

Passive Photocatalytic Oxidation of Air Pollution Workshop

Health Benefits of Reducing Air Pollution in California

June 29, 2007

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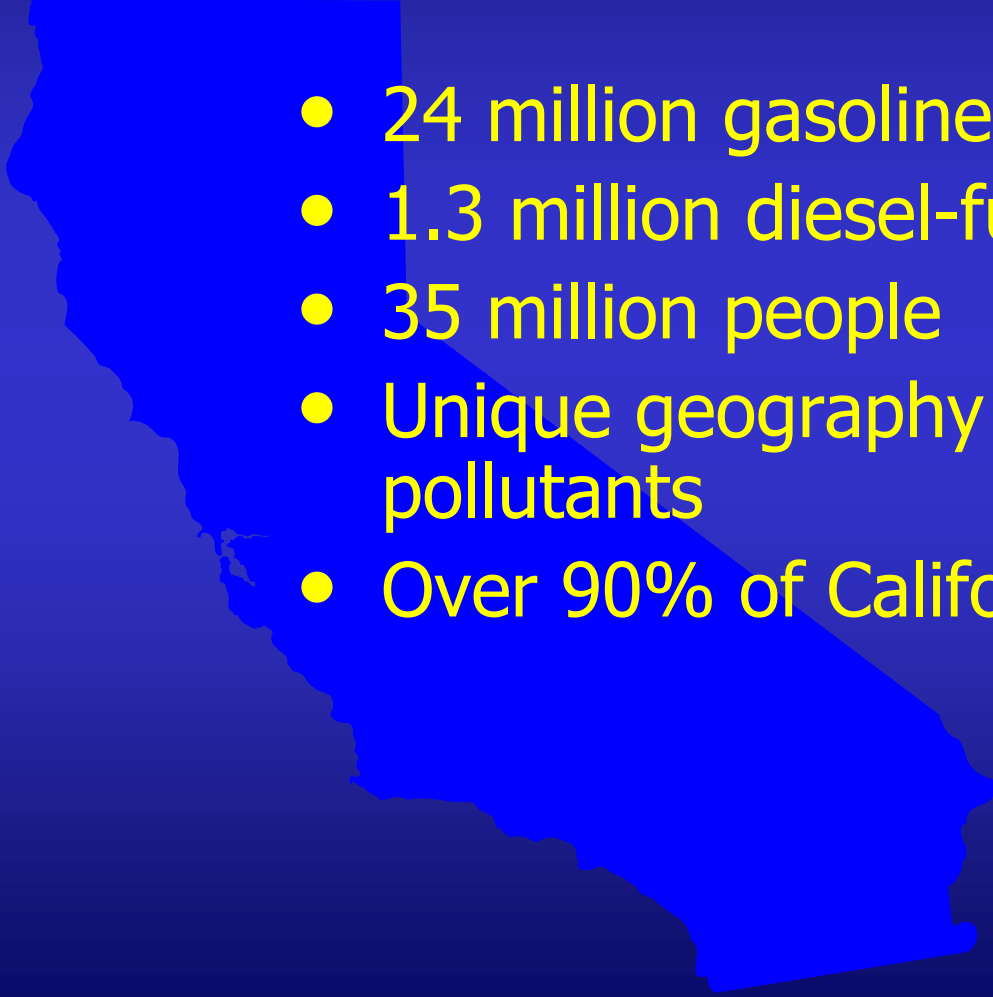
California Environmental Protection Agency

Air Resources Board

Overview

- Introduction
- Scientific Background
- Health Effects of Ozone
- Health Effects of Particulate Matter

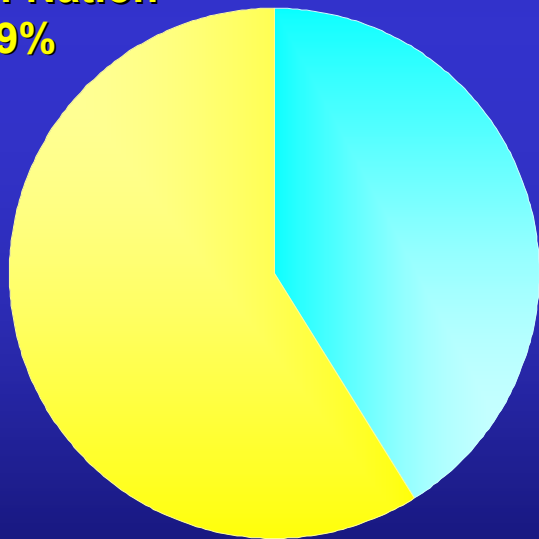
California's Air Pollution Problem

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- 24 million gasoline-powered vehicles
 - 1.3 million diesel-fueled vehicles and engines
 - 35 million people
 - Unique geography and meteorology confine air pollutants
 - Over 90% of Californians breathe unhealthy air

California's Disproportionate Air Pollution Exposure

8-Hour Ozone (NAAQS = 0.08 ppm)

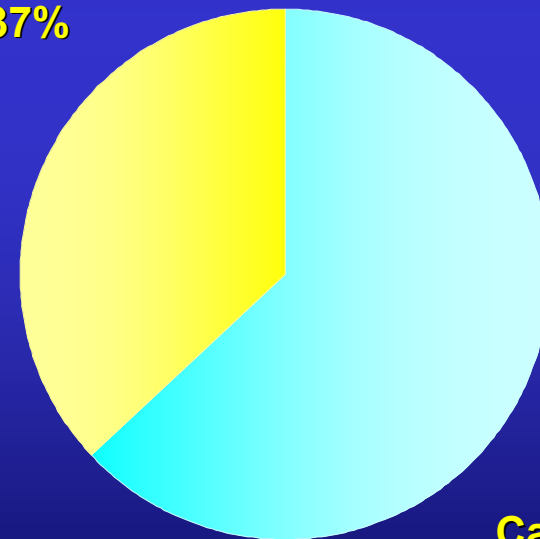
Rest of Nation
59%



California
41%

Annual PM2.5 (NAAQS = 15 $\mu\text{g}/\text{m}^3$)

Rest of Nation
37%



California
63%

Population-weighted and minus national ambient air quality standard (NAAQS), based on 2000-2002 data

Ambient Air Quality Standards (AAQS)

- Legal definition of clean air
 - No control measures included in AAQS
- Foundation of regulatory programs
- State and federal ambient air standards
- Criteria Pollutants
 - Oxidants (O_3 , NO_2)
 - Particulate matter (PM)
 - Others (SO_2 , CO, H_2S , vinyl chloride, Pb)

Scientific Background:

Sources of Information For Health Effects Associated With Air Pollution

- Controlled exposure studies
- Epidemiological studies
- Animal studies

Controlled Human Exposure Studies

- Simulate real world exposures
- Typical subjects: healthy adults
 - Some studies on children, older adults, and people with chronic heart or lung disease
- Advantage: Good measures of exposure and response
- Disadvantages: Mostly healthy adults; small samples; limited endpoints; few co-pollutants

Epidemiological Studies

- Investigate effects of acute and long-term exposures in free-living populations
- Typical endpoints
 - Premature death
 - Hospitalization & emergency room usage
 - Lung function
 - Symptoms
 - Asthma exacerbation & medication usage

Epidemiological Studies

Can:

- Show *associations* between air pollution and adverse health effects
- Estimate population level risk of experiencing adverse effects
- Evaluate effects in populations that cannot be studied under laboratory conditions

Cannot:

- Demonstrate cause and effect
- Identify the specific concentrations or averaging times relating to adverse health outcomes

Health Effects of Ozone

Why We Are Concerned About Ozone

- Health effects are significant
- Body of evidence is substantial
- Exposure is high in California
- Children, athletes, outdoor workers, and people who are active outdoors may be particularly vulnerable

Ozone Health Effects

- Rapid, shallow breathing
- Cough, chest tightness
- Reduced lung function
- Reduced exercise and work capacity
- Lung inflammation
- Exacerbation of lung disease
- Hospitalization for exacerbation of chronic heart/lung disease
- ER usage for asthma
- Premature death

Effects of Multi-Hour Ozone Exposures: Lowest Concentrations Showing Effects

- Lung function decrements: 0.08 ppm
- Increased respiratory symptoms: 0.08 ppm
- Increased airway reactivity: 0.08 ppm
- Airway inflammation: 0.08 ppm
- No effects reported at 0.04 ppm

Ozone Standards

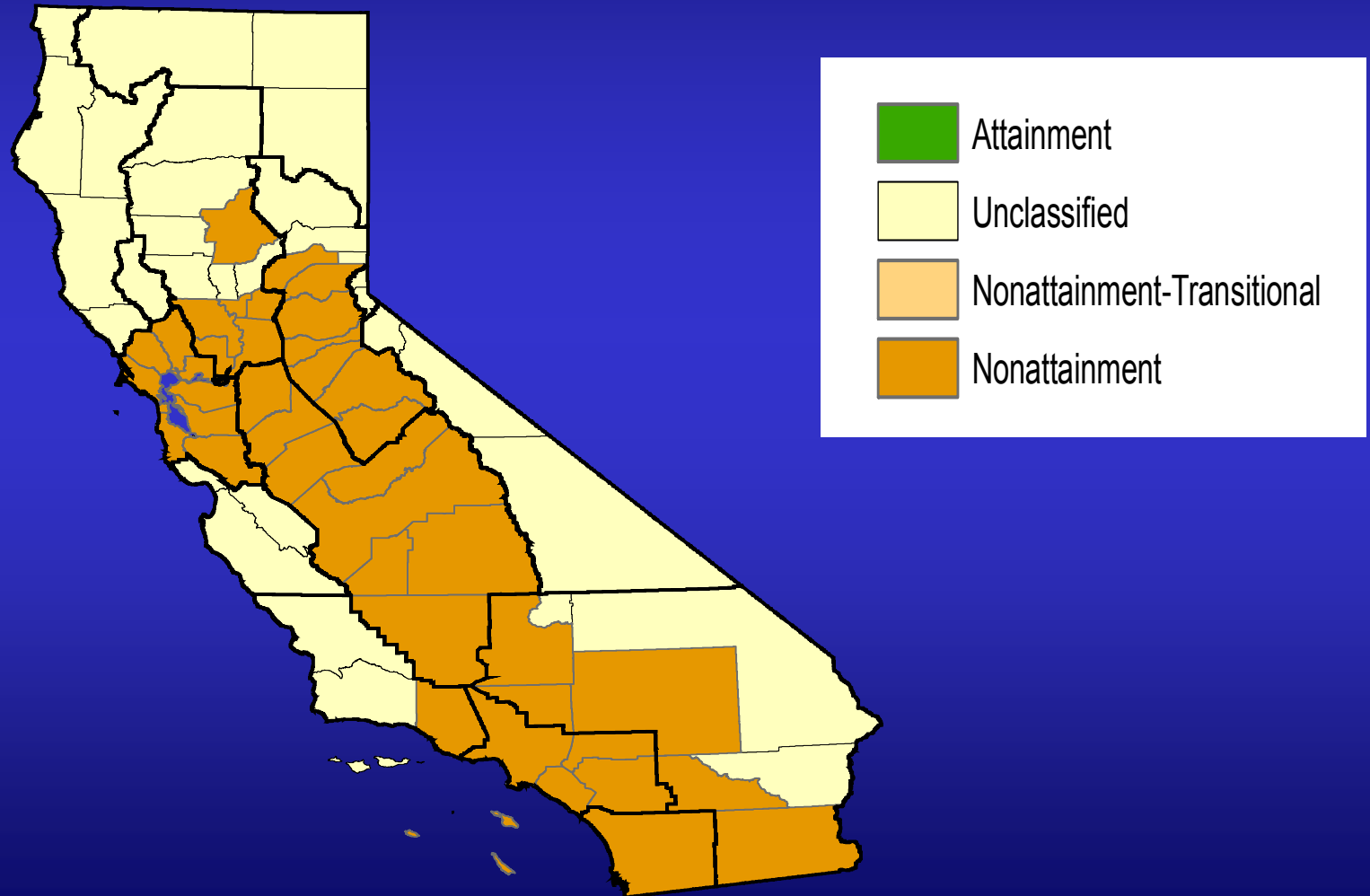
California	National	Averaging Time
0.09 ppm	--	1 hour
0.070 ppm	0.08 ppm	8 hours



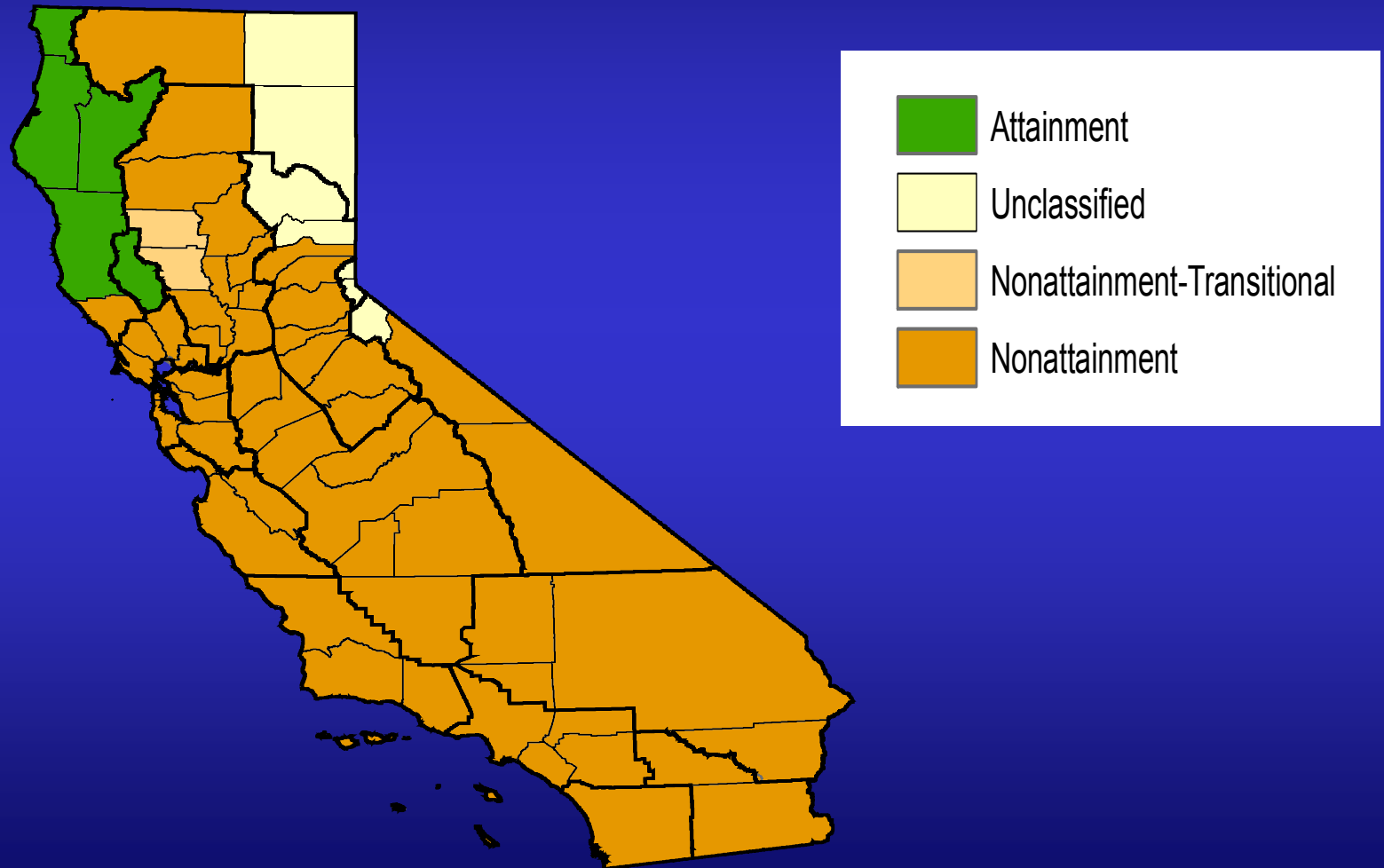
California Ozone Standards based on:

- decreased lung function
- cough and chest pain
- aggravated breathing problems

Federal Ozone Attainment Status 2006



State Ozone Attainment Status 2006



Health & Economic Impacts Associated with Exposures Above California Ozone Standards

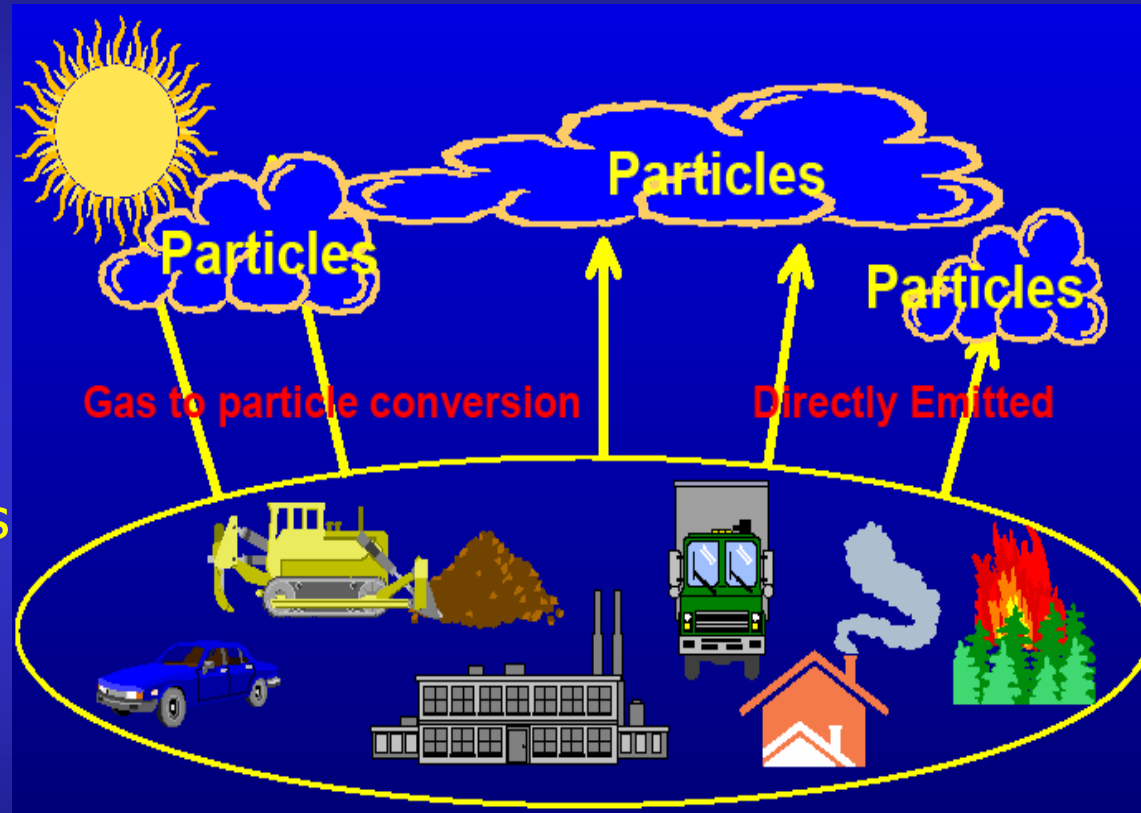
Health Endpoint	Annual # Cases (95% CI)	Average Value (millions*)
Premature Deaths	630 (310-950)	\$5,000
Hospitalizations for Respiratory Causes	4,200 (2,400-5,800)	\$140
School Absence Days	4,700,000 (1,200,000-8,600,000)	\$420
Minor Restricted Activity Days	3,100,000 (1,300,000-5,000,000)	\$190

Values based on Year 2000 census, 2001-2003 ambient air quality data; cost in 2005 \$

BD Ostro, H Tran & JI Levy. 2006.

Health Effects of Particulate Matter

Where Do Particles Come From?



secondary formation

$\text{NO}_x \rightarrow \text{NO}_3^-$ particles

VOCs \rightarrow aerosols

primary formation

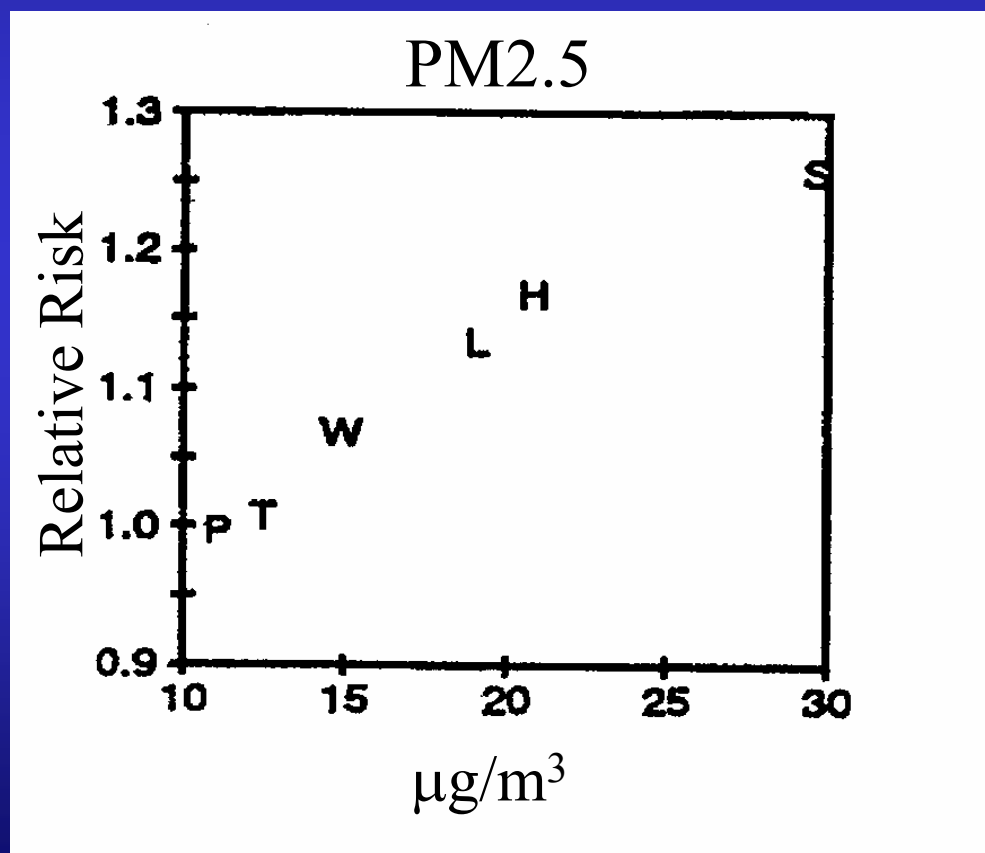
Why We Are Concerned About Particulate Matter

- Significant health effects including premature death and cardiorespiratory disease
- Compelling and growing body of evidence
- Vulnerable groups include infants & children, asthmatics, the elderly, and those with pre-existing heart or lung disease
- High exposures in California
- Substantial health benefits from lowering PM levels

Effects of Long-term Exposure to PM

- Long-term PM exposure is associated with premature death in older adults with cardiopulmonary disease
- American Cancer Society study (Pope et al., 1995, 2002)
 - Over 550,000 adults from 151 US cities
 - Followed for 16 years
- Harvard Six-Cities study (Dockery et al., 1993)
 - Over 8000 adults
 - Followed for 14 to 16 years

Mortality Risk and Long-term PM 2.5 Exposure: *Harvard Six-Cities Study*



From Dockery et al., 1993

PM2.5 Standards

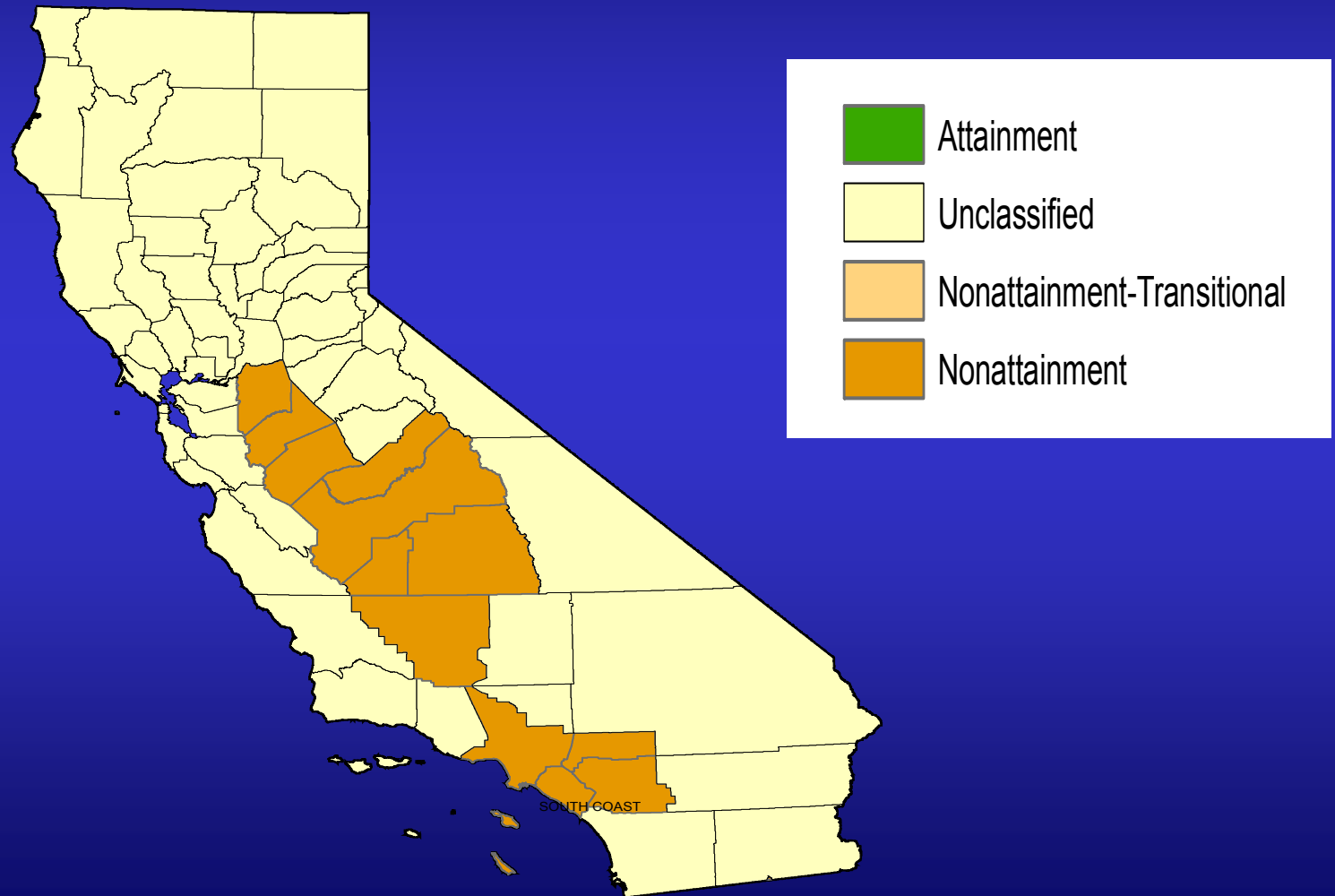


California	National	Averaging Time
12 $\mu\text{g}/\text{m}^3$	15 $\mu\text{g}/\text{m}^3$	annual average
--	35 $\mu\text{g}/\text{m}^3$	24-hr average

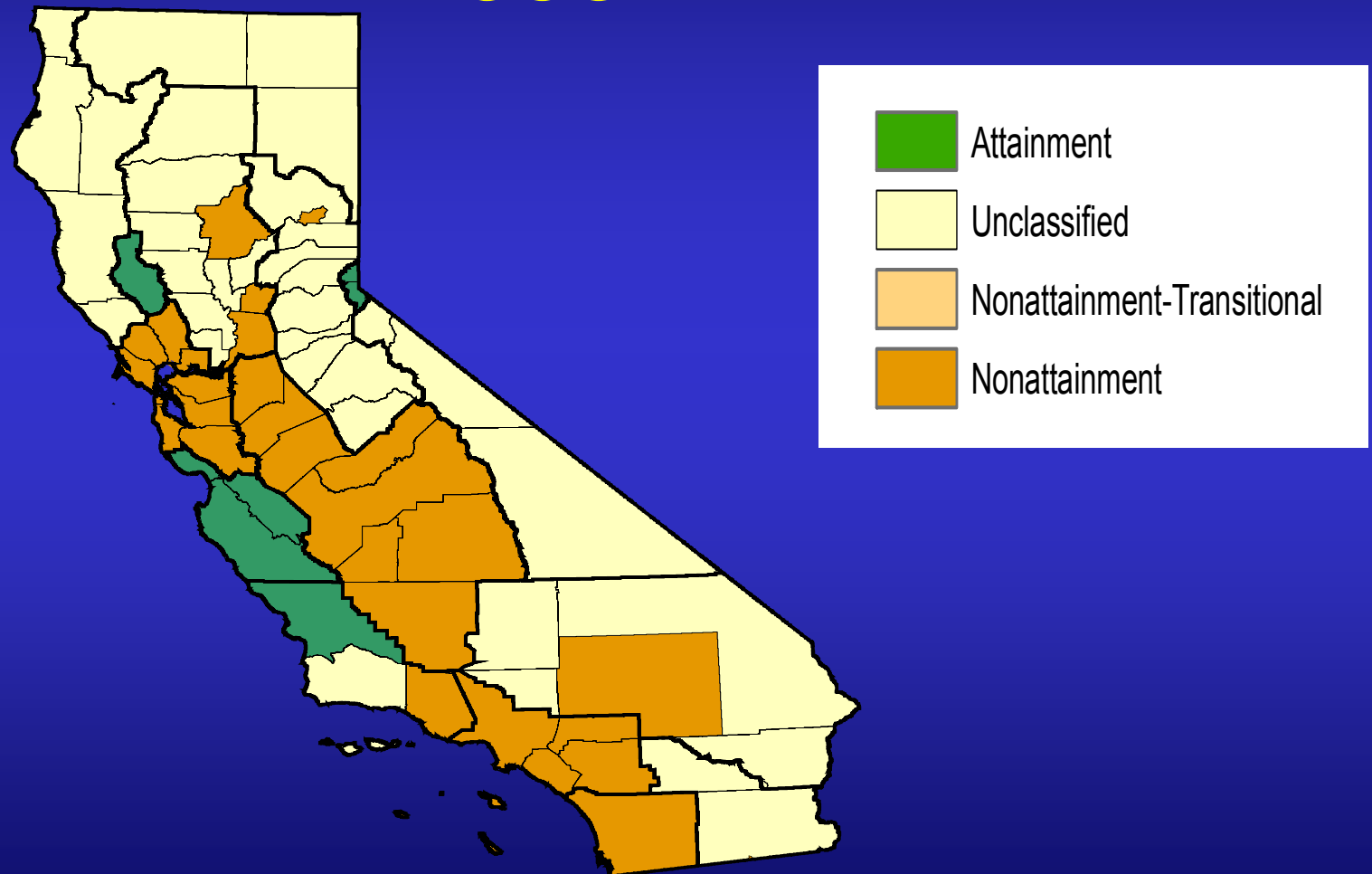
California PM2.5 Standard based on:

- Premature death
- Reduced lung function in kids
- Hospital visits in people with existing respiratory and cardiac problems
- Emergency room visits for asthma

Federal PM2.5 Attainment Status 2006



State PM2.5 Attainment Status 2006

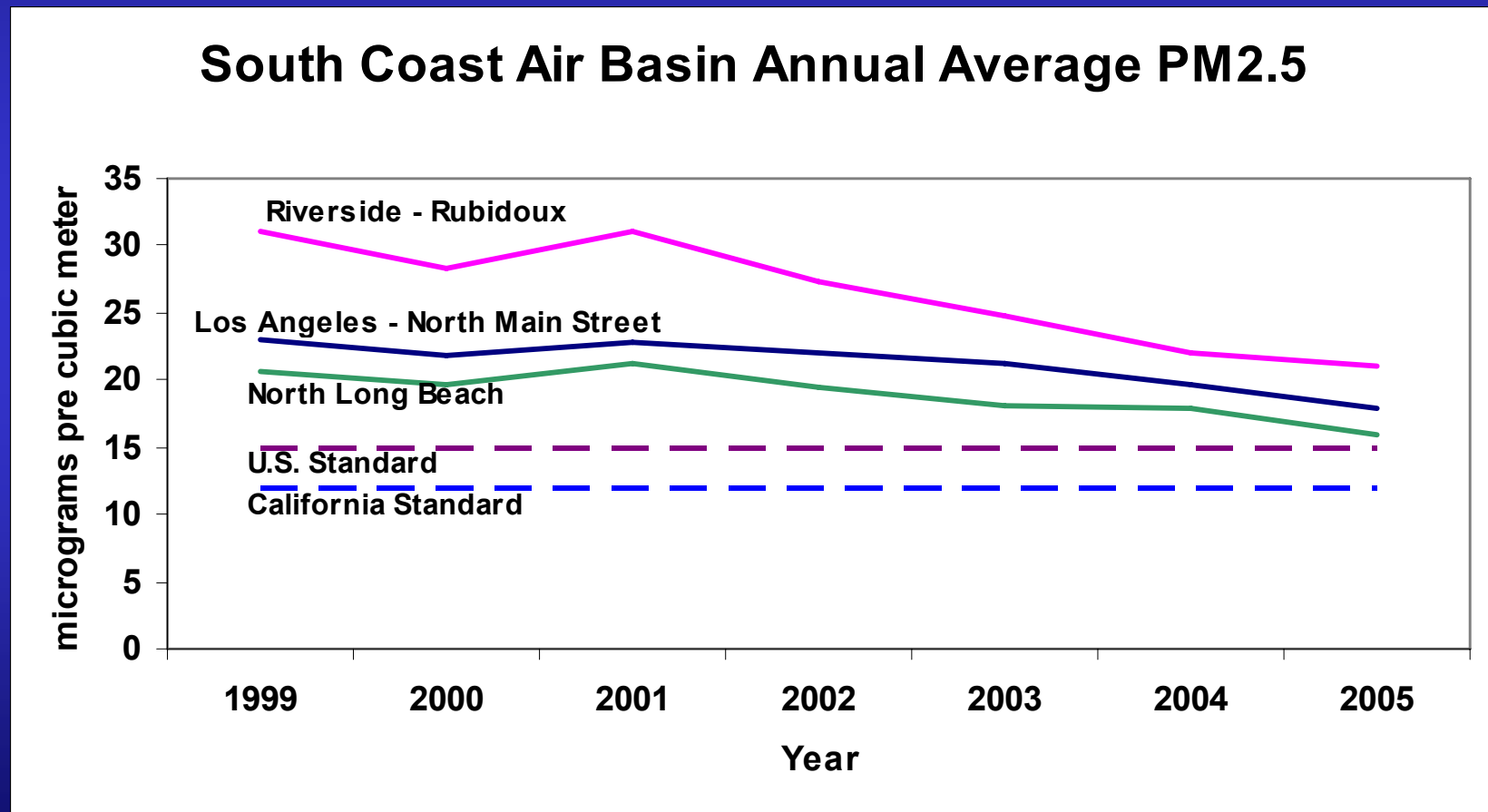


Health & Economic Impacts Associated with Exposures Above the CA PM2.5 Standard

Health Endpoint	Annual # Cases (95% CI)	Average Value (millions*)
Premature deaths	8,200 (2,800-14,000)	\$65,000
Hospitalizations – Respiratory Causes	1,900 (630-3,200)	\$66
Hospitalizations - Cardiovascular Causes	1,500 (1,300-1,800)	\$64
Asthma & Lower Respiratory Symptoms	210,000 (81,000-320,000)	\$4.0
Acute Bronchitis	17,000 (0-34,000)	\$7.6
Work Loss Days	1,400,000 (1,200,000-1,700,000)	\$260
Minor Restricted Activity Days	7,600,000 (6,200,000-8,900,000)	\$470

Values based on Year 2000 census, 1999/2000 ambient air quality data; *cost in 2005 \$

Bright Spot – Falling PM2.5 levels in the South Coast Air Basin



Statewide Emissions Trends

