Advancing the Science of Air Monitoring:

Research Priorities and New Approaches for Enhancing Monitoring Data

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Presentation Overview

- Monitoring Objectives and Research Priorities
- Monitoring Research in EPA's Office of Research and Development (ORD)
- Approaches for Enhancing Ambient Monitoring

Monitoring for Multiple Objectives

Monitoring Purpose	Measurements Needed
Compliance with NAAQS	FRM / FEM
Public Information/Reporting	Continuous / real time measurements
Air Quality Management Activities - Development of Emission Reduction Strategies - Evaluation of Emission Reduction Strategies - Air Quality Trends	Continuous / semi-continuous sampling
	PM Speciation
	Precursor species
	Air Toxics
Research/Scientific Studies - Health Assessments - Ecological Assessment - Source-Receptor Relationships - Model Development and Evaluation	Continuous / semi-continuous sampling
	PM Speciation
	Precursor species and co-pollutants
	Air Toxics
	Deposition

Monitoring Priorities to Support EPA Programs

- NAAQS Development
  - PM Size Fractions
    - Coarse and Ultrafine
  - PM Speciation / Components
- NAAQS Implementation
  - FRM / FEM
  - Emission Reduction Strategies Development
  - Accountability
- Public Reporting
  - AirNOW and AQI
- National Ambient Air Monitoring Strategy (Dec 05 Draft)
  - Continuous Measurements
  - Multipollutant Measurements (NCORE Sites)
  - Increased integration with Science Objectives
  - Integration of Air Toxics into monitoring networks
  - Ecological Assessment

Monitoring Priorities from External Recommendations: National Research Council Reports

- Research Priorities for Airborne Particulate Matter IV (2004)
  - Challenge - Enhancing Air Quality Monitoring for Research
  - Move from a focus on compliance with NAAQS toward multiple monitoring purposes
    - Continuous / semi-continuous measurements
    - PM species
  - The report specifically mentions the need to measure ultrafine PM, soluble metals, and organic species.

- Air Quality Management in the US (2004)
  - Recommendation – Enhance Air Pollution Monitoring
  - Expanded to other important objectives beyond compliance
  - Use of semi-continuous methods
  - Develop more reliable methods and analytical procedures for chemical composition of PM

Monitoring Priorities from External Recommendations: NARSTO PM Assessment (2004)

- Improve integration of atmospheric and health sciences to understand relationships between PM and public health impacts.
  - "Health impacts based on epidemiological studies can only be derived for PM characteristics for which ambient measurements are available."

- Improve the understanding of carbonaceous aerosols
  - Chemical speciation
  - Spatial and temporal resolution
  - Composition

- Develop methods to identify important markers or tracer species to relate ambient concentrations to sources.

- Replace integrated measurements with continuous, real-time measurements for PM mass and composition, where feasible and as technology evolves.

Monitoring Research in EPA's Office of Research Development (ORD)

ORD Monitoring Research

- Methods Development and Evaluation
- Source Apportionment Applications
- Exposure Assessment Applications
- Health Effects Applications

ORD's Monitoring Research Program: Methods Development and Evaluation

- Sampling Methods
  - Coarse particles
  - Semi-continuous PM species
  - Air Toxics
    - Acrolein and 1,3 butadiene
    - Mercury dry deposition

- Analytical Methods
  - Inorganic and Organic Source marker compounds

- Research Grants
  - Carbonaceous PM
  - Source Apportionment
  - Continuous PM

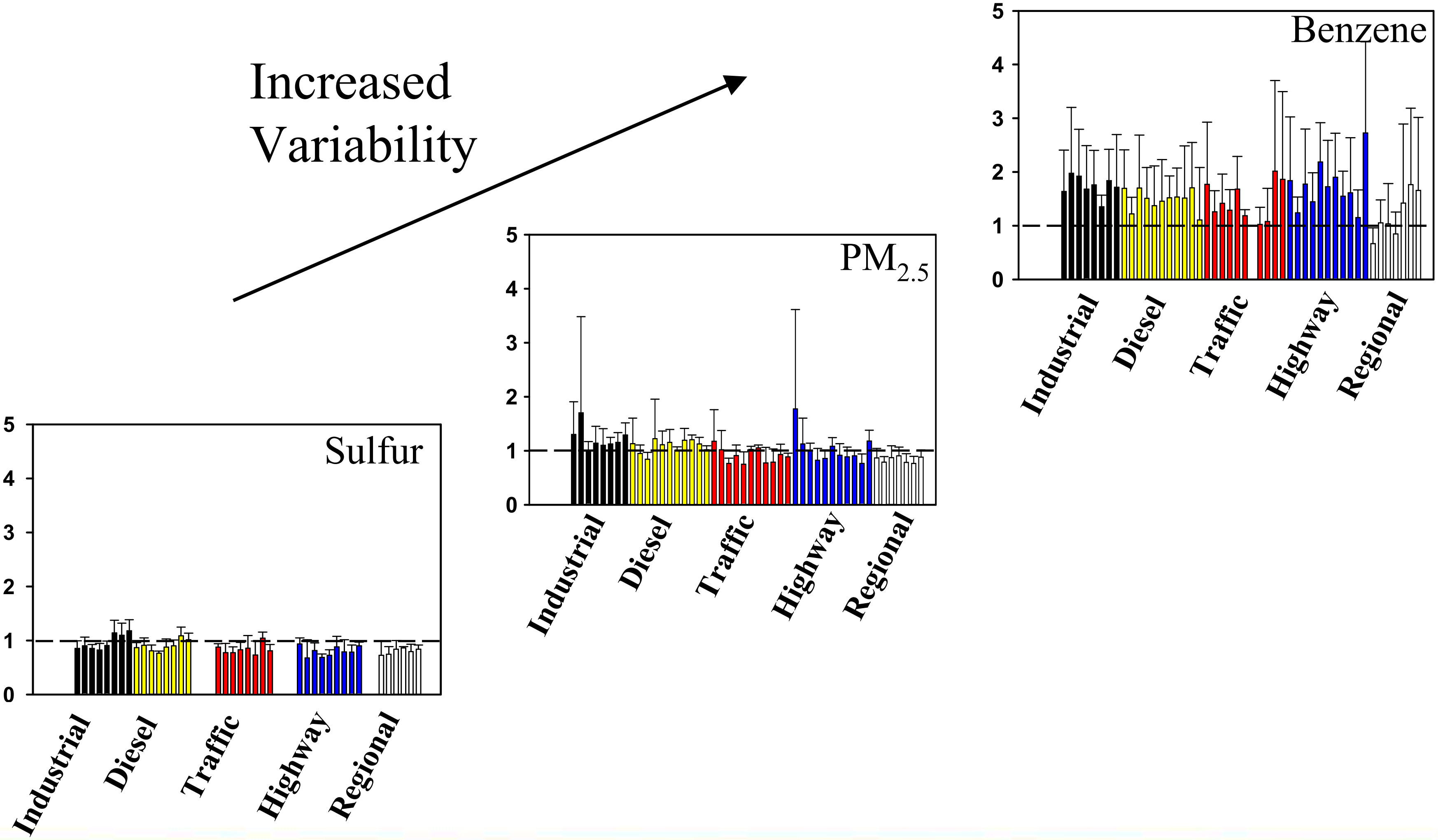
- PM Supersites

ORD's Monitoring Research Program: Source Apportionment and Exposure Applications

- Detroit Exposure and Aerosol Research Study (DEARS)
  - PM Components and Size Fractions
  - Air Toxics
- Steubenville Source Apportionment Study
  - Integrated and Continuous PM
  - Continuous Criteria Gases
  - Deposition
  - Ambient Mercury Speciation
- Coarse PM Methods Evaluation
  - FRM / FEM
  - Continuous Methods
  - Saturation Samplers
- Near Roadway Exposures
  - PM Composition and Size Fractions
  - Mobile Source Air Toxics

Preliminary DEARS Results

(Concentration Ratios – Outdoor Residential to Community Central Site)



Steubenville PMF Apportionment Results 2003 & 2004

Analyte	Factor 1 Oil/Incineration	Factor 2	Factor 3 Crustal	Factor 4	Factor 5 Iron/Steel	Factor 6 Coal
Mg	*	105.12	**568.88**	29.24	191.09	*
Al	76.43	*	**365.66**	38.50	56.26	38.94
P	*	**65.72**	*	*	*	*
S	*	*	534.38	*	*	**11832.0**
Cl	2167.7	*	*	712.45	263.86	709.84
V	1.11	*	*	*	**2.87**	*
Cr	0.53	*	*	*	**2.44**	*
Mn	*	16.36	37.42	*	**53.67**	*
Fe	118.82	28.71	25.63	*	**343.61**	36.17
Ni	**3.54**	0.55	*	*	*	*
Cu	14.17	2.26	*	8.68	*	20.25
Zn	**45.88**	3.85	*	14.83	3.99	16.15
As	0.58	0.03	0.07	0.31	0.04	0.76
Se	0.22	0.02	*	1.39	*	**2.45**
Rb	0.21	0.27	0.14	0.09	*	0.25
Sr	2.78	1.57	5.77	*	0.56	1.25
Mo	*	*	*	3.84	*	*
Cd	0.23	*	*	0.26	0.10	0.37
La	0.11	*	**0.64**	0.01	*	*
Ce	*	*	**1.26**	*	0.04	*
Hg	*	0.004	*	*	0.012	**0.142**
Pb	**5.92**	0.18	0.22	1.34	1.03	4.57
NO_3	**6143.4**	104.33	1010.7	*	*	**6515.2**
% Hg Explained	*	2	*	*	5	74

* = Not Significant at 95% confidence interval

Source: Keeler et al, *Environment Science and Technology*, in press

ORD's Monitoring Research Program: Health Effects Applications

- Epidemiological
  - Detroit Children's Health Study
    - Childhood asthma and mobile sources
  - Multi-city
    - Compositional differences in Air Quality
  - Chronic exposures to PM

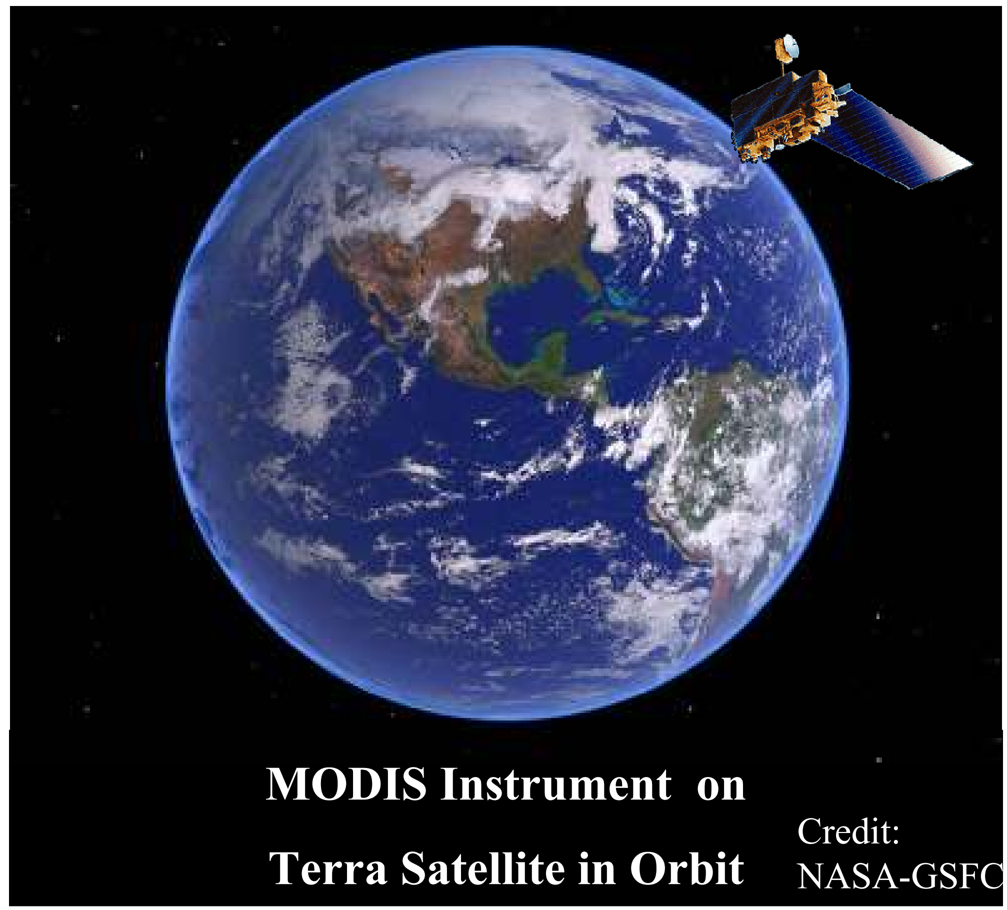
- Toxicological
  - Source-specific effects
  - Coarse particles

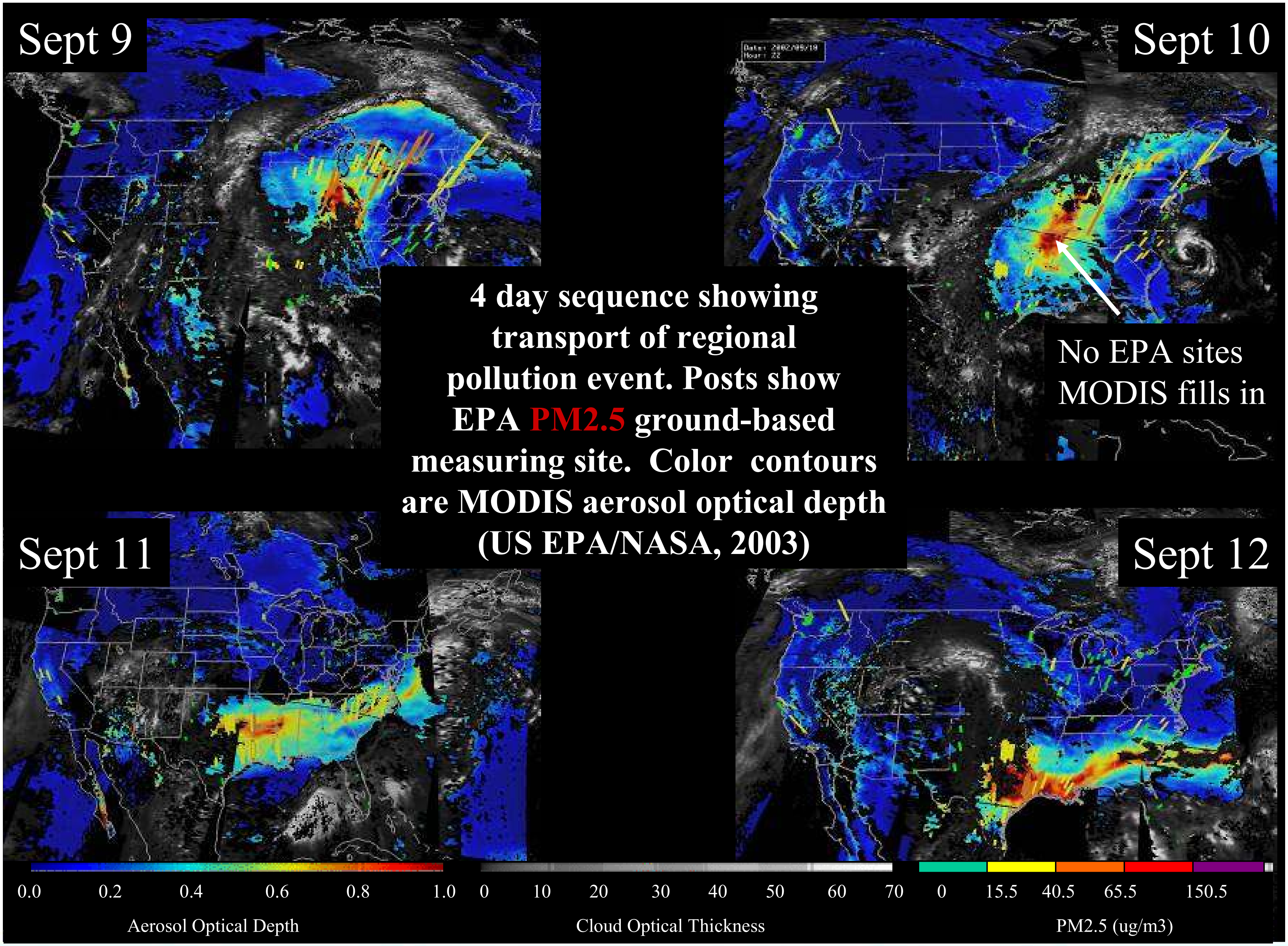
- PM Research Centers
  - Harvard University
  - New York University
  - University of Washington
  - Rochester University
  - UCLA

New Approaches for Enhancing Ambient Monitoring

Satellite Data

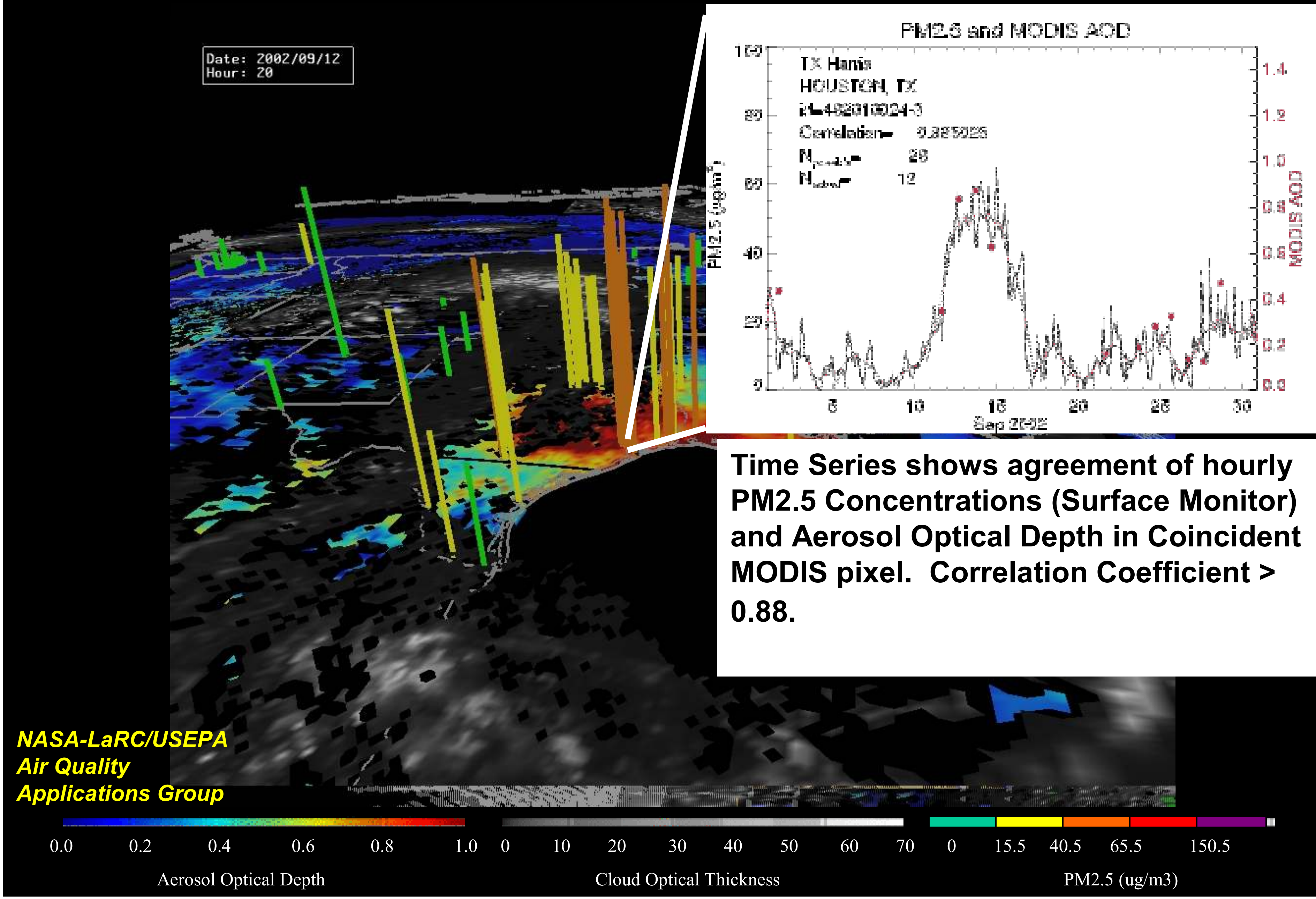
- Emerging source of air quality data
- Aerosol optical depth (AOD) used to estimate ground level concentrations
- Spatial and Temporal Gaps
  - Cloud cover
  - Reflective surfaces





Sept 9
Sept 10
Sept 11
Sept 12
4 day sequence showing transport of regional pollution event. Posts show EPA PM2.5 ground-based measuring site. Color contours are MODIS aerosol optical depth (US EPA/NASA, 2003)
No EPA sites MODIS fills in
0.0 0.2 0.4 0.6 0.8 1.0
Aerosol Optical Depth
0 10 20 30 40 50 60 70
Cloud Optical Thickness
0 15.5 40.5 65.5 150.5
PM2.5 (ug/m3)

12 Sept. 2002-A close-up of Houston shows many of the hourly PM2.5 monitors recorded 24 averages in excess of 40.5 ug/m3, (AQI>100). High AOD extends into a large portion of TX.



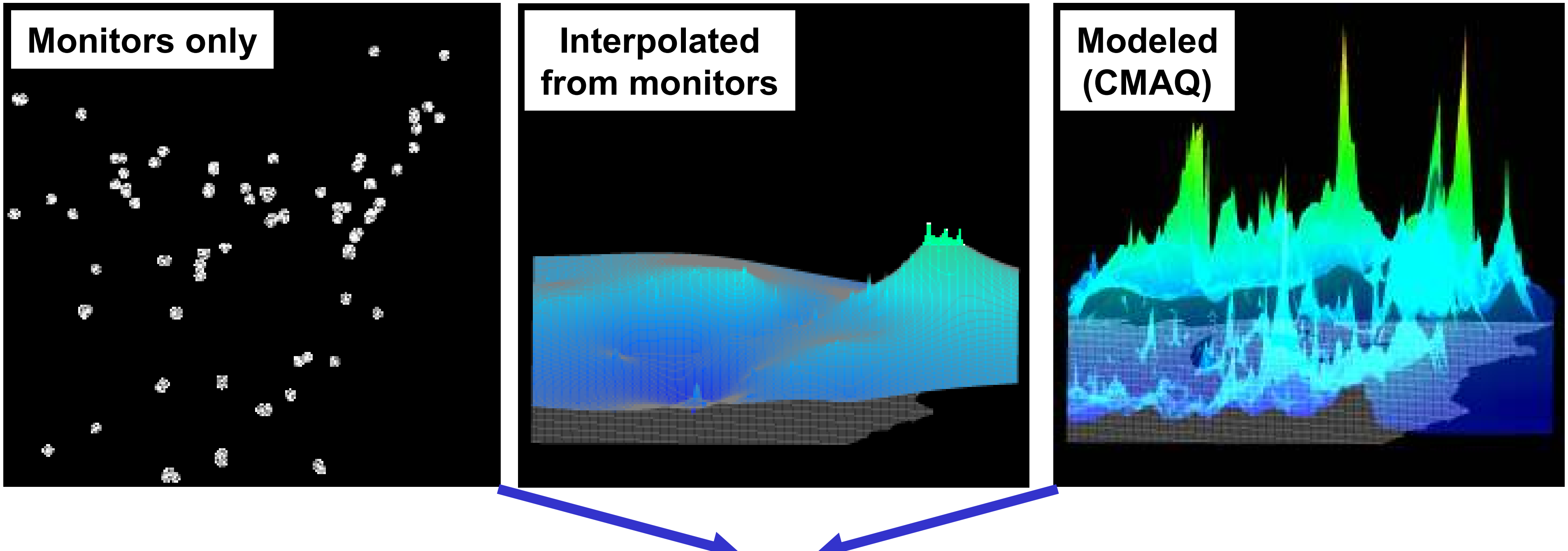
Time Series shows agreement of hourly PM2.5 Concentrations (Surface Monitor) and Aerosol Optical Depth in Coincident MODIS pixel. Correlation Coefficient > 0.88.

NASA-LaRC/USEPA Air Quality Applications Group

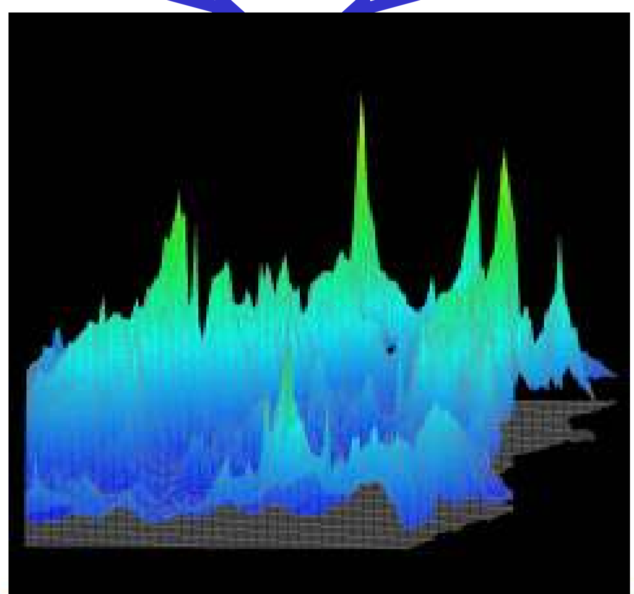
"Data Fusion"

- Combining monitoring data with other sources of air quality data (e.g., modeled output, satellite) to generate air quality surfaces
  - Capitalize on the strengths of monitoring data ("true" measure) and modeling data (spatial and temporal coverage)
  - Minimize weaknesses of each data source

Data Fusion Example – PM Concentrations in NE US (Feb 14, 2001)



<u>Data fusion results:</u>
Spatially and temporally resolved surface enhanced with ground truth data from monitors



Summary

- Enhanced monitoring for multiple objectives
- Monitoring Priorities include
  - Continuous methods
  - PM species and size fractions
  - Air toxics
  - Increased integration with science objectives
- ORD Monitoring Research
  - Methods Development and Evaluation
  - Source Apportionment, Exposure, and Health Applications
- Approaches are emerging to enhance, not replace, ambient monitoring
  - Satellites
  - Data Fusion

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