

Emission and Air Quality Trends Review

Kentucky

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

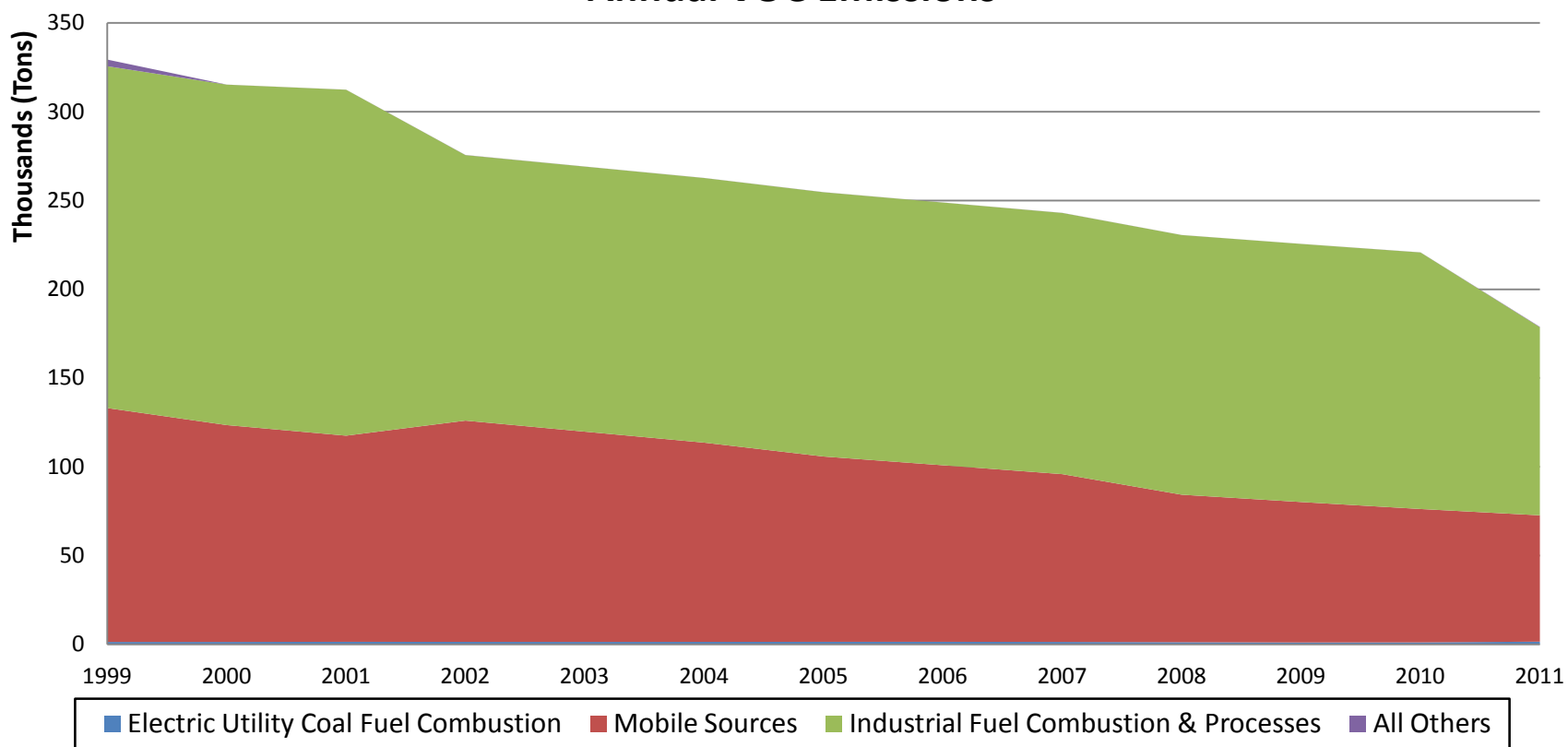
Kentucky Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	1,365	1,441	1,385	1,435	1,439	1,375	1,213	1,067	1,114	1,522
Mobile Sources	131,718	116,092	118,408	104,364	99,430	94,495	83,077	79,101	75,125	71,152
Industrial Fuel Combustion & Processes	192,506	194,832	149,275	148,831	147,963	147,095	146,227	145,359	144,491	105,946
All Others	3,735	39	49	58	42	60	38	33	55	228
Total	329,323	312,404	269,117	254,688	248,874	243,024	230,555	225,560	220,785	178,848

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%	2%	5%	5%	1%	-11%	-22%	-18%	12%
Mobile Sources	0%	-12%	-10%	-21%	-25%	-28%	-37%	-40%	-43%	-46%
Industrial Fuel Combustion & Processes	0%	1%	-22%	-23%	-23%	-24%	-24%	-24%	-25%	-45%
All Others	0%	-99%	-99%	-98%	-99%	-98%	-99%	-99%	-99%	-94%
Total	0%	-5%	-18%	-23%	-24%	-26%	-30%	-32%	-33%	-46%

Kentucky Emission Trends (VOC)

**Major Source Category Summary
Annual VOC Emissions**



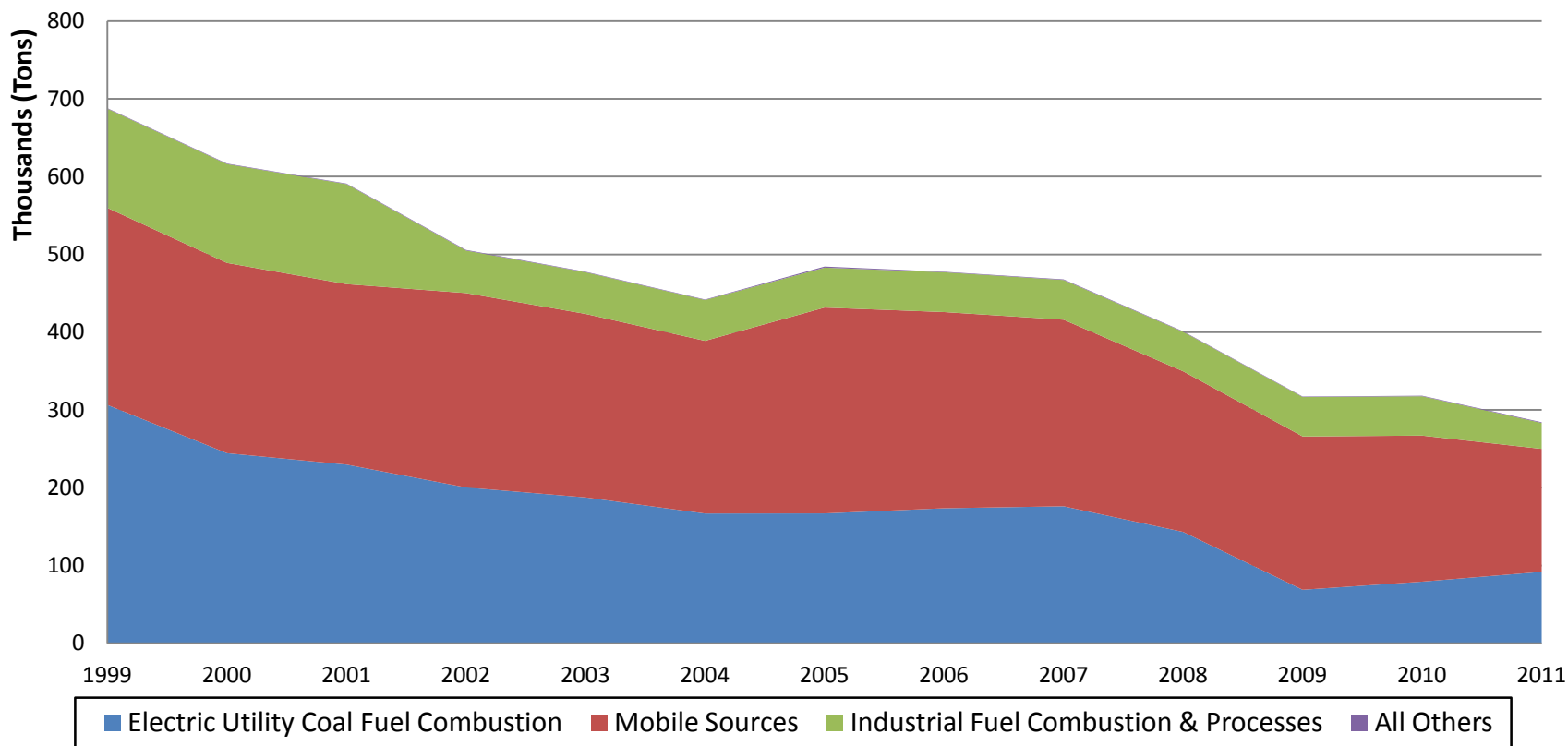
Kentucky Emission Trends (NO_x)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	306,404	229,722	187,519	166,983	173,568	176,110	143,140	68,765	79,245	91,871
Mobile Sources	253,389	232,081	235,963	264,672	252,294	239,917	206,532	197,149	187,767	158,059
Industrial Fuel Combustion & Processes	127,433	128,562	53,589	51,300	51,191	51,041	50,800	50,667	50,542	33,318
All Others	673	693	641	1,421	648	789	649	595	707	893
Total	687,899	591,058	477,713	484,376	477,702	467,856	401,120	317,176	318,261	284,140

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-25%	-39%	-46%	-43%	-43%	-53%	-78%	-74%	-70%
Mobile Sources	0%	-8%	-7%	4%	0%	-5%	-18%	-22%	-26%	-38%
Industrial Fuel Combustion & Processes	0%	1%	-58%	-60%	-60%	-60%	-60%	-60%	-60%	-74%
All Others	0%	3%	-5%	111%	-4%	17%	-4%	-12%	5%	33%
Total	0%	-14%	-31%	-30%	-31%	-32%	-42%	-54%	-54%	-59%

Kentucky Emission Trends (NO_x)

**Major Source Category Summary
Annual NO_x Emissions**



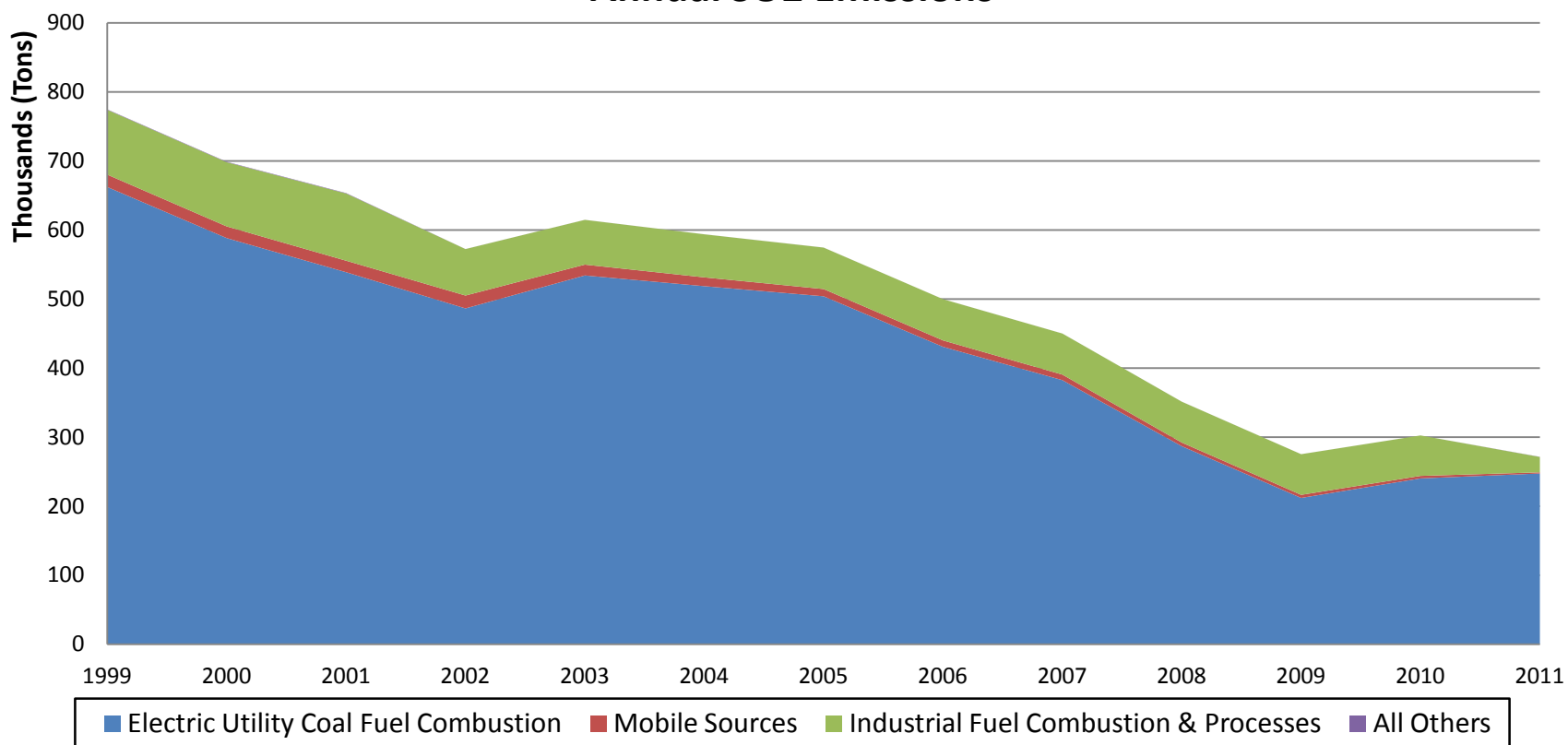
Kentucky Emission Trends (SO₂)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	662,247	538,860	534,169	504,008	430,825	382,538	286,877	211,940	240,213	247,341
Mobile Sources	17,921	16,677	15,706	10,470	9,251	8,031	5,260	4,441	3,621	1,640
Industrial Fuel Combustion & Processes	93,877	97,388	64,813	60,039	59,748	59,457	59,166	58,874	58,583	22,275
All Others	565	593	67	60	48	46	56	39	27	216
Total	774,610	653,518	614,755	574,578	499,871	450,073	351,360	275,293	302,445	271,472

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-19%	-19%	-24%	-35%	-42%	-57%	-68%	-64%	-63%
Mobile Sources	0%	-7%	-12%	-42%	-48%	-55%	-71%	-75%	-80%	-91%
Industrial Fuel Combustion & Processes	0%	4%	-31%	-36%	-36%	-37%	-37%	-37%	-38%	-76%
All Others	0%	5%	-88%	-89%	-92%	-92%	-90%	-93%	-95%	-62%
Total	0%	-16%	-21%	-26%	-35%	-42%	-55%	-64%	-61%	-65%

Kentucky Emission Trends (SO₂)

**Major Source Category Summary
Annual SO₂ Emissions**



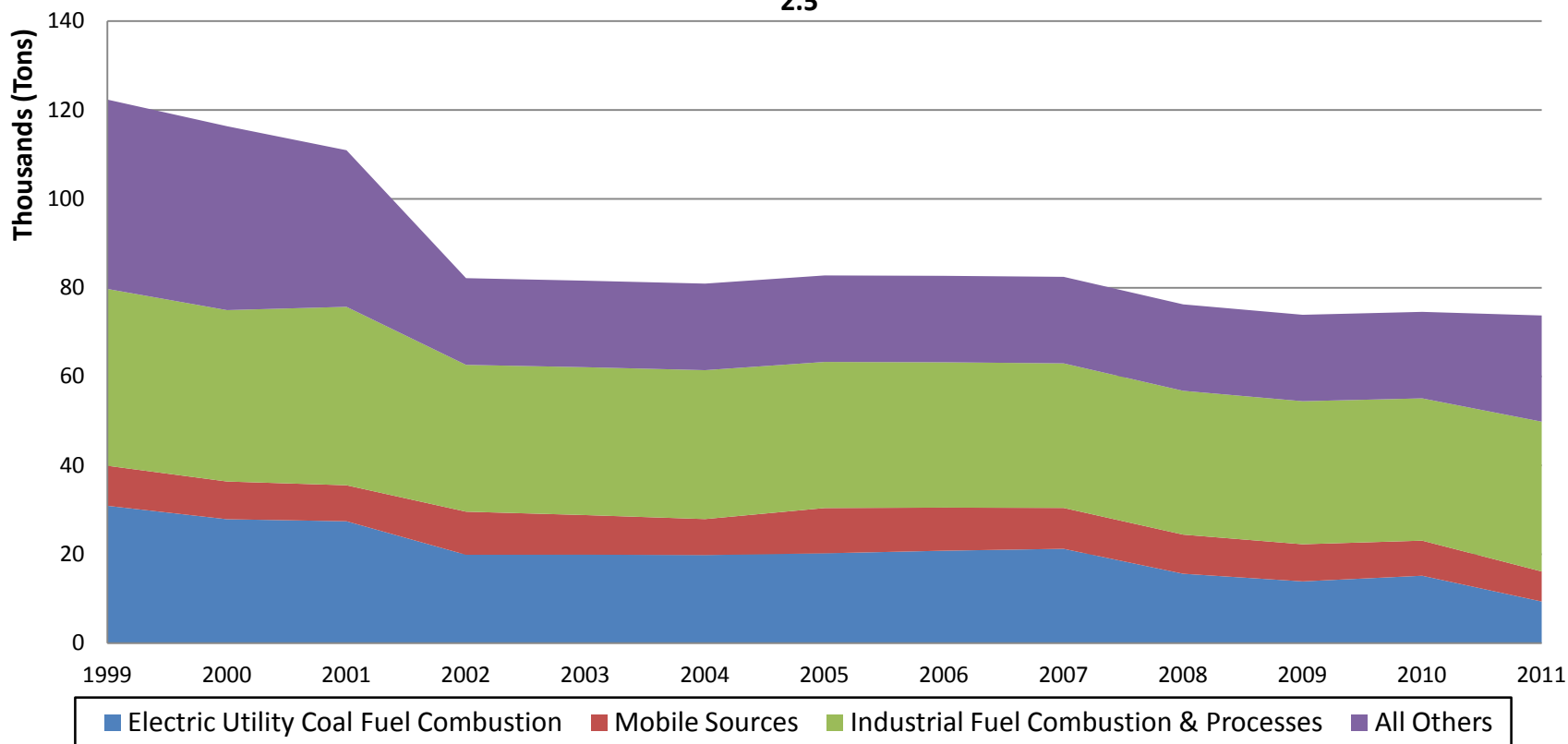
Kentucky Emission Trends (PM_{2.5})

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	30,904	27,428	19,916	20,215	20,800	21,224	15,613	13,898	15,165	9,367
Mobile Sources	9,014	8,100	8,906	10,187	9,695	9,204	8,809	8,355	7,901	6,759
Industrial Fuel Combustion & Processes	39,792	40,161	33,276	32,883	32,711	32,539	32,366	32,194	32,022	33,720
All Others	42,610	35,241	19,470	19,467	19,457	19,471	19,454	19,449	19,466	23,895
Total	122,320	110,930	81,567	82,752	82,663	82,437	76,242	73,896	74,554	73,740

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-11%	-36%	-35%	-33%	-31%	-49%	-55%	-51%	-70%
Mobile Sources	0%	-10%	-1%	13%	8%	2%	-2%	-7%	-12%	-25%
Industrial Fuel Combustion & Processes	0%	1%	-16%	-17%	-18%	-18%	-19%	-19%	-20%	-15%
All Others	0%	-17%	-54%	-54%	-54%	-54%	-54%	-54%	-54%	-44%
Total	0%	-9%	-33%	-32%	-32%	-33%	-38%	-40%	-39%	-40%

Kentucky 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 Kentucky
- ❑ 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

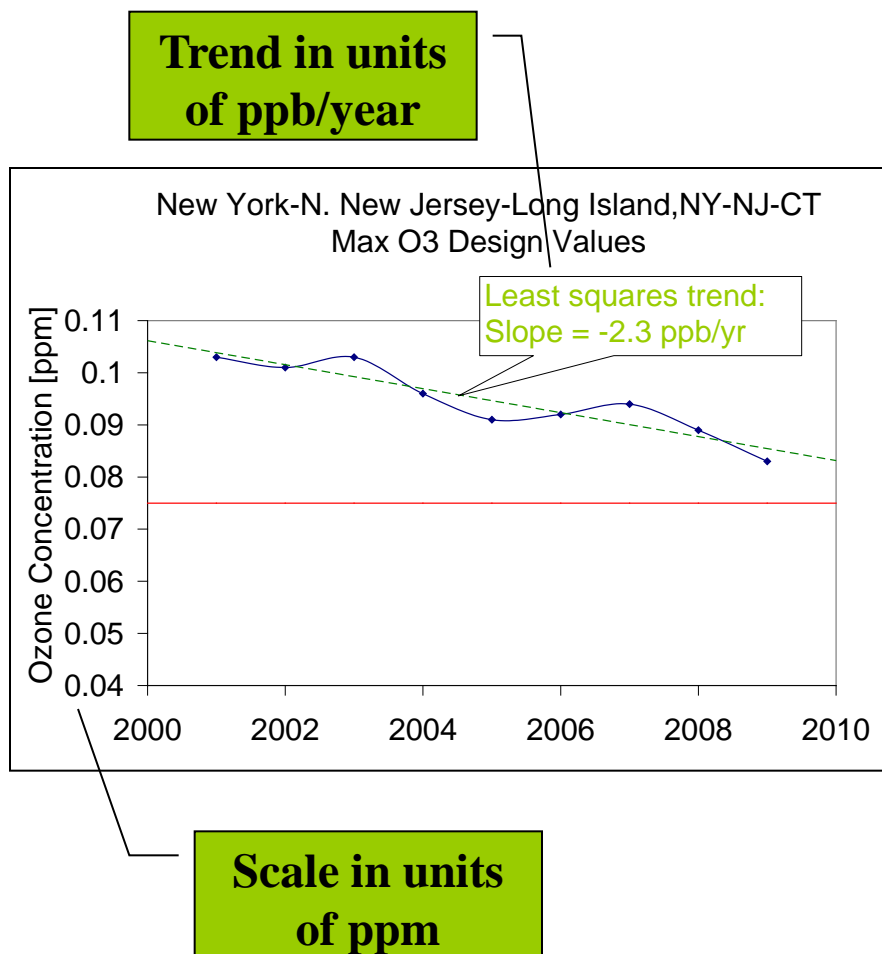
Data Handling Procedures

- 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

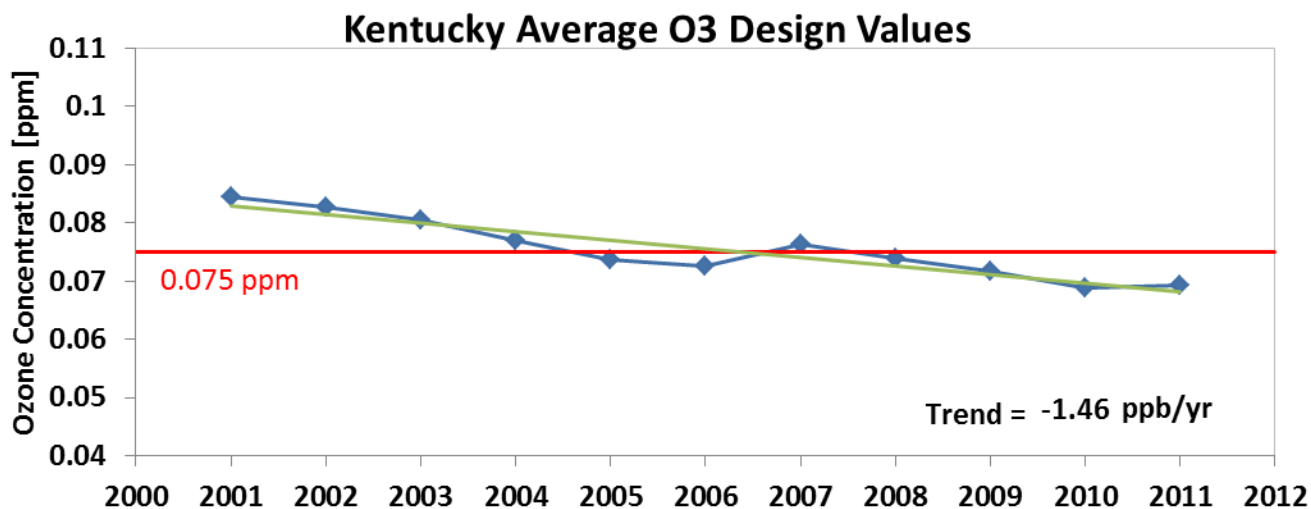
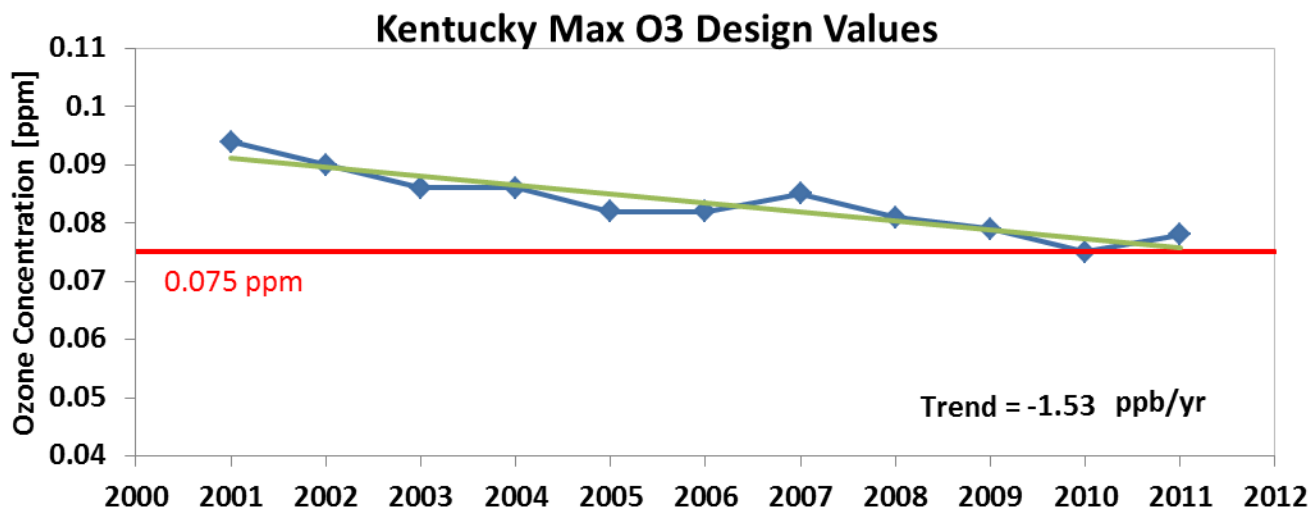
- Annual $PM_{2.5}$ DV and 24-hr $PM_{2.5}$ DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculations based on EPA data handling conventions
 - Data extracted from monitors that have a non-regulatory monitoring type are omitted
 - Selection of trend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

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
2101300024420101	Bell, KY	0.063	-2.21
2101500034420101	Boone, KY	0.067	-2.20
2101900174420101	Boyd, KY	0.069	-2.27
2102900064420101	Bullitt, KY	0.07	-1.63
2104305004420101	Carter, KY	0.066	-1.53
2105900054420101	Daviess, KY	0.073	-0.40
2106105014420101	Edmonson, KY	0.07	-1.57
2106700124420101	Fayette, KY	0.069	-1.04
2108900074420101	Greenup, KY	0.068	-1.65

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in Kentucky

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
2109100124420101	Hancock, KY	0.072	-1.20
2109300064420101	Hardin, KY	0.068	-1.13
2110100144420101	Henderson, KY	0.074	-0.76
2111100274420101	Jefferson, KY	0.074	-1.21
2111100514420101	Jefferson, KY	0.078	-0.75
2111110214420101	Jefferson, KY	N/A	-1.72
2111300014420101	Jessamine, KY	0.068	-1.00
2111700074420101	Kenton, KY	N/A	-1.37

Note: Only monitoring sites meeting data completeness criteria listed

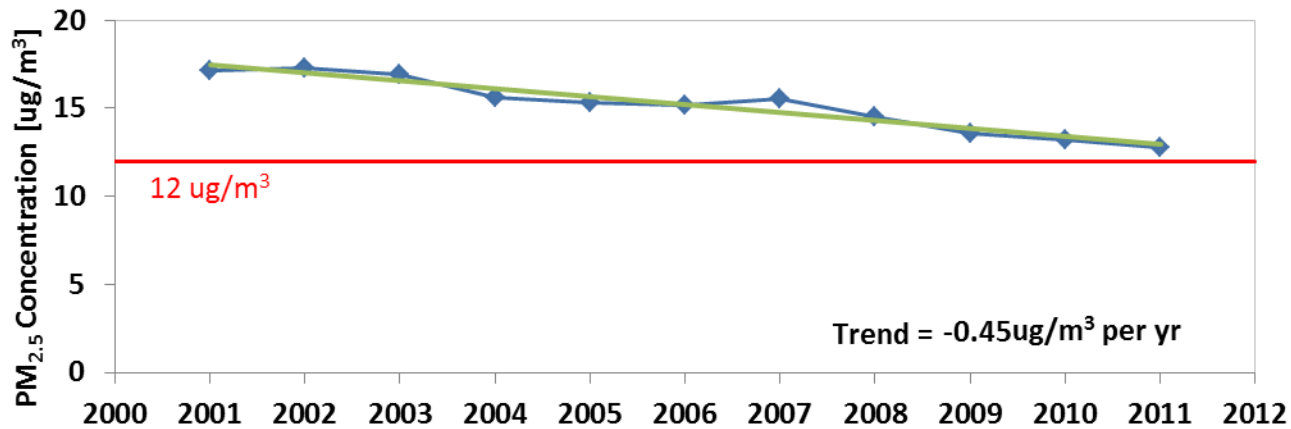
Ozone Trends by Site in Kentucky

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
2113900034420101	Livingston, KY	0.068	-2.10
2114510244420101	McCracken, KY	0.07	-1.33
2118500044420101	Oldham, KY	0.078	-1.59
2119300034420101	Perry, KY	0.065	-1.00
2119500024420101	Pike, KY	0.066	-0.95
2119900034420101	Pulaski, KY	0.064	-2.01
2121300044420101	Simpson, KY	0.07	-1.49
2122700084420101	Warren, KY	0.064	-2.32

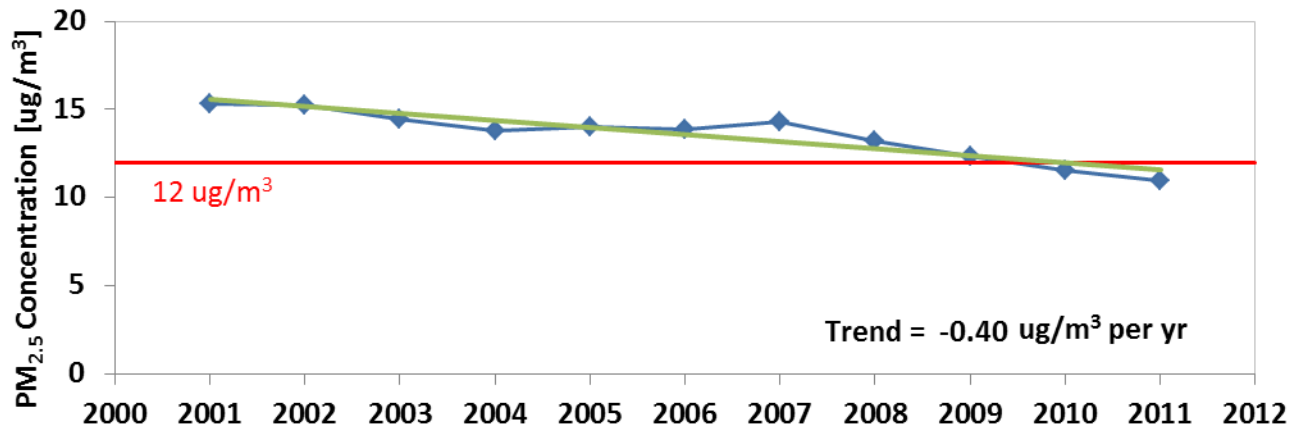
Note: Only monitoring sites meeting data completeness criteria listed

Max/Ave PM_{2.5} Annual DVs and Trend

Kentucky Max PM2.5 Annual Design Values

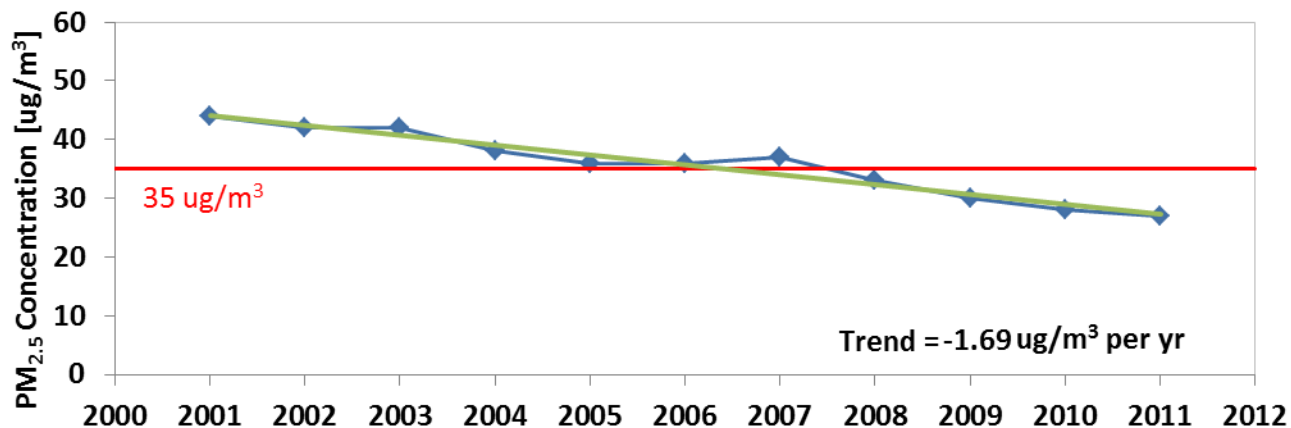


Kentucky Average PM2.5 Annual Design Values

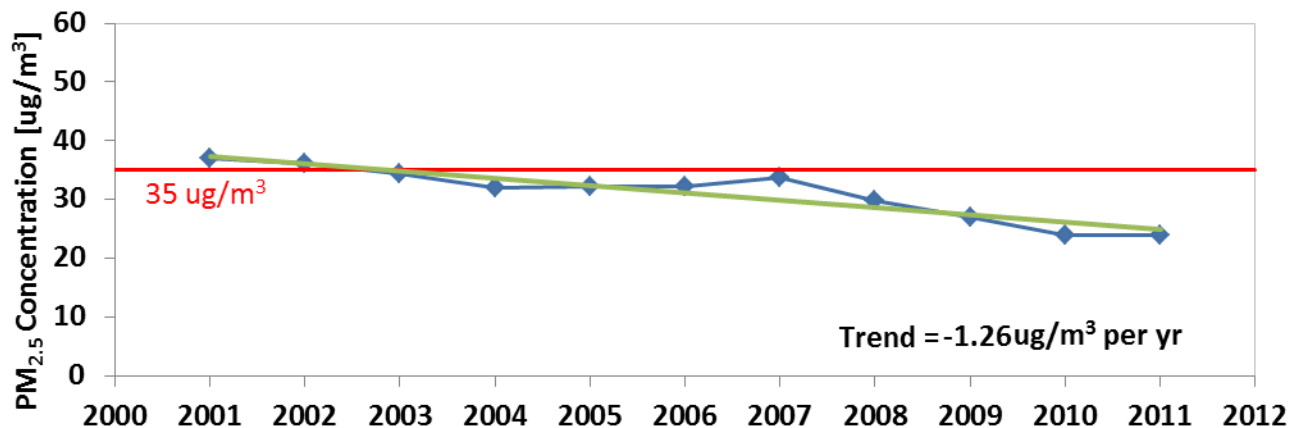


Max/Ave PM_{2.5} 24-Hour DVs and Trend

Kentucky Max PM_{2.5} 24-Hour Design Values



Kentucky Average PM_{2.5} 24-Hour Design Values



PM_{2.5} Trends by Site in Kentucky

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
210130002	Bell	11.3	26	-0.40	-1.08
210190017	Boyd	10.8	24	-0.43	-1.24
210290006	Bullitt	N/A	N/A	-0.28	-1.15
210430500	Carter	9.1	19	-0.31	-1.05
210670012	Fayette	11.2	23	-0.42	-1.47
210670014	Fayette	N/A	N/A	-0.49	-1.62
210730006	Franklin	N/A	N/A	-0.32	-1.18
210930006	Hardin	11.1	23	-0.32	-1.02

Note: Only monitoring sites meeting data completeness criteria listed

PM_{2.5} Trends by Site in Kentucky

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
211110043	Jefferson	N/A	27	N/A	-1.42
211110044	Jefferson	12.8	27	-0.45	-1.51
211110051	Jefferson	12.7	27	-0.34	-0.82
211170007	Kenton	N/A	N/A	-0.37	-1.07
211451004	McCracken	11.1	24	-0.29	-0.73
211510003	Madison	9.9	20	-0.45	-1.26
211950002	Pike	9.7	24	-0.46	-1.35

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 Kentucky
- O₃ and PM_{2.5} design values have decreased since 1999 in all currently designated O₃ and PM_{2.5} non-attainment areas in Kentucky