

Emission and Air Quality Trends Review 1999-2011

California

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

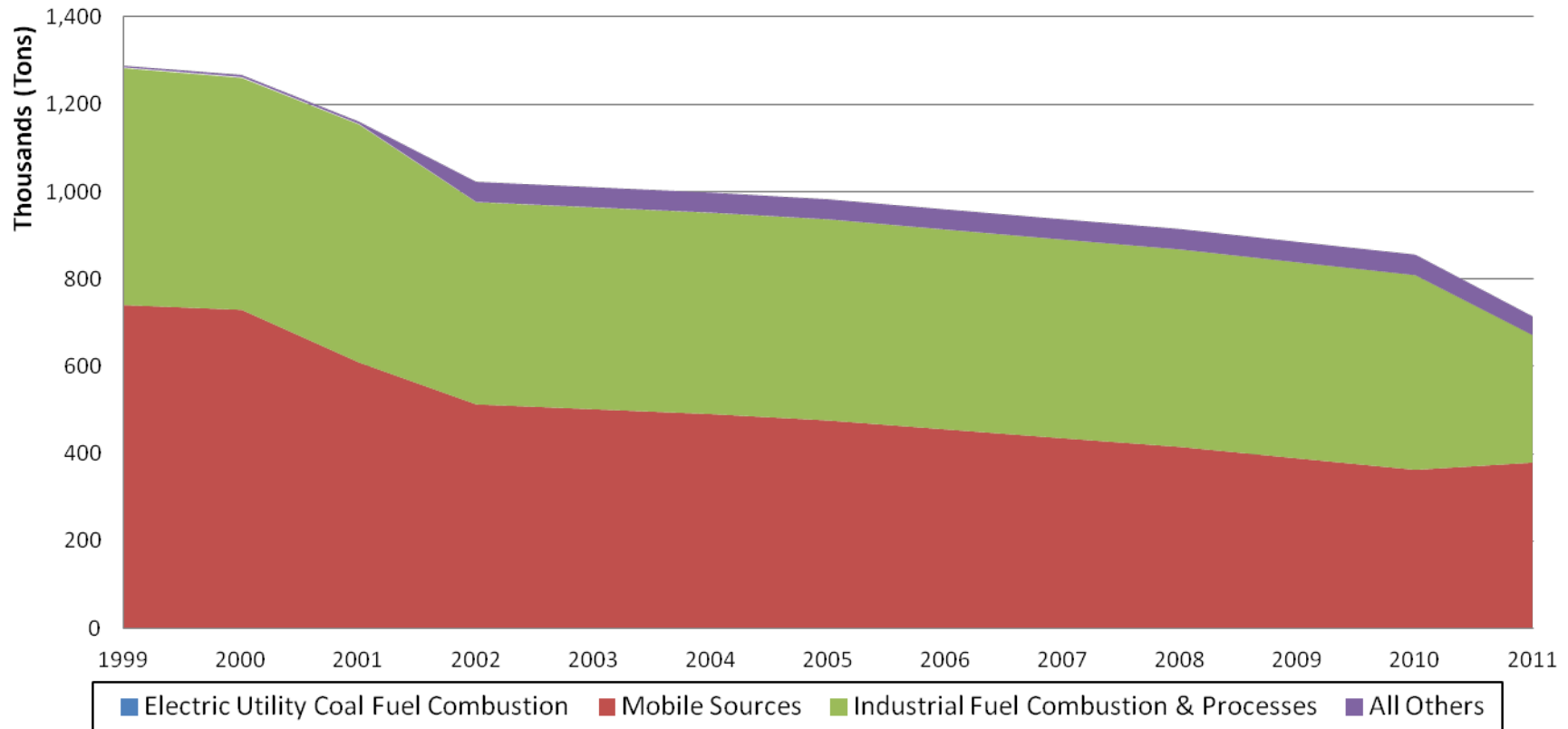
California Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0	0	4	2	2	2	1	1	1	5
Mobile Sources	740,112	608,531	501,217	475,530	455,075	434,621	414,767	388,499	362,231	378,723
Industrial Fuel Combustion & Processes	543,555	546,012	462,952	461,266	458,358	455,789	453,111	449,838	446,924	293,398
All Others	3,332	5,175	45,736	45,485	45,840	46,185	46,505	46,750	46,993	42,941
Total	1,286,999	1,159,718	1,009,910	982,283	959,275	936,596	914,384	885,088	856,149	715,066

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	10%	1870%	970%	820%	665%	510%	360%	205%	2185%
Mobile Sources	0%	-18%	-32%	-36%	-39%	-41%	-44%	-48%	-51%	-49%
Industrial Fuel Combustion & Processes	0%	0%	-15%	-15%	-16%	-16%	-17%	-17%	-18%	-46%
All Others	0%	55%	1273%	1265%	1276%	1286%	1296%	1303%	1310%	1189%
Total	0%	-10%	-22%	-24%	-25%	-27%	-29%	-31%	-33%	-44%

California Emission Trends (VOC)

**Major Source Category Summary
Annual VOC Emissions**



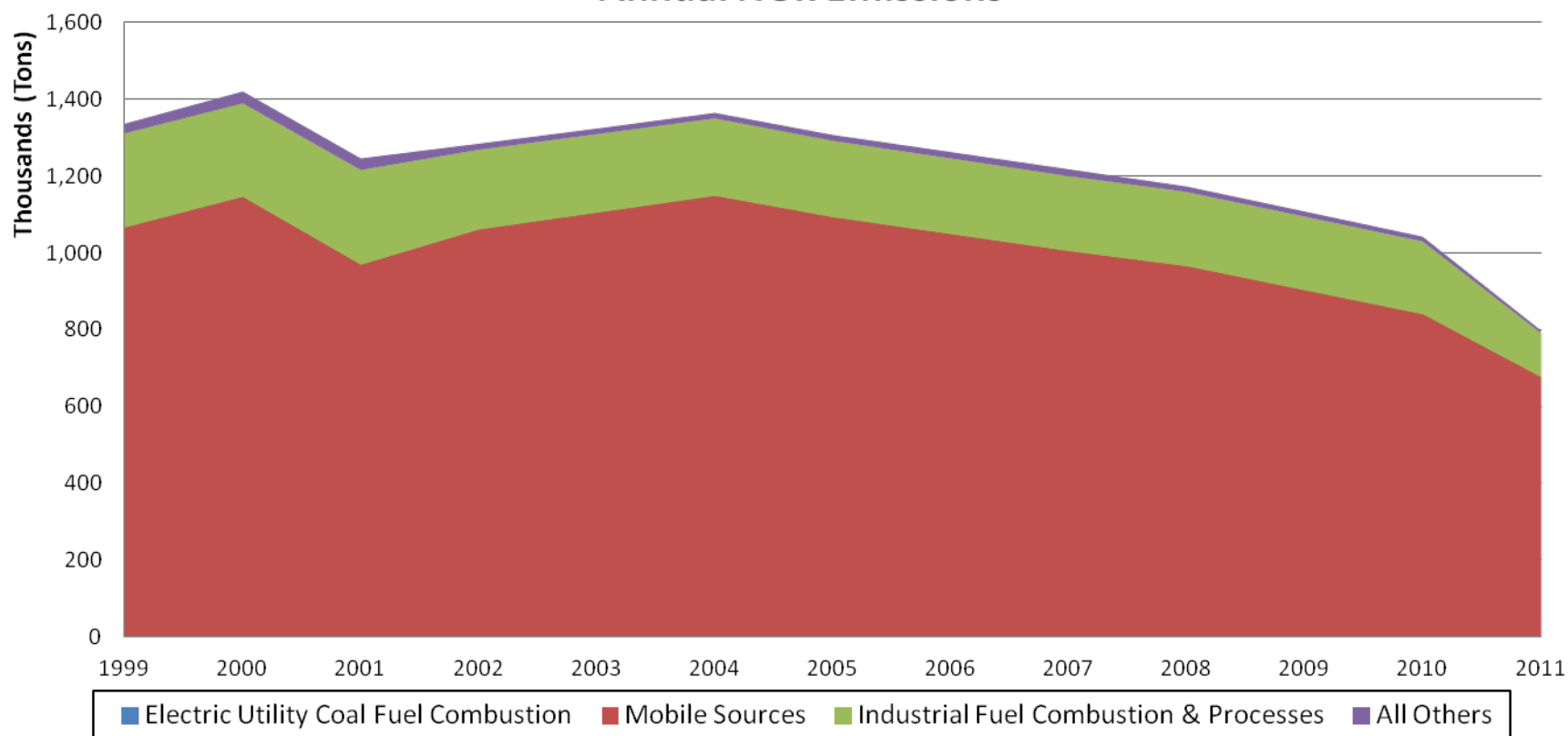
California Emission Trends (NO_x)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	471	503	440	191	163	136	109	82	54	1,001
Mobile Sources	1,066,364	969,177	1,104,904	1,093,392	1,049,231	1,005,070	965,557	903,022	840,486	675,605
Industrial Fuel Combustion & Processes	245,636	247,300	205,136	199,553	197,636	195,806	193,994	192,032	190,123	115,512
All Others	25,172	30,077	14,313	15,162	16,564	17,862	14,011	13,357	12,263	6,891
Total	1,337,642	1,247,056	1,324,792	1,308,298	1,263,595	1,218,874	1,173,672	1,108,493	1,042,926	799,008

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	7%	-7%	-59%	-65%	-71%	-77%	-83%	-88%	113%
Mobile Sources	0%	-9%	4%	3%	-2%	-6%	-9%	-15%	-21%	-37%
Industrial Fuel Combustion & Processes	0%	1%	-16%	-19%	-20%	-20%	-21%	-22%	-23%	-53%
All Others	0%	19%	-43%	-40%	-34%	-29%	-44%	-47%	-51%	-73%
Total	0%	-7%	-1%	-2%	-6%	-9%	-12%	-17%	-22%	-40%

California Emission Trends (NO_x)

**Major Source Category Summary
Annual NO_x Emissions**



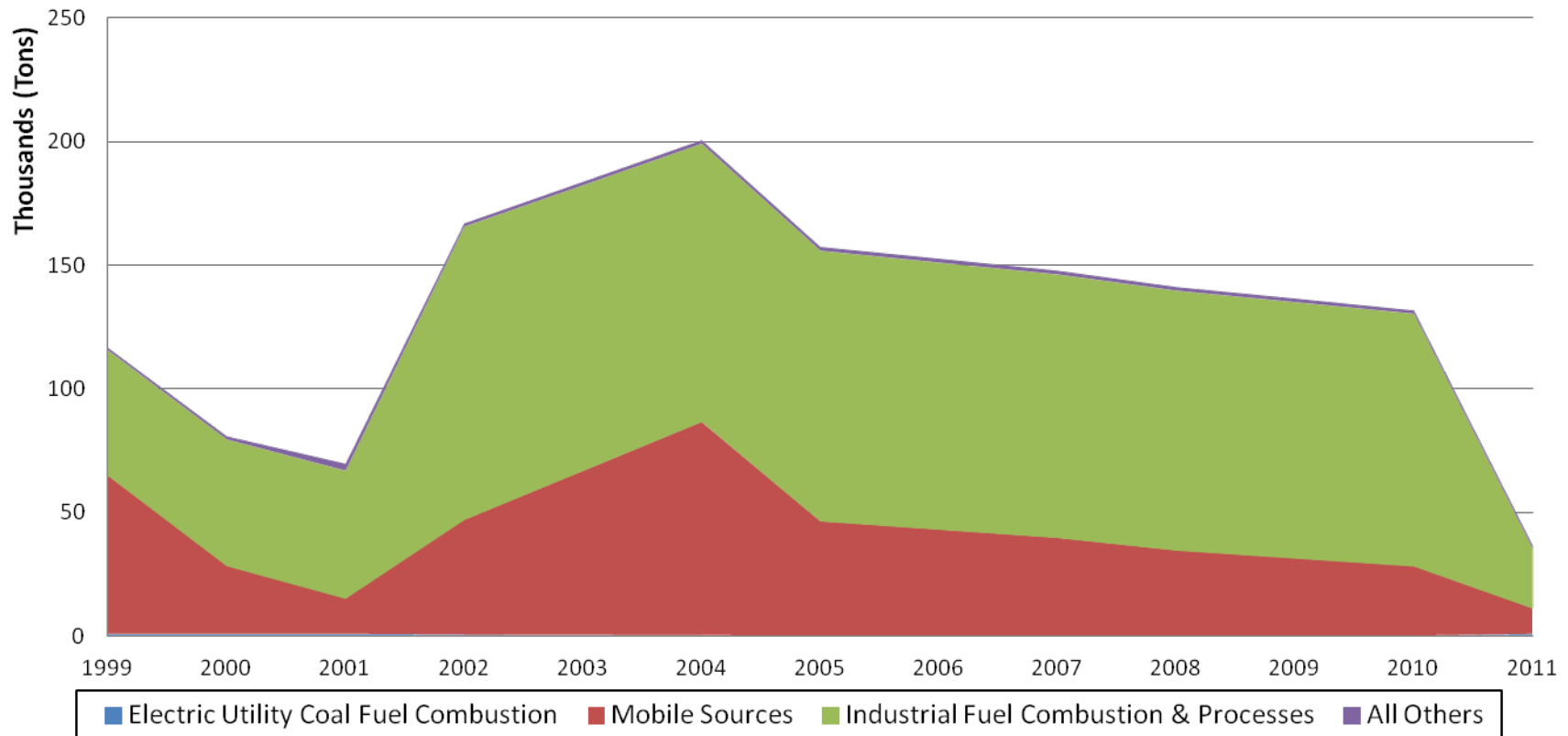
California Emission Trends (SO₂)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	631	674	288	68	58	48	39	29	19	665
Mobile Sources	64,326	14,526	66,647	46,445	43,095	39,744	34,654	31,459	28,263	10,588
Industrial Fuel Combustion & Processes	50,750	51,850	115,630	109,534	108,080	106,632	105,172	103,719	102,265	24,279
All Others	951	2,716	1,297	1,453	1,519	1,479	1,404	1,407	1,265	1,166
Total	116,658	69,766	183,862	157,499	152,751	147,904	141,270	136,614	131,813	36,699

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	7%	-54%	-89%	-91%	-92%	-94%	-95%	-97%	5%
Mobile Sources	0%	-77%	4%	-28%	-33%	-38%	-46%	-51%	-56%	-84%
Industrial Fuel Combustion & Processes	0%	2%	128%	116%	113%	110%	107%	104%	102%	-52%
All Others	0%	186%	36%	53%	60%	55%	48%	48%	33%	23%
Total	0%	-40%	58%	35%	31%	27%	21%	17%	13%	-69%

California Emission Trends (SO₂)

**Major Source Category Summary
Annual SO₂ Emissions**



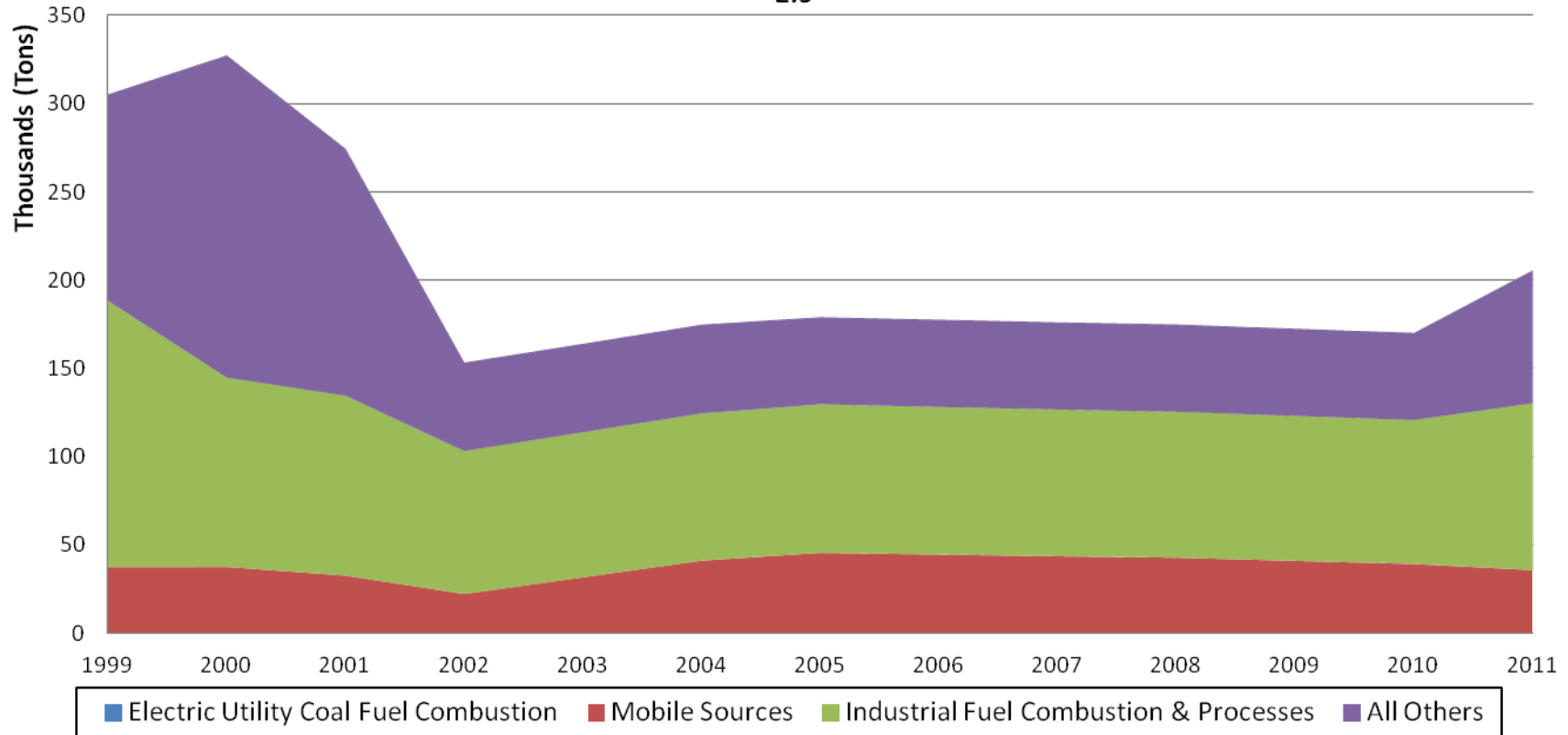
California Emission Trends (PM_{2.5})

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	8	9	73	17	14	12	10	7	5	24
Mobile Sources	37,218	32,479	31,425	45,359	44,393	43,427	42,625	40,848	39,070	35,566
Industrial Fuel Combustion & Processes	151,011	101,947	82,248	84,186	83,657	83,188	82,707	82,115	81,588	94,582
All Others	116,947	139,865	50,056	49,352	49,361	49,363	49,382	49,367	49,357	75,282
Total	305,184	274,300	163,801	178,914	177,426	175,991	174,724	172,337	170,020	205,454

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	7%	790%	106%	77%	47%	18%	-12%	-41%	195%
Mobile Sources	0%	-13%	-16%	22%	19%	17%	15%	10%	5%	-4%
Industrial Fuel Combustion & Processes	0%	-32%	-46%	-44%	-45%	-45%	-45%	-46%	-46%	-37%
All Others	0%	20%	-57%	-58%	-58%	-58%	-58%	-58%	-58%	-36%
Total	0%	-10%	-46%	-41%	-42%	-42%	-43%	-44%	-44%	-33%

California 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 California
- 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

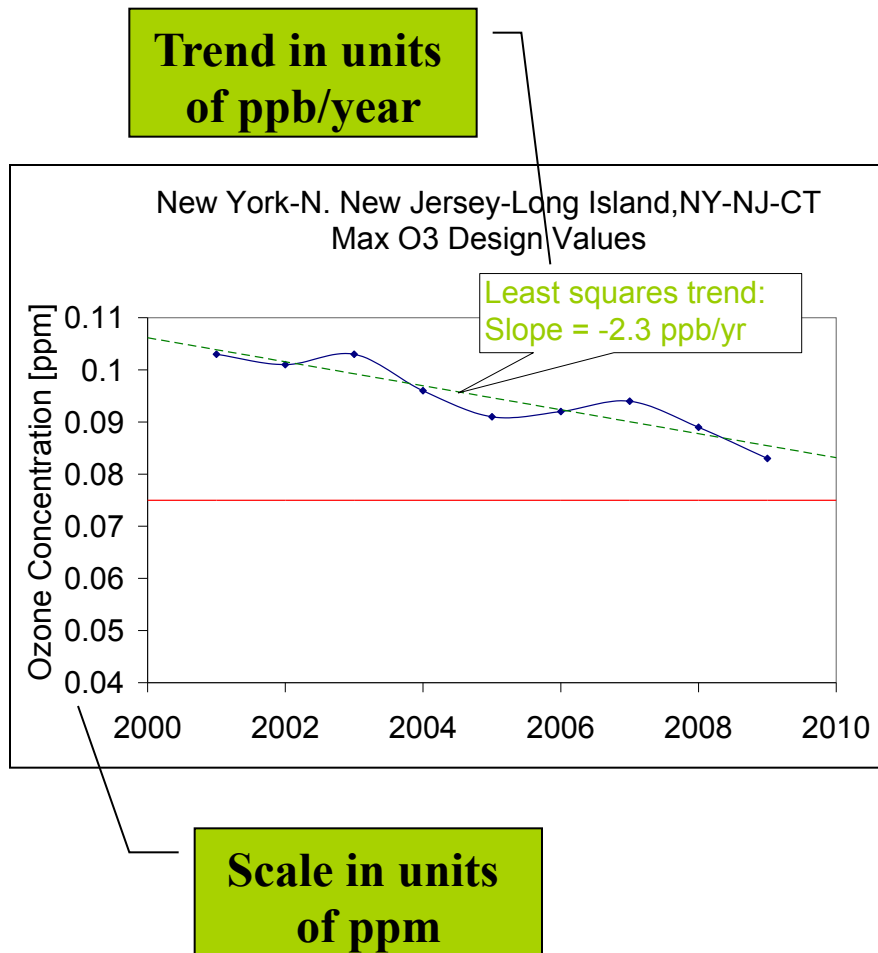
Data Handling Procedures

- 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

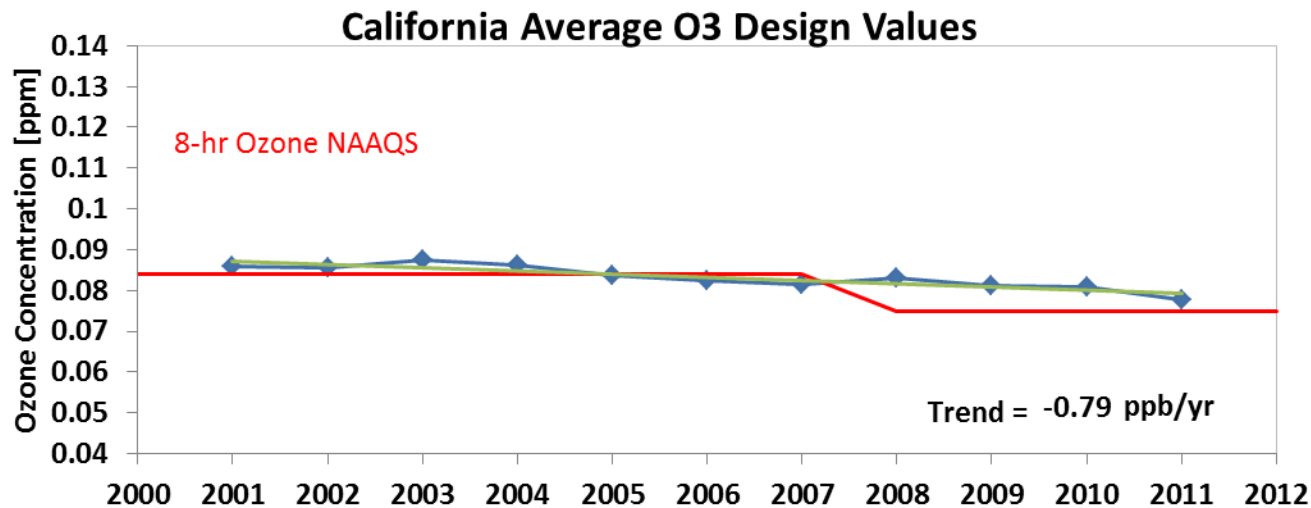
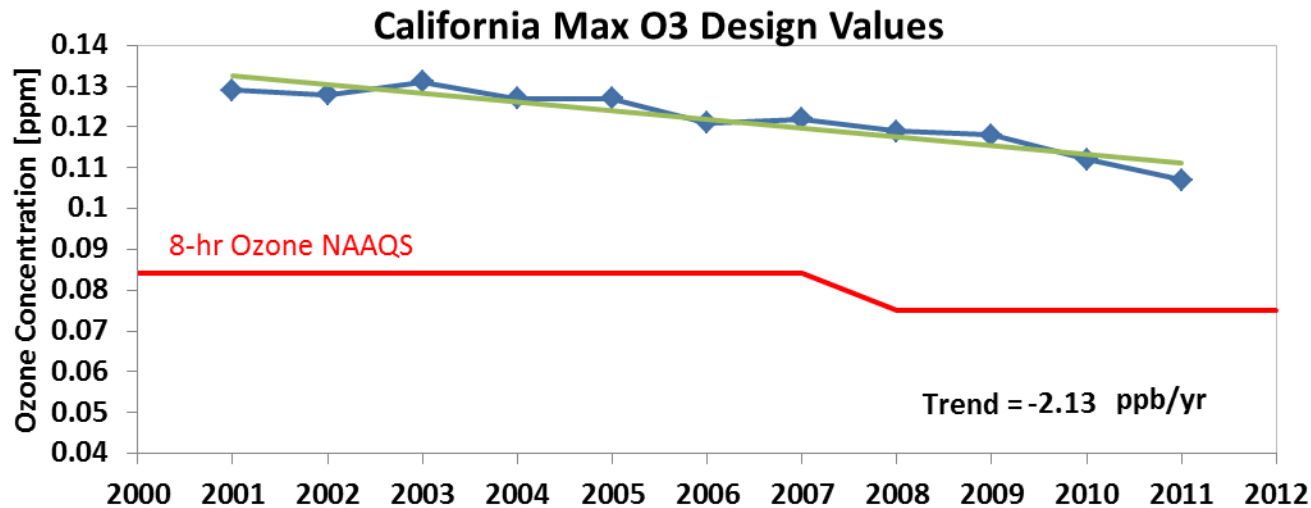
- ❑ Annual $\text{PM}_{2.5}$ DV and 24-hr $\text{PM}_{2.5}$ DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculations based on EPA data handling conventions
 - Data extracted from monitors that have a non-regulatory monitoring type are omitted
 - Selection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

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
0600100074420101	Alameda, CA	0.076	-0.56
0600110014420101	Alameda, CA	N/A	-0.32
0600500024420101	Amador, CA	0.071	-1.29
0600700074420101	Butte, CA	0.077	-1.22
0600900014420101	Calaveras, CA	0.077	-1.37
0601300024420101	Contra Costa, CA	0.073	-0.72
0601310024420101	Contra Costa, CA	0.074	-0.52
0601700104420101	El Dorado, CA	0.08	-0.95
0601700204420101	El Dorado, CA	0.084	-1.99
0601900074420101	Fresno, CA	0.095	-1.31
0601900084420101	Fresno, CA	0.094	-0.85
0601902424420101	Fresno, CA	0.095	-1.90
0601940014420101	Fresno, CA	0.088	-2.24
0601950014420101	Fresno, CA	0.099	-0.46
0602500054420101	Imperial, CA	0.073	-0.76

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in California

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
0602510034420101	Imperial, CA	0.08	-1.08
0602540044420101	Imperial, CA	0.073	-0.43
0602701014420101	Inyo, CA	0.071	-0.75
0602900074420101	Kern, CA	0.096	-0.65
0602900084420101	Kern, CA	0.088	-1.37
0602900104420101	Kern, CA	N/A	-1.87
0602900114420101	Kern, CA	0.08	-1.70
0602900144420101	Kern, CA	0.088	-1.07
0602902324420101	Kern, CA	0.089	-0.75
0602950014420101	Kern, CA	N/A	-0.96
0602960014420101	Kern, CA	0.085	-1.04
0603330014420101	Lake, CA	0.057	-0.55
0603700024420101	Los Angeles, CA	0.082	-1.52
0603700164420101	Los Angeles, CA	0.097	-0.88
0603710024420101	Los Angeles, CA	0.081	-0.65

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in California

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
0603712014420101	Los Angeles, CA	0.09	-0.42
0603717014420101	Los Angeles, CA	0.085	0.09
0603720054420101	Los Angeles, CA	0.082	-0.96
0603760124420101	Los Angeles, CA	0.097	-4.05
0603790334420101	Los Angeles, CA	0.091	-0.05
0603900044420101	Madera, CA	0.081	-0.96
0604100014420101	Marin, CA	0.053	0.45
0604300034420101	Mariposa, CA	0.077	-0.80
0604300064420101	Mariposa, CA	0.076	-1.36
0604700034420101	Merced, CA	0.084	-1.72
0605300024420101	Monterey, CA	0.058	-0.73
0605310034420101	Monterey, CA	0.054	-0.45
0605500034420101	Napa, CA	0.065	-0.17
0605700054420101	Nevada, CA	0.079	-1.76
0605700074420101	Nevada, CA	0.076	-1.35

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in California

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
0605920224420101	Orange, CA	N/A	-0.03
0605950014420101	Orange, CA	N/A	0.65
0606100024420101	Placer, CA	0.085	-1.71
0606100044420101	Placer, CA	0.074	-1.04
0606100064420101	Placer, CA	0.086	-0.20
0606500124420101	Riverside, CA	0.099	-1.69
0606520024420101	Riverside, CA	0.082	-1.18
0606550014420101	Riverside, CA	0.093	-1.16
0606560014420101	Riverside, CA	0.098	-1.10
0606580014420101	Riverside, CA	0.095	-1.43
0606590014420101	Riverside, CA	0.091	-1.29
0606700024420101	Sacramento, CA	0.077	-1.69
0606700064420101	Sacramento, CA	0.081	-1.33
0606700104420101	Sacramento, CA	N/A	-0.22
0606700114420101	Sacramento, CA	0.074	-0.31

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in California

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
0606700124420101	Sacramento, CA	0.095	-0.01
0606750034420101	Sacramento, CA	0.087	-0.71
0606900024420101	San Benito, CA	0.066	-0.67
0606900034420101	San Benito, CA	0.07	-0.75
0607100014420101	San Bernardino, CA	0.076	-0.95
0607100054420101	San Bernardino, CA	0.107	-2.13
0607100124420101	San Bernardino, CA	0.096	-0.83
0607103064420101	San Bernardino, CA	0.083	-1.73
0607110044420102	San Bernardino, CA	0.096	-1.33
0607112344420101	San Bernardino, CA	0.069	-0.90
0607120024420101	San Bernardino, CA	0.098	-1.37
0607140014420101	San Bernardino, CA	0.097	-1.06
0607140034420101	San Bernardino, CA	0.103	-2.05
0607190024420101	San Bernardino, CA	0.093	0.16
0607190044420101	San Bernardino, CA	0.099	-1.42

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in California

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
0607300014420101	San Diego, CA	0.063	-0.17
0607300034420101	San Diego, CA	0.071	0.16
0607300064420101	San Diego, CA	0.069	-0.62
0607310014420101	San Diego, CA	0.064	-0.37
0607310024420101	San Diego, CA	0.072	0.28
0607310064420101	San Diego, CA	0.082	-0.83
0607310084420101	San Diego, CA	0.067	-0.85
0607320074420101	San Diego, CA	0.058	-0.27
0607500054420101	San Francisco, CA	0.047	0.14
0608110014420101	San Mateo, CA	N/A	0.27
0608300084420101	Santa Barbara, CA	0.059	-0.75
0608310084420101	Santa Barbara, CA	0.052	0.24
0608310134420101	Santa Barbara, CA	0.064	-0.68
0608310144420101	Santa Barbara, CA	0.069	-1.45
0608310184420101	Santa Barbara, CA	0.056	-1.13

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in California

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
0608310214420101	Santa Barbara, CA	0.071	0.26
0608310254420101	Santa Barbara, CA	0.073	0.09
0608320044420101	Santa Barbara, CA	0.054	-0.45
0608320114420101	Santa Barbara, CA	0.057	-0.47
0608330014420101	Santa Barbara, CA	0.062	-0.49
0608340034420101	Santa Barbara, CA	0.061	-0.29
0608500024420101	Santa Clara, CA	0.071	-0.67
0608510014420101	Santa Clara, CA	0.07	-0.05
0608520064420101	Santa Clara, CA	0.074	-0.87
0608700044420101	Santa Cruz, CA	N/A	-0.33
0608700074420101	Santa Cruz, CA	0.055	-0.25
0608900044420101	Shasta, CA	0.064	-1.43
0608930034420101	Shasta, CA	0.064	-0.54
0609500044420101	Solano, CA	0.061	-0.12
0609700034420101	Sonoma, CA	0.05	-0.15

Note: Only monitoring sites meeting data completeness criteria listed

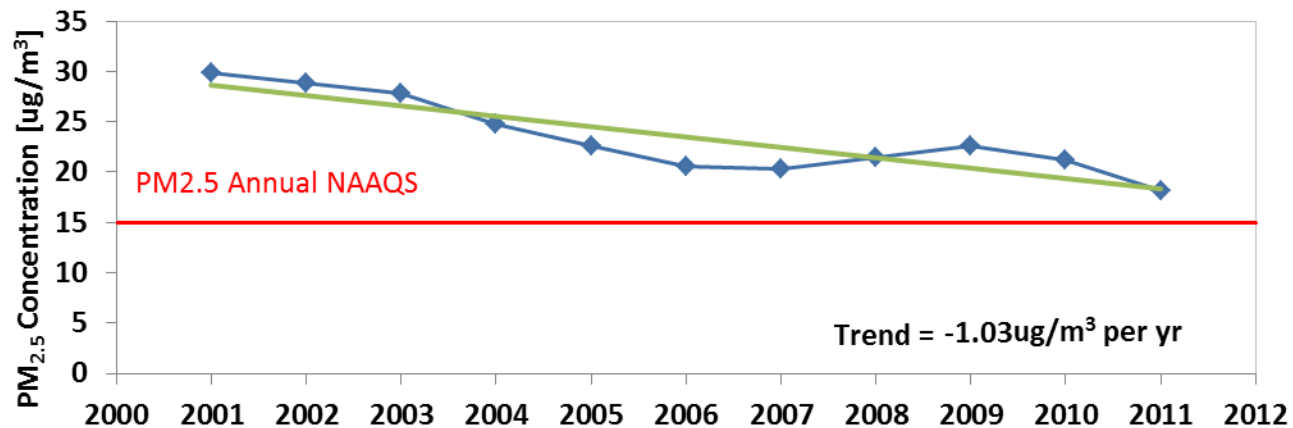
Ozone Trends by Site in California

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
0609900054420101	Stanislaus, CA	N/A	-0.71
0609900064420101	Stanislaus, CA	0.087	-0.54
0610100044420101	Sutter, CA	N/A	-0.75
0610300044420101	Tehama, CA	0.076	-0.61
0610700064420101	Tulare, CA	0.079	-1.53
0610700094420101	Tulare, CA	0.096	-0.64
0610720024420101	Tulare, CA	0.088	-0.78
0610900054420101	Tuolumne, CA	N/A	0.02
0611100074420101	Ventura, CA	0.076	-0.87
0611100094420101	Ventura, CA	0.077	-0.64
0611110044420101	Ventura, CA	0.077	-1.93
0611120024420101	Ventura, CA	0.083	-1.54
0611120034420101	Ventura, CA	N/A	-0.93
0611130014420101	Ventura, CA	0.063	-0.49
0611310034420101	Yolo, CA	0.069	-1.21

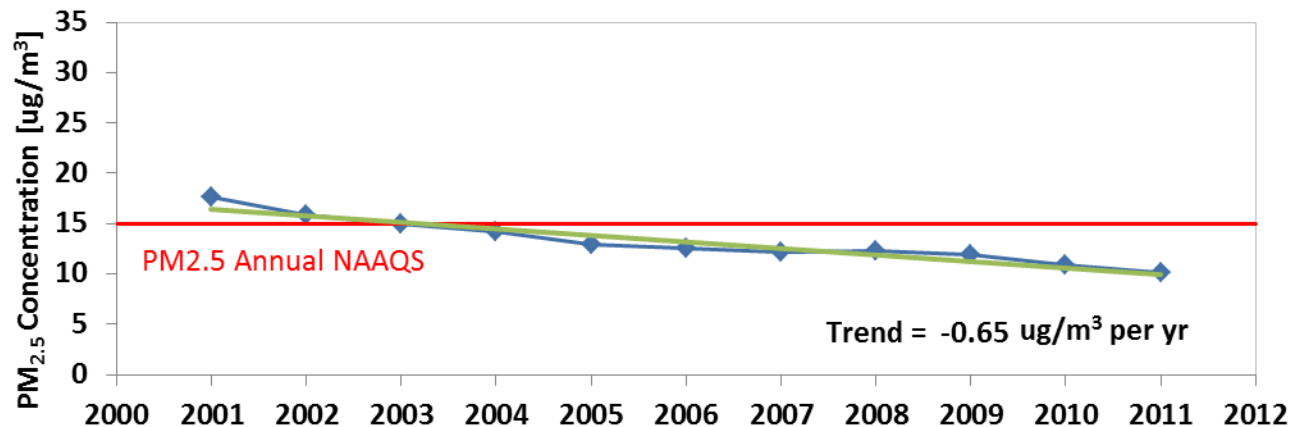
Note: Only monitoring sites meeting data completeness criteria listed

Max/Ave PM_{2.5} Annual DVs and Trend

California Max PM_{2.5} Annual Design Values

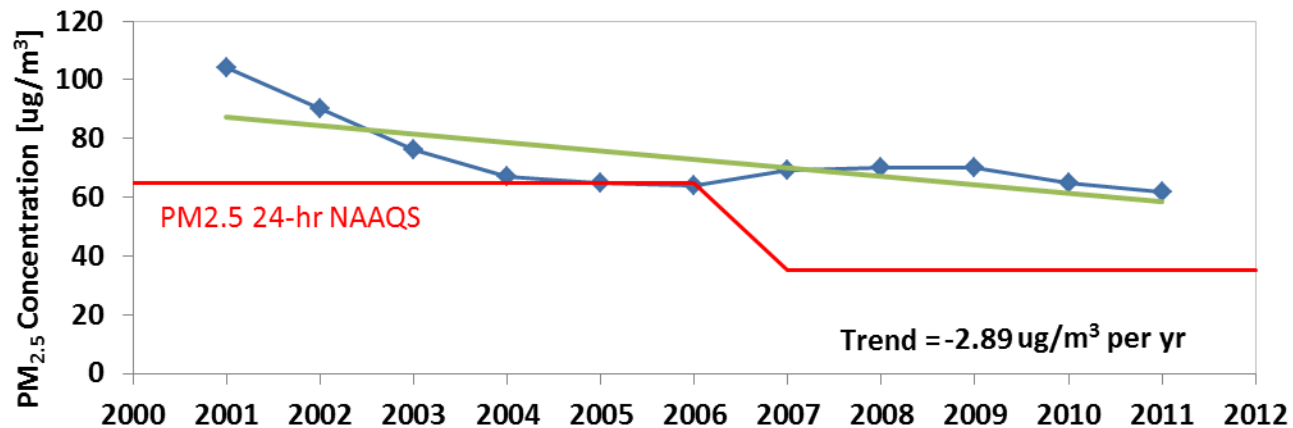


California Average PM_{2.5} Annual Design Values

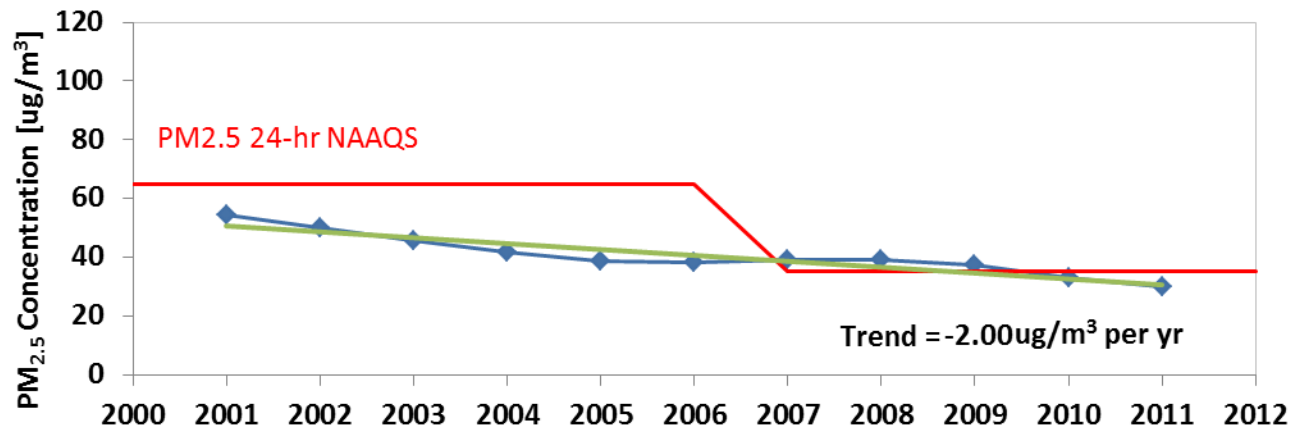


Max/Ave PM_{2.5} 24-Hour DVs and Trend

California Max PM_{2.5} 24-Hour Design Values



California Average PM_{2.5} 24-Hour Design Values



PM_{2.5} Trends by Site in California

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
060010007	Alameda	8.2	28	-0.40	-2.06
060011001	Alameda	N/A	N/A	-0.38	-1.98
060070002	Butte	10.1	35	-0.38	-0.74
060090001	Calaveras	7.3	17	-0.21	-0.08
060111002	Colusa	6.3	20	-0.32	-1.77
060130002	Contra Costa	7.8	27	-0.43	-1.91
060190008	Fresno	14.5	58	-0.76	-2.90
060195001	Fresno	17.0	54	-0.10	-1.38
060195025	Fresno	14.5	48	-0.54	-2.04
060250005	Imperial	N/A	38	N/A	-1.29
060251003	Imperial	7.4	N/A	-0.26	N/A

Note: Only monitoring sites meeting data completeness criteria listed

PM_{2.5} Trends by Site in California

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
060271003	Inyo	7.3	N/A	0.19	N/A
060290010	Kern	N/A	N/A	-0.61	-2.92
060290014	Kern	16.5	62	-0.35	-2.35
060290016	Kern	18.2	55	0.00	-0.56
060310004	Kings	N/A	46	-0.12	-1.97
060333001	Lake	3.3	7	-0.11	-0.43
060370002	Los Angeles	N/A	36	N/A	-2.65
060371002	Los Angeles	13.9	34	-1.11	-3.61
060371103	Los Angeles	13.5	34	-0.98	-2.97
060371201	Los Angeles	N/A	28	N/A	-2.61

Note: Only monitoring sites meeting data completeness criteria listed

PM_{2.5} Trends by Site in California

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
060371602	Los Angeles	13.3	33	-1.24	-3.26
060372005	Los Angeles	N/A	N/A	-1.03	-2.48
060374002	Los Angeles	11.5	30	-0.94	-2.37
060450006	Mendocino	8.6	16	0.02	-0.78
060472510	Merced	N/A	39	N/A	-1.53
060531003	Monterey	6.1	14	-0.25	-0.80
060571001	Nevada	6.0	17	-0.19	-0.30
060590007	Orange	N/A	29	N/A	-2.95
060592022	Orange	8.7	23	-0.72	-2.22
060610006	Placer	7.9	22	-0.45	-2.14

Note: Only monitoring sites meeting data completeness criteria listed

PM_{2.5} Trends by Site in California

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
060651003	Riverside	12.0	30	-1.65	-3.44
060652002	Riverside	7.3	15	-0.53	-1.24
060658001	Riverside	14.2	35	-1.65	-4.27
060670006	Sacramento	N/A	35	N/A	-2.05
060670010	Sacramento	9.2	33	-0.36	-2.26
060674001	Sacramento	N/A	35	N/A	-1.04
060710025	San Bernardino	13.7	34	-1.30	-3.58
060710306	San Bernardino	N/A	N/A	-0.54	-1.85
060712002	San Bernardino	12.9	31	-1.26	-3.08
060718001	San Bernardino	N/A	29	N/A	0.27

Note: Only monitoring sites meeting data completeness criteria listed

PM_{2.5} Trends by Site in California

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
060719004	San Bernardino	12.1	N/A	-1.54	-3.28
060730001	San Diego	10.3	20	-0.38	-1.19
060730003	San Diego	11.8	24	-0.48	-1.98
060730006	San Diego	9.4	18	-0.29	-1.03
060731010	San Diego	11.0	24	-0.51	-1.90
060750005	San Francisco	9.9	27	-0.25	-2.47
060771002	San Joaquin	11.1	38	-0.43	-1.34
060792006	San Luis Obispo	6.1	12	-0.25	-0.72
060798001	San Luis Obispo	7.7	22	-0.21	-1.74
060811001	San Mateo	N/A	N/A	N/A	-2.17

Note: Only monitoring sites meeting data completeness criteria listed

PM_{2.5} Trends by Site in California

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
060890004	Shasta	5.3	15	-0.47	-1.89
060950004	Solano	9.1	29	-0.38	-2.06
060970003	Sonoma	8.0	24	-0.30	-1.57
060990005	Stanislaus	N/A	50	-0.53	-2.26
061010003	Sutter	7.3	27	-0.47	-0.87
061072002	Tulare	15.2	47	-0.73	-4.31
061110007	Ventura	9.3	20	-0.42	-2.02
061112002	Ventura	9.3	19	-0.58	-1.99
061113001	Ventura	9.2	18	-0.39	-1.37
061131003	Yolo	6.9	24	-0.33	-1.23

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 California

- O_3 and $PM_{2.5}$ design values have decreased since 1999 in all currently designated O_3 and $PM_{2.5}$ non-attainment areas in California in which monitoring data met the 1999–2011 trends completeness criteria. Additional O_3 or $PM_{2.5}$ nonattainment areas in California in which monitoring data did not meet the 1999–2011 trends completeness criteria include:
 - San Luis Obispo County (Eastern part), CA (ozone)