Air program directions and perspective on NASA products and partnerships

NASA Air Quality Meeting
June 18-20, 20076
Bolger Center, Maryland

Rich Scheffe, EPA-OAR

Acknowledgments

- Everyone

Where is Jack?

simply, Arithmetic injustice

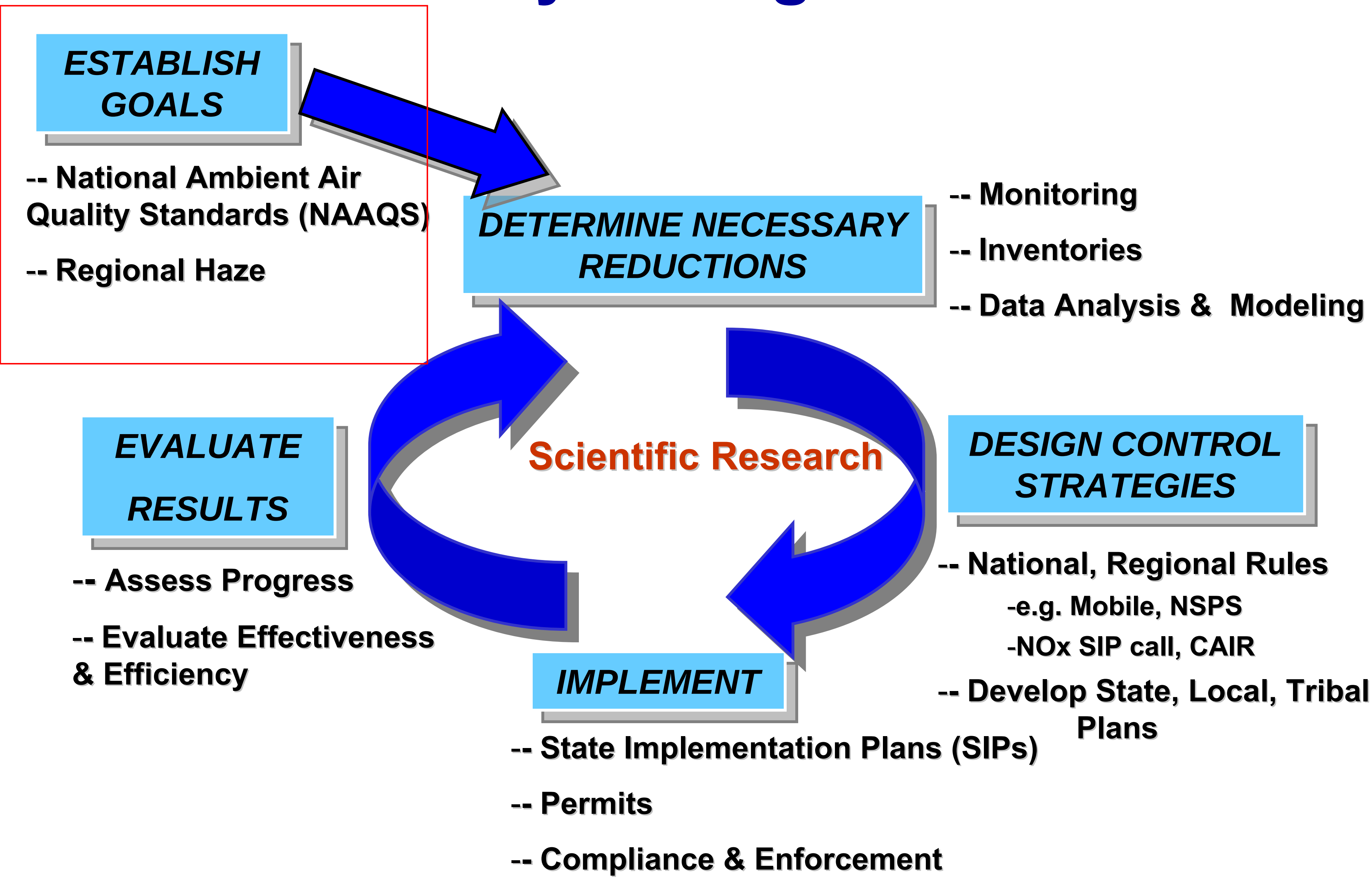
- Greater than 95% of air pollutant mass is located above 100m,
  yet we (air program community) focus 95 % of our characterization on the bottom 10 meters

  {compromises both predictive and current characterization phenomena}

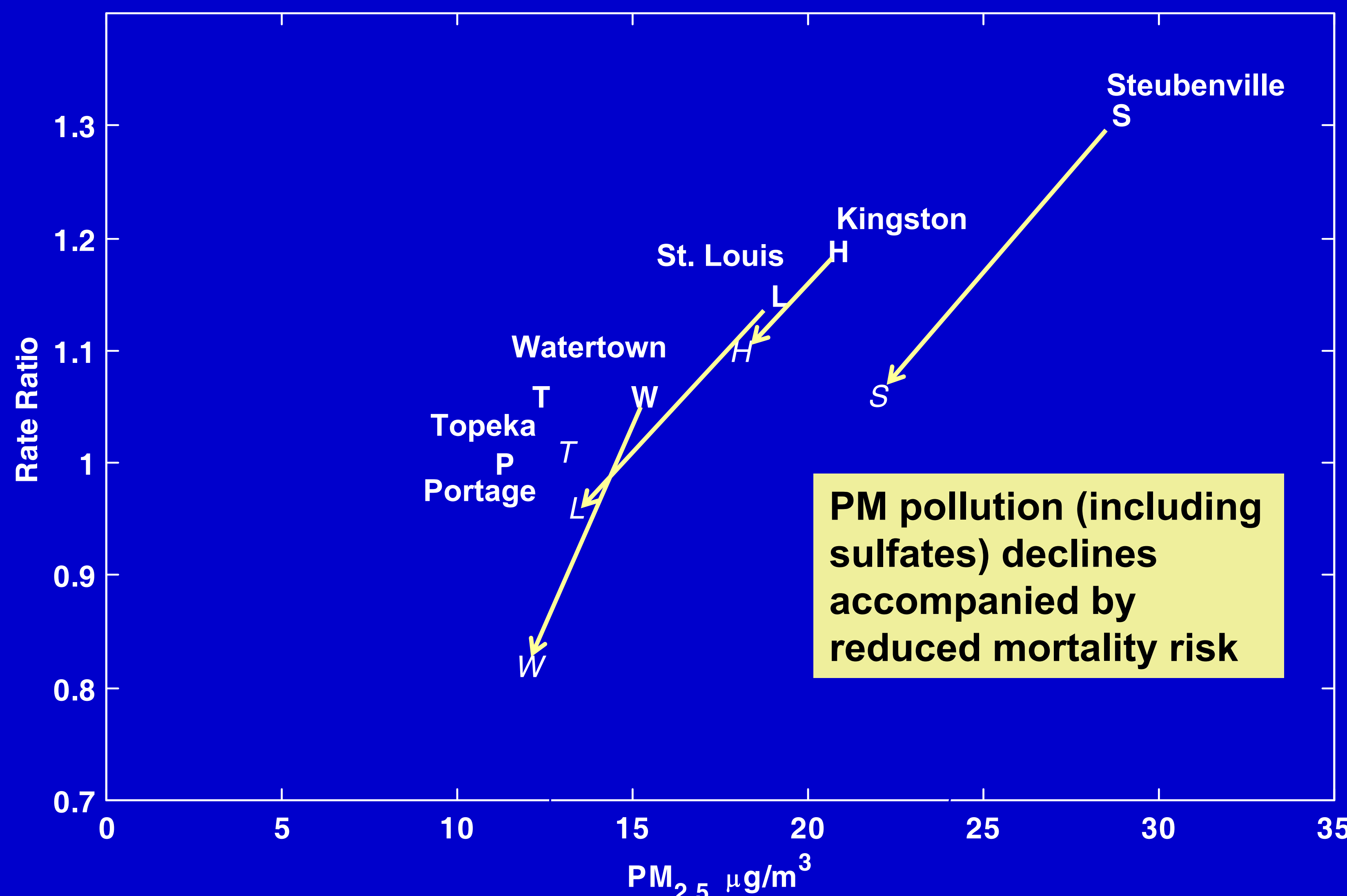
Sequence

- Background on Current/historical/future air program priorities
  - Recent rules
  - New Ozone and PM NAAQS
  - New drivers and challenges
    - Multimedia
    - Multi-pollutant
      - Climate-AQ interactions
    - Accountability
    - Multiple scales
- Air program user perspective on linkage with NASA products.

The Air Quality Management Process



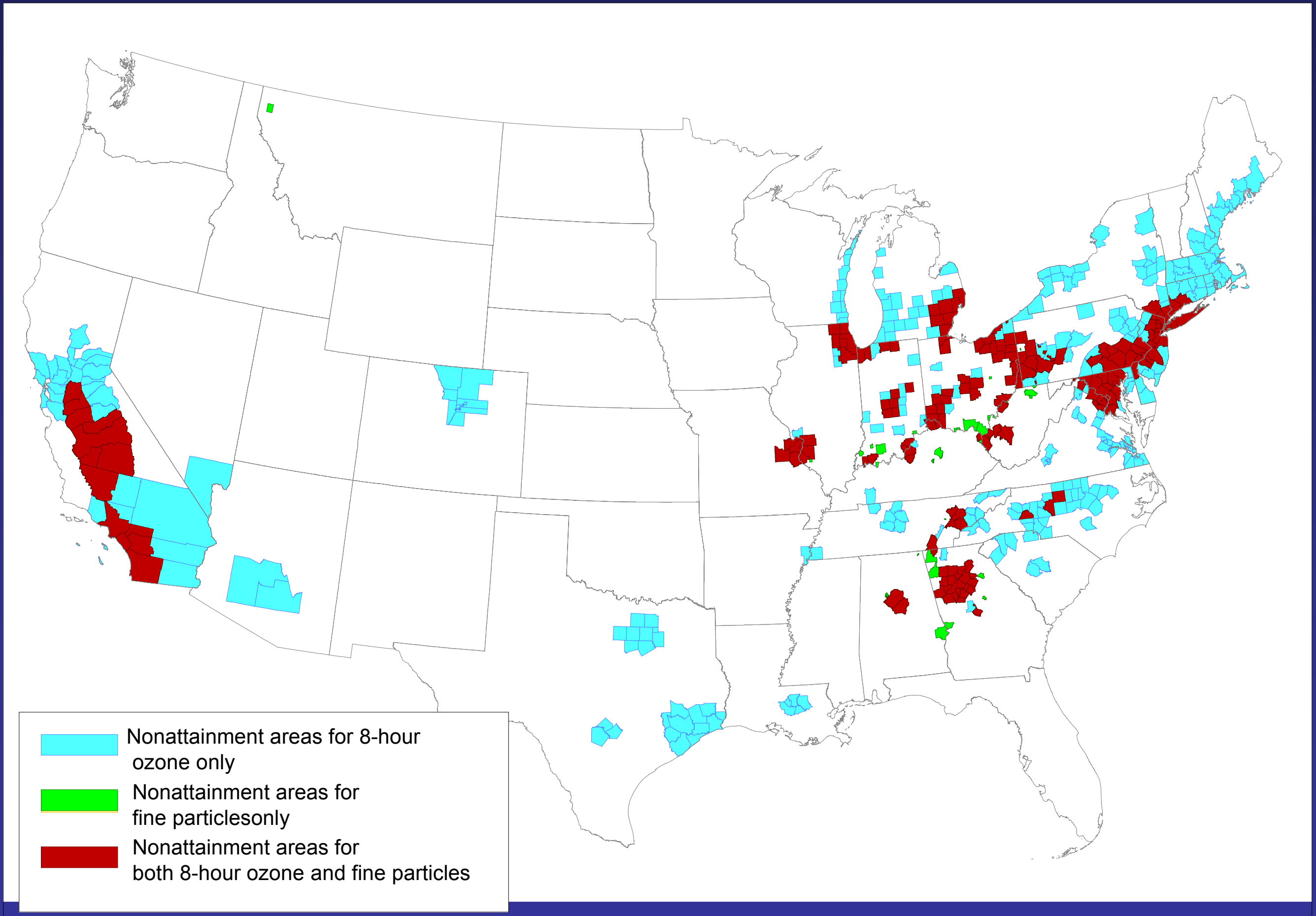
Fine Particle Reductions Work



Layden et al (2006). Effect of Reduction in Fine Particulate Air Pollution and on Mortality: A extended follow-up in of the Harvard Six Cities Adult Cohort

Which NAAQS are most important?

Areas Designated Nonattainment for Ozone and $PM_{2.5}$ 2004

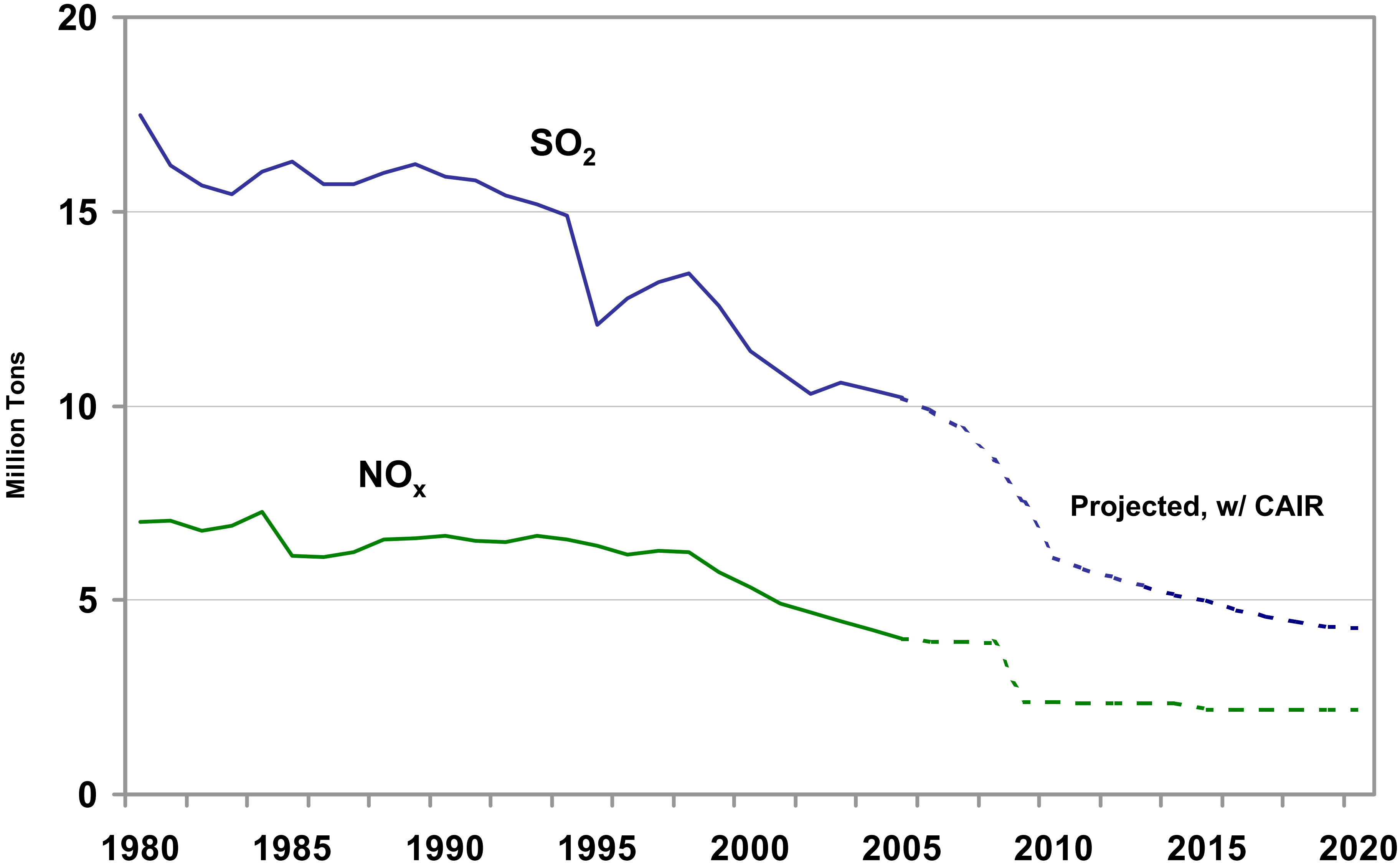


No. Counties with Monitors>NAAQS

CO	0
Lead	1
SO2	0
NO2	0
PM 10	46
PM 2.5	82
O_3	297

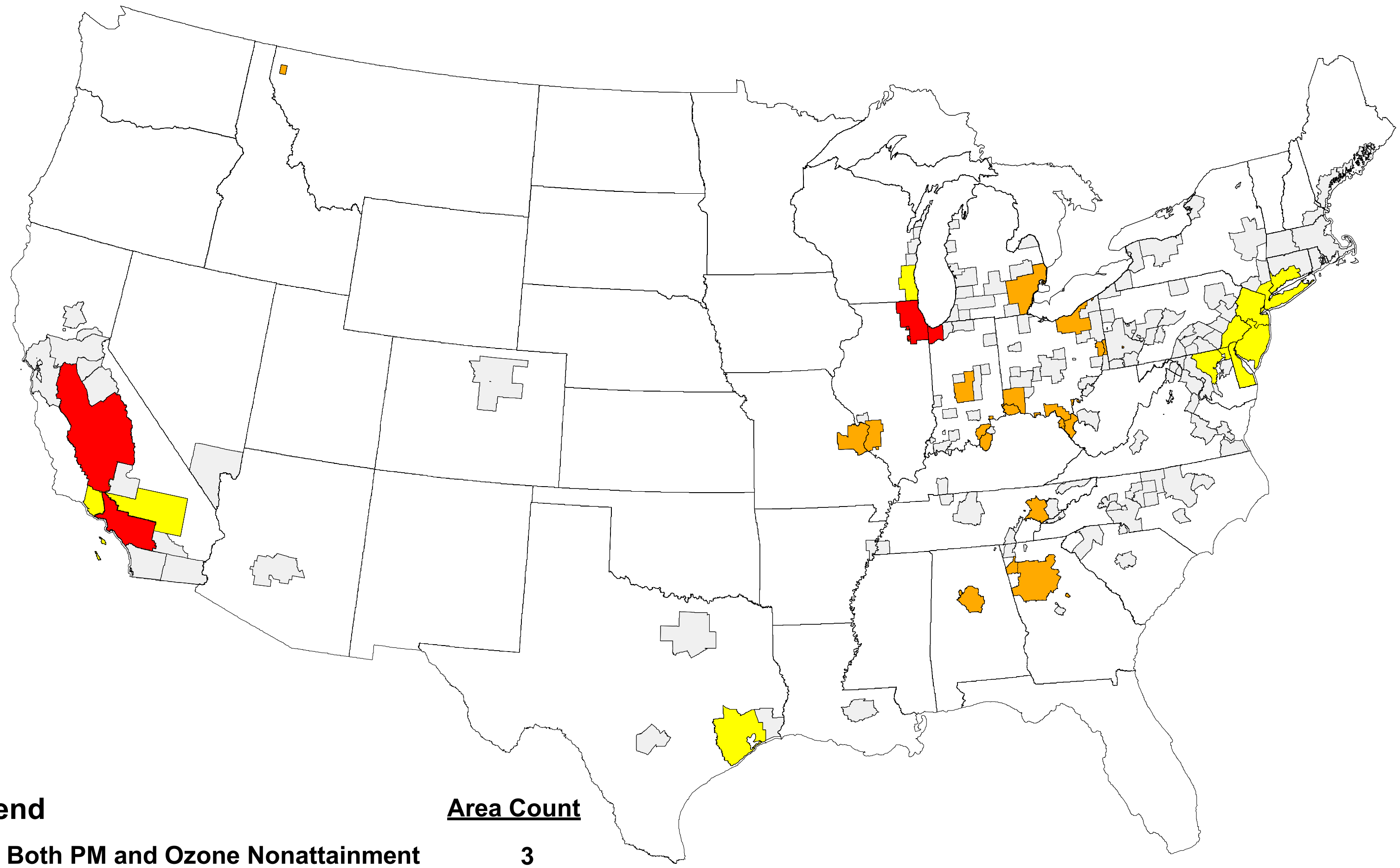
Ozone and PM are our highest priority

National NO_x and SO_2 Power Plant Emissions: Historic and Projected with CAIR



Source: EPA

Areas Projected to Exceed the $PM_{2.5}$ and 8-Hour Ozone Standards in 2015 with CAIR/CAMR/CAVR and Some Current Rules* Absent Additional Local Controls



Legend

	Area Count
Both PM and Ozone Nonattainment	3
PM Only Nonattainment	14
Ozone Only Nonattainment	7
Nonattainment areas projected to attain	105

**Areas forecast to remain in nonattainment may need to adopt additional local or regional controls to attain the standards by dates set pursuant to the Clean Air Act. These additional local or regional measures are not forecast here, and therefore this figure overstates the extent of expected nonattainment.

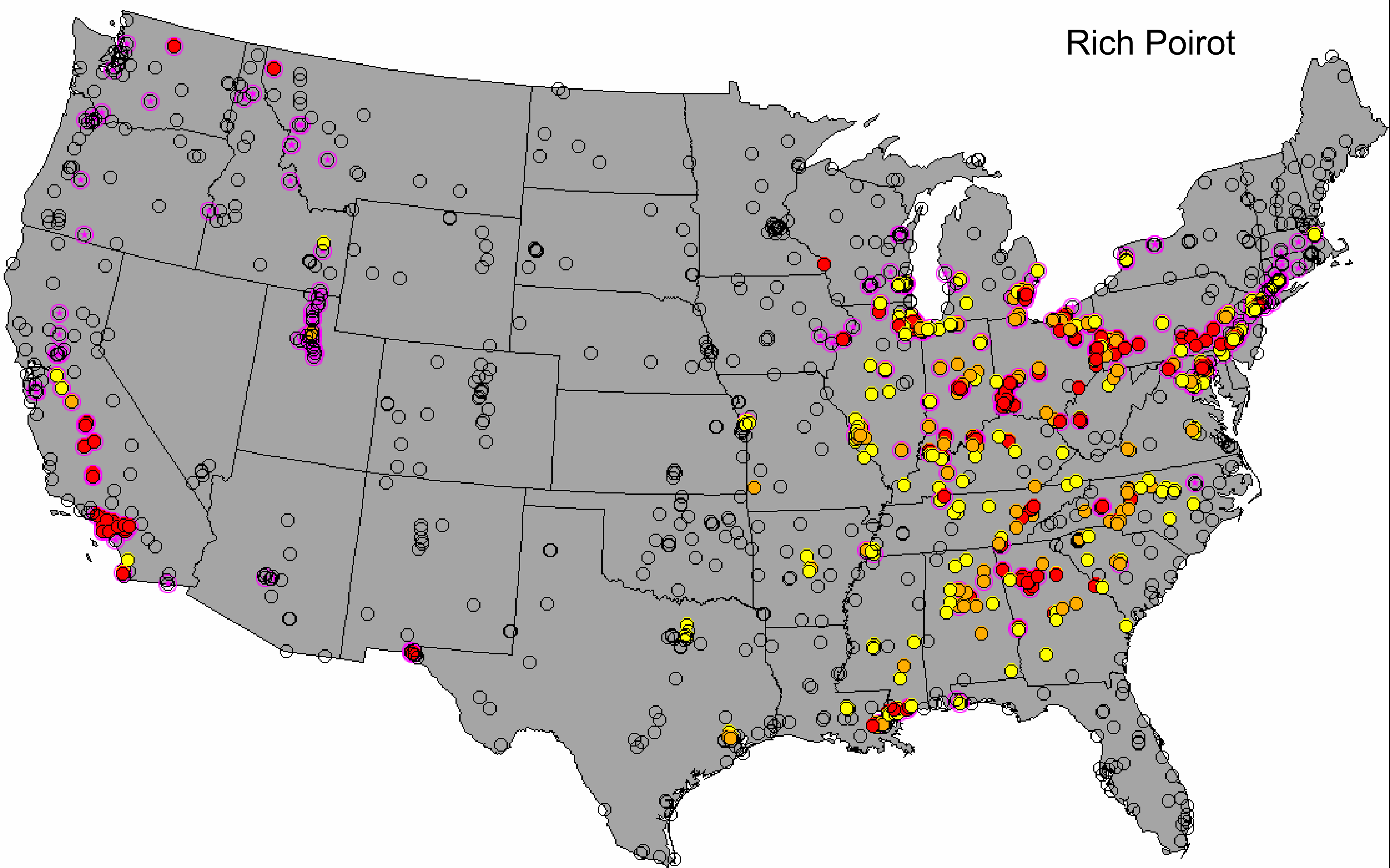
*Current rules include Title IV of CAA, NO_x SIP Call, and some existing State rules.

New PM NAAQS 2006

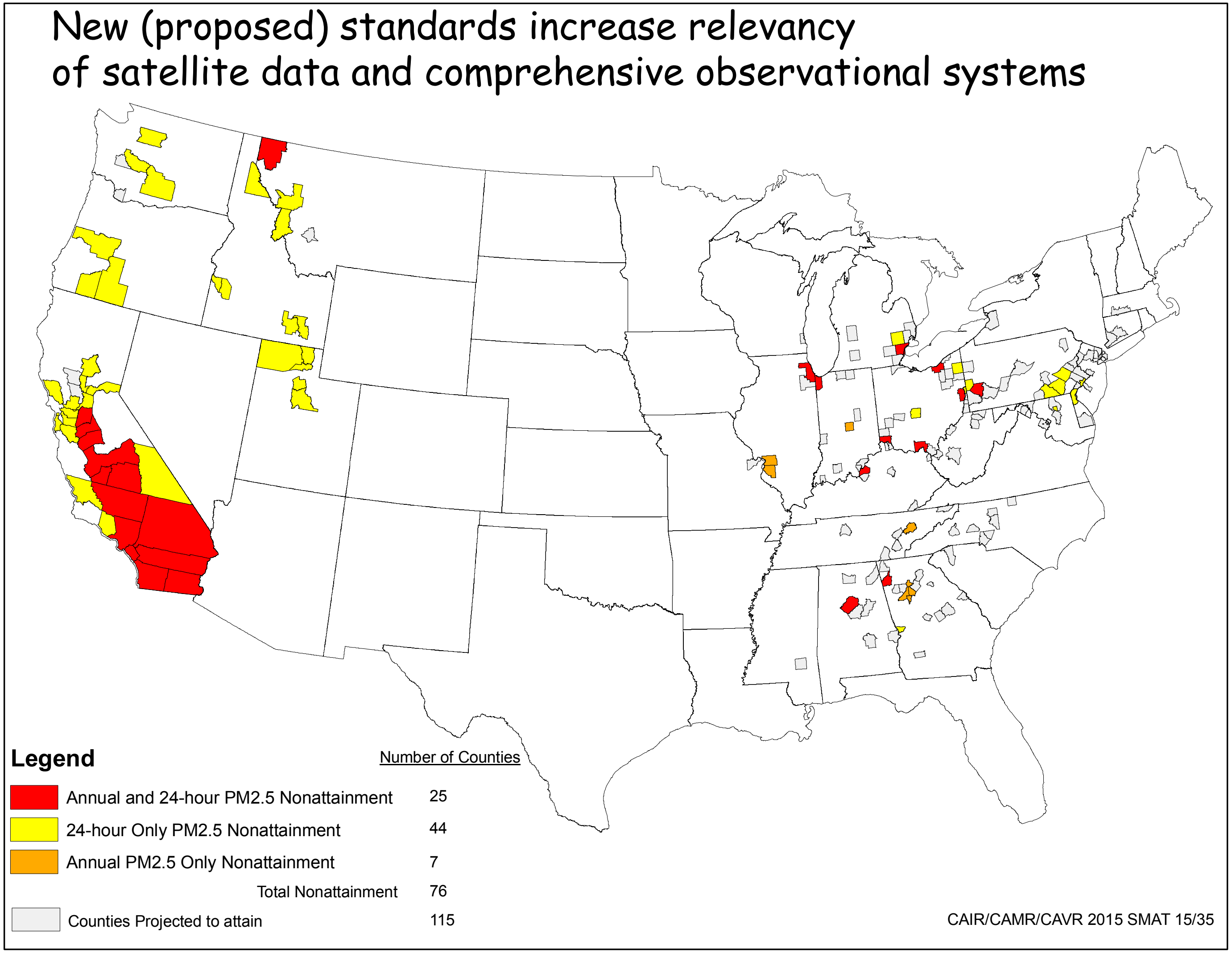
- Annual NAAQS 15 ug/m3
- 24 hour 98th percentile NAAQS 35 µg/m3
  - From 65 µ g/m3
  - Implications ….new definition for anomalous events
    - Increased relevance of remote sensing information
- PM10 remains
- Requirements for $PM_{10-2.5}$ monitoring
  - focus on urban coarse PM resuspended by heavy traffic, industrial sources, and construction
    - excludes rural dust uncontaminated by urban, industrial sources (excludes agriculture, mining, wind blown dust

Sites with 2003-05 $PM_{2.5}$ Design Values:

> 15 ug/m³, 14-15, 13-14 ug/m³ annual, > 35 ug/m³ 24 hr 98%tile



Counties Exceeding the Proposed PM2.5 NAAQS- 2015 Base Case Annual 15 ug/m3 and 24-Hour 35 ug/m3



**EPA models assume implementation of CAIR/CAMR/CAVR, mobile source and other federal rules and existing state programs. Air quality is expected to be better than shown. This approach does not forecast actions states will take to meet current PM standards. Also note that modeled air quality forecasts are subject to a number of uncertainties.*

Ozone Standard under review

- Current standard (not to exceed) of 0.08 ppm running 8 hour average
- Recent health effects research suggesting link between ozone exposure and mortality
- Ozone assessment considering reduced levels as low as 0.06 ppm
- Raises importance of background ozone, transport and climate-AQ interactions

Emerging Findings Suggesting Link between Ozone and Mortality

A Meta-Analysis of Time-Series Studies of Ozone and Mortality With Comparison to the National Morbidity, Mortality, and Air Pollution Study Michelle L. Bell,* Francesca Dominici,† and Jonathan M. Samet‡, Epidemiology • Volume 16, Number 4, July 2005

Ruidavets, J.-B.; Cournot, M.; Cassadou, S.; Giroux, M.; Meybeck, M.; Ferrires, J. (2005) Ozone air pollution is associated with acute myocardial infarction. Circulation 111: 563-569.

Kim, S.-Y.; Lee, J.-T.; Hong, Y.-C.; Ahn, K.-J.; Kim, H. (2004) Determining the threshold effect of ozone on daily mortality: an analysis of ozone and mortality in Seoul, Korea, 1995-1999. Environ. Res. 94: 113-119.

Huang, Y.; Dominici, F.; Bell, M. L. (2005) Bayesian hierarchical distributed lag models for summer ozone exposure and cardio-respiratory mortality. Environmetrics 16: 547-562.

Ito, K.; De Leon, S. F.; Lippmann, M. (2005) Associations between ozone and daily mortality, analysis and metaanalysis. Epidemiology 16: 446-457.

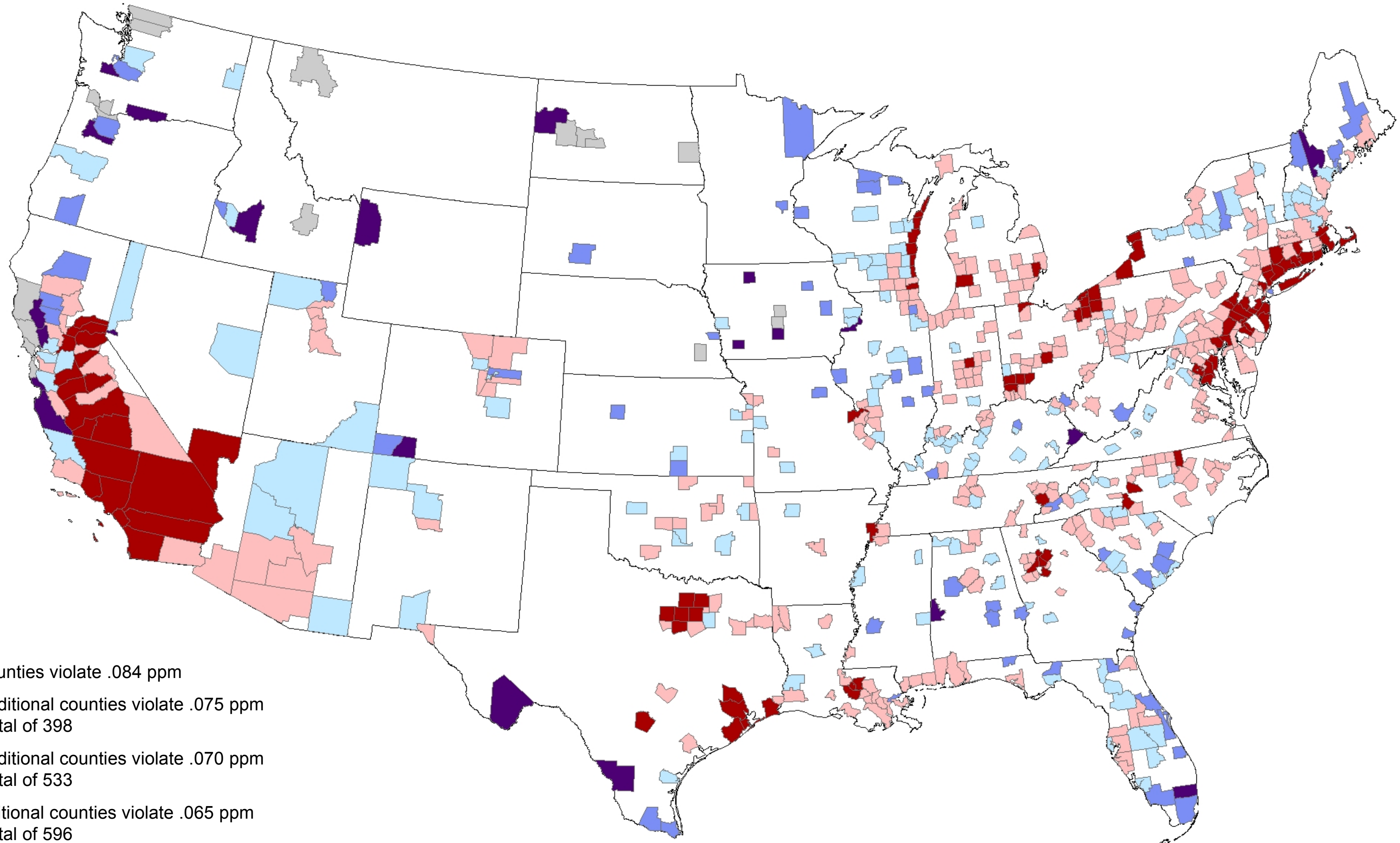
Levy, J. I.; Chemerynski, S. M.; Sarnat, J. A. (2005) Ozone exposure and mortality, an empiric Bayes metaregression analysis. Epidemiology 16: 458-468.

Liao, D.; Duan, Y.; Whitsel, E. A.; Zheng, Z.-J.; Heiss, G.; Chinchilli, V. M.; Lin, H.-M. (2004) Association of highe levels of ambient criteria pollutants with impaired cardiac autonomic control: a population-based study. Am. J. Epidemiol. 159: 768-777.

Rich, D. Q.; Schwartz, J.; Mittleman, M. A.; Link, M.; Luttmann-Gibson, H.; Catalano, P. J.; Speizer, F. E.; Dockery, D. W. (2005) Association of short-term ambient air pollution concentrations and ventricular arrhythmias. Am. J. Epidemiol. 161: 1123-1132.

Schwartz, J. (2005) How sensitive is the association between ozone and daily deaths to control for temperature? Am. J. Respir. Crit. Care Med. 171: 627-631.

Counties With Monitors Violating Alternative 8-hr Ozone Standards (Based on 2003 – 2005 Air Quality Data)



- 104 counties violate .084 ppm
- 294 additional counties violate .075 ppm for a total of 398
- 135 additional counties violate .070 ppm for a total of 533
- 63 additional counties violate .065 ppm for a total of 596
- 22 additional counties violate .060 ppm for a total of 618

- 21 counties meet .060 ppm for a total of 639

Notes:

[1] Out of 639 monitored counties

[2] No monitored counties outside the continental U.S. violate

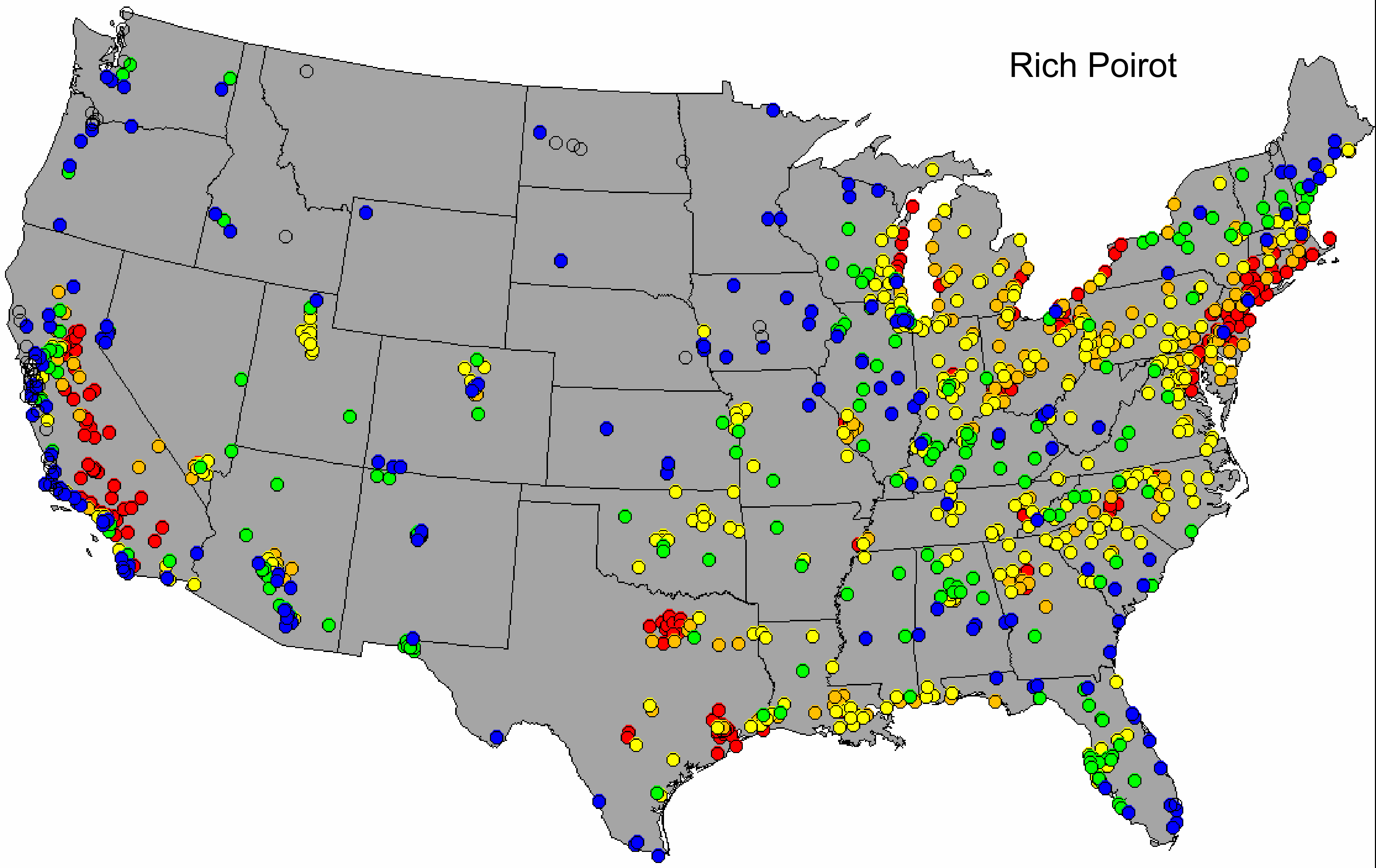
[3] Monitored data can be obtained from the AQS system at http://www.epa.gov/ttn/airs/airsaqs/

[4] The current standard of 0.08 ppm is effectively expressed as 0.084 ppm when rounding conventions are applied.

[5] These estimates are based on the most recent data certified as complete(2003 – 2005). EPA will not designate areas as nonattainment on these data, but likely on 2006 - 2008 data which we expect to show improved air quality.

Sites with 2003-05 Ozone Design Values:

> 0.084 ppm, 0.081-0.084, 0.075-0.080, 0.071-0.074, 0.061-0.070 ppm

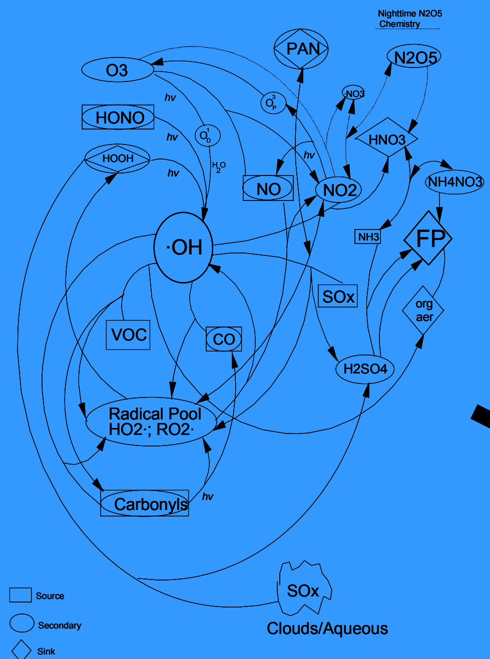


Don’t forget ozone

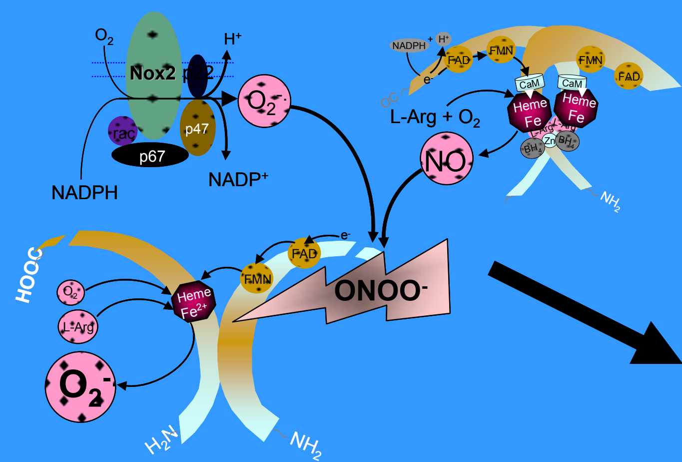
And EPA’s research budget

- exploded for PM in the late 90’s -2000’s
- What happened to fundamental oxidant research?

Health Effects: Symmetries in atmospheric and cellular level chemistries



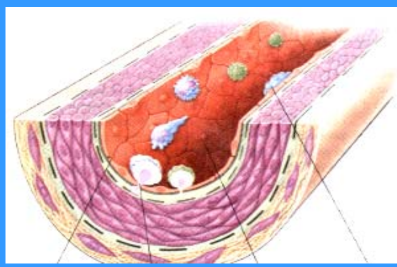
Atmospheric Pathways



Source, Harrison, 2006

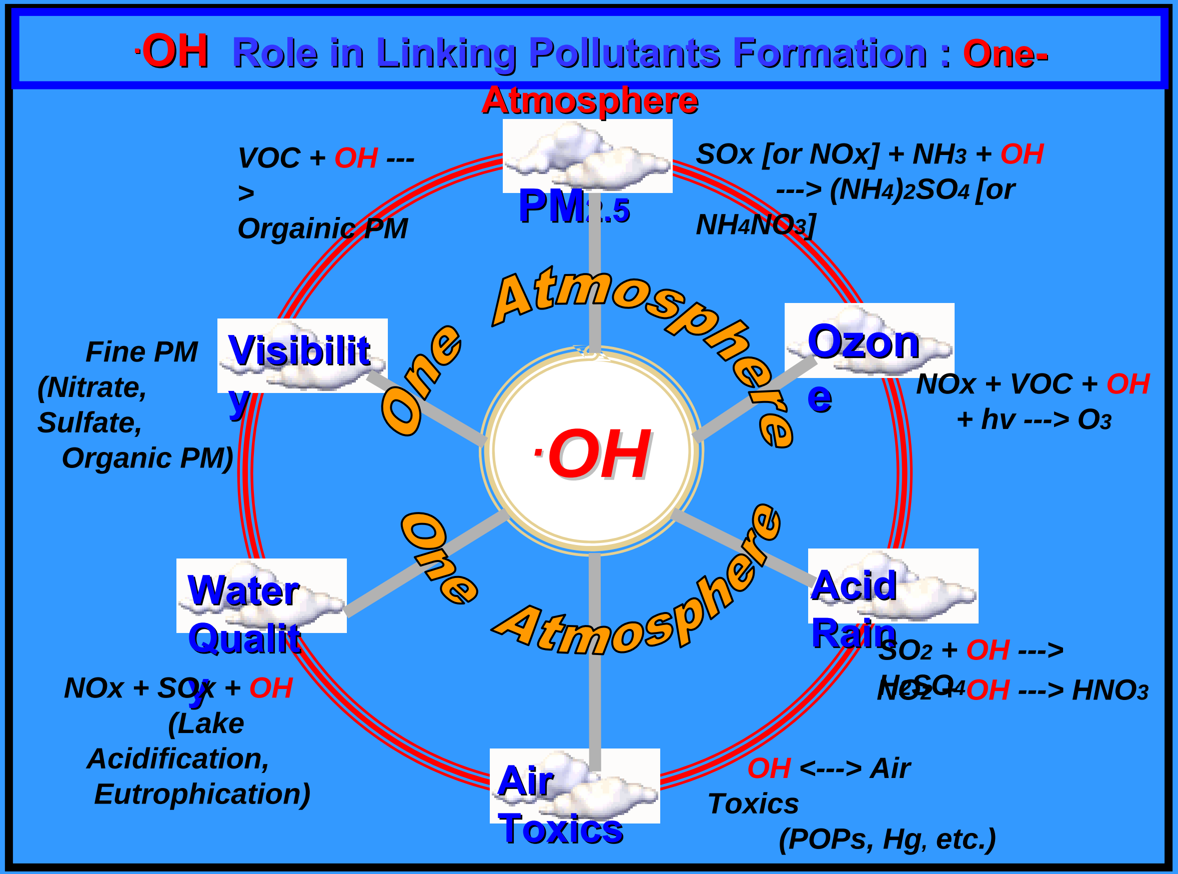
Reactive Oxidant
Cell Chemistry Processes

Source, Harrison, 2006



Hypothesized effect

We need to re-respect the Center of the Environmental Assessment Universe…



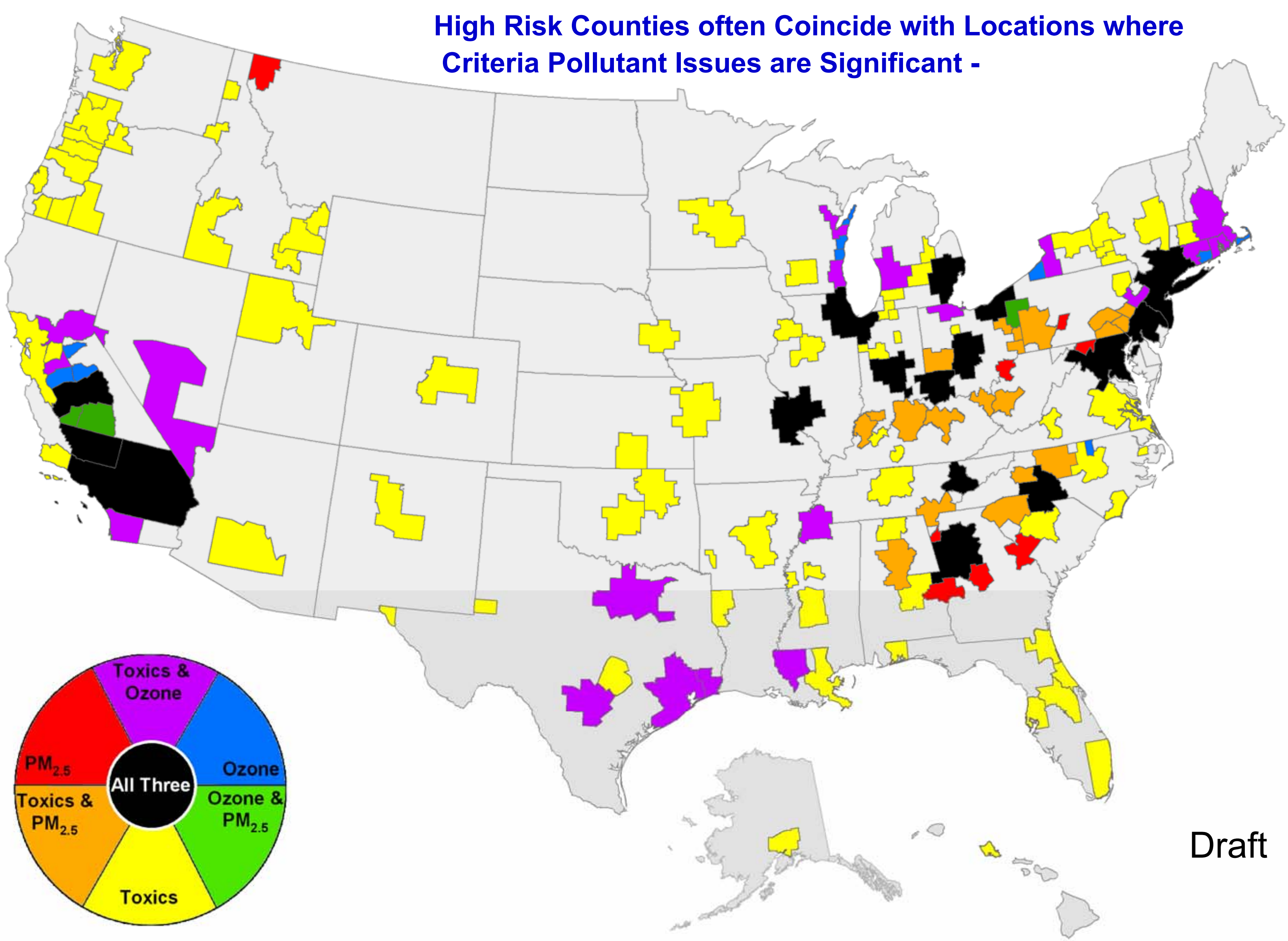
Artist…C. Jang

Emerging Challenges for Air Policy

- Developing Multiple pollutant integrated management strategies
- Assessing and Protecting Ecosystem Health
- Multiple spatial scales of interest
- Intercontinental and Cross-Border Transport
- Maintaining AQM System Efficiency in the face of Changing Climate
- Ongoing Assessments and feedbacks of program progress (accountability)

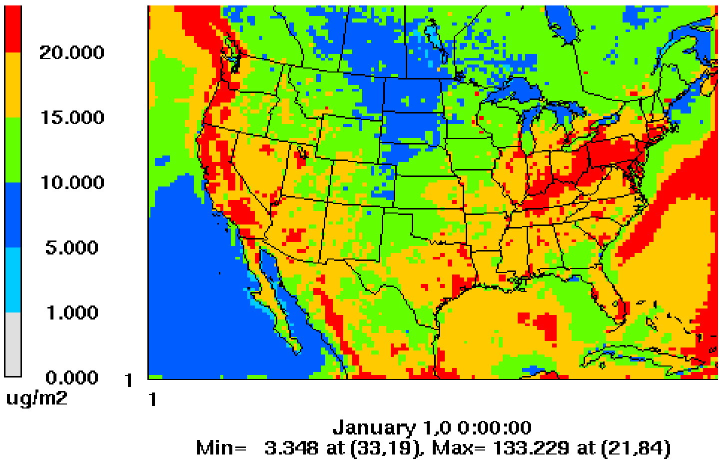
Air Toxics

Nexus of ozone, $PM_{2.5}$ (2003-5) and air toxics (NATA 1999)

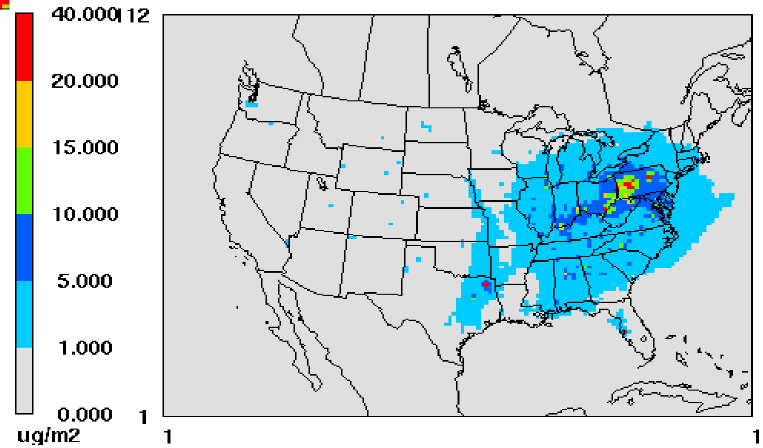


Mercury, current and future AQ challenge requiring multiple – scale approach

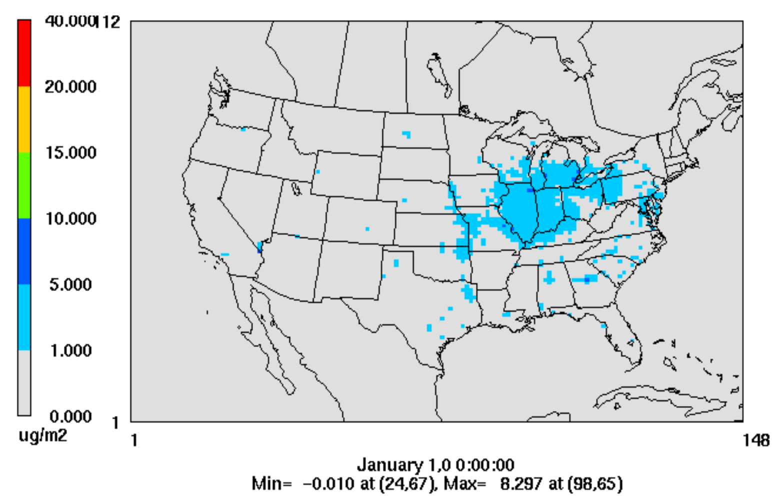
Mercury Deposition From All Sources: 2001



Mercury Deposition from US Power Plants: 2001



Mercury Deposition from US Power Plants: 2020 with CAIR & CAMR

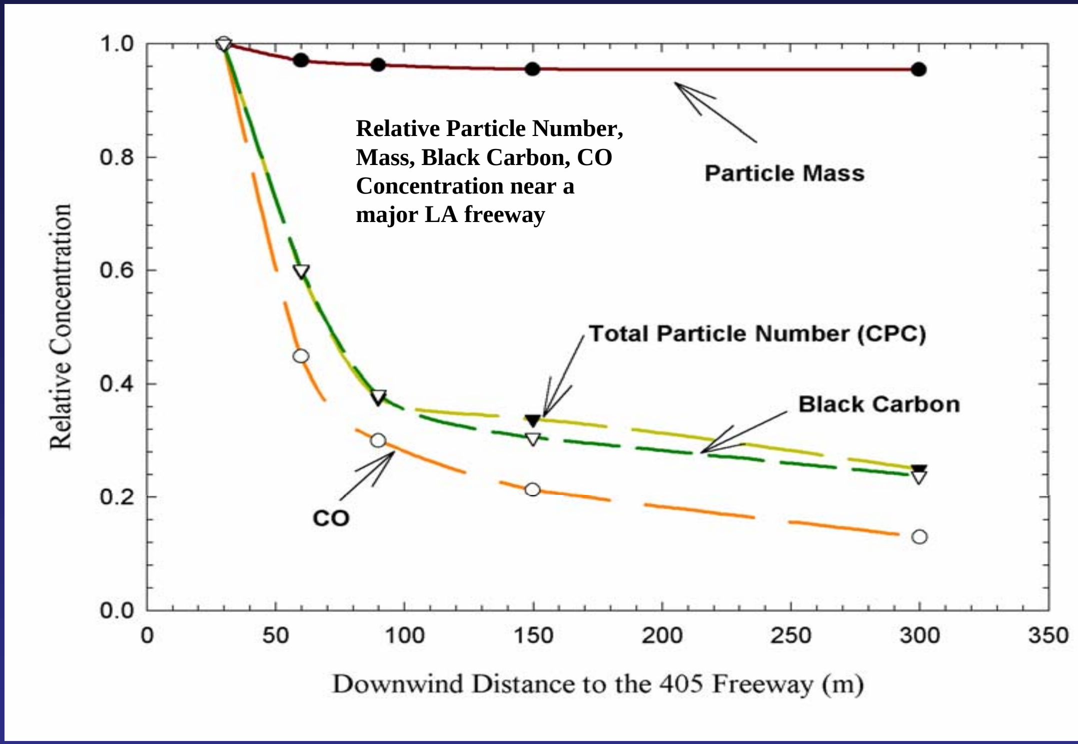


MANAGING MULTIPLE SPATIAL SCALES

New findings on roadway pollution

High exposure to ultrafine particles, CO, other pollution near roadway

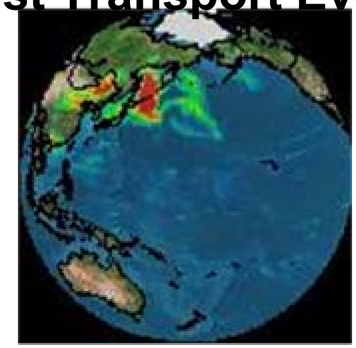
Increased risk near and on roadways



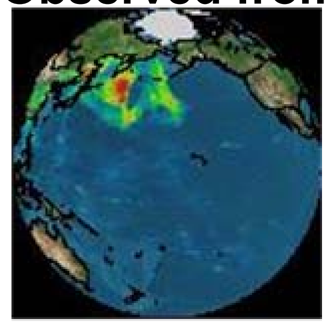
International transport/climate interactions **Scale: global/regional**

April 2001 Dust Transport Event Observed from TOMS

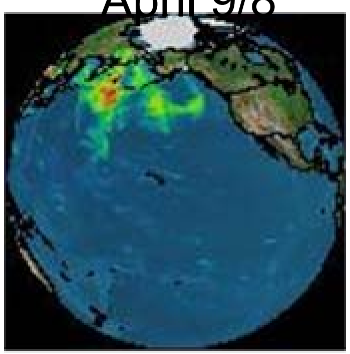
April 9/8



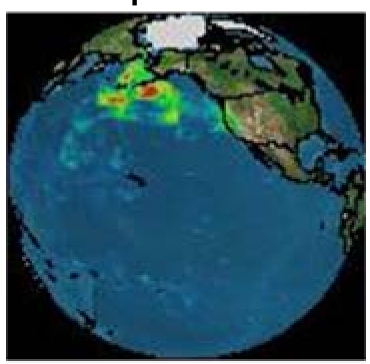
April 10/9



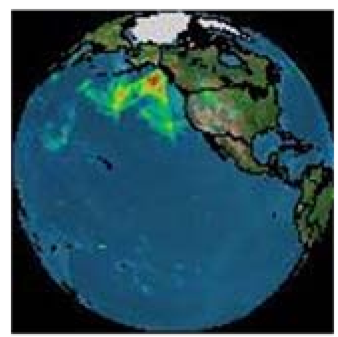
April 11/10



April 12/11

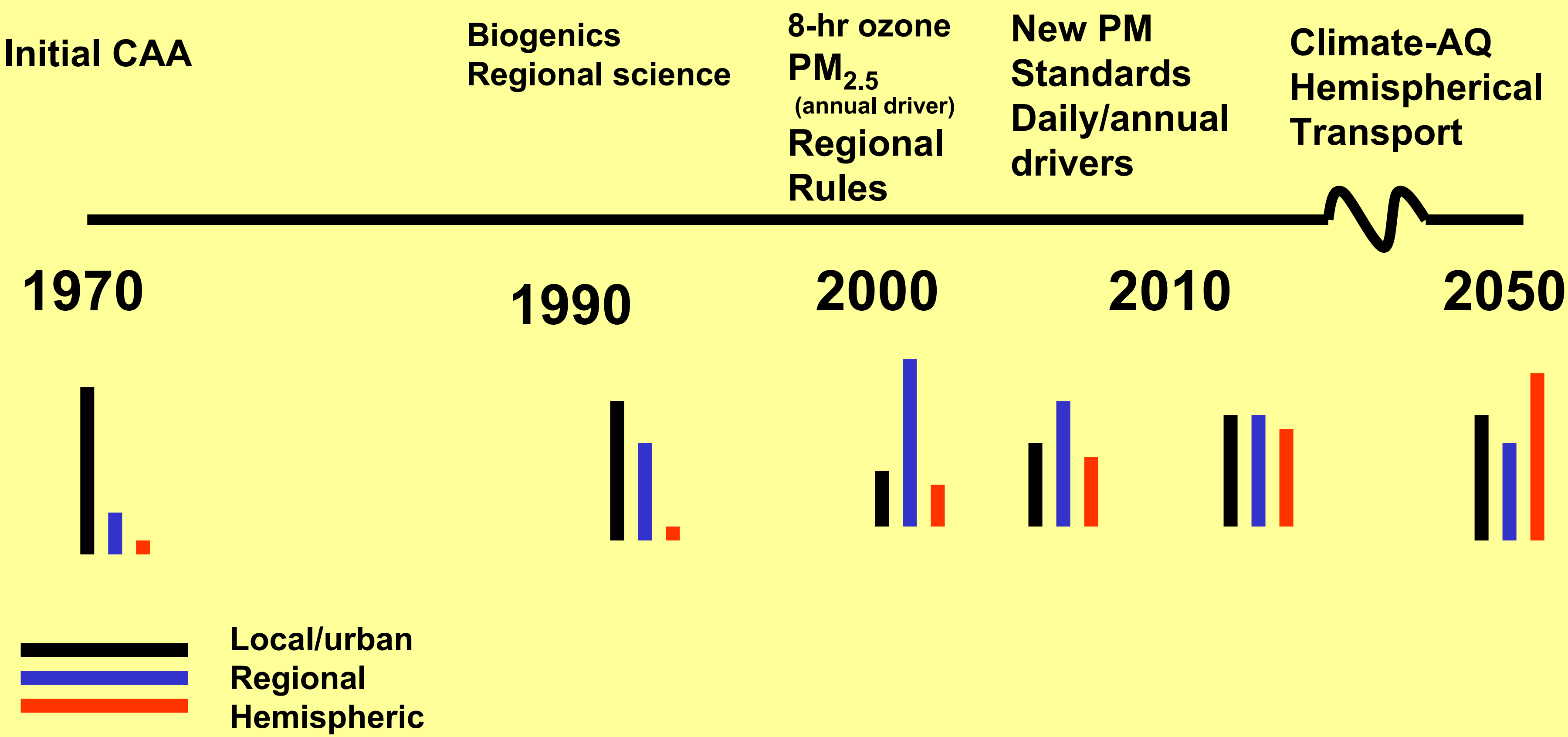


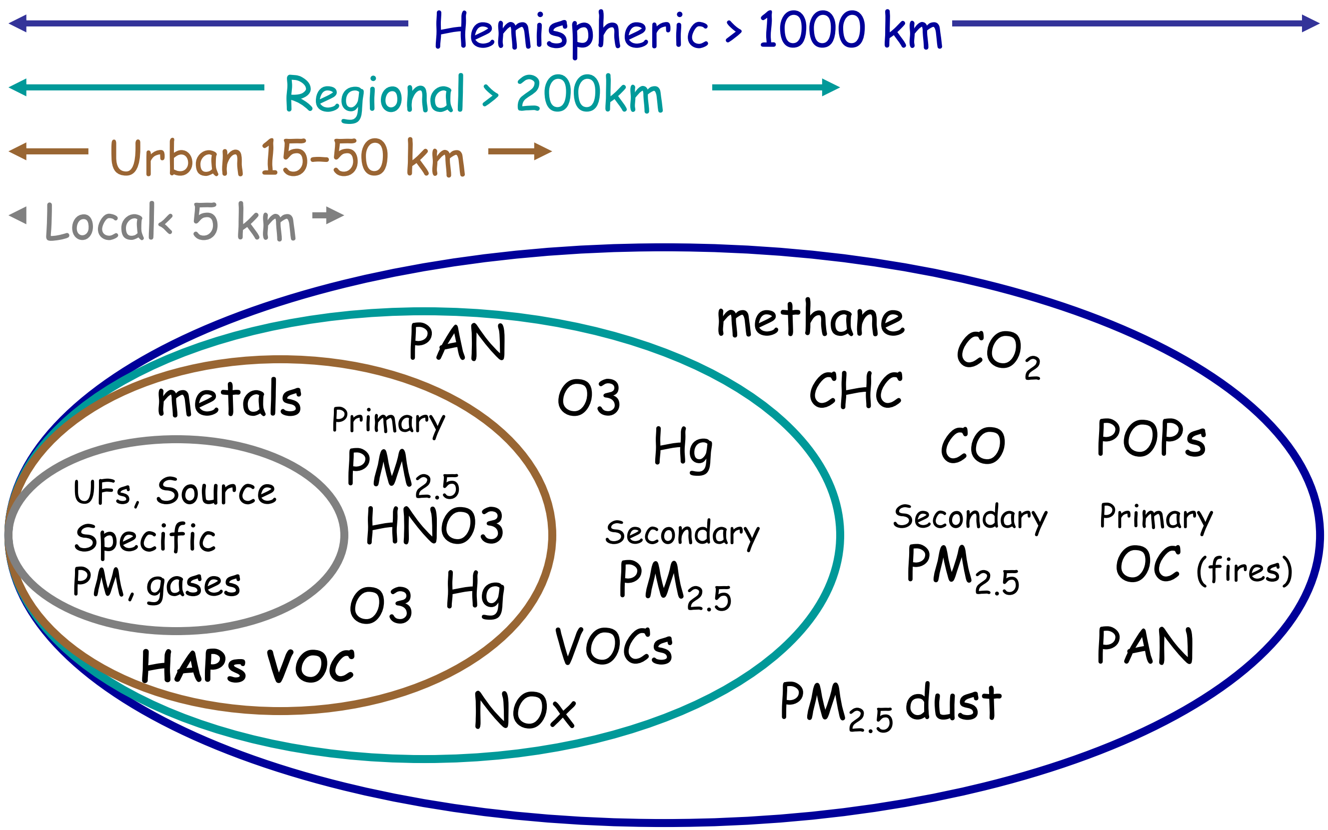
April 13/12



April 14/13

Evolutional change in National Air Pollution Management





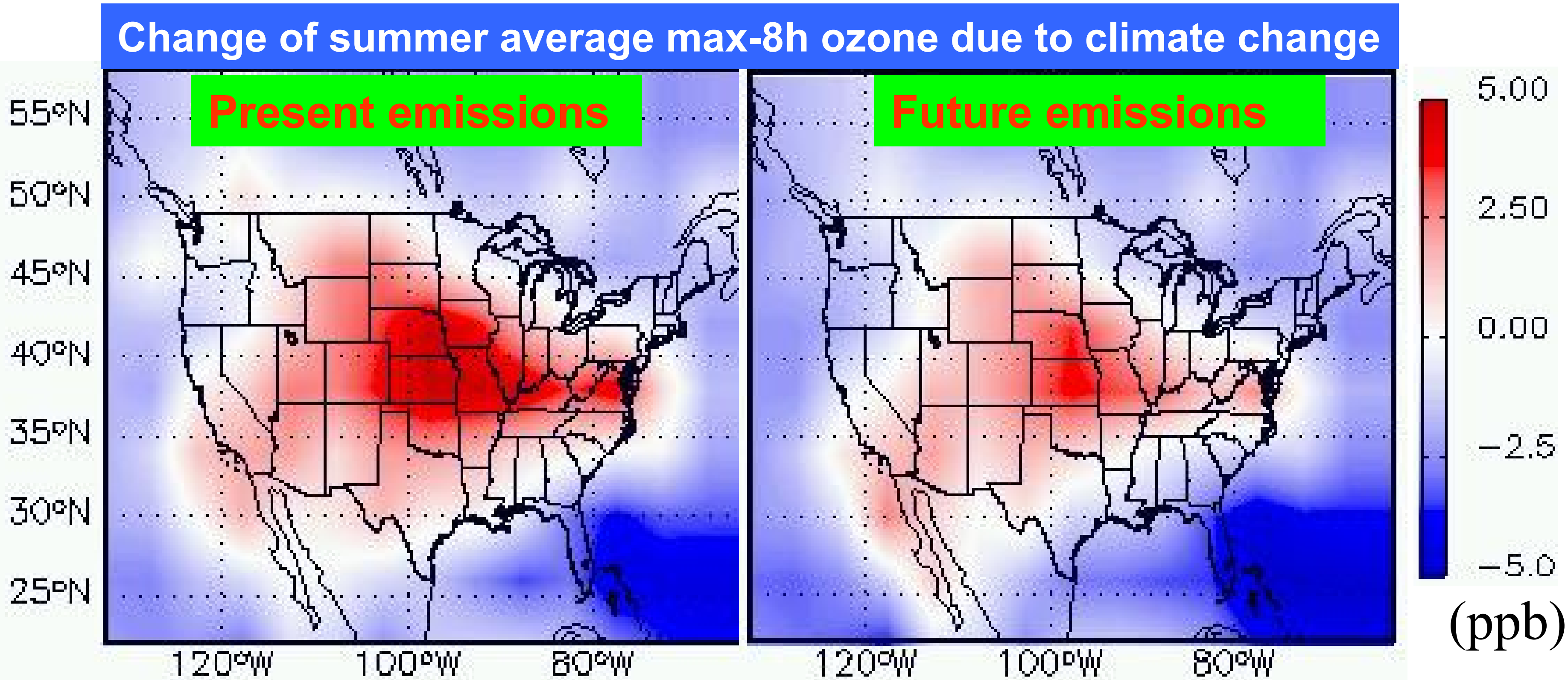
Hemispheric > 1000 km
Regional > 200km
Urban 15-50 km
Local< 5 km
UFs, Source Specific PM, gases
metals
Primary $PM_{2.5}$
HNO3
O3
Hg
HAPs VOC
PAN
O3
Hg
Secondary $PM_{2.5}$
VOCs
NOx
methane
CHC
CO_2
CO
POPs
Secondary $PM_{2.5}$
Primary OC (fires)
PAN
$PM_{2.5}$ dust

EPA and Climate Change (acceleration)

- Roles
  - Near term regulatory activity (OTAQ) …Supreme court ruling
    - Mobile source rulemaking under development, “20 in 10” plan to reduce GHG emissions (with USDA, DOE and DOT)
      - Alt. fuels, CAFE Standards
  - Communicating effects and mitigation strategies (OAP)
  - Emissions Inventory development (OAP/OAQPS/ORD)
    - GHG; harmonization with NEI
  - Linkages with Hemispheric transport (OAR)
    - Similar tools (emissions, obs., models)
    - Climate induced transport pathway alterations
  - Climate influences on air quality (OAQPS/ORD)
    - Linking global and regional scale modeling
    - Accounting for climate impacts in developing policies

Mitigation of climate penalty by emission reductions in ozone precursors (Wu et al.)

"climate penalty" for ozone air quality = $\Delta[O_3]$ from climate change

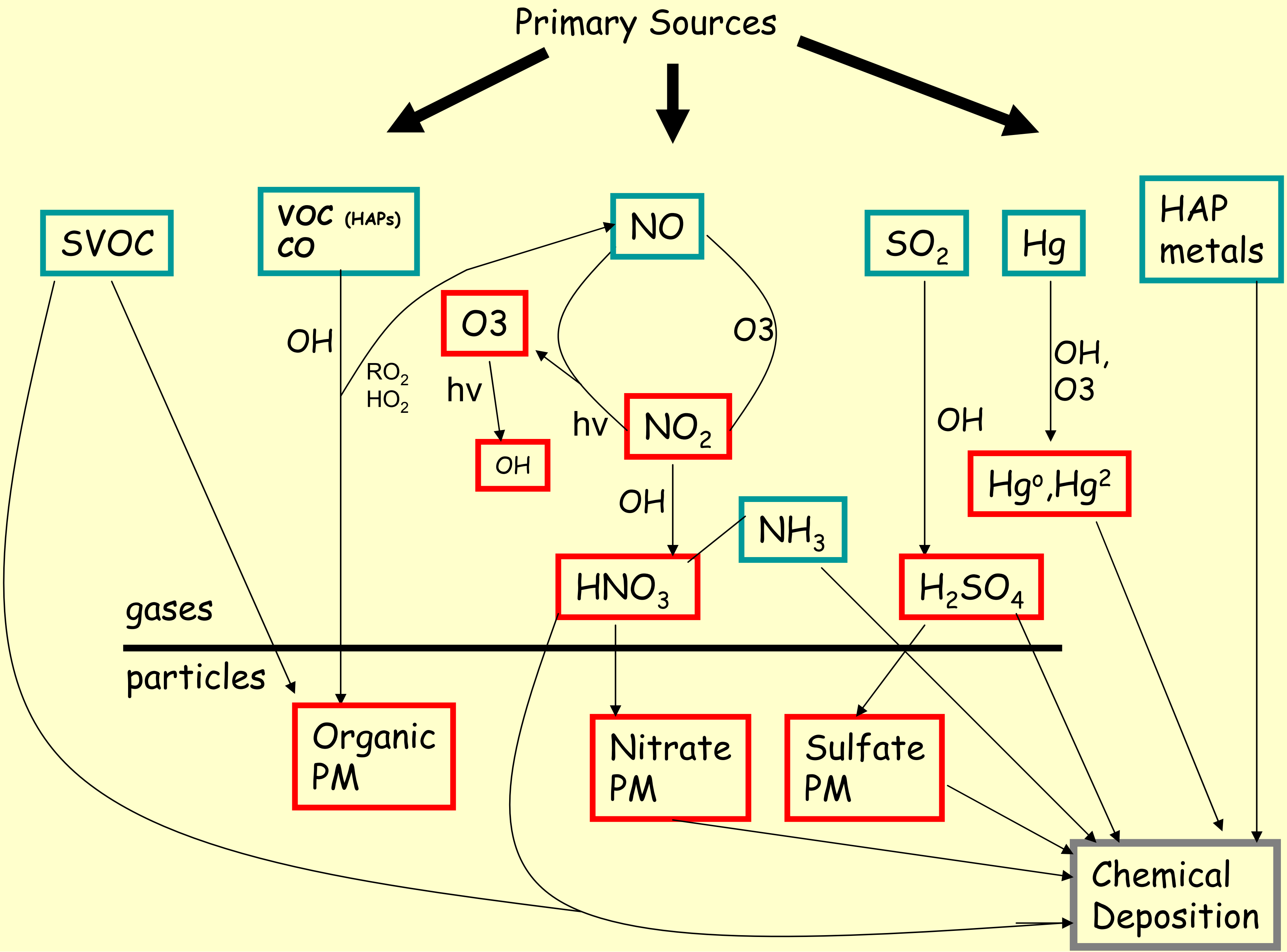


Reductions of anthropogenic emissions significantly mitigate the "climate penalty" and can even turn it into a "climate benefit" in southeast and northwest U.S.

Multimedia Assessments

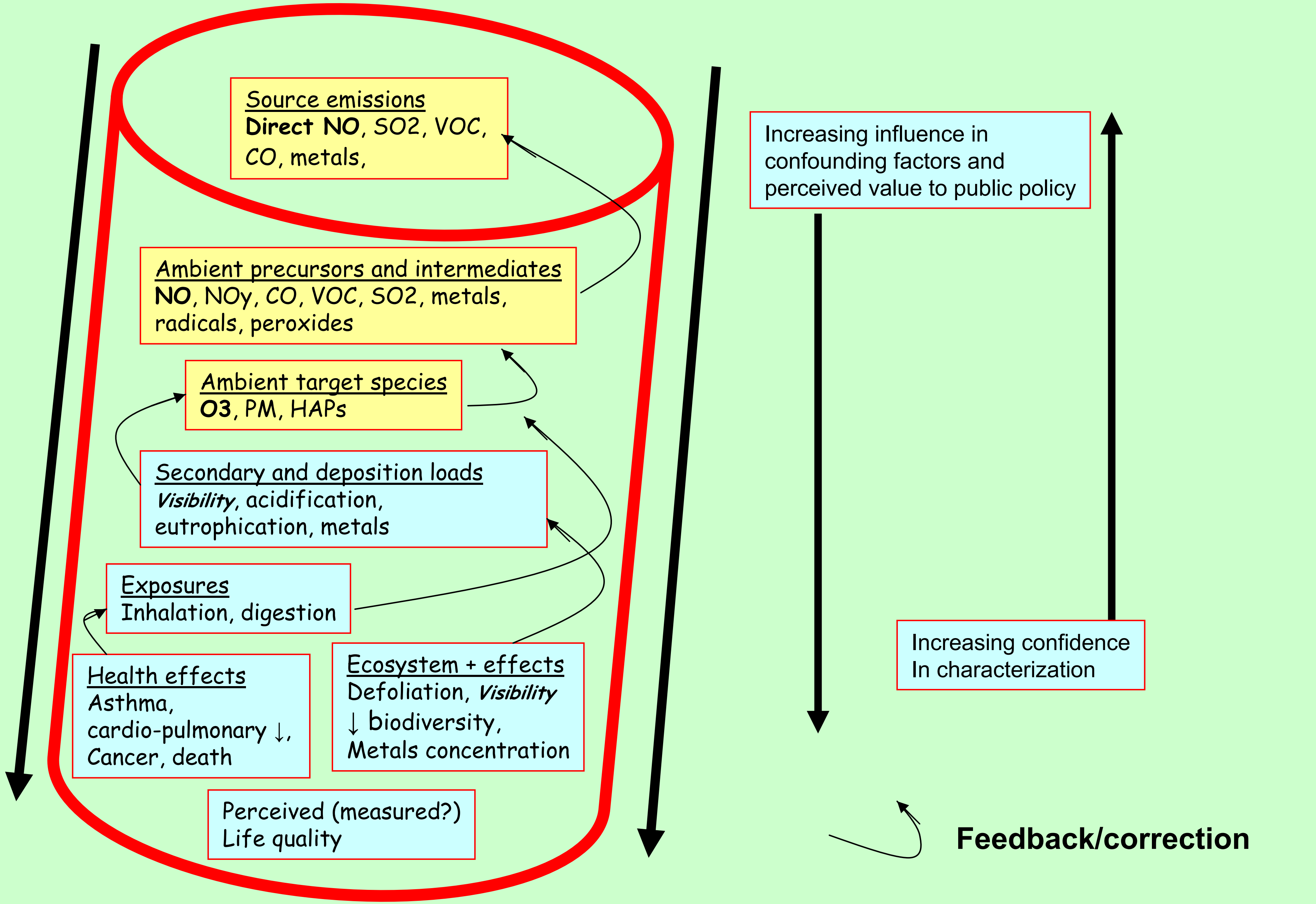
- Start with NAPAP (Acid rain, Title 4)
  - Interest waning as ozone, then PM2.5 emerged as dominant air quality interests starting in the late 1980's
- 2004 NAS AQ Report driving EPA, AQ community
  - Reorganization
  - Resource allocations
  - New NARSTO MP-MM-ACC assessment
    - NASA participation requested

Integration across pollutants and media: tradeoffs and optimum strategies?



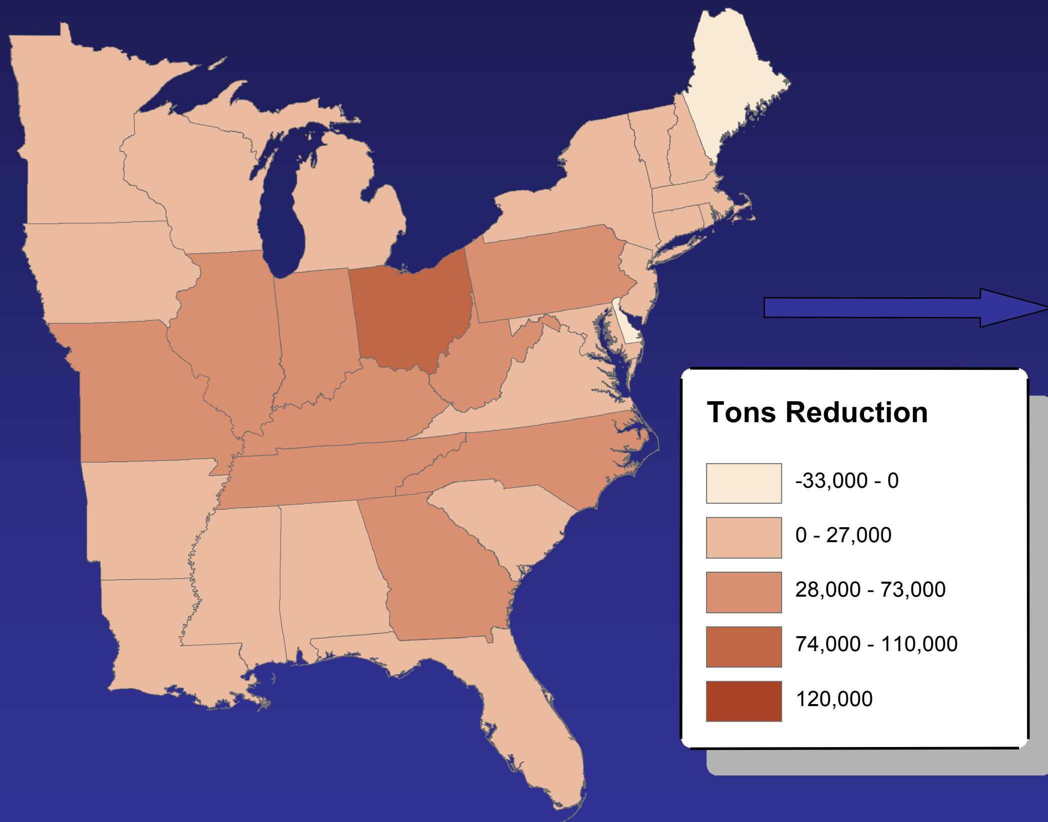
ACCOUNTABILITY

Accountability and Indicators Pipeline

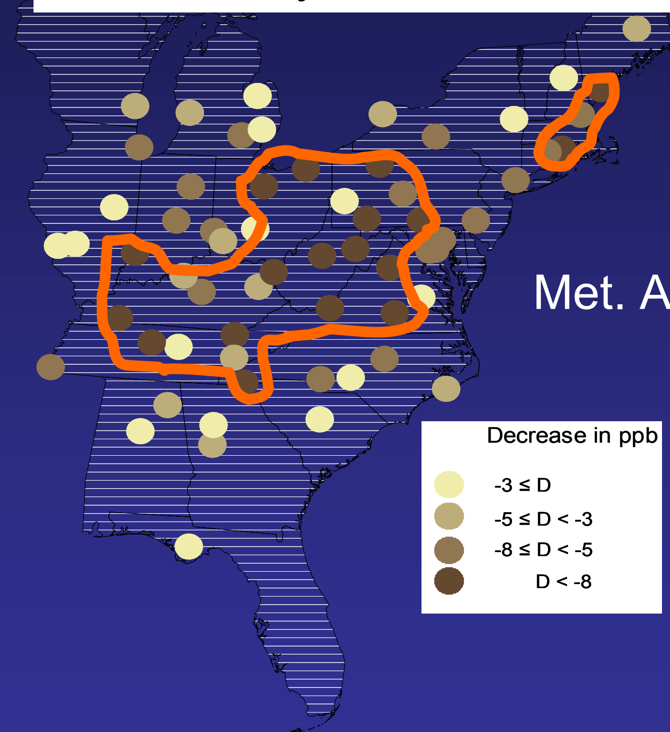


Largest decline in ozone occurs in and downwind of EGU NOx emissions reductions (2002-2004) (analysis constrained by absence ambient NOx data)

EGU NOx Tons Reduced



Decline in "Seasonal Average" 8-Hour Daily Maximum Ozone



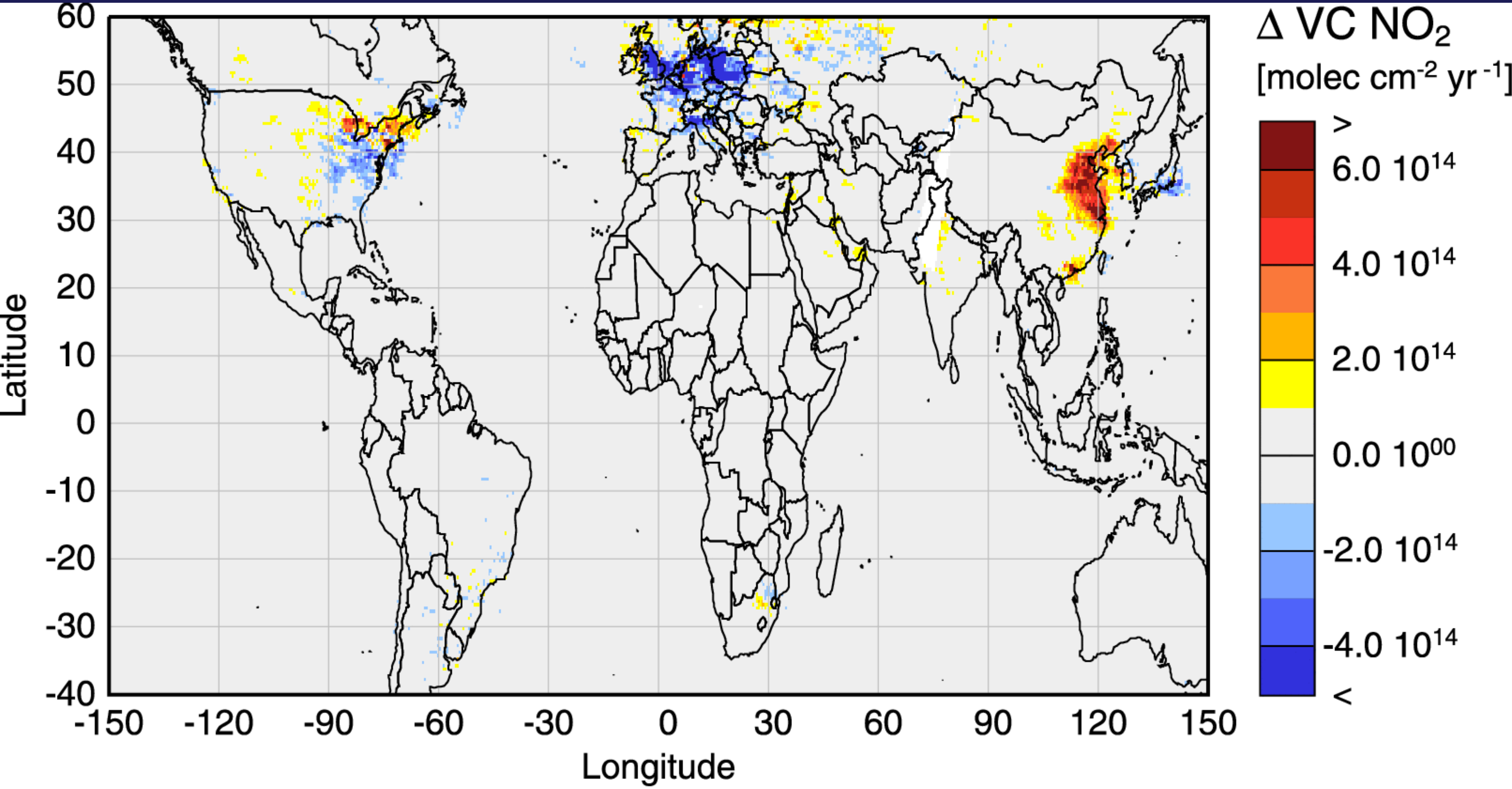
Met. Adj.

The major EGU NOx emissions reductions occurs after 2002 (mostly NOx SIP Call)

Average rate of decline in ozone between 1997 and 2002 is 1.1%/year.

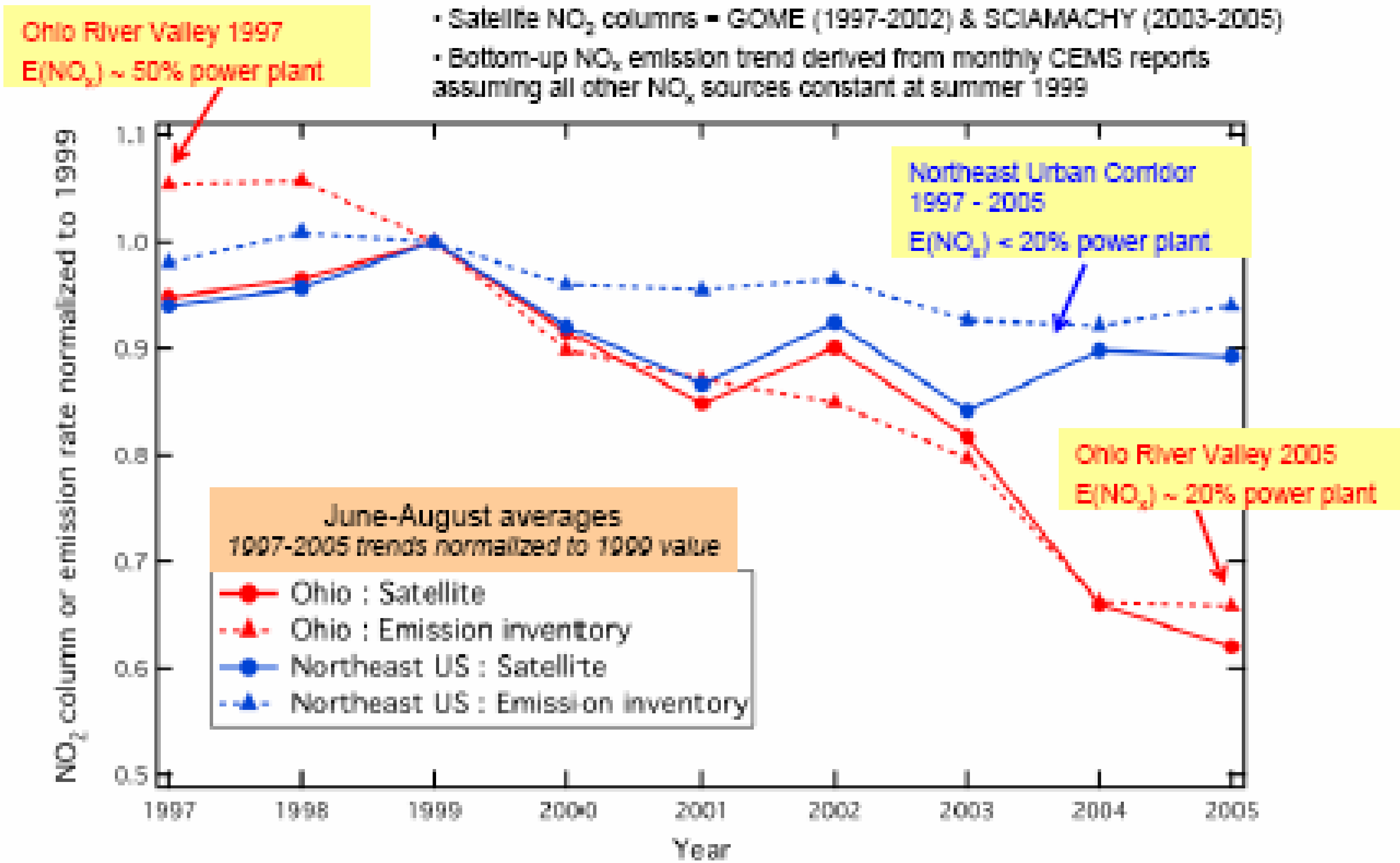
Average rate of decline in ozone between 2002 and 2004 is 3.1%/year.

GOME Satellite NO_2 Trends (1995-2002)



Richter et al., 2005

Annual Changes in Satellite NO_2 Columns and Emissions

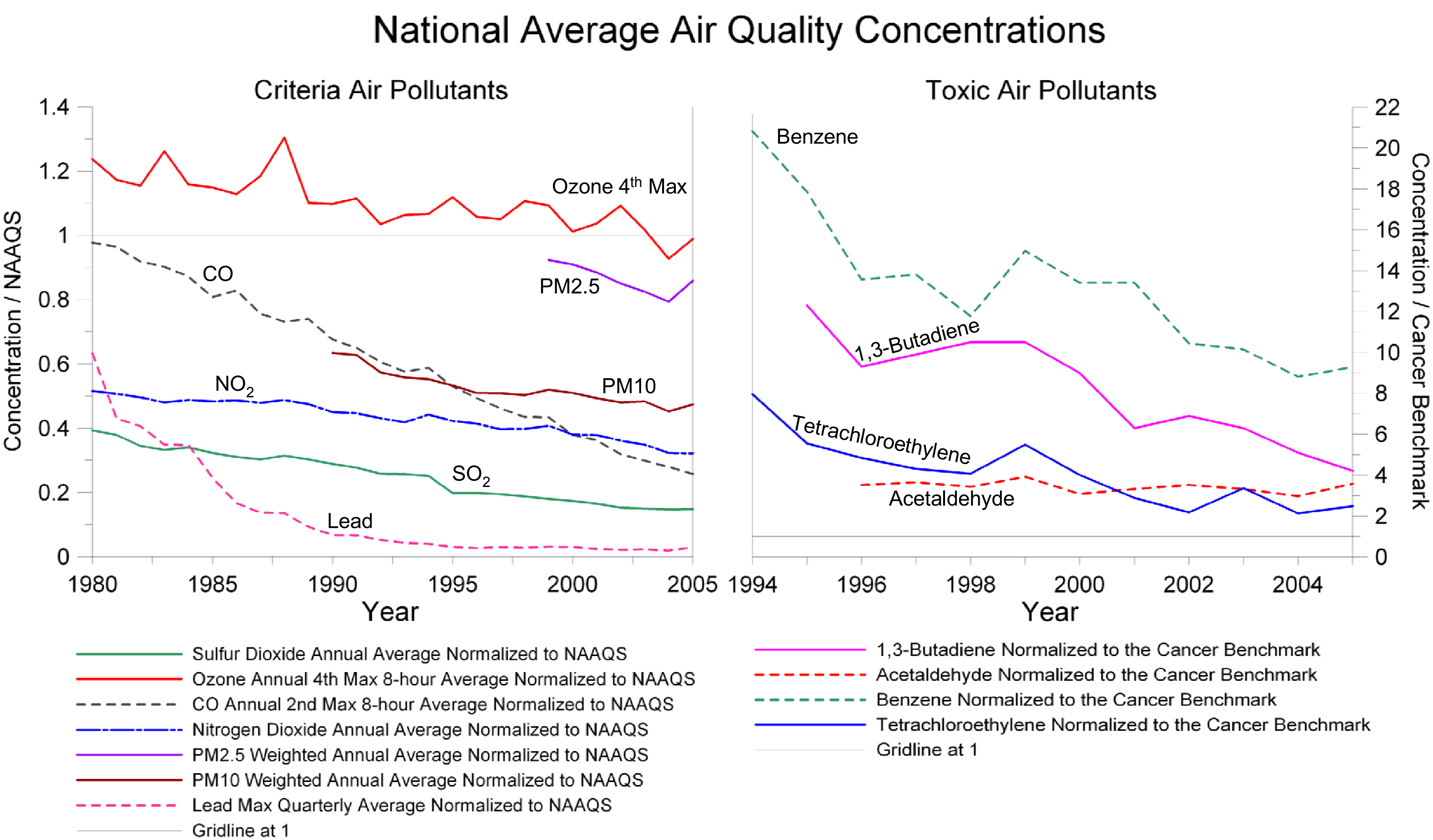


•Similar trends in satellite NO_2 columns and NO_x emissions

➢Power plant NO_x controls have affected NO_2 columns

➢Mobile NO_x emission changes smaller than those for power plants

Courtesy NOAA, Kim et al.


National Average Air Quality Concentrations
Criteria Air Pollutants
Toxic Air Pollutants
Concentration / NAAQS
Concentration / Cancer Benchmark
Year
Year
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1980
1985
1990
1995
2000
2005
1994
1996
1998
2000
2002
2004
22
20
18
16
14
12
10
8
6
4
2
0
Ozone 4th Max
CO
PM2.5
NO2
PM10
SO2
Lead
Benzene
1,3-Butadiene
Tetrachloroethylene
Acetaldehyde
Sulfur Dioxide Annual Average Normalized to NAAQS
Ozone Annual 4th Max 8-hour Average Normalized to NAAQS
CO Annual 2nd Max 8-hour Average Normalized to NAAQS
Nitrogen Dioxide Annual Average Normalized to NAAQS
PM2.5 Weighted Annual Average Normalized to NAAQS
PM10 Weighted Annual Average Normalized to NAAQS
Lead Max Quarterly Average Normalized to NAAQS
Gridline at 1
1,3-Butadiene Normalized to the Cancer Benchmark
Acetaldehyde Normalized to the Cancer Benchmark
Benzene Normalized to the Cancer Benchmark
Tetrachloroethylene Normalized to the Cancer Benchmark
Gridline at 1

Draft

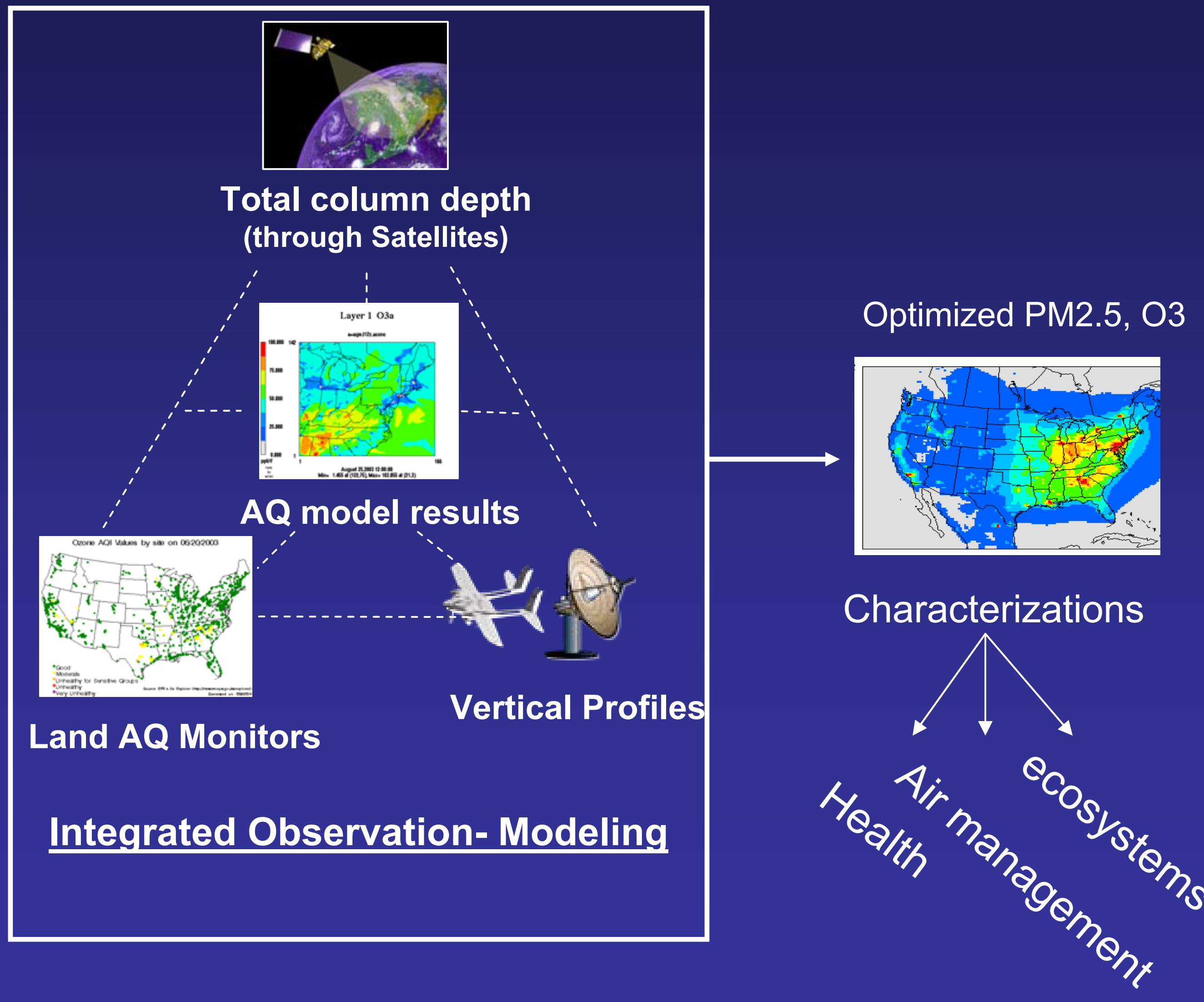
Perspectives on NASA Products/Partnerships

Start with….

- A simple overarching goal or vision,
  - Strive for maximum and efficient AQ characterization in time, space and compositional terms
- the intersecting or common link between air programs and satellite data and integrated advanced systems

TGAS/Aerosol Satellite Measurements and Numerical Predictive Models

- Integration of systems to improve
  - air quality models for forecast
  - Current and
  - Retrospective assessments
- Global-Regional Air Quality Connections
- Climate-AQ connections

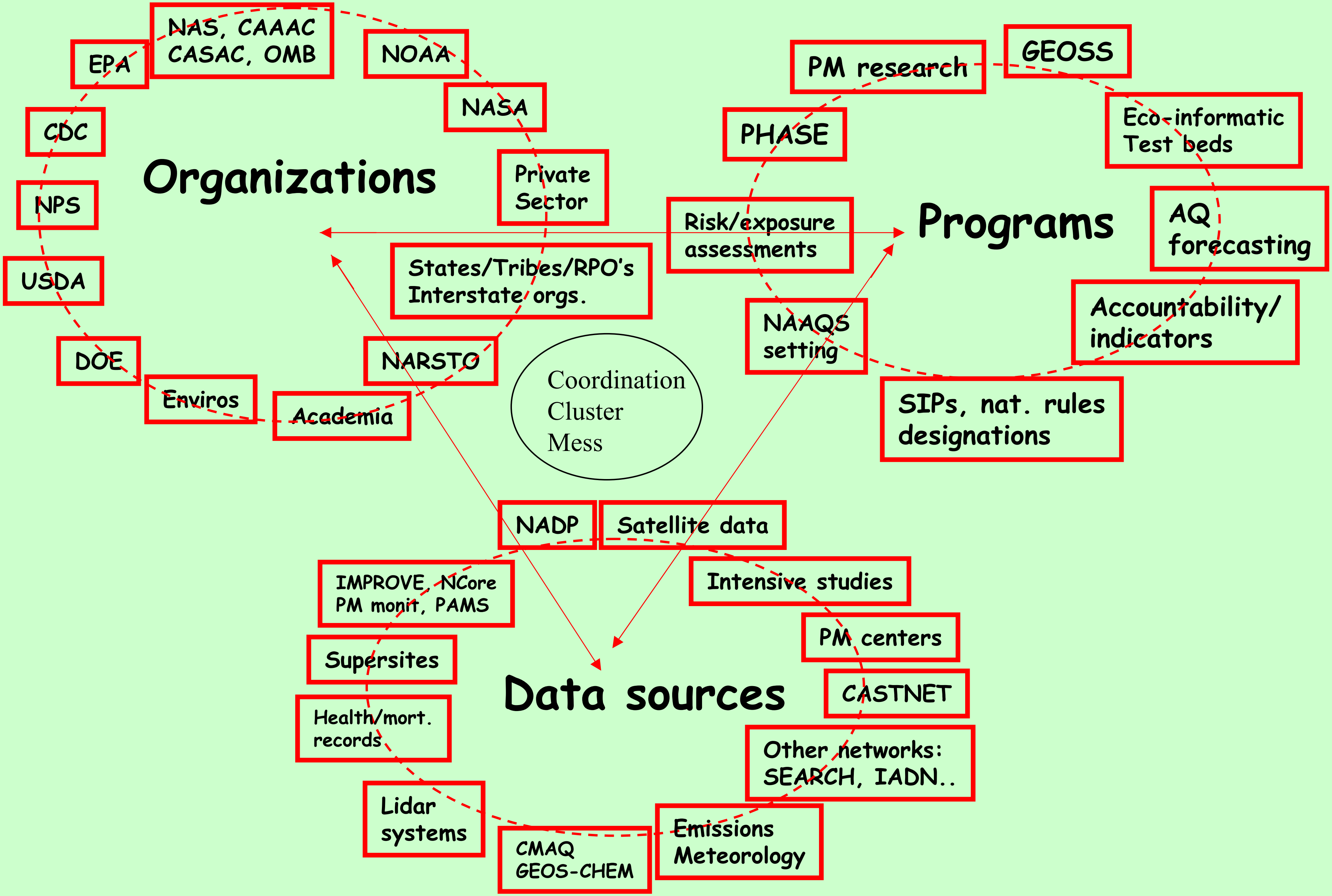


Using "characterization" as a driver, …consider

- Integration of observations and modeling logically is more critical than observations alone; might imply priority on
    - Inverse emissions generation
    - "data assimilation"
    - Observation gap filling an input to above
        - Lower expectations of replacing in-situ observations
- Vertical characterization severely neglected (most mass is well above the surface)
- NASA supported outreach providing conceptual pictures/models is a major contribution filling a gap
    - Smog blog
    - IDEA

How serious (re: partnerships) are agencies

- Technical collaboration is happening
- Opportunities remain/missed?
  - Ground surface complement to leverage total column data
    - NASA dedicated resources in linking column and vertical observations to surface data
    - EPA/States/USDA/USGS/DOI rest on established networks
      - Suggestions: in situ HCHO, trace gases (SO2, CO, NO2) to evaluate OMI
      - EPA Sustain Brewer UV network
      - Aggressive NH3 and Hg monitoring (space complements not available
      - Integrated multi-agency strategy development


Organizations
EPA
NAS, CAAAC
CASAC, OMB
NOAA
NASA
Private
Sector
CDC
NPS
USDA
DOE
Enviros
Academia
NARSTO
States/Tribes/RPO's
Interstate orgs.
Programs
PM research
GEOSS
PHASE
Eco-informatic
Test beds
Risk/exposure
assessments
AQ
forecasting
NAAQS
setting
Accountability/
indicators
SIPs, nat. rules
designations
Coordination
Cluster
Mess
Data sources
NADP
Satellite data
IMPROVE, NCore
PM monit, PAMS
Intensive studies
Supersites
PM centers
CASTNET
Health/mort.
records
Other networks:
SEARCH, IADN..
Lidar
systems
CMAQ
GEOS-CHEM
Emissions
Meteorology

Bridging atmospheric science-IT worlds

- EPA/NASA/NOAA IT systems
- US GEO role?
- Building the ESIP, DataFED concepts into a working system accessible and usable by the non expert community
  - Lessons from WMO/GAW, GEMS, GIOVANNI, VIEWS

Thank You!