

# Emission and Air Quality Trends Review 1999-2011



## Missouri

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

# 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

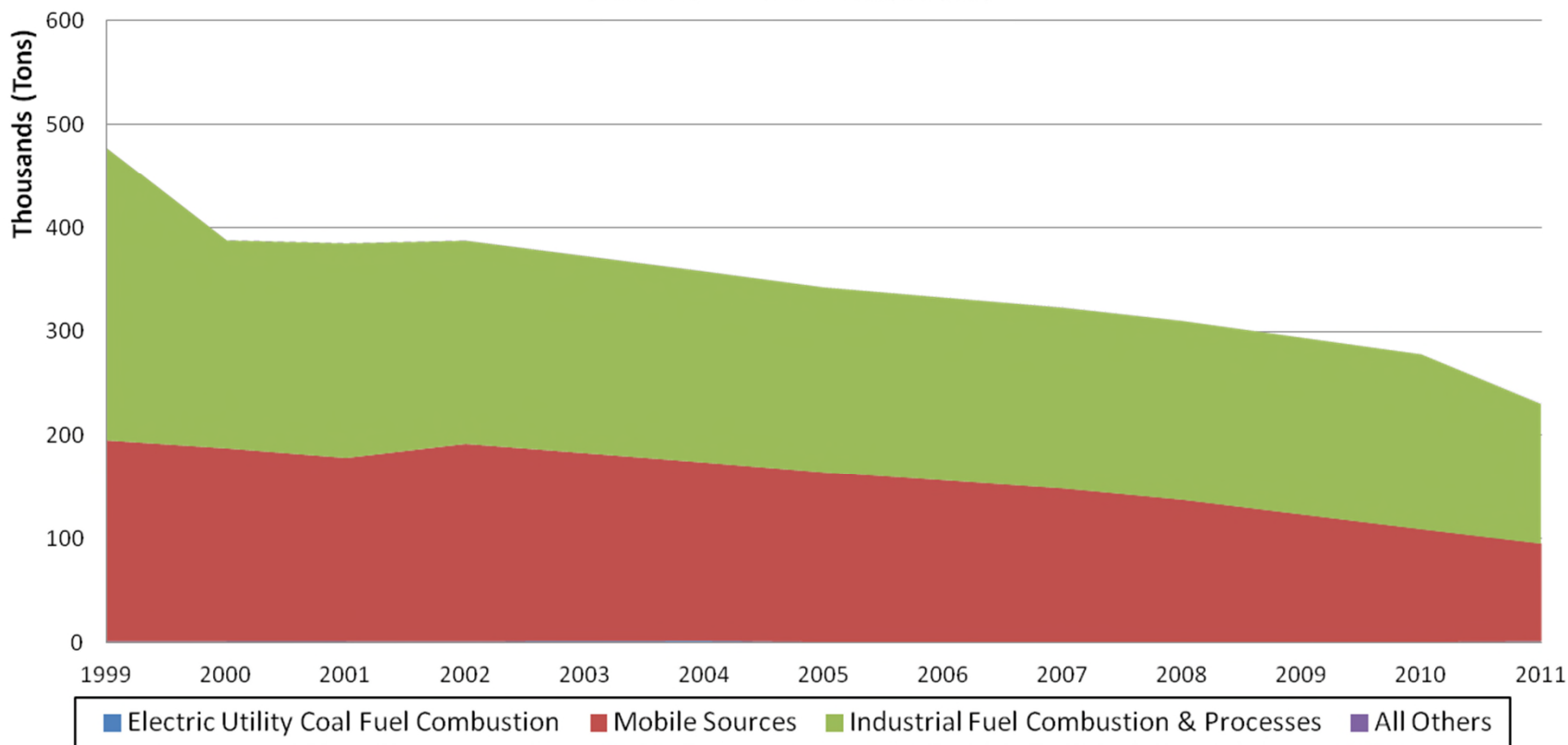
# Missouri Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	1,350	1,425	1,685	748	753	745	703	719	762	1,466
Mobile Sources	194,172	177,222	181,561	163,871	155,946	148,022	137,091	122,855	108,618	94,107
Industrial Fuel Combustion & Processes	280,864	205,919	189,124	177,662	175,873	174,080	172,286	170,495	168,704	134,900
All Others	133	162	147	114	110	113	103	85	88	116
<b>Total</b>	<b>476,519</b>	<b>384,727</b>	<b>372,517</b>	<b>342,395</b>	<b>332,683</b>	<b>322,960</b>	<b>310,184</b>	<b>294,154</b>	<b>278,172</b>	<b>230,589</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%	6%	25%	-45%	-44%	-45%	-48%	-47%	-44%	9%
Mobile Sources	0%	-9%	-6%	-16%	-20%	-24%	-29%	-37%	-44%	-52%
Industrial Fuel Combustion & Processes	0%	-27%	-33%	-37%	-37%	-38%	-39%	-39%	-40%	-52%
All Others	0%	22%	11%	-14%	-17%	-15%	-22%	-36%	-34%	-12%
<b>Total</b>	<b>0%</b>	<b>-19%</b>	<b>-22%</b>	<b>-28%</b>	<b>-30%</b>	<b>-32%</b>	<b>-35%</b>	<b>-38%</b>	<b>-42%</b>	<b>-52%</b>

# Missouri Emission Trends (VOC)

Major Source Category Summary  
Annual VOC Emissions



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

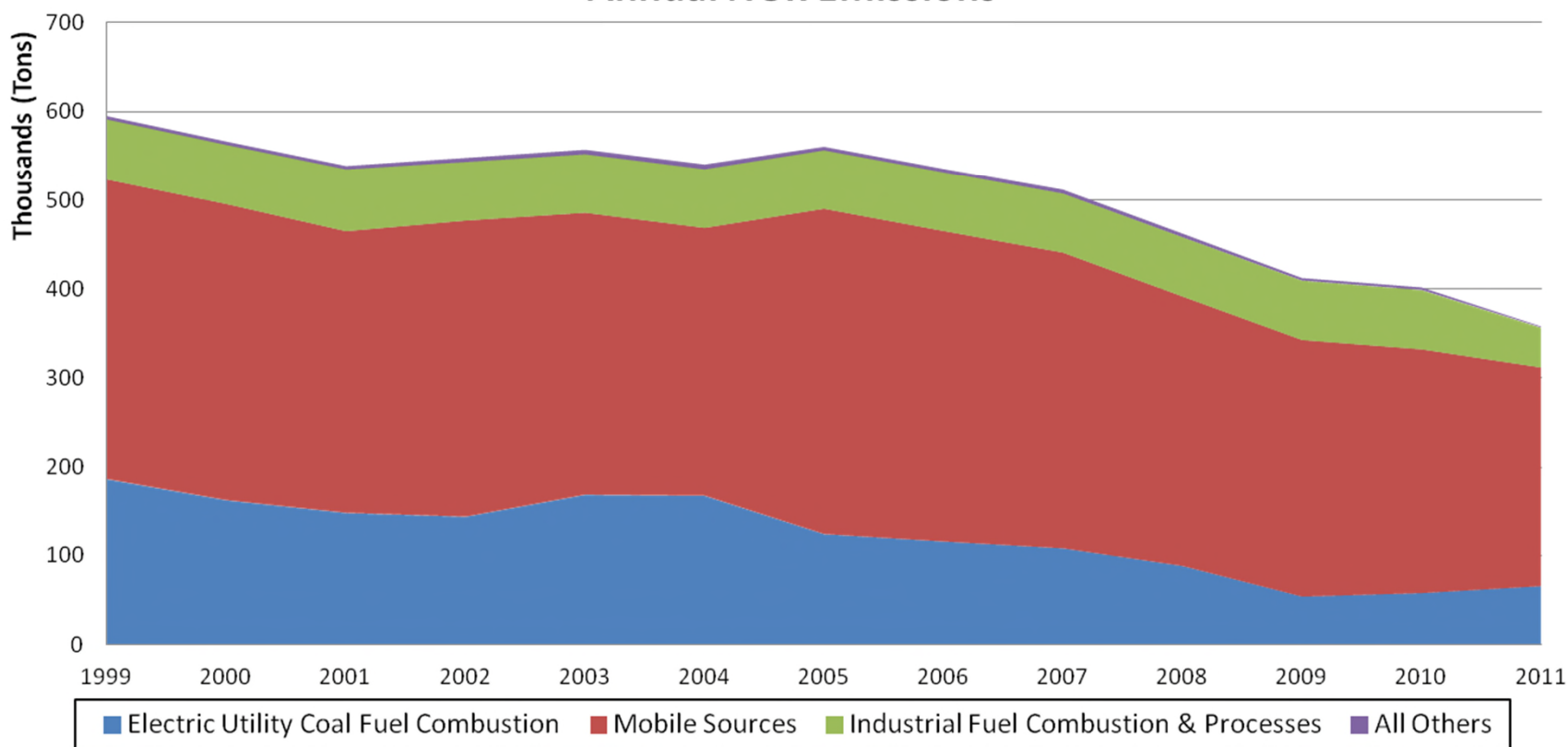
Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	185,571	147,673	168,087	123,877	115,539	107,896	88,091	53,695	57,654	65,421
Mobile Sources	337,015	316,723	317,062	365,797	349,166	332,536	303,226	288,851	274,475	246,287
Industrial Fuel Combustion & Processes	69,262	70,758	67,159	67,120	66,989	66,855	66,720	66,587	66,455	44,585
All Others	3,742	3,838	5,221	4,069	3,963	4,486	3,989	2,653	2,717	1,009
<b>Total</b>	<b>595,590</b>	<b>538,993</b>	<b>557,529</b>	<b>560,863</b>	<b>535,657</b>	<b>511,773</b>	<b>462,027</b>	<b>411,786</b>	<b>401,300</b>	<b>357,302</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%	-20%	-9%	-33%	-38%	-42%	-53%	-71%	-69%	-65%
Mobile Sources	0%	-6%	-6%	9%	4%	-1%	-10%	-14%	-19%	-27%
Industrial Fuel Combustion & Processes	0%	2%	-3%	-3%	-3%	-3%	-4%	-4%	-4%	-36%
All Others	0%	3%	40%	9%	6%	20%	7%	-29%	-27%	-73%
<b>Total</b>	<b>0%</b>	<b>-10%</b>	<b>-6%</b>	<b>-6%</b>	<b>-10%</b>	<b>-14%</b>	<b>-22%</b>	<b>-31%</b>	<b>-33%</b>	<b>-40%</b>



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

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



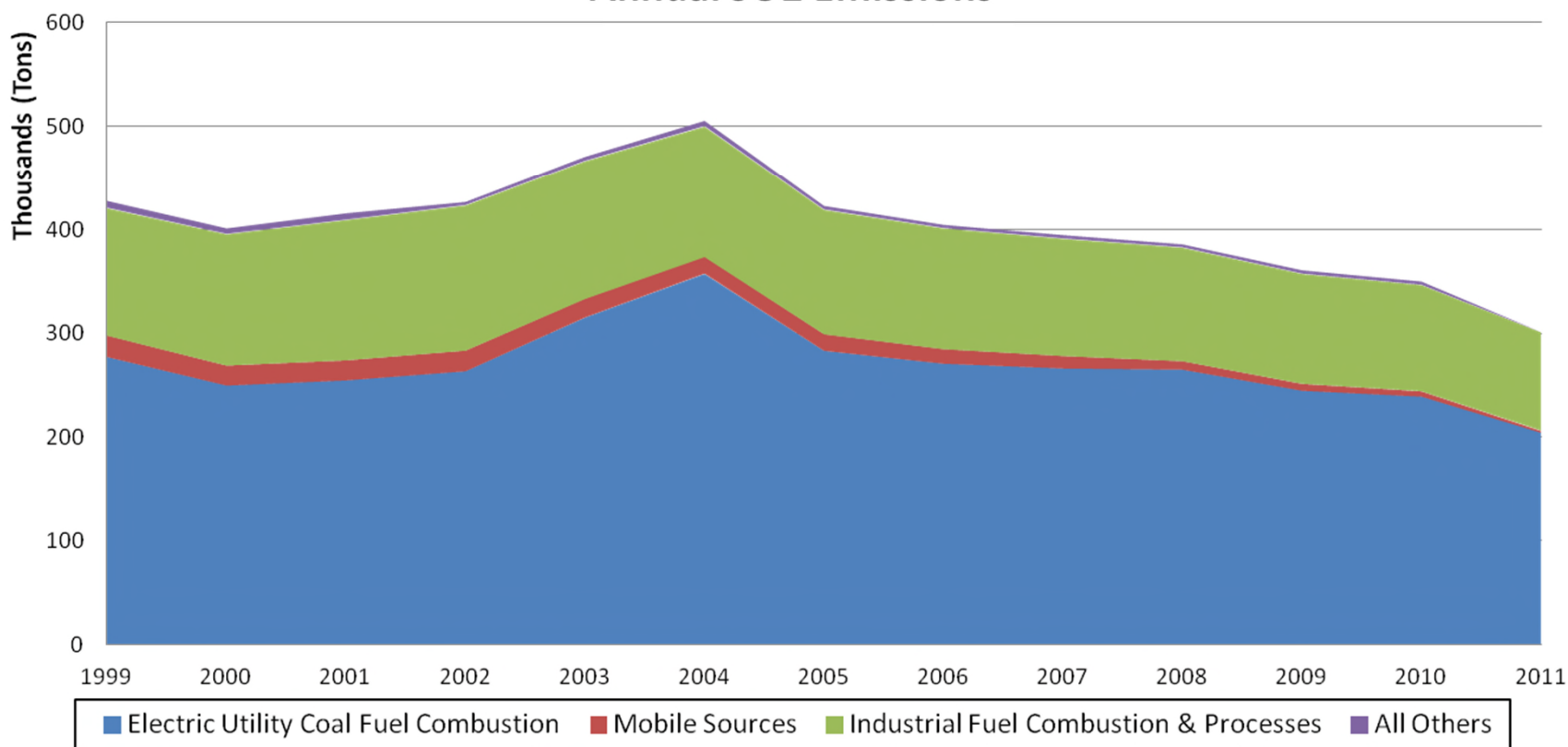
# Missouri Emission Trends (SO<sub>2</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	277,492	255,177	315,298	283,458	271,108	266,564	265,418	245,268	239,631	205,098
Mobile Sources	20,669	19,257	18,242	16,013	14,030	12,047	8,190	6,625	5,061	1,832
Industrial Fuel Combustion & Processes	122,665	134,952	133,114	119,784	116,255	112,725	109,196	105,667	102,138	94,402
All Others	6,552	6,012	3,694	3,283	2,945	3,059	2,732	3,080	2,967	38
<b>Total</b>	<b>427,377</b>	<b>415,397</b>	<b>470,348</b>	<b>422,537</b>	<b>404,338</b>	<b>394,395</b>	<b>385,537</b>	<b>360,640</b>	<b>349,796</b>	<b>301,370</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%	-8%	14%	2%	-2%	-4%	-4%	-12%	-14%	-26%
Mobile Sources	0%	-7%	-12%	-23%	-32%	-42%	-60%	-68%	-76%	-91%
Industrial Fuel Combustion & Processes	0%	10%	9%	-2%	-5%	-8%	-11%	-14%	-17%	-23%
All Others	0%	-8%	-44%	-50%	-55%	-53%	-58%	-53%	-55%	-99%
<b>Total</b>	<b>0%</b>	<b>-3%</b>	<b>10%</b>	<b>-1%</b>	<b>-5%</b>	<b>-8%</b>	<b>-10%</b>	<b>-16%</b>	<b>-18%</b>	<b>-29%</b>

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

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



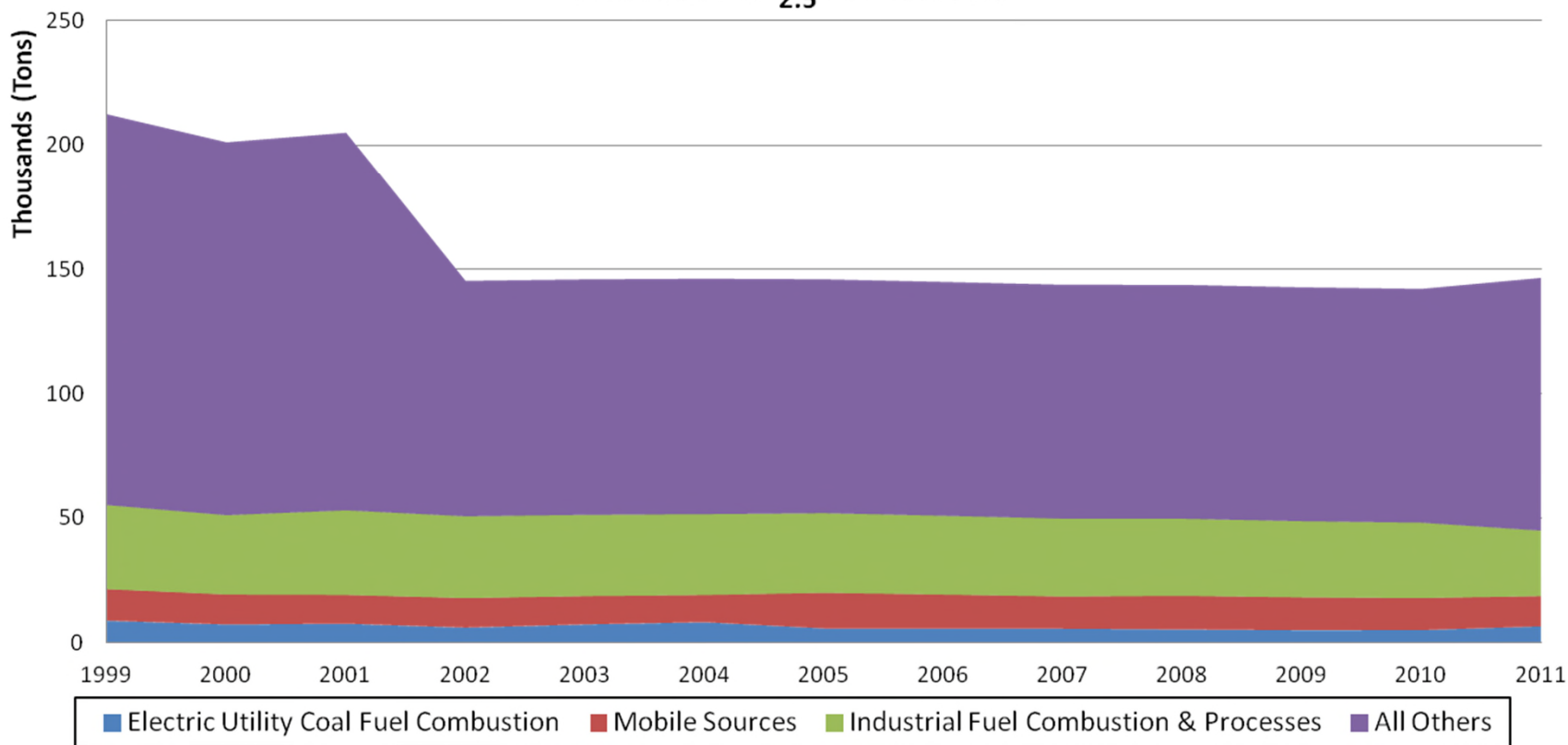
# Missouri Emission Trends (PM<sub>2.5</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	8,653	7,435	7,122	5,533	5,501	5,411	5,128	4,802	4,857	6,377
Mobile Sources	12,810	11,699	11,536	14,467	13,784	13,100	13,662	13,347	13,032	12,276
Industrial Fuel Combustion & Processes	33,875	34,090	32,773	32,088	31,749	31,410	31,071	30,731	30,392	26,410
All Others	157,078	151,812	94,546	93,914	93,916	93,920	93,916	93,913	93,909	101,494
<b>Total</b>	<b>212,416</b>	<b>205,035</b>	<b>145,976</b>	<b>146,003</b>	<b>144,950</b>	<b>143,841</b>	<b>143,777</b>	<b>142,793</b>	<b>142,190</b>	<b>146,557</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%	-14%	-18%	-36%	-36%	-37%	-41%	-45%	-44%	-26%
Mobile Sources	0%	-9%	-10%	13%	8%	2%	7%	4%	2%	-4%
Industrial Fuel Combustion & Processes	0%	1%	-3%	-5%	-6%	-7%	-8%	-9%	-10%	-22%
All Others	0%	-3%	-40%	-40%	-40%	-40%	-40%	-40%	-40%	-35%
<b>Total</b>	<b>0%</b>	<b>-3%</b>	<b>-31%</b>	<b>-31%</b>	<b>-32%</b>	<b>-32%</b>	<b>-32%</b>	<b>-33%</b>	<b>-33%</b>	<b>-31%</b>

# Missouri 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 Missouri
- NOx and SO2 from Electric Utility Fuel Combustion sources show significant decrease over time as a result of 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

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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>

# State-Wide Design Value (DV) Trends

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- 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

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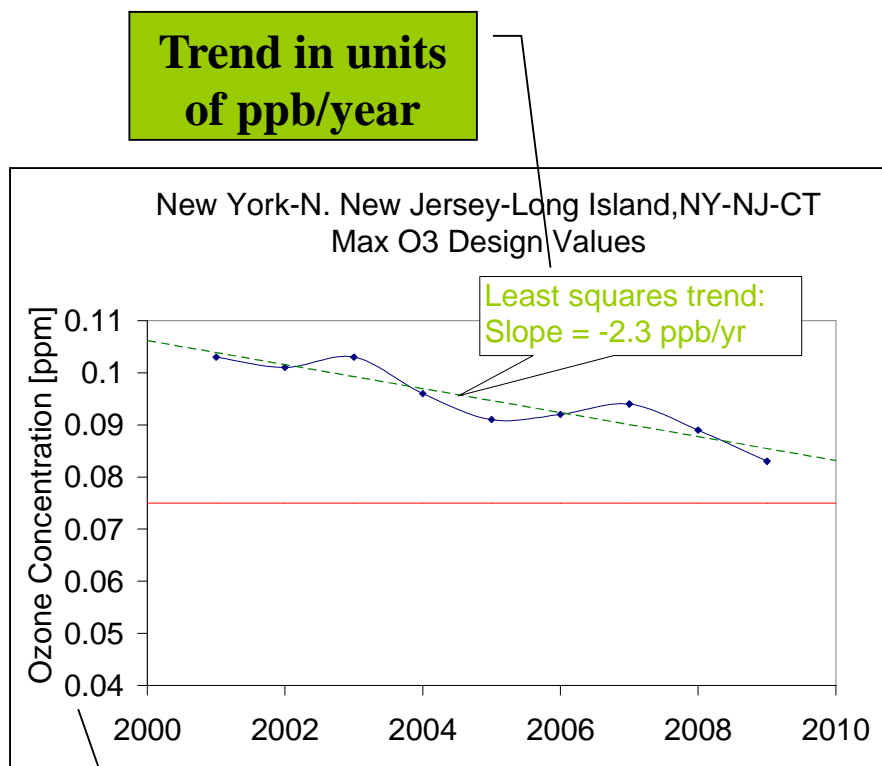
- O<sub>3</sub> design value (DV) for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculated using annual 4<sup>th</sup> highest daily max 8-hr averages and percent of valid observations, based on EPA data handling conventions
  - Data associated with exceptional 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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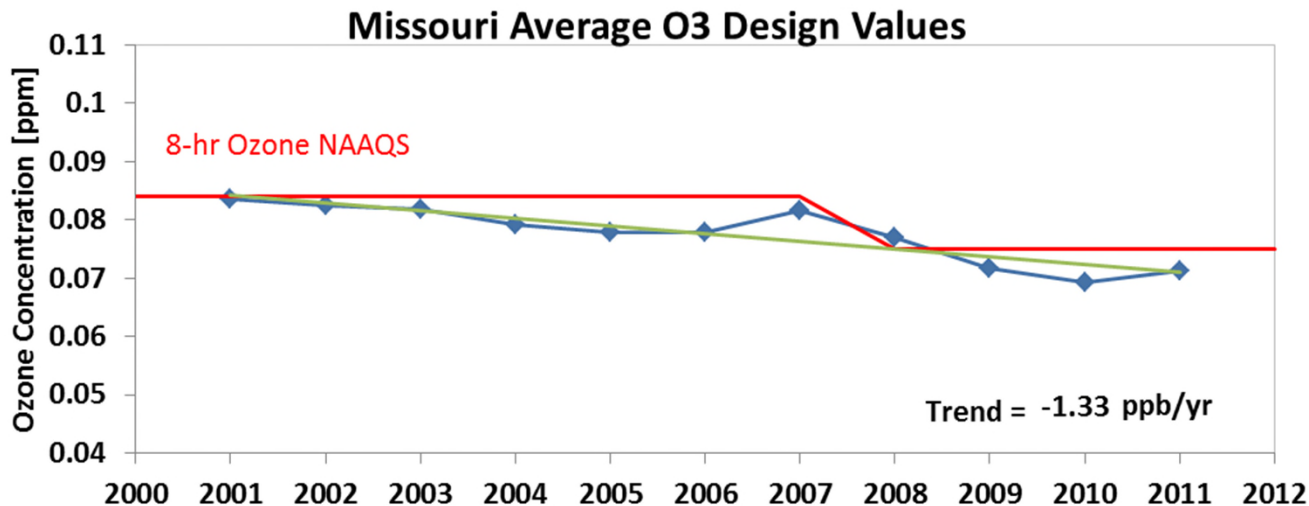
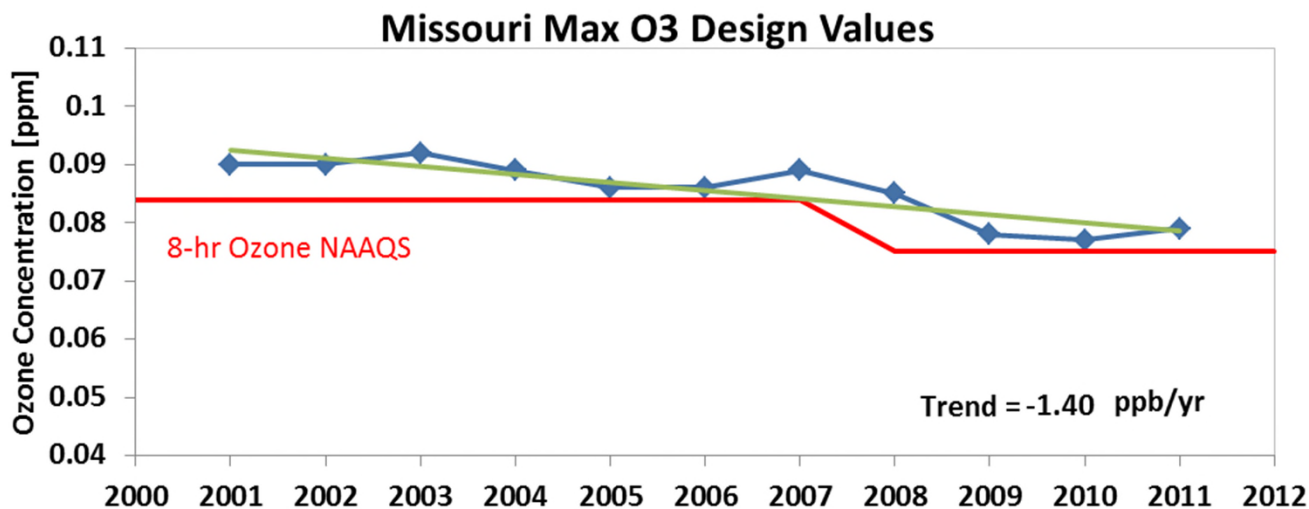
- Annual  $PM_{2.5}$  DV and 24-hr  $PM_{2.5}$  DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculations based on EPA data handling conventions
  - Data extracted from monitors that have a non-regulatory monitoring type are omitted
  - Selection 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 O<sub>3</sub> DVs and Trend



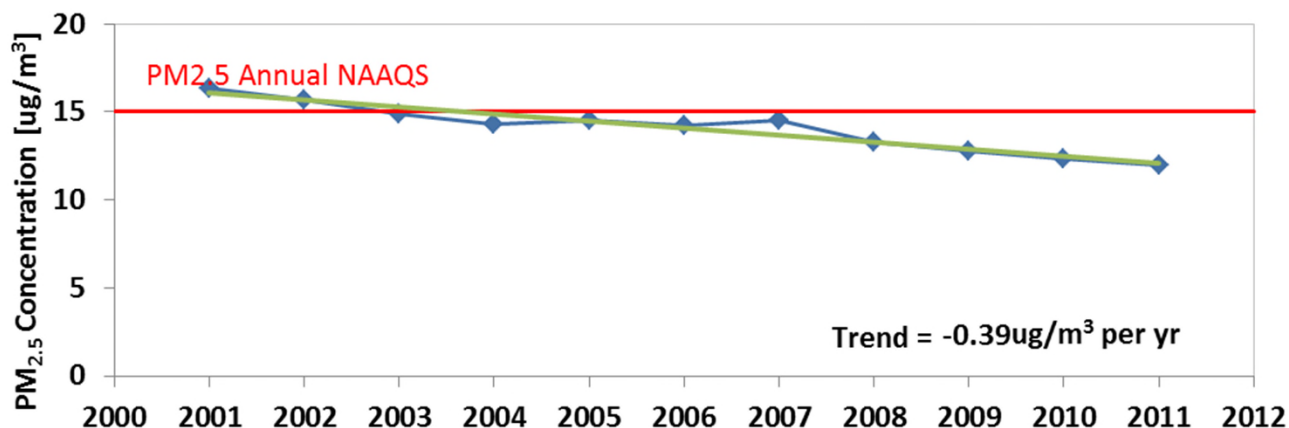
# Ozone Trends by Site in Missouri

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
2903700034420101	Cass, MO	0.067	-1.50
2903900014420101	Cedar, MO	0.068	-1.77
2904700034420101	Clay, MO	0.075	-0.72
2904700054420101	Clay, MO	0.073	-1.29
2907700364420101	Greene, MO	0.067	-0.63
2913700014420101	Monroe, MO	0.067	-1.44
2918310024420101	St. Charles, MO	0.079	-1.36
2918310044420101	St. Charles, MO	0.075	-1.78
2918600054420101	Ste. Genevieve, MO	0.07	-1.38

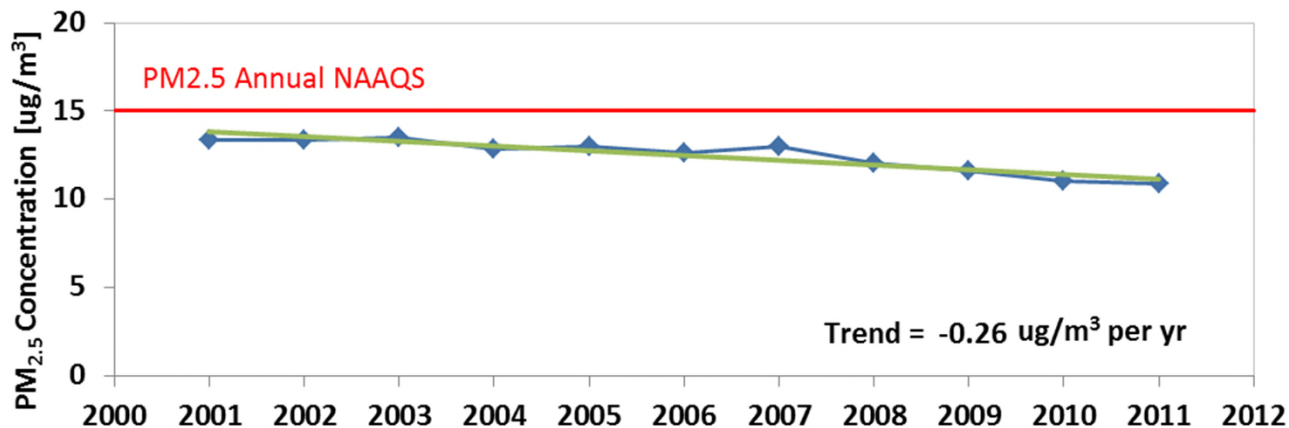
Note: Only monitoring sites meeting data completeness criteria listed

# Max/Ave PM<sub>2.5</sub> Annual DVs and Trend

Missouri Max PM<sub>2.5</sub> Annual Design Values

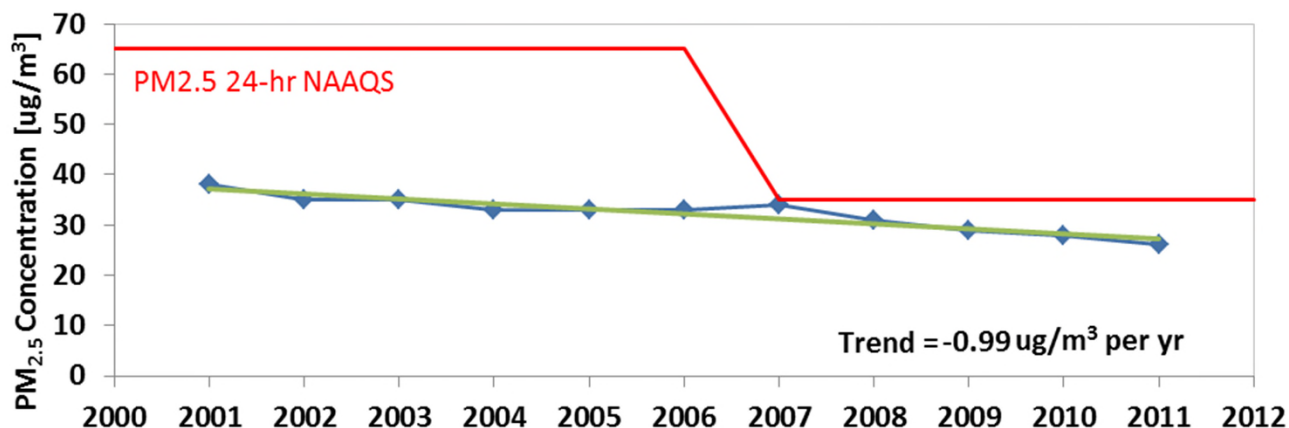


Missouri Average PM<sub>2.5</sub> Annual Design Values

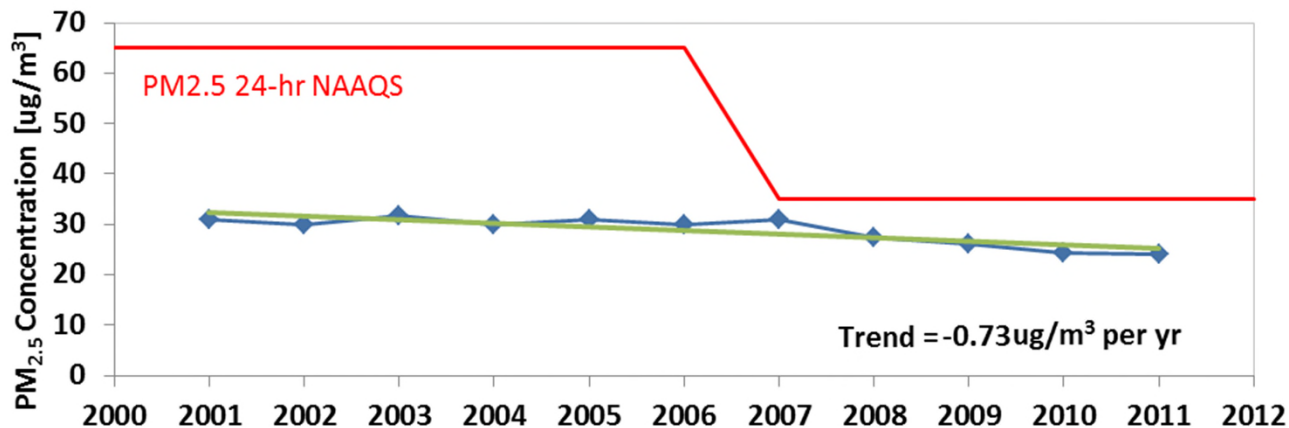


# Max/Ave PM<sub>2.5</sub> 24-Hour DVs and Trend

Missouri Max PM<sub>2.5</sub> 24-Hour Design Values



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



# PM<sub>2.5</sub> Trends by Site in Missouri

Monitoring Site	County	2009-2011 DV [ug/m <sup>3</sup> ]		Trend [ug/m <sup>3</sup> per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
290470005	Clay	9.5	22	-0.24	-0.65
290770032	Greene	10.1	22	-0.24	-0.72
295100007	St. Louis city	12.0	26	-0.36	-1.17
295100085	St. Louis city	12.0	26	-0.40	-0.95

Note: Only monitoring sites meeting data completeness criteria listed



# Air Quality Trends Summary

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- Average O<sub>3</sub> and PM<sub>2.5</sub> design values have decreased since 1999 in Missouri.
- O<sub>3</sub> design values have decreased in St. Louis-St. Charles-Farmington, MO-IL, the only currently designated O<sub>3</sub> non-attainment area in Missouri. Annual PM<sub>2.5</sub> design values have also decreased in St. Louis, MO-IL, the only currently designated PM<sub>2.5</sub> non-attainment area in Missouri.