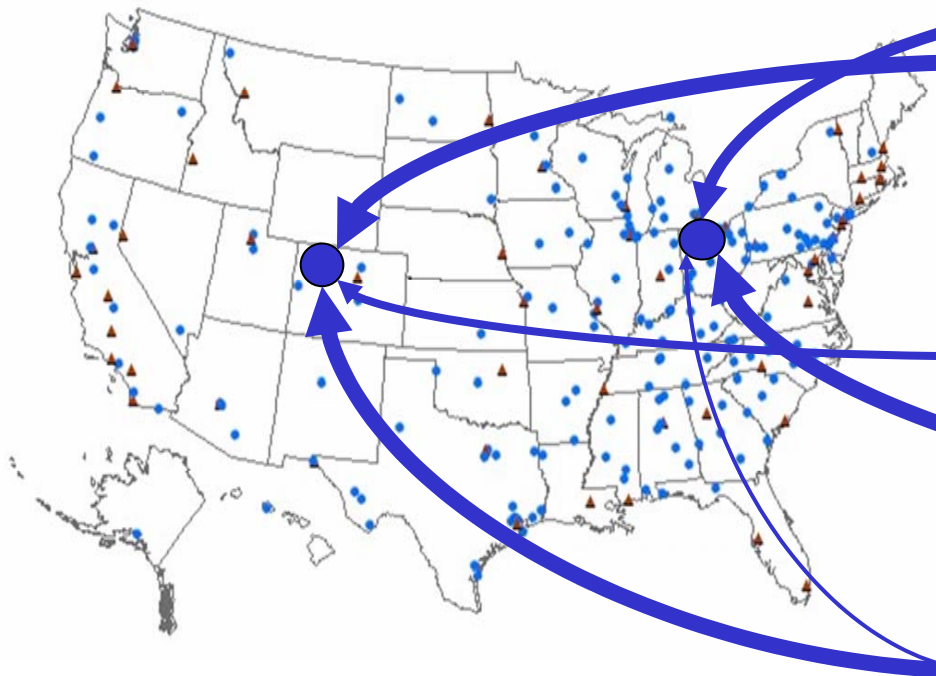


Size-related
 Toxicity with
 Source-Derived
 Particles (Coal)

Diesel Inhalation Exposure System



MultiPollutant / MultiCity Studies to Link to Sources and Health Outcomes

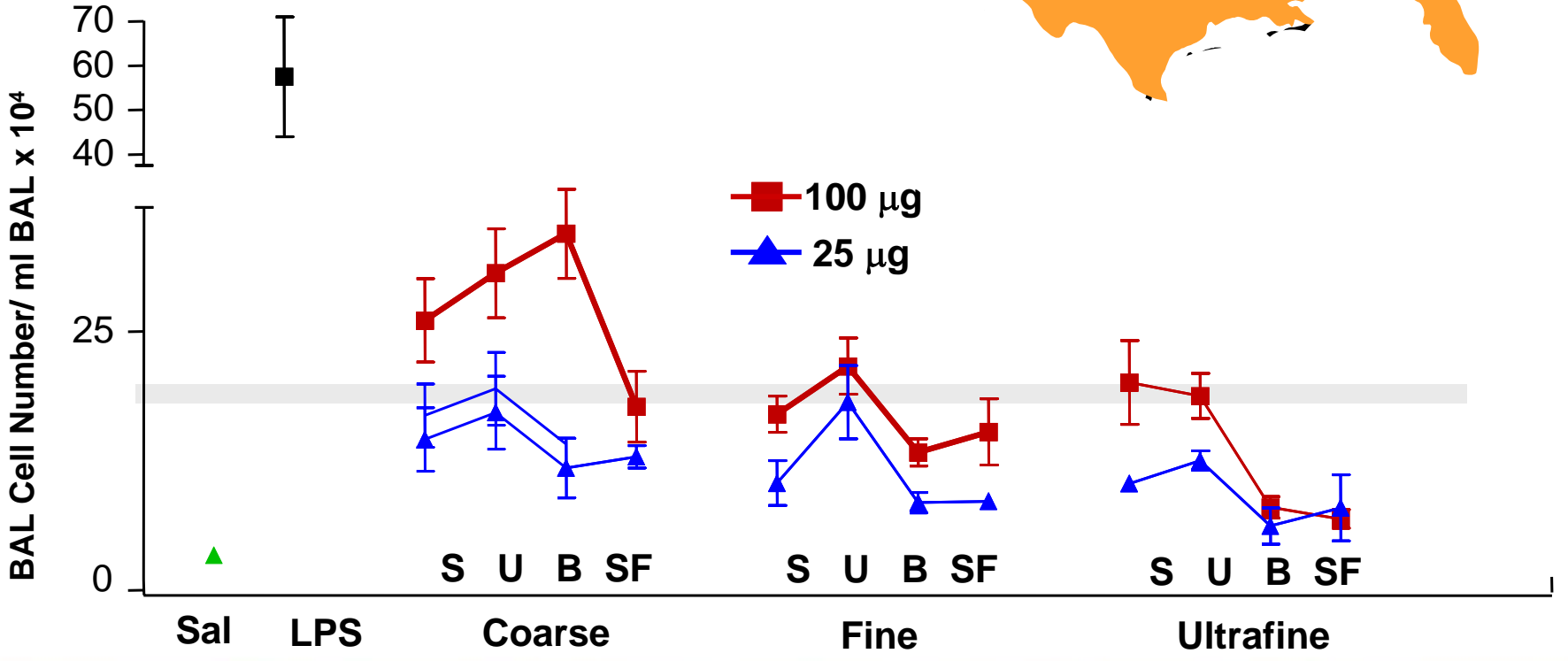
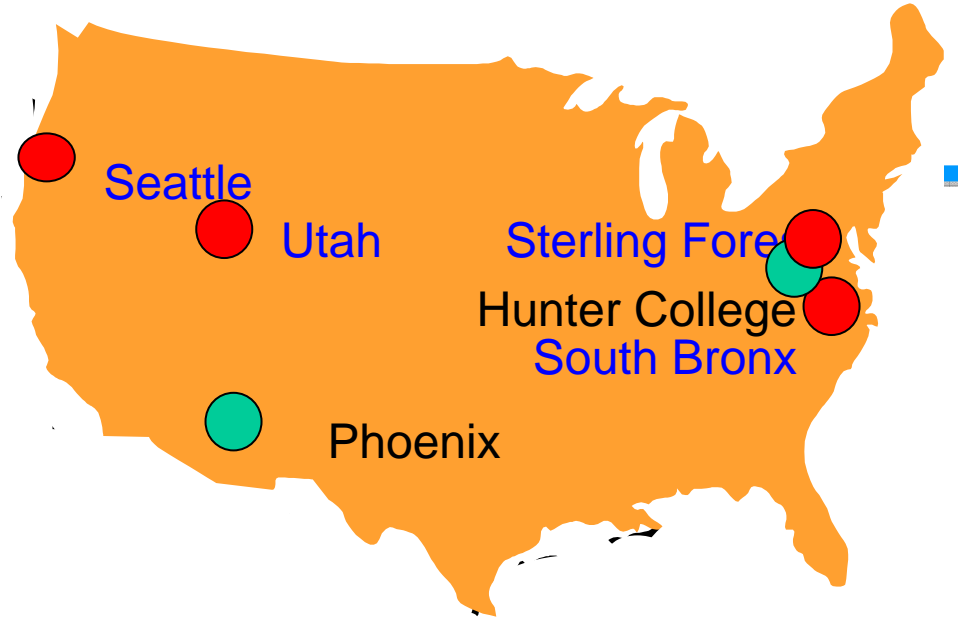


Associating health outcomes with different source types provides additional information about source-related toxicity

Merging source apportionment techniques with epidemiology and ambient monitoring can yield important information about source to health outcome linkages.

**Multicity
Multipollutant
Approaches**

**Linked to NCore
Monitoring Program**



Near Roadway Effects – Pressing Regional Need with PM and Air Toxic Implications

Significant changes occur in size distribution of PM with distance from the roadway.

Zhu et al., 2002



- Asthma
- Birth defects
- CV effects
- Cancer

- What do we really know about exposure?
- Implications are significant
- Interventions exist – value?

- The percentage of people living in the 'burbs more than doubled from 1950 to 2000.
- People spend 31% more time commuting than in 1950's



- Emission characterization

- Exposure assessment
- Health effects

El Paso & Detroit
(DEARS/DCHS)

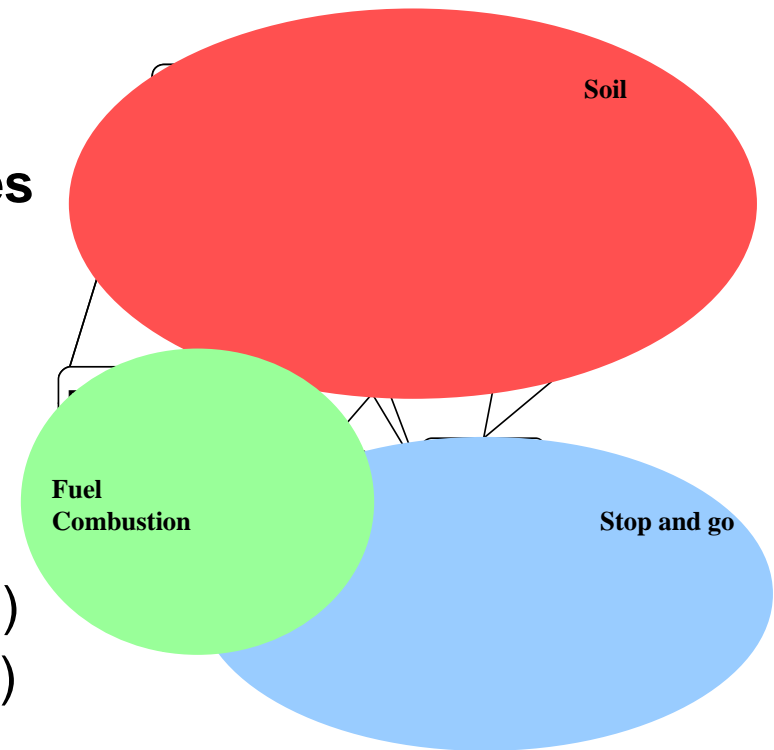
Sample collection
for tox tests

Need for partnering (e.g., PM
Ctrs., HEI, FHWA, CDC, others)

Linking specific sources or PM attributes to adverse health effects?

In-Vehicle North Carolina Highway Patrol Trooper study (COP Study)

- Measured in vehicle, roadside, and ambient air pollutants
- Evaluated pollution source signatures
 - Soil and Roads
 - Fuel Combustion
 - Stop and Go Traffic
- Found:
 - Pro-inflammatory & thrombotic(?)
 - HRV Changes: pre-arrhythmia(?)
 - Stop-and-go traffic pollutants appear to be the most potent.



Riediker et al., 2004

Source Apportionment / Atmospheric Chemistry Projects

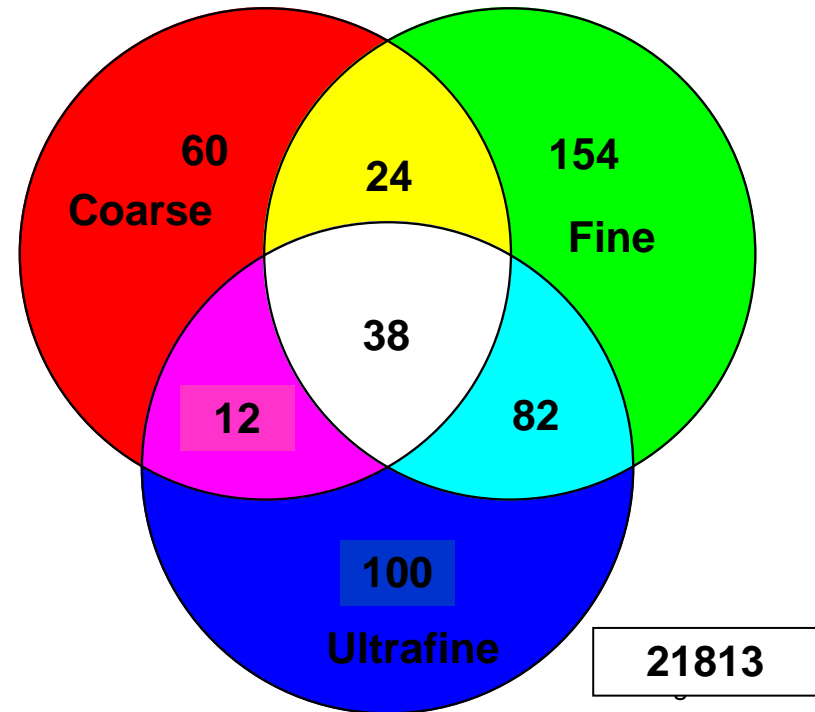
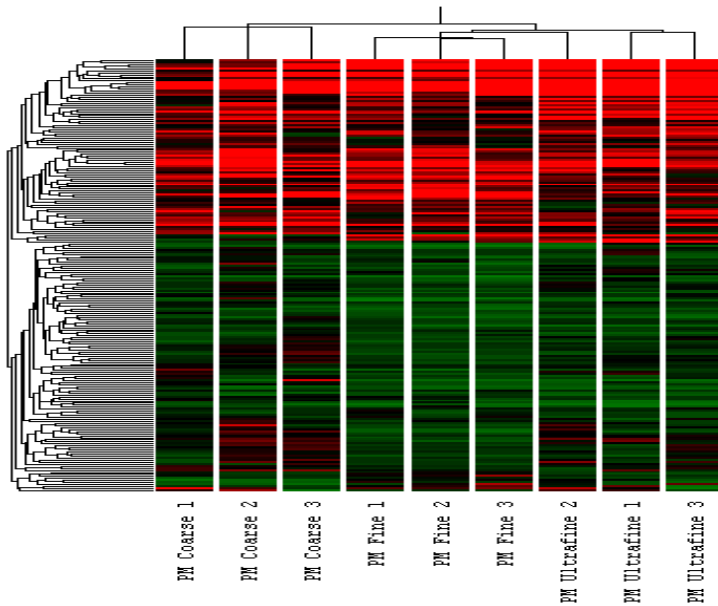
- **In house Source Apportionment (multiple projects)**
 - COPPs Study
 - DEARS
 - Receptor modeling
- **Source Apportionment (FY04/05) 11 grants**
 - Evaluate and improve receptor modeling for PM source apportionment (3)
 - Integrate receptor, source-based, and inverse modeling for PM source apportionment (4)
 - Improve tracer/measurement methods for source apportionment (4)
- **Continuous Measurement (FY 05) 3 grants**
 - Improve measurement methods for PM chemical composition (3)

Health effects and Mechanism Research

- **CAPs studies in humans and animal models**
- **Susceptibility (genetic, age, disease)**
- **Cardiac, vascular, and other systemic outcomes (e.g., neural, developmental)**
- **Physiologic & cell/molecular approaches (e.g., ‘omics)**
 - 6 STAR CVD grants (collaboration with NIEHS)
- **Chronic studies (STAR – MESA; other retrospective studies; limited animal studies)**
- **Initiate / develop “one-atmosphere” concept (MAPP)**

“Omics” May Change Everything

Genes Uniquely Expressed in Lung Cells Exposed to
Either Coarse, Fine, or Ultrafine PM



Implications for linkage of health effects to PM components or sources

Partner with NIH Studies to Address the Long term Impacts of PM Exposure on CVD?

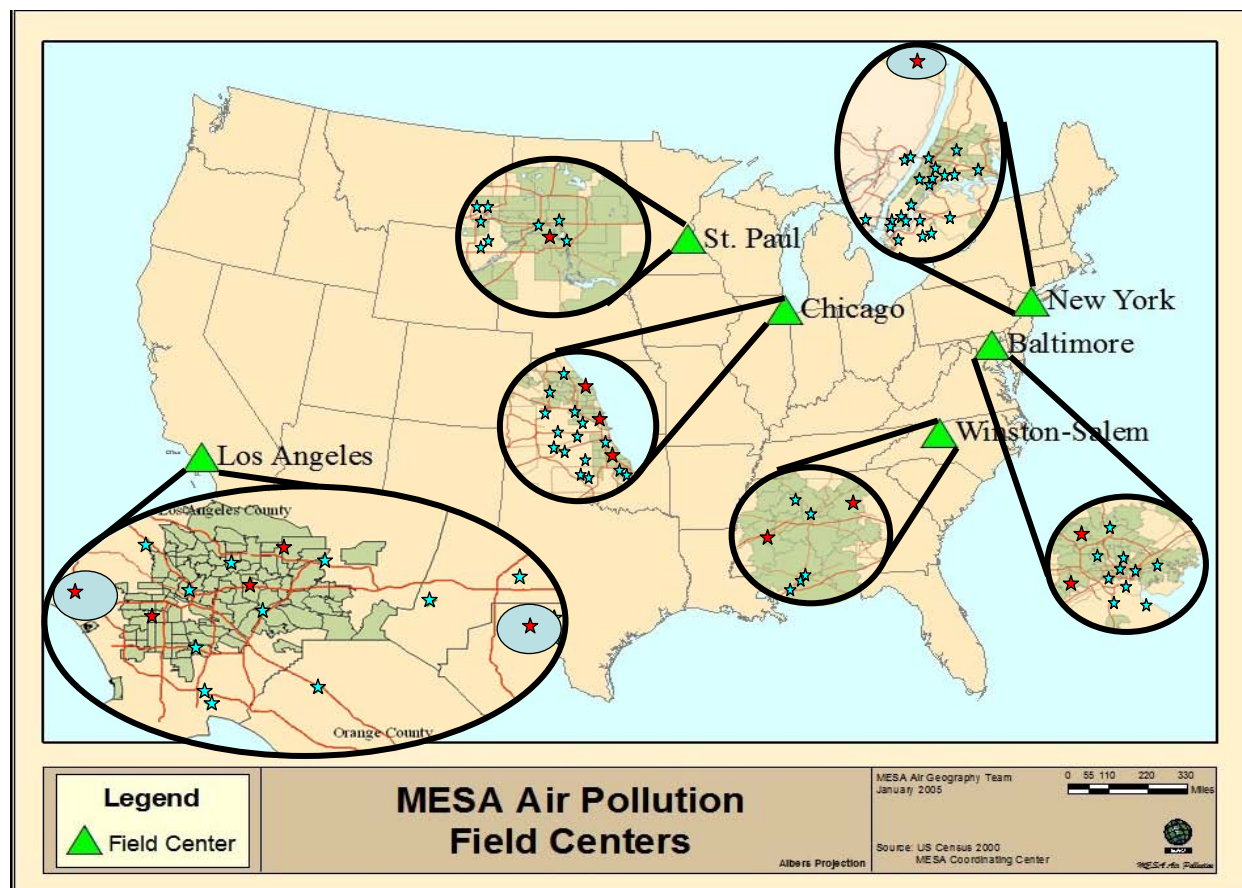
Opportunities to partner with other STAR grantees to enhance understanding of potential long term effects

Retrospective Studies

- Medi-Coh/Vet Study – JHU
- Nurses Study - HSPH
- M-Eth Study on Ath.(NHLBI) - UMich
- Adventist Study – LLU
- Wom Health Initiative Study - UW

A New Prospective Study of Air Pollution and Cardiovascular Disease: “MESA Air Pollution”

Kaufman - Univ. of Washington



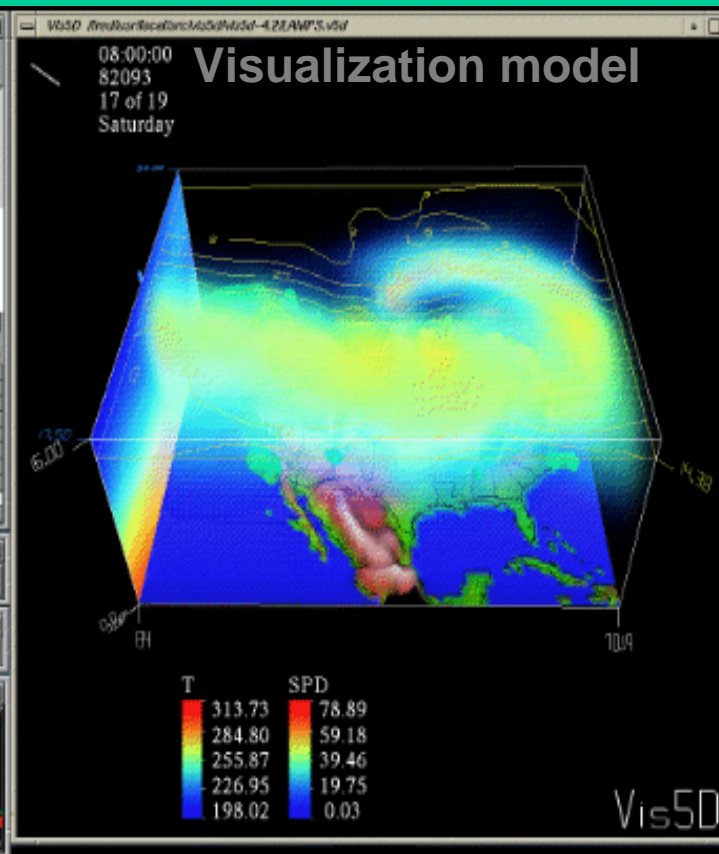
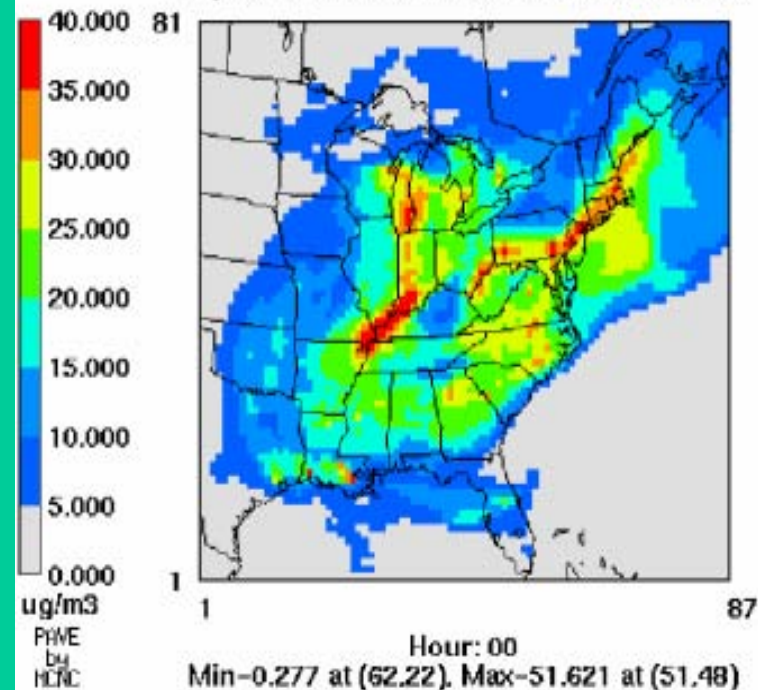
RESEARCH & DEVELOPMENT

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Advanced simulation tools (e.g., Community Multiscale Air Quality - CMAQ) are being developed to accurately model emission sources and atmospheric processes to design effective control strategies.

Mean PM2.5 (36 km Grid)

July 13, 1995 04:00 to Jul 14, 1995 03:00 GMT

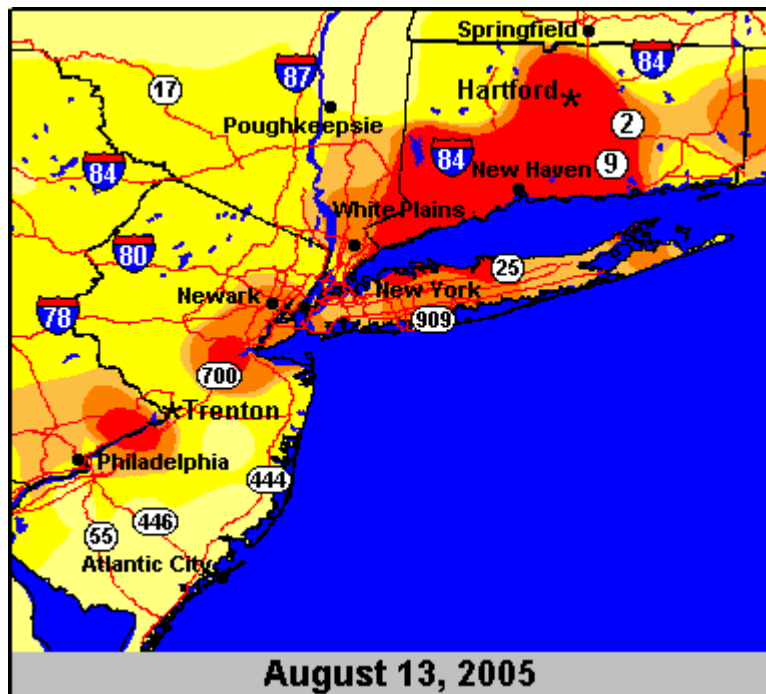


Accountability – An Example

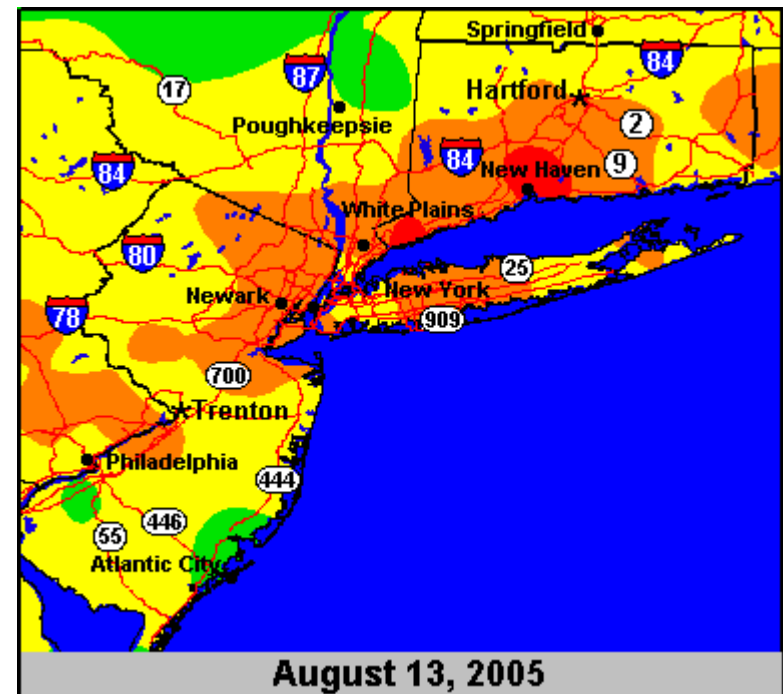
Daily air quality forecasting and monitoring are producing an accountability database



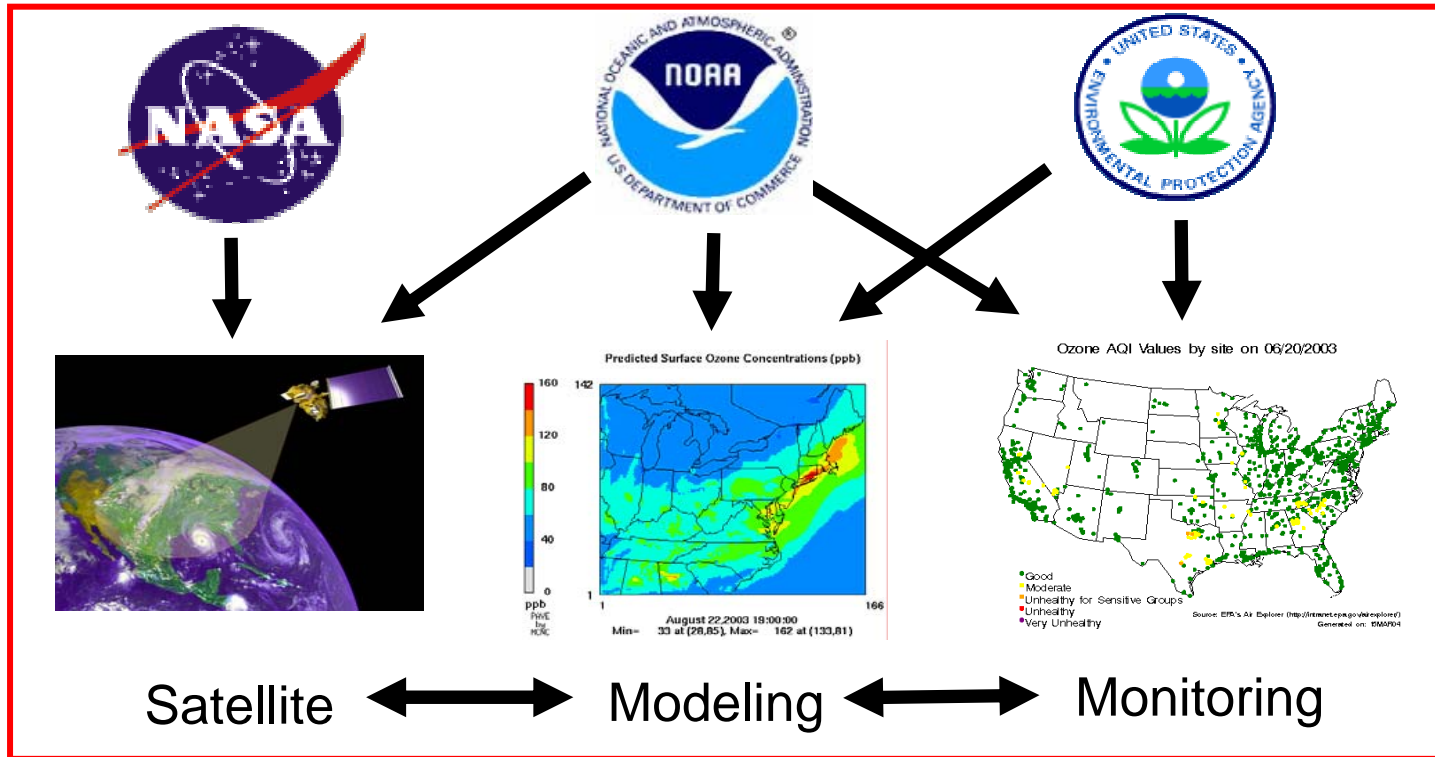
Ozone - Peak AQI



Ozone - 1-hour Average Peak Concentration



Partnerships in Characterizing Air Quality to Estimate Public Exposure



- **Assessment of risk**
- **Forecasting**
- **Public Communication**

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Cross-cutting Issues for the Air Program

- **Increasing Number of Adverse Health Outcomes Associated With PM and Related Susceptible Subpopulations**
- **Increasing Emphasis on Exposure-Dose-Response Relationships**
- **Particle Toxicity In Relation To Different Particle Characteristics and Emission-Source Types (Source to Health Outcome)**
- **PM Health Effects Must be Considered Within the Broader Context of Other Pollutants Present in Ambient Air**
- **Use Atmospheric and Exposure Models as Research as well as Regulatory Tools**
- **Explore Opportunities to Leverage Across Research Programs and Agencies to Effectively Inform the Setting & Implementation of Standards**