Initial $PM_{2.5}$/Haze/O_3 Air Quality Analyses: Partial Results

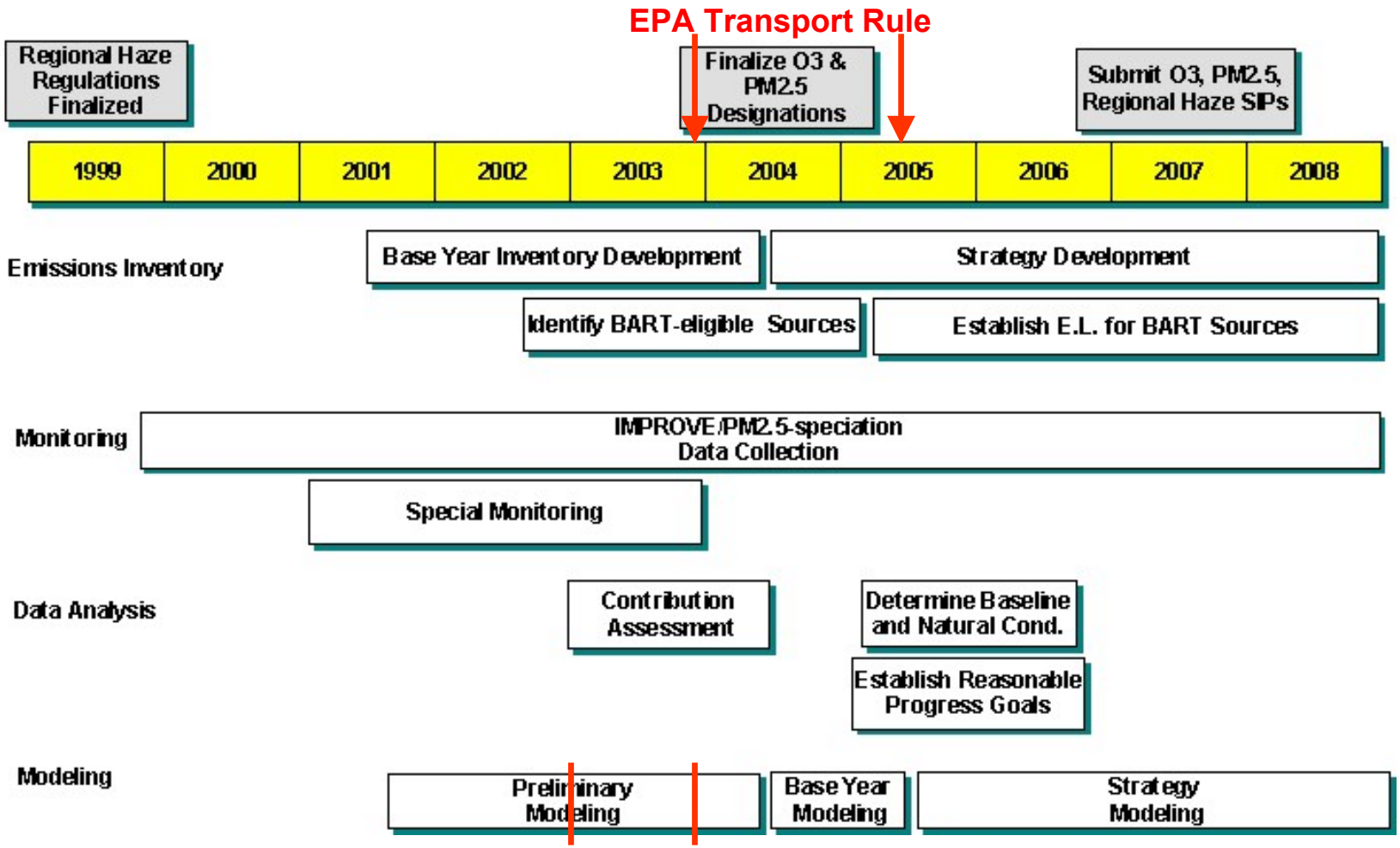
Midwest Regional Planning Organization
Lake Michigan Air Directors Consortium

June 9, 2003

Policy Questions

- What will it take..
  - to provide for attainment of $PM_{2.5}$ and O_3 (8-hour) NAAQS?
  - to meet reasonable progress requirements for regional haze?
- What level of regional SOx/NOx control is needed?
  - How can we influence USEPA's proposed transport rule?

$PM_{2.5}$/Regional Haze/O_3 Timeline



Overview of Presentation

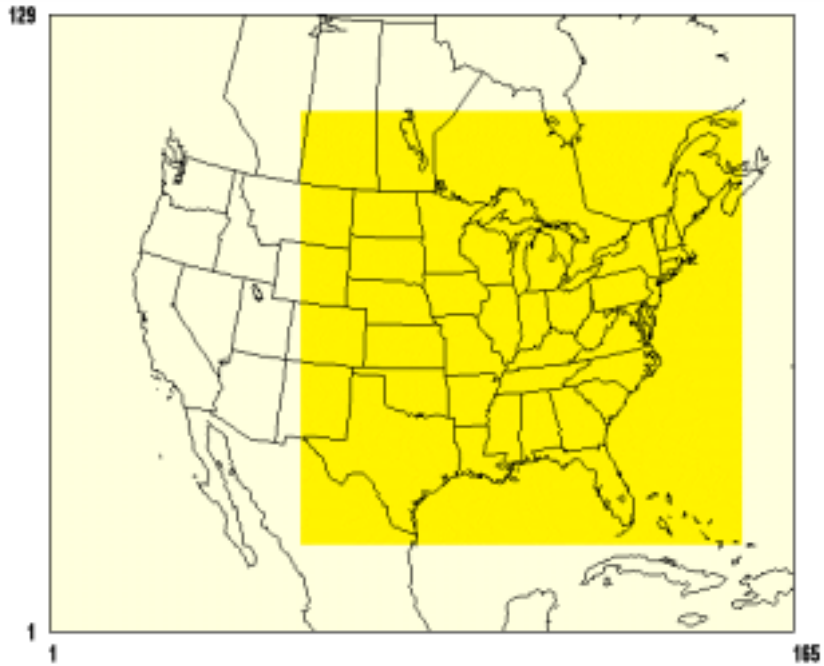
- What did we do?
- What is relative effectiveness of emission reductions?
- What can we say about attainment?
- What's next?

Part I: What did we do?

- Basecase modeling
- Sensitivity modeling
- Data analysis

Modeling Basics

- Models
  - CAMx (v. 3.10, Mech4)
  - CMAQ (June 2002 release)
  - REMSAD (v. 7.03)
- Episodes
  - Jan 2 - Feb 17, 2000
  - June 18 - Aug 13, 2001



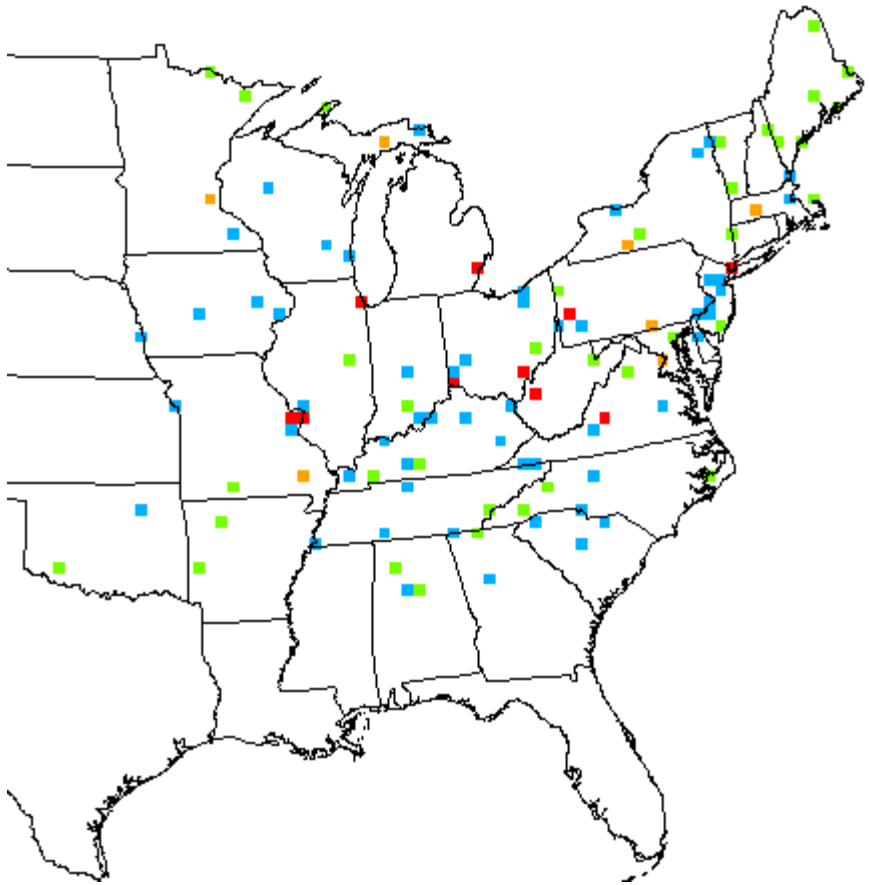
Emissions

Anthropogenic emissions based on USEPA's 1999 National Emissions Inventory

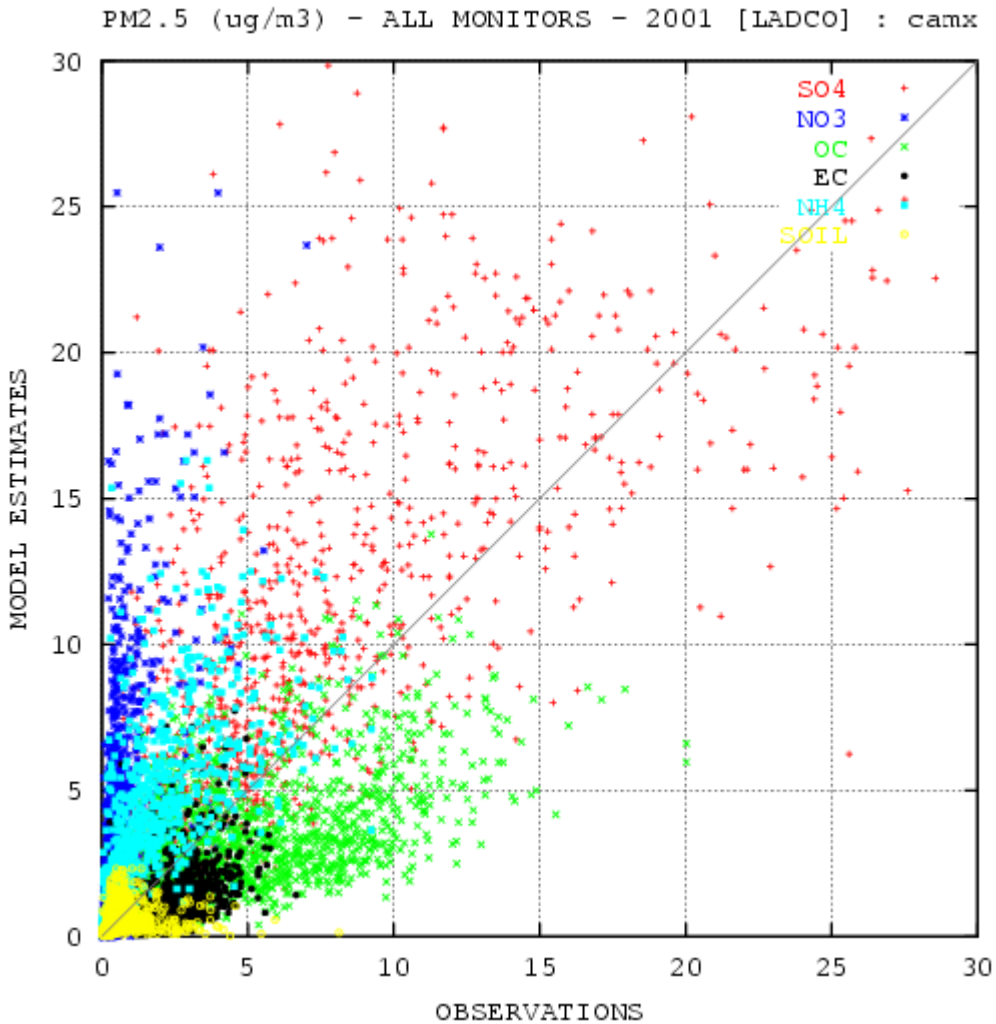
- Point and Other Area (Ver 2.0)
- Utility temporal profiles based on CEM data
- Motor vehicle based on Mobile6
- Offroad based on NONROAD model (Ver 2.0)
- Updated CMU NH3 inventory (30% lower)
- Dust emissions reduced by 99% (was 75%)
- New Canadian inventory
- No soil NH3 or Mexico inventories

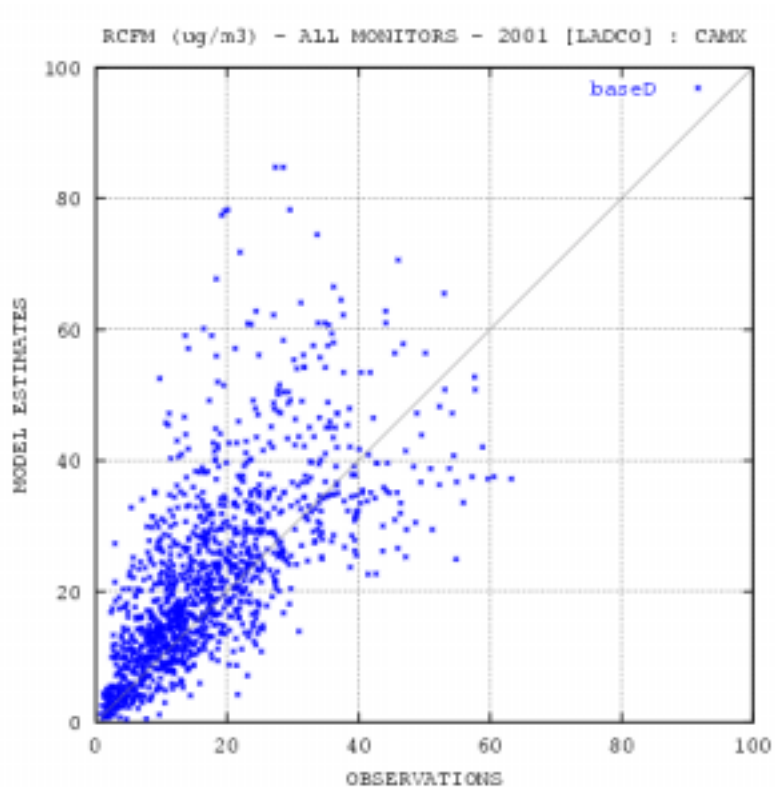
Basecase Modeling

- **March Midwest (red)**
  - daily 24 hr samples
  - Only 3 of 6 stations in winter 2000
  - PM2.5 Speciation
  - NH3, HNO3, HNO2, SO2
- **IMPROVE and CASTnet (green)**
  - 24 hr samples every 3 days
  - PM2.5 Speciation
- **Super Sites (red)**
  - Hourly gases and meteorology
  - Hourly/daily PM2.5 Speciation
- **EPA Speciation (blue)**
  - 24 hr samples every 3 days
  - PM2.5 Speciation
- **AIRS -- not shown on map**
  - Hourly criteria pollutants

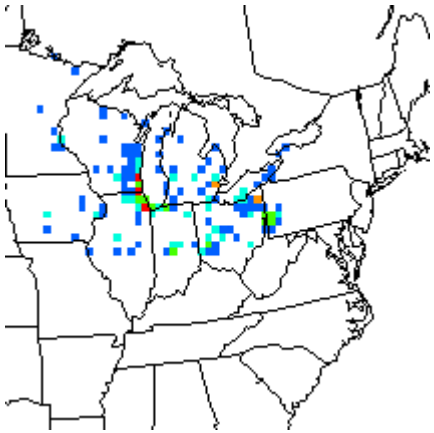


PM Model Performance Summer 2001

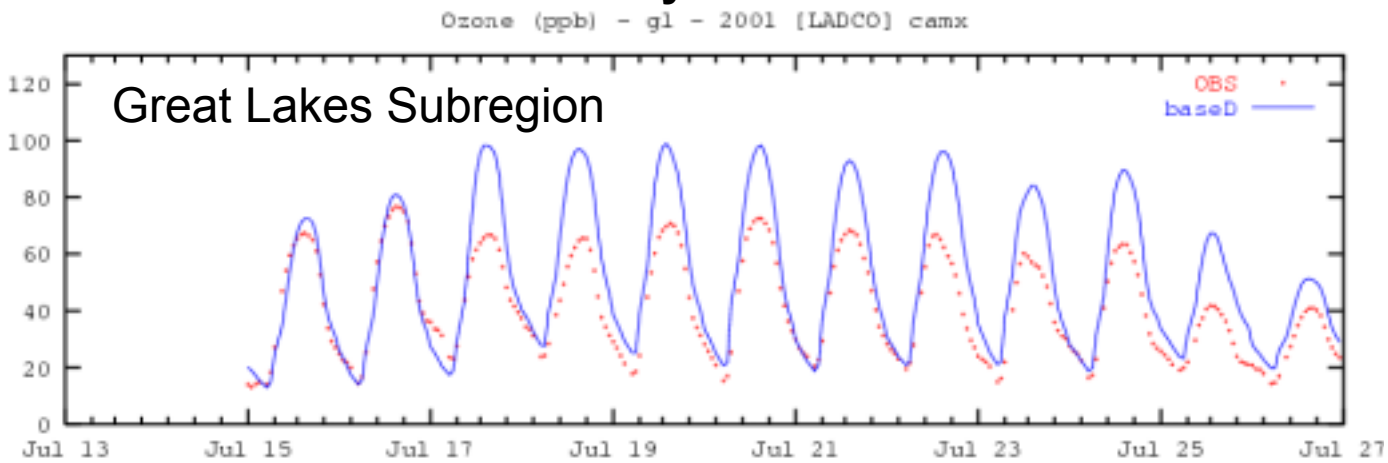


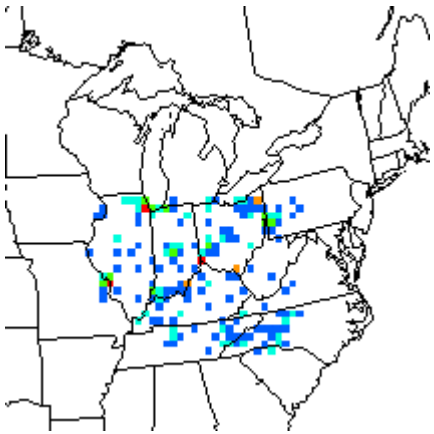


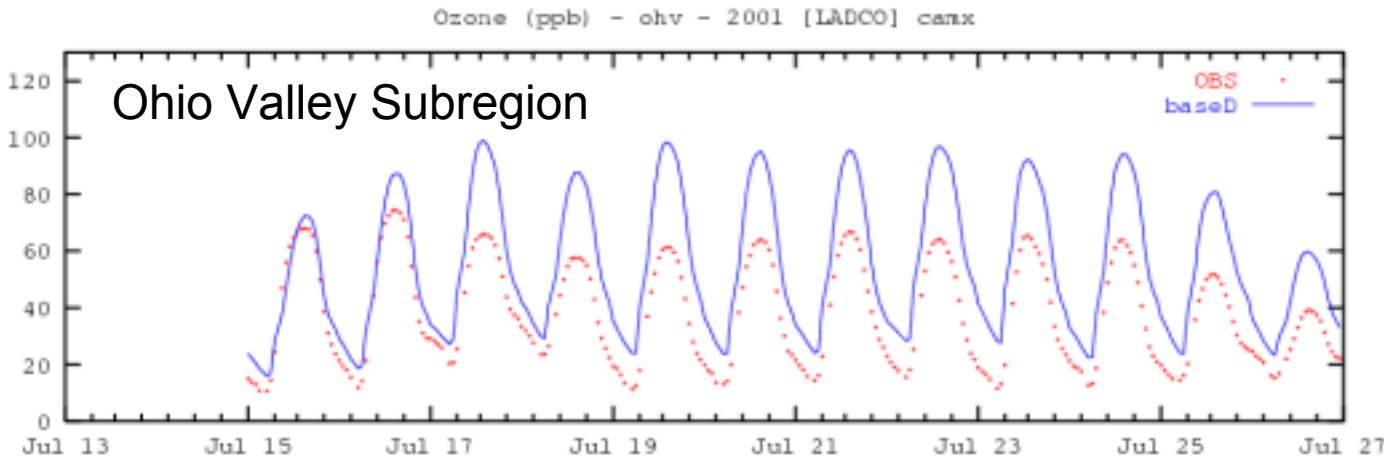
Ozone Model Performance



July 2001







Sensitivity Modeling

- What is the relative effectiveness of reducing emissions by:
  - *species?*
  - *source category?*
  - *geographic area?*
- What is the effect of expected future federal/state controls? of Clear Skies?

Data Analyses

- Conceptual models for $PM_{2.5}$ and O_3 (spatial, temporal, chemical variation)
- Source apportionment *(source category)*
- Indicator species/ratios *(species)*
- Meteorological analyses *(geographic area)*
- Trends analyses *(species)*

Part II: What is effect of reducing emissions…

- by pollutant?
- by geographic area?
- by source category?

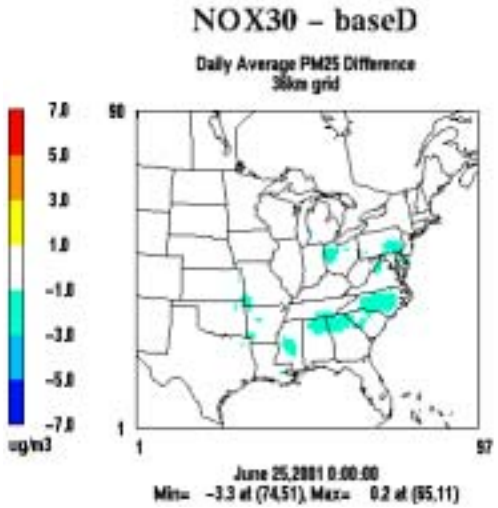
Global Emission Reductions

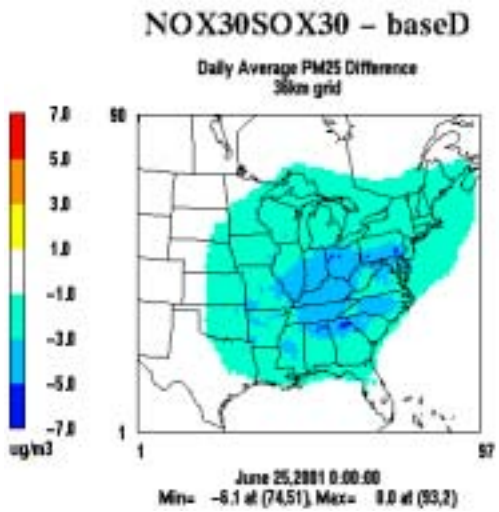
(entire domain)

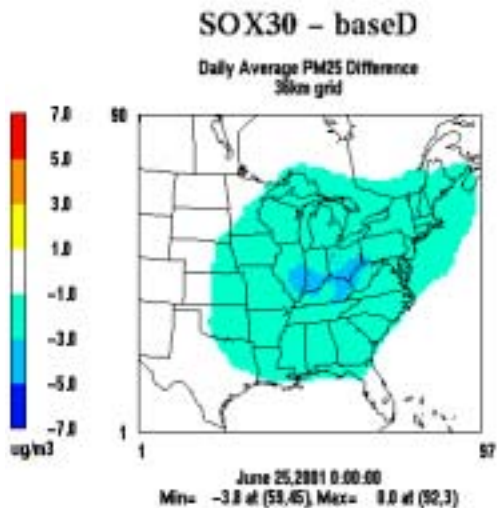
		VOC			SOx		NOx	
		-0%	-30%	-60%	-30%	-60%	-30%	-60%
NOx	-0%		X	X	X	X		
	-30%	X	X		X			
	-60%	X		X				
NH3	-30%	X			X		X	
	-60%	X				X		

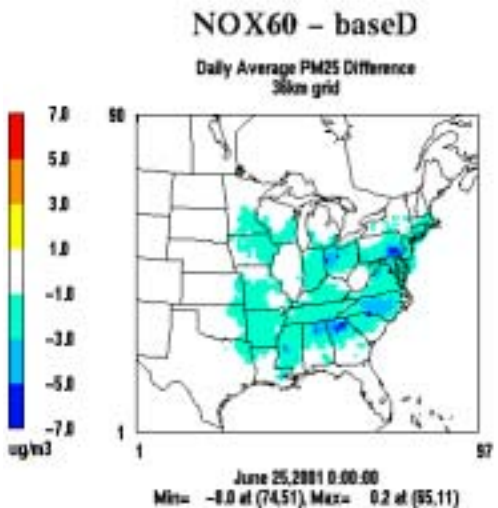
Global Emission Reductions

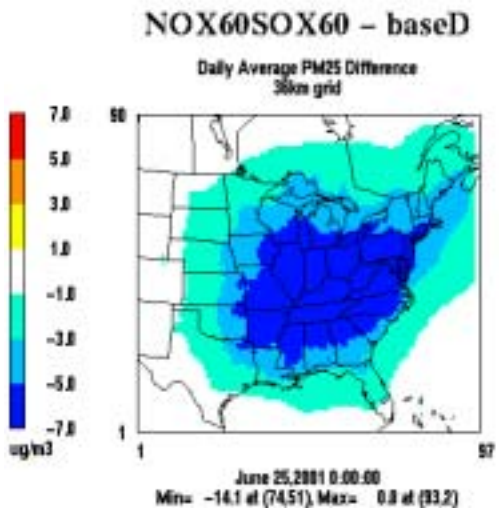
$PM_{2.5}$: Summer 2001

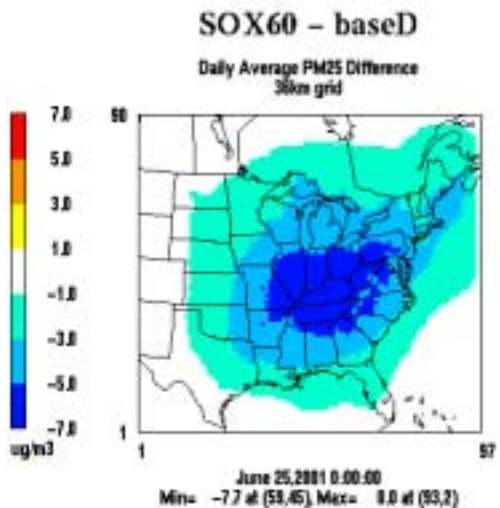






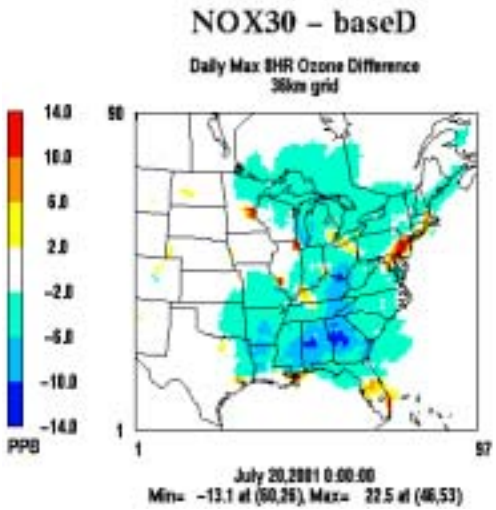


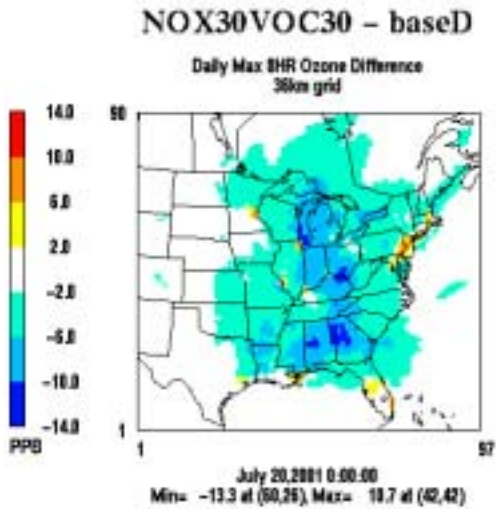


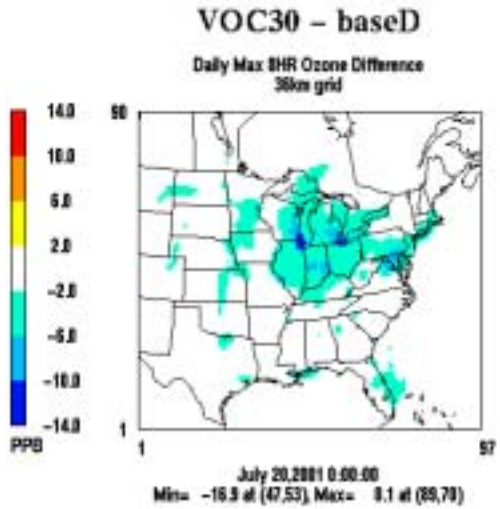


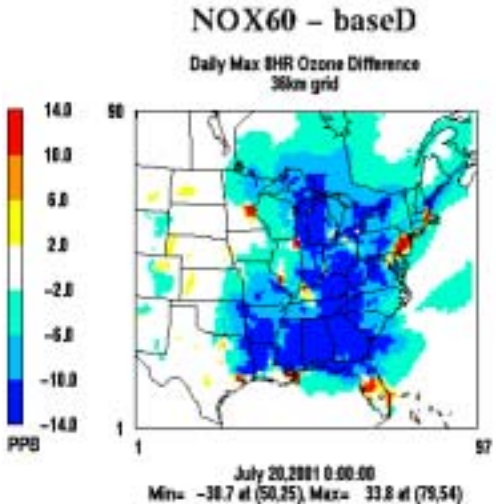
Global Emission Reductions

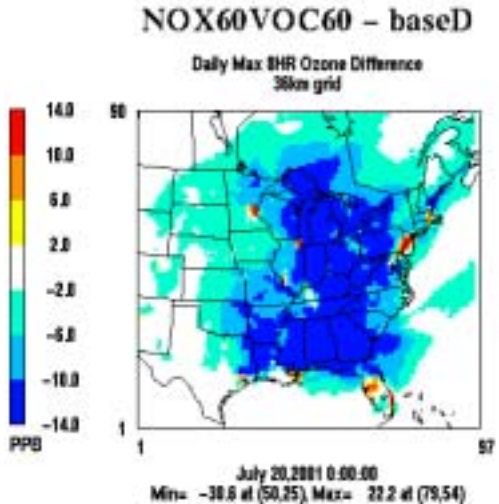
Ozone: July 20, 2001

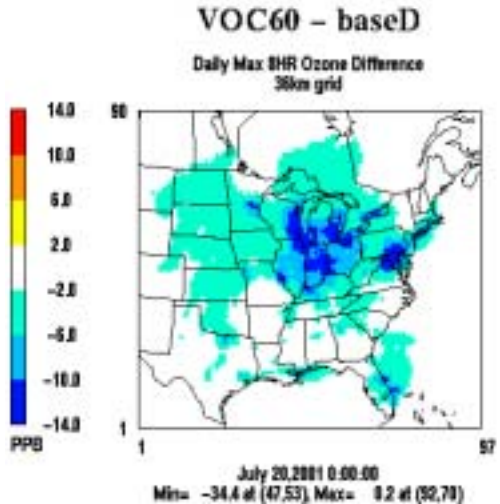












Data Analyses

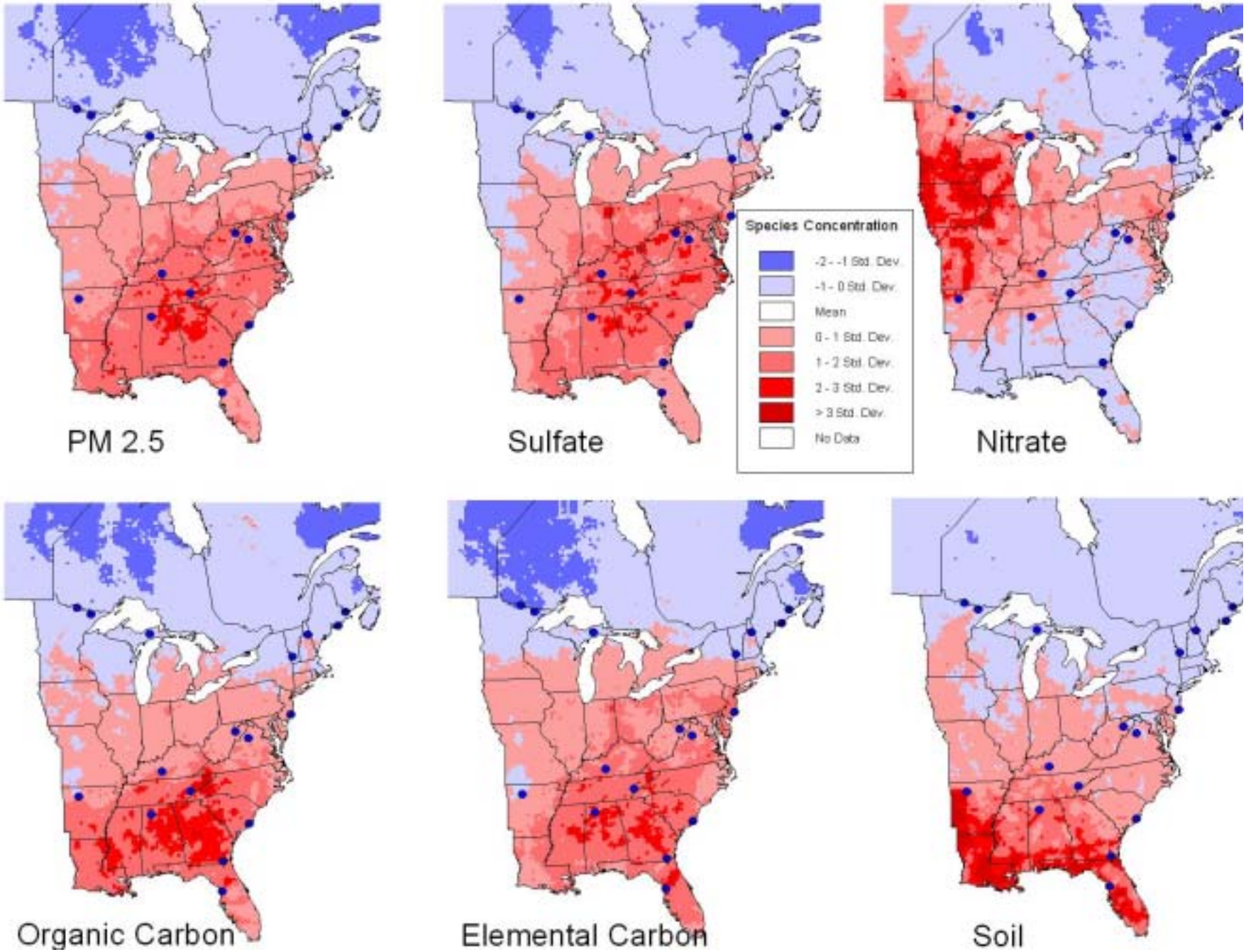
Data Set:

17 Class I Sites,

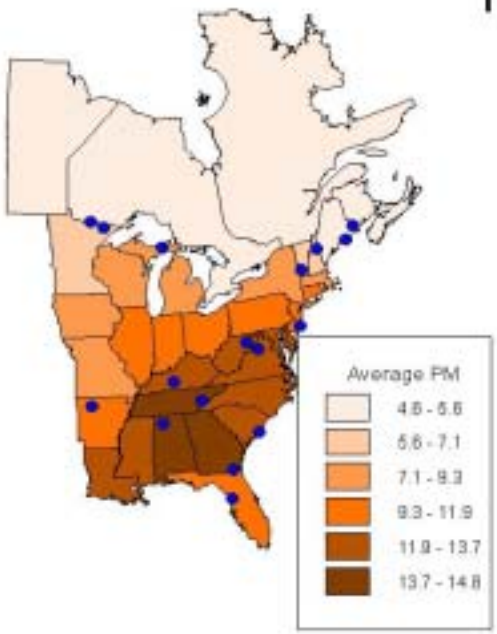
IMPROVE speciated PM data, Jan 1997-Dec 2001

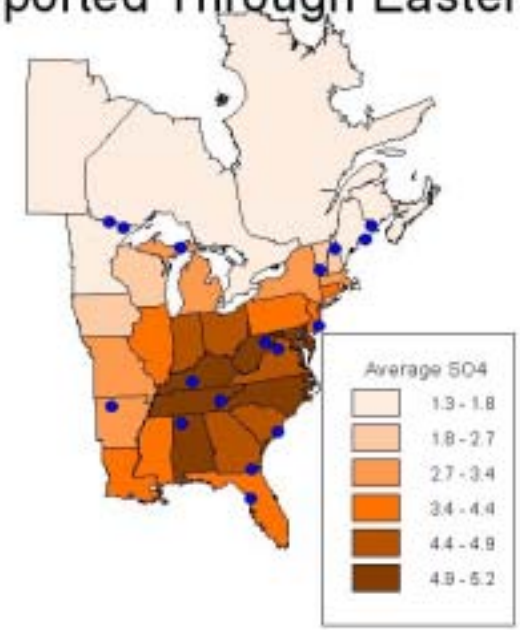
Hysplit 72-hour back trajectories

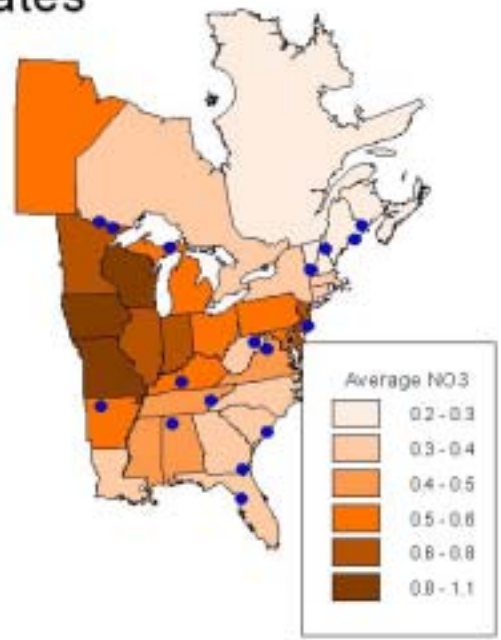
~500,000 data points

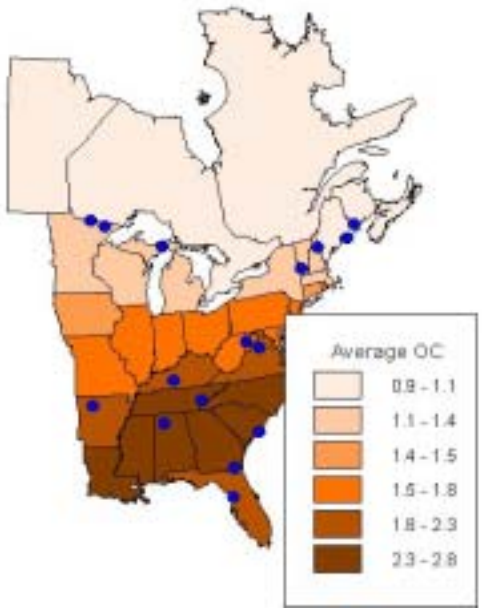

PM 2.5
Sulfate
Nitrate
Species Concentration
-2 - -1 Std. Dev.
-1 - 0 Std. Dev.
Mean
0 - 1 Std. Dev.
1 - 2 Std. Dev.
2 - 3 Std. Dev.
> 3 Std. Dev.
No Data
Organic Carbon
Elemental Carbon
Soil

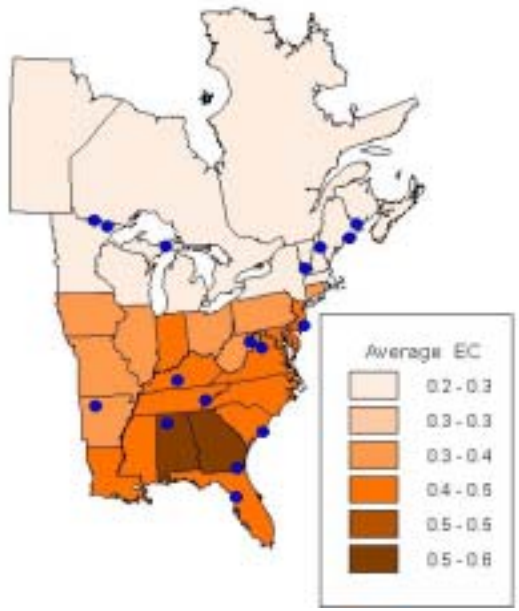
Average PM2.5 Species Associated with Air Masses Transported Through Eastern States

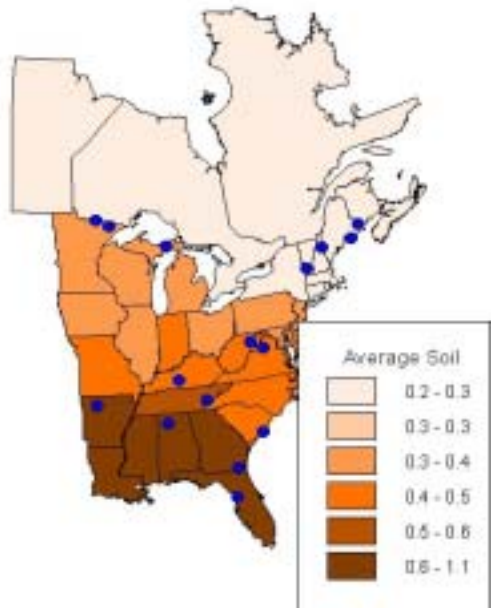












State-by-State Contributions to Class I Areas

	Illinois		Indiana		Wisconsin	
	Avg. PM2.5	Pct.Mass	Avg. PM2.5	Pct. Mass	Avg. PM2.5	Pct. Mass
Boundary Waters	9.52	1.66	12.47	0.61	7.08	7.61
Seney	10.98	4.31	8.61	1.49	6.14	9.93
Mammoth Cave	11.28	5.25	12.49	6.30	9.65	1.51
Dolly Sods	8.70	1.63	11.11	3.17	8.98	1.31

Avg. PM2.5 is the average PM2.5 concentration associated with the endpoints in each state of trajectories that originate at the indicated Class I area. Percent mass is calculated as $\frac{Avg.Concn._{StateA}\ No.endpts_{StateA}}{\sum_{AllStates}(Concn * Endpts)} * 100$

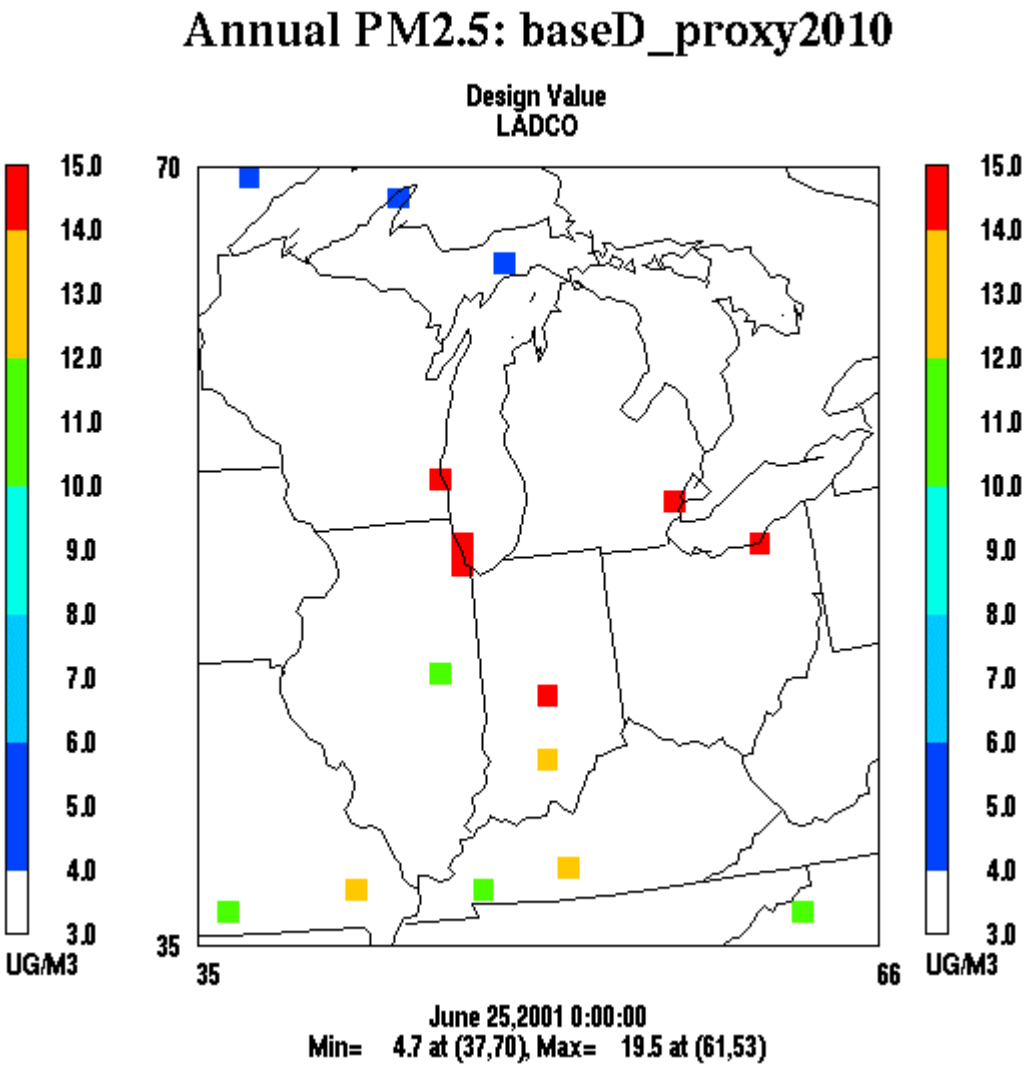
Part 3: What can we say about attainment (and reasonable progress)?

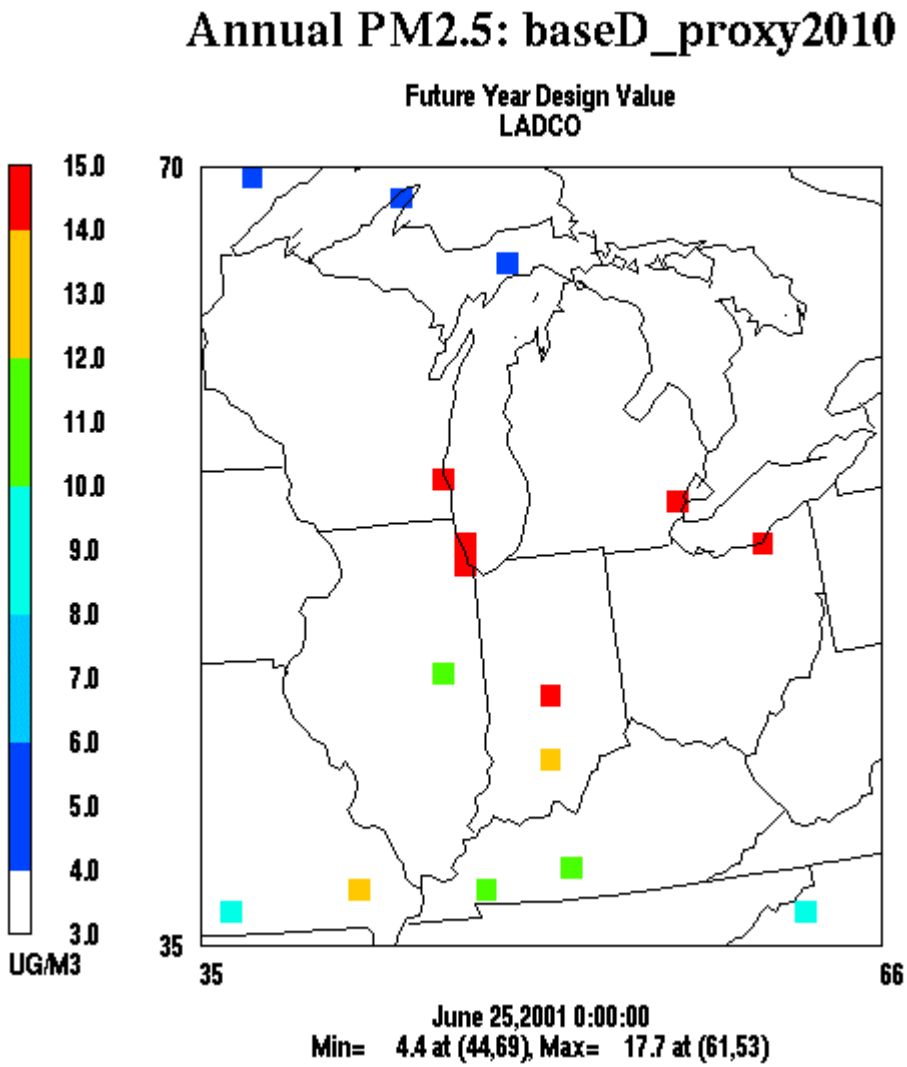
- Ozone
- PM2.5
- Regional Haze

“Control Strategies”

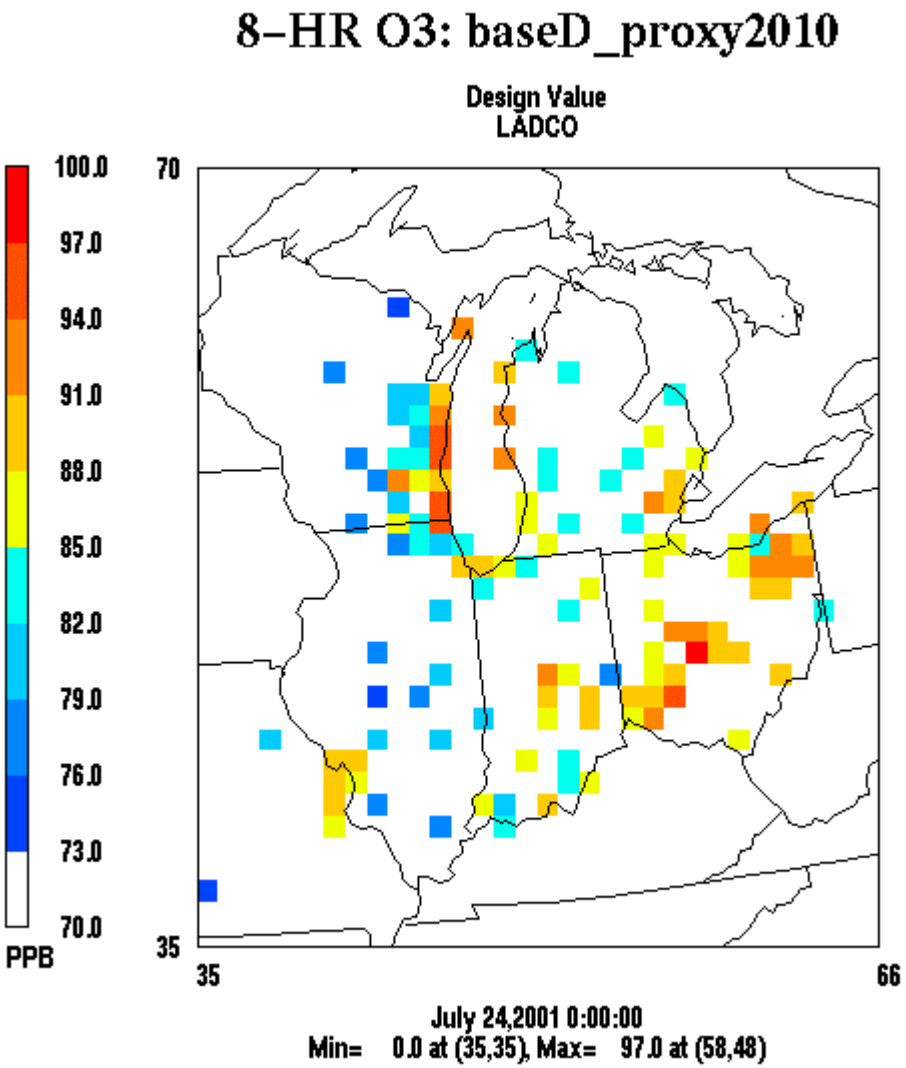
- 2010 Base Inventory
  - Proxy based on ratioing-up 1999 base inventory to reflect expected growth and federal/state controls
- 2010 Clear Skies Inventory
  - 2010 base inventory plus EGU SOx, NOx reductions from proposed Clear Skies legislation

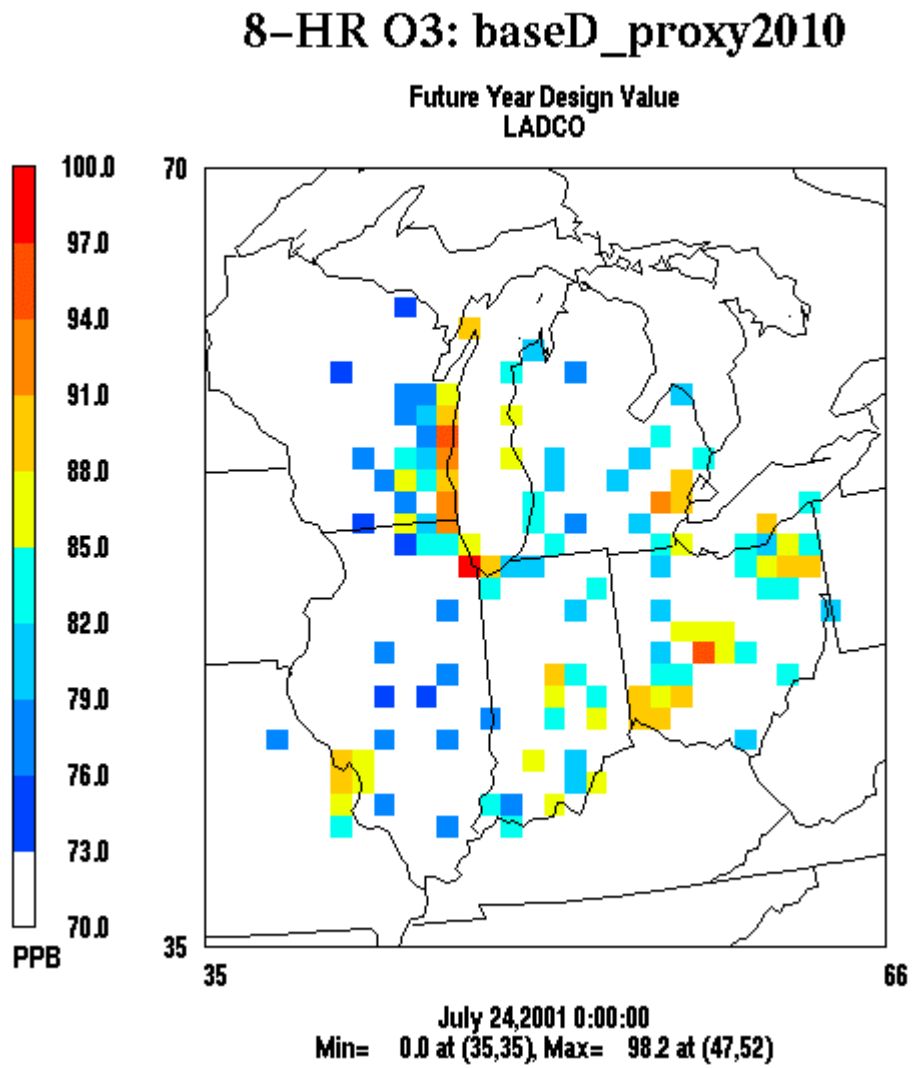
$PM_{2.5}$: 2010 Base





O_3: 2010 Base

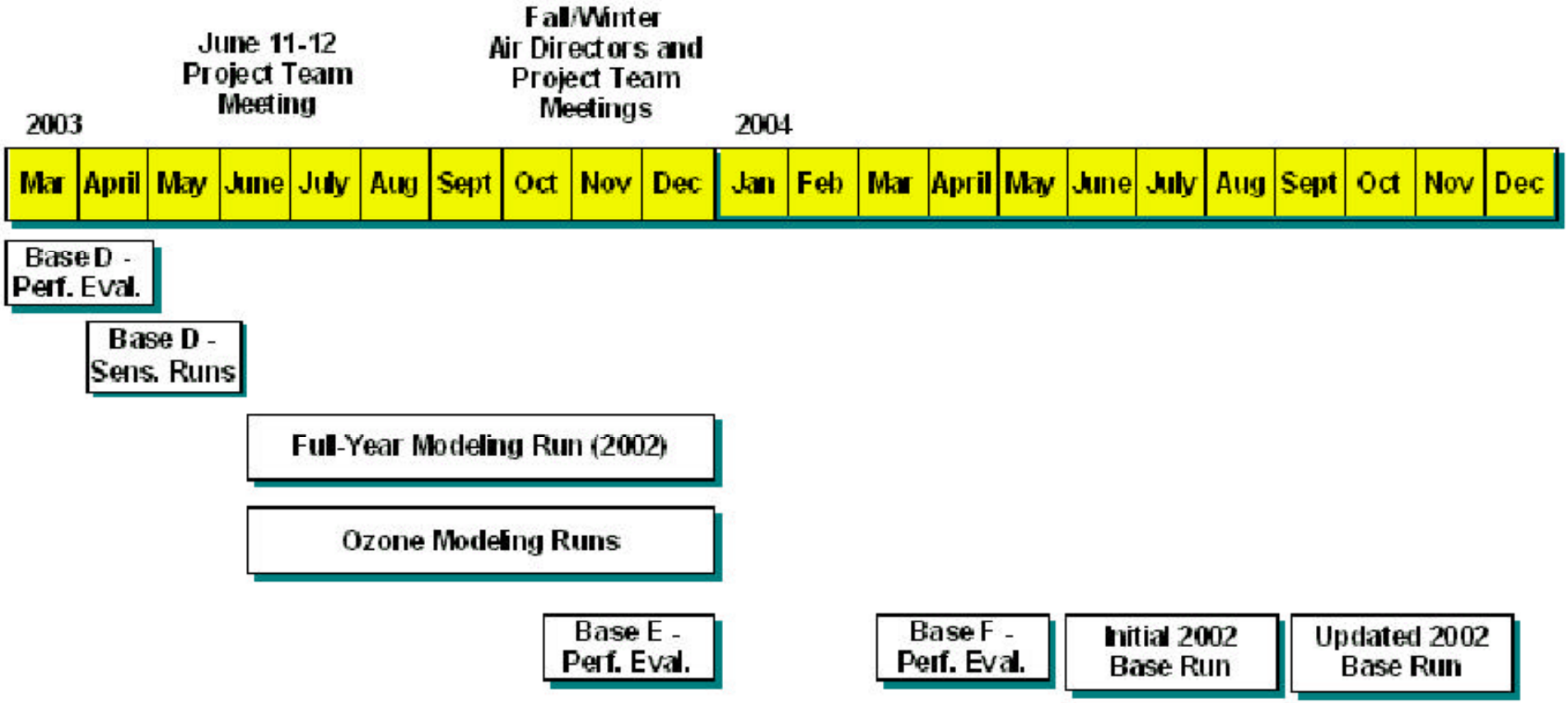

8-HR O3: baseD_proxy2010
Design Value
LADCO
100.0
97.0
94.0
91.0
88.0
85.0
82.0
79.0
76.0
73.0
70.0
PPB
70
35
35
66
July 24,2001 0:00:00
Min= 0.0 at (35,35), Max= 97.0 at (58,48)


8-HR O3: baseD_proxy2010
Future Year Design Value
LADCO
100.0
97.0
94.0
91.0
88.0
85.0
82.0
79.0
76.0
73.0
70.0
PPB
70
35
35
66
July 24,2001 0:00:00
Min= 0.0 at (35,35), Max= 98.2 at (47,52)

Part 4: What's Next?

- Modeling
  - Model selection: CAMx "workhorse", CMAQ supplemental
  - Model performance: nitrates and organics
  - New projects
- Emissions
  - Develop 2002 base inventory
  - Inventory improvements
- Attainment Analyses
  - Identify/evaluate candidate control measures

Near-Term Modeling Timeline



Base E = Improved motor vehicle (state/local network VMT and day-specific MOBILE6), improved utility temporal profiles, updated spatial surrogates (new census data), shipping SO2, ...