8-Hour Ozone and $PM_{2.5}$ Modeling to Support the Georgia SIP

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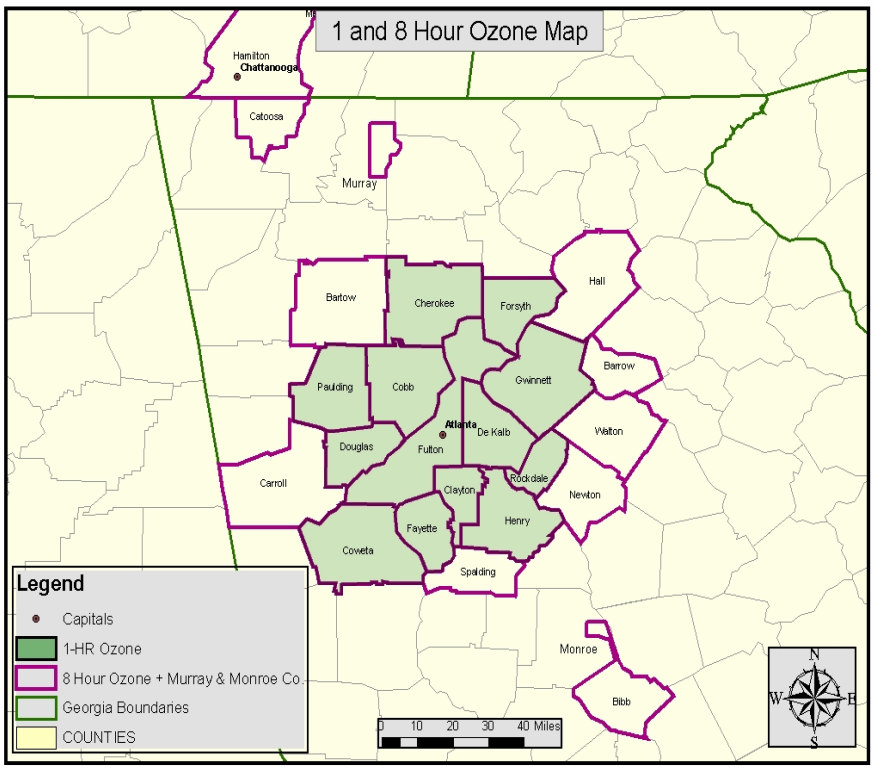
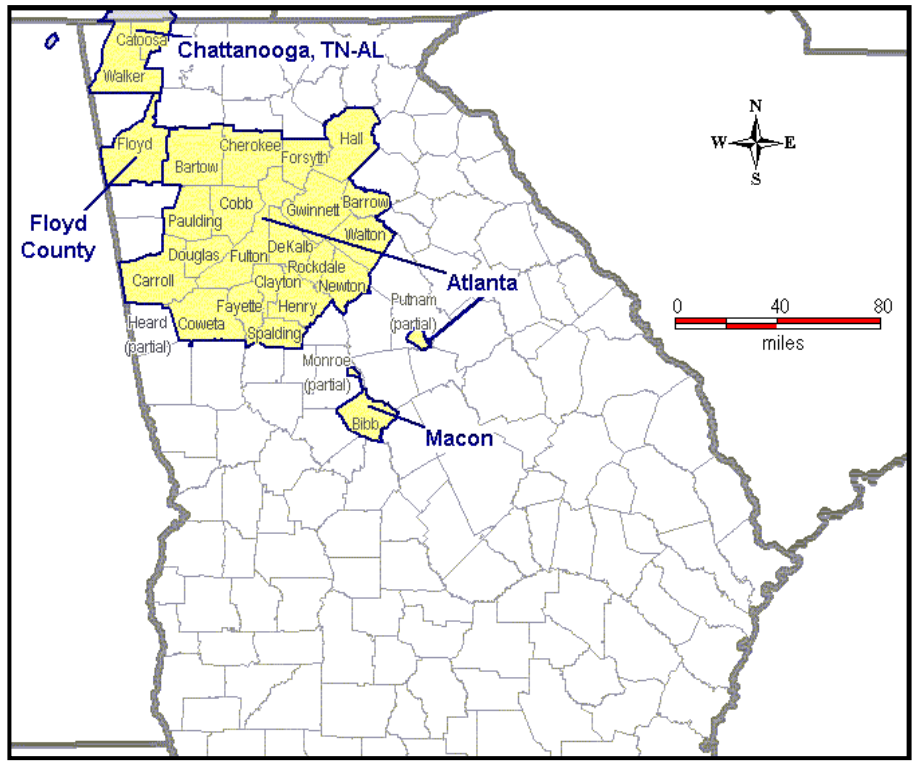
Background: Attainment Status in Georgia

- Certain regions in Georgia are in non-attainment of NAAQS:
  - 8-hour ozone standard (85 ppb): Atlanta, Macon
  - Annual $PM_{2.5}$ standard (15 $\mu g/m^3$): Atlanta, Macon, Floyd county, Chattanooga

Ozone non-attainment areas

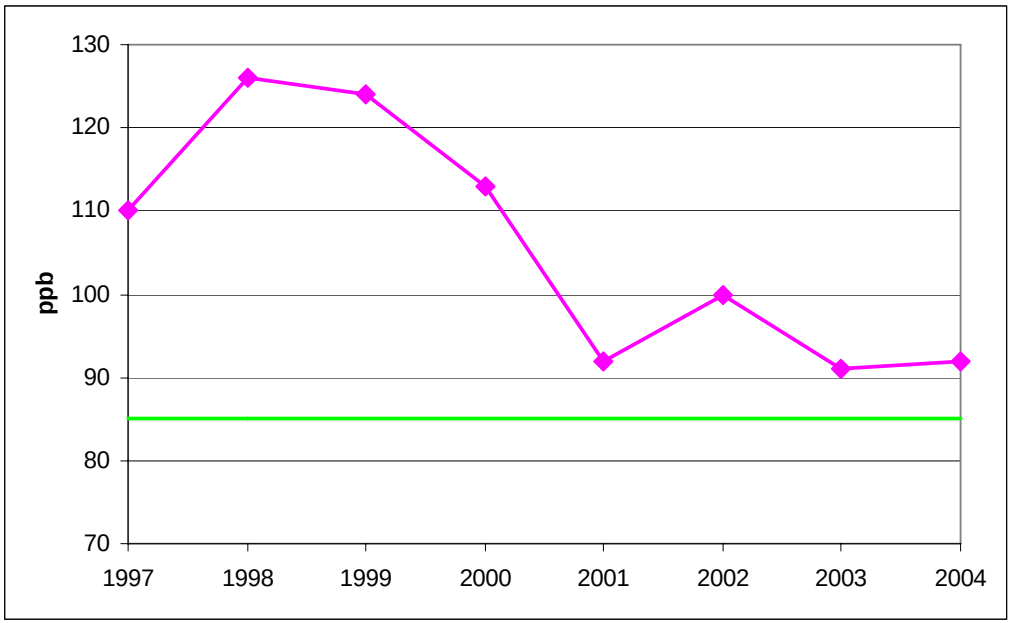


$PM_{2.5}$ non-attainment areas



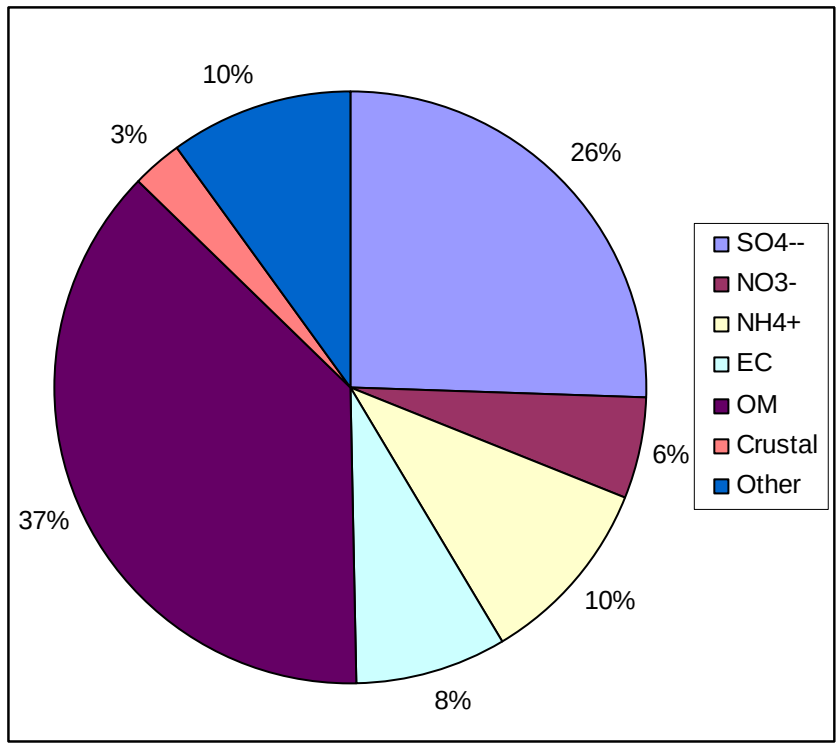
Background: Air quality in Georgia

Ozone 4th highest values in Atlanta, 1997-2004

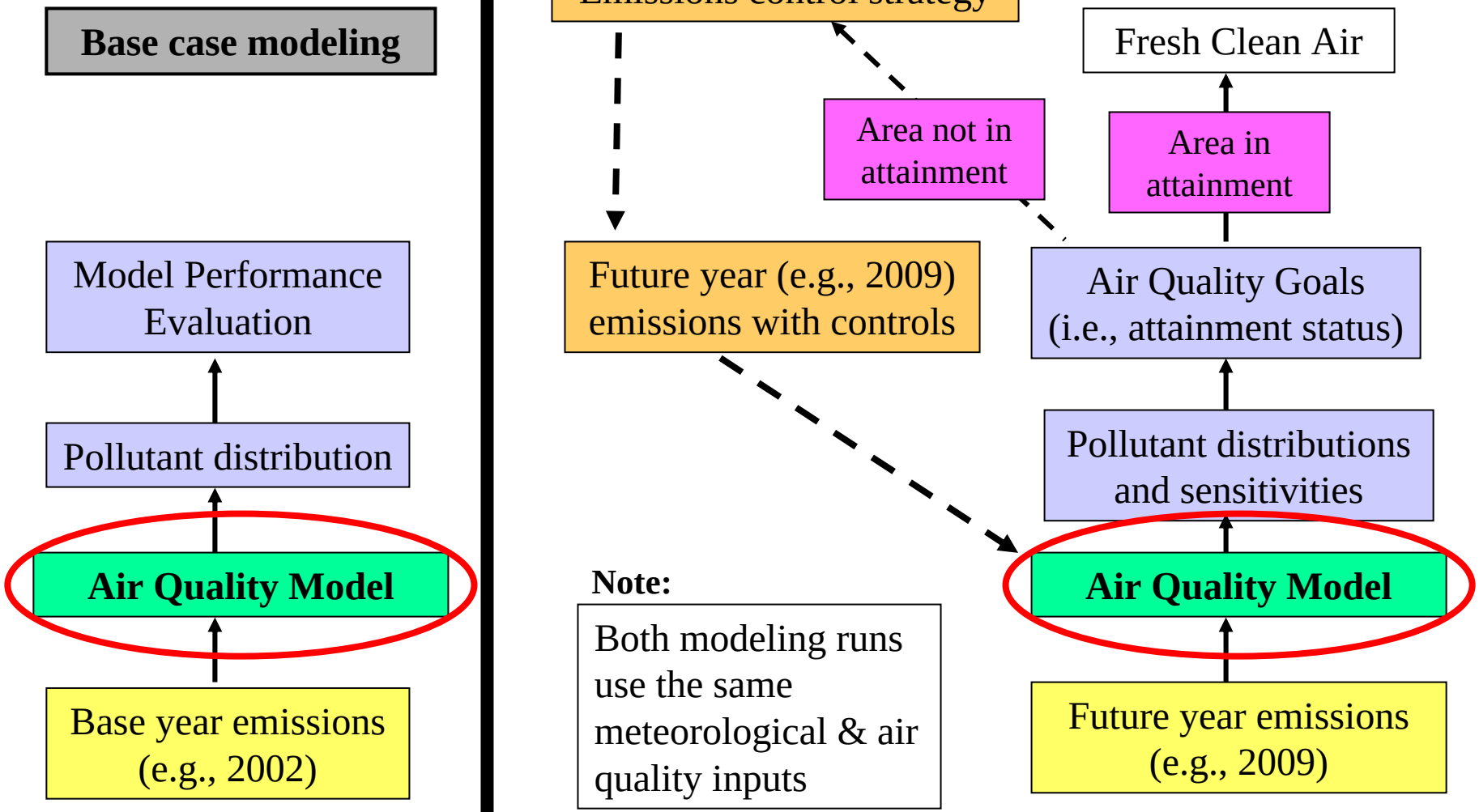


$PM_{2.5}$ composition, 2001-2003

Design value (JST site): 17.4 μg/m3



Demonstrating attainment using AQ models



Ozone Attainment Demonstration

- Models are used in a **relative sense**, rather than an absolute sense:

$$DV_{Future} = RRF * DV_{Current}$$

  - **$DV_{Current}$**: Current **D**esign **V**alue, weighted average of the 4th highest measured 8-hour ozone concentration per season
  - **RRF**: **R**elative **R**eduction **F**actor, calculated based on model simulations (controlled case compared to base case)

$$RRF = \frac{\text{Modeled Future Mean Peak 8-hr Daily Max}}{\text{Modeled Current Mean Peak 8-hr Daily Max}}$$

If $DV_{Future} < 85$ ppb $\Rightarrow$ attainment demonstrated

- Similar concepts for $PM_{2.5}$, but based on yearly (quarterly) averages and per species (SO_4^{-2}, NO_3^-, NH_4^+, EC, OC)

Example Ozone Attainment Demonstration

Site	Current Obs. DV	Current Peak Predicted max. (2002)	Future Peak Predicted max. (2009)	RRF	Future DV
Atlanta	95 ppb	88 ppb	80 ppb	0.91	86 ppb
Macon	91 ppb	84 ppb	75 ppb	0.89	81 ppb

State Implementation Plans (SIP)

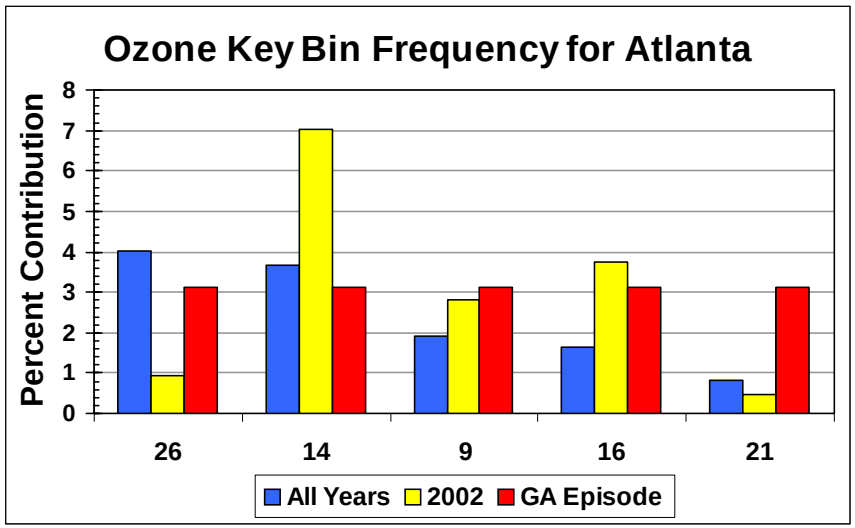
- Need to develop SIPs for both ozone and $PM_{2.5}$
  - 2002 used as “base case” for modeling (2002 emissions inventory and DVs)
  - 2009 used as “future year” (projected 2009 emissions inventory + additional controls to show attainment)
    - Federal level emissions reductions (Federal rules)
    - Georgia specific regulations to achieve attainment (State level)

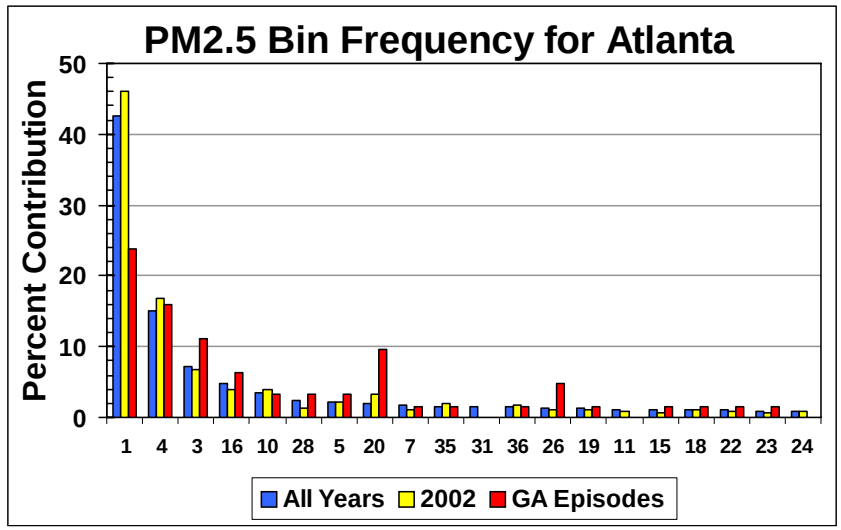
- To develop state-level controls, conduct sensitivity-analysis to model the benefits (reduction in ozone and $PM_{2.5}$) achieved by reductions in precursors

Why 2002 as base case?

- 2002 representative of "typical" meteorological conditions
  - ➢ Chose representative episodes for modeling:
    - May 25 - June 25, 2002
    - Nov 19 - Dec 19, 2002

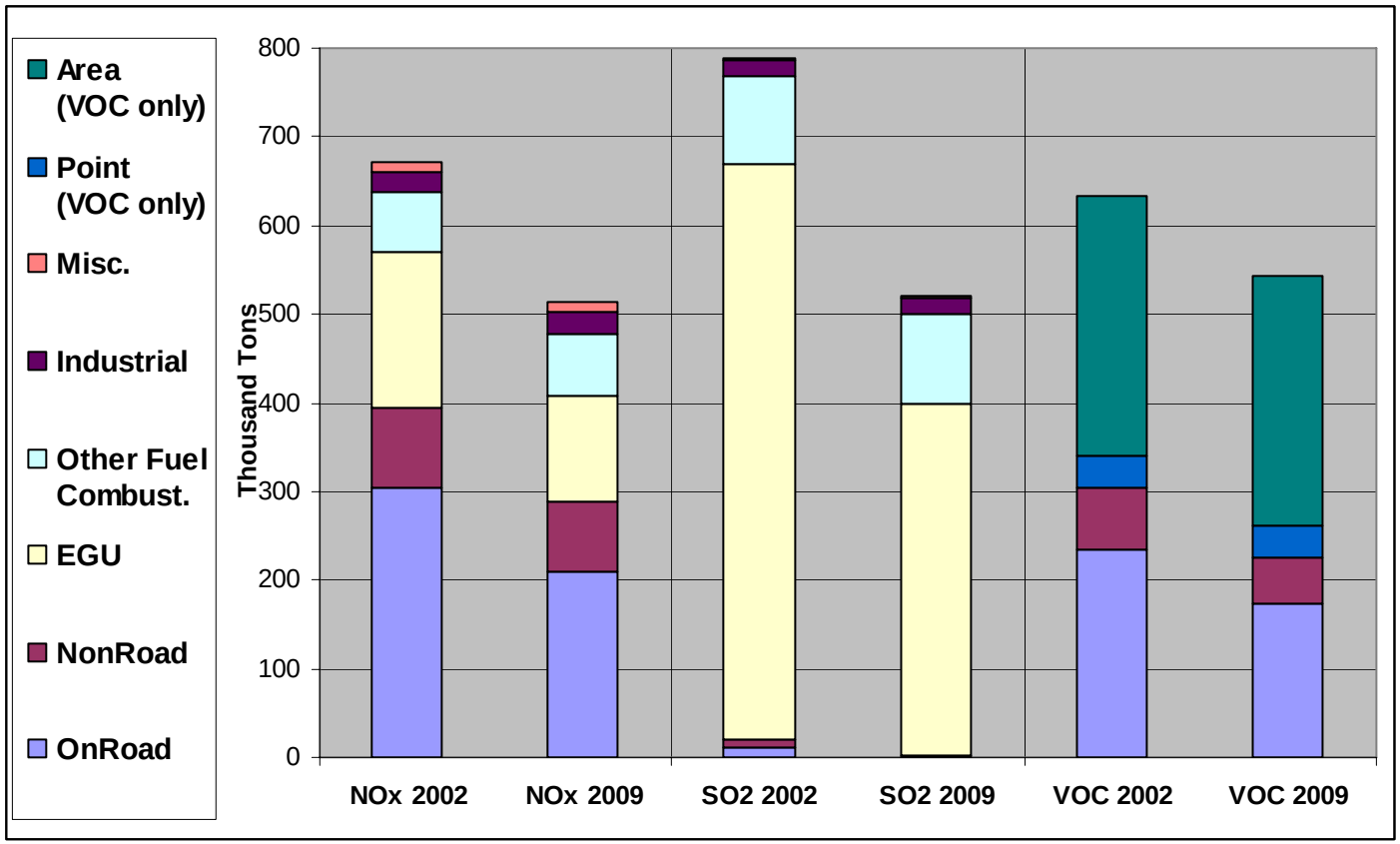
CART analysis (**C**lassification **a**nd **R**egression **T**ree)



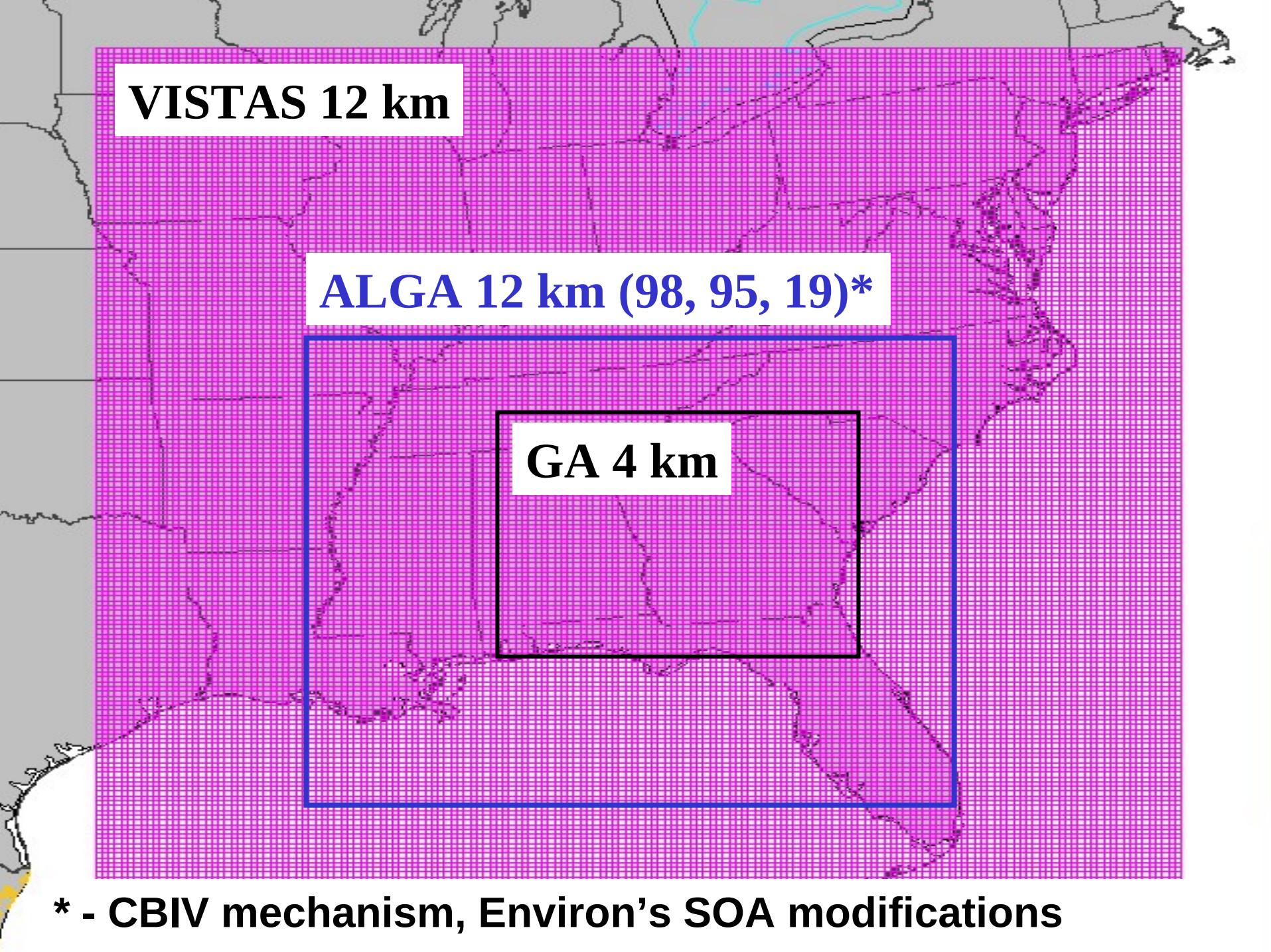


- But … consider "extreme" cases for ensuring long-term attainment
  - What would happen if 1998-2000 meteorology would reoccur?
    - Develop "safety buffer" (**additional** reductions below the mandated 85 ppb)

2009 vs. 2002 emissions inventory



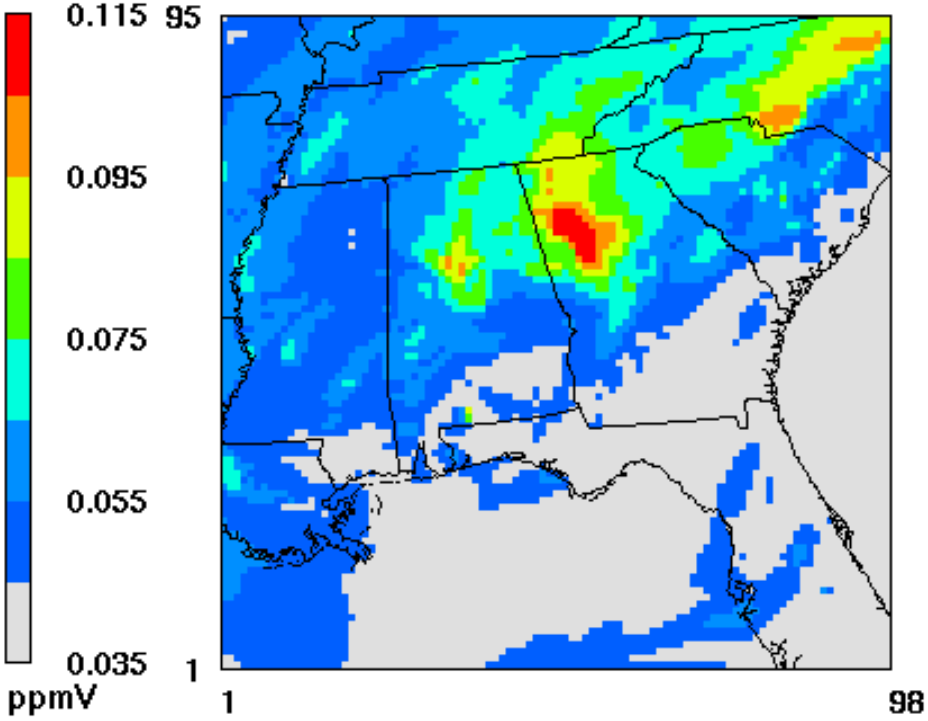
Reductions in NO_x and SO_2 $\Rightarrow$ reductions in ozone and sulfate $PM_{2.5}$



* - CBIV mechanism, Environ's SOA modifications

Reductions in ozone based on 2009 controls

Max 8-hour O3 on June 12, 2002
2002 emissions (VISTAS BaseD)



Max 8-hour O3 on June 12, 2002
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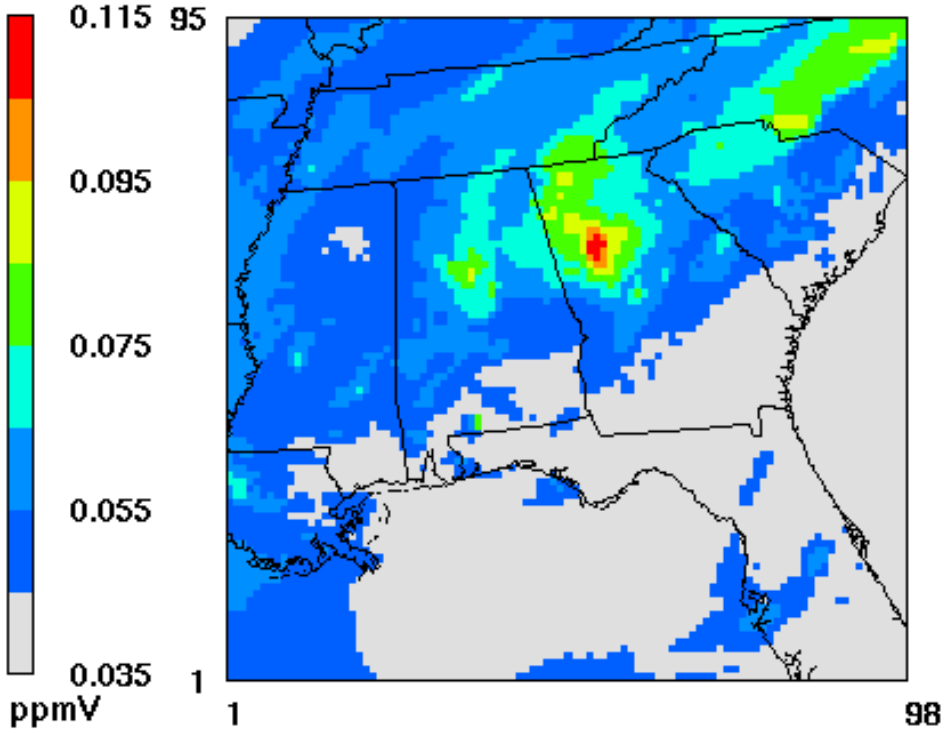
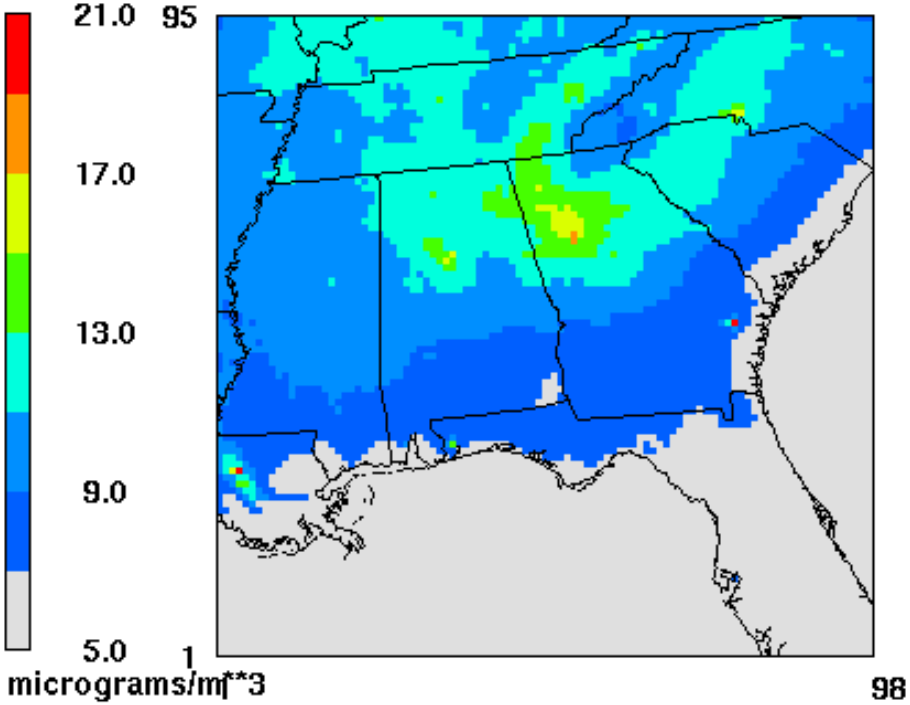


Reductions in $PM_{2.5}$ based on 2009 controls

Episode average $PM_{2.5}$ concentration
2002 emissions (VISTAS BaseD)



Episode average $PM_{2.5}$ concentration
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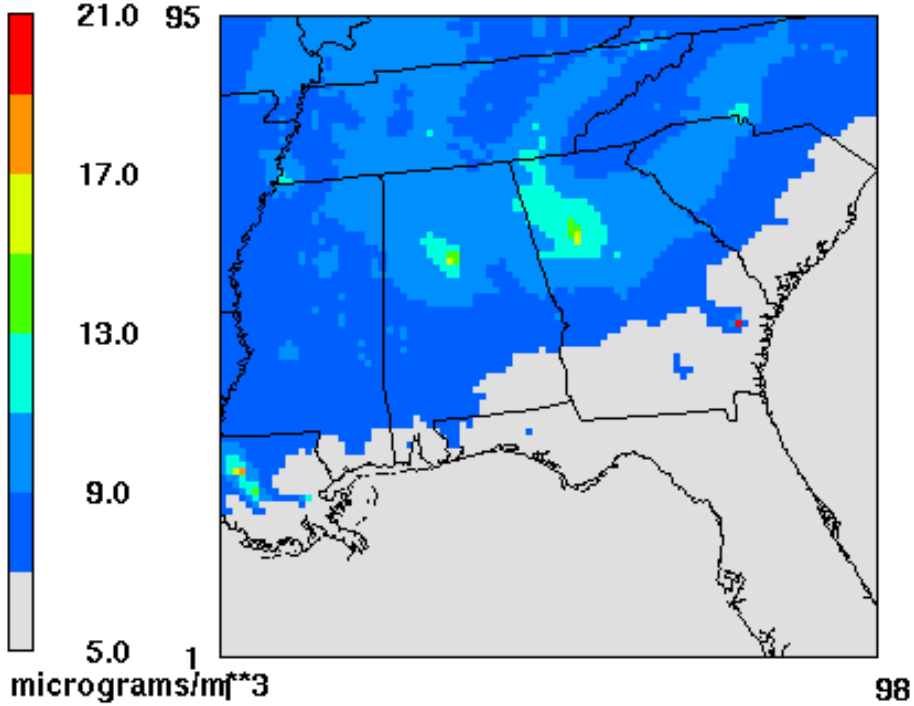
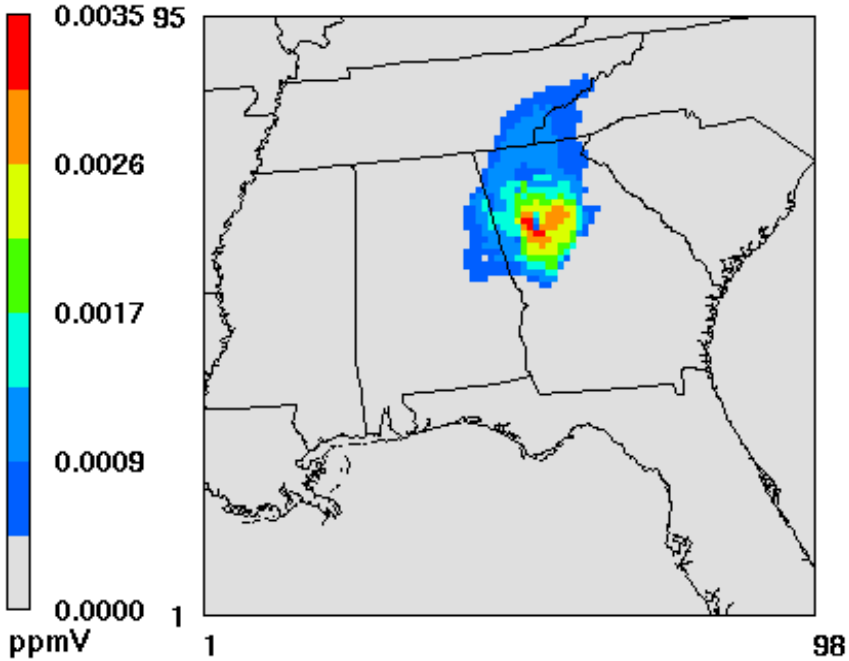


Why sensitivity analysis?

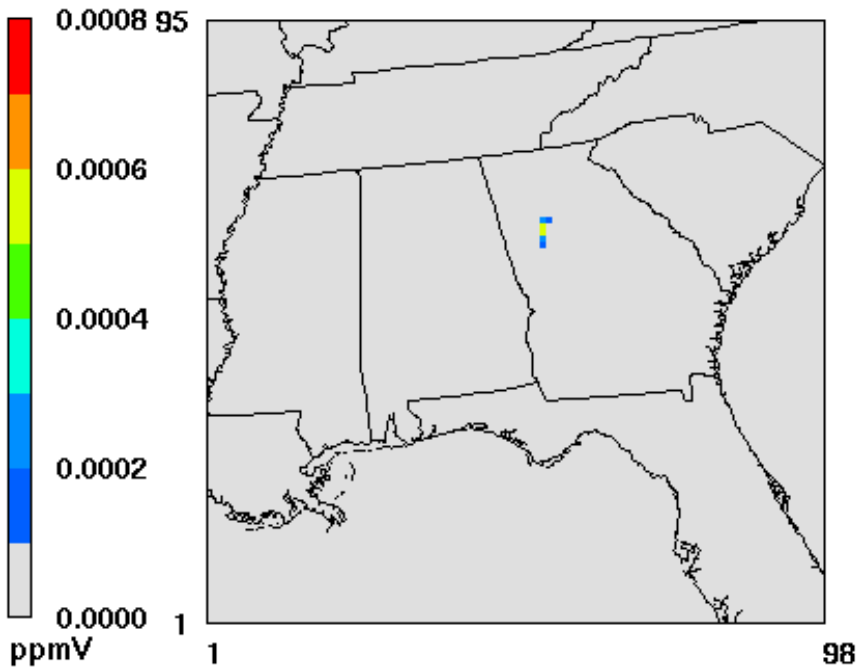
- Federal controls alone (in 2009 emissions inventory) may not bring Atlanta into attainment – need to further reduce emissions
- GA-EPD is interested in demonstrating attainment with a “safety buffer”, to ensure long-term attainment under less favorable meteorological conditions
- Sensitivity analysis would provide response (ppb/ton or $\mu g/m^3$/ton) to changes in emissions of various precursors, both from “regional” sources and point sources:
  - 10% regional reduction in NO_x, SO_2, VOC, NH_3 and primary carbon.
  - Specific point-source sensitivities, simulating the installation of scrubbers (for SO_2 reduction) and SCRs (for NO_x reductions) at major power-plants in Georgia

Regional emissions reductions: Ozone in Atlanta

Sensitivity to a 10% reduction in non-power plant anthropogenic NO_x in the Atlanta area (38 TPD), June 12, 2002

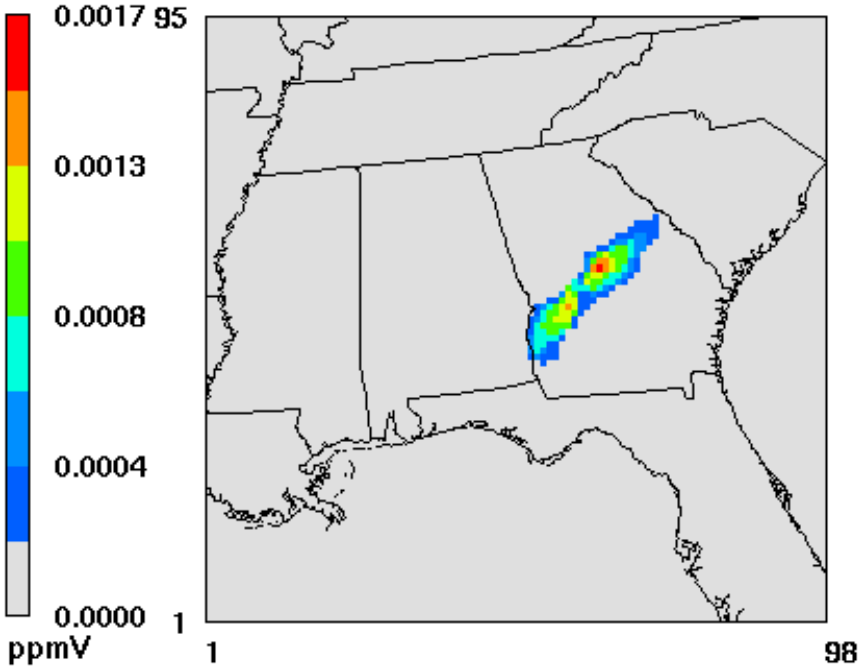


Sensitivity to a 10% reduction in non-power plant anthropogenic VOC in the Atlanta area (49 TPD), June 12, 2002

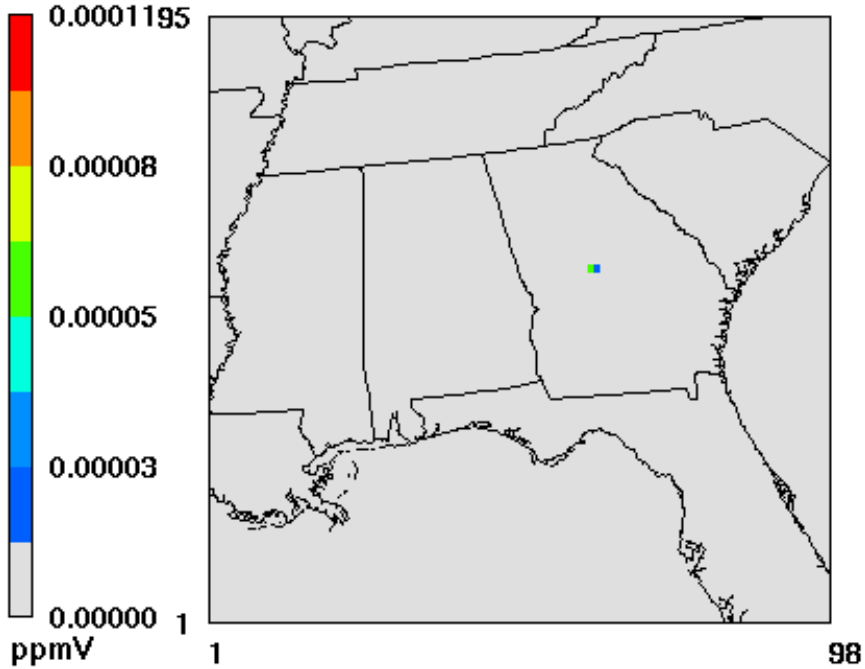


Regional emissions reductions: Ozone in Macon

Sensitivity to a 10% reduction in non-power plant anthropogenic NO_x in the Macon area (23 TPD), June 13, 2002

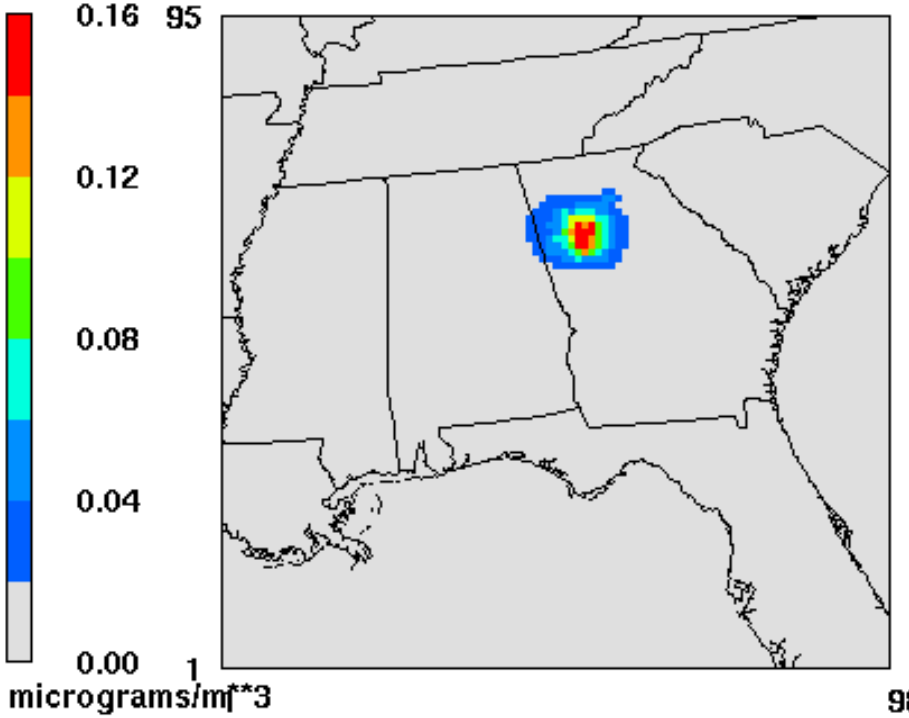


Sensitivity to a 10% reduction in non-power plant anthropogenic VOC in the Macon area (33 TPD), June 13, 2002

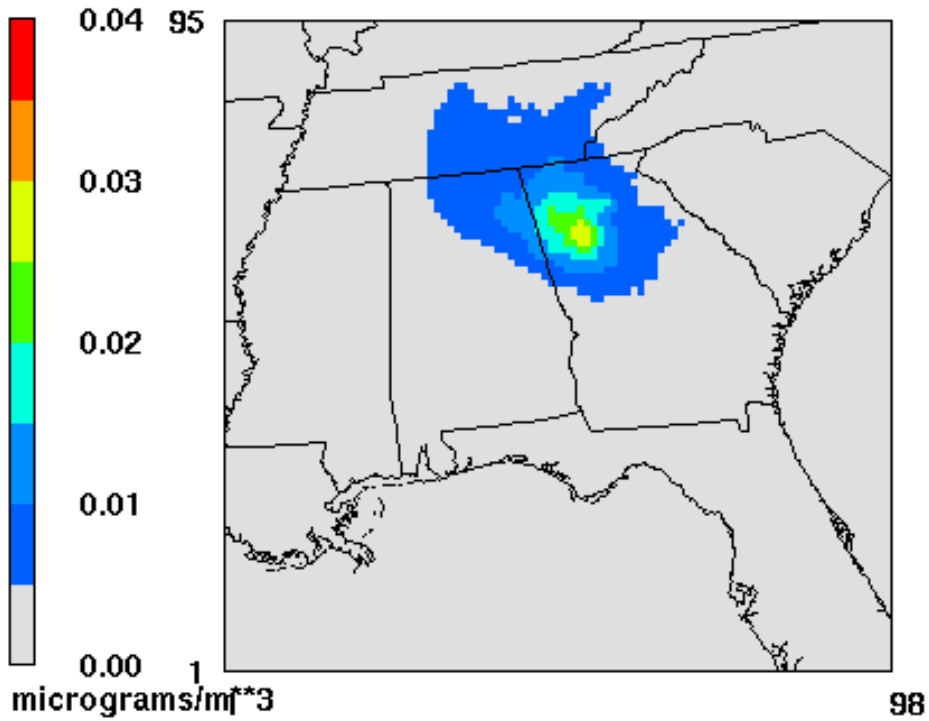


Regional emissions reductions: $PM_{2.5}$ in Atlanta

Sensitivity to a 10% reduction in non-power plant anthropogenic primary carbon in the Atlanta area (2 TPD); episode average



Sensitivity to a 10% reduction in non-power plant anthropogenic SO_2 in the Atlanta area (8 TPD); episode average



Point Source Sensitivities

- Sensitivity of ozone (ppb) and $PM_{2.5}$ ($\mu g/m^3$)
  - SCR (NO_x) and Scrubber (SO_2) Reductions
  - 12-km ALGA domain

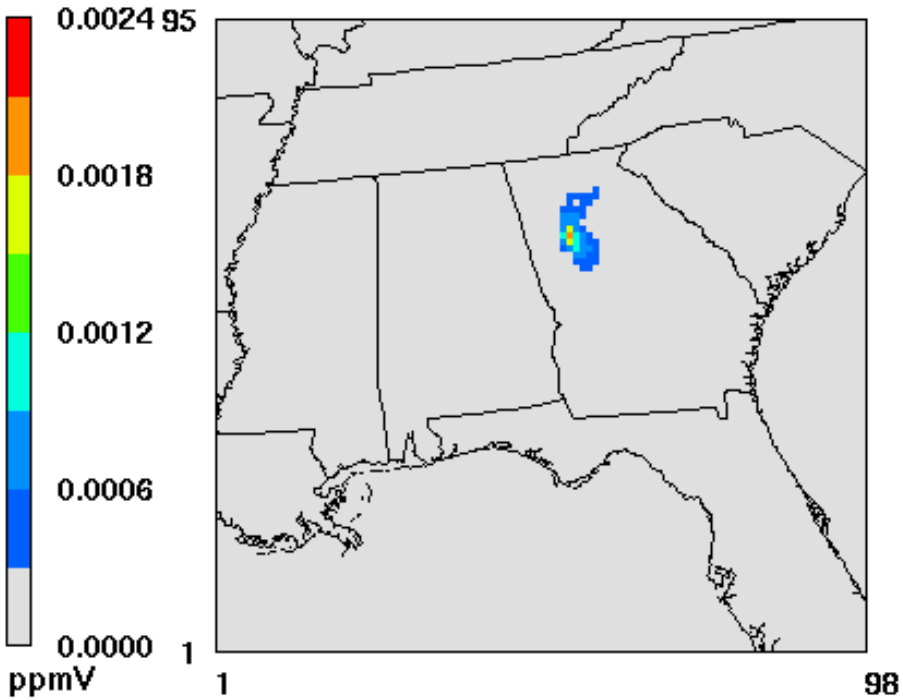
Plant (# of units)	2009 Inventory SCRs	2009 Inventory Scrubbers	Additional Sensitivity SCRs	Additional Sensitivity Scrubbers	NOx (%, TPD)	SO_2 (%, TPD)
Bowen (4)	4	2	0	2	--	88%, 172
Scherer (4)	0	0	4	4	53%, 30	95%, 295
Branch (4)	0	0	2	4	34%, 15	95%, 141
Yates (7)	0	1	2	2	33%,11	63%, 80
Wansley (2)	2	1	0	1	--	87%, 92
McDonough(2)	0	0	2	2	68%, 7	95%, 47
Hammond (4)	1	0	3	4	68%, 11	95%, 77

black – existing

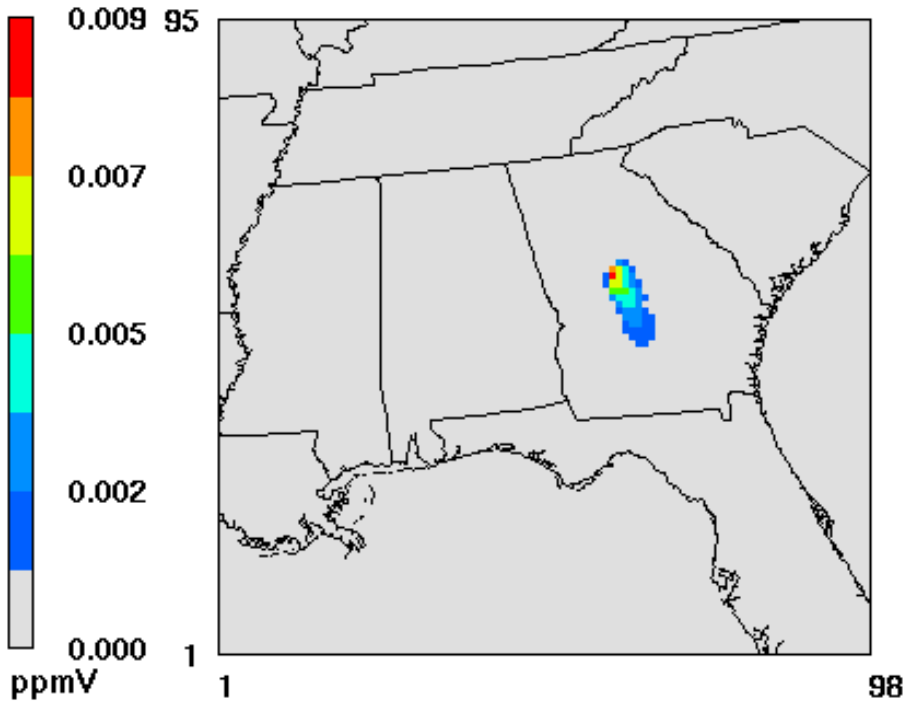
red – projected/modeled

EGU controls: Ozone

Sensitivity to a 68% reduction in NO_x (SCR installation) from Plant McDonough , June 12, 2002

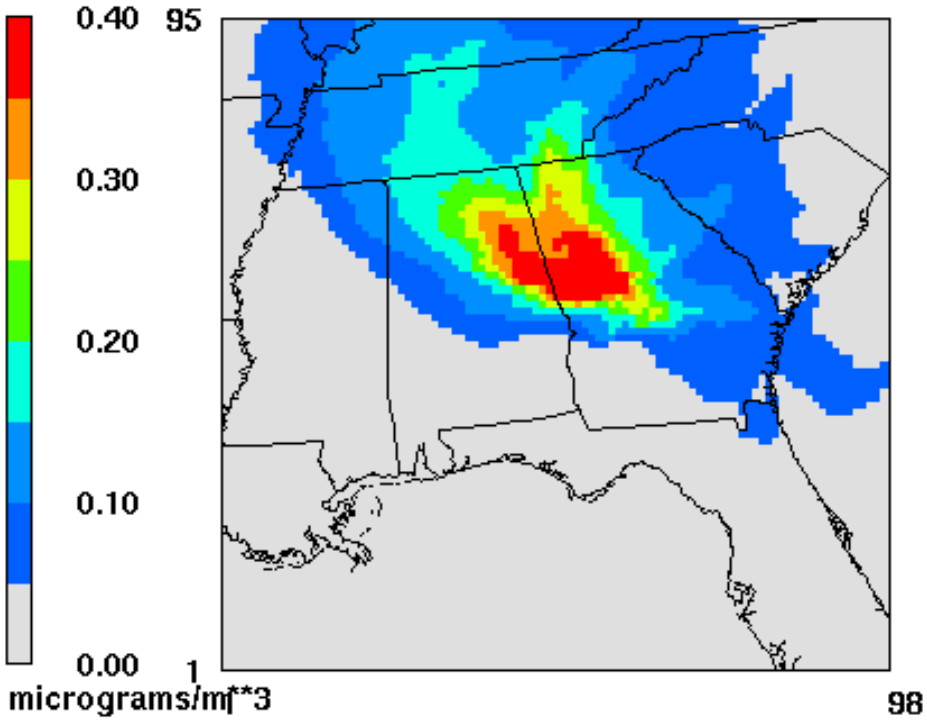


Sensitivity to a 53% reduction in NO_x (SCR installation) from Plant Scherer, June 3, 2002

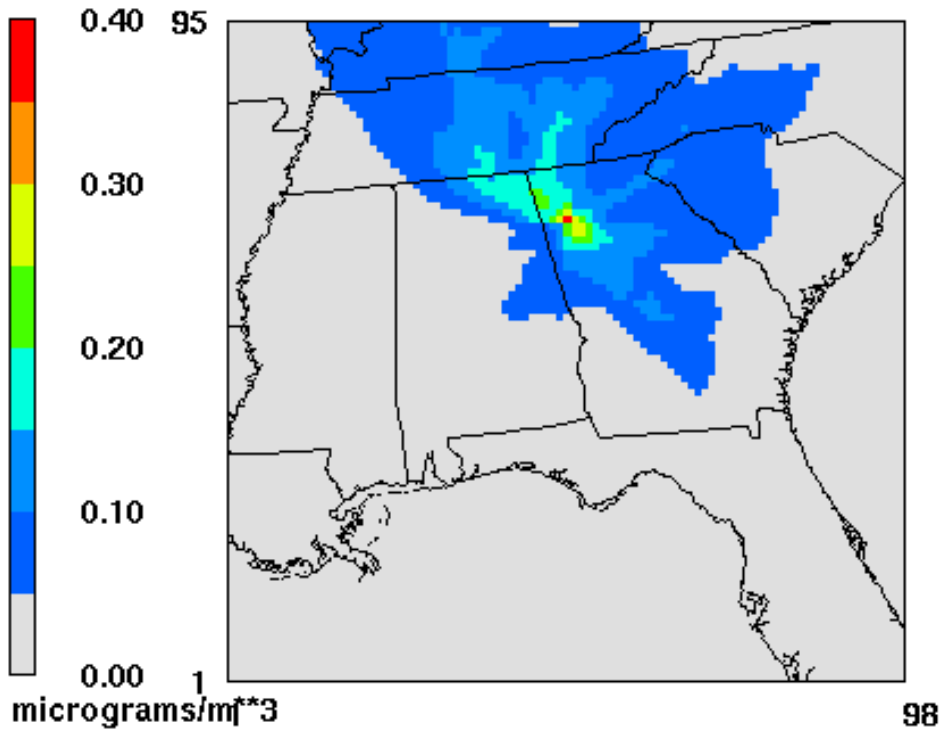


EGU controls: $PM_{2.5}$

Sensitivity to a 95% reduction in SO_2 (scrubber installation) and a 68% reduction in NO_x (SCR) from Plant Scherer; episode average

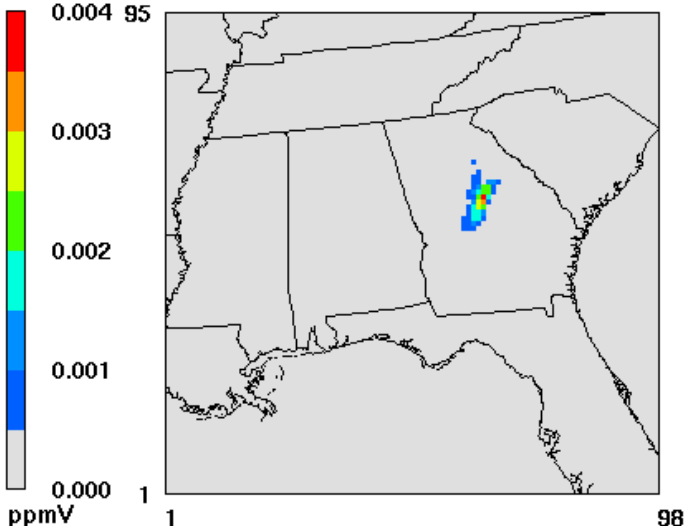


Sensitivity to a 88% reduction in SO_2 (scrubber installation) from Plant Bowen; episode average

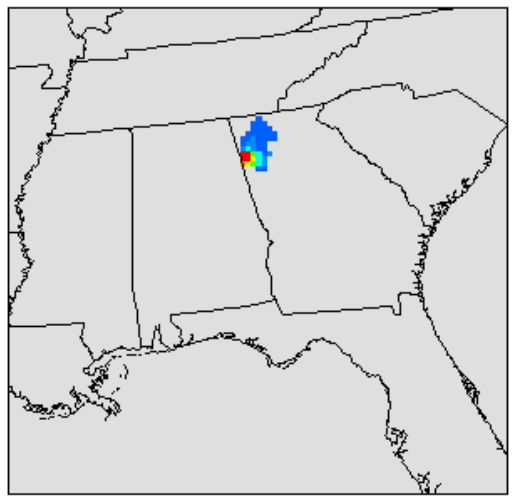


EGU controls: High ozone day

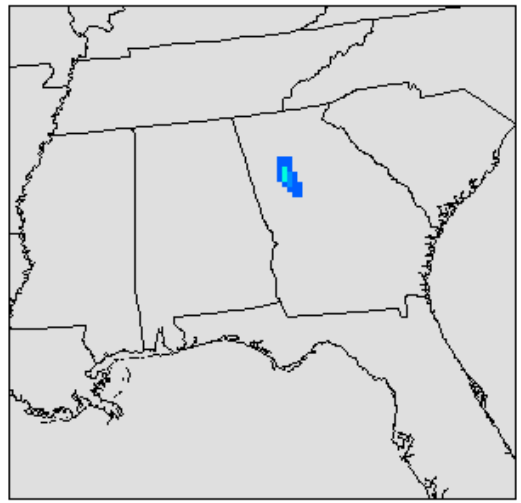
Branch (34%)



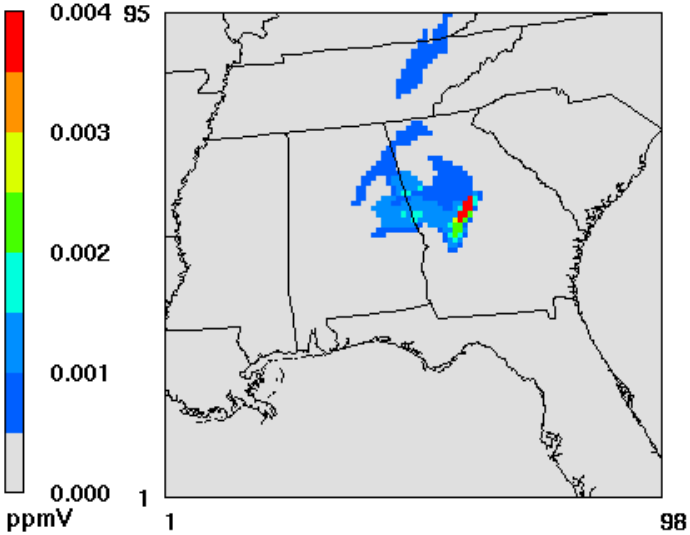
Hammond (68%)



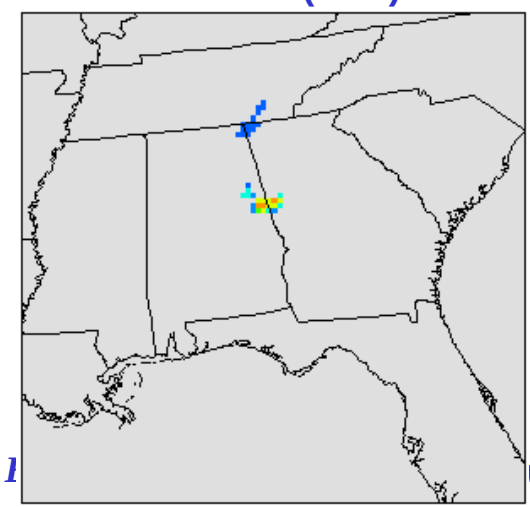
McDonough (68%)



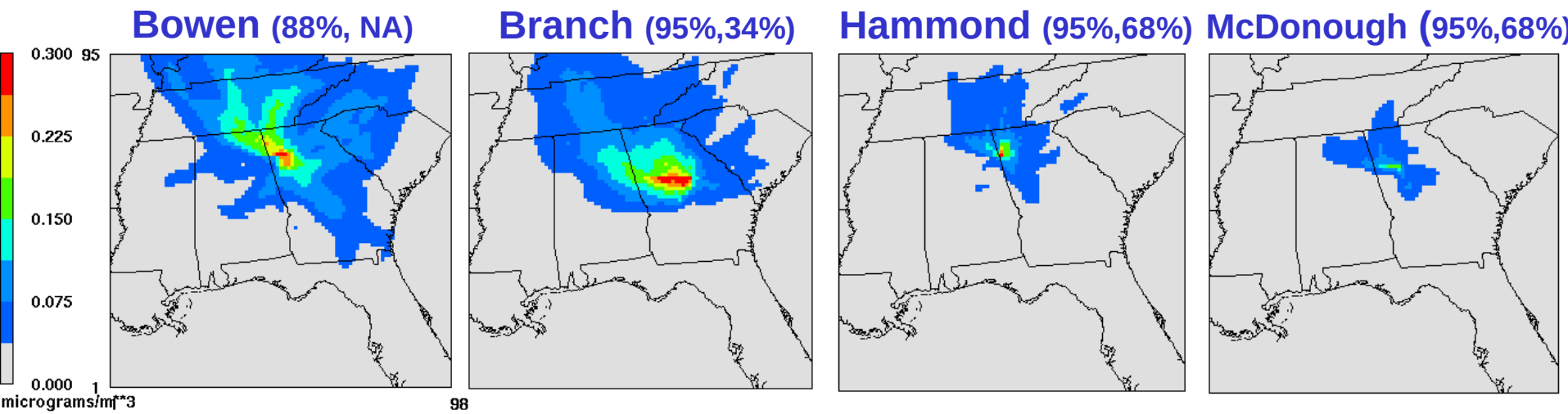
Scherer (63%)

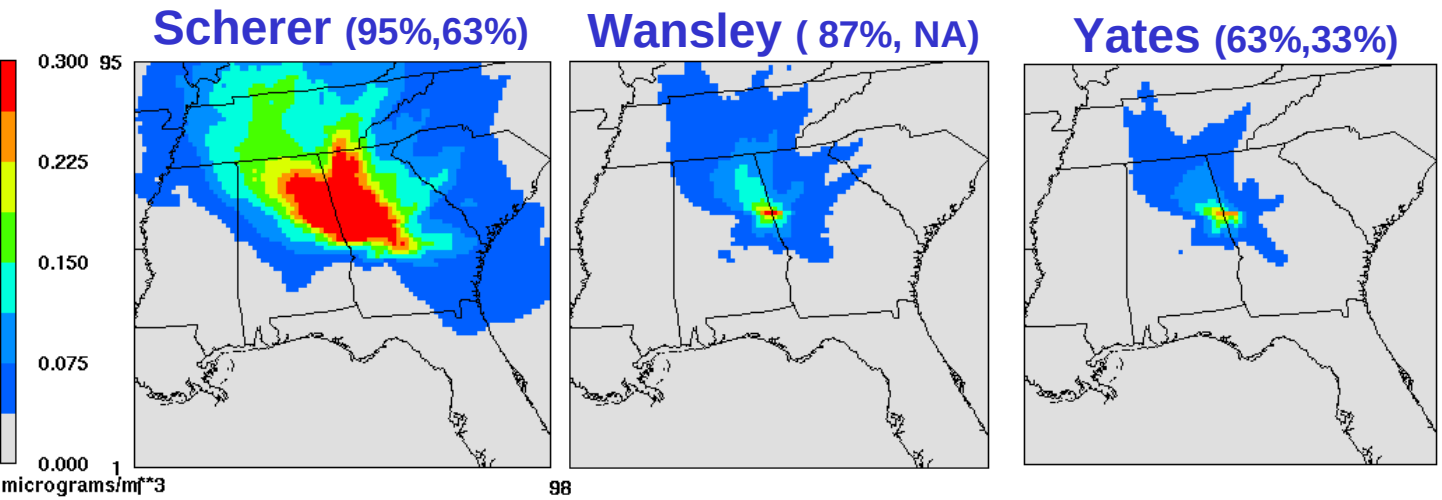


Yates (33%)



EGU controls: Episode average $PM_{2.5}$





Reductions per ton: "Regional" sensitivities

	Ozone		$PM_{2.5}$	
10% change in	maximum reduction (ppb)	reduction per ton (ppb/TPD)	episode average reduction (μg/m3)	reduction per ton (μg/m3/TPD)
NO_x	3.5	**0.092**	0.09	0.002
VOC	0.8	0.016	0.004	8E-05
SO_2	-	-	0.03	0.004
NH_3	-	-	0.08	0.01
carbon	-	-	0.45	**0.22**

Reductions per ton: Point-source sensitivities

	Ozone		$PM_{2.5}$	
Scrubbers & SCRs at	maximum reduction (ppb)	reduction per ton (ppb/TPD)	episode average reduction (μg/m3)	reduction per ton (μg/m3/TPD)
Branch	5	0.33	0.36	0.0023
Bowen	-	-	0.42	0.0024
Hammond	5	0.45	0.30	0.0034
McDonough	1.5	0.21	0.18	0.0033
Scherer	6	0.20	0.66	0.0020
Wansley	-	-	0.31	0.0034
Yates	5	0.45	0.26	0.0028

Preliminary conclusions based on sensitivity analysis

- NO_x controls for reducing ozone, likely a combination of:
  - Non EGU NO_x
  - EGU NO_x
- EGU SO_2 controls for lowering sulfate levels
  - scrubbers underway in several Georgia-Power facilities
- Local (non-EGU) primary carbon emissions controls (e.g., diesel retrofits)

- **However**:
  - a more detailed analysis is needed to consider the frequency of various meteorological conditions (as represented by the CART bins)
  - model a winter episode for annual $PM_{2.5}$ representation

Next steps in SIP development…

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

Modeled base & controlled pollutant concentrations

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

Cost Assessment

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

Benefit Assessment

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