

Emission and Air Quality Trends Review

Ohio

May 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 generation 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

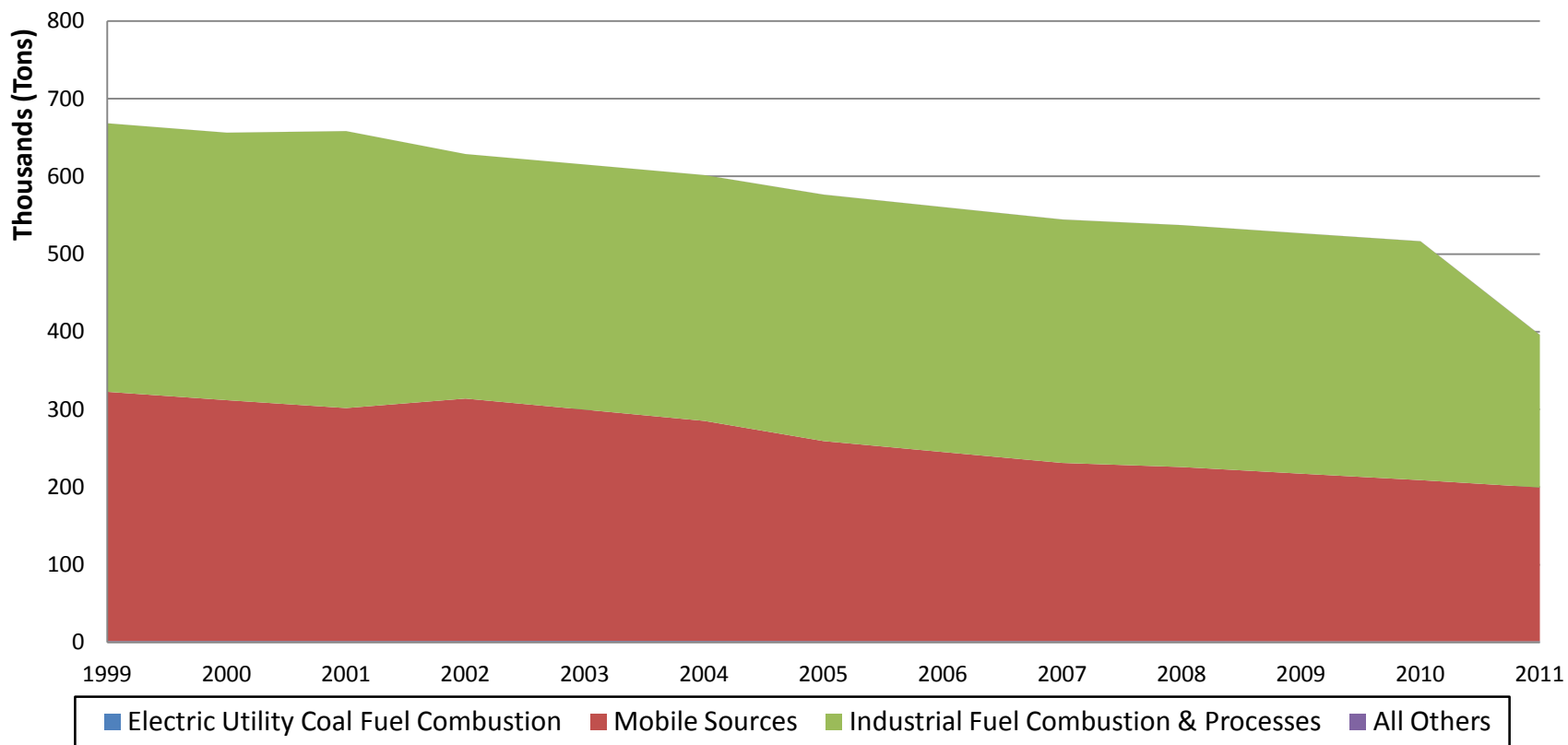
Ohio Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	1,584	1,625	1,775	1,598	1,578	1,601	1,543	1,374	1,407	1,419
Mobile Sources	321,023	300,081	297,844	257,591	243,528	229,465	224,233	215,878	207,523	198,029
Industrial Fuel Combustion & Processes	345,741	356,590	315,649	317,315	315,358	313,400	311,443	309,486	307,529	196,451
All Others	66	70	59	124	110	132	105	126	160	222
Total	668,414	658,366	615,327	576,627	560,574	544,599	537,324	526,865	516,619	396,121

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	3%	12%	1%	0%	1%	-3%	-13%	-11%	-10%
Mobile Sources	0%	-7%	-7%	-20%	-24%	-29%	-30%	-33%	-35%	-38%
Industrial Fuel Combustion & Processes	0%	3%	-9%	-8%	-9%	-9%	-10%	-10%	-11%	-43%
All Others	0%	6%	-11%	87%	66%	100%	59%	91%	142%	236%
Total	0%	-2%	-8%	-14%	-16%	-19%	-20%	-21%	-23%	-41%

Ohio Emission Trends (VOC)

**Major Source Category Summary
Annual VOC Emissions**



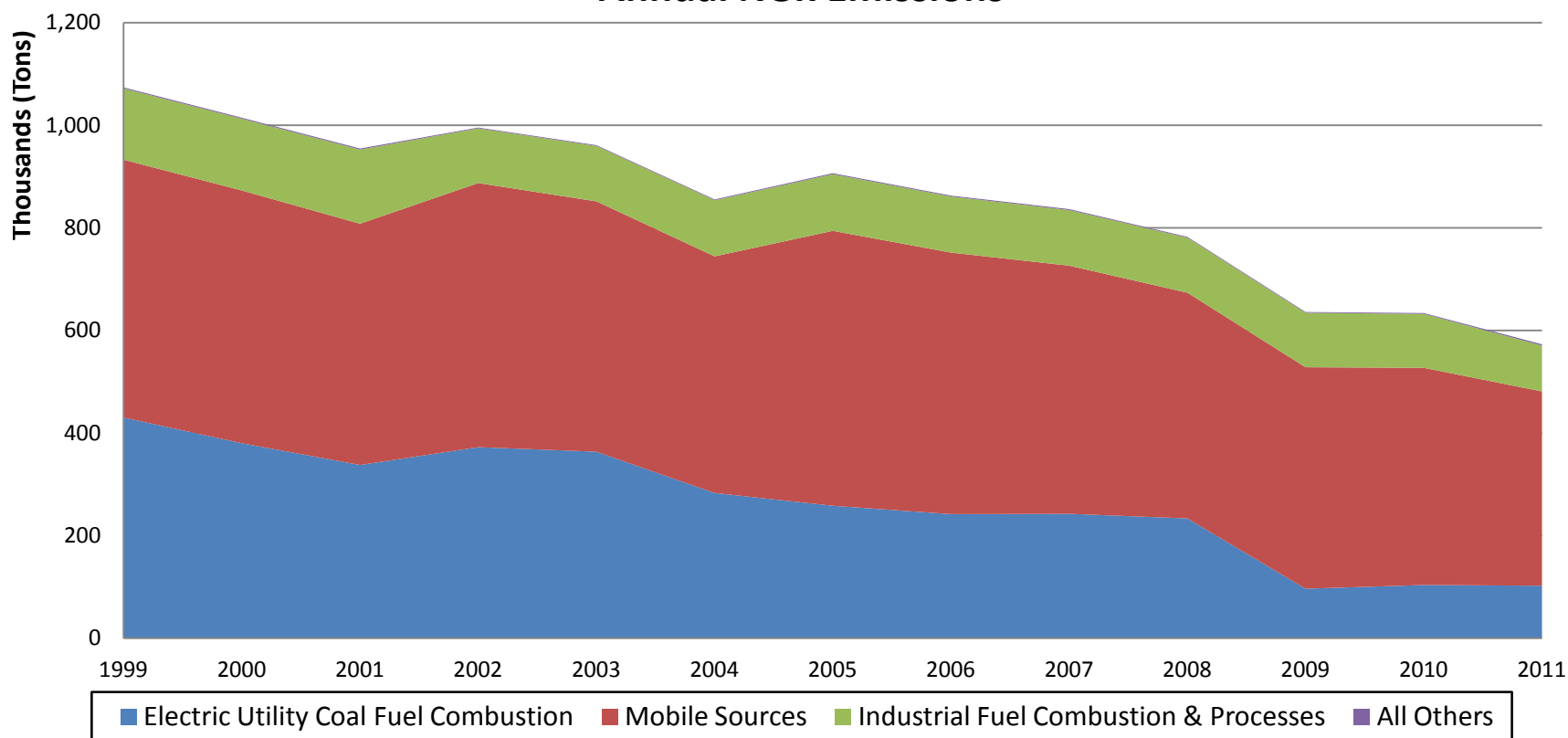
Ohio Emission Trends (NO_x)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	430,140	337,708	363,518	258,198	241,839	242,447	233,469	96,453	103,733	102,335
Mobile Sources	502,645	470,334	488,119	535,959	509,892	483,826	440,083	431,738	423,394	378,733
Industrial Fuel Combustion & Processes	139,024	144,571	108,043	110,467	109,404	108,341	107,278	106,215	105,152	89,406
All Others	2,004	2,066	1,549	1,936	1,747	1,924	1,607	1,506	1,656	2,515
Total	1,073,813	954,679	961,229	906,559	862,883	836,538	782,436	635,911	633,935	572,989

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-21%	-15%	-40%	-44%	-44%	-46%	-78%	-76%	-76%
Mobile Sources	0%	-6%	-3%	7%	1%	-4%	-12%	-14%	-16%	-25%
Industrial Fuel Combustion & Processes	0%	4%	-22%	-21%	-21%	-22%	-23%	-24%	-24%	-36%
All Others	0%	3%	-23%	-3%	-13%	-4%	-20%	-25%	-17%	25%
Total	0%	-11%	-10%	-16%	-20%	-22%	-27%	-41%	-41%	-47%

Ohio Emission Trends (NO_x)

**Major Source Category Summary
Annual NO_x Emissions**



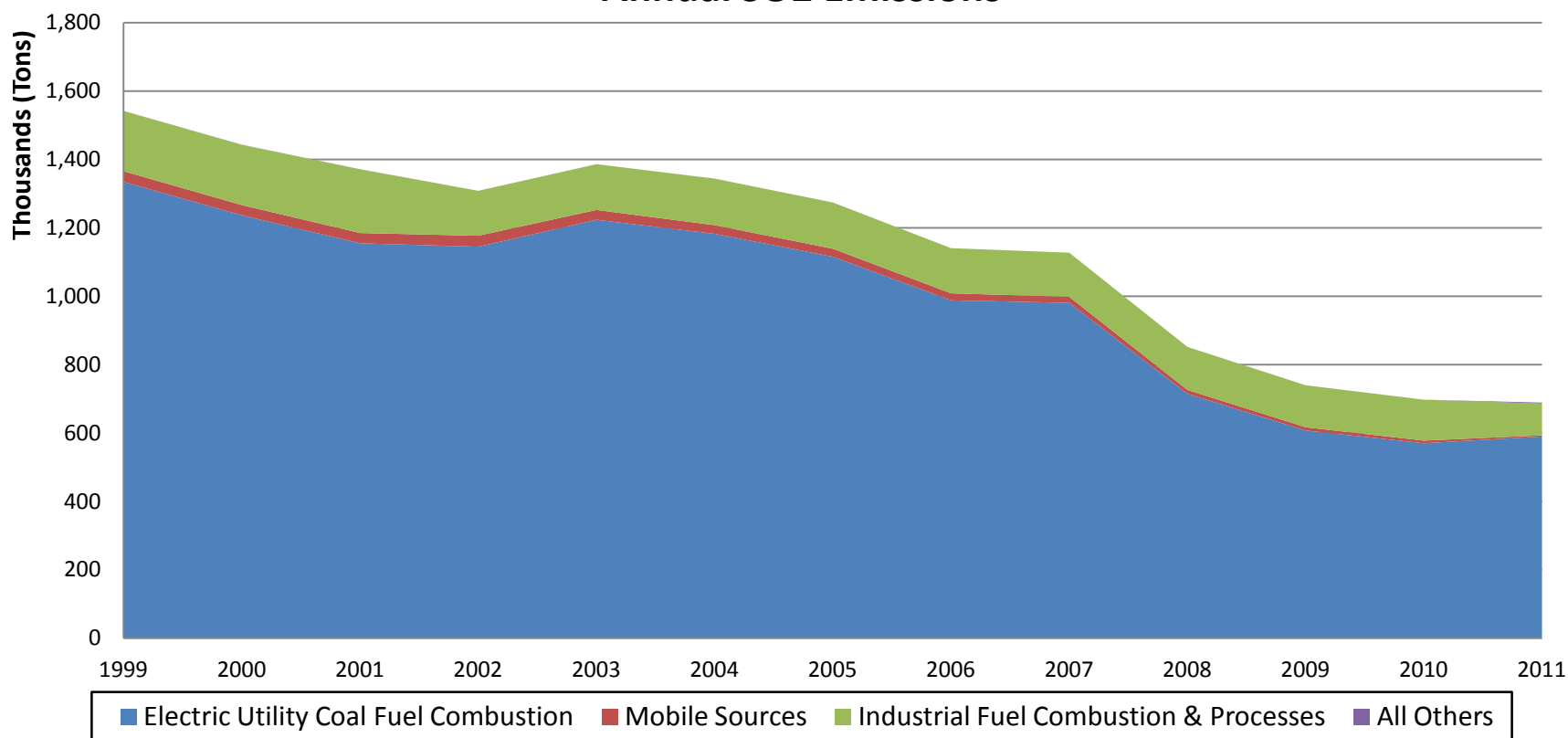
Ohio Emission Trends (SO₂)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	1,334,410	1,154,828	1,223,630	1,115,591	987,952	980,680	714,627	607,411	570,177	589,755
Mobile Sources	31,131	30,122	28,764	23,476	20,613	17,749	11,391	9,508	7,625	3,493
Industrial Fuel Combustion & Processes	176,113	186,159	133,637	134,999	131,926	128,853	125,781	122,708	119,635	93,098
All Others	348	354	133	110	94	92	78	75	85	2,702
Total	1,542,002	1,371,463	1,386,165	1,274,175	1,140,584	1,127,375	851,877	739,702	697,522	689,048

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-13%	-8%	-16%	-26%	-27%	-46%	-54%	-57%	-56%
Mobile Sources	0%	-3%	-8%	-25%	-34%	-43%	-63%	-69%	-76%	-89%
Industrial Fuel Combustion & Processes	0%	6%	-24%	-23%	-25%	-27%	-29%	-30%	-32%	-47%
All Others	0%	2%	-62%	-68%	-73%	-74%	-78%	-78%	-76%	676%
Total	0%	-11%	-10%	-17%	-26%	-27%	-45%	-52%	-55%	-55%

Ohio Emission Trends (SO₂)

**Major Source Category Summary
Annual SO₂ Emissions**



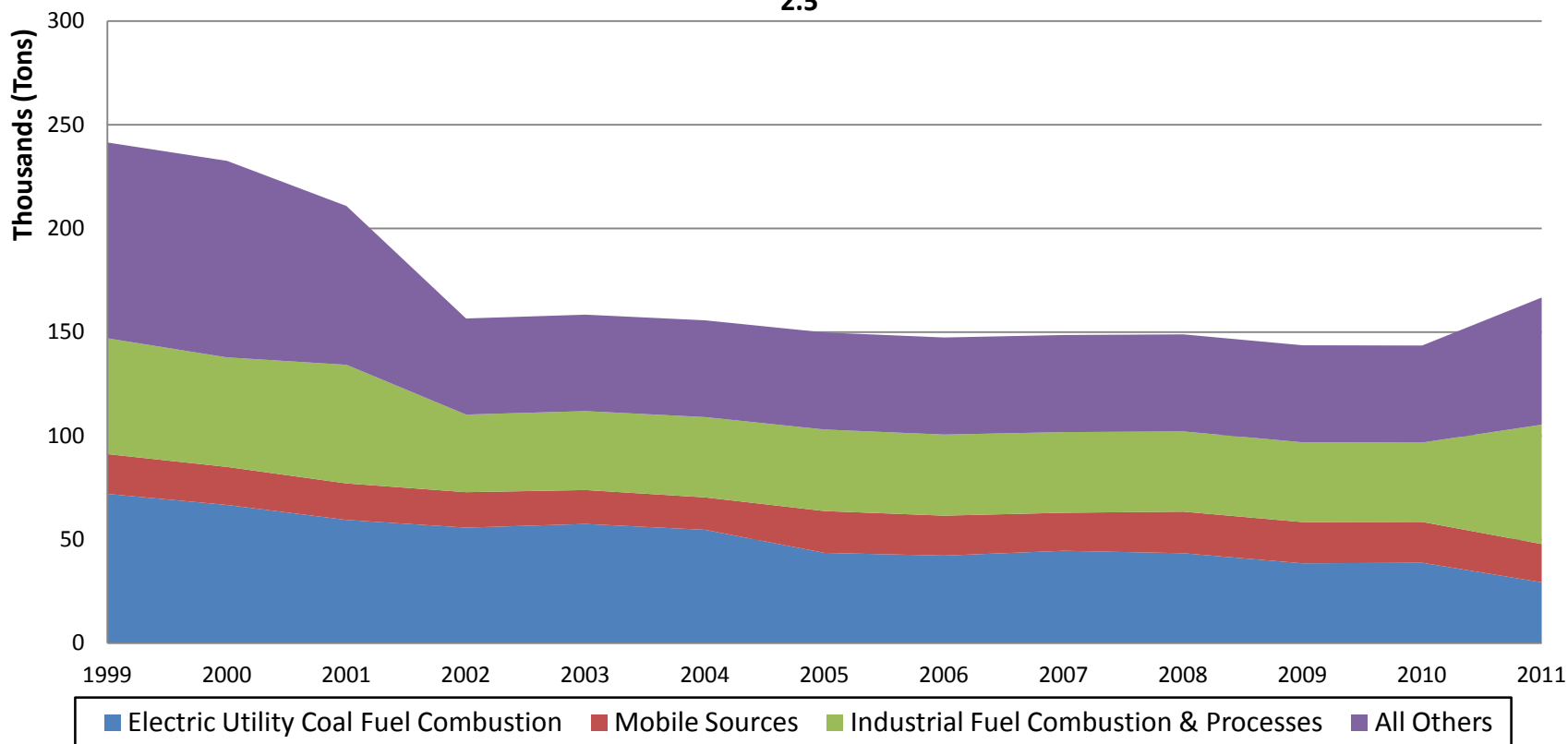
Ohio Emission Trends (PM_{2.5})

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	71,959	59,414	57,472	43,523	42,224	44,535	43,366	38,492	38,768	29,332
Mobile Sources	19,202	17,618	16,360	20,173	19,259	18,345	20,055	19,877	19,699	18,468
Industrial Fuel Combustion & Processes	55,848	57,207	38,073	39,318	39,108	38,899	38,689	38,480	38,270	57,558
All Others	94,428	76,560	46,506	46,816	46,809	46,805	46,797	46,794	46,792	61,314
Total	241,436	210,798	158,410	149,830	147,400	148,584	148,907	143,643	143,529	166,672

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%	-20%	-40%	-41%	-38%	-40%	-47%	-46%	-59%
Mobile Sources	0%	-8%	-15%	5%	0%	-4%	4%	4%	3%	-4%
Industrial Fuel Combustion & Processes	0%	2%	-32%	-30%	-30%	-30%	-31%	-31%	-31%	3%
All Others	0%	-19%	-51%	-50%	-50%	-50%	-50%	-50%	-50%	-35%
Total	0%	-13%	-34%	-38%	-39%	-38%	-38%	-41%	-41%	-31%

Ohio 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 Ohio
- ❑ 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

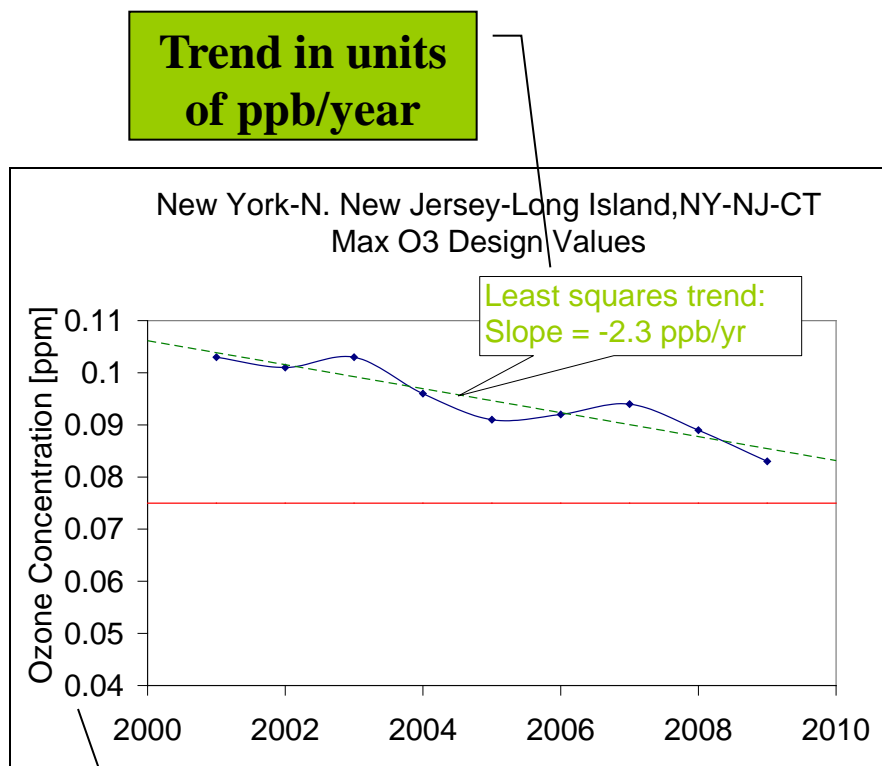
Data Handling Procedures

- 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

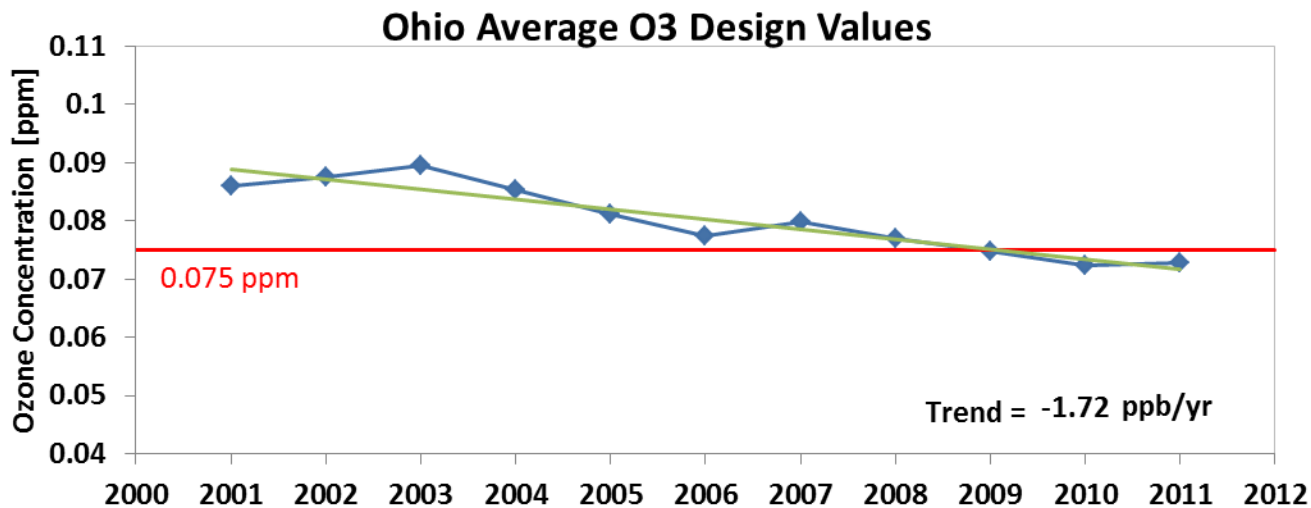
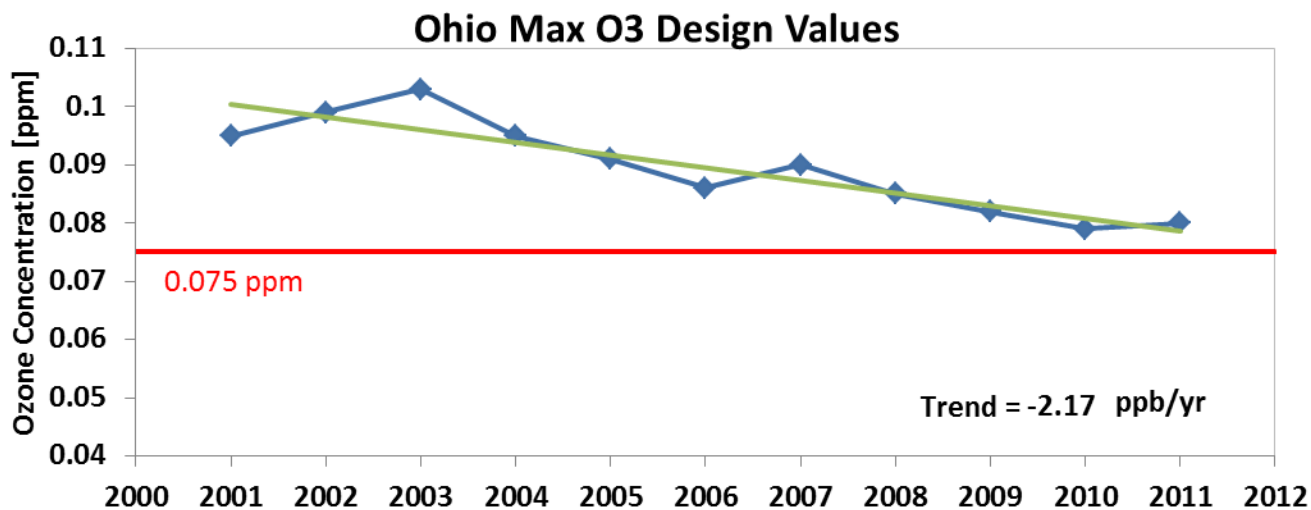
- Annual $PM_{2.5}$ DV and 24-hr $PM_{2.5}$ DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculations based on EPA data handling conventions
 - Data extracted from monitors that have a non-regulatory monitoring type are omitted
 - Selection of trend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

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
3900300024420101	Allen, OH	N/A	-2.35
3900710014420101	Ashtabula, OH	0.078	-1.83
3901700044420101	Butler, OH	0.076	-1.59
3901710044420103	Butler, OH	0.079	-1.07
3902300014420101	Clark, OH	0.074	-1.82
3902300034420101	Clark, OH	0.074	-1.51
3902500224420101	Clermont, OH	0.075	-2.12
3902710024420101	Clinton, OH	0.076	-2.45
3903500344420101	Cuyahoga, OH	0.075	-0.10
3903500644420101	Cuyahoga, OH	0.066	-1.35

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in Ohio

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
3903550024420101	Cuyahoga, OH	0.074	-1.31
3904100024420101	Delaware, OH	0.072	-2.11
3904900294420101	Franklin, OH	0.079	-2.00
3904900374420101	Franklin, OH	0.073	-2.02
3904900814420101	Franklin, OH	0.07	-1.73
3905500044420101	Geauga, OH	0.073	-3.05
3905700064420101	Greene, OH	0.072	-1.75
3906100064420101	Hamilton, OH	0.08	-1.01
3906100104420101	Hamilton, OH	0.074	-1.17
3906100404420101	Hamilton, OH	0.078	-0.95

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in Ohio

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
3908300024420101	Knox, OH	0.073	-1.98
3908500034420101	Lake, OH	0.077	-2.07
3908700064420101	Lawrence, OH	N/A	-1.82
3908700114420101	Lawrence, OH	0.064	-1.54
3908900054420101	Licking, OH	0.074	-1.96
3909500244420101	Lucas, OH	0.064	-1.68
3909500274420101	Lucas, OH	0.065	-1.59
3909500344420101	Lucas, OH	0.072	-2.01
3909700074420101	Madison, OH	0.073	-2.03
3909900134420101	Mahoning, OH	0.069	-2.33

Note: Only monitoring sites meeting data completeness criteria listed

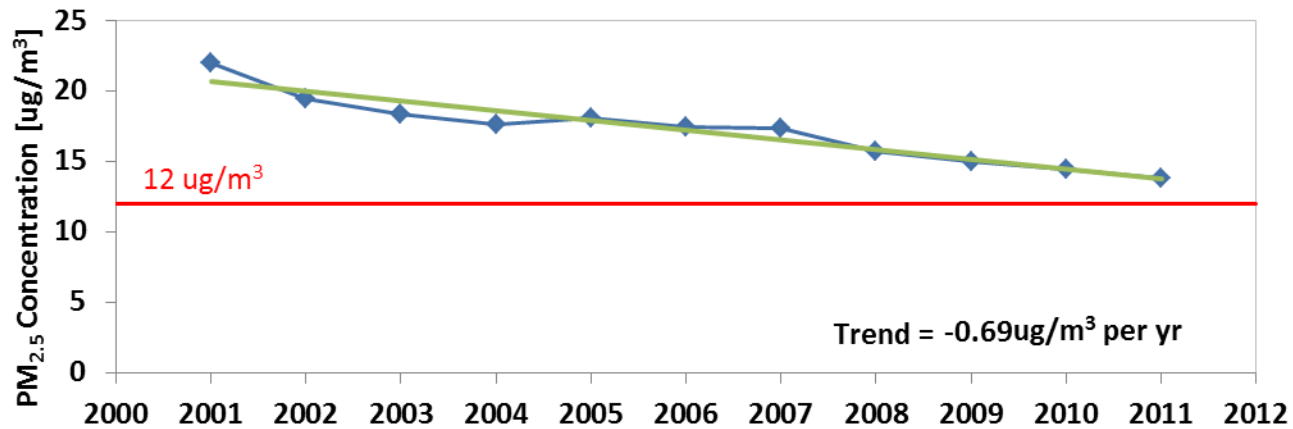
Ozone Trends by Site in Ohio

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
3910300034420101	Medina, OH	N/A	-2.29
3910900054420101	Miami, OH	0.072	-1.93
3913310014420101	Portage, OH	0.067	-2.91
3913510014420101	Preble, OH	0.071	-1.17
3915100164420101	Stark, OH	0.075	-1.61
3915140054420101	Stark, OH	0.071	-1.88
3915300204420101	Summit, OH	0.074	-2.11
3915500094420101	Trumbull, OH	0.071	-1.92
3916700044420101	Washington, OH	0.071	-1.55
3917300034420101	Wood, OH	0.07	-1.98

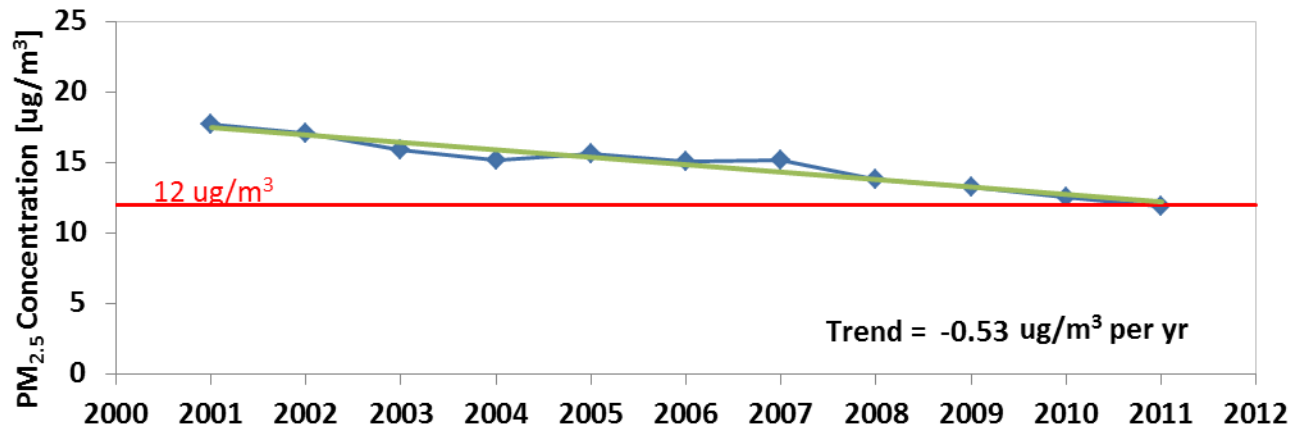
Note: Only monitoring sites meeting data completeness criteria listed

Max/Ave PM_{2.5} Annual DVs and Trend

Ohio Max PM_{2.5} Annual Design Values

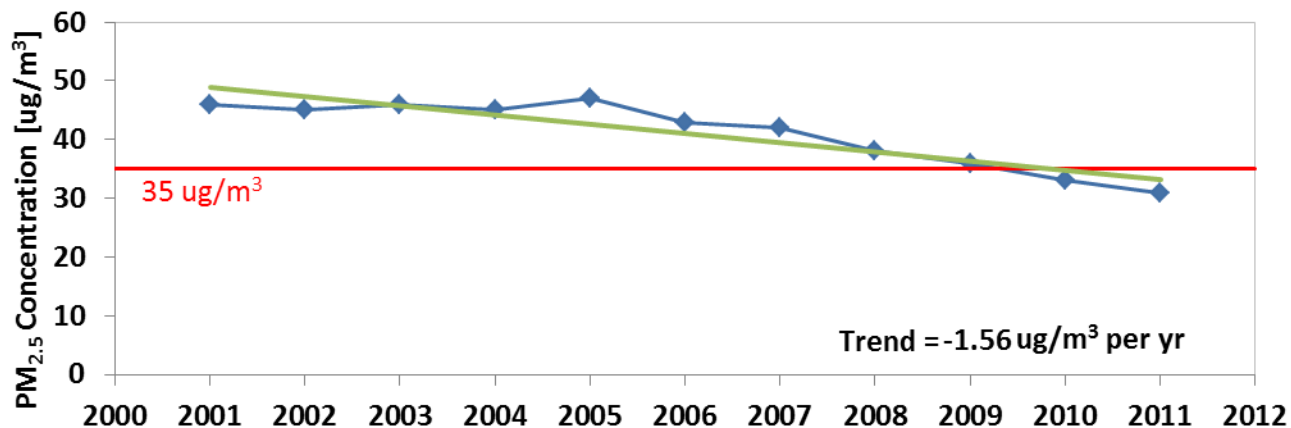


Ohio Average PM_{2.5} Annual Design Values

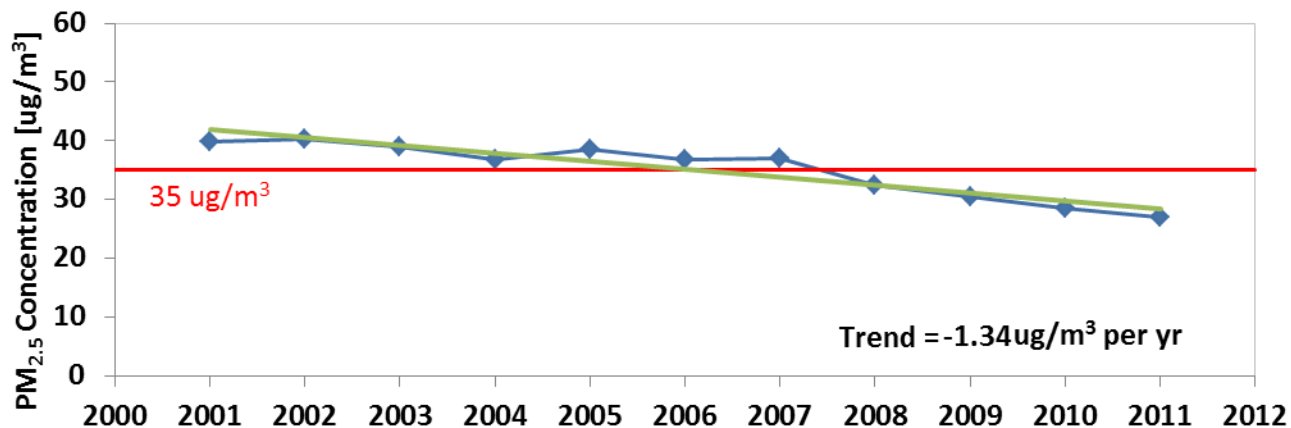


Max/Ave PM_{2.5} 24-Hour DVs and Trend

Ohio Max PM_{2.5} 24-Hour Design Values



Ohio Average PM_{2.5} 24-Hour Design Values



PM_{2.5} Trends by Site in Ohio

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
390090003	Athens	9.0	18	-0.41	-1.55
390170003	Butler	N/A	29	N/A	-1.30
390170016	Butler	13.0	29	-0.37	-1.04
390230005	Clark	12.6	28	-0.27	-0.82
390350034	Cuyahoga	10.4	25	-0.50	-1.38
390350038	Cuyahoga	13.1	30	-0.69	-1.61
390350045	Cuyahoga	12.3	27	-0.57	-1.24
390350065	Cuyahoga	12.7	28	-0.42	-1.35
390351002	Cuyahoga	10.9	24	-0.43	-1.01
390490024	Franklin	12.2	26	-0.58	-1.56
390490025	Franklin	11.9	28	-0.52	-1.31
390610014	Hamilton	13.8	29	-0.50	-1.51
390610040	Hamilton	12.8	28	-0.35	-1.11

Note: Only monitoring sites meeting data completeness criteria listed

PM_{2.5} Trends by Site in Ohio

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
390610042	Hamilton	13.8	31	-0.45	-1.35
390617001	Hamilton	N/A	N/A	-0.37	-1.21
390618001	Hamilton	N/A	N/A	-0.39	-0.57
390811001	Jefferson	11.8	24	-0.64	-1.85
390950024	Lucas	11.1	27	-0.50	-1.10
390950026	Lucas	11.0	26	-0.46	-1.25
390990005	Mahoning	11.4	28	-0.43	-1.10
391130032	Montgomery	N/A	29	N/A	-1.57
391330002	Portage	10.9	26	-0.40	-1.24
391450013	Scioto	10.9	22	-0.94	-2.22
391530017	Summit	12.6	29	-0.47	-1.24
391530023	Summit	11.7	27	-0.47	-1.50

Note: Only monitoring sites meeting data completeness criteria listed

Air Quality Trends Summary

- Average O₃ and PM_{2.5} design values have decreased since 1999 in Ohio

- O₃ and PM_{2.5} design values have decreased since 1999 in all currently designated O₃ and PM_{2.5} non-attainment areas in Ohio in which monitoring data met the 1999–2011 trends completeness criteria. Additional O₃ or PM_{2.5} non-attainment areas in Ohio in which monitoring data did not meet the 1999–2011 trends completeness criteria include:
 - Canton-Massillon, OH (Annual & 24-Hour PM_{2.5})