

# Emission and Air Quality Trends Review 1999-2011

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## Southeastern States

July 2013

# Project Objective

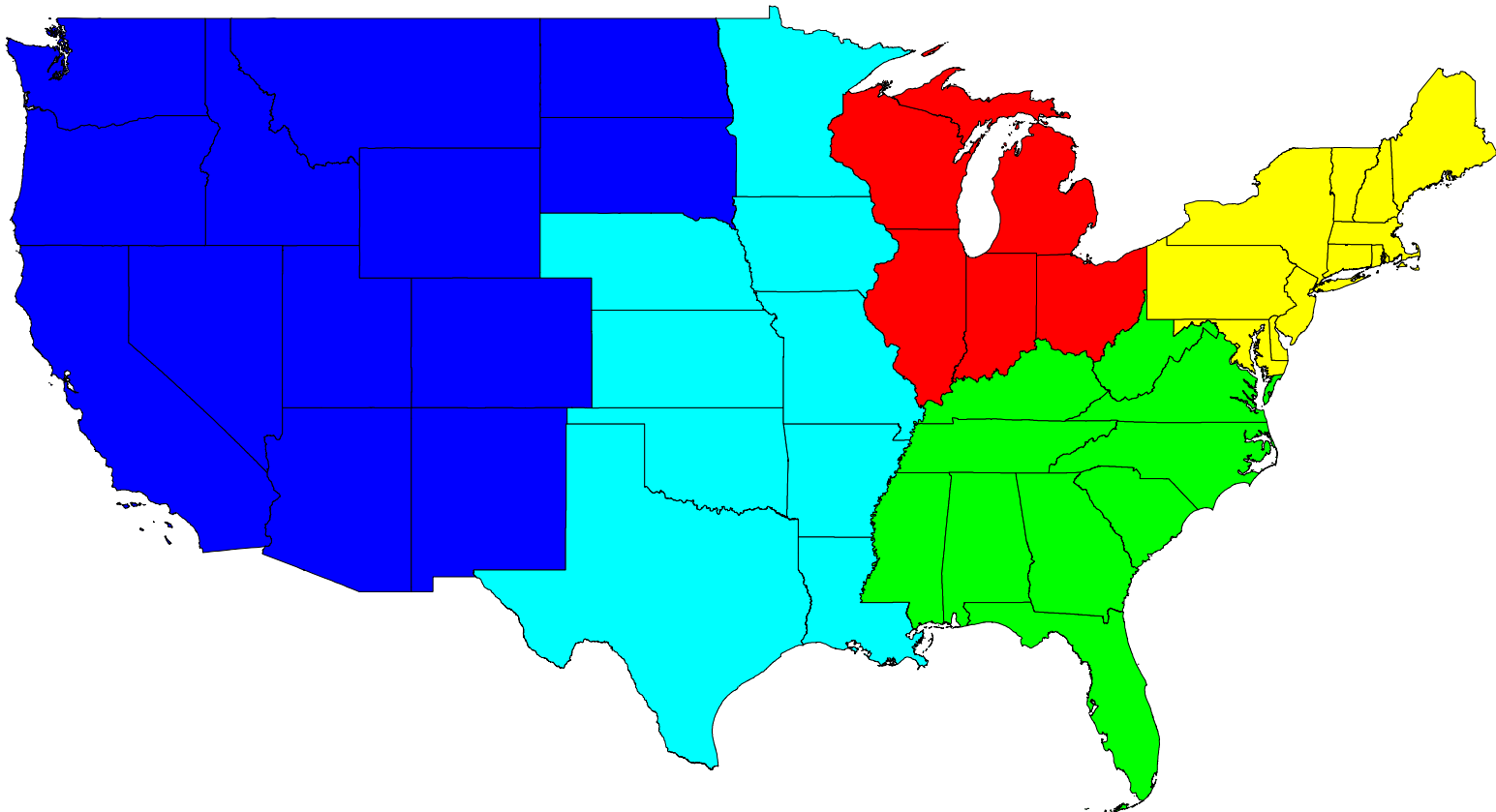
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- ❑ To develop and present publicly available information on trends in emissions and ambient air quality in the U.S. since 1999 in easy to understand visual and tabular formats

# Trends Analysis

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Metrics developed for U.S. by Region



# Emission Trends

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- ❑ Study Team collected and processed U.S. EPA emission inventories for years within the study period of interest (1999-2011)
  
- ❑ By pollutant and source category
  - electric utility coal fuel combustion
  - mobile sources
  - industrial fuel combustion & industrial processes
  - all other

# Emissions Data Summary

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- Data Obtained from EPA National Emission Inventory (NEI) and Trends Websites
  - EPA's Trends reports and emission comparisons include interpolations of all categories between key years (1999, 2002, 2005, 2008, 2011) at county-pollutant level
  - Represented Pollutants: VOC, NO<sub>x</sub>, SO<sub>2</sub>, and PM<sub>2.5</sub>
- Project Improvement
  - The Study Team augmented above data with year specific CEM emissions (2002 through 2011)

# Emission Changes

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- ❑ The following slides also include the tonnage-based emissions change from 1999 to 2011 for each pollutant
- ❑ Negative values indicate decrease in emissions, positive values indicate an increase

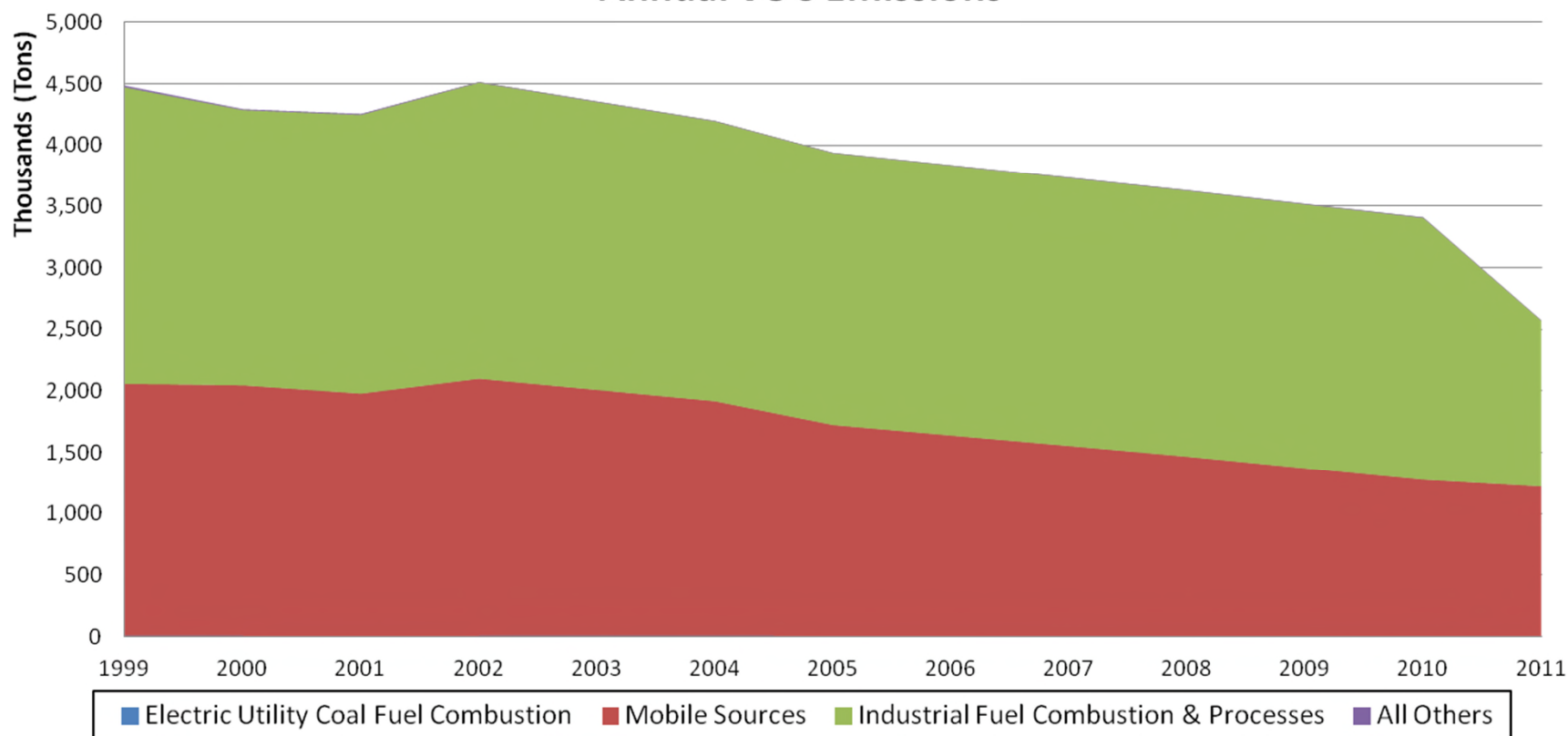
# Southeast Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	8,930	8,740	9,548	8,431	8,551	9,061	7,843	6,513	6,889	7,256
Mobile Sources	2,050,300	1,970,775	1,999,911	1,717,107	1,631,453	1,545,799	1,459,947	1,365,782	1,271,618	1,215,593
Industrial Fuel Combustion & Processes	2,415,337	2,270,290	2,344,200	2,210,332	2,193,873	2,177,420	2,160,972	2,144,524	2,128,081	1,349,564
All Others	14,656	8,705	5,424	4,739	5,042	5,331	5,215	5,657	5,961	5,204
<b>Total</b>	<b>4,489,223</b>	<b>4,258,510</b>	<b>4,359,084</b>	<b>3,940,610</b>	<b>3,838,918</b>	<b>3,737,610</b>	<b>3,633,976</b>	<b>3,522,477</b>	<b>3,412,549</b>	<b>2,577,617</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-2%	7%	-6%	-4%	1%	-12%	-27%	-23%	-19%
Mobile Sources	0%	-4%	-2%	-16%	-20%	-25%	-29%	-33%	-38%	-41%
Industrial Fuel Combustion & Processes	0%	-6%	-3%	-8%	-9%	-10%	-11%	-11%	-12%	-44%
All Others	0%	-41%	-63%	-68%	-66%	-64%	-64%	-61%	-59%	-64%
<b>Total</b>	<b>0%</b>	<b>-5%</b>	<b>-3%</b>	<b>-12%</b>	<b>-14%</b>	<b>-17%</b>	<b>-19%</b>	<b>-22%</b>	<b>-24%</b>	<b>-43%</b>

# Southeast Emission Trends (VOC)

**Major Source Category Summary  
Annual VOC Emissions**





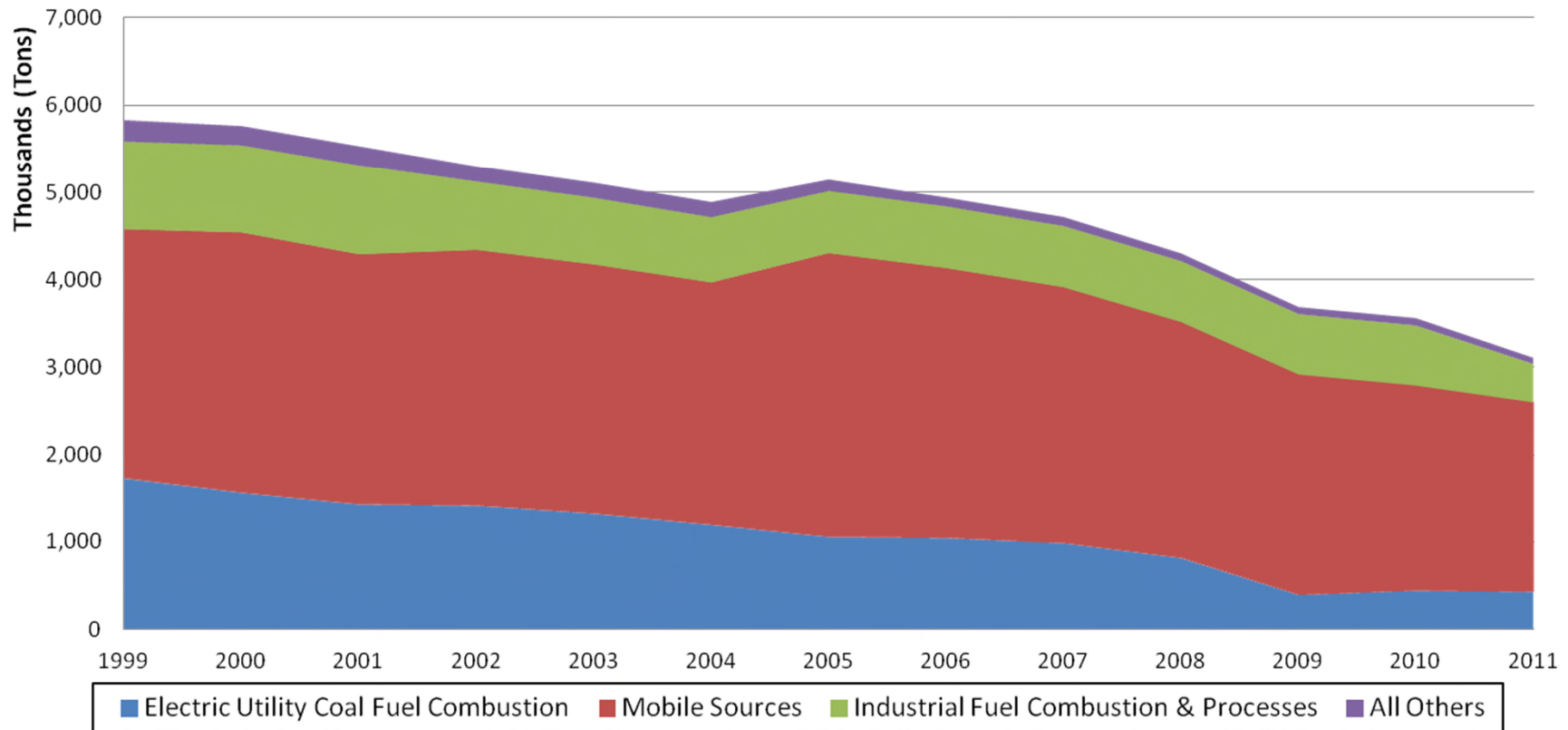
# Southeast Emission Trends (NO<sub>x</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	1,719,411	1,421,288	1,316,521	1,049,821	1,038,676	979,139	809,638	388,007	436,912	422,337
Mobile Sources	2,856,768	2,868,538	2,856,706	3,253,341	3,094,464	2,935,588	2,709,430	2,534,412	2,359,395	2,182,045
Industrial Fuel Combustion & Processes	1,012,933	1,022,908	765,520	712,534	706,543	700,829	697,170	690,272	685,400	438,879
All Others	244,256	219,484	172,434	131,634	101,001	103,235	88,205	79,133	84,115	70,259
<b>Total</b>	<b>5,833,368</b>	<b>5,532,218</b>	<b>5,111,181</b>	<b>5,147,329</b>	<b>4,940,685</b>	<b>4,718,791</b>	<b>4,304,444</b>	<b>3,691,824</b>	<b>3,565,823</b>	<b>3,113,521</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-17%	-23%	-39%	-40%	-43%	-53%	-77%	-75%	-75%
Mobile Sources	0%	0%	0%	14%	8%	3%	-5%	-11%	-17%	-24%
Industrial Fuel Combustion & Processes	0%	1%	-24%	-30%	-30%	-31%	-31%	-32%	-32%	-57%
All Others	0%	-10%	-29%	-46%	-59%	-58%	-64%	-68%	-66%	-71%
<b>Total</b>	<b>0%</b>	<b>-5%</b>	<b>-12%</b>	<b>-12%</b>	<b>-15%</b>	<b>-19%</b>	<b>-26%</b>	<b>-37%</b>	<b>-39%</b>	<b>-47%</b>

# Southeast Emission Trends (NO<sub>x</sub>)

**Major Source Category Summary  
Annual NO<sub>x</sub> Emissions**



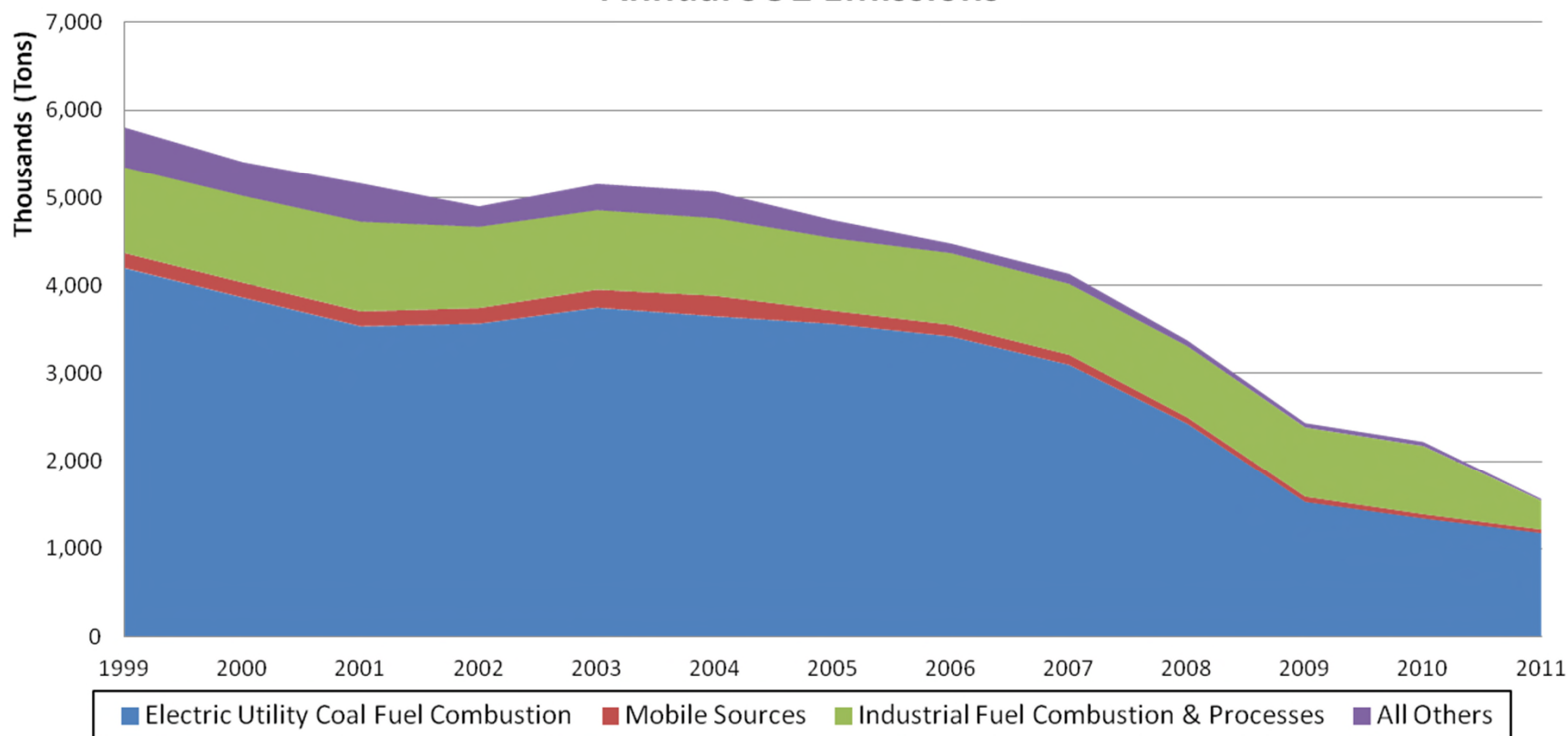
# Southeast Emission Trends (SO<sub>2</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	4,194,928	3,533,609	3,745,630	3,561,568	3,417,980	3,095,792	2,427,651	1,531,522	1,342,333	1,176,264
Mobile Sources	169,801	169,312	204,726	148,206	131,071	113,936	73,131	62,153	51,175	41,215
Industrial Fuel Combustion & Processes	981,808	1,020,479	905,064	827,299	817,341	807,435	809,641	792,483	780,049	329,405
All Others	458,264	439,453	300,530	205,634	109,396	114,100	65,340	48,727	46,694	16,705
<b>Total</b>	<b>5,804,801</b>	<b>5,162,853</b>	<b>5,155,950</b>	<b>4,742,708</b>	<b>4,475,788</b>	<b>4,131,262</b>	<b>3,375,762</b>	<b>2,434,884</b>	<b>2,220,251</b>	<b>1,563,589</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-16%	-11%	-15%	-19%	-26%	-42%	-63%	-68%	-72%
Mobile Sources	0%	0%	21%	-13%	-23%	-33%	-57%	-63%	-70%	-76%
Industrial Fuel Combustion & Processes	0%	4%	-8%	-16%	-17%	-18%	-18%	-19%	-21%	-66%
All Others	0%	-4%	-34%	-55%	-76%	-75%	-86%	-89%	-90%	-96%
<b>Total</b>	<b>0%</b>	<b>-11%</b>	<b>-11%</b>	<b>-18%</b>	<b>-23%</b>	<b>-29%</b>	<b>-42%</b>	<b>-58%</b>	<b>-62%</b>	<b>-73%</b>

# Southeast Emission Trends (SO<sub>2</sub>)

**Major Source Category Summary  
Annual SO<sub>2</sub> Emissions**



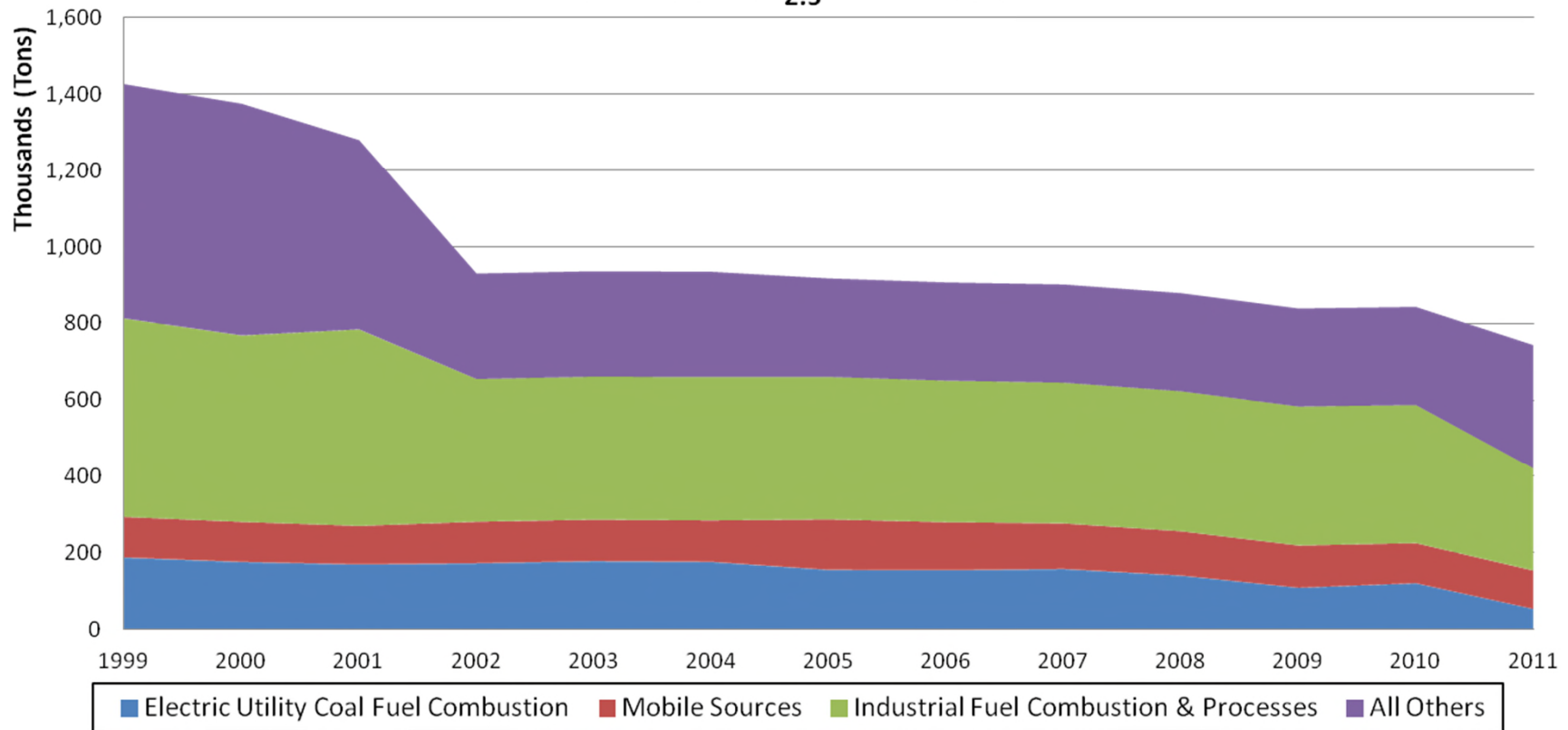
# Southeast Emission Trends (PM<sub>2.5</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	186,691	168,473	177,006	154,169	153,203	156,449	139,331	107,438	119,169	51,935
Mobile Sources	105,708	100,475	108,216	131,762	125,387	119,011	115,706	110,225	104,743	100,090
Industrial Fuel Combustion & Processes	520,875	515,735	376,331	374,896	372,576	370,276	368,441	365,920	363,720	269,308
All Others	612,655	494,980	274,280	256,439	255,617	255,822	255,408	255,310	255,530	322,226
<b>Total</b>	<b>1,425,930</b>	<b>1,279,663</b>	<b>935,832</b>	<b>917,265</b>	<b>906,782</b>	<b>901,558</b>	<b>878,887</b>	<b>838,893</b>	<b>843,161</b>	<b>743,560</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-10%	-5%	-17%	-18%	-16%	-25%	-42%	-36%	-72%
Mobile Sources	0%	-5%	2%	25%	19%	13%	9%	4%	-1%	-5%
Industrial Fuel Combustion & Processes	0%	-1%	-28%	-28%	-28%	-29%	-29%	-30%	-30%	-48%
All Others	0%	-19%	-55%	-58%	-58%	-58%	-58%	-58%	-58%	-47%
<b>Total</b>	<b>0%</b>	<b>-10%</b>	<b>-34%</b>	<b>-36%</b>	<b>-36%</b>	<b>-37%</b>	<b>-38%</b>	<b>-41%</b>	<b>-41%</b>	<b>-48%</b>

# Southeast Emission Trends (PM<sub>2.5</sub>)

**Major Source Category Summary**  
**Annual PM<sub>2.5</sub> Emissions**



# Emission Trends Summary

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- All pollutants have decreased since 1999 in aggregate across the southeastern United States
- NOx and SO2 from Electric Utility Fuel Combustion sources show significant decrease over time as a result of Acid Rain Program, NOx Budget Trading Program and CAIR control implementation
- Onroad emission step increase seen between 2004 and 2005 is the result of EPA's method change and MOVES model integration for estimating onroad mobile source emissions

# AQ Trends Scope

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- ▣ Compute, summarize and display ozone and PM<sub>2.5</sub> design value trends in the Southeastern states for the period 1999 – 2011
- ▣ Create a spreadsheet database of O<sub>3</sub> and PM<sub>2.5</sub> values at each monitoring site for additional analyses



# Design Values

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## □ Ozone

- Annual 4<sup>th</sup> highest daily maximum 8-hour average averaged over three consecutive years
- Current standard = 0.075 ppm

## □ PM<sub>2.5</sub> Annual

- Annual arithmetic mean of quarterly means averaged over three consecutive years
- Current standard = 12 ug/m<sup>3</sup>

## □ PM<sub>2.5</sub> 24-Hour

- Annual 98<sup>th</sup> percentile of daily averages averaged over three consecutive years
- Current standard = 35 ug/m<sup>3</sup>

# Area-Wide Design Values

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- For regional and state trends: for each three-year period, calculated **average** of DVs over all monitoring sites within the region/state meeting data completeness requirements
- For non-attainment areas: for each three-year period, calculated **maximum** DV over all monitoring sites within the non-attainment area meeting data completeness requirements (conforms with EPA methodology for determining attainment/non-attainment designation)

# Data Handling Procedures

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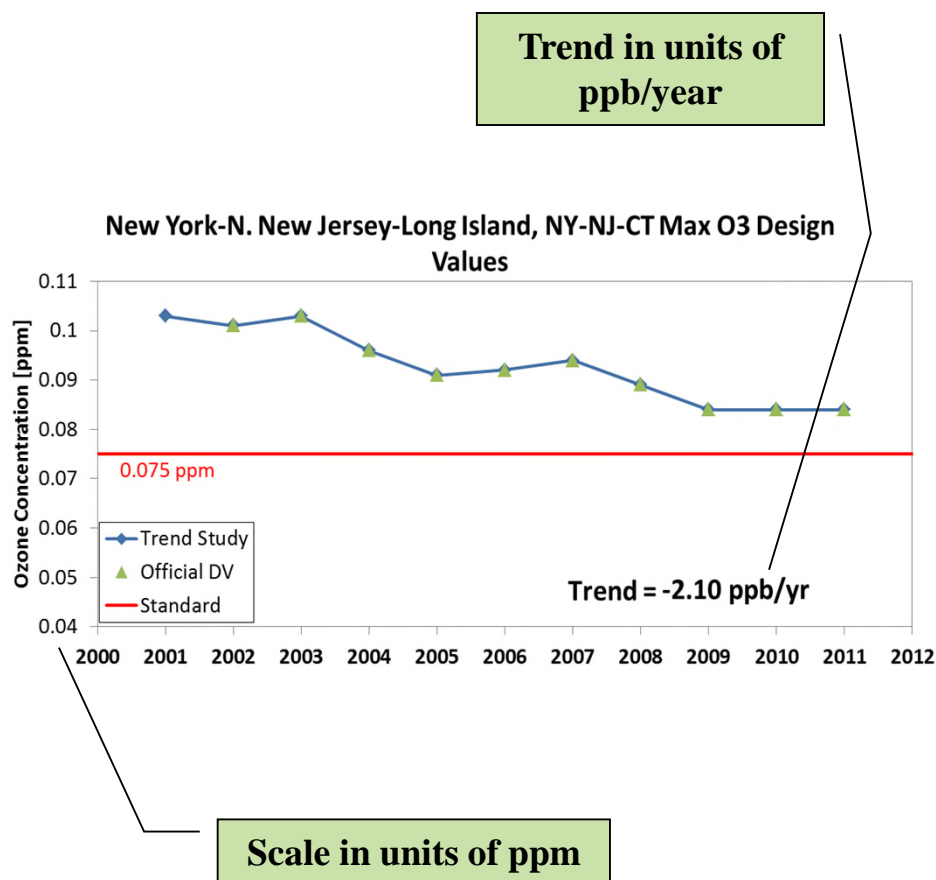
- O<sub>3</sub> design value (DV) for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculated using annual 4<sup>th</sup> highest daily max 8-hr averages and percent of valid observations, based on EPA data handling conventions
  - Data associated with exceptional events that have received EPA concurrence are omitted
  - Selection of trend sites require valid DV in 9 out of 11 three-year periods between 1999 and 2011
  - Identification of nonattainment areas is with respect to the 2008 8-hour standard only

# Data Handling Procedures

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- Annual PM<sub>2.5</sub> DV and 24-hr PM<sub>2.5</sub> DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculations based on EPA data handling conventions
  - Data extracted from monitors that have a non-regulatory monitoring type are omitted
  - Selection of trend sites require valid DV in at least 9 out of 11 three-year periods between 1999 and 2011

# Trend Calculation

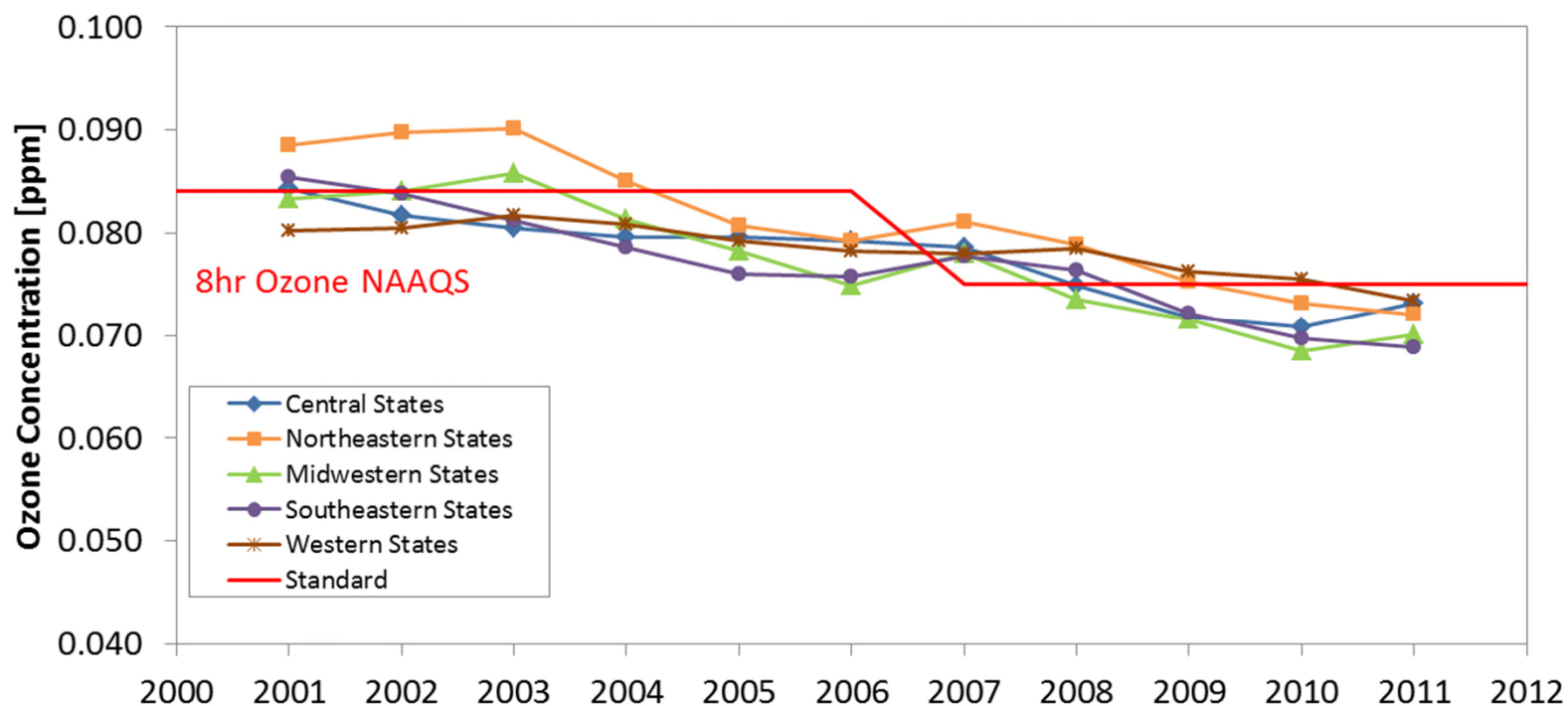


- Trends based on linear least squares fit to rolling three year design values (DVs)
- Negative trend indicates improving air quality
- DVs based on each 3-year period: 1999-2001, 2000-2002, ... 2009-2011
- Notes

- On plots, DVs are for three year period ending in year shown (i.e., 2009-2011 DV plotted as 2011 value)
- Ozone trend values expressed as ppb/year (1,000 ppb = 1 ppm); DVs are plotted as ppm

# O<sub>3</sub> Trends by Regions

## Regional Average O<sub>3</sub> Design Values



- Average ozone DVs have decreased in all five regions
- Trends are not monotonic, possibly reflecting influence of meteorology

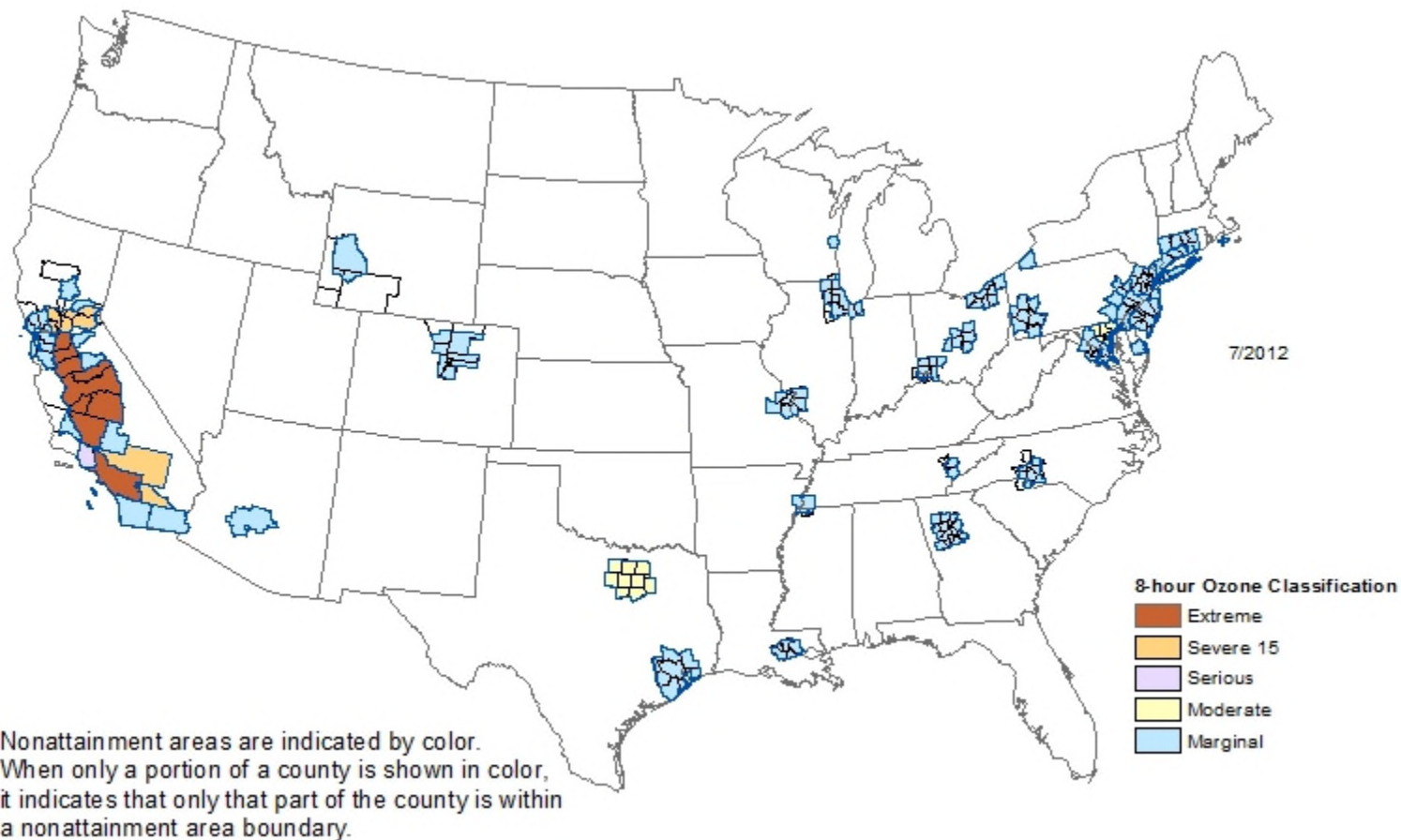
# O<sub>3</sub> Trend Slopes by Region

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Region	O <sub>3</sub> Trend Slope
Central States	-1.2 ppb/year
Northeastern States	-1.9 ppb/year
Midwestern States	-1.7 ppb/year
Southeastern States	-1.5 ppb/year
Western States	-0.7 ppb/year

**Note: 1 ppb = 0.001 ppm**

## Designated O<sub>3</sub> Non-Attainment Areas (based on 2008 8-Hour Ozone standard)

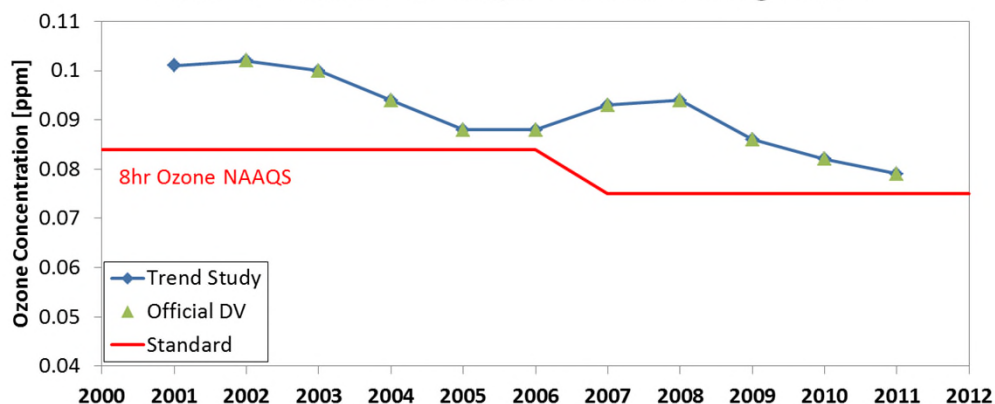


Source: EPA Green Book  
(<http://www.epa.gov/oar/oaqps/greenbk/index.html>)



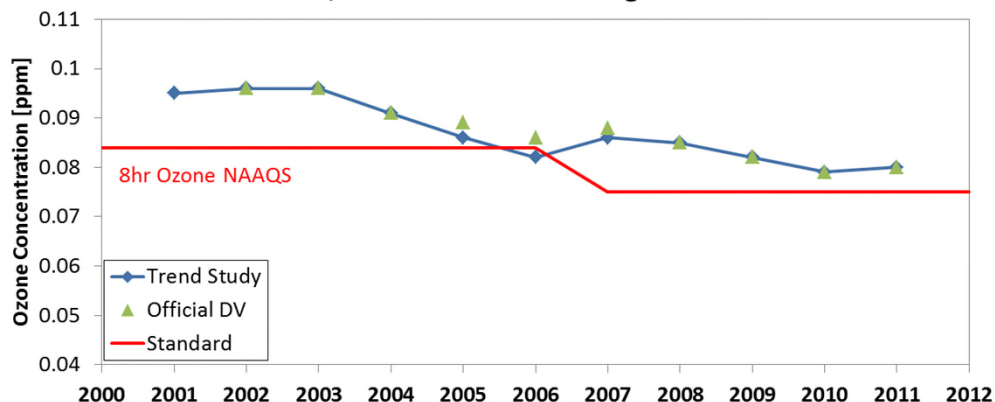
# Trends in Southeast States Non-Attainment Areas

Charlotte-Gastonia-Rock Hill, NC-SC Max O3 Design Values



- Trends range from - 2.06 ppb/yr (Charlotte-Gastonia-Rock Hill, NC-SC) to - 1.79 ppb/yr (Cincinnati, OH-KY-IN)

Cincinnati, OH-KY-IN Max O3 Design Values



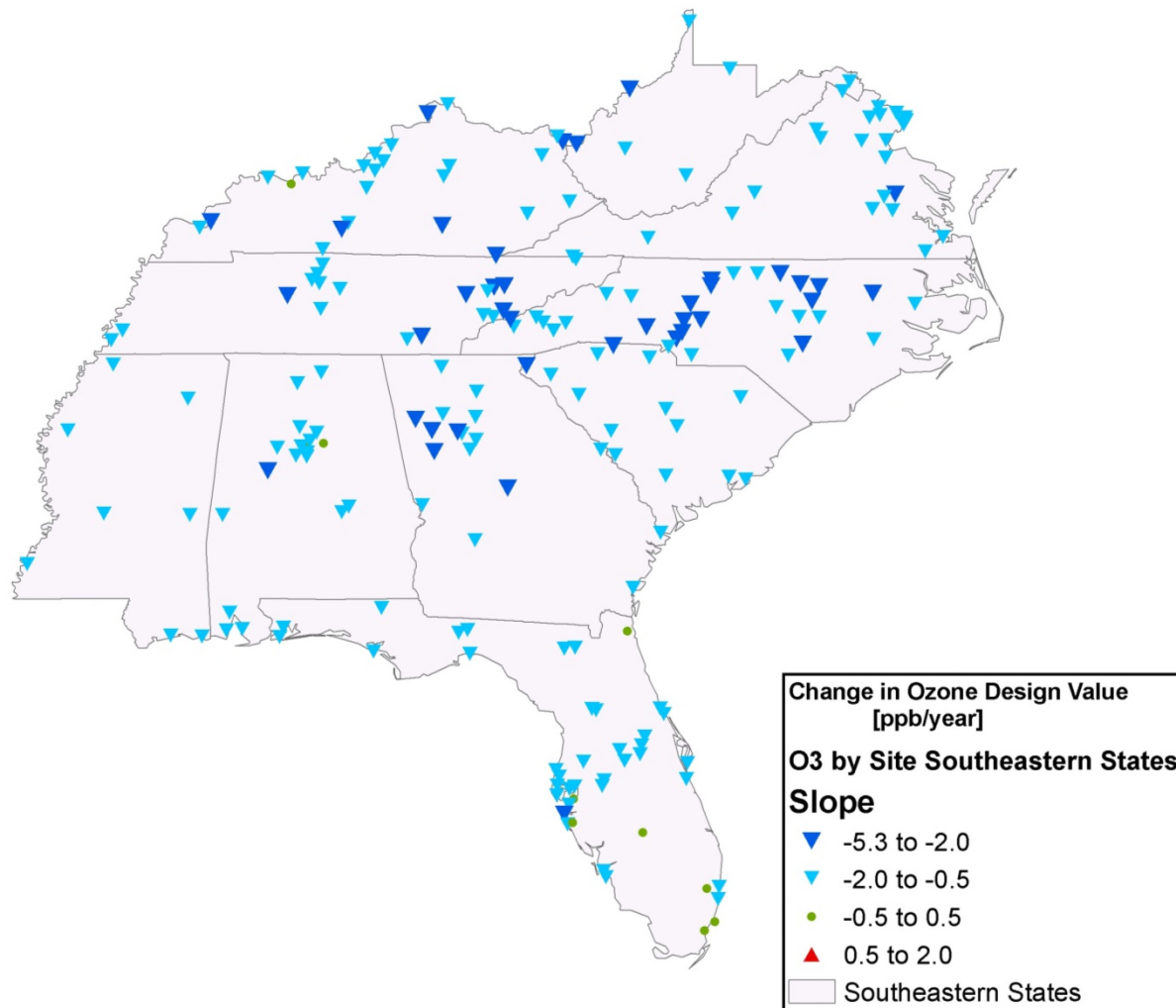
- Trends are negative (downward) in all 6 non-attainment areas in Southeast states.

## O<sub>3</sub> Trend Slopes in Southeast States Non-Attainment Areas

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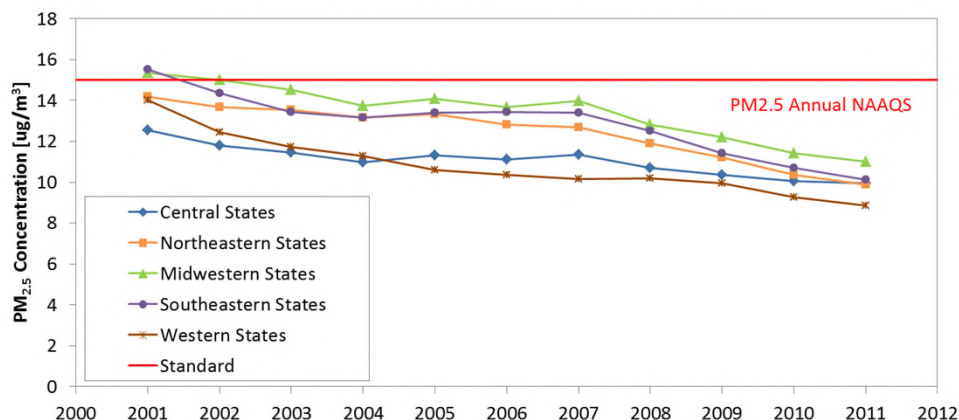
Non-Attainment Areas	O <sub>3</sub> Trend Slope [ppb/year]
Charlotte-Gastonia-Rock Hill, NC-SC	-2.06
Atlanta, GA	-1.95
Washington, DC-MD-VA	-1.92
Knoxville, TN	-1.86
Memphis, TN-MS-AR	-1.83
Cincinnati, OH-KY-IN	-1.79

# Southeast States Monitoring Sites O<sub>3</sub> Trend Slopes



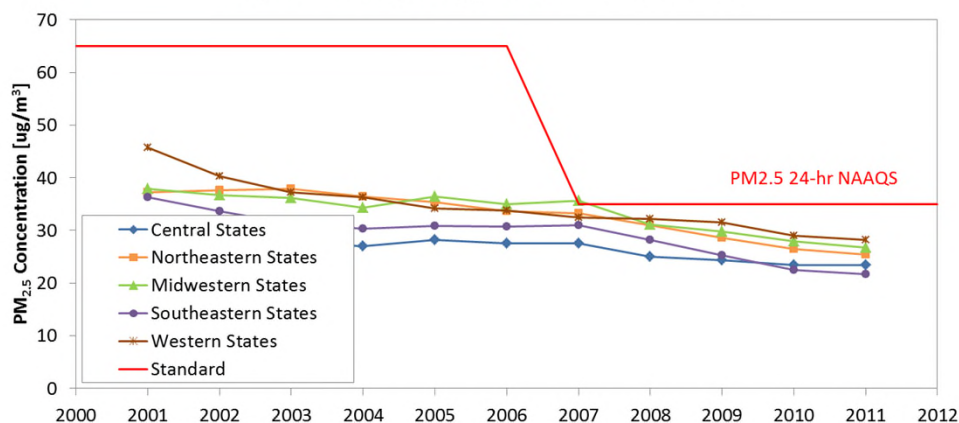
# PM<sub>2.5</sub> Trends by Regions

Regional Average PM<sub>2.5</sub> Annual Design Values



- Both average and 24-hr PM<sub>2.5</sub> DVs have decreased (negative trends) in all five regions
- Trends are not monotonic, possibly reflecting influence of meteorology

Regional Average PM<sub>2.5</sub> 24-Hour Design Values

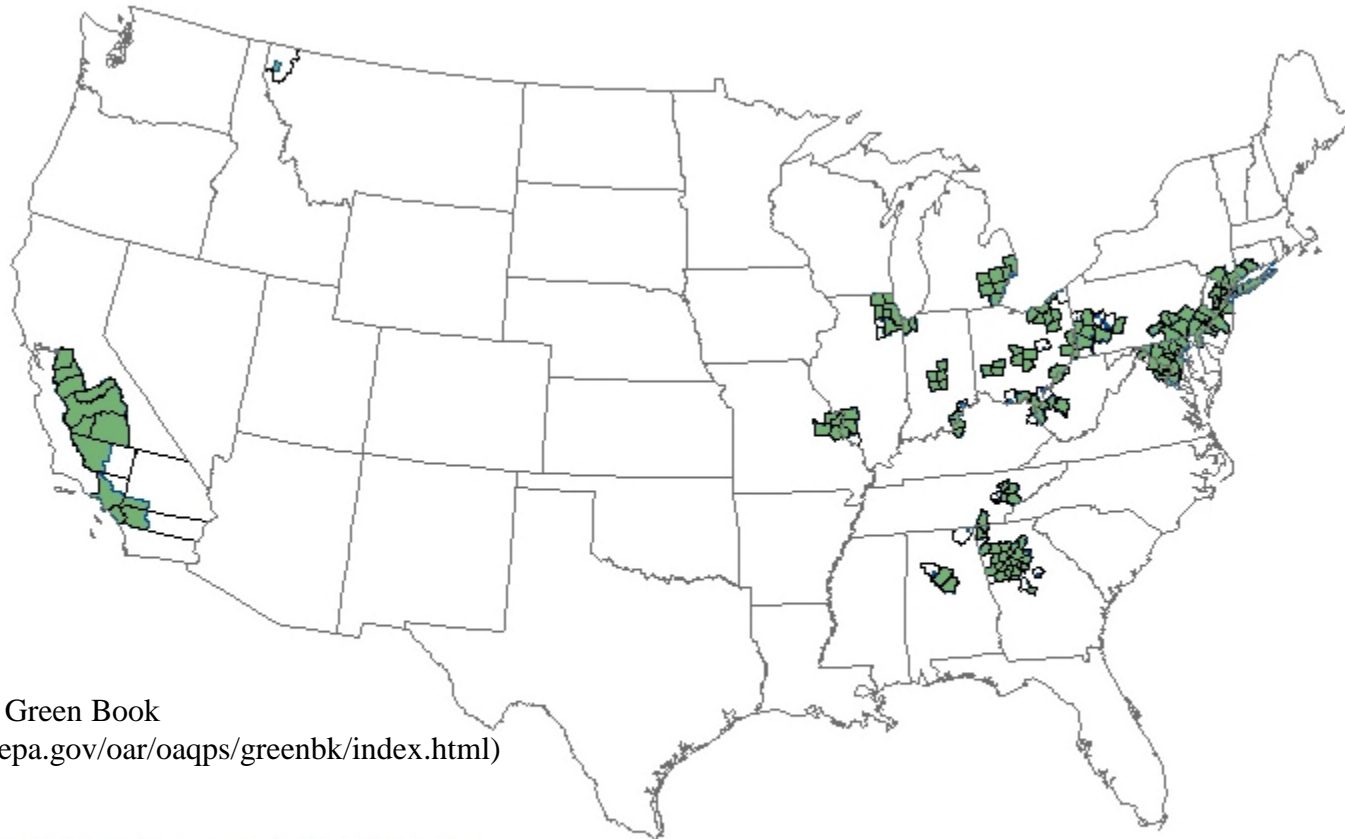


# PM<sub>2.5</sub> Trend Slopes by Region

Region	Annual PM <sub>2.5</sub> Trend Slope	24-Hr PM <sub>2.5</sub> Trend Slope
Central States	-0.22 ug/m <sup>3</sup> /year	-0.61 ug/m <sup>3</sup> /year
Northeastern States	-0.41 ug/m <sup>3</sup> /year	-1.32 ug/m <sup>3</sup> /year
Midwestern States	-0.41 ug/m <sup>3</sup> /year	-1.07 ug/m <sup>3</sup> /year
Southeastern States	-0.45 ug/m <sup>3</sup> /year	-1.27 ug/m <sup>3</sup> /year
Western States	-0.42 ug/m <sup>3</sup> /year	-1.45 ug/m <sup>3</sup> /year

## Designated PM<sub>2.5</sub> Non-Attainment Areas (based on 1997 Annual PM<sub>2.5</sub> Standards)

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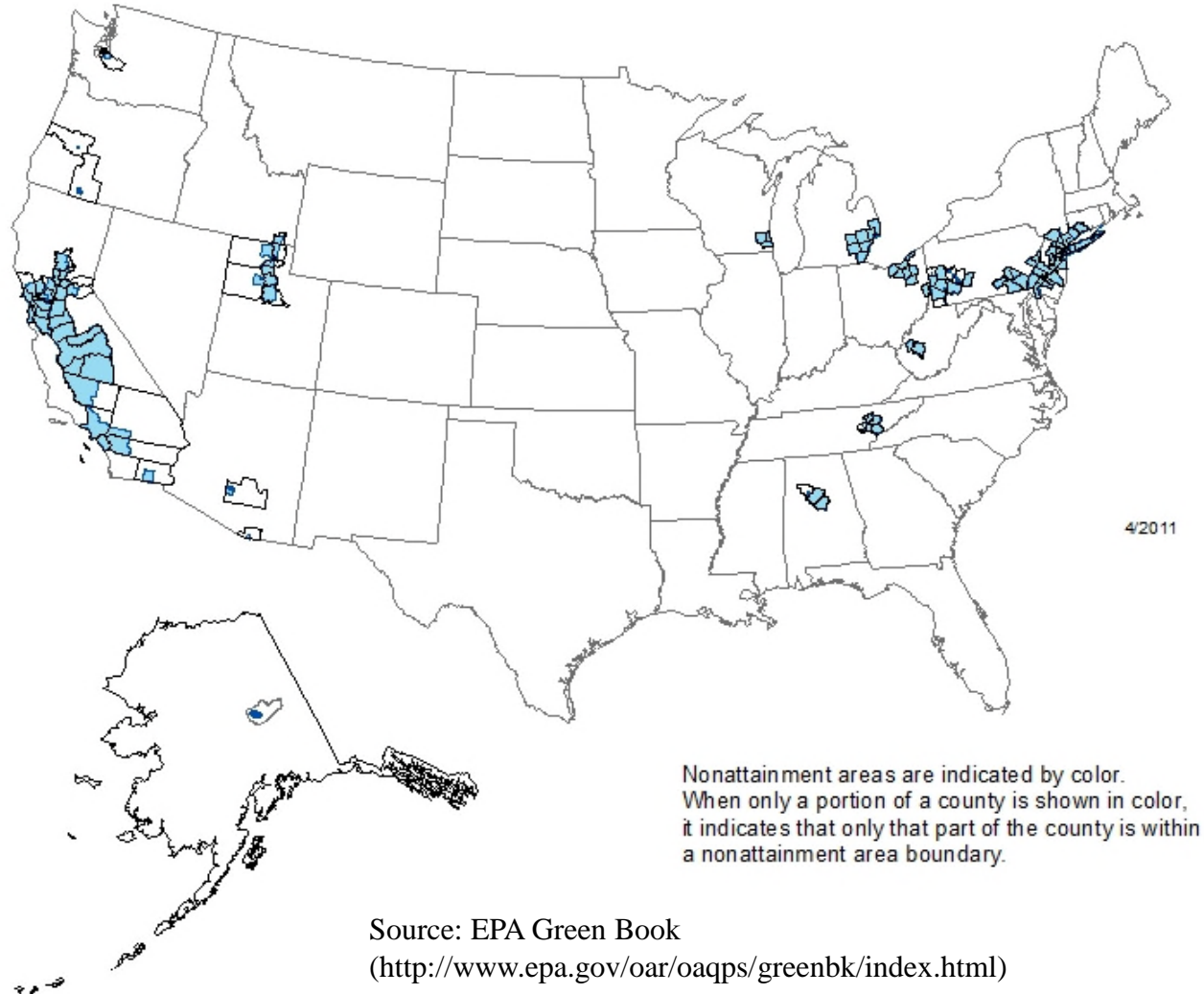


Source: EPA Green Book  
(<http://www.epa.gov/oar/oaqps/greenbk/index.html>)

Nonattainment areas are indicated by color.  
When only a portion of a county is shown in color,  
it indicates that only that part of the county is within  
a nonattainment area boundary.

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## Designated PM<sub>2.5</sub> Non-Attainment Areas (based on 2006 24-Hr PM<sub>2.5</sub> Standards)

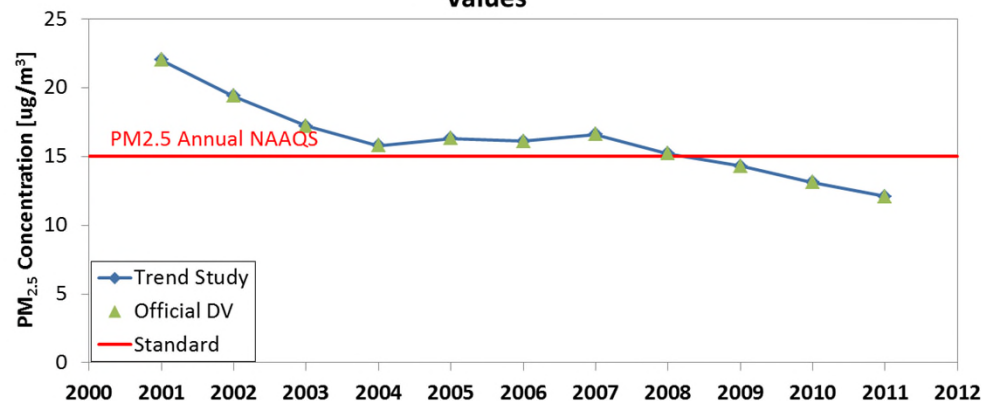


Source: EPA Green Book  
(<http://www.epa.gov/oar/oaqps/greenbk/index.html>)

# Annual PM<sub>2.5</sub> DV Trends in Southeast States

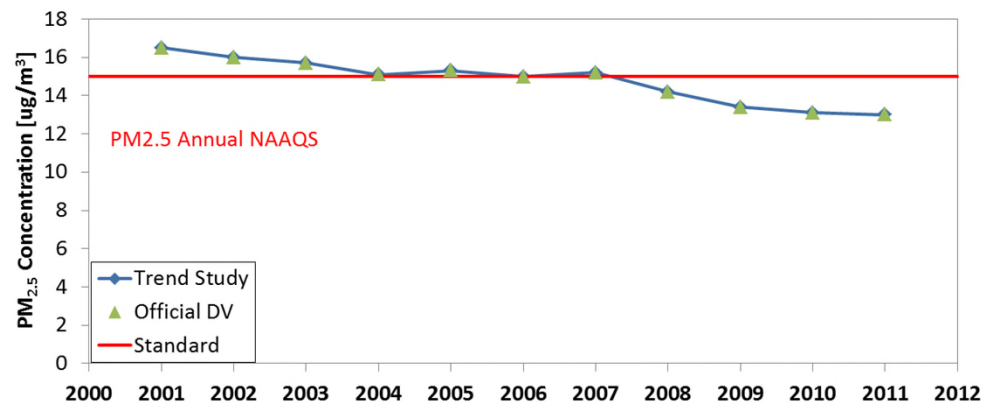
## Non-Attainment Area

Huntington-Ashland, WV-KY-OH Max PM<sub>2.5</sub> Annual Design Values



- Trends range from -0.77 ug/m<sup>3</sup>/yr (Huntington-Ashland, WV-KY-OH) to 0.34 ug/m<sup>3</sup>/yr (Wheeling, WV-OH)

Wheeling, WV-OH Max PM<sub>2.5</sub> Annual Design Values



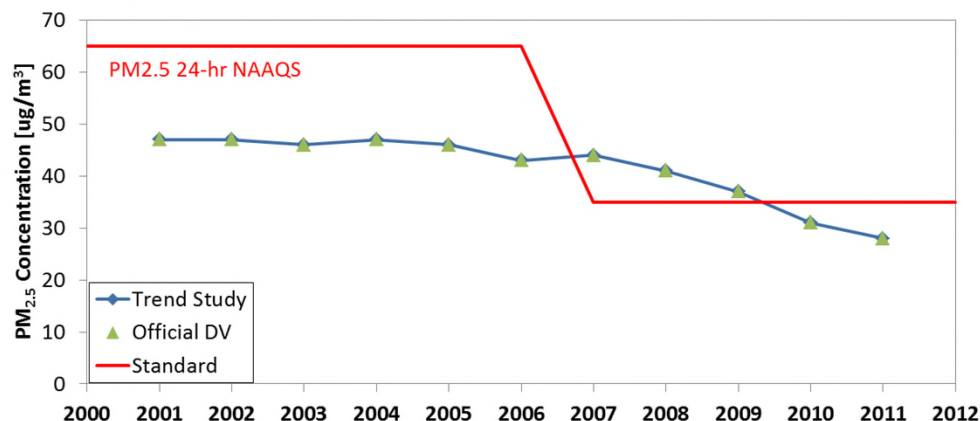
- Trends are negative (downward) in all 14 non-attainment areas in the Southeast States.



# 24-Hour PM<sub>2.5</sub> DV Trends in Southeast States

## Non-Attainment Area

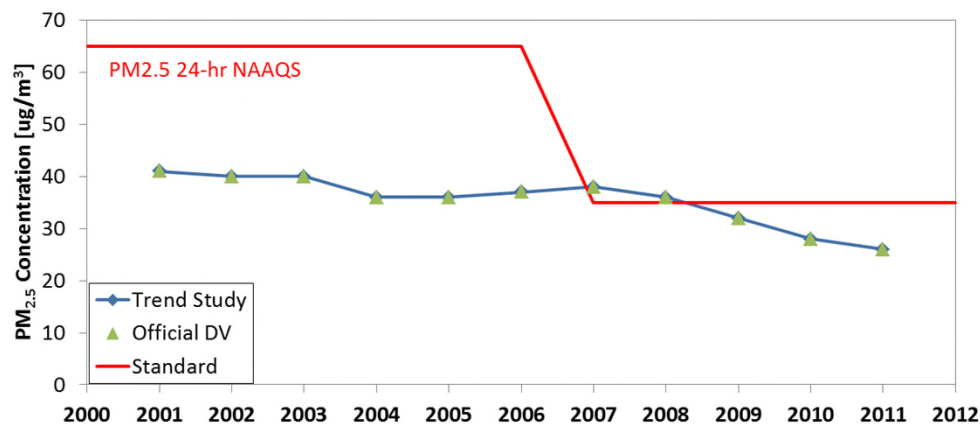
Steubenville-Weirton, OH-WV Max PM<sub>2.5</sub> 24-Hour Design Values



■ Trends range from -1.82  $\mu\text{g}/\text{m}^3/\text{yr}$  (Steubenville-Weirton, OH-WV) to -1.32  $\mu\text{g}/\text{m}^3/\text{yr}$  (Charleston, WV)

■ Trends are negative (downward) in all 4 non-attainment areas in Southeast states.

Charleston, WV Max PM<sub>2.5</sub> 24-Hour Design Values



# Annual PM<sub>2.5</sub> Trend Slopes for Southeast States Non-Attainment Areas

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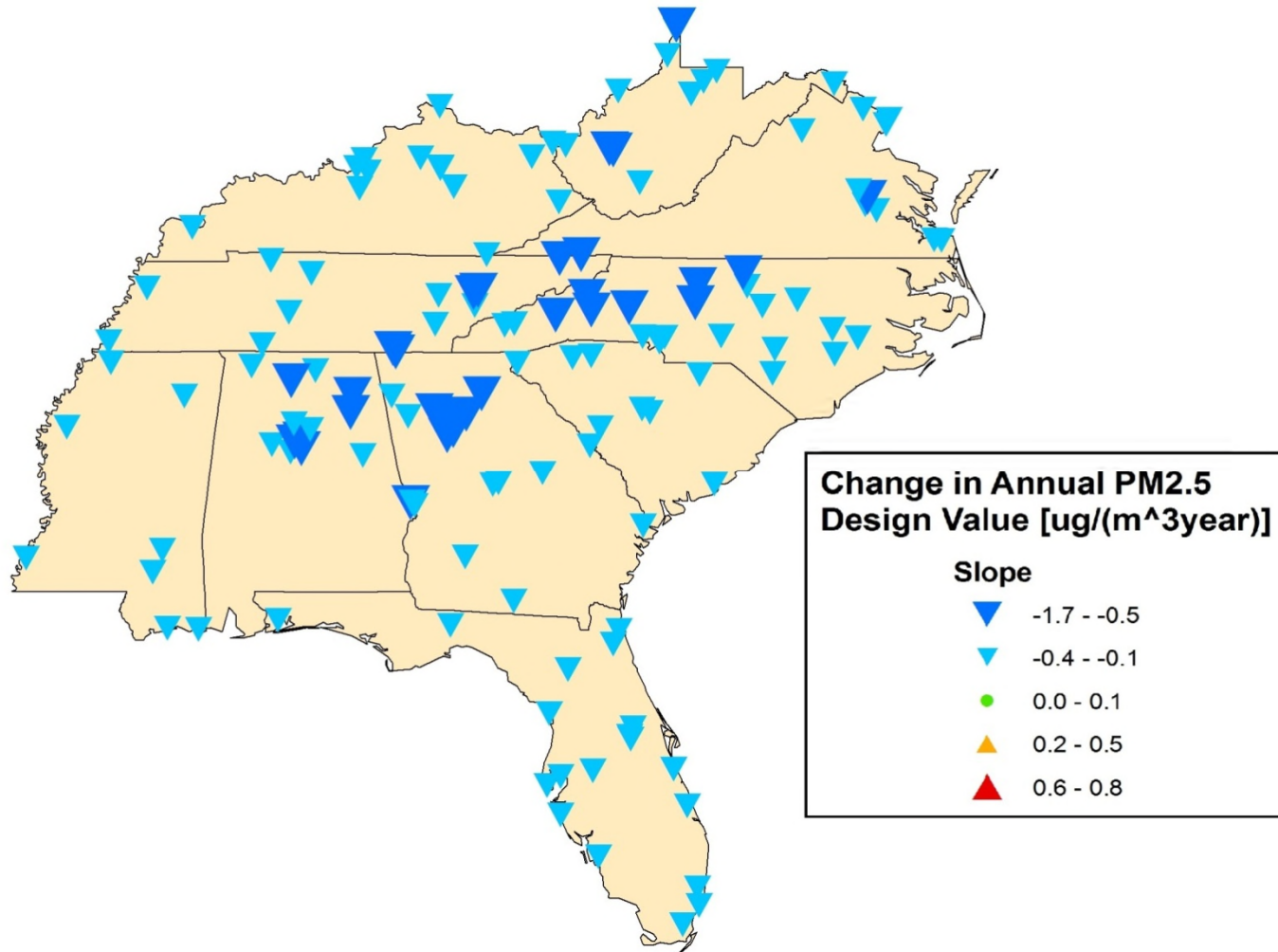
Non-Attainment Area	Annual PM <sub>2.5</sub> Slopes (ug/m <sup>3</sup> /yr)
Huntington-Ashland, WV-KY-OH	-0.77
Birmingham, AL	-0.69
Knoxville, TN	-0.69
Chattanooga, AL-TN-GA	-0.67
Atlanta, GA	-0.60
Washington, DC-MD-VA	-0.60
Charleston, WV	-0.53
Steubenville-Weirton, OH-WV	-0.51
Rome, GA	-0.47
Parkersburg-Marietta, WV-OH	-0.46
Martinsburg, WV-Hagerstown, MD	-0.40
Macon, GA	-0.37
Louisville, KY-IN	-0.35
Wheeling, WV-OH	-0.34

## 24-Hour PM<sub>2.5</sub> Trend Slopes for Southeast States Non-Attainment Areas

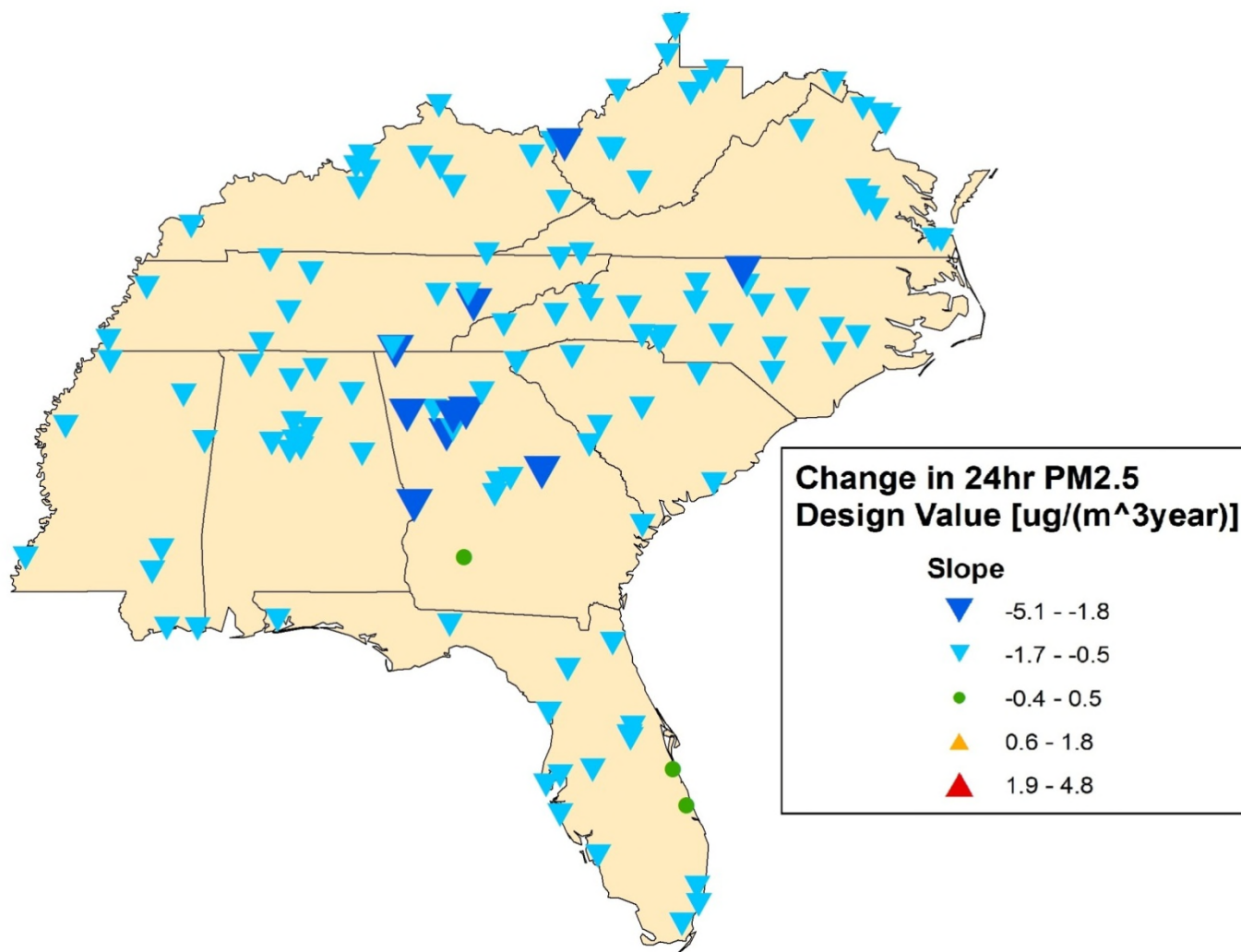
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Non-Attainment Area	24-Hour PM <sub>2.5</sub> Slopes (ug/m <sup>3</sup> /yr)
Steubenville-Weirton, OH-WV	-1.82
Knoxville-Sevierville-La Follette, TN	-1.55
Birmingham, AL	-1.73
Charleston, WV	-1.32

# Annual PM<sub>2.5</sub> Trend Slopes at Southeast States Monitoring Sites



# 24-Hr PM<sub>2.5</sub> Trend Slopes at Southeast States Monitoring Sites



# Air Quality Trends Summary

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- Average  $O_3$  and  $PM_{2.5}$  design values have decreased since 1999 in the Southeast States domain
- $O_3$  and  $PM_{2.5}$  design values have decreased since 1999 in all currently designated Southeast States  $O_3$  and  $PM_{2.5}$  non-attainment areas