

Emission and Air Quality Trends Review 1999-2011

North 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

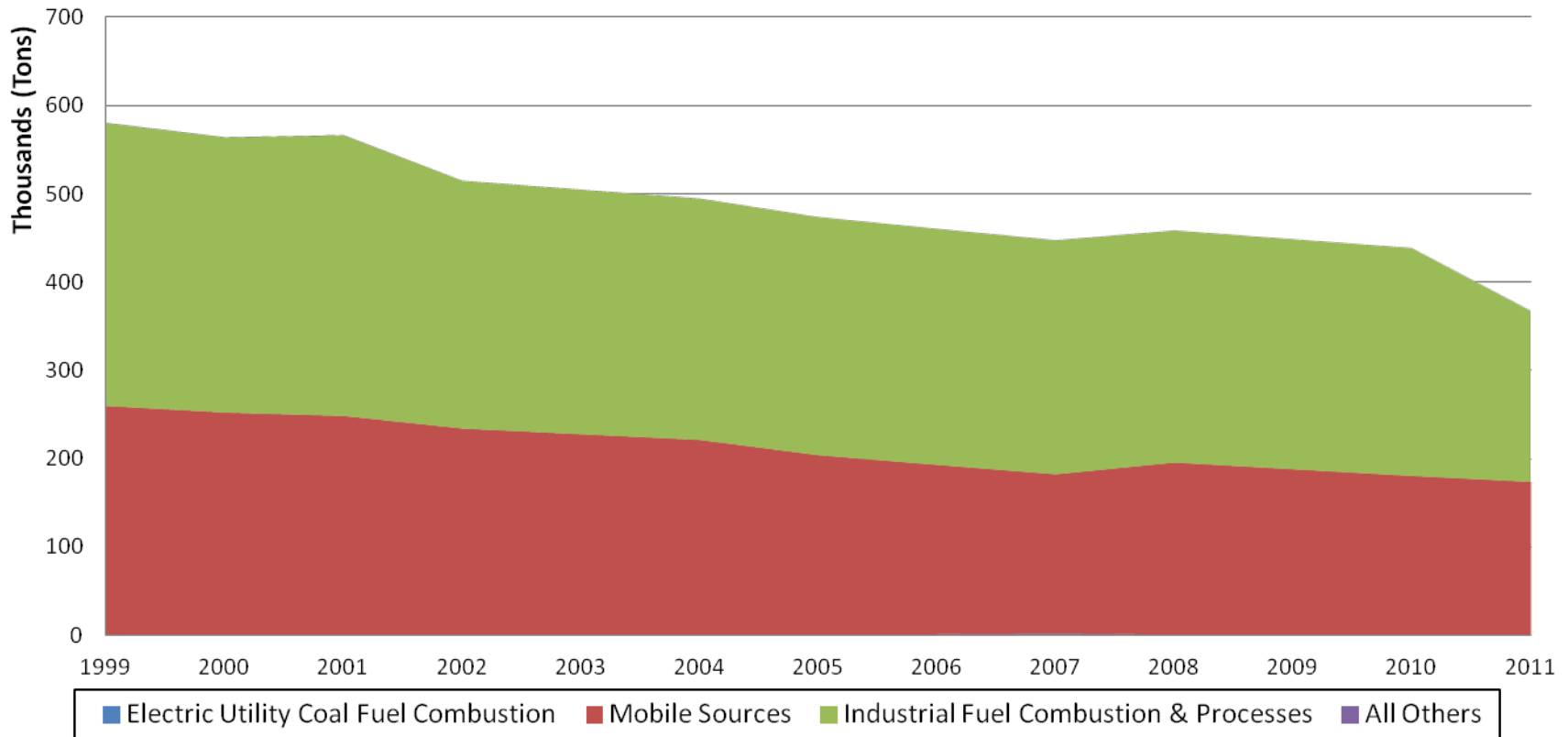
North Carolina Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	810	827	905	985	1,161	1,603	893	812	887	701
Mobile Sources	259,222	247,945	227,160	203,348	192,208	181,068	195,149	187,575	180,000	173,384
Industrial Fuel Combustion & Processes	320,365	317,740	276,771	269,474	267,158	264,843	262,544	260,222	257,910	193,638
All Others	163	171	101	76	77	113	98	105	122	227
Total	580,560	566,683	504,937	473,882	460,604	447,627	458,685	448,713	438,919	367,950

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%	12%	22%	43%	98%	10%	0%	9%	-13%
Mobile Sources	0%	-4%	-12%	-22%	-26%	-30%	-25%	-28%	-31%	-33%
Industrial Fuel Combustion & Processes	0%	-1%	-14%	-16%	-17%	-17%	-18%	-19%	-19%	-40%
All Others	0%	5%	-38%	-54%	-53%	-31%	-40%	-36%	-25%	40%
Total	0%	-2%	-13%	-18%	-21%	-23%	-21%	-23%	-24%	-37%

North Carolina Emission Trends (VOC)

**Major Source Category Summary
Annual VOC Emissions**



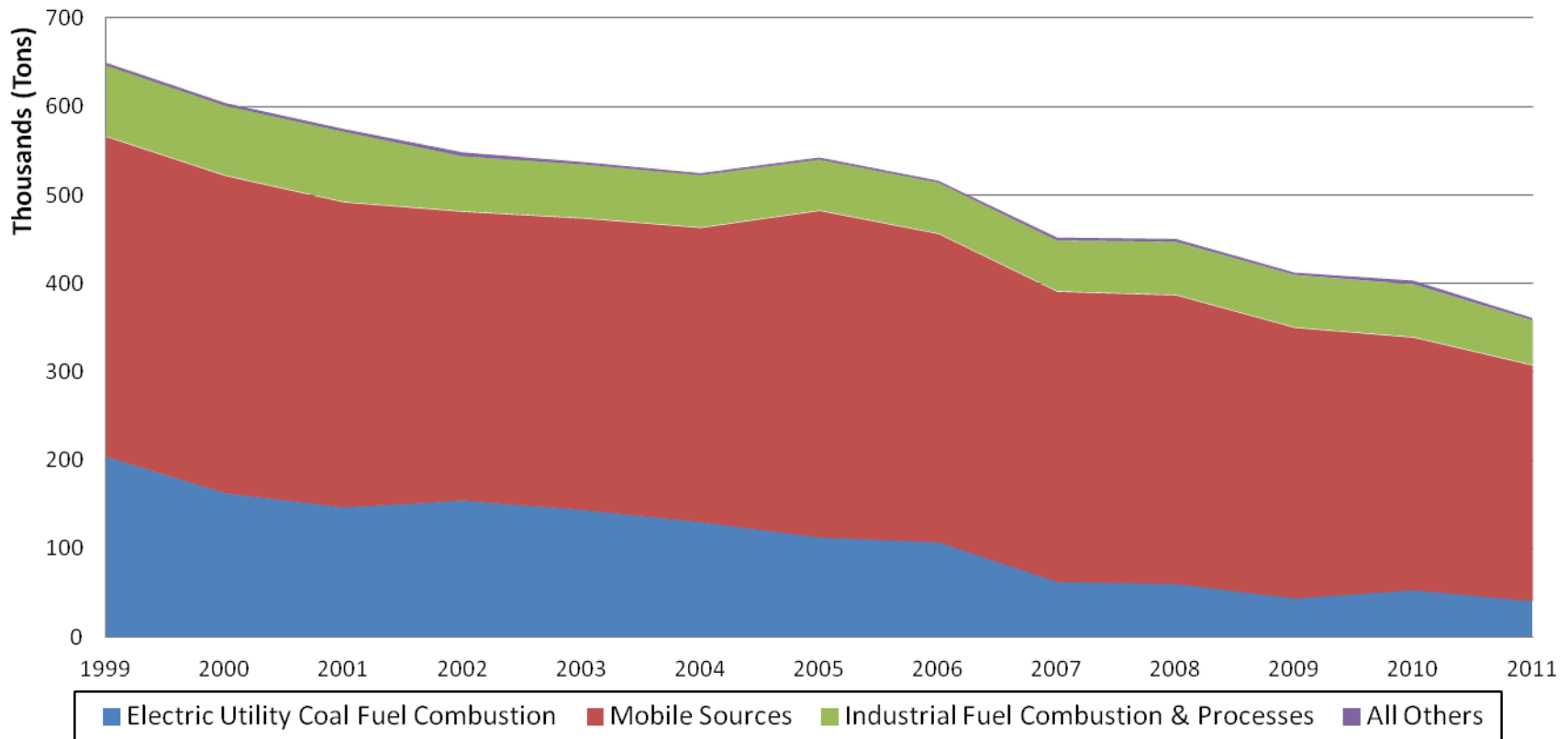
North Carolina Emission Trends (NO_x)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	204,425	147,080	144,374	113,173	107,681	62,825	60,528	44,176	53,506	41,072
Mobile Sources	361,880	345,161	329,738	369,455	348,905	328,355	326,569	306,134	285,699	266,563
Industrial Fuel Combustion & Processes	80,256	79,212	60,495	57,302	57,216	57,130	59,777	58,826	59,424	50,082
All Others	2,984	3,113	2,588	2,389	2,226	3,292	3,046	2,565	3,992	2,688
Total	649,545	574,566	537,195	542,319	516,028	451,602	449,920	411,700	402,620	360,405

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-28%	-29%	-45%	-47%	-69%	-70%	-78%	-74%	-80%
Mobile Sources	0%	-5%	-9%	2%	-4%	-9%	-10%	-15%	-21%	-26%
Industrial Fuel Combustion & Processes	0%	-1%	-25%	-29%	-29%	-29%	-26%	-27%	-26%	-38%
All Others	0%	4%	-13%	-20%	-25%	10%	2%	-14%	34%	-10%
Total	0%	-12%	-17%	-17%	-21%	-30%	-31%	-37%	-38%	-45%

North Carolina Emission Trends (NO_x)

**Major Source Category Summary
Annual NO_x Emissions**



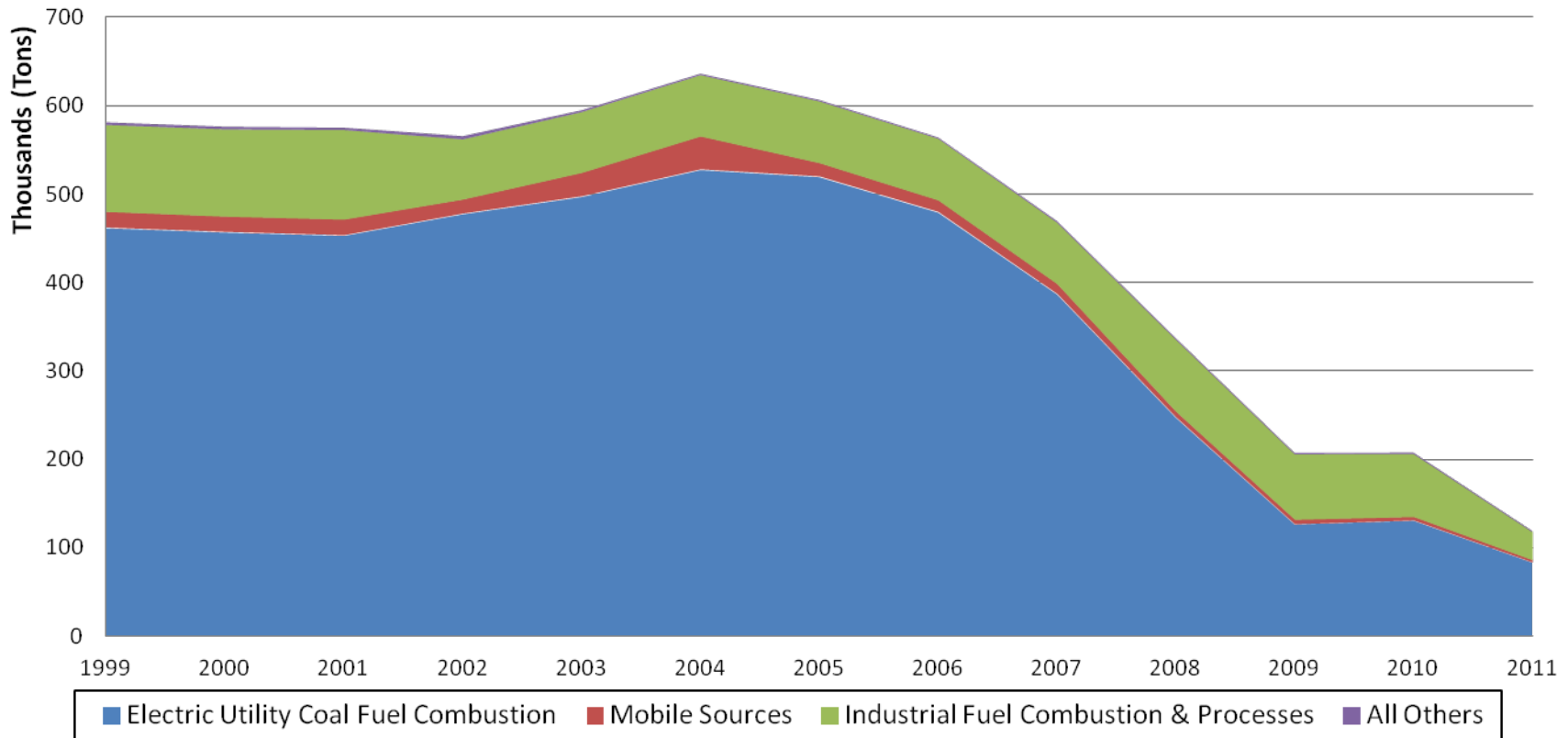
North Carolina Emission Trends (SO₂)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	461,636	452,913	496,988	519,467	479,291	386,585	246,881	125,809	130,102	82,604
Mobile Sources	18,192	18,127	26,934	15,444	13,525	11,606	6,834	5,712	4,589	3,111
Industrial Fuel Combustion & Processes	98,791	101,747	69,160	70,357	70,195	70,033	82,140	74,733	71,897	32,579
All Others	2,864	2,637	2,135	1,430	1,410	1,629	1,600	1,409	1,462	1,300
Total	581,484	575,424	595,216	606,699	564,420	469,853	337,456	207,663	208,049	119,594

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%	8%	13%	4%	-16%	-47%	-73%	-72%	-82%
Mobile Sources	0%	0%	48%	-15%	-26%	-36%	-62%	-69%	-75%	-83%
Industrial Fuel Combustion & Processes	0%	3%	-30%	-29%	-29%	-29%	-17%	-24%	-27%	-67%
All Others	0%	-8%	-25%	-50%	-51%	-43%	-44%	-51%	-49%	-55%
Total	0%	-1%	2%	4%	-3%	-19%	-42%	-64%	-64%	-79%

North Carolina Emission Trends (SO₂)

**Major Source Category Summary
Annual SO₂ Emissions**



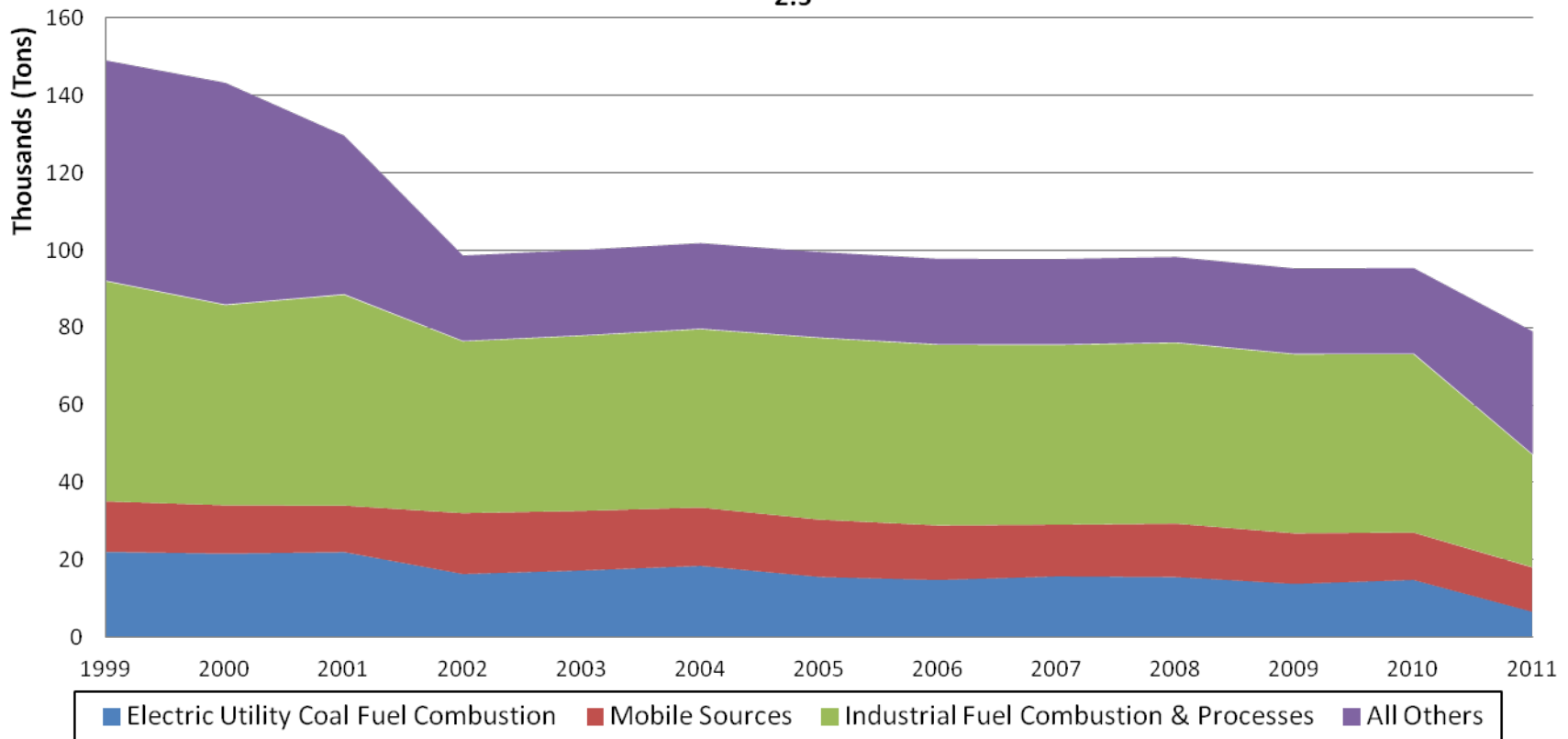
North Carolina Emission Trends (PM_{2.5})

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	22,050	21,999	17,244	15,572	14,782	15,703	15,524	13,789	14,793	6,578
Mobile Sources	13,031	11,984	15,382	14,805	14,071	13,338	13,796	13,011	12,226	11,445
Industrial Fuel Combustion & Processes	56,969	54,600	45,318	47,018	46,777	46,536	46,787	46,351	46,209	29,142
All Others	56,915	40,985	22,066	22,067	22,072	22,074	22,064	22,054	22,063	31,779
Total	148,965	129,567	100,010	99,461	97,703	97,651	98,171	95,206	95,291	78,945

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	0%	-22%	-29%	-33%	-29%	-30%	-37%	-33%	-70%
Mobile Sources	0%	-8%	18%	14%	8%	2%	6%	0%	-6%	-12%
Industrial Fuel Combustion & Processes	0%	-4%	-20%	-17%	-18%	-18%	-18%	-19%	-19%	-49%
All Others	0%	-28%	-61%	-61%	-61%	-61%	-61%	-61%	-61%	-44%
Total	0%	-13%	-33%	-33%	-34%	-34%	-34%	-36%	-36%	-47%

North 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 North Carolina
- NO_x and SO₂ from Electric Utility Fuel Combustion sources show significant decrease over time as a result of Acid Rain Program, NO_x 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

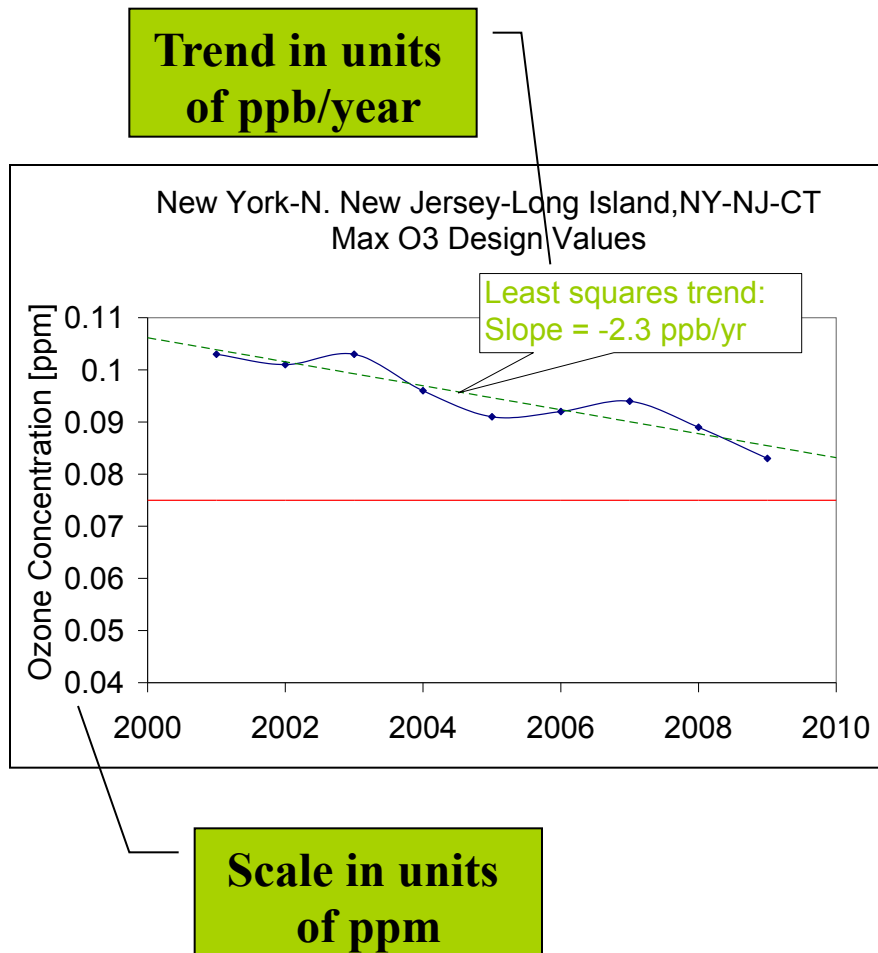
Data Handling Procedures

- 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

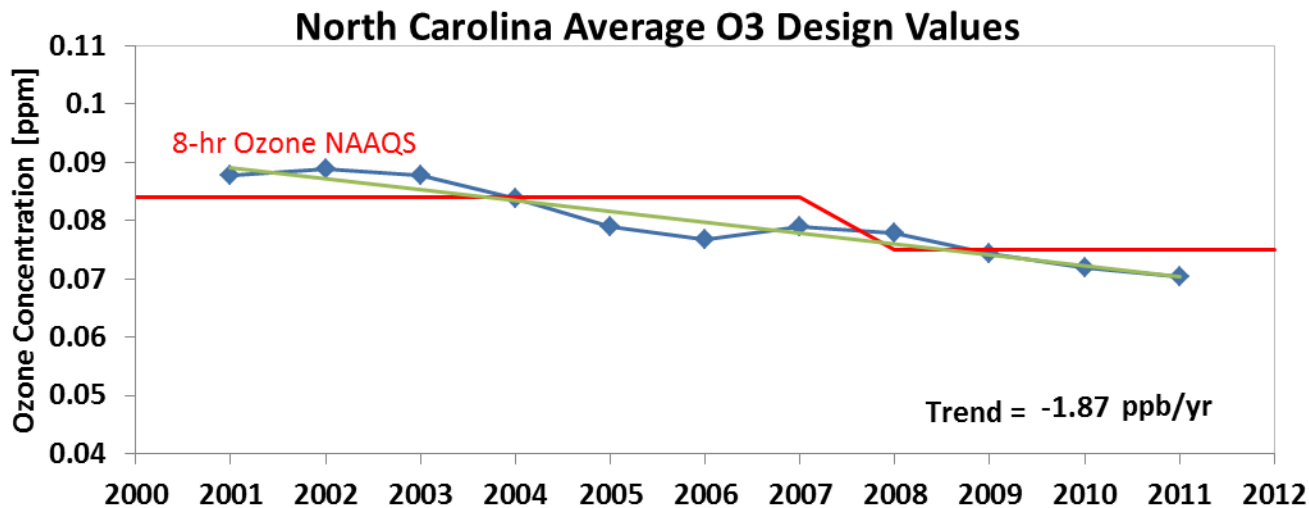
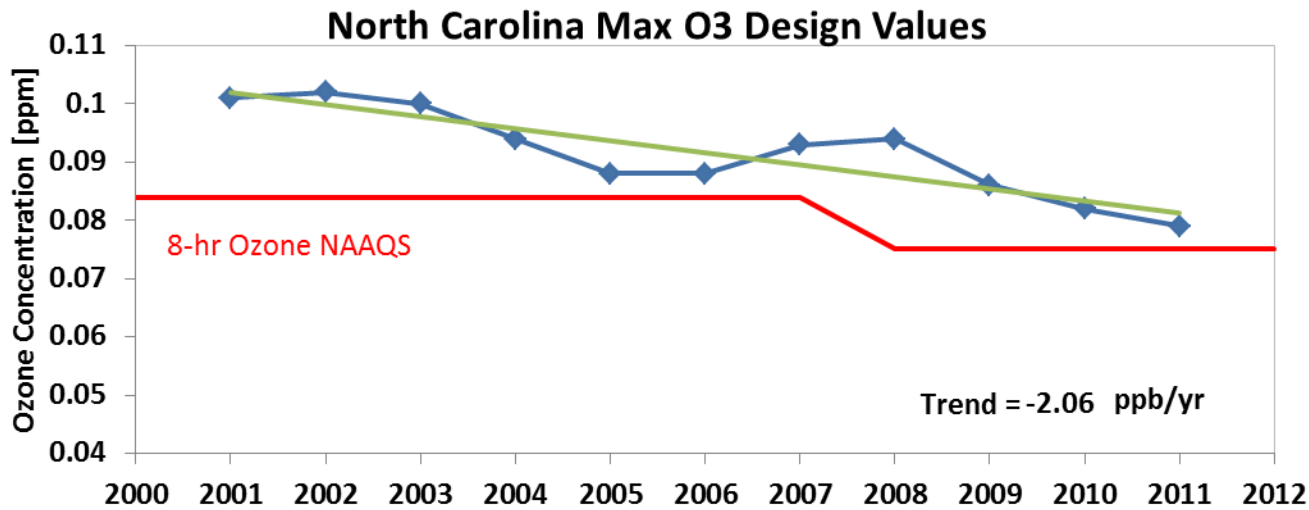
- Annual $\text{PM}_{2.5}$ DV and 24-hr $\text{PM}_{2.5}$ DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculations based on EPA data handling conventions
 - Data extracted from monitors that have a non-regulatory monitoring type are omitted
 - Selection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

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
3701100024420101	Avery, NC	0.064	-1.48
3702100304420101	Buncombe, NC	0.067	-1.70
3702700034420101	Caldwell, NC	0.067	-1.95
3703300014420101	Caswell, NC	0.07	-1.98
3703700044420101	Chatham, NC	0.066	-1.71
3705100084420101	Cumberland, NC	0.069	-2.09
3705110034420101	Cumberland, NC	0.071	-1.75
3705900024420101	Davie, NC	N/A	-2.30
3706500994420101	Edgecombe, NC	0.07	-2.01
3706700224420101	Forsyth, NC	0.074	-2.13
3706700284420101	Forsyth, NC	0.069	-2.19

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in North Carolina

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
3706900014420101	Franklin, NC	0.069	-2.16
3707700014420101	Granville, NC	0.071	-2.16
3708700044420101	Haywood, NC	N/A	-1.61
3708700354420101	Haywood, NC	N/A	-1.40
3708700364420101	Haywood, NC	0.067	-1.85
3710100024420101	Johnston, NC	0.071	-1.69
3710700044420101	Lenoir, NC	0.067	-1.47
3710900044420101	Lincoln, NC	0.071	-2.20
3711700014420101	Martin, NC	0.066	-1.54
3711900414420101	Mecklenburg, NC	0.079	-2.06

Note: Only monitoring sites meeting data completeness criteria listed

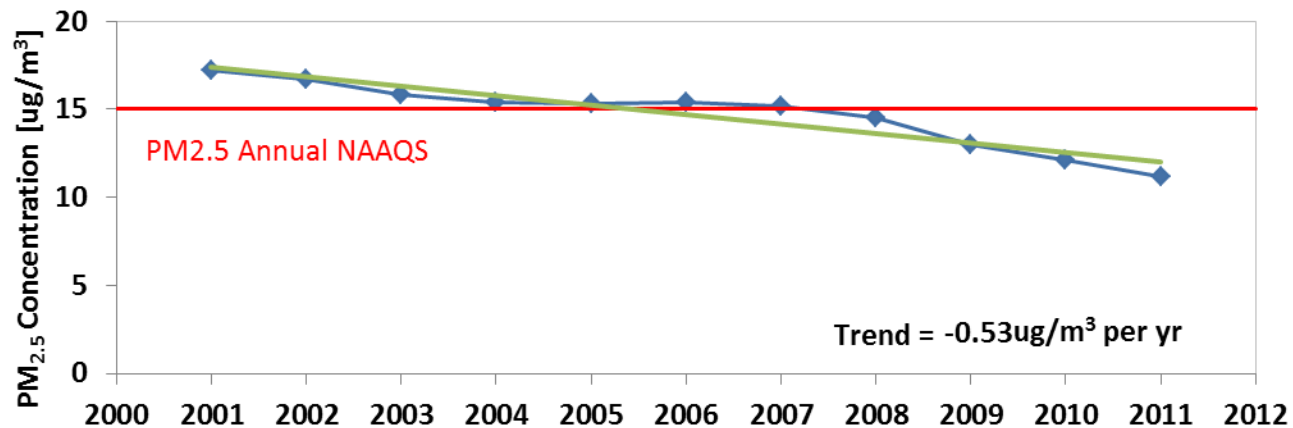
Ozone Trends by Site in North Carolina

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
3711910054420101	Mecklenburg, NC	0.076	-1.52
3711910094420101	Mecklenburg, NC	0.078	-2.01
3714500034420101	Person, NC	0.07	-2.18
3715700994420101	Rockingham, NC	0.071	-1.61
3715900214420101	Rowan, NC	0.075	-2.37
3715900224420101	Rowan, NC	0.076	-2.36
3717300024420101	Swain, NC	0.062	-1.24
3717900034420101	Union, NC	0.07	-1.75
3718300144420101	Wake, NC	0.071	-2.36
3718300164420101	Wake, NC	0.073	-1.67

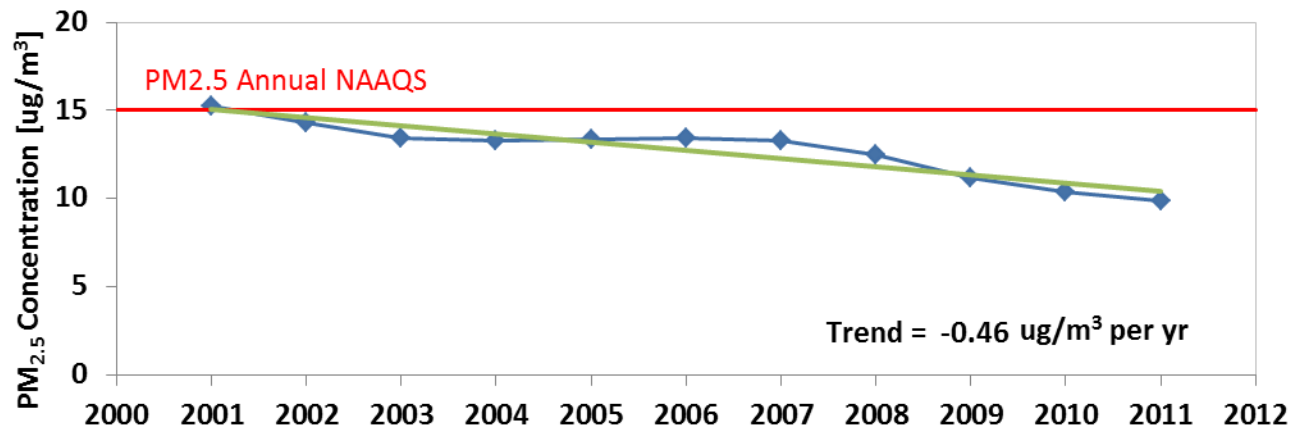
Note: Only monitoring sites meeting data completeness criteria listed

Max/Ave PM_{2.5} Annual DVs and Trend

North Carolina Max PM_{2.5} Annual Design Values

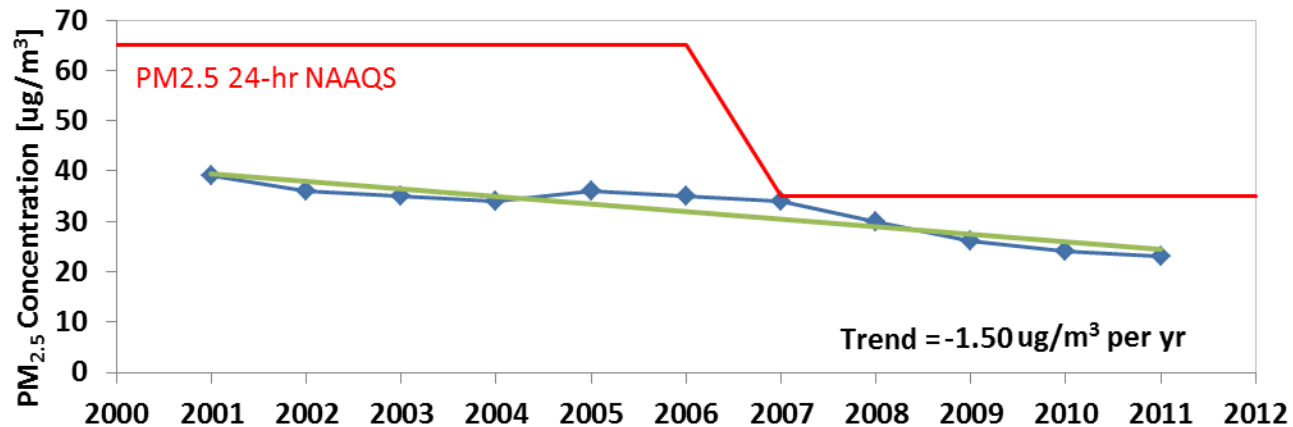


North Carolina Average PM_{2.5} Annual Design Values

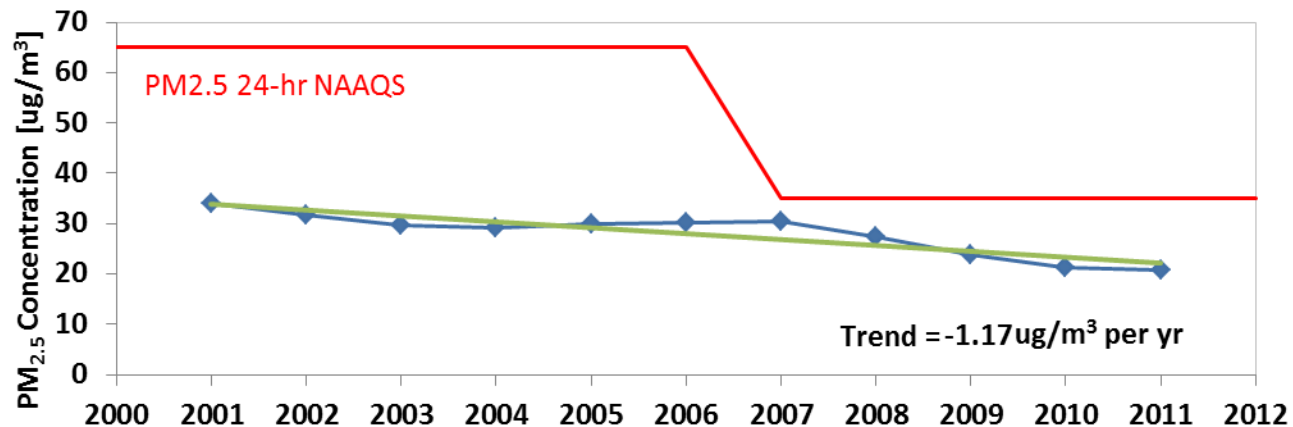


Max/Ave PM_{2.5} 24-Hour DVs and Trend

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



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



PM_{2.5} Trends by Site in North Carolina

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
370010002	Alamance	10.1	20	-0.44	-1.40
370210034	Buncombe	9.3	19	-0.52	-1.29
370330001	Caswell	8.9	18	-0.51	-1.85
370350004	Catawba	10.6	22	-0.56	-1.38
370370004	Chatham	8.5	19	-0.41	-0.95
370510009	Cumberland	10.3	22	-0.44	-1.14
370570002	Davidson	11.1	21	-0.54	-1.65
370610002	Duplin	8.9	19	-0.38	-0.88
370670022	Forsyth	10.0	21	-0.55	-1.42
370710016	Gaston	10.5	23	-0.42	-0.76
370990006	Jackson	9.4	N/A	-0.39	N/A

Note: Only monitoring sites meeting data completeness criteria listed

PM_{2.5} Trends by Site in North Carolina

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
371070004	Lenoir	9.3	22	-0.31	-0.72
371110004	McDowell	9.8	19	-0.54	-1.43
371190041	Mecklenburg	10.8	23	-0.42	-0.85
371190042	Mecklenburg	11.2	23	-0.40	-0.99
371210001	Mitchell	9.3	19	-0.54	-1.34
371230001	Montgomery	9.3	20	-0.35	-0.79
371550005	Robeson	10.0	22	-0.36	-0.82
371730002	Swain	9.7	20	-0.35	-1.15
371830014	Wake	9.8	22	-0.49	-1.15
371910005	Wayne	9.9	21	-0.47	-1.06

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