

# Emission and Air Quality Trends Review 1999-2011

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## Western States

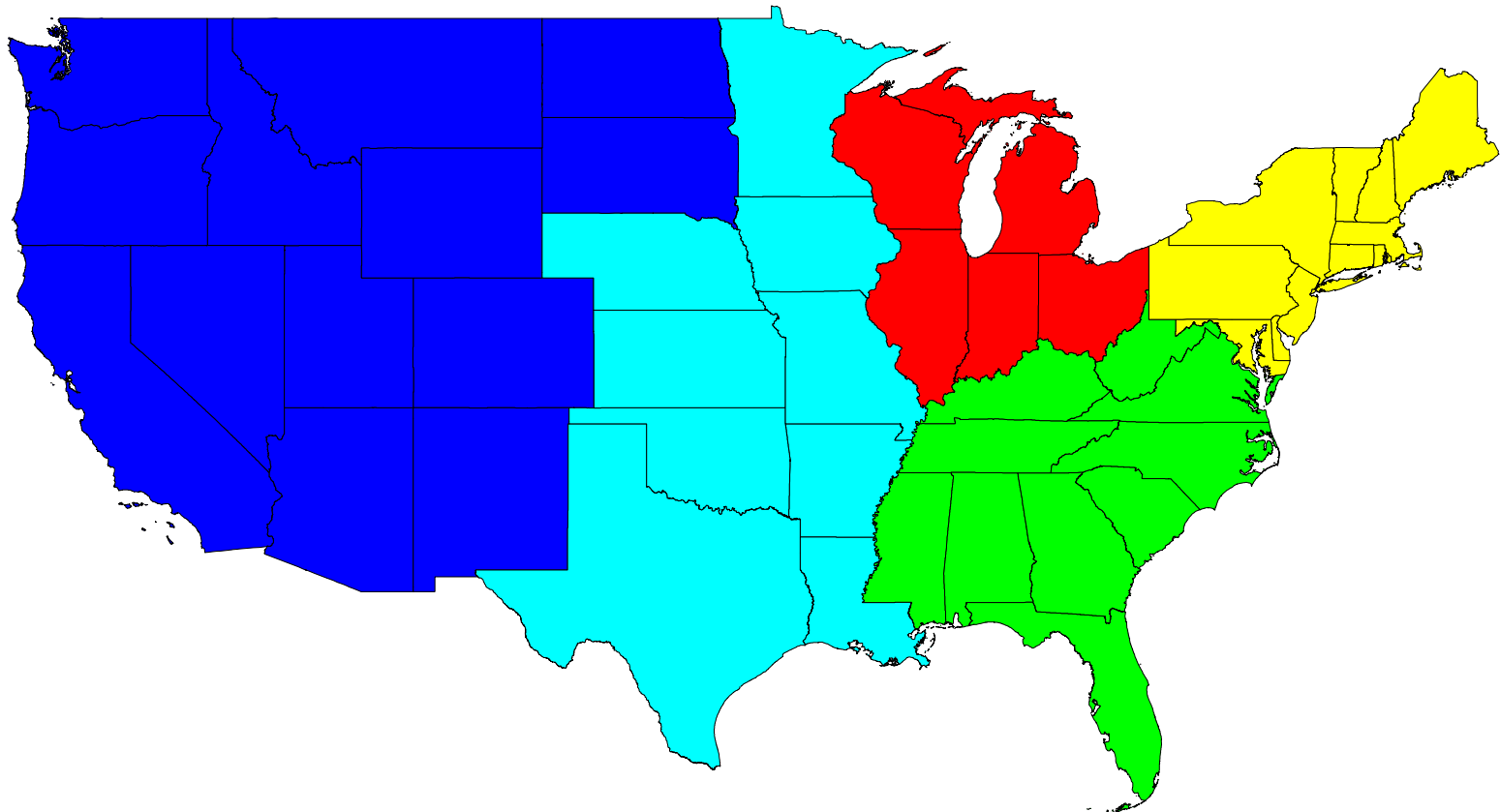
July 2013

# 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

## Metrics developed for U.S. by Region



# 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

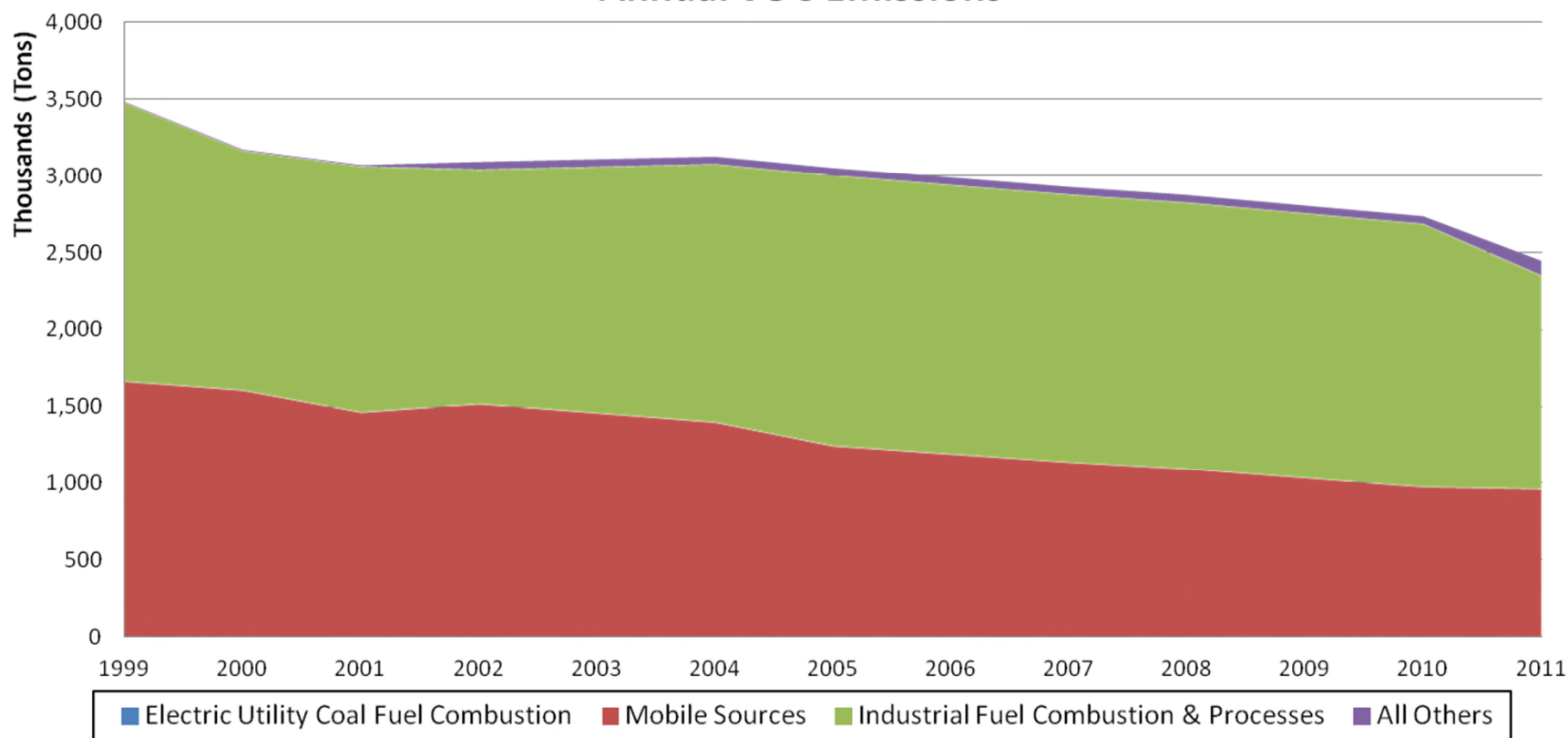
# Western Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	4,408	4,687	4,452	4,513	4,240	4,255	4,284	3,983	4,032	3,188
Mobile Sources	1,658,849	1,457,111	1,452,808	1,238,930	1,185,368	1,131,805	1,087,818	1,028,019	968,220	955,488
Industrial Fuel Combustion & Processes	1,814,322	1,600,763	1,602,121	1,757,751	1,748,367	1,739,368	1,730,207	1,720,438	1,711,033	1,388,929
All Others	4,534	6,473	47,748	47,992	48,329	48,788	48,958	49,147	49,218	95,021
<b>Total</b>	<b>3,482,113</b>	<b>3,069,035</b>	<b>3,107,129</b>	<b>3,049,187</b>	<b>2,986,303</b>	<b>2,924,215</b>	<b>2,871,268</b>	<b>2,801,587</b>	<b>2,732,502</b>	<b>2,442,626</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%	1%	2%	-4%	-3%	-3%	-10%	-9%	-28%
Mobile Sources	0%	-12%	-12%	-25%	-29%	-32%	-34%	-38%	-42%	-42%
Industrial Fuel Combustion & Processes	0%	-12%	-12%	-3%	-4%	-4%	-5%	-5%	-6%	-23%
All Others	0%	43%	953%	959%	966%	976%	980%	984%	986%	1996%
<b>Total</b>	<b>0%</b>	<b>-12%</b>	<b>-11%</b>	<b>-12%</b>	<b>-14%</b>	<b>-16%</b>	<b>-18%</b>	<b>-20%</b>	<b>-22%</b>	<b>-30%</b>

# Western Emission Trends (VOC)

**Major Source Category Summary  
Annual VOC Emissions**





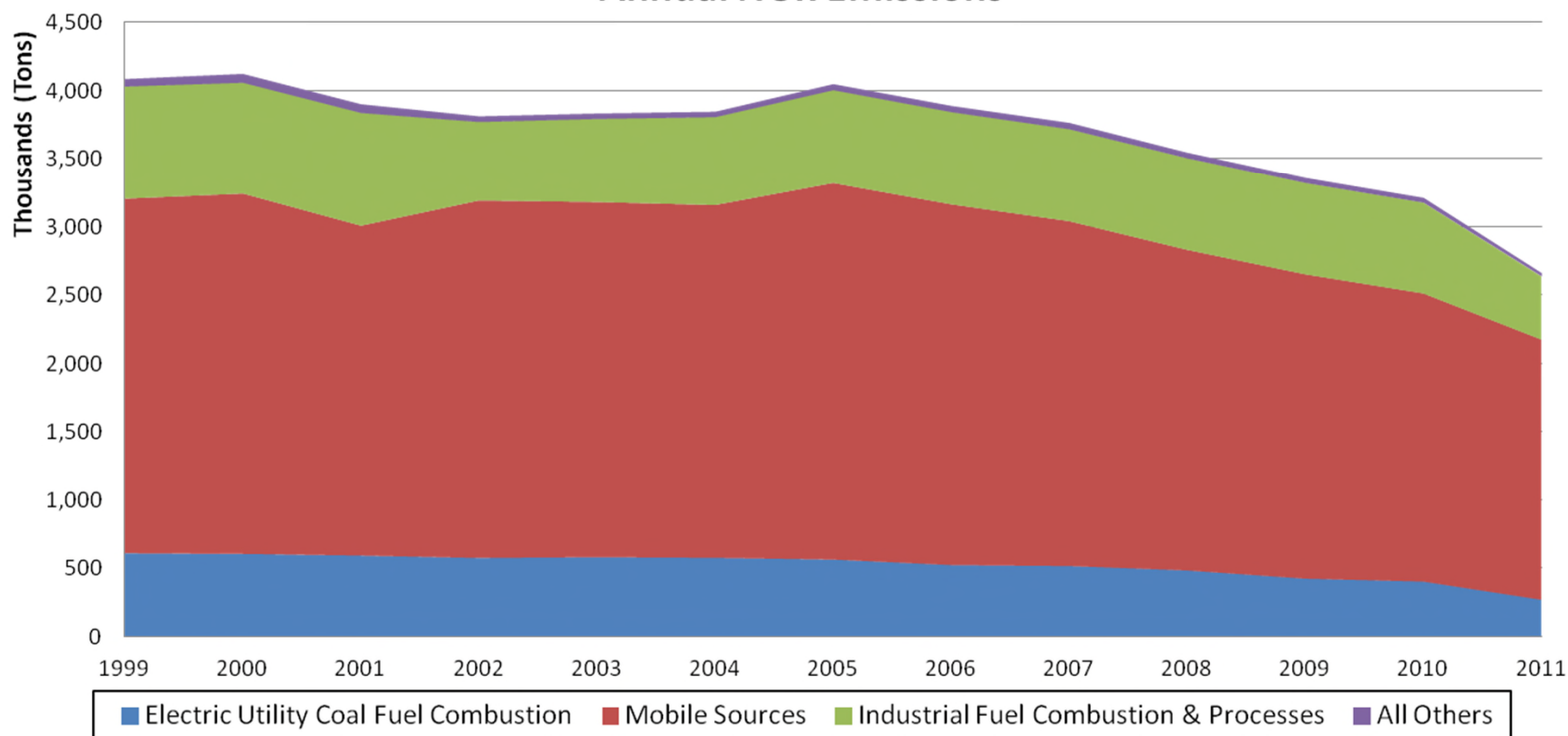
# Western Emission Trends (NO<sub>x</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	612,664	595,636	583,889	565,995	526,486	519,318	486,974	426,974	405,889	272,625
Mobile Sources	2,592,057	2,411,727	2,596,470	2,753,270	2,637,173	2,521,076	2,344,634	2,226,538	2,108,442	1,905,724
Industrial Fuel Combustion & Processes	828,429	832,258	615,341	686,968	681,963	679,191	674,420	668,310	663,068	460,879
All Others	54,683	63,744	40,172	44,786	45,834	47,045	41,456	38,221	35,521	23,654
<b>Total</b>	<b>4,087,833</b>	<b>3,903,366</b>	<b>3,835,872</b>	<b>4,051,019</b>	<b>3,891,456</b>	<b>3,766,629</b>	<b>3,547,485</b>	<b>3,360,044</b>	<b>3,212,920</b>	<b>2,662,882</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%	-3%	-5%	-8%	-14%	-15%	-21%	-30%	-34%	-56%
Mobile Sources	0%	-7%	0%	6%	2%	-3%	-10%	-14%	-19%	-26%
Industrial Fuel Combustion & Processes	0%	0%	-26%	-17%	-18%	-18%	-19%	-19%	-20%	-44%
All Others	0%	17%	-27%	-18%	-16%	-14%	-24%	-30%	-35%	-57%
<b>Total</b>	<b>0%</b>	<b>-5%</b>	<b>-6%</b>	<b>-1%</b>	<b>-5%</b>	<b>-8%</b>	<b>-13%</b>	<b>-18%</b>	<b>-21%</b>	<b>-35%</b>

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

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



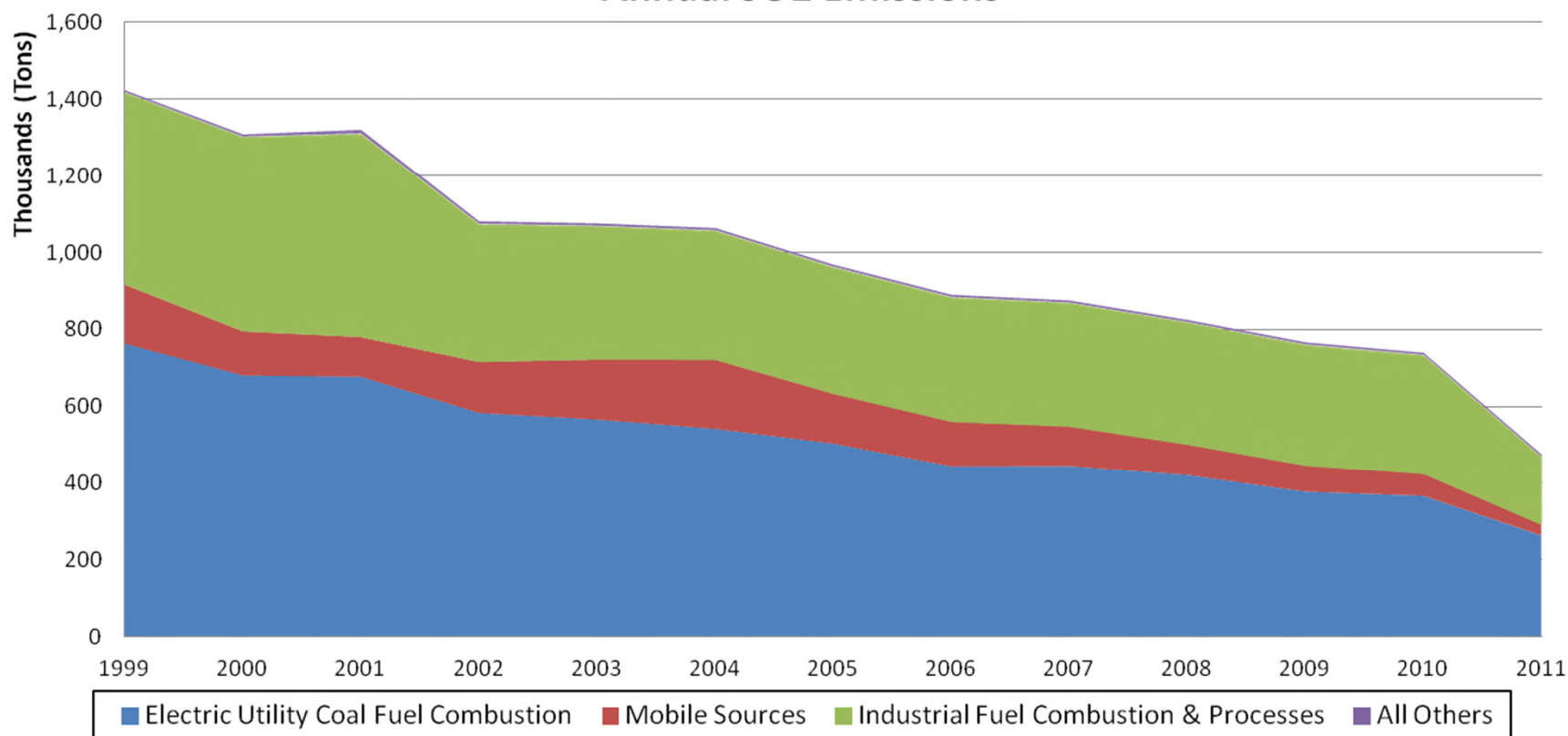
# Western Emission Trends (SO<sub>2</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	763,885	677,437	565,871	503,118	443,609	444,279	419,968	376,473	365,361	261,608
Mobile Sources	153,487	103,604	156,914	130,715	117,413	104,111	81,290	69,961	58,633	29,466
Industrial Fuel Combustion & Processes	501,644	530,148	346,567	329,068	323,494	321,328	318,124	314,781	310,176	178,067
All Others	4,418	8,945	5,568	4,920	5,007	5,010	4,964	4,948	4,765	5,099
<b>Total</b>	<b>1,423,434</b>	<b>1,320,133</b>	<b>1,074,920</b>	<b>967,821</b>	<b>889,522</b>	<b>874,728</b>	<b>824,346</b>	<b>766,163</b>	<b>738,936</b>	<b>474,240</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%	-11%	-26%	-34%	-42%	-42%	-45%	-51%	-52%	-66%
Mobile Sources	0%	-33%	2%	-15%	-24%	-32%	-47%	-54%	-62%	-81%
Industrial Fuel Combustion & Processes	0%	6%	-31%	-34%	-36%	-36%	-37%	-37%	-38%	-65%
All Others	0%	102%	26%	11%	13%	13%	12%	12%	8%	15%
<b>Total</b>	<b>0%</b>	<b>-7%</b>	<b>-24%</b>	<b>-32%</b>	<b>-38%</b>	<b>-39%</b>	<b>-42%</b>	<b>-46%</b>	<b>-48%</b>	<b>-67%</b>

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

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



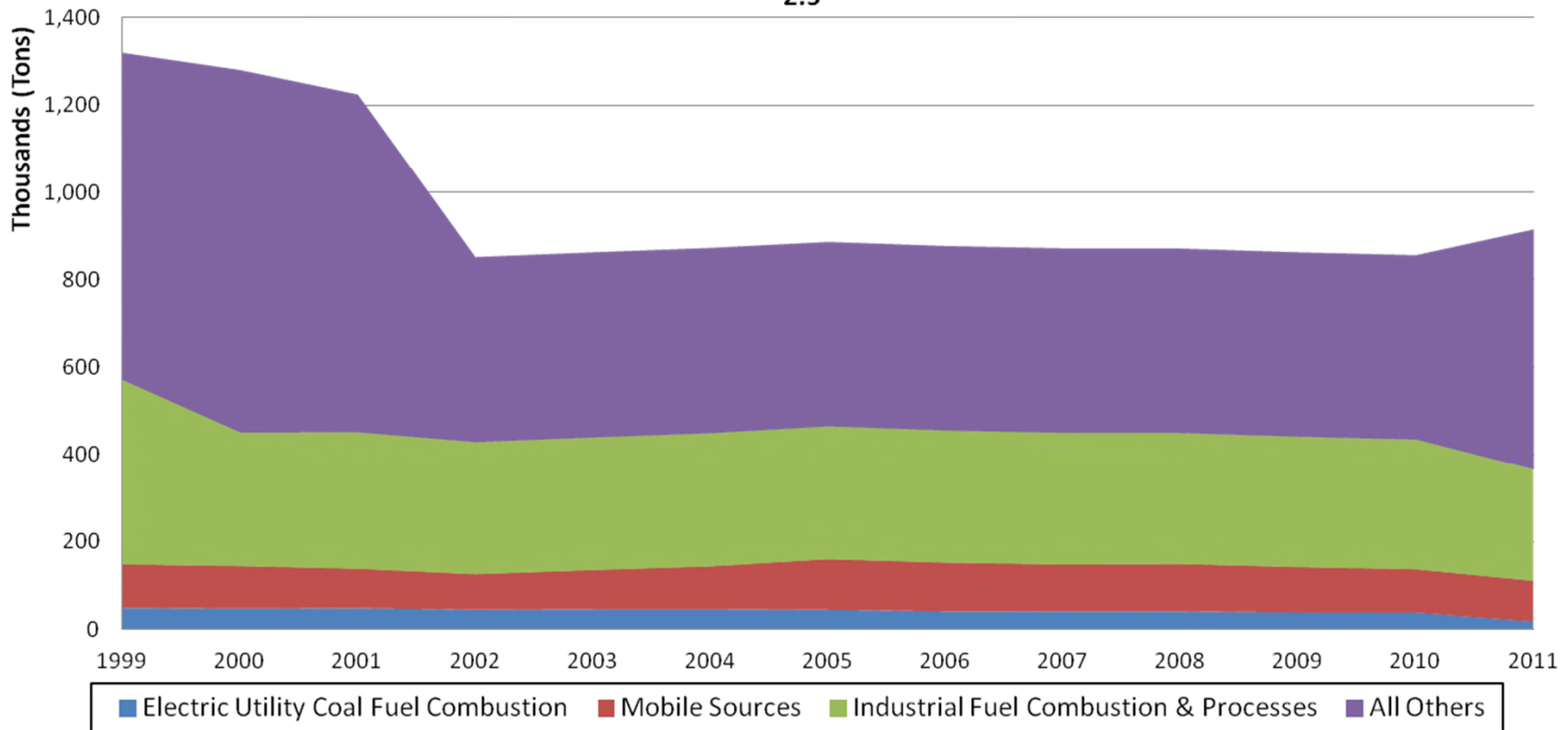
# Western Emission Trends (PM<sub>2.5</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	48,833	48,180	45,536	44,478	40,689	40,814	40,519	38,273	38,159	17,116
Mobile Sources	99,853	90,433	90,080	116,036	111,867	107,698	108,996	104,152	99,309	93,993
Industrial Fuel Combustion & Processes	423,023	313,507	304,602	305,199	303,750	302,468	301,051	299,514	298,033	255,196
All Others	748,995	773,159	422,481	420,881	420,872	420,890	420,879	420,838	420,816	548,796
<b>Total</b>	<b>1,320,705</b>	<b>1,225,279</b>	<b>862,699</b>	<b>886,593</b>	<b>877,178</b>	<b>871,871</b>	<b>871,444</b>	<b>862,777</b>	<b>856,316</b>	<b>915,101</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%	-1%	-7%	-9%	-17%	-16%	-17%	-22%	-22%	-65%
Mobile Sources	0%	-9%	-10%	16%	12%	8%	9%	4%	-1%	-6%
Industrial Fuel Combustion & Processes	0%	-26%	-28%	-28%	-28%	-28%	-29%	-29%	-30%	-40%
All Others	0%	3%	-44%	-44%	-44%	-44%	-44%	-44%	-44%	-27%
<b>Total</b>	<b>0%</b>	<b>-7%</b>	<b>-35%</b>	<b>-33%</b>	<b>-34%</b>	<b>-34%</b>	<b>-34%</b>	<b>-35%</b>	<b>-35%</b>	<b>-31%</b>

# Western 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 the western United States
- ❑ NOx and SO2 from Electric Utility Fuel Combustion sources show significant decrease over time as a result of Acid Rain Program
- ❑ 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

# AQ Trends Scope

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- ❑ Compute, summarize and display ozone and PM<sub>2.5</sub> design value trends in the Western states for the period 1999 – 2011
- ❑ Create a spreadsheet database of O<sub>3</sub> and PM<sub>2.5</sub> values at each monitoring site for additional analyses



# 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>

# Area-Wide Design Values

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- For regional and state trends: for each three-year period, calculated **average** of DVs over all monitoring sites within the region/state meeting data completeness requirements
- For non-attainment areas: for each three-year period, calculated **maximum** DV over all monitoring sites within the non-attainment area meeting data completeness requirements (conforms with EPA methodology for determining attainment/non-attainment designation)

# Data Handling Procedures

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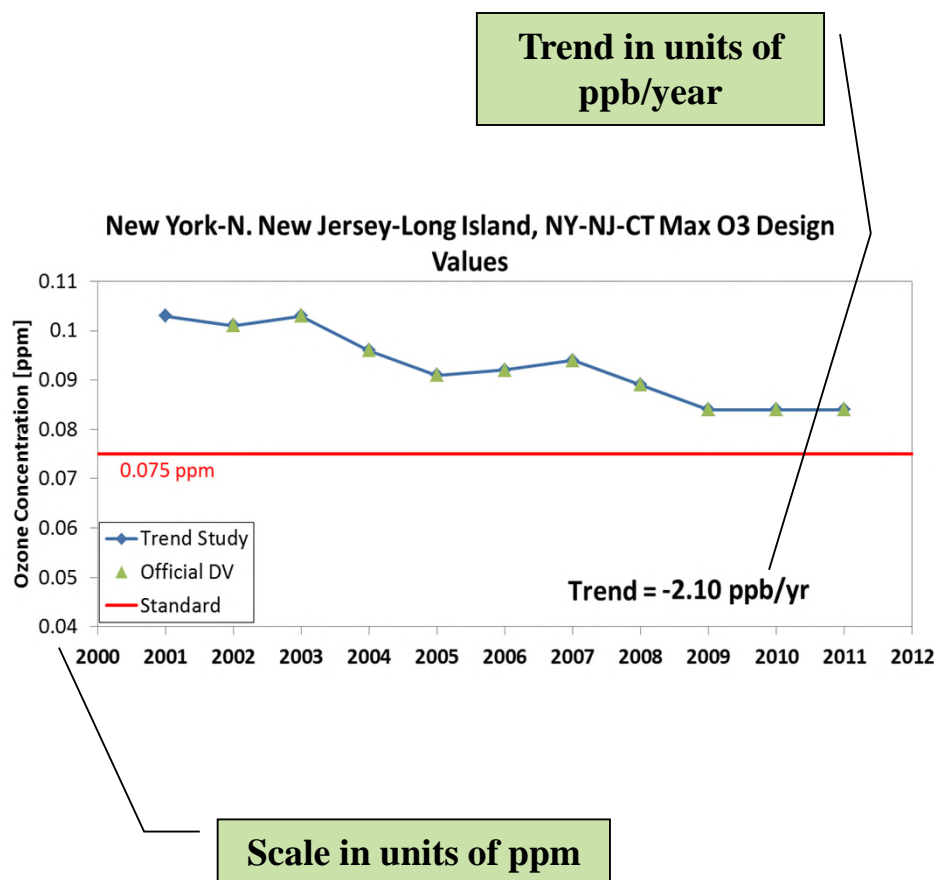
- O<sub>3</sub> design value (DV) for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculated using annual 4<sup>th</sup> highest daily max 8-hr averages and percent of valid observations, based on EPA data handling conventions
  - Data associated with exceptional 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<sub>2.5</sub> DV and 24-hr PM<sub>2.5</sub> 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 at least 9 out of 11 three-year periods between 1999 and 2011

# Trend Calculation

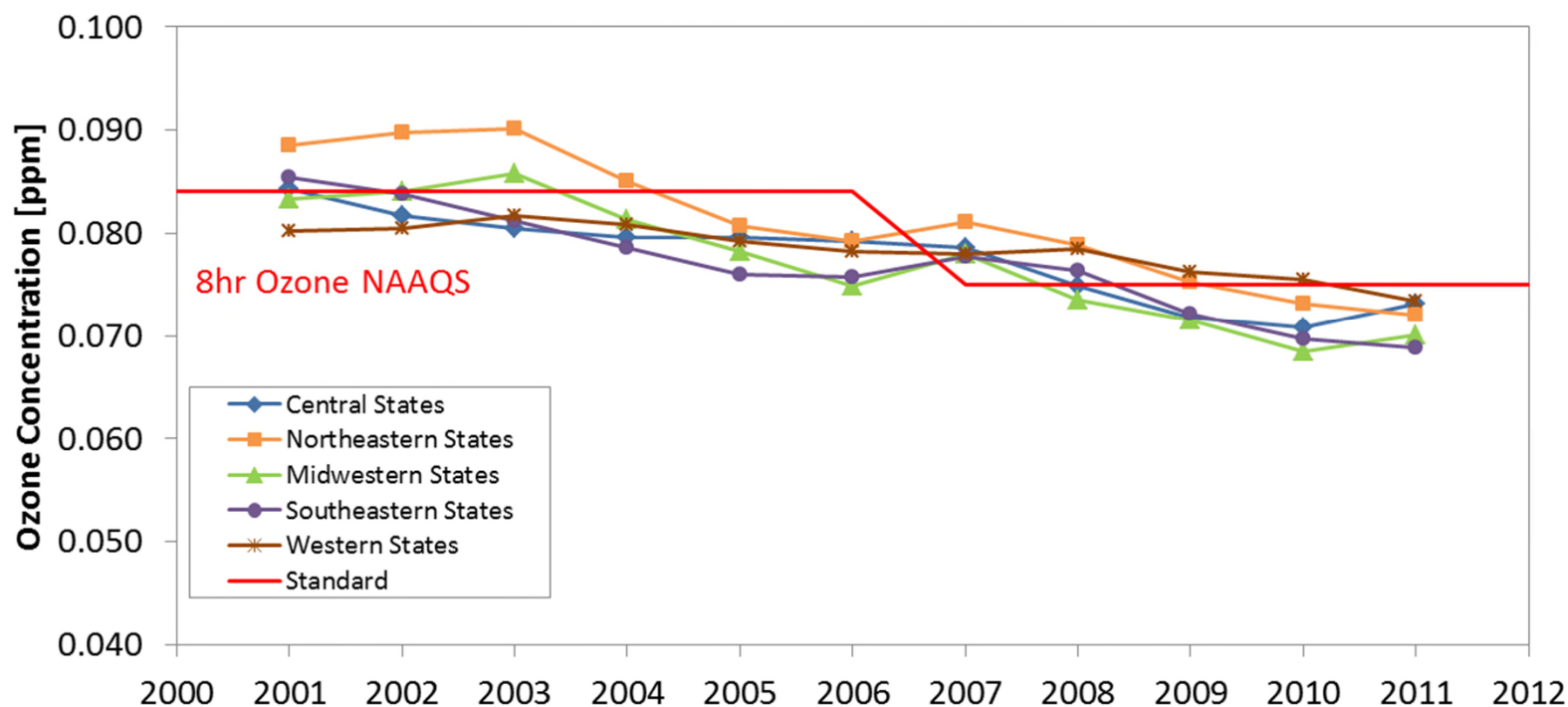


- Trends based on linear least squares fit to rolling three year design values (DVs)
- Negative trend indicates improving air quality
- DVs based on each 3-year period: 1999-2001, 2000-2002, ... 2009-2011
- Notes

- 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

# O<sub>3</sub> Trends by Regions

## Regional Average O<sub>3</sub> Design Values



- Average ozone DVs have decreased in all five regions
- Trends are not monotonic, possibly reflecting influence of meteorology
- Western States trend flatter than in other regions

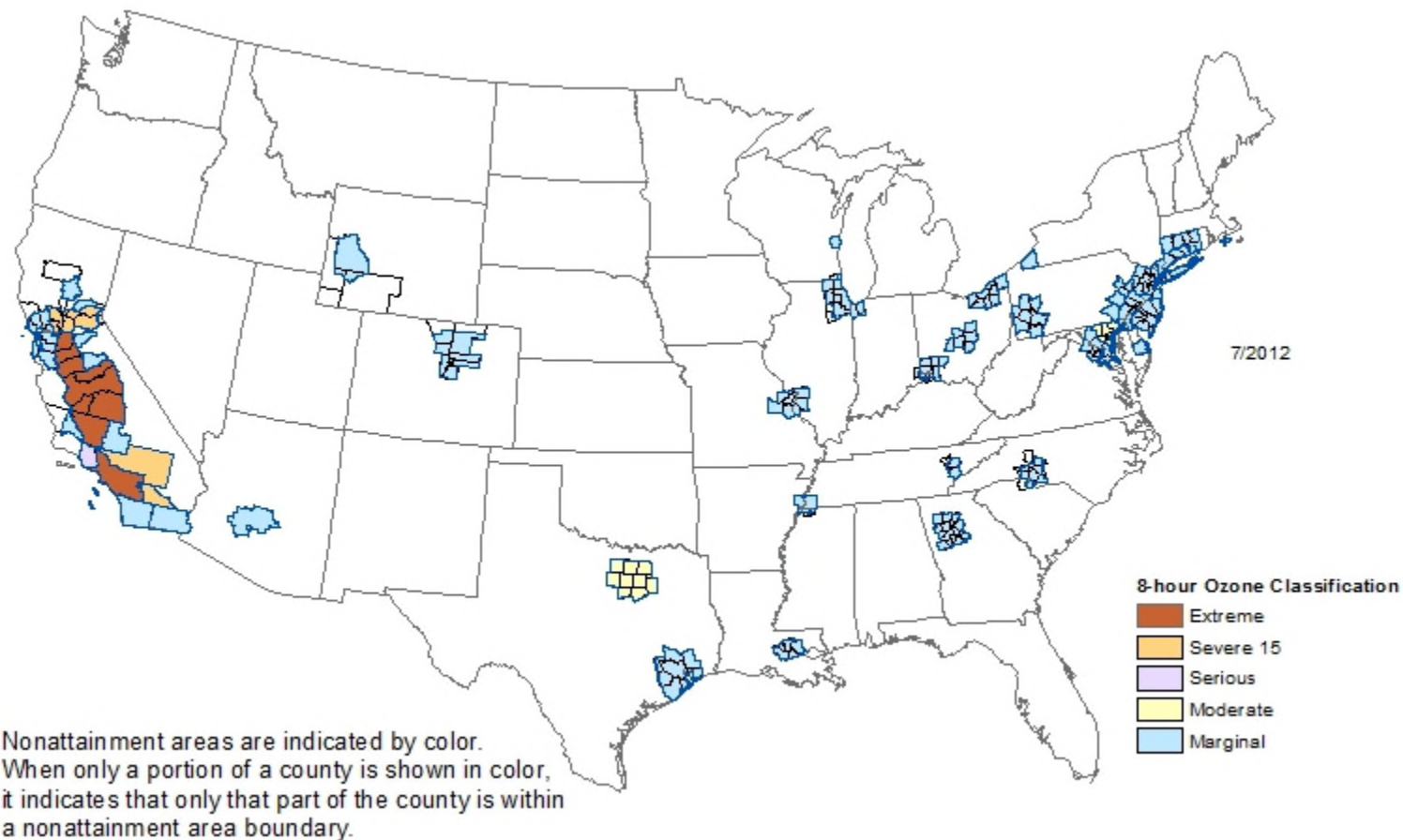
# O<sub>3</sub> Trend Slopes by Region

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Region	O <sub>3</sub> Trend Slope
Central States	-1.2 ppb/year
Northeastern States	-1.9 ppb/year
Midwestern States	-1.7 ppb/year
Southeastern States	-1.5 ppb/year
Western States	-0.7 ppb/year

**Note: 1 ppb = 0.001 ppm**

## Designated O<sub>3</sub> Non-Attainment Areas (based on 2008 8-Hour Ozone standard)

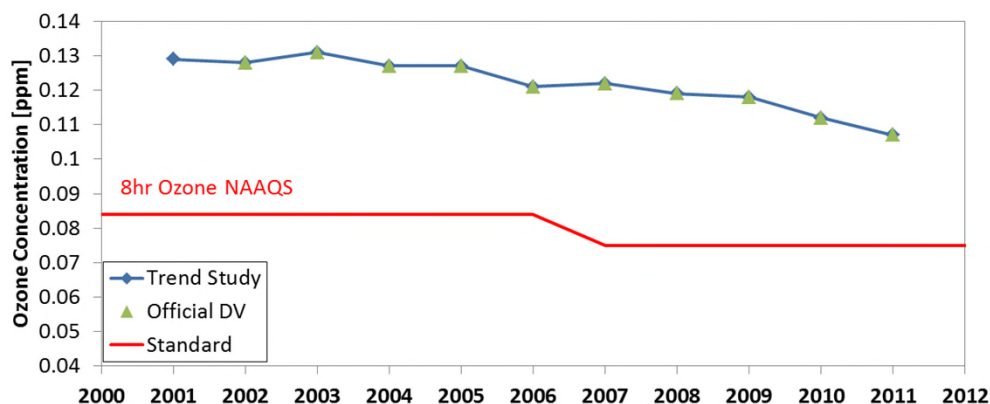


Source: EPA Green Book  
(<http://www.epa.gov/oar/oaqps/greenbk/index.html>)



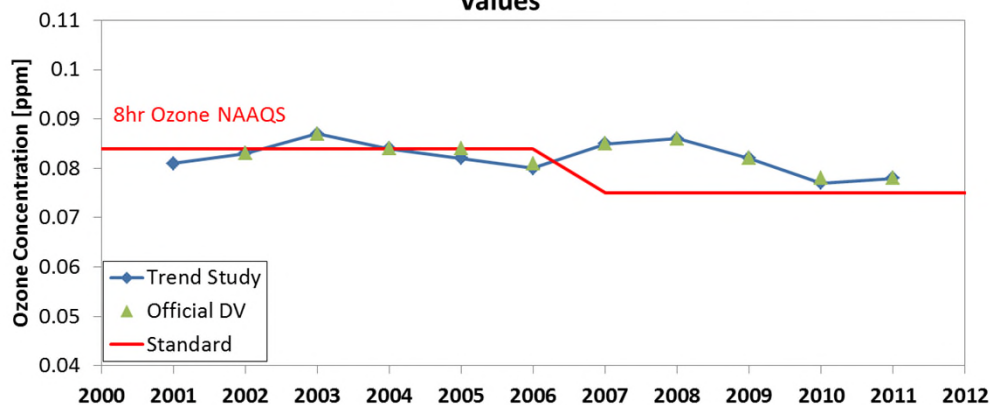
# Trends in Western States Non-Attainment Areas

Los Angeles South Coast Air Basin, CA Max O3 Design Values



Trends range from -2.13 ppb/yr (Los Angeles South Coast Air Basin, CA) to -0.43 ppb/yr (Denver-Boulder-Greeley-Ft Collins-Loveland, CO)

Denver-Boulder-Greeley-Ft Collins-Loveland, CO Max O3 Design Values



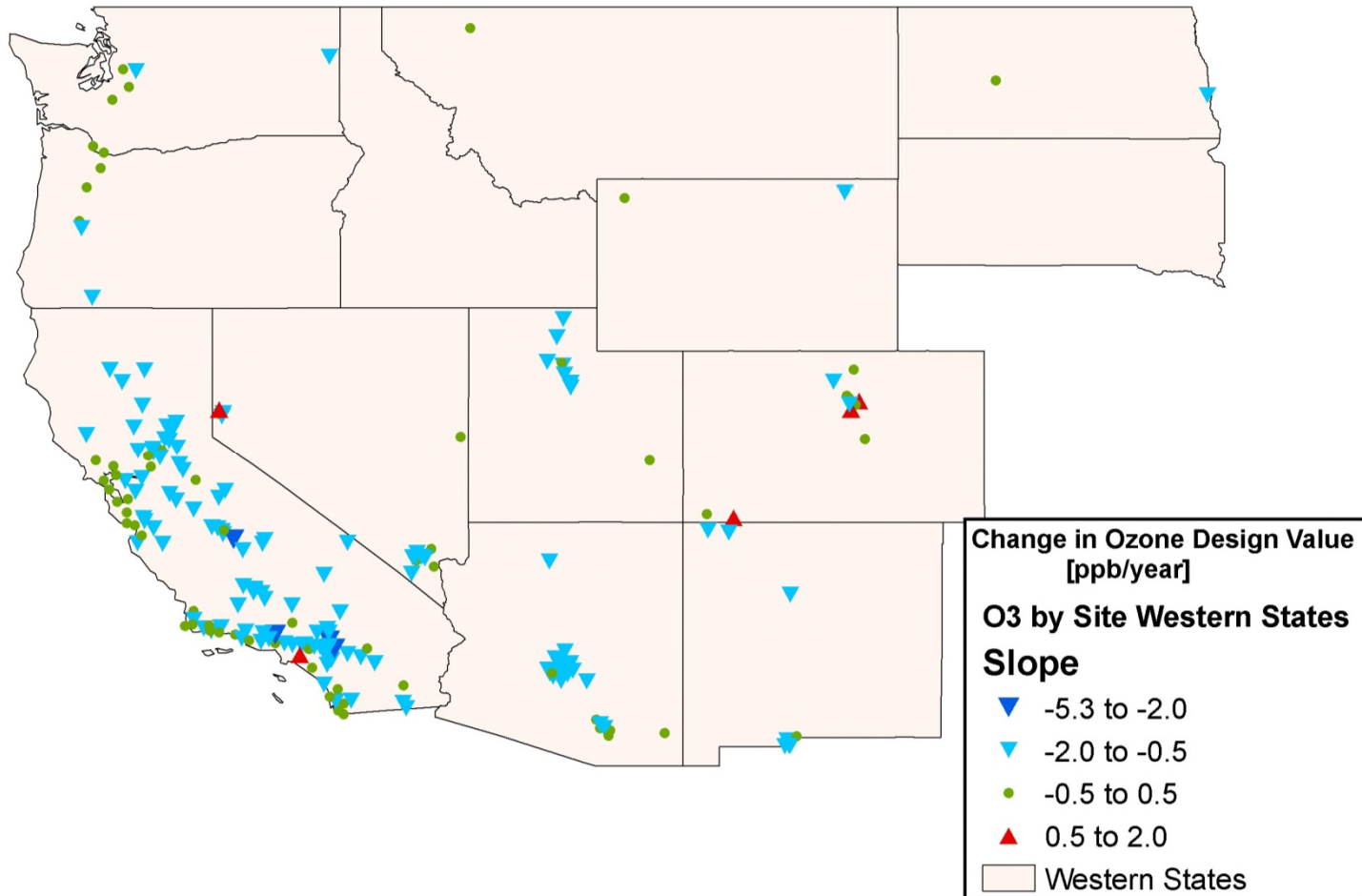
Trends are negative (downward) in 19 out of 21 non-attainment areas in Western states. The trends at San Luis Obispo County (Eastern Part), CA and Upper Green River Basin Area, WY are not determined due to limited data available

# O<sub>3</sub> Trend Slopes in Western States Non-Attainment Areas

Non-Attainment Areas	O <sub>3</sub> Trend Slope [ppb/year]
Los Angeles South Coast Air Basin, CA	-2.13
Nevada County (Western part), CA	-1.76
Kern County (Eastern Kern), CA	-1.70
Morongo Indian Reservation, CA	-1.69
Ventura County, CA	-1.57
Calaveras County, CA	-1.37
San Joaquin Valley, CA	-1.33
Pechanga Indian Reservation, CA	-1.29
Chico (Butte County), CA	-1.22
Riverside County (Coachella Valley), CA	-1.16
Mariposa County, CA	-1.05
Phoenix-Mesa, AZ	-1.04
Imperial County, CA	-1.02
San Diego County, CA	-0.83
Sacramento Metro, CA	-0.74
Los Angeles & San Bernardino Counties (W Mojave), CA	-0.72
San Francisco Bay Area, CA	-0.63
Tuscan Buttes, CA	-0.61
Denver-Boulder-Greeley-Ft Collins-Loveland, CO	-0.43
San Luis Obispo County (Eastern part), CA *	#N/A
Upper Green River Basin Area, WY *	#N/A

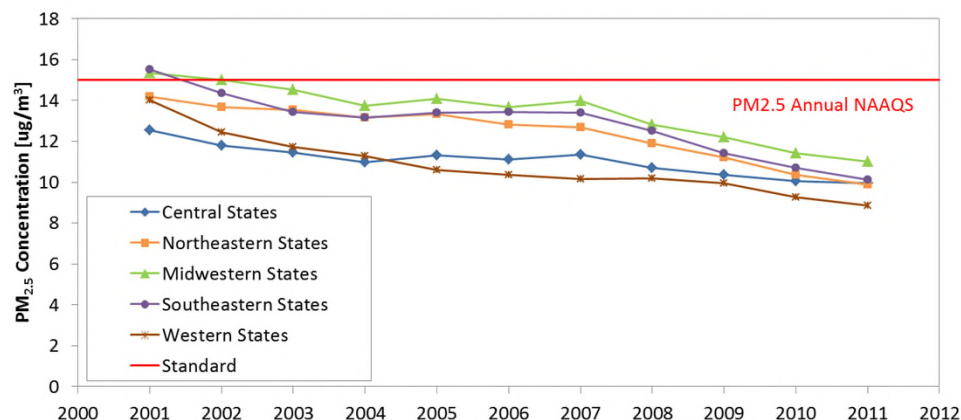
\* Monitoring sites in this NAA do not meet completeness requirement for trend analysis

# Western States Monitoring Sites O<sub>3</sub> Trend Slopes



# PM<sub>2.5</sub> Trends by Regions

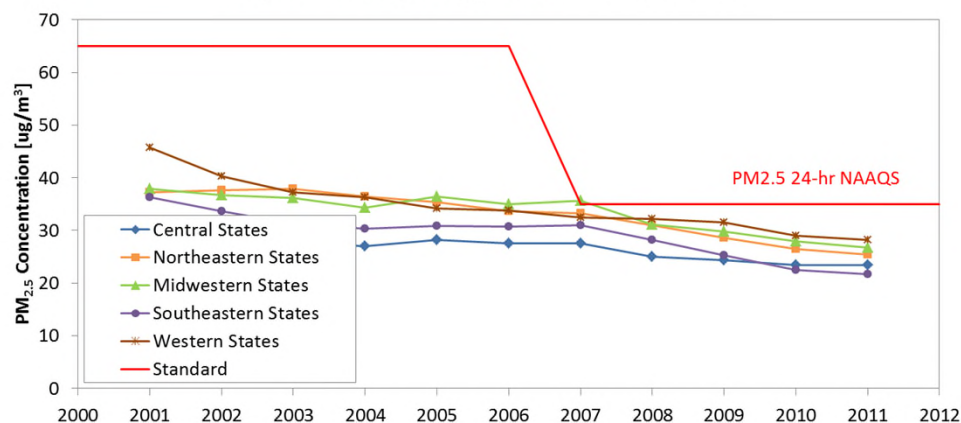
Regional Average PM<sub>2.5</sub> Annual Design Values



Both average and 24-hr PM<sub>2.5</sub> DVs have decreased (negative trends) in all five regions

Trends are not monotonic, possibly reflecting influence of meteorology

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



Average Annual DVs lowest in the Western States

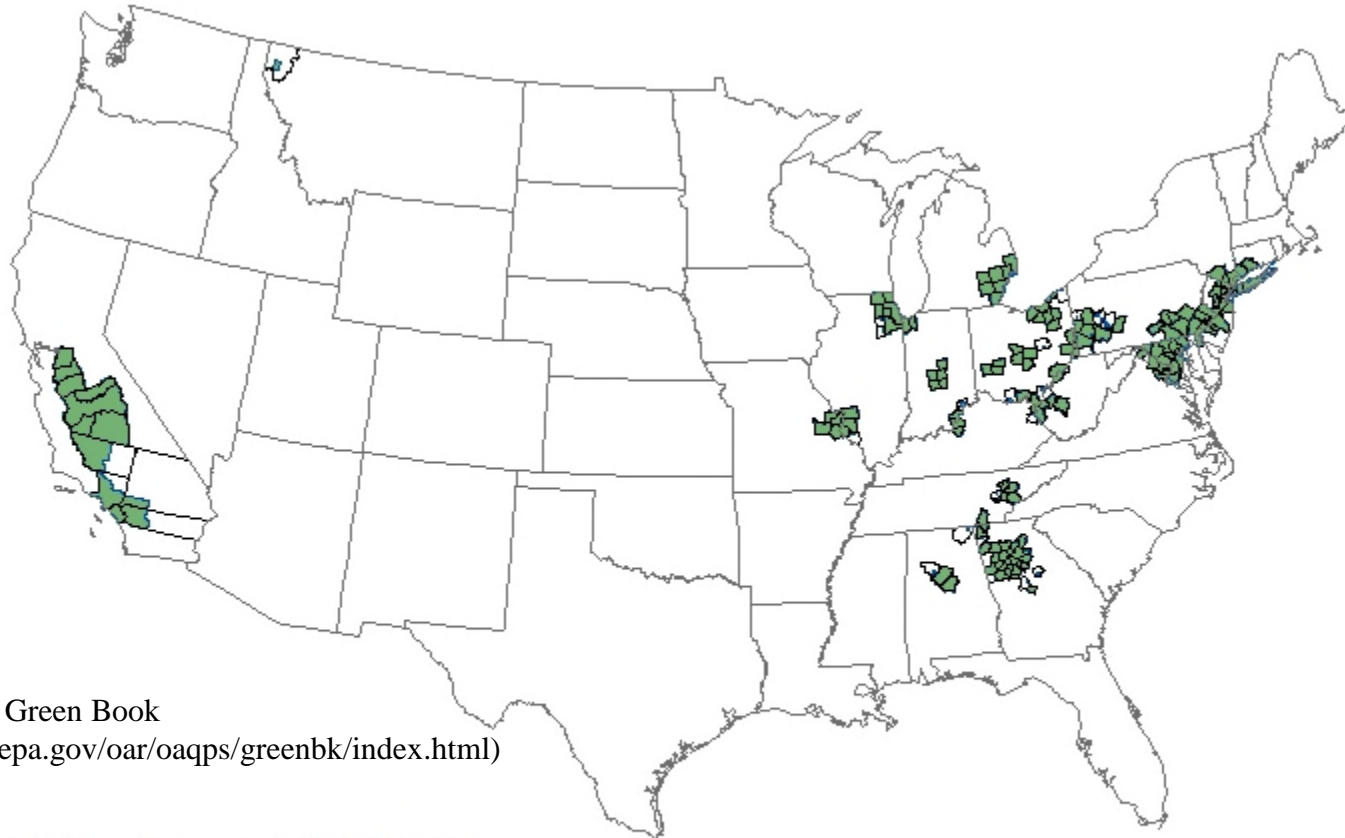
Western States average 24-hour DVs decrease more rapidly during first half of trend period

# PM<sub>2.5</sub> Trend Slopes by Region

Region	Annual PM <sub>2.5</sub> Trend Slope	24-Hr PM <sub>2.5</sub> Trend Slope
Central States	-0.22 ug/m <sup>3</sup> /year	-0.61 ug/m <sup>3</sup> /year
Northeastern States	-0.41 ug/m <sup>3</sup> /year	-1.32 ug/m <sup>3</sup> /year
Midwestern States	-0.41 ug/m <sup>3</sup> /year	-1.07 ug/m <sup>3</sup> /year
Southeastern States	-0.45 ug/m <sup>3</sup> /year	-1.27 ug/m <sup>3</sup> /year
Western States	-0.42 ug/m <sup>3</sup> /year	-1.45 ug/m <sup>3</sup> /year

## Designated PM<sub>2.5</sub> Non-Attainment Areas (based on 1997 Annual PM<sub>2.5</sub> Standards)

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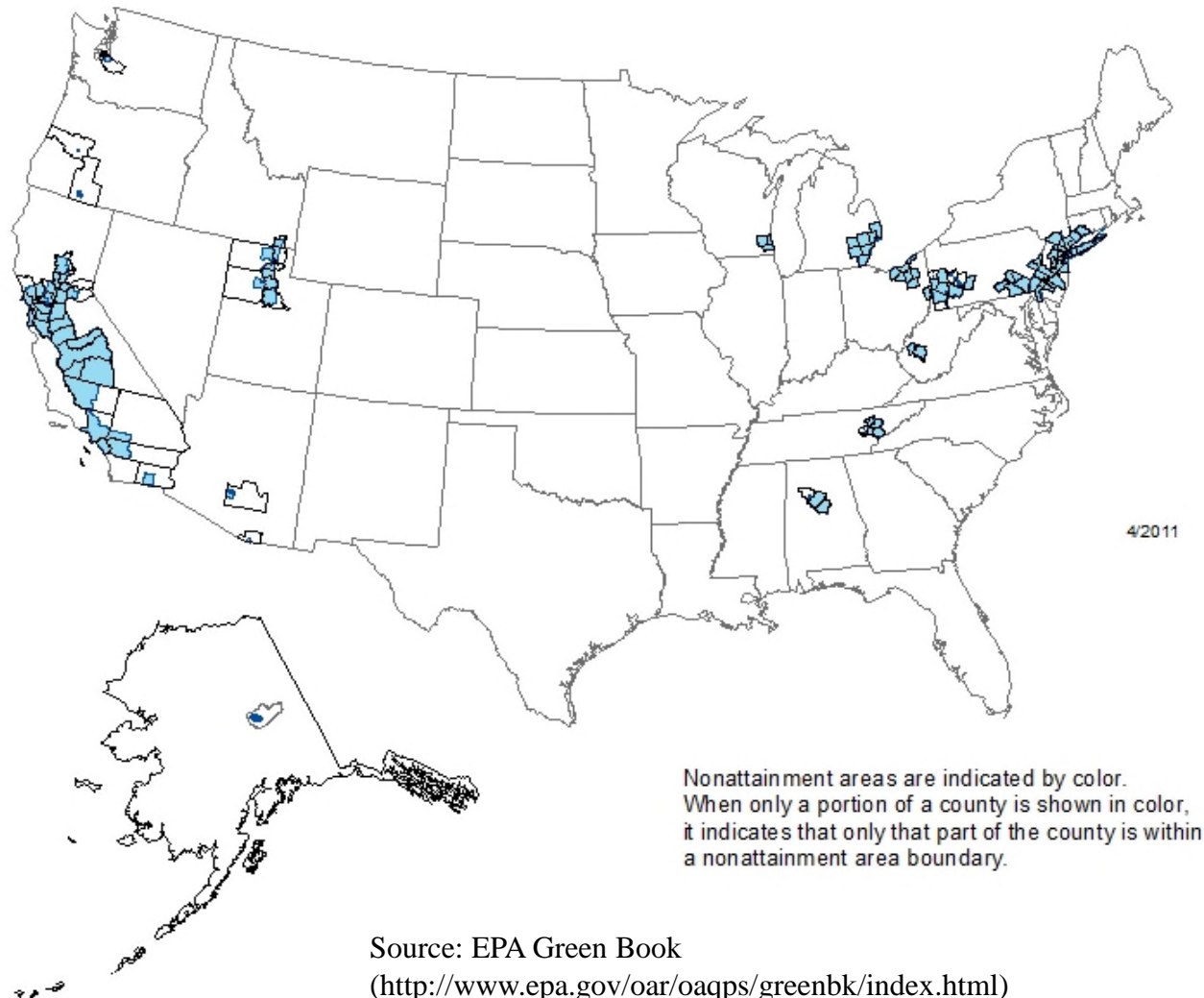


Source: EPA Green Book  
(<http://www.epa.gov/oar/oaqps/greenbk/index.html>)

Nonattainment areas are indicated by color.  
When only a portion of a county is shown in color,  
it indicates that only that part of the county is within  
a nonattainment area boundary.

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## Designated PM<sub>2.5</sub> Non-Attainment Areas (based on 2006 24-Hr PM<sub>2.5</sub> Standards)



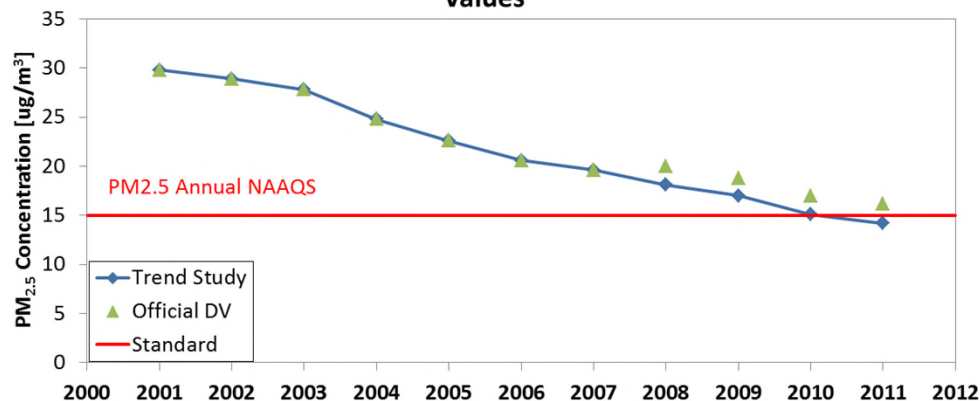
Source: EPA Green Book  
(<http://www.epa.gov/oar/oaqps/greenbk/index.html>)



# Annual PM<sub>2.5</sub> DV Trends in Western States

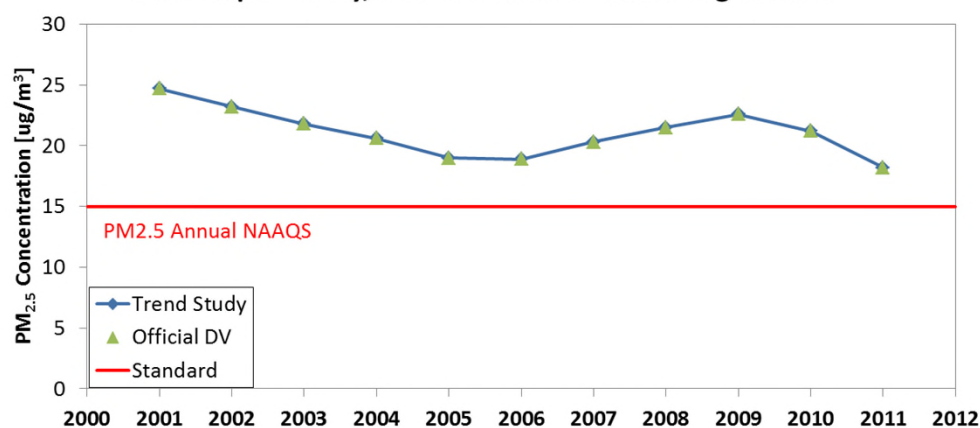
## Non-Attainment Area

Los Angeles-South Coast Air Basin, CA Max PM<sub>2.5</sub> Annual Design Values



- Trends range from -1.65 ug/m³/yr (Los Angeles-South Coast Air Basin, CA) to -0.32 ug/m³/yr (San Joaquin Valley, CA)

San Joaquin Valley, CA Max PM<sub>2.5</sub> Annual Design Values



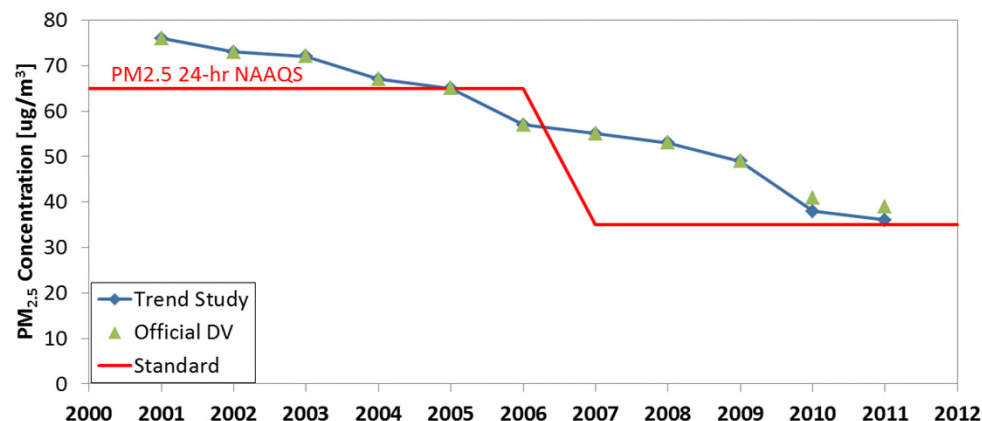
- Trends are negative (downward) in all 3 non-attainment areas in the Western States



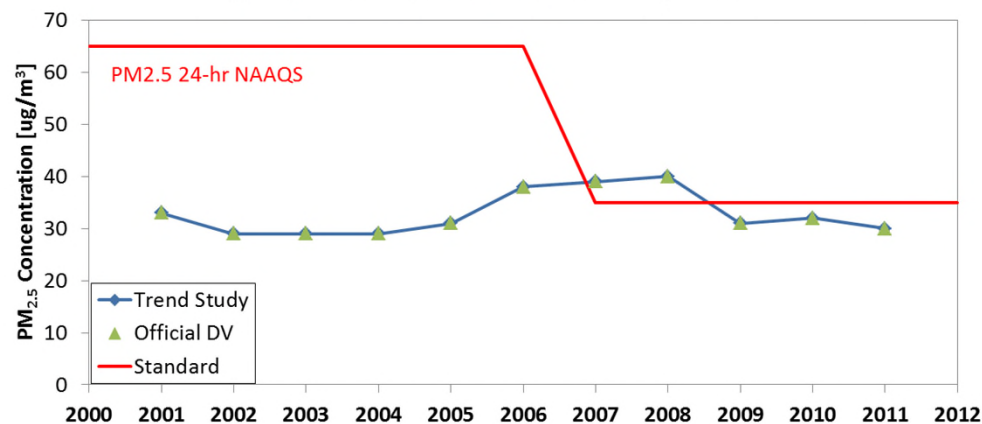
# 24-Hour PM<sub>2.5</sub> DV Trends in Western States

## Non-Attainment Area

Los Angeles, CA Max PM<sub>2.5</sub> 24-Hour Design Values



Nogales, AZ Max PM<sub>2.5</sub> 24-Hour Design Values



- Trends range from -4.06 ug/m<sup>3</sup>/yr (Los Angeles, CA) to 0.30 ug/m<sup>3</sup>/yr (Nogales, AZ)
- Non-U.S. sources may have significant impacts in Nogales, AZ
- Trends are negative (downward) in 14 out of 16 non-attainment areas and positive in one non-attainment area; trend in West Central Pinal County, AZ was not determined due to limited data available

# Annual PM<sub>2.5</sub> Trend Slopes for Western States Non-Attainment Areas

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Non-Attainment Area	Annual PM <sub>2.5</sub> Slopes (ug/m <sup>3</sup> /yr)
Los Angeles-South Coast Air Basin, CA	-1.65
Libby, MT	-0.51
San Joaquin Valley, CA	-0.32

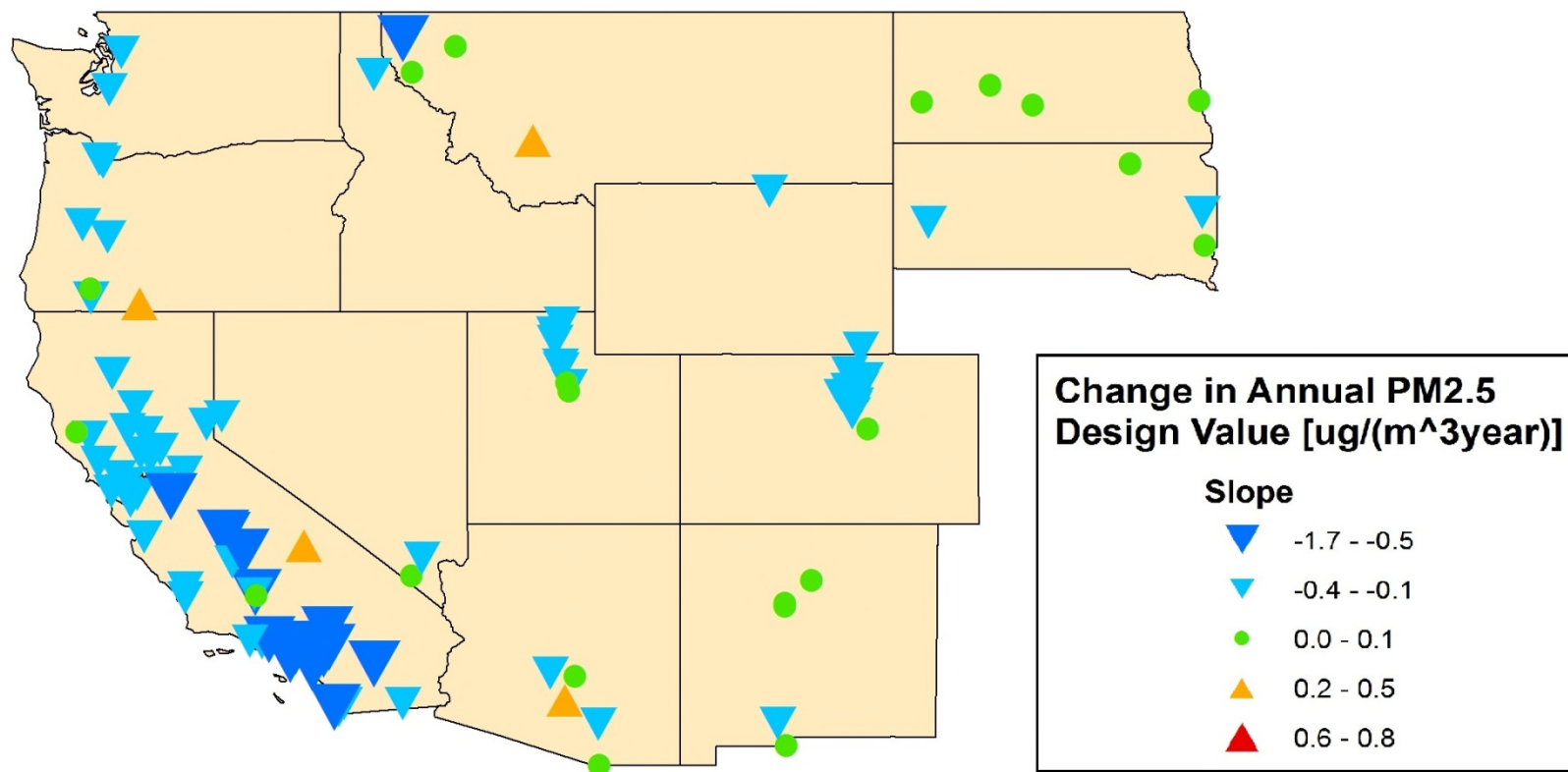
## 24-Hour PM<sub>2.5</sub> Trend Slopes for Western States Non-Attainment Areas

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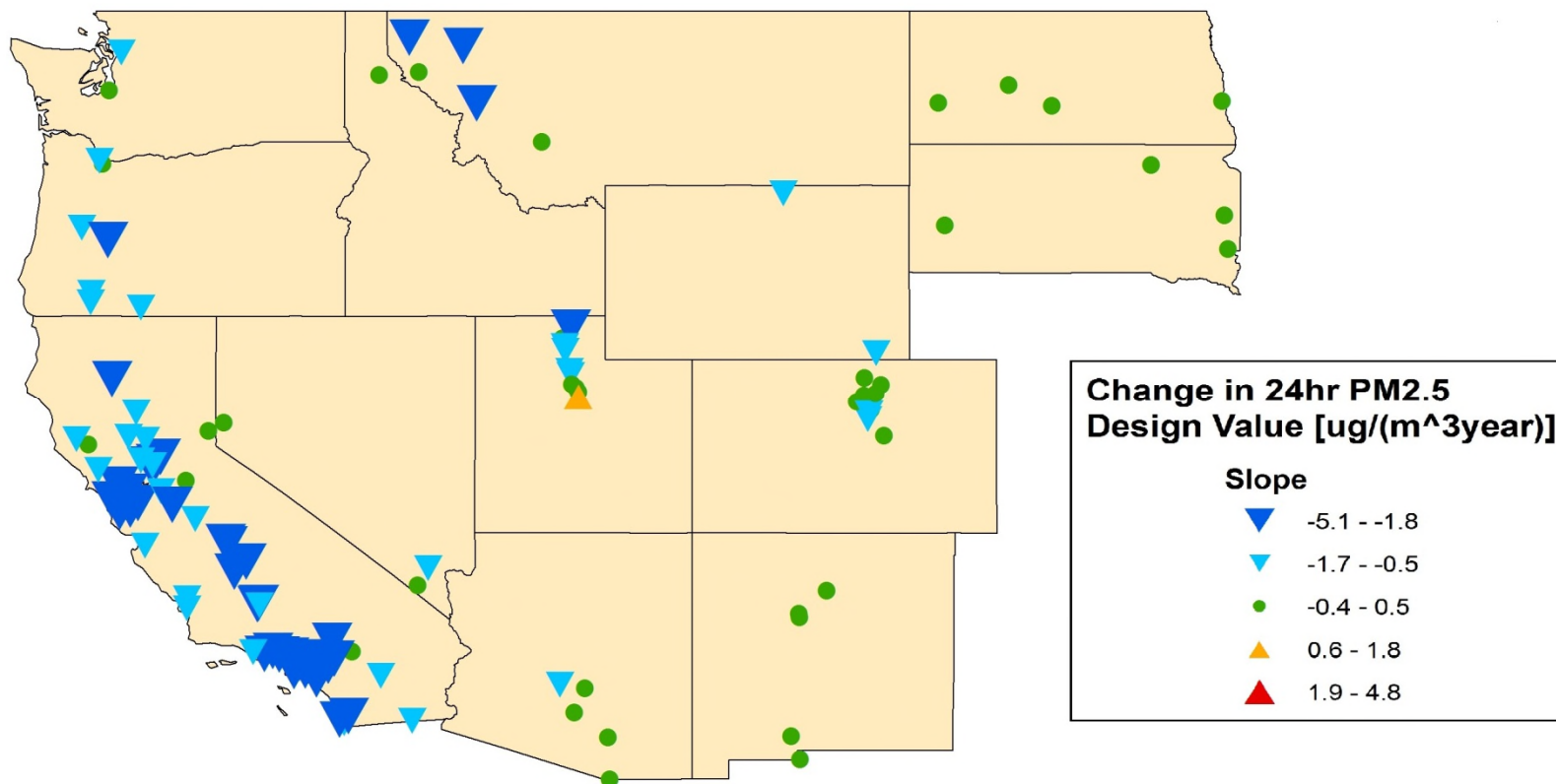
Non-Attainment Area	24-Hour PM <sub>2.5</sub> Slopes (ug/m <sup>3</sup> /yr)
Los Angeles, CA	-4.06
San Joaquin Valley, CA	-2.75
Logan, UT-ID	-2.56
San Francisco Bay Area, CA	-2.27
Sacramento, CA	-2.13
Oakridge, OR	-2.11
Fairbanks, AK	-2.05
Imperial Co, CA	-1.29
Salt Lake City, UT	-1.17
Yuba City-Marysville, CA	-0.87
Klamath Falls, OR	-0.75
Chico, CA	-0.74
Seattle-Tacoma, WA	-0.34
Provo, UT	-0.09
Nogales, AZ	0.30
West Central Pinal County, AZ *	#N/A

\* Monitoring sites in this NAA do not meet completeness requirement for trend analysis

# Annual PM<sub>2.5</sub> Trend Slopes at Western States Monitoring Sites



# 24-Hr PM<sub>2.5</sub> Trend Slopes at Western States Monitoring Sites



# Air Quality Trends Summary

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- Average  $O_3$  and  $PM_{2.5}$  design values have decreased since 1999 in the Western States domain
  
- $O_3$  and  $PM_{2.5}$  design values have decreased since 1999 in all currently designated  $O_3$  and  $PM_{2.5}$  non-attainment areas in the Western States in which monitoring data met the 1999–2011 trends completeness criteria. Additional  $O_3$  or  $PM_{2.5}$  nonattainment areas in which monitoring data did not meet the 1999–2011 trends completeness criteria include:
  - San Luis Obispo County (Eastern Part), CA ( $O_3$ )
  - Upper Green River Basin Area, WY ( $O_3$ )
  - West Central Pinal County, AZ (24-hour  $PM_{2.5}$ )