Integrated Approach to Air Quality Attainment in Georgia

Jim Boylan

GA EPD - Air Protection Branch

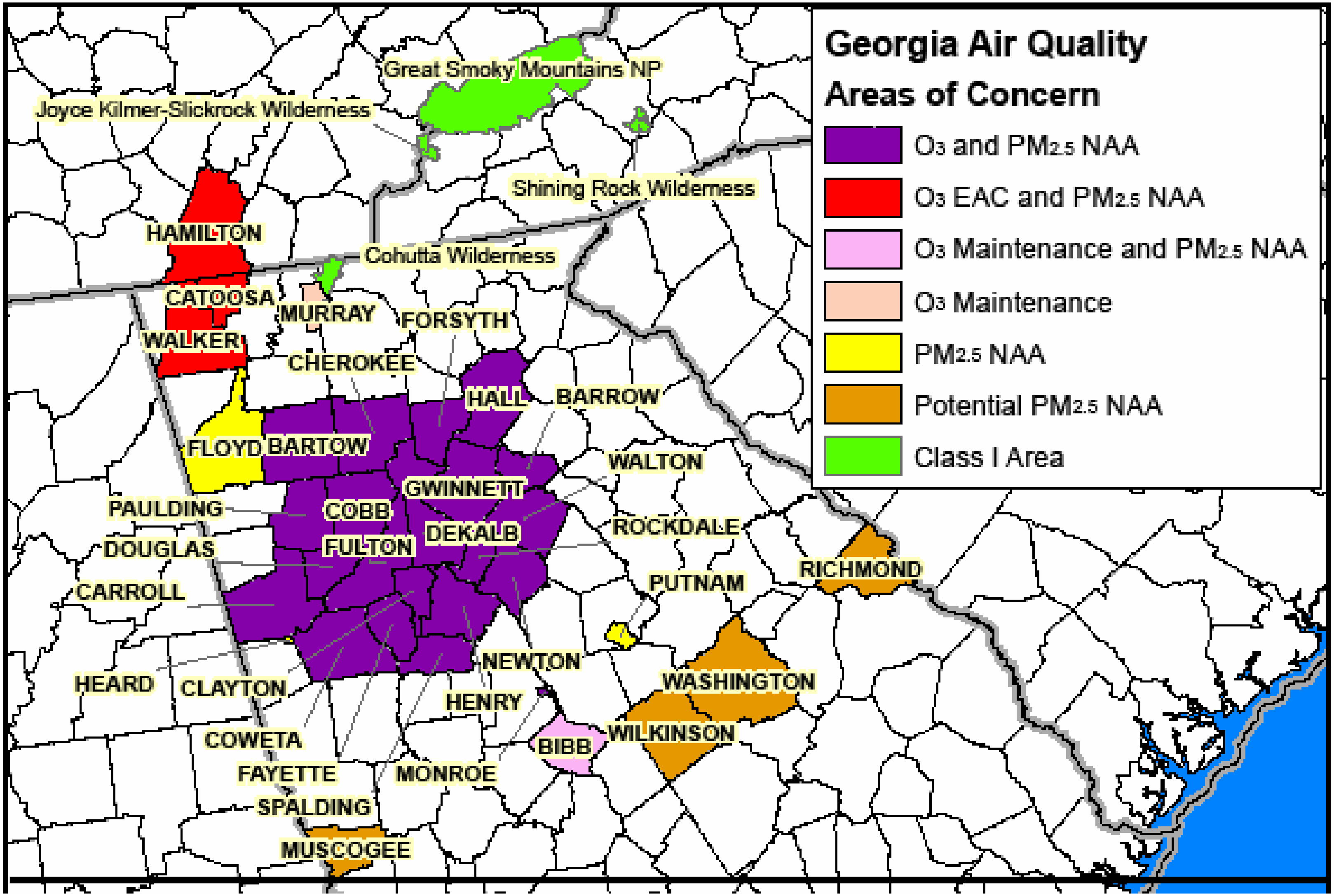
Air Quality Management Meeting

Chapel Hill, NC - June 4, 2008

Outline

- Background Information
- Modeling Overview
- Health Benefits Modeling
- Cost/Benefit Analysis
- Potential Control Measures
- Next Steps & Lessons Learned

Non-Attainment in Georgia



Integrated Approach to Air Quality Attainment

Policy Development

- Identify menu of control options to be considered
- Consider regulatory and practical implications ***along with costs, benefits, & sensitivities***
- Develop and implement regulations and policies

Individual measures, overall strategy to model

Sensitivity to controls; Impact & attainment (Y/N) of overall strategy

Iterative search for additional measures

Air Quality Modeling

- Meteorology, emissions & photochemistry for base & future
- ***Sensitivity analysis of responses to various controls by location and species***
- Impact (relative reduction factor) of overall strategy

Control measures to be evaluated

Estimated $/ton of each measure

Morbidity/mortality averted, visibility improved, etc. due to control strategy

Modeled base & controlled pollutant concentrations

Cost Assessment

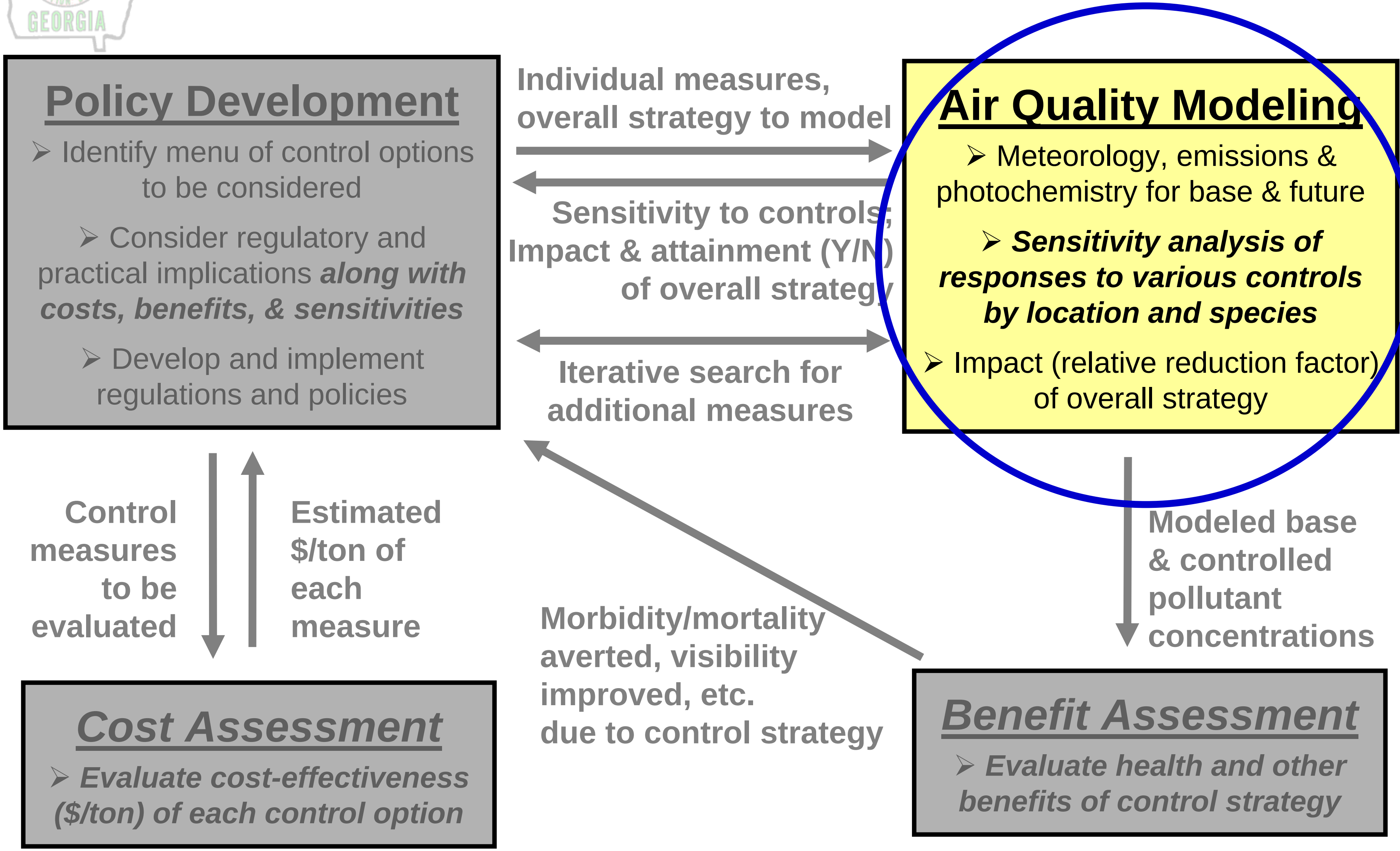
- ***Evaluate cost-effectiveness ($/ton) of each control option***

Benefit Assessment

- ***Evaluate health and other benefits of control strategy***

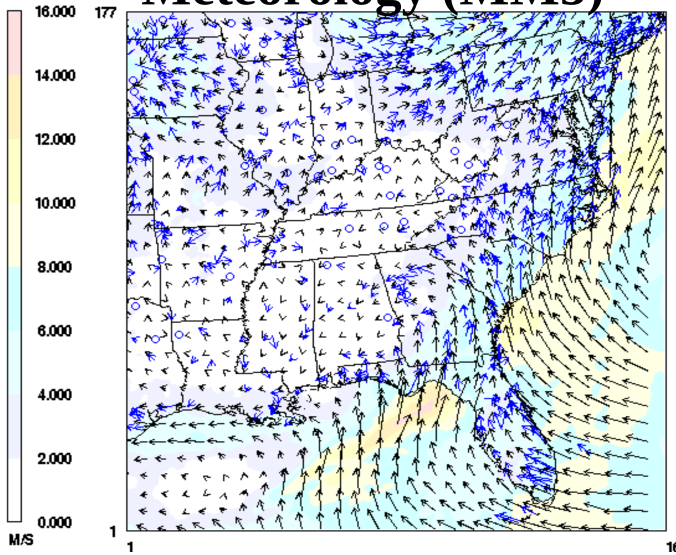
Modeling Overview

Integrated Approach to Air Quality Attainment

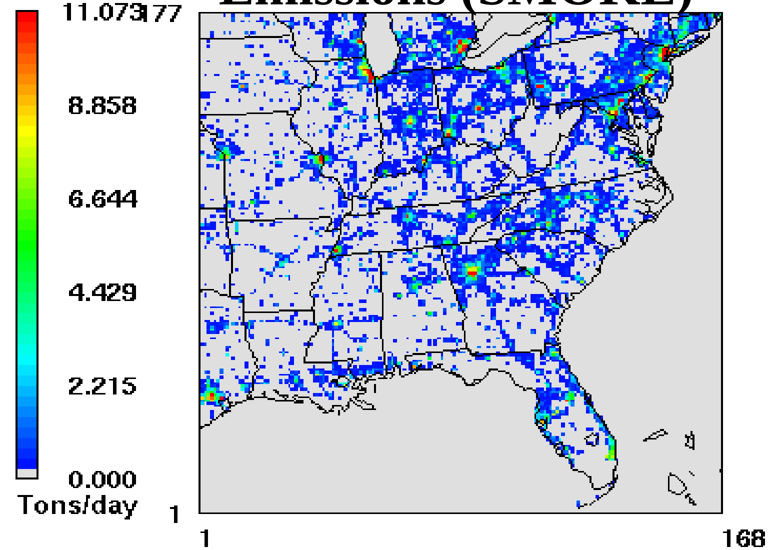


Atmospheric Modeling System

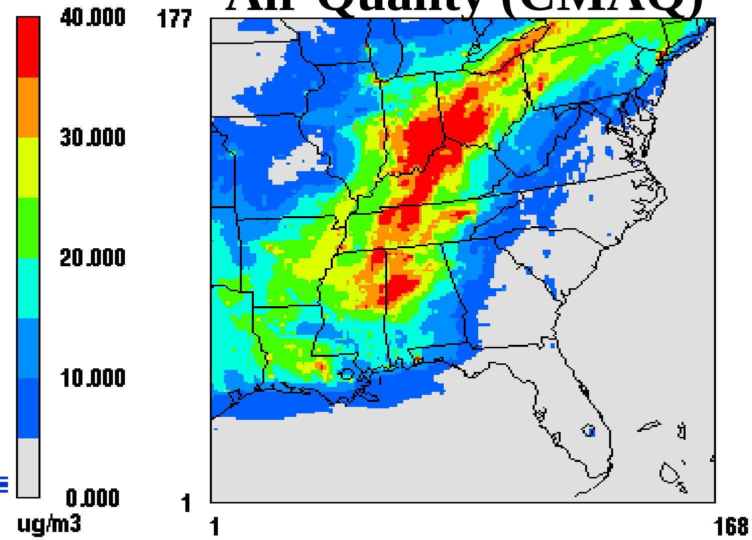
Meteorology (MM5)



Emissions (SMOKE)

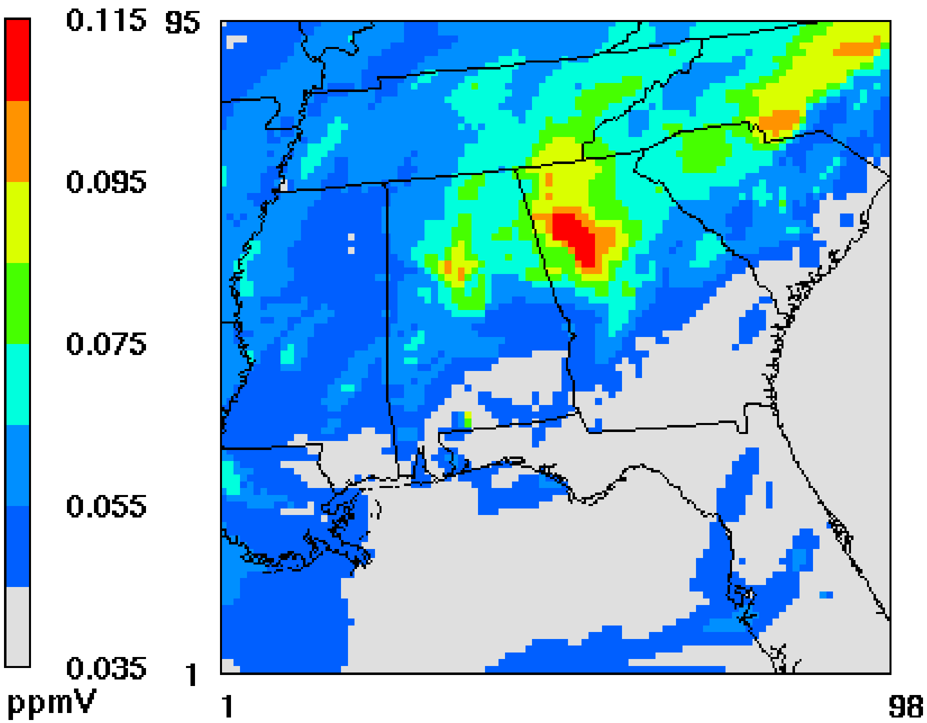


Air Quality (CMAQ)

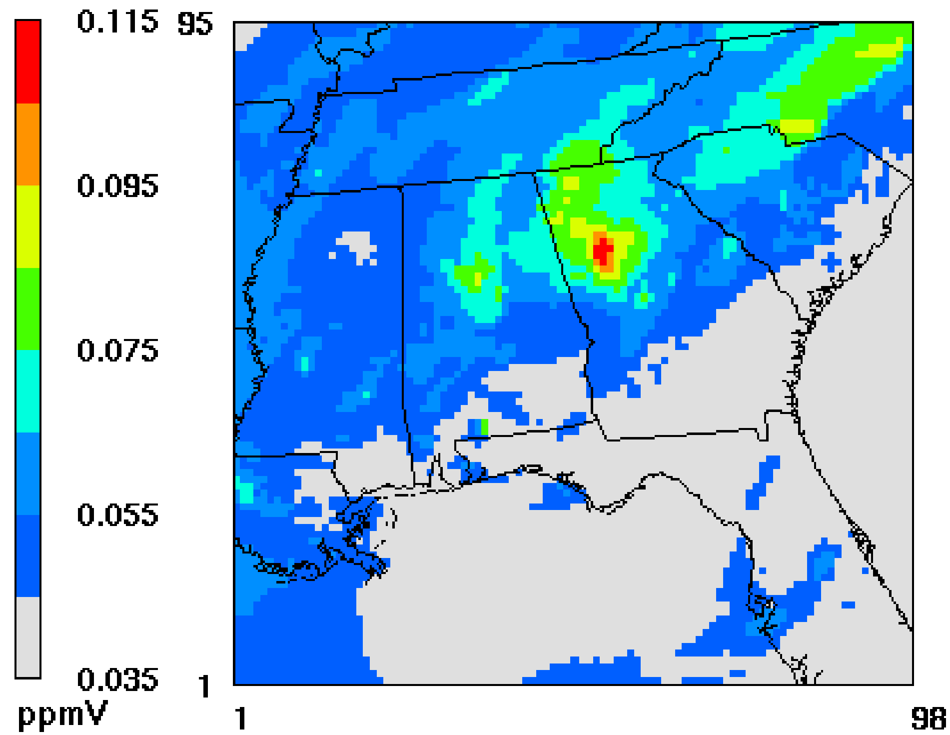


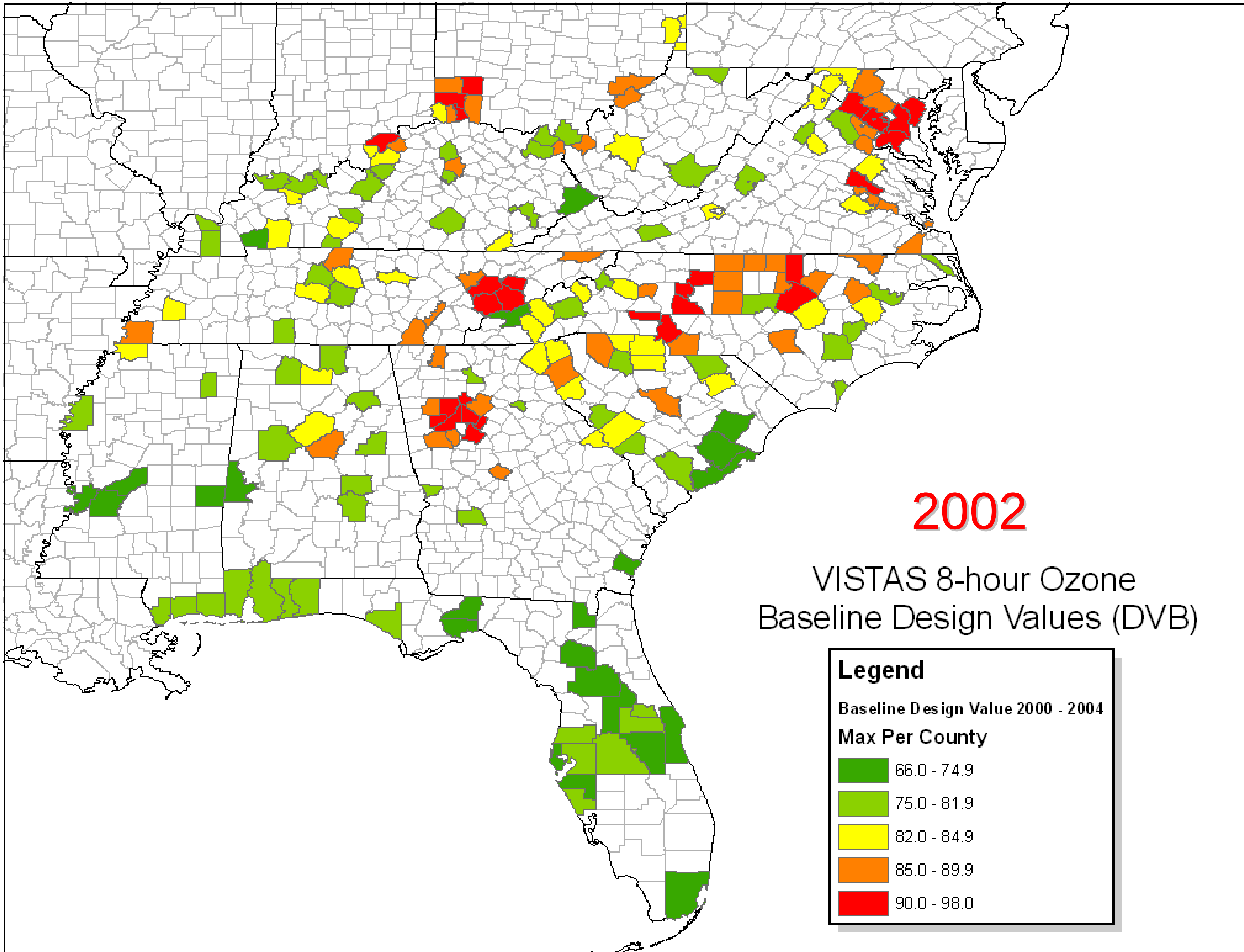
Reductions in Ozone (2002 → 2009)

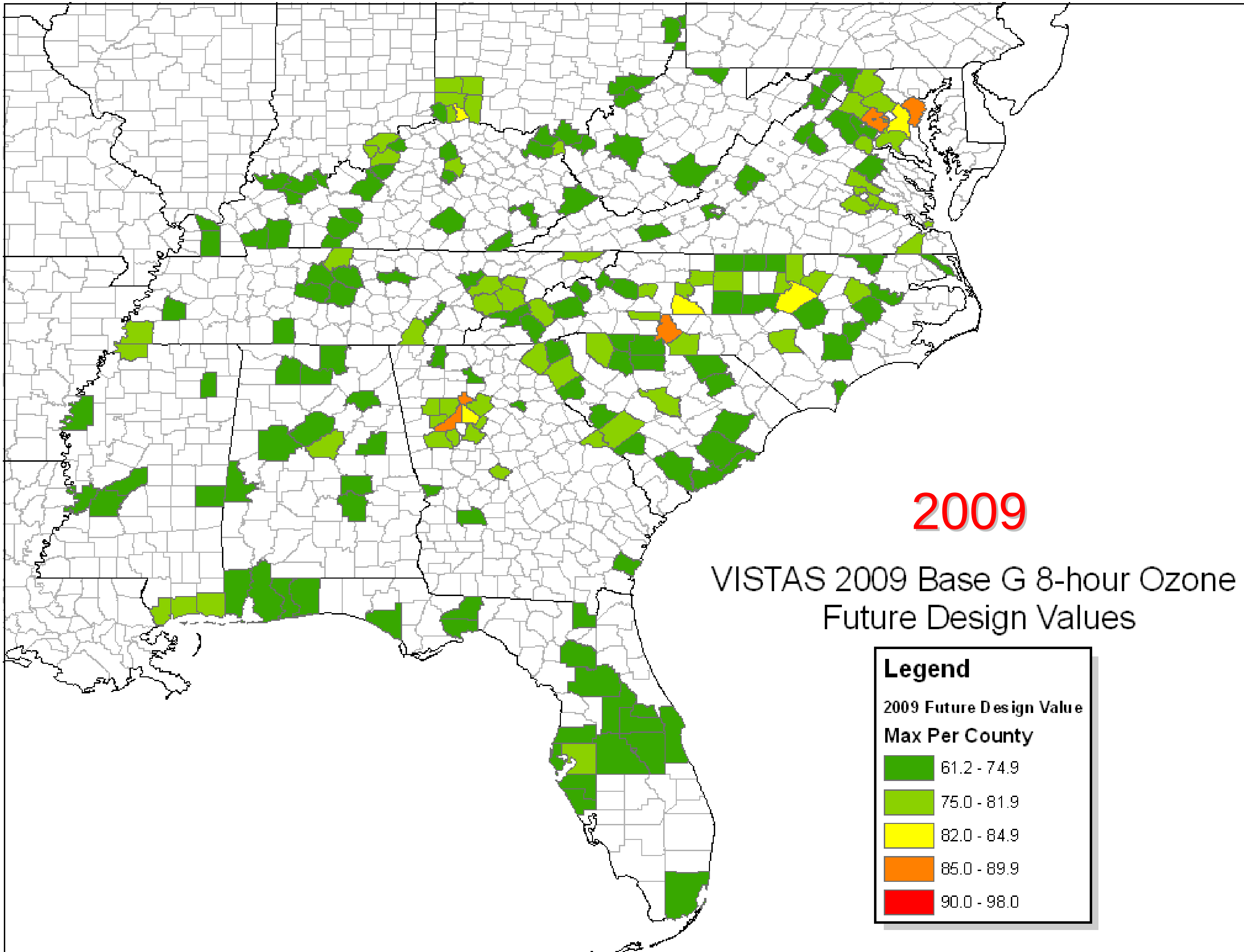
Max 8-hour O3 on June 12, 2002
2002 Emissions



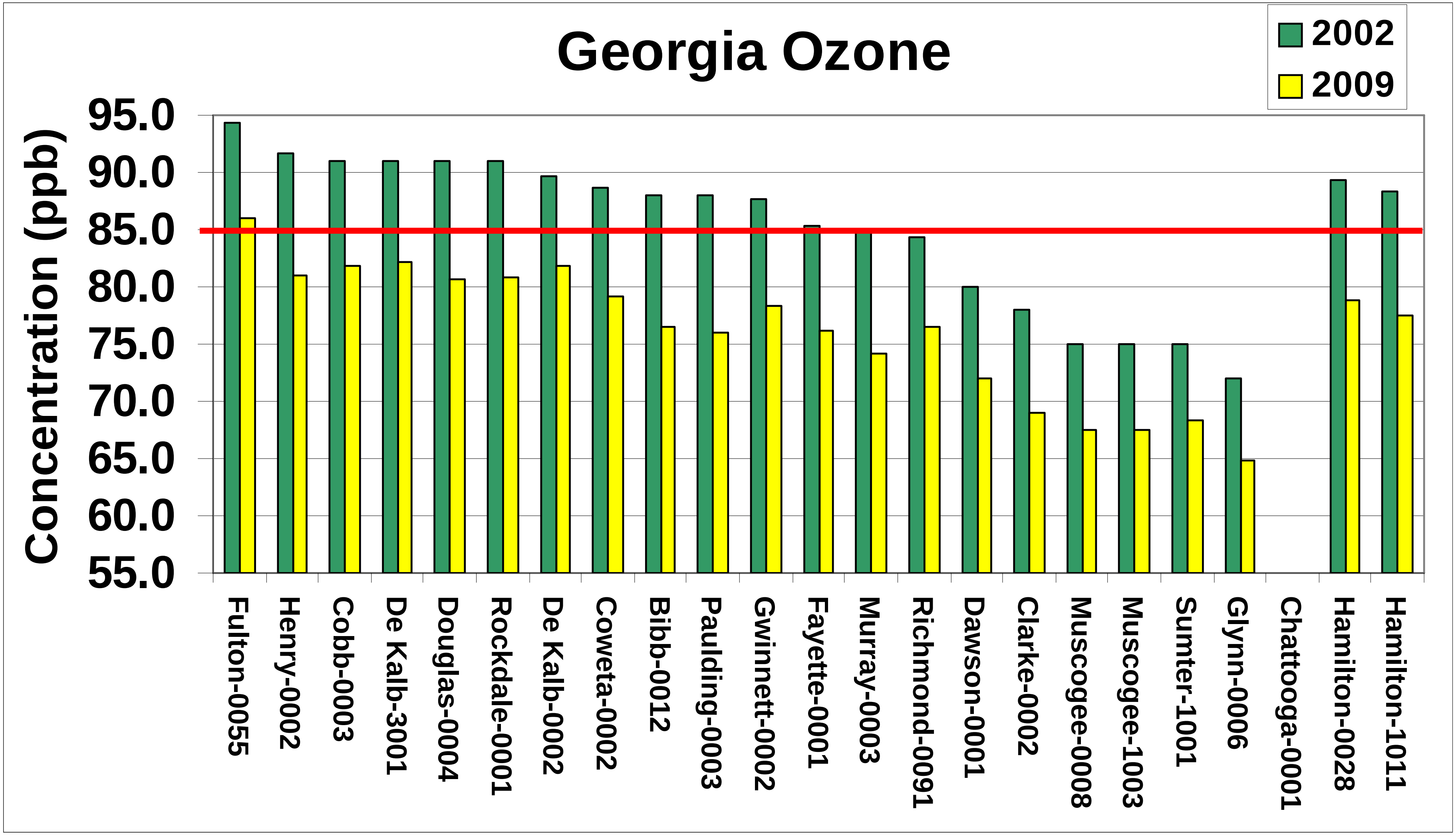
Max 8-hour O3 on June 12, 2002
2009 Emissions

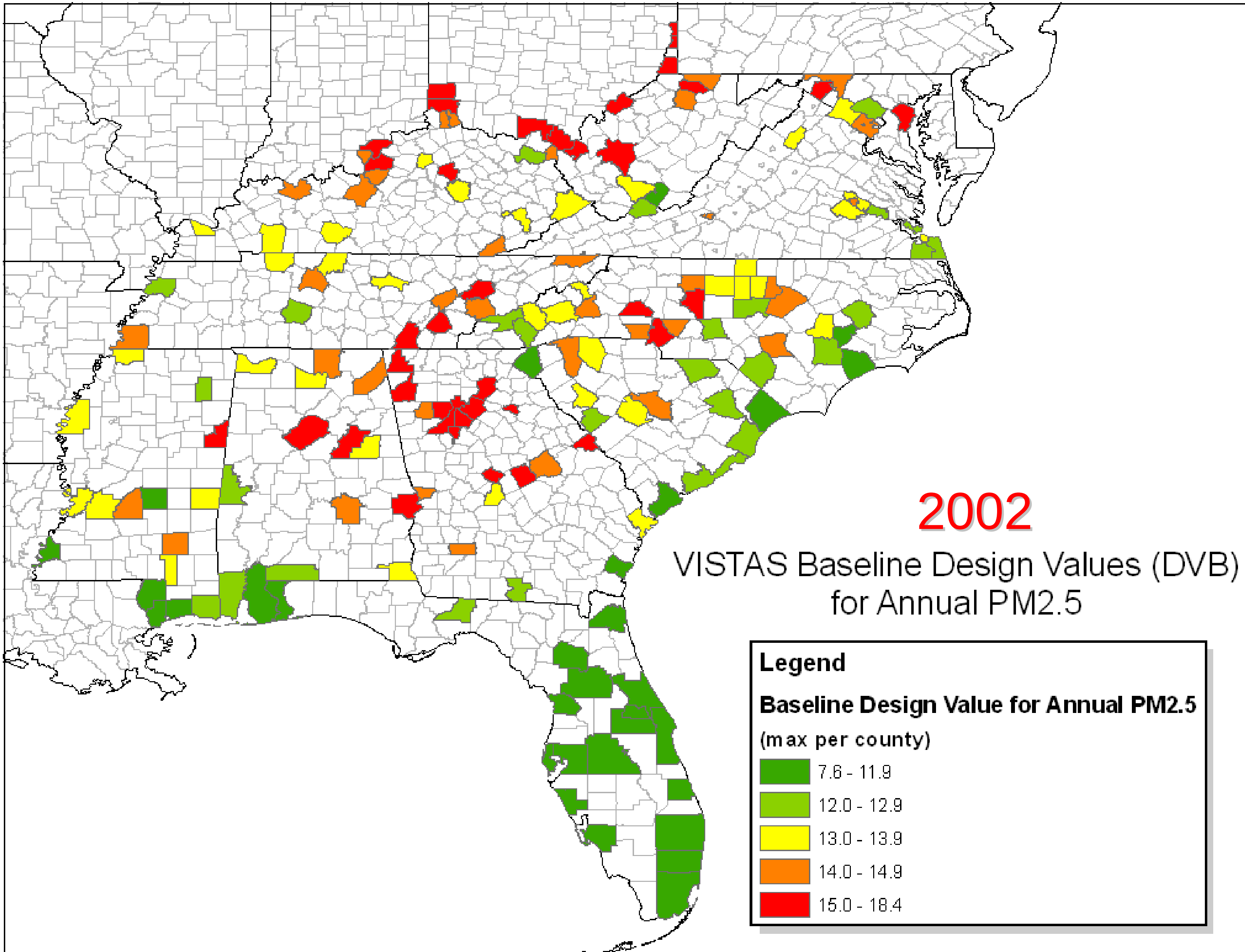


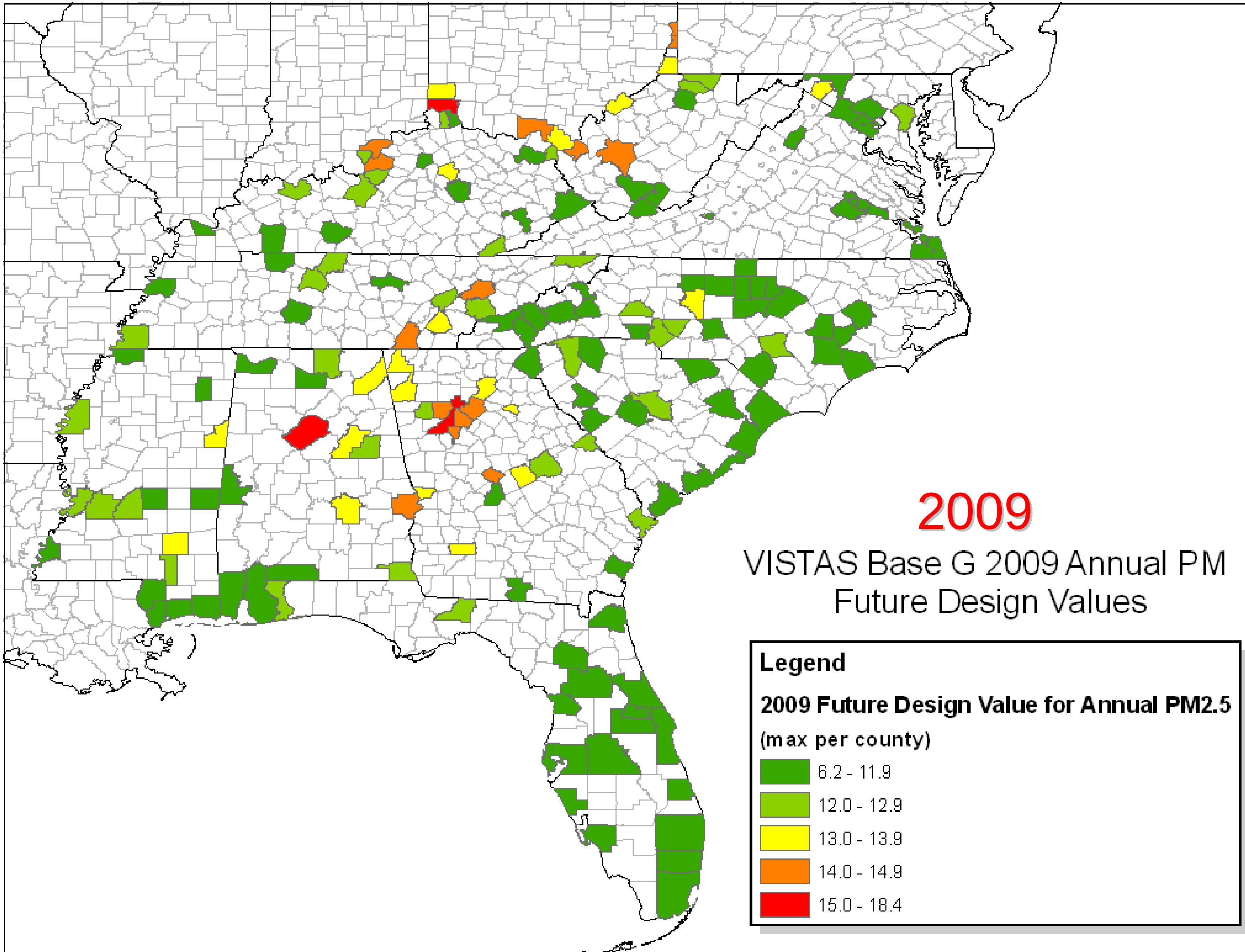

2002
VISTAS 8-hour Ozone
Baseline Design Values (DVB)
Legend
Baseline Design Value 2000 - 2004
Max Per County
66.0 - 74.9
75.0 - 81.9
82.0 - 84.9
85.0 - 89.9
90.0 - 98.0


2009
VISTAS 2009 Base G 8-hour Ozone
Future Design Values
Legend
2009 Future Design Value
Max Per County
61.2 - 74.9
75.0 - 81.9
82.0 - 84.9
85.0 - 89.9
90.0 - 98.0

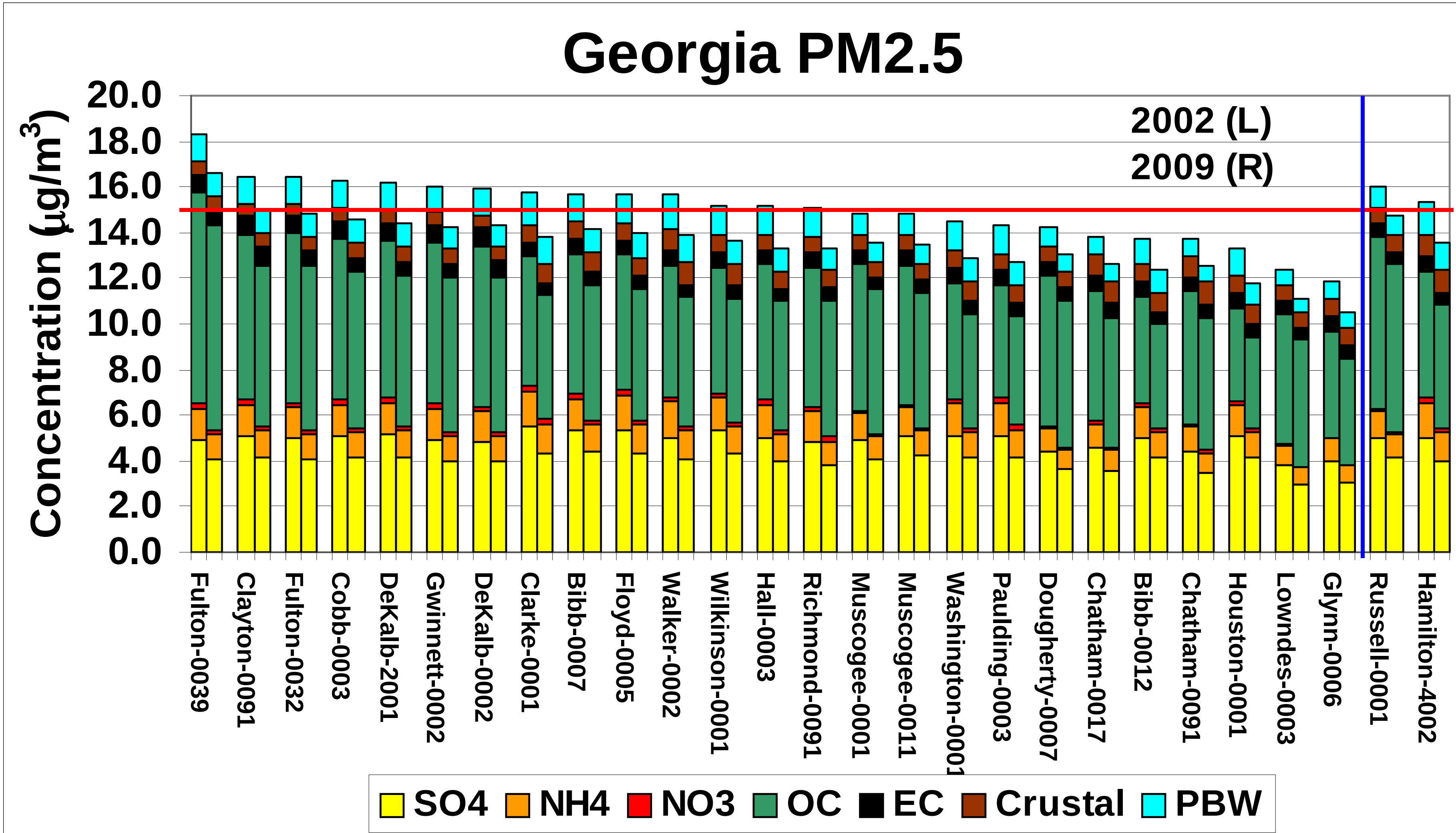
Future Ozone Concentrations




2002
VISTAS Baseline Design Values (DVB)
for Annual PM2.5
Legend
Baseline Design Value for Annual PM2.5
(max per county)
7.6 - 11.9
12.0 - 12.9
13.0 - 13.9
14.0 - 14.9
15.0 - 18.4


2009
VISTAS Base G 2009 Annual PM
Future Design Values
Legend
2009 Future Design Value for Annual PM2.5
(max per county)
6.2 - 11.9
12.0 - 12.9
13.0 - 13.9
14.0 - 14.9
15.0 - 18.4

Future $PM_{2.5}$ Concentrations



Emission Sensitivities

- Sensitivity of ozone (ppb) and $PM_{2.5}$ ($\mu g/m^3$)
  - Annual and Episodic Simulations
- Regional 10% Emission Reductions
  - Mobile (on-road/non-road), area, non-EGU
  - NOx, VOCs, SO_2, NH_3, and primary carbon (PC)
  - **Atlanta**, Macon, Chattanooga, and Floyd County
- Point Emission Reductions
  - Additional SCRs (NO_x) and Scrubbers (SO_2) at seven largest Power Plants in Georgia

Ozone at Confederate Avenue

Sensitivity*	Δ ppb	Δ ppt/TPD
10% Atlanta ground-level AVOCs**	0.08	1.5
10% Atlanta ground-level NOx	1.41	38.1
10% Atlanta area NOx	0.14	36.5
10% Atlanta on-road NOx	**0.92**	39.5
10% Atlanta non-road NOx	0.28	31.7
4 SCRs at Branch	**0.22**	4.4
3 SCRs at Hammond	0.04	3.4
2 SCRs at McDonough	**0.27**	35.7
4 SCRs at Scherer	**0.17**	6.2
7 SCRs at Yates**	0.11	9.9

***Based on 2009 emissions**

****Based on Summer Episode**

$PM_{2.5}$ at FS #8 (Fulton)

Sensitivity*	**Δ μg/m³**	**Δ ng/m³/TPD**
10% Atlanta SO2	0.02	2.3
10% Atlanta VOCs	0.01	0.13
10% Atlanta on-road PC	0.03	92.6
10% Atlanta non-road PC	**0.12**	133
10% Atlanta area PC	**0.16**	137
10% Atlanta non-EGU PC	0.01	132
10% Atlanta area NOx	-0.007	-0.70
10% Atlanta on-road NOx	-0.004	-0.30
10% Atlanta non-road NOx	-0.007	-0.83
10% Atlanta area NH3	0.03	4.6
10% Atlanta mobile NH3	0.02	10.9

***Based on 2009 emissions**

$PM_{2.5}$ at FS #8 (Fulton)

Sensitivity*	Δ μg/m³	Δ ng/m³/TPD
2 Scrubbers at Bowen	**0.16**	0.71
4 Scrubbers at Branch	**0.16**	0.85
2 Scrubbers at McDonough	0.09	1.54
4 Scrubbers at Scherer	**0.20**	0.70
1 Scrubber at Wansley	0.09	0.87
2 Scrubbers at Yates**	**0.17**	1.22

***Based on 2009 emissions**

Health Benefits Modeling

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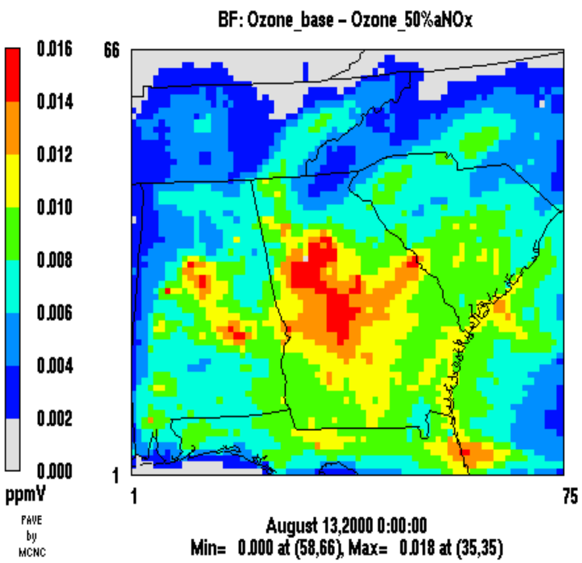
Benefits Analysis with BenMAP

Modeled (or measured) reductions in pollutant levels



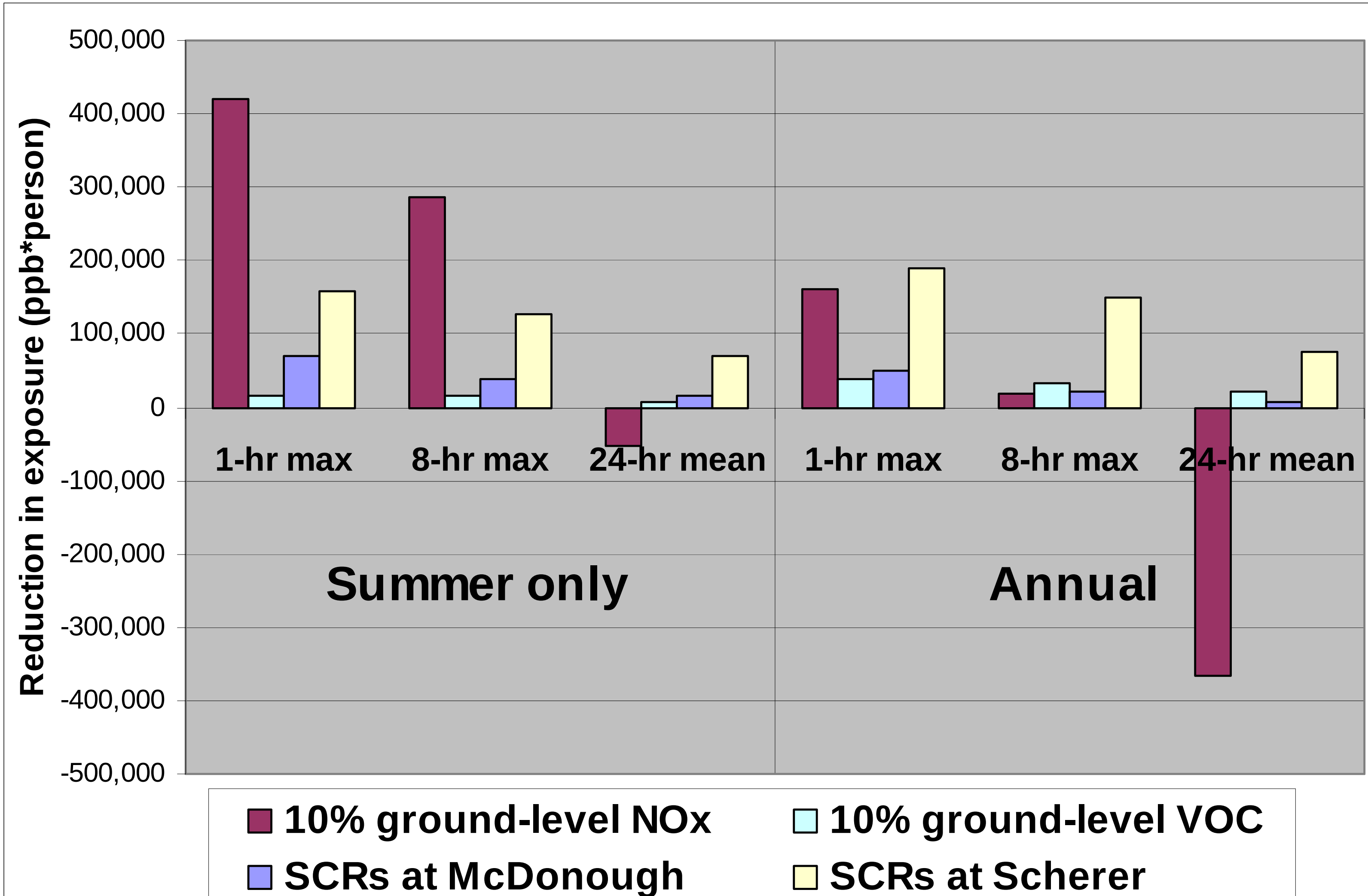
U.S. Version
BenMAP
Environmental Benefits Mapping and Analysis Program

Reduced morbidity, mortality, health costs

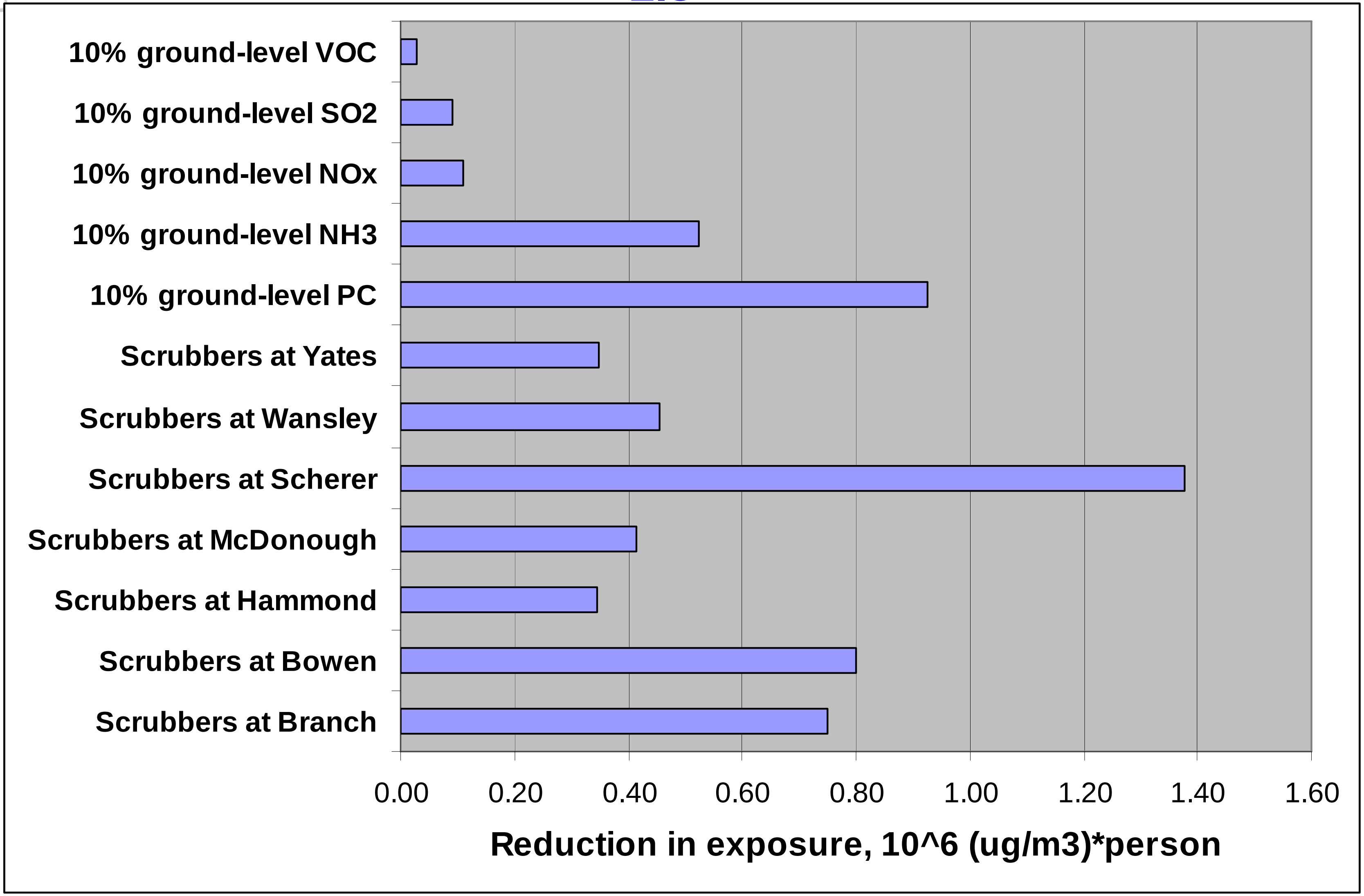
What is BenMAP?

- Environmental **Ben**efits **M**apping and **A**nalysis **P**rogram
- A population based geographic information system
- Uses air quality data (monitor or model based) as inputs
- Concentration-response functions and valuation estimates are used to estimate changes in health endpoints and the value of those changes
- Can produce estimates at the population grid scale, county, state, or national level

Potential Reductions in Statewide Exposure to Various Ozone Metrics

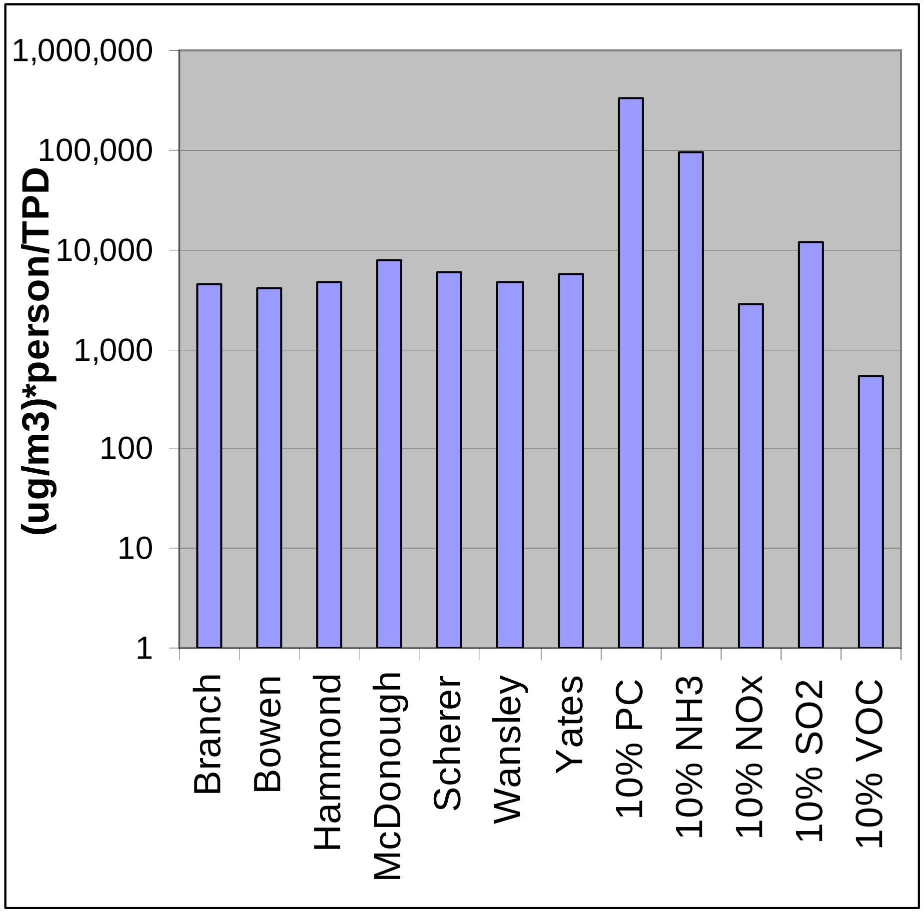


Potential Reductions in Statewide Exposure to $PM_{2.5}$

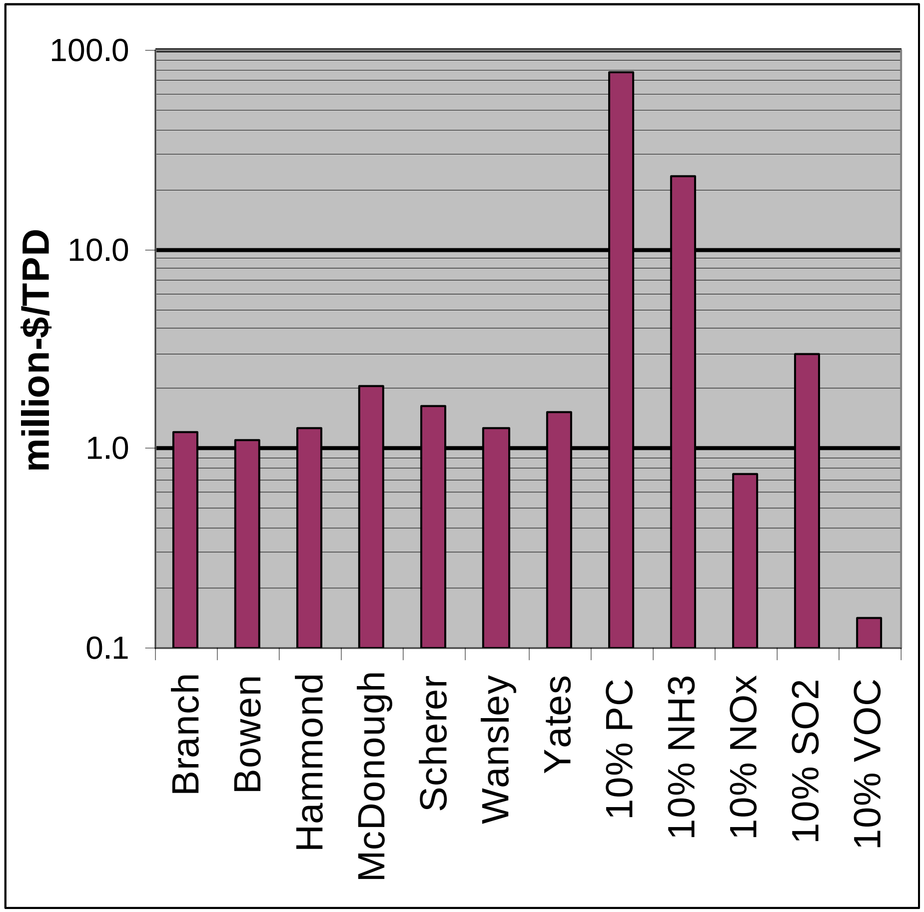


$PM_{2.5}$ Exposure and Benefits

ΔExposure/TPD



$ Benefits/TPD



Cost/Benefits Analysis

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Cost/Benefits Analysis

- Cost/Impact at Specific Monitors:
  - $/(Δ ppb) = $/ton divided by (Δ ppb)/ton
  - $/(Δ μg/m^3) = $/ton divided by (Δ μg/m^3)/ton
- Cost/Health Benefits across Region:
  - $/$ = $/ton divided by $Benefits/ton
- Rank Control Options in Order of Cost Effectiveness
- Select Control Options

Potential Control Measures

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Current Ozone Controls

- All controls required by CAA for Severe Ozone NAA
- Georgia Gas
- I&M/ Enhanced I&M
- Seasonal Burn Ban
- NOx & VOC RACT/Expanded RACT
- Stationary Source NOx & VOC rules
- Stationary Source NOx & VOC SIP permit conditions
- Partnership for a Smog Free Georgia/CAA
- NSR/Expanded NSR
- Power Plant Controls
- New Equipment Rules

Potential New Ozone Controls

- Revised NOx & VOC RACT
- Additional Power Plant Controls
  - Required by CAIR & Georgia Multi-Pollutant Rule
- Anti-Idling Regulations
- Truck Stop Electrification
- School Bus Retrofits
- Voluntary Measures
  - CMAQ funded Rail Road Locomotive Retrofits
  - Airport Activity
- Extend stationary source controls outside of non-attainment area
- Additional Federal Controls

Example Menu of Options for Ozone

Measure	Concept	Init NOx Emissions (tpOSD)	NOx Cut (tpOSD)	Cost ($/year)	Equiv. $/ton	Sens. (ppt/tpd)	Ozone Cut (ppt)	Ozone Health Benefit (ppb*persons/TPD)	Cost-Effectiveness for attainment ($/ppt)
McDonough 1: SCR	Install SCR	4.92	3.64	$4,029,421	$3,034	184.0	669.5	5540	$6,019
McDonough 2: SCR	Install SCR	5.07	3.75	$4,044,635	$2,957	184.0	689.6	5540	$5,865
Scherer 1: SCR	Install SCR	13.765827	8.2594802	10742498.75	3563.36	8.5	70.205582	4260	153014.88
Scherer 2: SCR	Install SCR	13.666309	8.1997694	10825367.73	3617	8.5	69.69804	4260	155318.11
Owens-Brockaway Glass	Oxygen Enriched Air Staging	0.5712164	0.1999178	218910	3000	40.4	8.0766795	7560	27103.96
	Low NOx Burner	1.3476712	0.6738356	877303.65	3567	40.4	27.222959	7560	32226.609
	(Reduced Comb Air Temp)	1.3476712	0.8759699	315252.794	986	40.4	35.389182	7560	8908.1683
	SCR	1.3476712	1.0781151	1272224.296	3233	40.4	43.555849	7560	29209.035
	SNCR	1.3476712	0.6738219	1379997.395	5611	40.4	27.222405	7560	50693.441
School bus FBC+DOC+ULSD	Controls + fuel	6.17	0.3160248	8223815	71295	31.4	9.9231802	7560	828747.93
Locomotive idling reduction	Devices or practices	5.11	4.862351	3124000	1760.24	31.4	152.67782	7560	
Truck-stop electrification	Idle-Air, APU	1.0928643	1.0163638	980852.0586	2644	31.4	31.913824	7560	

Potential New PM Controls

- Power Plant Controls
- Non-EGU SO2 & PM RACT
- Anti-Idling Regulations
- Truck Stop Electrification
- School Bus Retrofits
- Locomotive Retrofits
- Additional Restrictions on Open Burning
- Commercial Meat Cooking
- Additional Federal Controls

Ozone Example

Table 1 Costs and benefits of scenarios for reducing ozone in Atlanta

Control Scenario	Annual cost (10^6 $)	Emissions reduced[a] (tpd)	Ozone response at monitor[b] (ppb)	Ozone sensitivity at monitor[b] (ppt/tpd)	Annual statewide benefits[c] (10^6 $)	Annual cost per 1 ppt reduction at monitor ($)	Cost per $1 health benefits ($)
10% Atlanta NO_x[d]	N/A	38	1.36	35.7	21.9	N/A	N/A
10% Atlanta VOC[d]	N/A	49	0.08	1.5	0.12	N/A	N/A
SCRs at Power Plant 1	8[e]	7	0.42	60.4	3.7	$19,000	$2.2
SCRs at Power Plant 2	43[e]	34	0.41	13.7	10.4	$106,000	$4.2

[a] On tons per ozone season day basis. SCRs reduce NO_x emissions

[b] Average ozone response and per tpd sensitivity at Atlanta's Confederate Avenue monitoring station to each emission reduction scenario, based on seven CMAQ-simulated days in which the 2002 base case modeled 8-hour ozone concentration was above 85 ppb

[c] Statewide health benefits computed by BenMAP based on ozone concentration-response functions for exposure of up to 8 hours

[d] Hypothetical scenarios of uniformly reducing regional non–power plant emissions by 10%. Actual costs of NO_x and VOC reductions will vary by particular control measure

[e] Costs computed in Year 1999 U.S. dollars based on costing equations from the Integrated Planning Model v. 2.1.9 (U.S. EPA 2004d) and baseline plant characteristics from VISTAS 2009 projections. SCRs are assumed to operate year-round

ppb, parts-per-billion; *ppt*, parts-per-trillion; *tpd*, tones per day; *NO_x*, nitric oxide; *VOC*, volatile organic compounds; *SCR*, selective catalytic reduction; *CMAQ*, Community Multiscale Air Quality

PM2.5 Example

Table 2 Costs and benefits of scenarios for reducing fine particulate matter ($PM_{2.5}$) in Atlanta

Control scenario	Annual cost (10^6 $)	Emissions reduced[a] (tpd)	$PM_{2.5}$ response at monitor[b] (μg/m3)	$PM_{2.5}$ sensitivity at monitor[b] (ng/m3/tpd)	Annual statewide benefits[c] (10^6 $)	Annual cost per 1 ng/m^3 reduction at monitor ($)	Cost per $1 health benefits ($)
10% Atlanta PC[d]	N/A	2	0.25	85.7	223	N/A	N/A
10% Atlanta NH_3[d]	N/A	5	0.09	22.5	127	N/A	N/A
Scrubbers at Power Plant 1	30[e]	49	0.070	1.39	107	$426,000	$0.28
Scrubbers at Power Plant 2	124[e]	278	0.150	0.56	375	$825,000	$0.33

[a] On annual average tons per day basis. Scrubbers reduce SO_2 emissions

[b] Average $PM_{2.5}$ response and per ton-per-day sensitivity at Atlanta's Fire Station 8 monitoring station to each emission reduction scenario, based on CMAQ simulations of a summertime and wintertime episode

[c] Statewide health benefits computed by BenMAP based on concentration-response functions to annual $PM_{2.5}$

[d] Hypothetical scenarios of uniformly reducing regional non–power plant emissions by 10%. Actual costs of primary carbon and ammonia reductions will vary by particular control measure

[e] Costs computed in Year 1999 U.S. dollars based on costing equations from the Integrated Planning Model v. 2.1.9 (U.S. EPA 2004d) and baseline plant characteristics from VISTAS 2009 projections

tpd tons per day, *pc* carbon particles, *CMAQ* Community Multiscale Air Quality

Next Steps & Lessons Learned

Next Steps

- Still a work in progress…
- Model final control strategy for SIPs based on controls and rules developed by Planning & Regulatory Development Unit
  - Update "Menu of Options" for control of ozone and PM2.5
  - Perform Cost/Benefit analysis for control options
  - Select final control options

Lessons Learned

- CMAQ emission sensitivities require a lot of resources (computers & personnel)
- BenMAP results can be highly uncertain and interpretation can be subjective
- Control costs estimates can be difficult to quantify accurately
- No straight forward way to integrate emission sensitivities, benefits, and costs to design an optimal control strategy across multiple pollutants
- "Incorporating Uncertainty Analysis into Integrated Air Quality Planning."
  - U.S. EPA STAR grant
  - Dr. Dan Cohan at Rice University

Contact Information

Jim Boylan, Ph.D.
Georgia Dept. of Natural Resources
4244 International Parkway, Suite 120
Atlanta, GA 30354

james_boylan@dnr.state.ga.us
404-362-4851