

Emission and Air Quality Trends Review 1999-2011

South Carolina

July 2013

Project Objective

- ▣ 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

Emission Trends

- ❑ 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

- 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_x, SO₂, and PM_{2.5}
- Project Improvement
 - The Study Team augmented above data with year specific CEM emissions (2002 through 2011)

Emission Changes

- ❑ 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

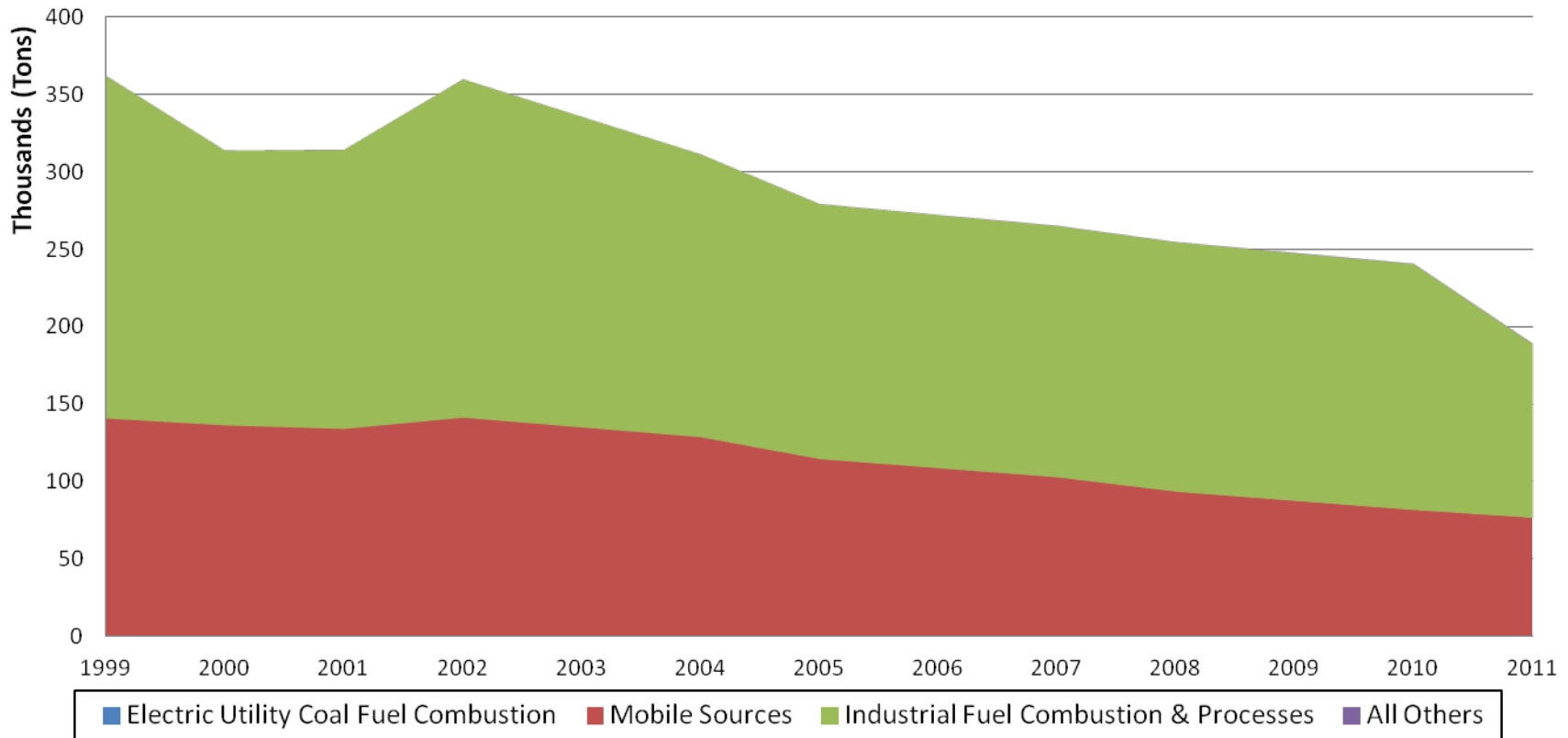
South Carolina Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	414	433	434	431	431	457	408	350	376	340
Mobile Sources	140,407	133,648	134,647	114,206	108,310	102,413	93,109	87,230	81,352	76,347
Industrial Fuel Combustion & Processes	221,412	180,515	200,815	164,842	163,688	162,535	161,381	160,227	159,073	112,425
All Others	62	62	59	92	109	117	112	201	188	267
Total	362,296	314,659	335,955	279,572	272,538	265,521	255,010	248,008	240,988	189,379

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	5%	5%	4%	4%	10%	-2%	-15%	-9%	-18%
Mobile Sources	0%	-5%	-4%	-19%	-23%	-27%	-34%	-38%	-42%	-46%
Industrial Fuel Combustion & Processes	0%	-18%	-9%	-26%	-26%	-27%	-27%	-28%	-28%	-49%
All Others	0%	0%	-5%	49%	75%	88%	80%	223%	202%	330%
Total	0%	-13%	-7%	-23%	-25%	-27%	-30%	-32%	-33%	-48%

South Carolina Emission Trends (VOC)

**Major Source Category Summary
Annual VOC Emissions**



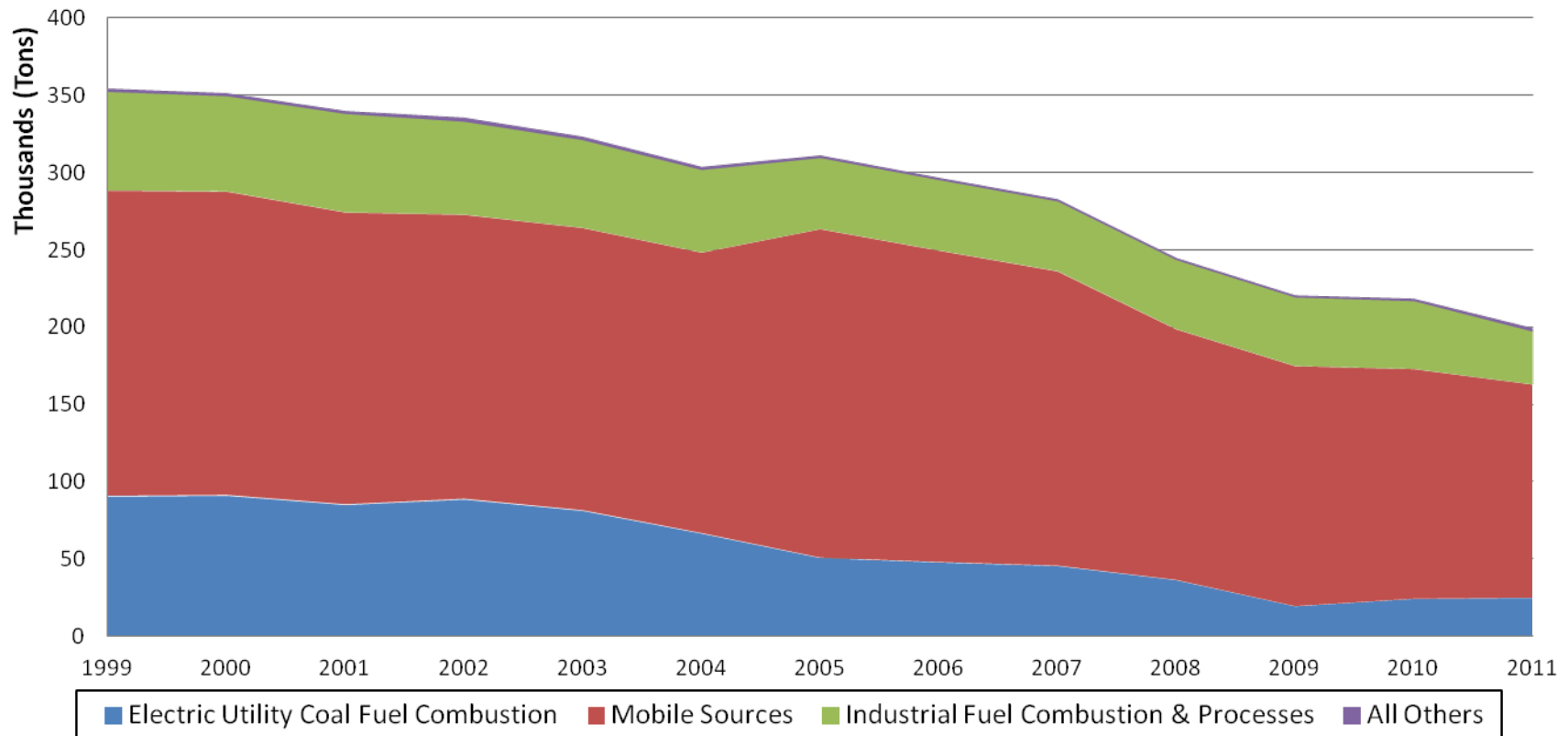
South Carolina Emission Trends (NO_x)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	90,590	85,059	81,220	50,527	47,660	45,311	36,071	19,029	23,837	24,544
Mobile Sources	197,629	189,019	182,767	212,750	201,686	190,621	162,286	155,522	148,758	138,069
Industrial Fuel Combustion & Processes	64,382	64,250	57,346	46,507	46,115	45,724	45,332	44,940	44,548	34,815
All Others	2,116	1,913	2,272	1,716	1,543	1,500	1,382	1,396	1,535	2,208
Total	354,717	340,242	323,606	311,500	297,005	283,156	245,071	220,887	218,678	199,637

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-6%	-10%	-44%	-47%	-50%	-60%	-79%	-74%	-73%
Mobile Sources	0%	-4%	-8%	8%	2%	-4%	-18%	-21%	-25%	-30%
Industrial Fuel Combustion & Processes	0%	0%	-11%	-28%	-28%	-29%	-30%	-30%	-31%	-46%
All Others	0%	-10%	7%	-19%	-27%	-29%	-35%	-34%	-27%	4%
Total	0%	-4%	-9%	-12%	-16%	-20%	-31%	-38%	-38%	-44%

South Carolina Emission Trends (NO_x)

**Major Source Category Summary
Annual NO_x Emissions**



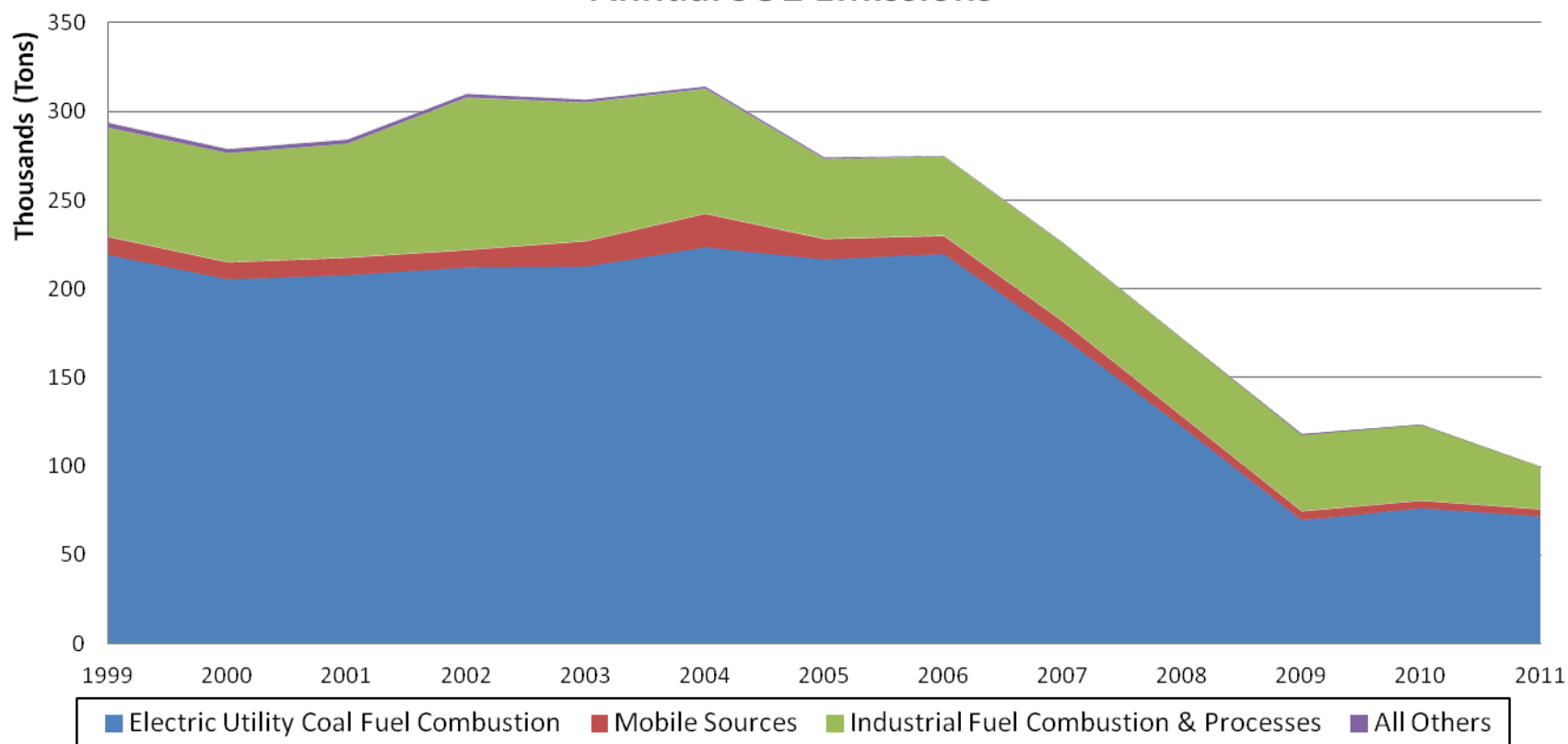
South Carolina Emission Trends (SO₂)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	219,281	207,914	212,713	216,795	219,853	172,646	122,078	69,418	76,215	71,697
Mobile Sources	10,141	9,775	14,350	11,490	10,216	8,943	5,931	5,106	4,281	3,924
Industrial Fuel Combustion & Processes	61,415	64,210	78,006	44,957	44,532	44,107	43,682	43,257	42,831	23,986
All Others	2,596	2,190	1,497	786	290	221	220	662	266	203
Total	293,433	284,089	306,565	274,029	274,892	225,918	171,911	118,443	123,593	99,810

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-5%	-3%	-1%	0%	-21%	-44%	-68%	-65%	-67%
Mobile Sources	0%	-4%	41%	13%	1%	-12%	-42%	-50%	-58%	-61%
Industrial Fuel Combustion & Processes	0%	5%	27%	-27%	-27%	-28%	-29%	-30%	-30%	-61%
All Others	0%	-16%	-42%	-70%	-89%	-91%	-92%	-74%	-90%	-92%
Total	0%	-3%	4%	-7%	-6%	-23%	-41%	-60%	-58%	-66%

South Carolina Emission Trends (SO₂)

Major Source Category Summary
Annual SO₂ Emissions



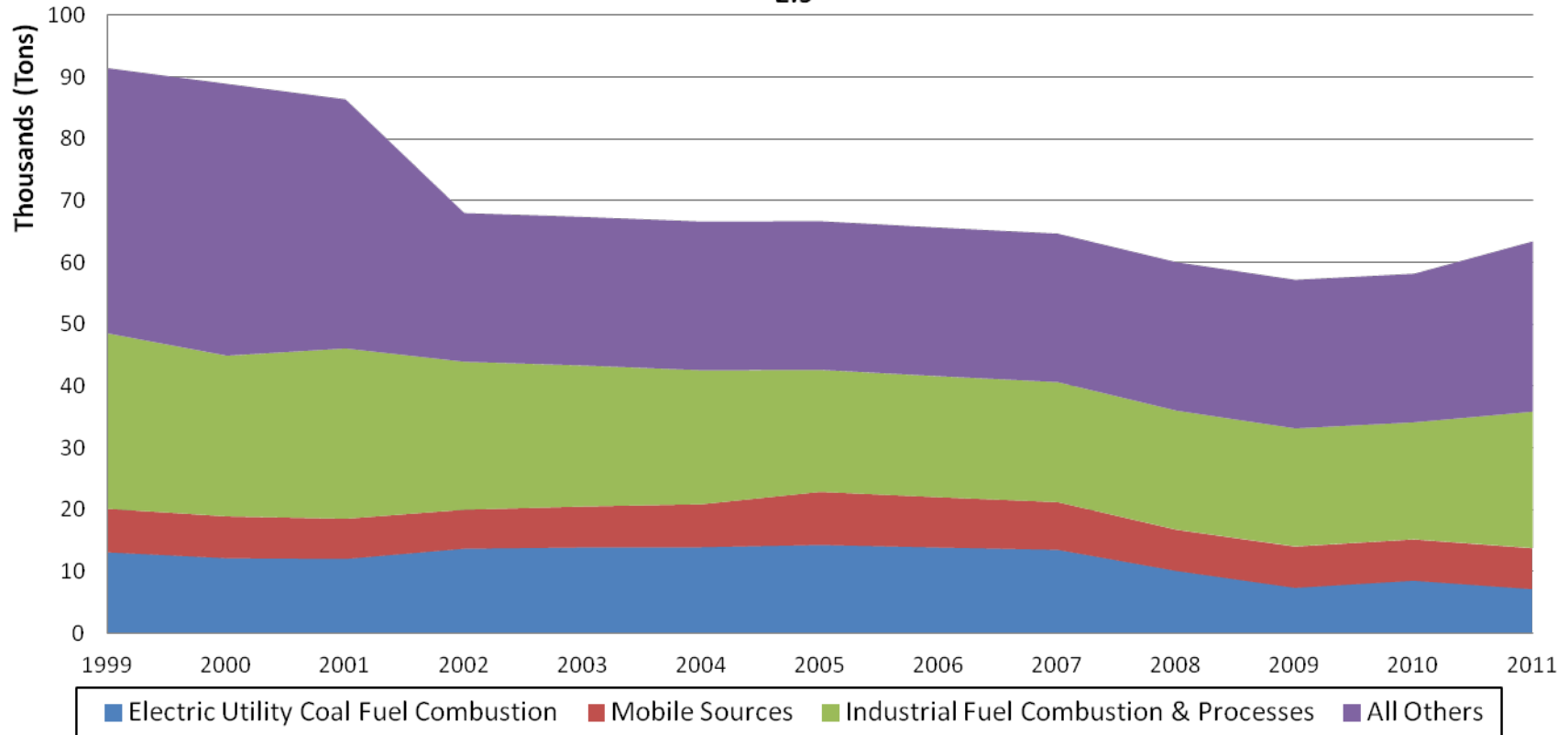
South Carolina Emission Trends (PM_{2.5})

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	13,091	12,023	13,872	14,281	13,860	13,504	10,095	7,372	8,518	7,149
Mobile Sources	7,008	6,482	6,610	8,560	8,121	7,682	6,641	6,650	6,660	6,604
Industrial Fuel Combustion & Processes	28,394	27,556	22,820	19,751	19,588	19,425	19,261	19,098	18,935	22,075
All Others	42,922	40,310	24,046	24,063	24,039	24,028	24,028	24,039	24,033	27,568
Total	91,416	86,370	67,348	66,655	65,608	64,640	60,026	57,159	58,145	63,396

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-8%	6%	9%	6%	3%	-23%	-44%	-35%	-45%
Mobile Sources	0%	-8%	-6%	22%	16%	10%	-5%	-5%	-5%	-6%
Industrial Fuel Combustion & Processes	0%	-3%	-20%	-30%	-31%	-32%	-32%	-33%	-33%	-22%
All Others	0%	-6%	-44%	-44%	-44%	-44%	-44%	-44%	-44%	-36%
Total	0%	-6%	-26%	-27%	-28%	-29%	-34%	-37%	-36%	-31%

South Carolina Emission Trends (PM_{2.5})

Major Source Category Summary
Annual PM_{2.5} Emissions



Emission Trends Summary

- All pollutants have decreased since 1999 in aggregate across South Carolina
- 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

Air Quality Design Values

□ Ozone

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

□ PM_{2.5} Annual

- Annual arithmetic mean of quarterly means averaged over three consecutive years
- Current standard = 12 ug/m³

□ PM_{2.5} 24-Hour

- Annual 98th percentile of daily averages averaged over three consecutive years
- Current standard = 35 ug/m³

State-Wide Design Value (DV) Trends

- ❑ Trends in state-wide maximum DV and average DV
 - Max DV: Maximum DVs over all valid trend monitoring sites in the state in each overlapping three year period
 - Average DV: Average of DVs over all valid trend monitoring sites in the state in each overlapping three year period
- ❑ Compute linear trend via least-squares regression

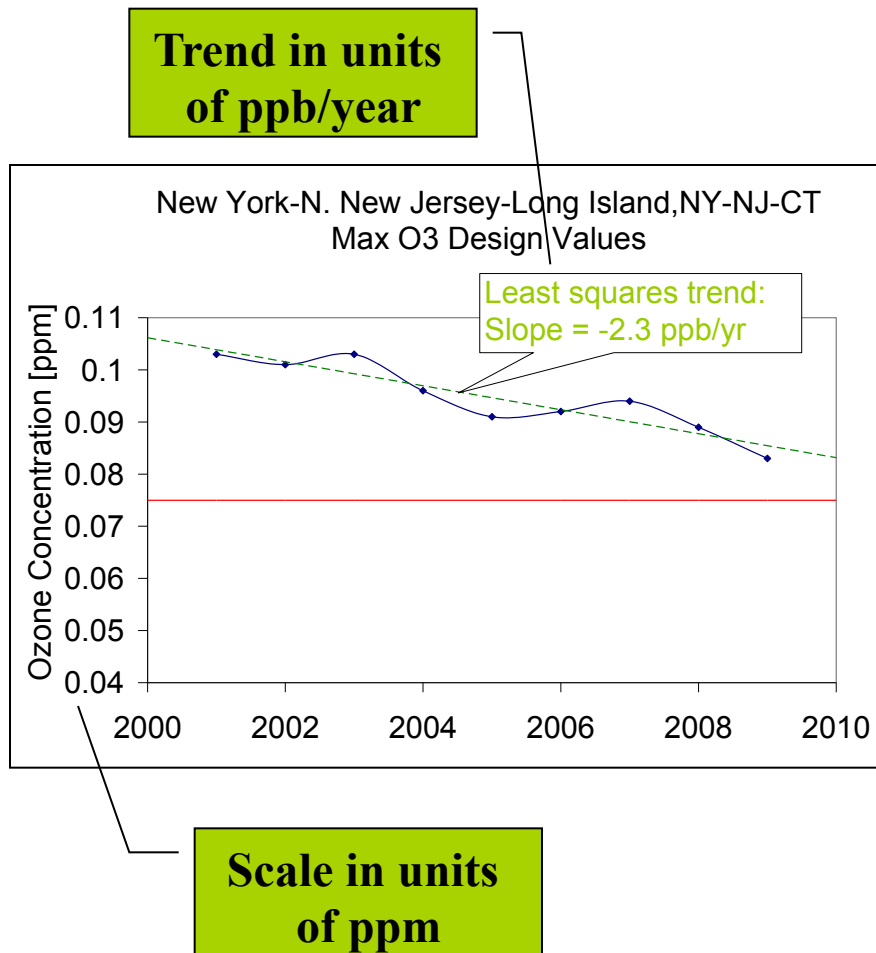
Data Handling Procedures

- O₃ design value (DV) for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculated using annual 4th 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

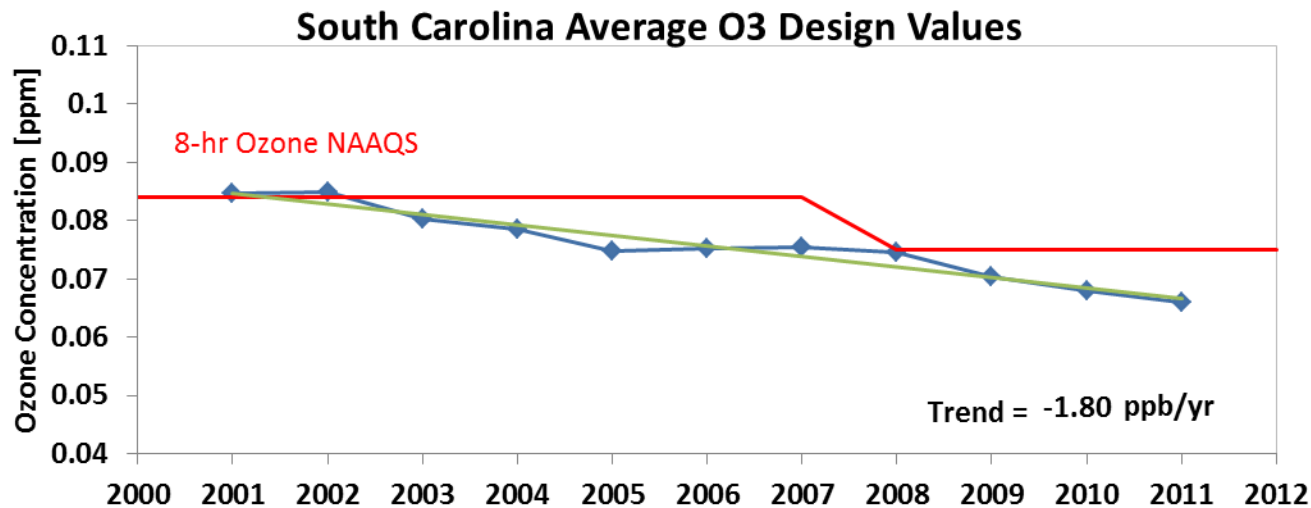
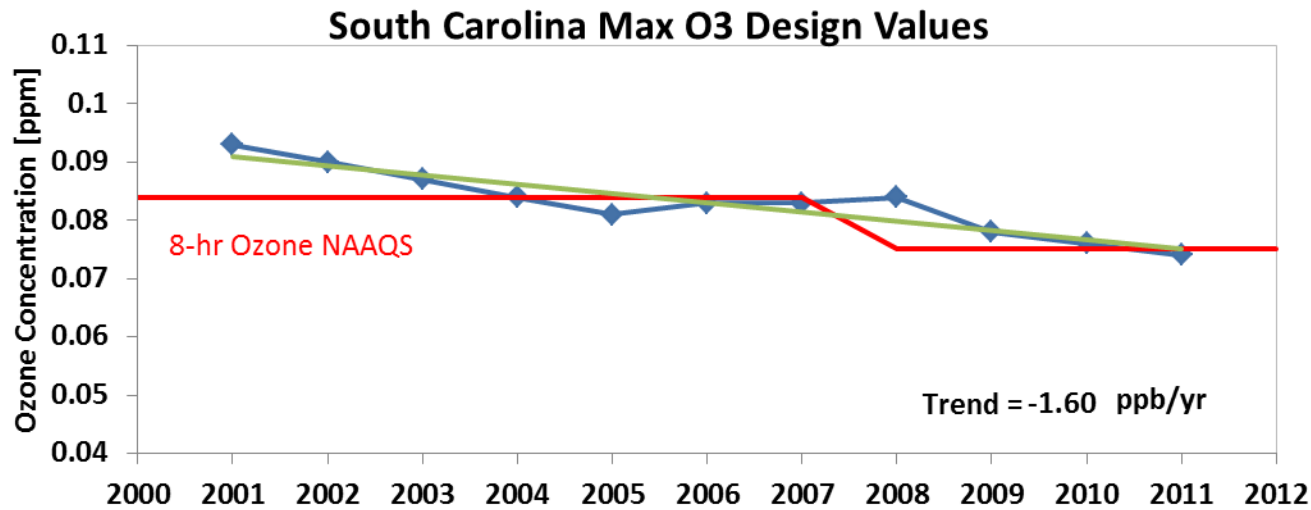
- ❑ Annual $\text{PM}_{2.5}$ DV and 24-hr $\text{PM}_{2.5}$ DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculations based on EPA data handling conventions
 - Data extracted from monitors that have a non-regulatory monitoring type are omitted
 - Selection of trend sites require valid DV in 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

Max/Ave O₃ DVs and Trend



Ozone Trends by Site in South Carolina

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
4500100014420101	Abbeville, SC	0.062	-1.98
4500300034420102	Aiken, SC	0.067	-1.75
4501500024420101	Berkeley, SC	0.062	-1.70
4501900464420101	Charleston, SC	0.065	-1.02
4502100024420101	Cherokee, SC	N/A	-2.38
4502900024420102	Colleton, SC	0.064	-1.55
4503100034420101	Darlington, SC	0.068	-1.79

Note: Only monitoring sites meeting data completeness criteria listed

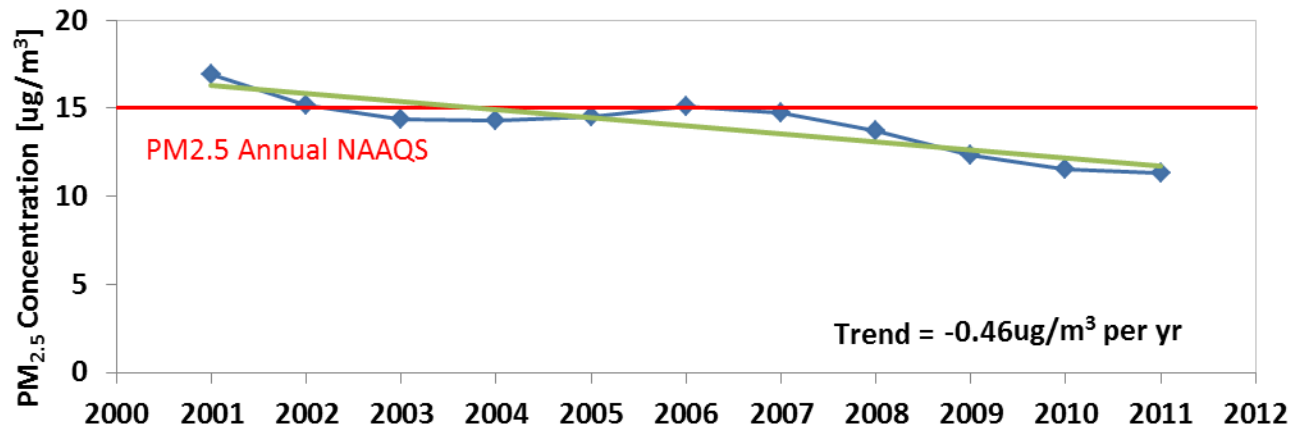
Ozone Trends by Site in South Carolina

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/ yr]
4503700014420101	Edgefield, SC	0.063	-1.83
4507300014420101	Oconee, SC	N/A	-2.02
4507700024420101	Pickens, SC	0.071	-1.41
4507900074420101	Richland, SC	0.07	-1.77
4507900214420101	Richland, SC	0.062	-1.55
4508300094420101	Spartanburg, SC	0.074	-1.60
4509100064420101	York, SC	0.064	-1.80

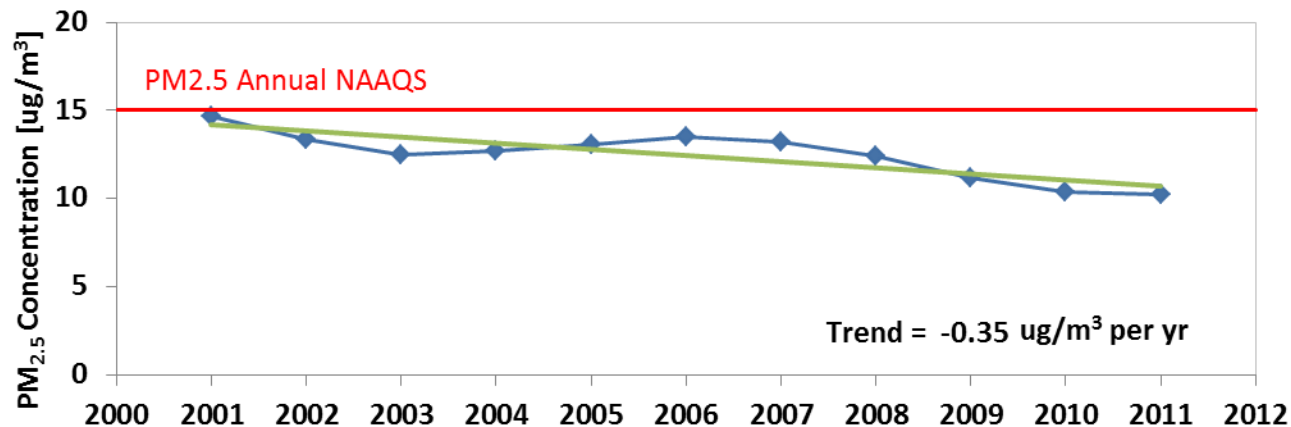
Note: Only monitoring sites meeting data completeness criteria listed

Max/Ave PM_{2.5} Annual DVs and Trend

South Carolina Max PM_{2.5} Annual Design Values

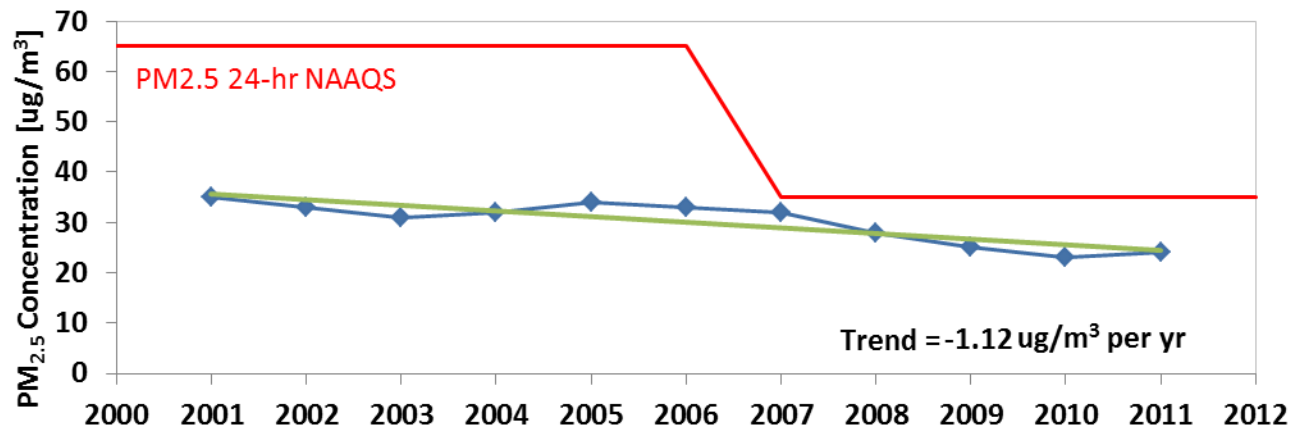


South Carolina Average PM_{2.5} Annual Design Values

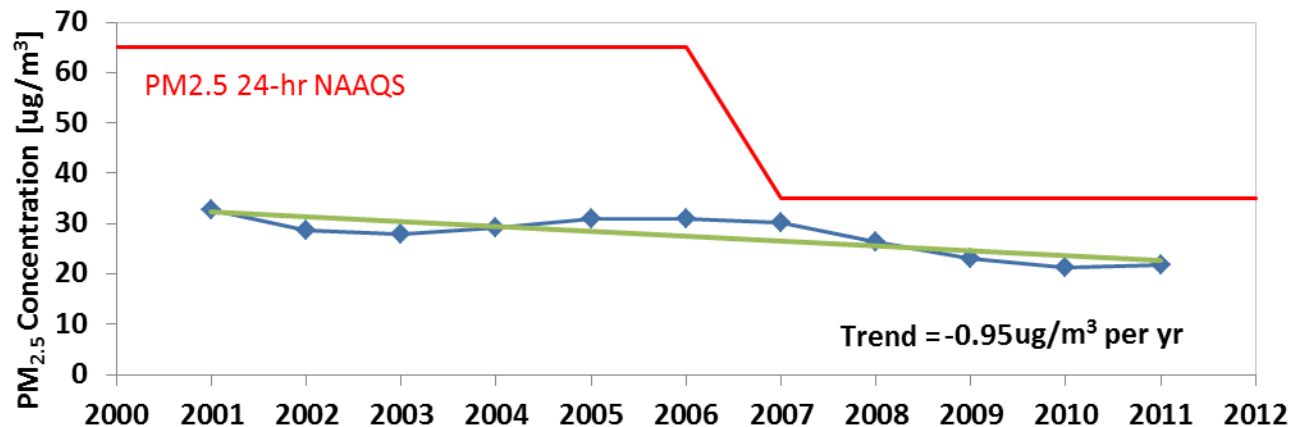


Max/Ave PM_{2.5} 24-Hour DVs and Trend

South Carolina Max PM_{2.5} 24-Hour Design Values



South Carolina Average PM_{2.5} 24-Hour Design Values



PM_{2.5} Trends by Site in South Carolina

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
450190049	Charleston	9.2	22	-0.32	-0.74
450250001	Chesterfield	9.7	20	-0.29	-0.86
450370001	Edgefield	10.1	21	-0.29	-0.99
450450009	Greenville	N/A	N/A	-0.44	-1.07
450630008	Lexington	11.3	24	-0.34	-0.81
450730001	Oconee	N/A	N/A	-0.28	-1.08
450790019	Richland	11.0	N/A	-0.43	N/A
450830010	Spartanburg	N/A	N/A	-0.25	N/A

Note: Only monitoring sites meeting data completeness criteria listed

Air Quality Trends Summary

- Average O_3 and $PM_{2.5}$ design values have decreased since 1999 in South Carolina.
- O_3 design values have decreased at Charlotte-Gastonia-Rock Hill, NC-SC, the only currently designated O_3 non-attainment area in South Carolina. There are no currently designated $PM_{2.5}$ non-attainment areas in South Carolina.