

Emission and Air Quality Trends Review 1999-2011

Vermont

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

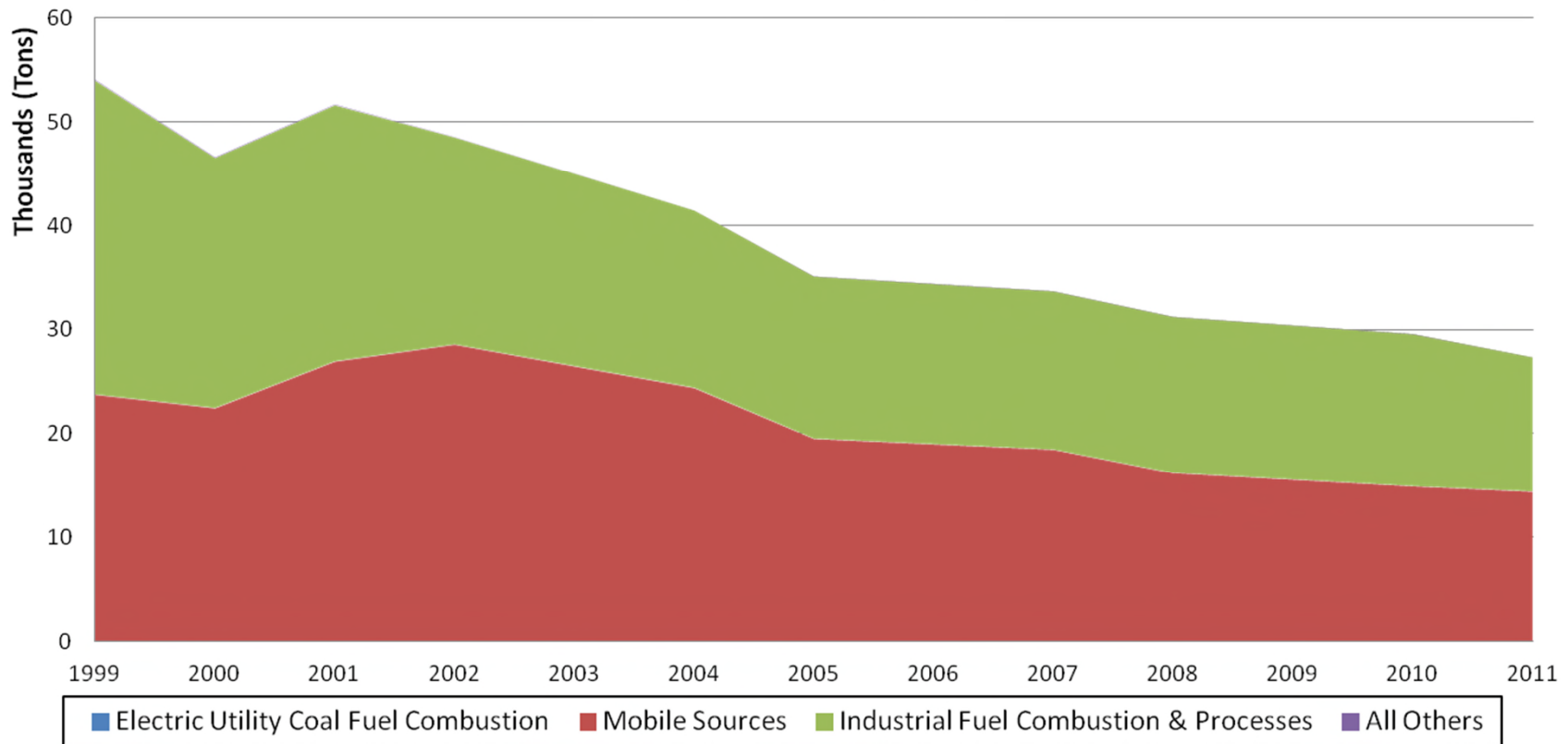
Vermont Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0	0	0	0	0	0	0	0	0	0
Mobile Sources	23,764	26,954	26,499	19,517	18,985	18,453	16,172	15,526	14,880	14,362
Industrial Fuel Combustion & Processes	30,246	24,696	18,497	15,577	15,400	15,223	15,045	14,868	14,691	12,963
All Others	48	45	14	25	29	31	29	26	29	17
Total	54,059	51,694	45,010	35,118	34,414	33,706	31,246	30,420	29,600	27,342

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%	0%	0%	0%	0%	0%	0%	0%	0%
Mobile Sources	0%	13%	12%	-18%	-20%	-22%	-32%	-35%	-37%	-40%
Industrial Fuel Combustion & Processes	0%	-18%	-39%	-49%	-49%	-50%	-50%	-51%	-51%	-57%
All Others	0%	-6%	-71%	-48%	-39%	-36%	-39%	-46%	-39%	-65%
Total	0%	-4%	-17%	-35%	-36%	-38%	-42%	-44%	-45%	-49%

Vermont Emission Trends (VOC)

**Major Source Category Summary
Annual VOC Emissions**



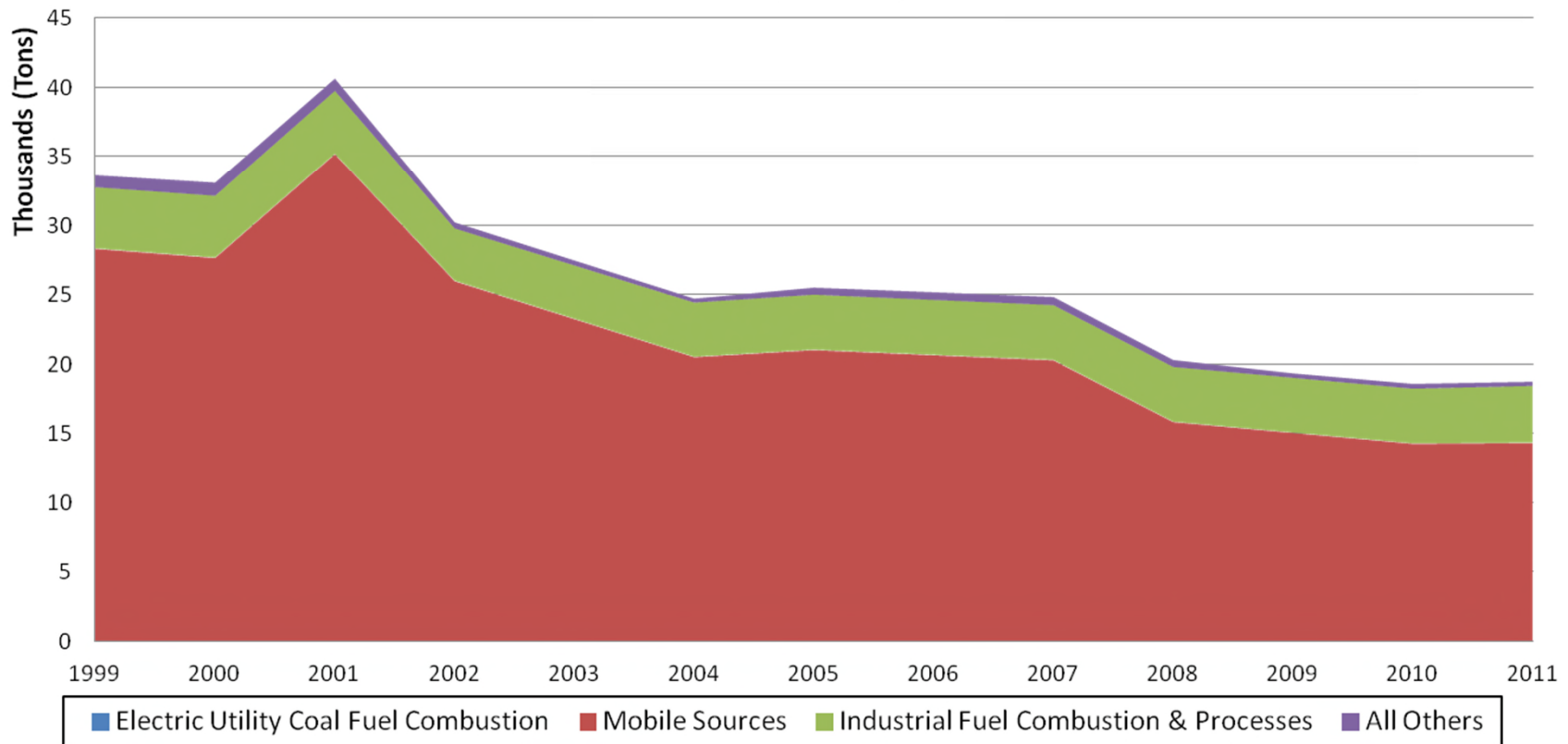
Vermont Emission Trends (NO_x)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0	0	0	0	0	0	0	0	0	0
Mobile Sources	28,335	35,205	23,263	21,032	20,661	20,289	15,838	15,057	14,275	14,328
Industrial Fuel Combustion & Processes	4,437	4,582	3,854	3,980	3,975	3,970	3,965	3,960	3,955	4,109
All Others	871	884	361	504	550	583	502	321	350	298
Total	33,643	40,672	27,477	25,516	25,186	24,843	20,306	19,338	18,580	18,735

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%	0%	0%	0%	0%	0%	0%	0%	0%
Mobile Sources	0%	24%	-18%	-26%	-27%	-28%	-44%	-47%	-50%	-49%
Industrial Fuel Combustion & Processes	0%	3%	-13%	-10%	-10%	-11%	-11%	-11%	-11%	-7%
All Others	0%	1%	-59%	-42%	-37%	-33%	-42%	-63%	-60%	-66%
Total	0%	21%	-18%	-24%	-25%	-26%	-40%	-43%	-45%	-44%

Vermont Emission Trends (NO_x)

Major Source Category Summary
Annual NO_x Emissions



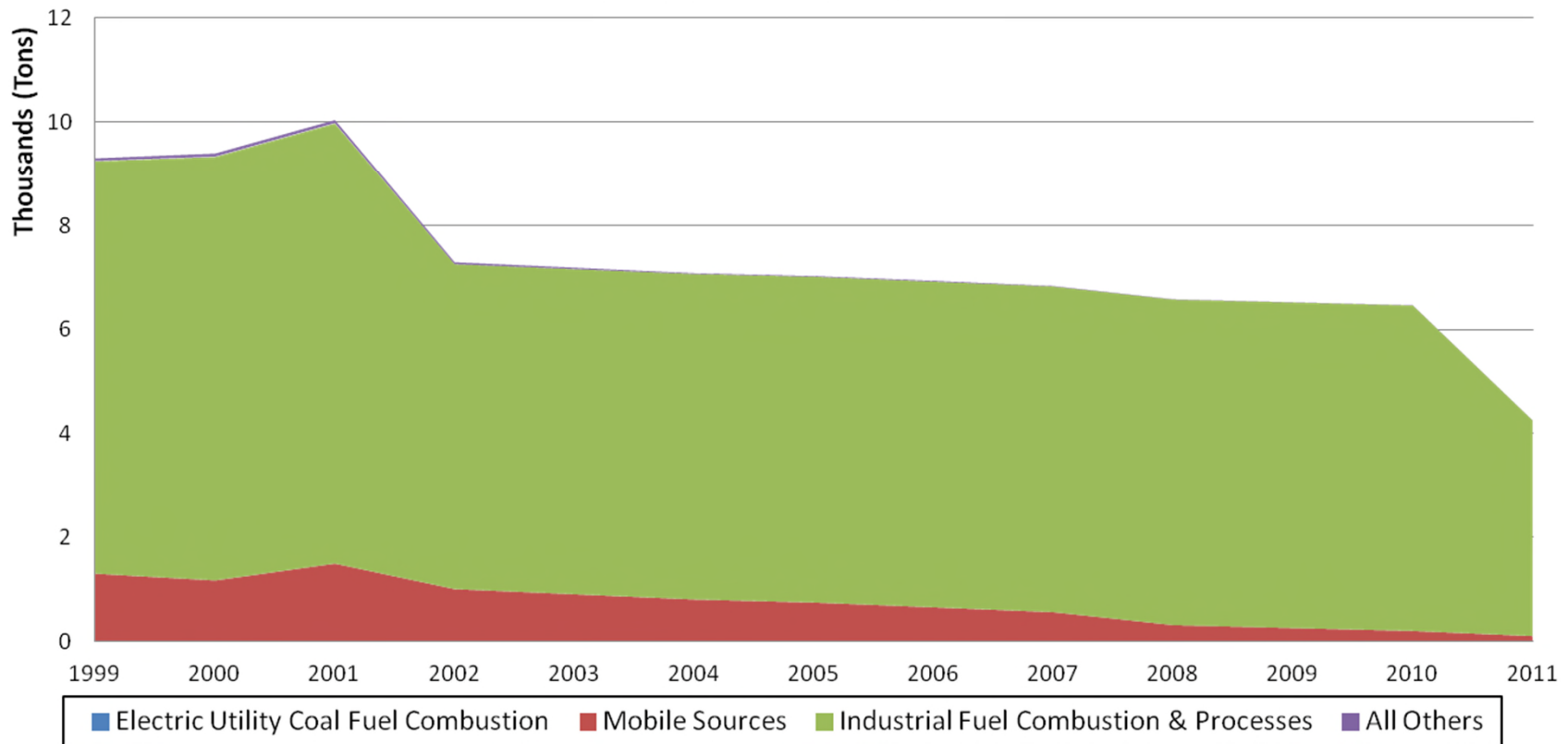
Vermont Emission Trends (SO₂)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0	0	0	0	0	0	0	0	0	0
Mobile Sources	1,293	1,487	896	737	644	551	302	245	189	91
Industrial Fuel Combustion & Processes	7,957	8,491	6,266	6,278	6,278	6,277	6,277	6,276	6,275	4,165
All Others	47	55	25	13	15	9	5	5	5	4
Total	9,296	10,033	7,187	7,029	6,937	6,837	6,584	6,526	6,469	4,260

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%	0%	0%	0%	0%	0%	0%	0%	0%
Mobile Sources	0%	15%	-31%	-43%	-50%	-57%	-77%	-81%	-85%	-93%
Industrial Fuel Combustion & Processes	0%	7%	-21%	-21%	-21%	-21%	-21%	-21%	-21%	-48%
All Others	0%	17%	-46%	-72%	-67%	-81%	-89%	-89%	-89%	-92%
Total	0%	8%	-23%	-24%	-25%	-26%	-29%	-30%	-30%	-54%

Vermont Emission Trends (SO₂)

Major Source Category Summary
Annual SO₂ Emissions



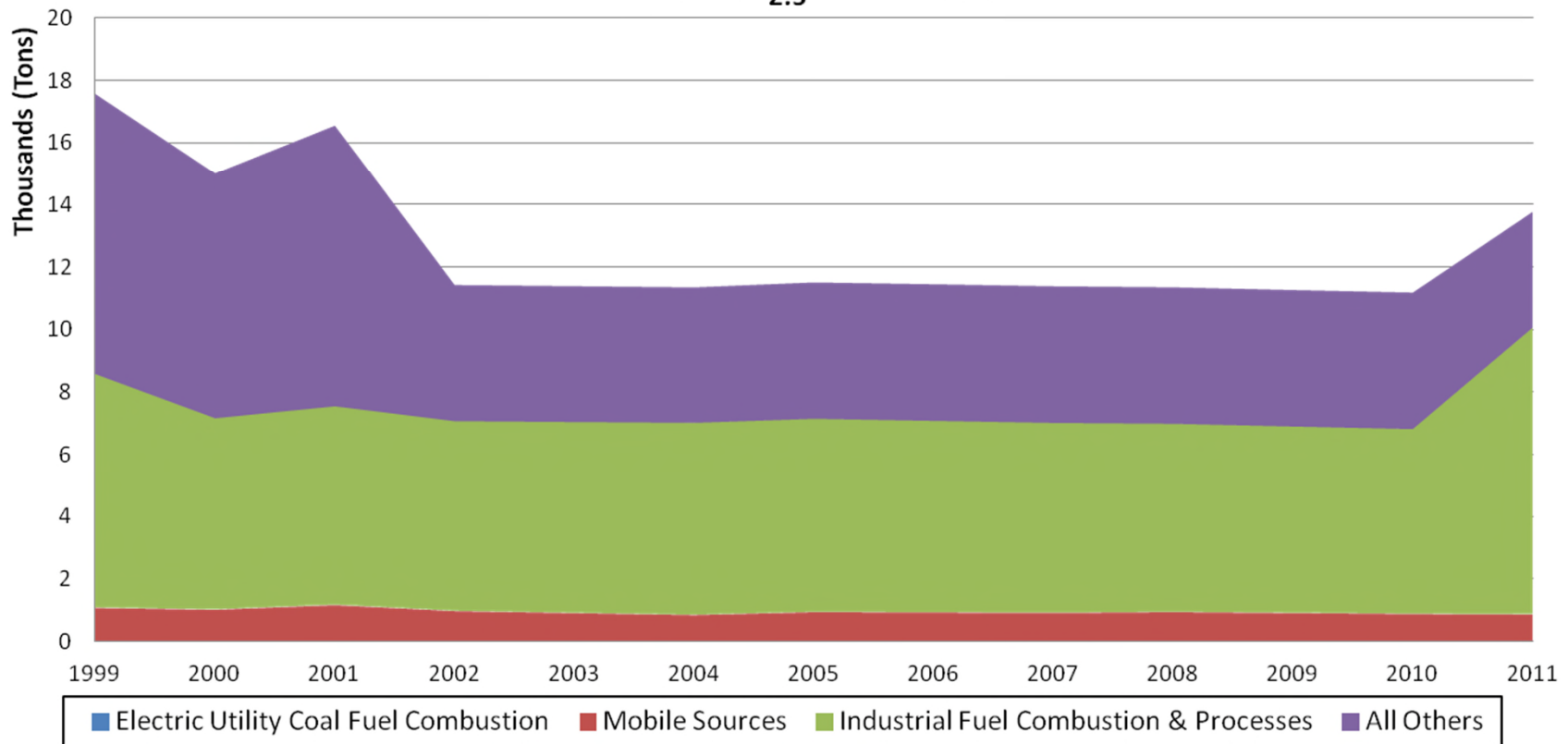
Vermont Emission Trends (PM_{2.5})

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0	0	0	0	0	0	0	0	0	0
Mobile Sources	1,078	1,170	912	942	930	918	942	912	882	867
Industrial Fuel Combustion & Processes	7,513	6,393	6,150	6,223	6,169	6,115	6,061	6,007	5,953	9,205
All Others	8,973	8,988	4,335	4,353	4,360	4,362	4,359	4,354	4,360	3,697
Total	17,564	16,551	11,397	11,517	11,459	11,395	11,363	11,273	11,194	13,769

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%	0%	0%	0%	0%	0%	0%	0%	0%
Mobile Sources	0%	9%	-15%	-13%	-14%	-15%	-13%	-15%	-18%	-20%
Industrial Fuel Combustion & Processes	0%	-15%	-18%	-17%	-18%	-19%	-19%	-20%	-21%	23%
All Others	0%	0%	-52%	-51%	-51%	-51%	-51%	-51%	-51%	-59%
Total	0%	-6%	-35%	-34%	-35%	-35%	-35%	-36%	-36%	-22%

Vermont 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 Vermont
- 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

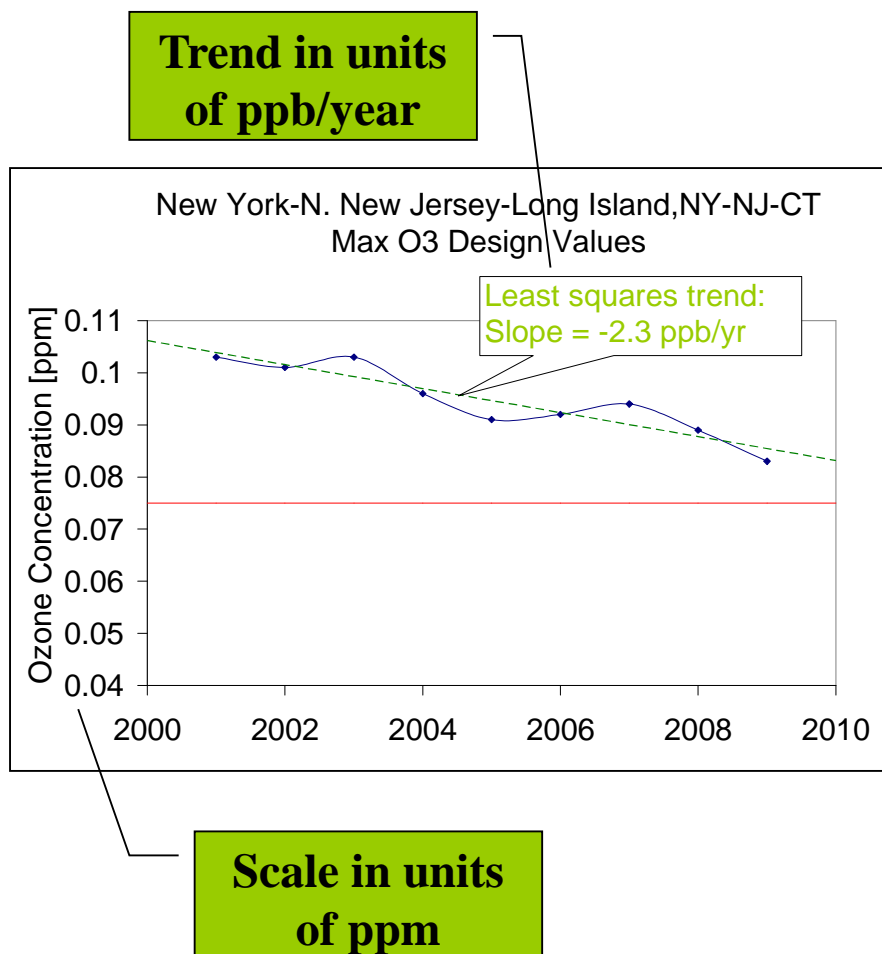
Data Handling Procedures

- 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

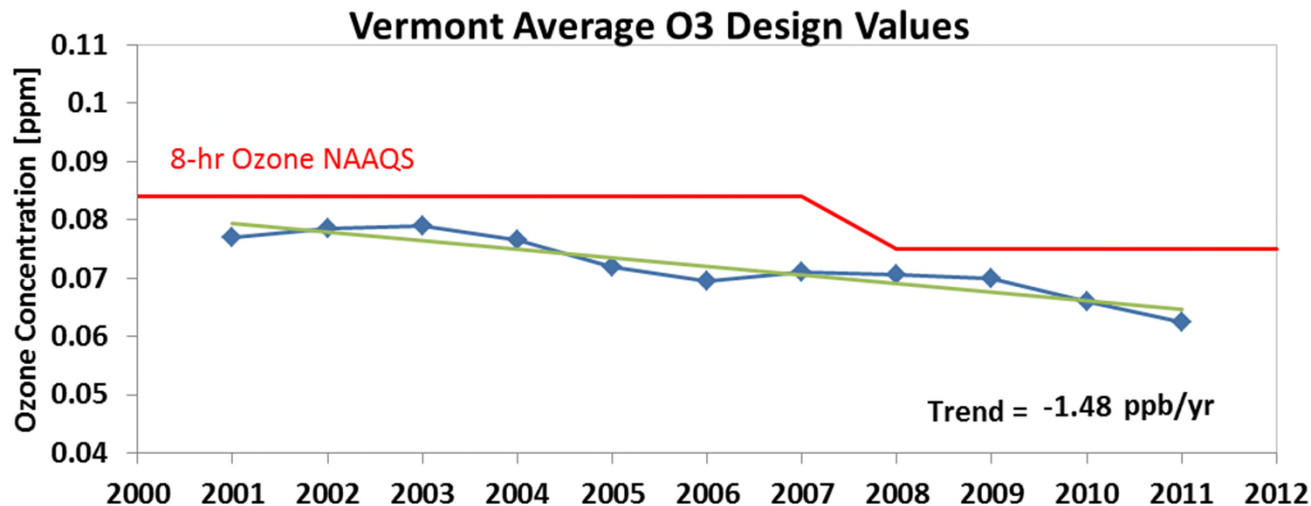
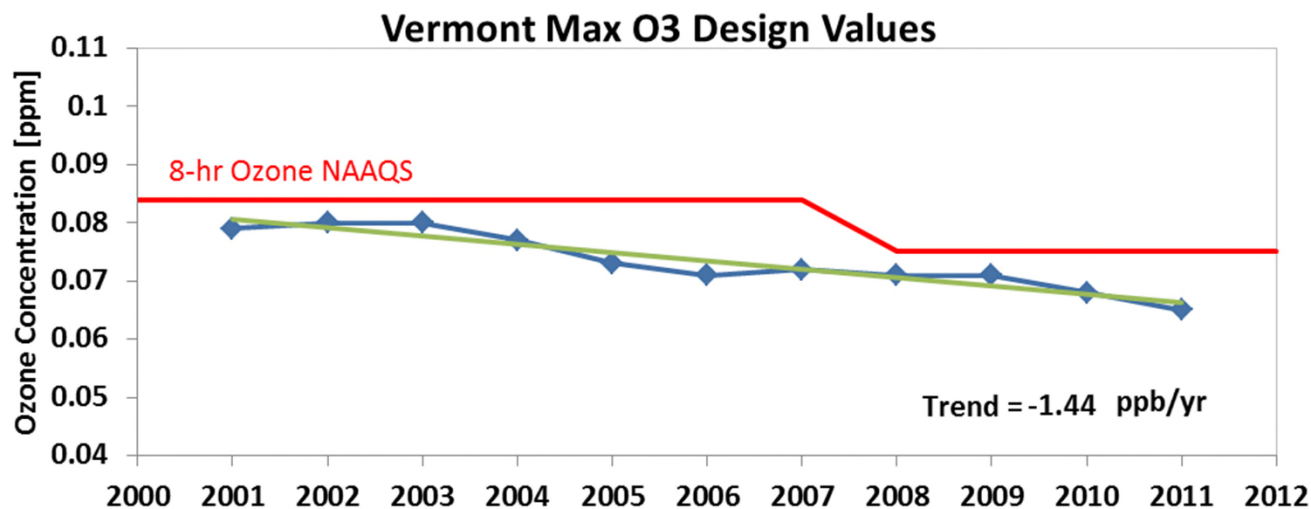
- Annual PM_{2.5} DV and 24-hr PM_{2.5} DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculations based on EPA data handling conventions
 - Data extracted from monitors that have a non-regulatory monitoring type are omitted
 - Selection of trend sites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



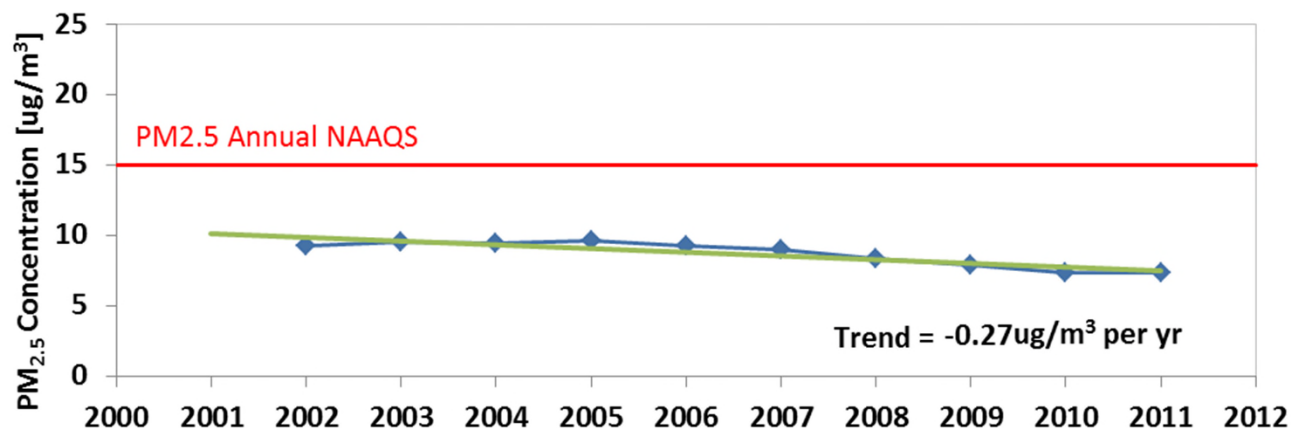
Ozone Trends by Site in Vermont

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
5000300044420101	Bennington, VT	0.065	-1.44
5000700074420101	Chittenden, VT	0.06	-1.52

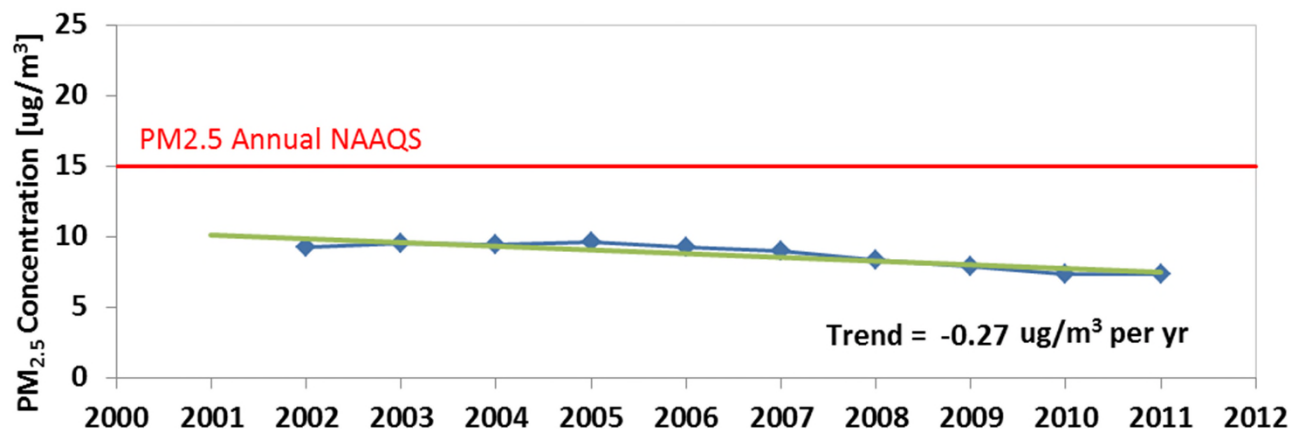
Note: Only monitoring sites meeting data completeness criteria listed

Max/Ave PM_{2.5} Annual DVs and Trend

Vermont Max PM_{2.5} Annual Design Values

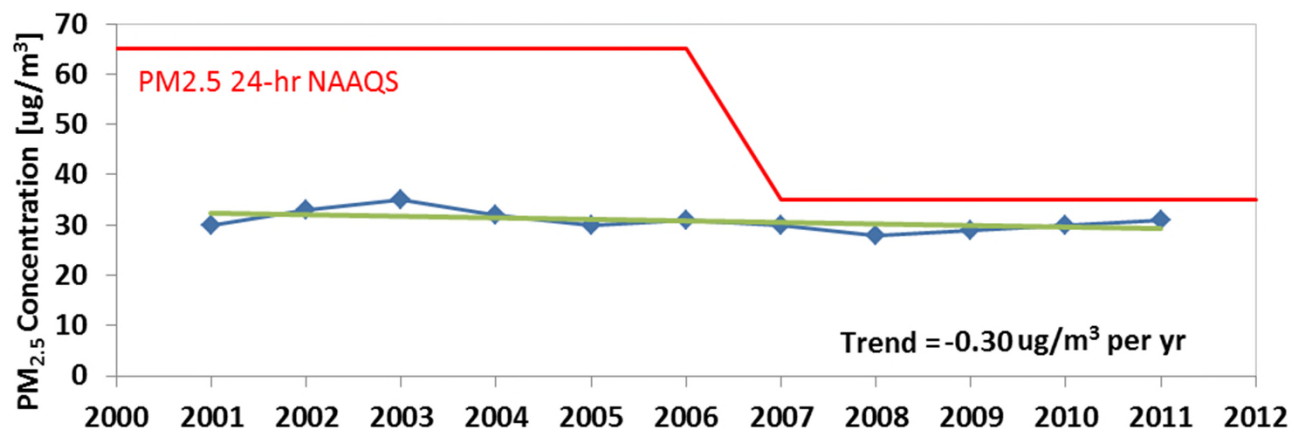


Vermont Average PM_{2.5} Annual Design Values

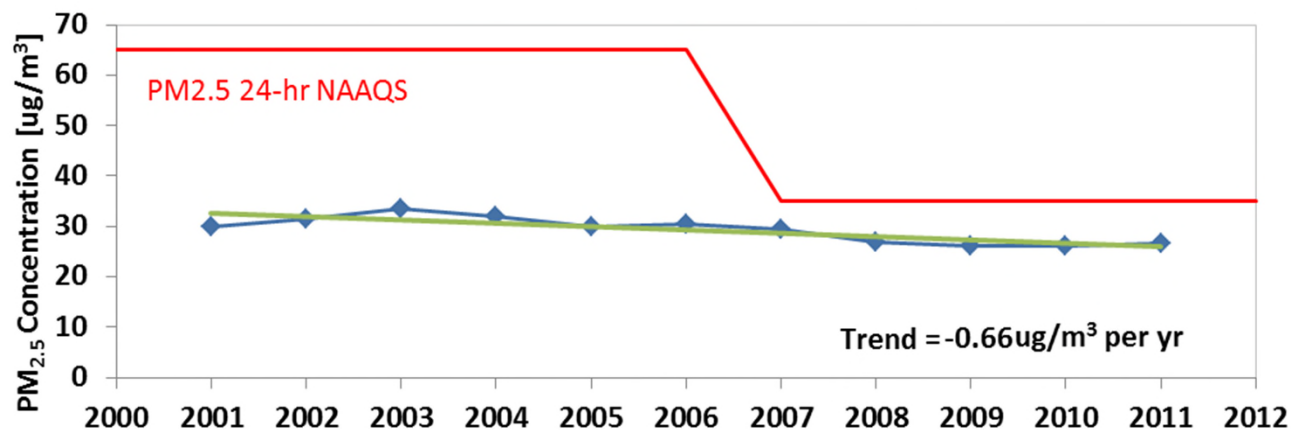


Max/Ave PM_{2.5} 24-Hour DVs and Trend

Vermont Max PM_{2.5} 24-Hour Design Values



Vermont Average PM_{2.5} 24-Hour Design Values



PM_{2.5} Trends by Site in Vermont

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
500070012	Chittenden	7.3	22	-0.27	-1.21
500210002	Rutland	N/A	31	N/A	-0.30

Note: Only monitoring sites meeting data completeness criteria listed

Air Quality Trends Summary

- ▣ Based on data from two monitoring stations separately for O_3 and for $PM_{2.5}$, average O_3 and 24-hr $PM_{2.5}$ design values have decreased since 1999 in Vermont; average annual $PM_{2.5}$ design values have decreased since 2000 (incomplete data in 1999)
- ▣ There are no currently designated O_3 or $PM_{2.5}$ non-attainment areas in Vermont