

# The Health Impacts of Air Pollution

## What are the Risks?

Barbara Weller, Ph.D.

October 25, 2010

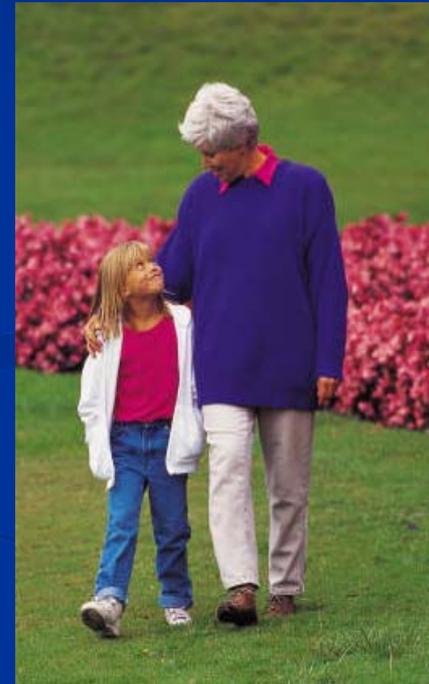


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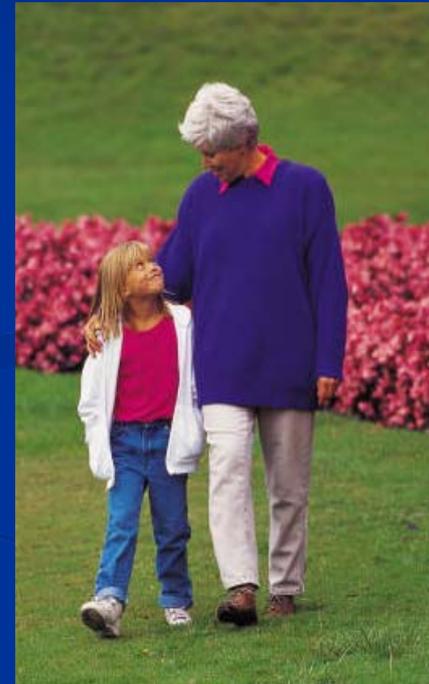
# Presentation Outline

- Sources and Exposures to Particulate Matter
  - Sizes
  - Traffic
  - Wood smoke
  - Indoor
- Risk and Preexisting Disease
  - Cardiovascular Disease
  - Obesity/Diabetes
  - Asthma
- Who is Affected by Air Pollution
  - Elderly
  - Women
  - Occupational
  - Infants
  - Children
- Relevant ARB Outreach and Mitigation Programs

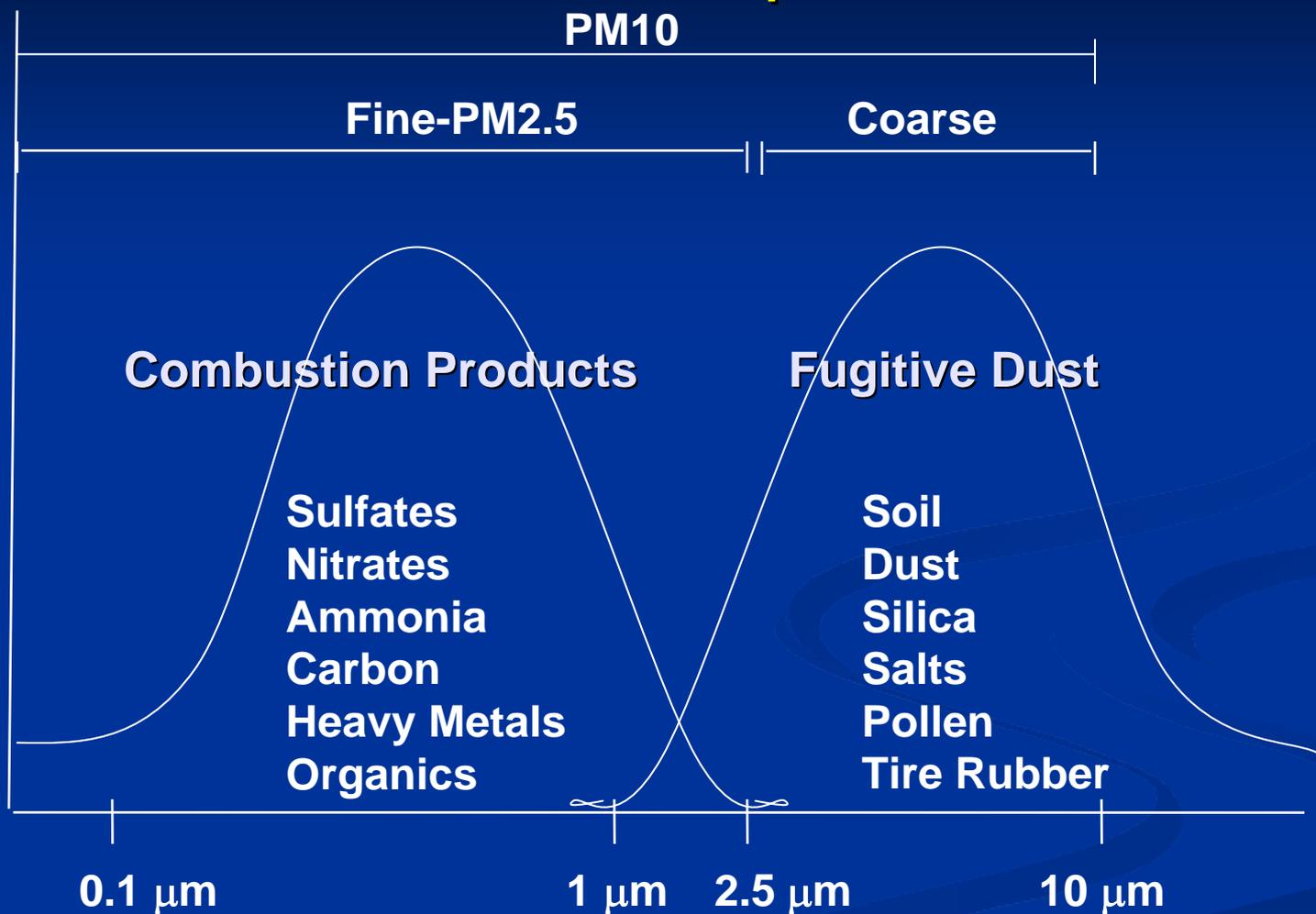


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# Particulate Matter 10 Air Pollution Size and Composition

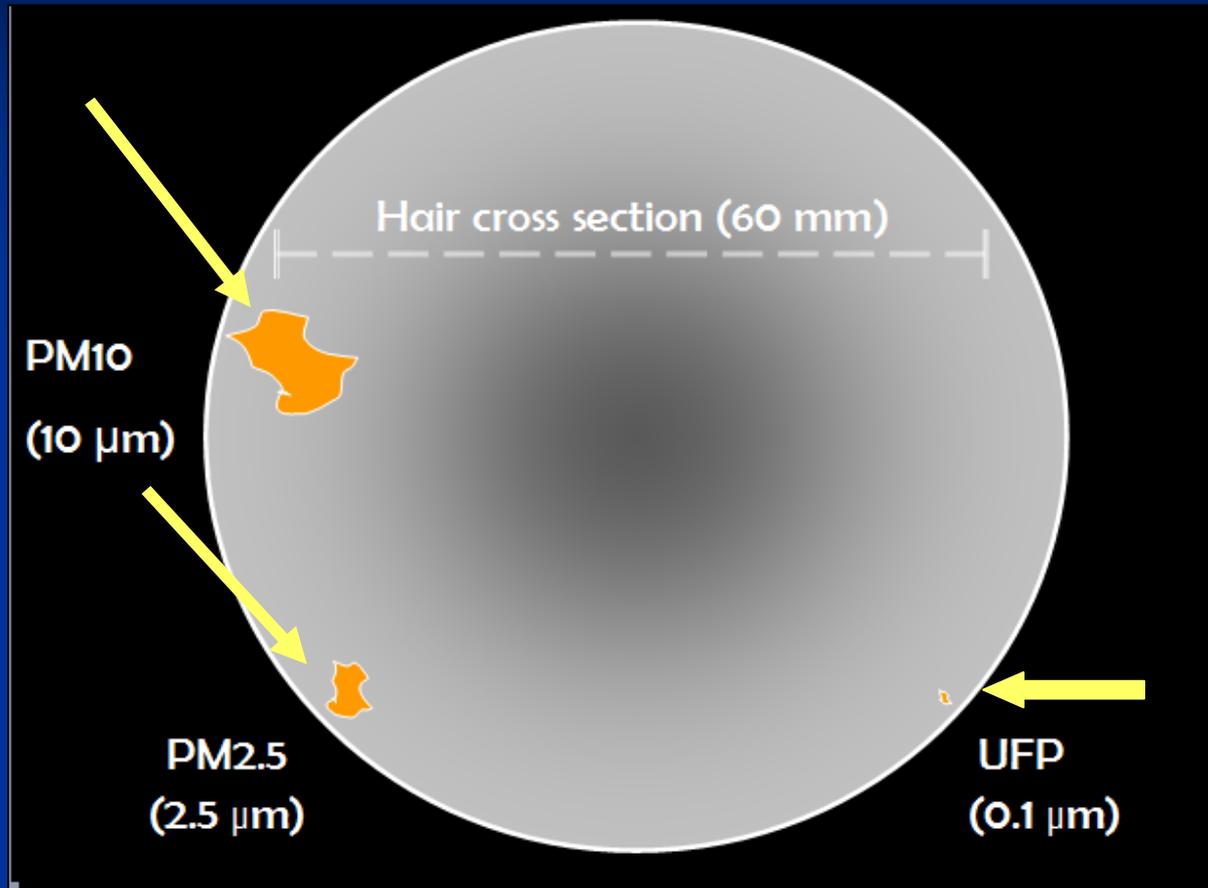


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# Relative Sizes of Particles

PM in the air has 3 size ranges



PM10 = Coarse + Fine + Ultra-Fine    PM2.5 = Fine + Ultra-Fine



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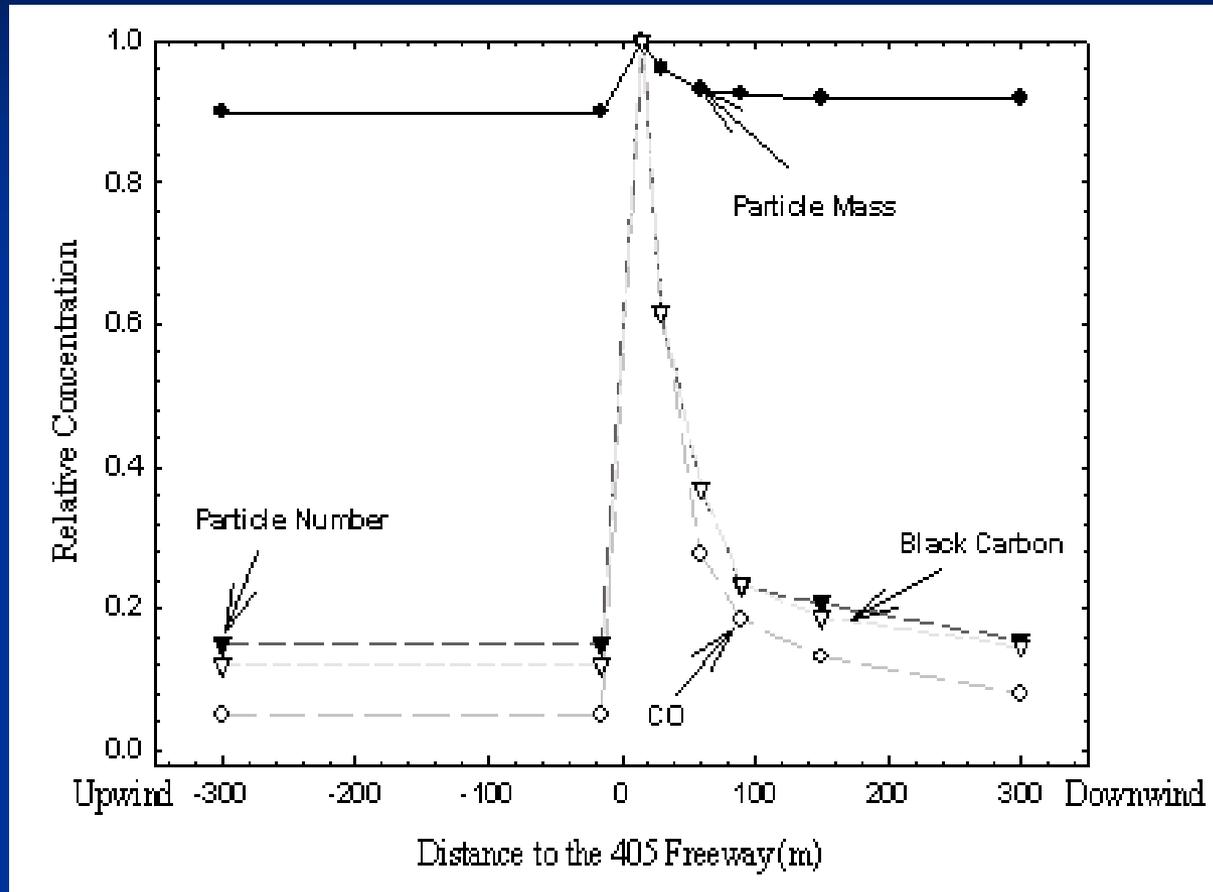
# Traffic Pollution



- Much of your exposure to ultrafine particles occurs during daily commute
- Measurements of traffic-related pollutants
- Freeways/Major Road Exposure:
  - Distance
  - Traffic volume and/or type
  - Traffic-modeled exposure
- In-vehicle studies



# Traffic pollutants greatly elevated downwind of freeway



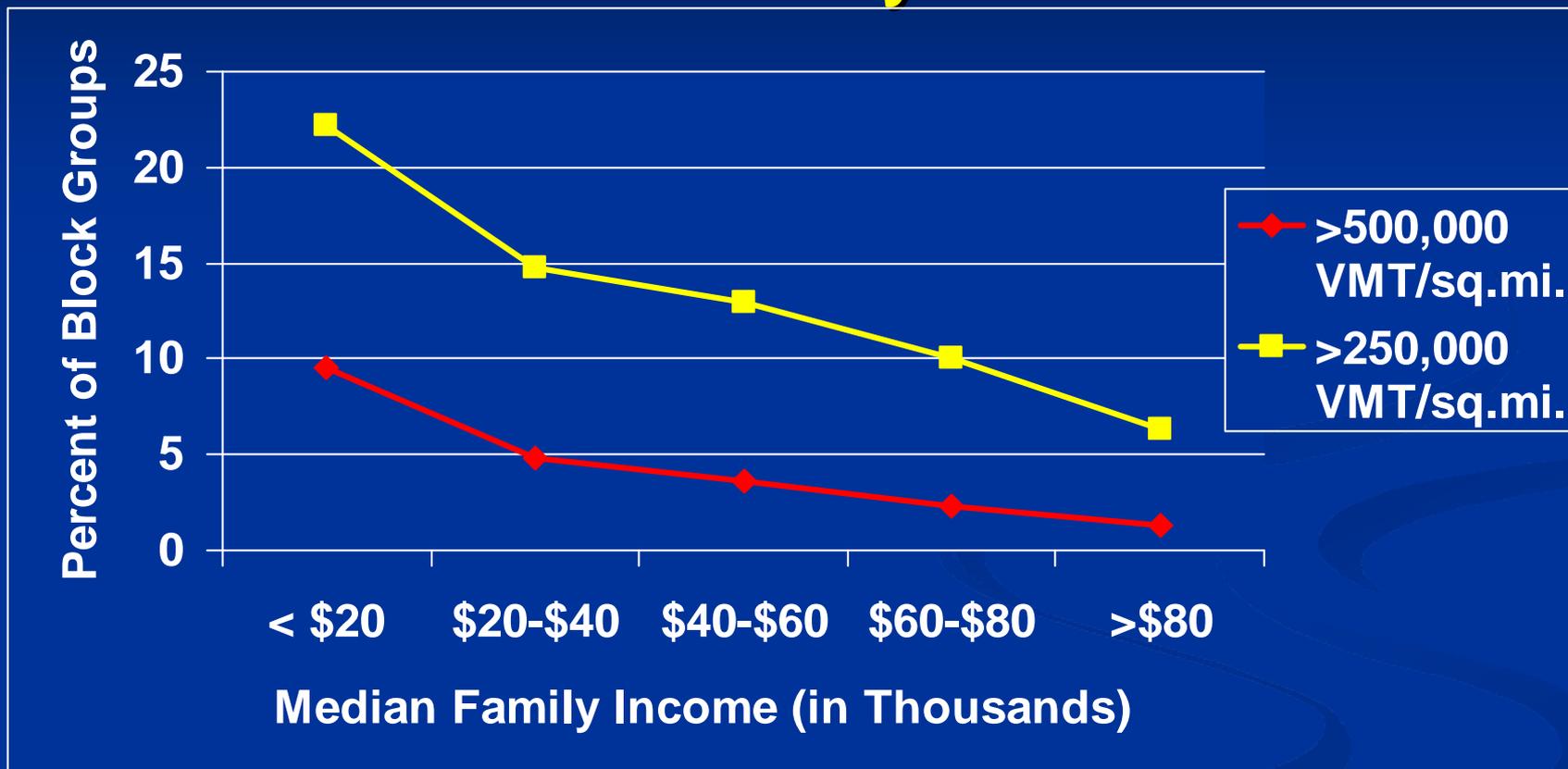
Zhu, et al. (2002) JAWMA, 52: 1032-1042.



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# Lower income families live near roadways



Adapted from Gunier et al. J Exp Anal Environ Epi 13:240-246, 2003  
Data source: California Department of Transportation and US Census

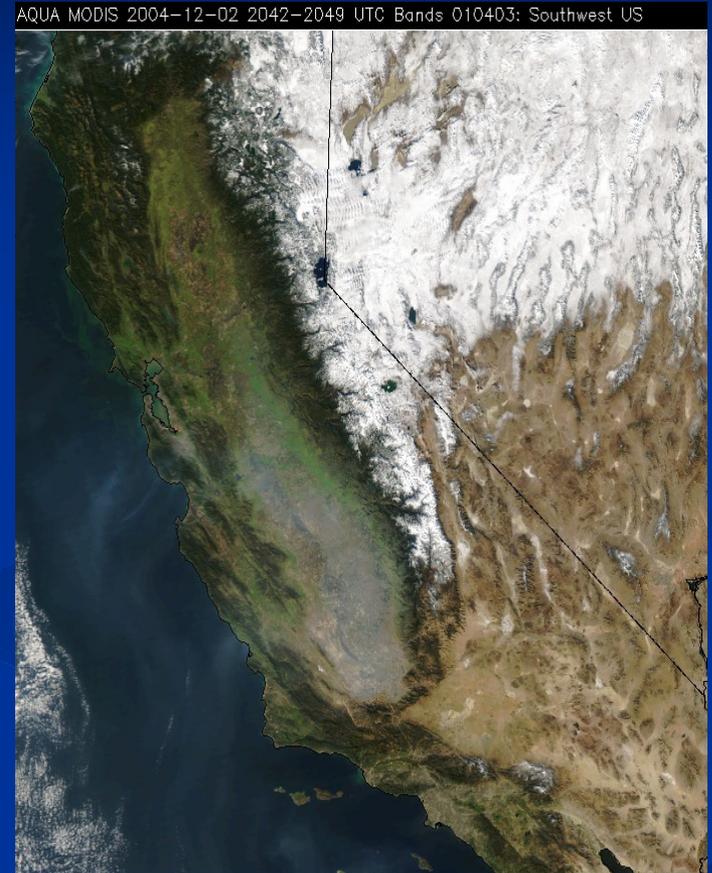


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# Wood Smoke Emissions

- Can be from 20% to 80% of ambient wintertime particulate matter (PM)
- Is a complex mixture of health damaging pollutants
- Readily penetrates other households throughout neighborhoods and regions



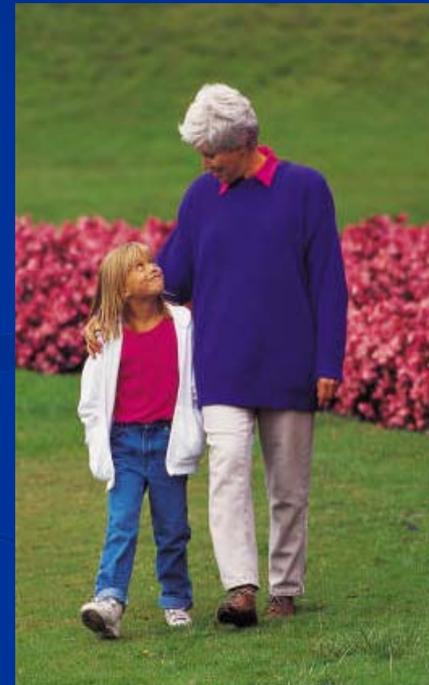
# Indoor Exposure

- Majority of our time spent indoors
- Outdoor pollution penetrates indoors
- Indoor Pollution
  - Indoor combustion sources
  - Allergens
  - Formaldehyde
  - Environmental Tobacco Smoke
  - Cleaning products
  - Volatile Organic Compounds



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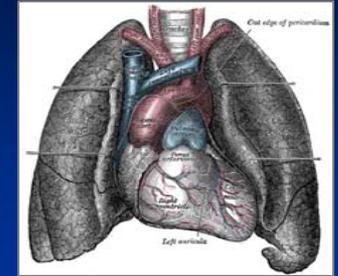
# PM and Ozone Exposure Adversely Affects Human Health



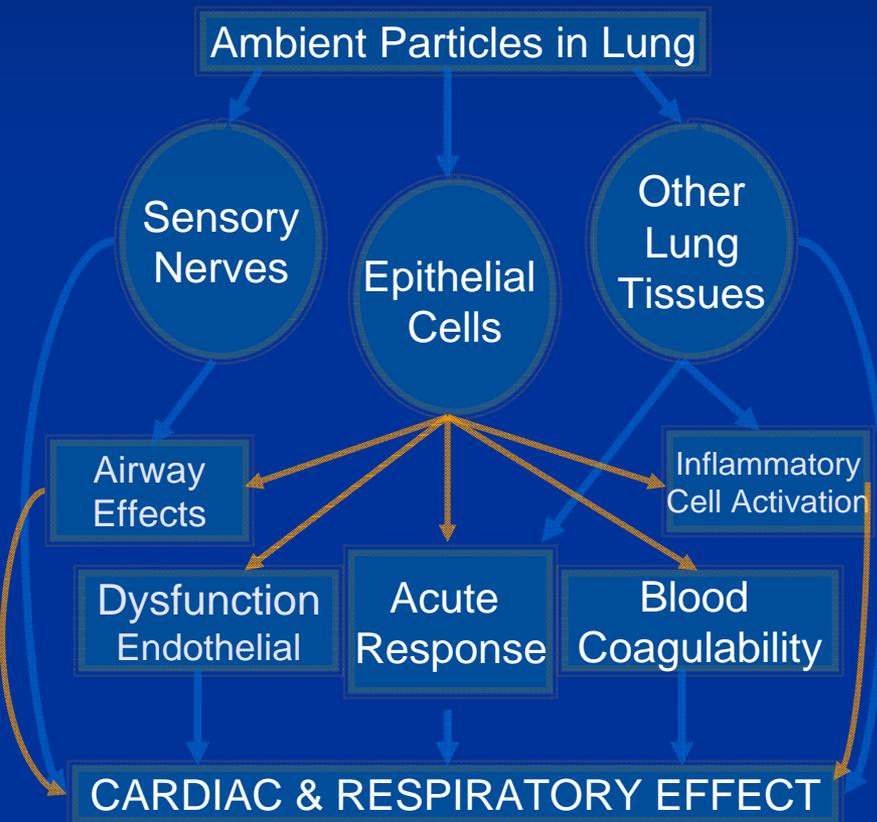
- Thousands of Premature Deaths, Hospitalizations & ER Visits, Asthma/Respiratory Symptoms, Acute Bronchitis
- Millions of Work Days Loss, Minor Restricted Activity Days, School Absences



# Biological Mechanisms of PM Health Effects



Possible Mechanism for PM Health Effects



- Short-term and long-term exposure effects have been seen
- Mechanisms may involve a number of pathways
- US EPA's PM Centers and others are currently investigating mechanisms

Source: Center for Disease Control



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# Air Pollution and Cardiovascular Disease

- Heart disease kills 30% of Californians
  - Atherosclerosis - primary cause of heart disease and stroke
- Ambient PM<sub>2.5</sub> may contribute to increased atherosclerosis
  - 3-6% long-term increase risk for heart attack

Kunzli, N.; et al., Environ Health Perspect. 113(2):201-6 (2005).



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# Obesity and Diabetes

- Obese and diabetic more at risk to air pollution impacts
- 2/3 of adults are overweight/obese
- Obesity/overweight increased risk for disease and death
  - High blood pressure, stroke, certain cancers, diabetes, heart disease
- 1 in 10 adult Californians has diabetes
  - rates are increasing



[www.nhlbi.nih.gov/guidelines/obesity/ob\\_gdlns.pdf](http://www.nhlbi.nih.gov/guidelines/obesity/ob_gdlns.pdf)

[http://www.caldiabetes.org/get\\_file.cfm?contentID=1029&ContentFilesID=1101](http://www.caldiabetes.org/get_file.cfm?contentID=1029&ContentFilesID=1101)



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# What is Asthma?

- One of the most common chronic conditions in the USA
- In 2005, 32.6 million Americans (11.2% of the population) diagnosed with asthma
- Characterized by wheezing and difficulty in breathing
- Often associated with allergy
- Genetic factors
- Complex disease



# Risk Factors in Asthma

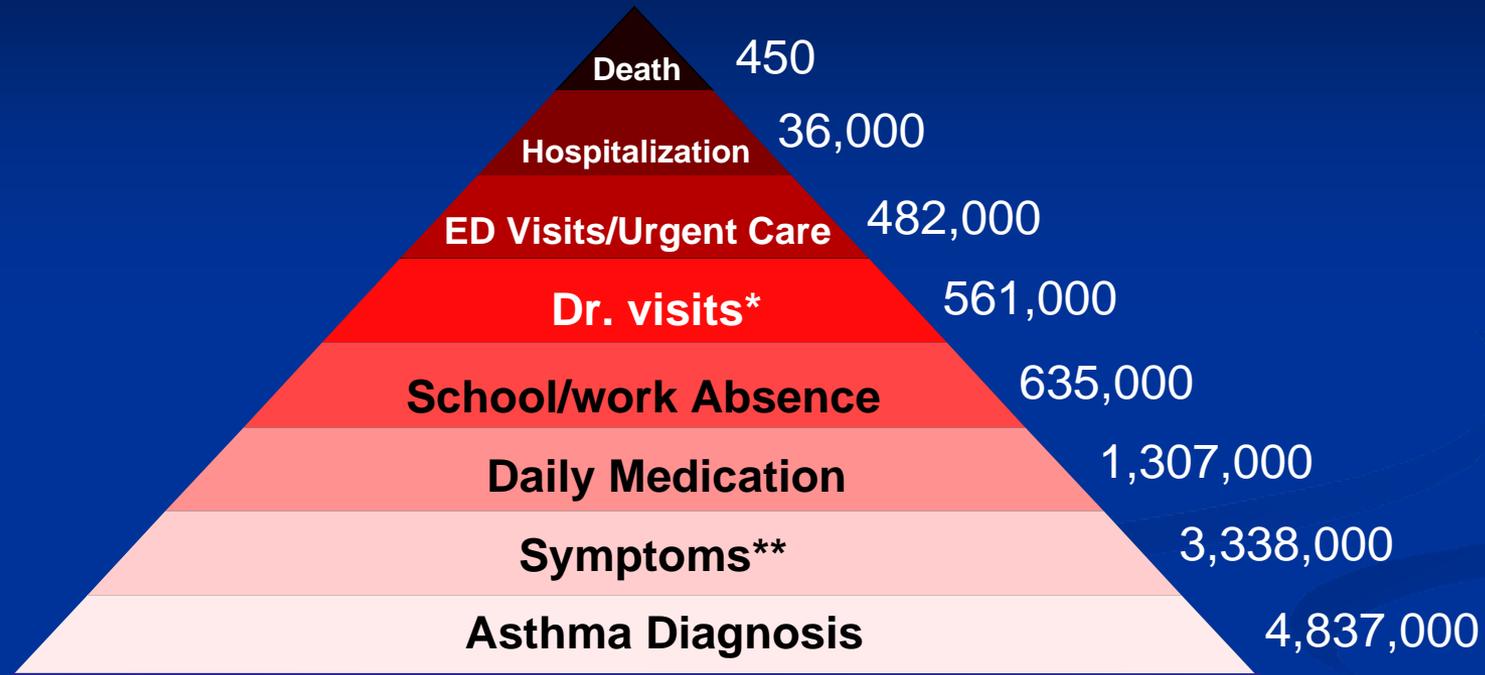
- The cause of asthma is unknown
- Obesity, smoking and allergens may be associated with an increased risk for asthma
- Traffic pollution risk factor for asthma
- Air Pollution risk factor for worsening asthma



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# Asthma Burden in California



**Number of people affected in 2005**

\* 9 or more Dr. visits, not necessarily asthma-related

\*\*An additional 3,399,000 Californians without an asthma diagnosis experienced wheezing in 2003.

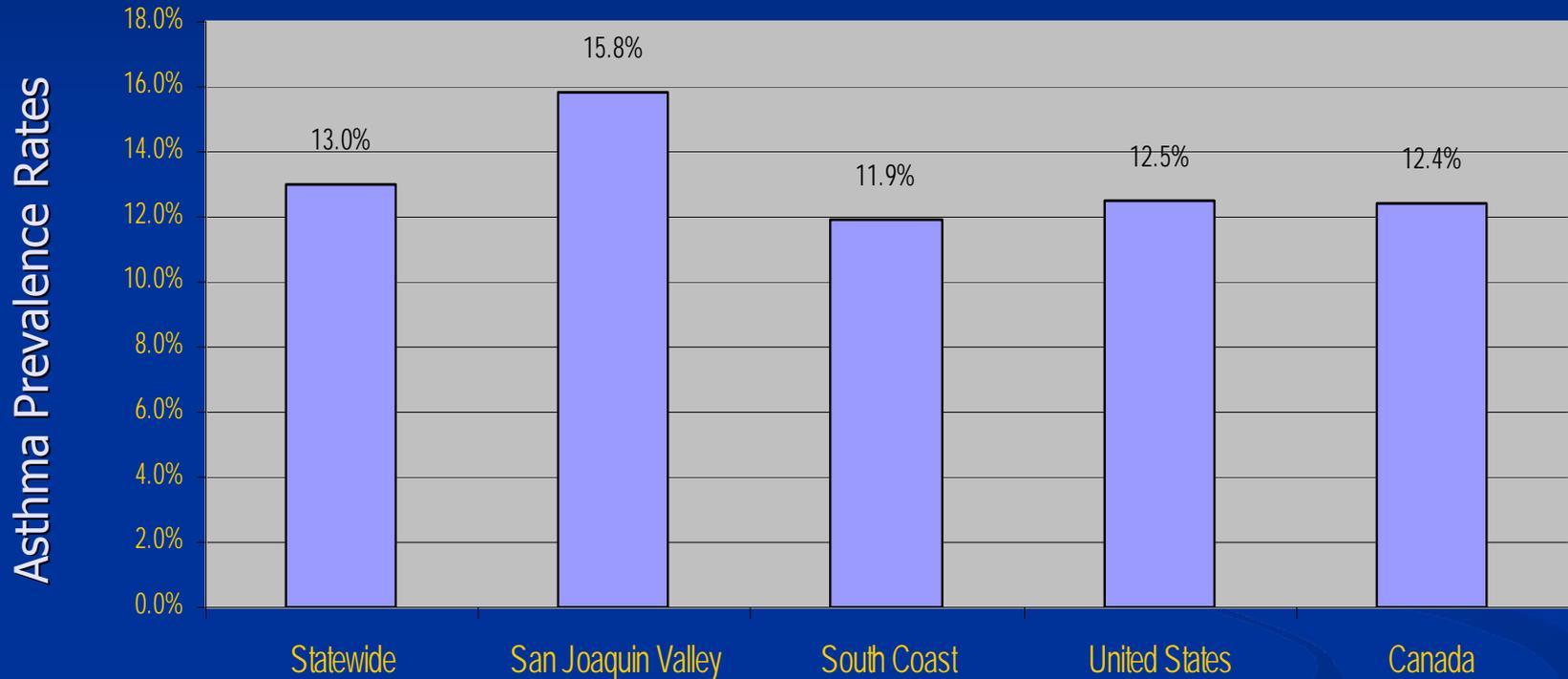
California Breathing Surveillance Report  
2007, CHIS 2005, CHIS 2003



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# Incidence of Childhood Asthma



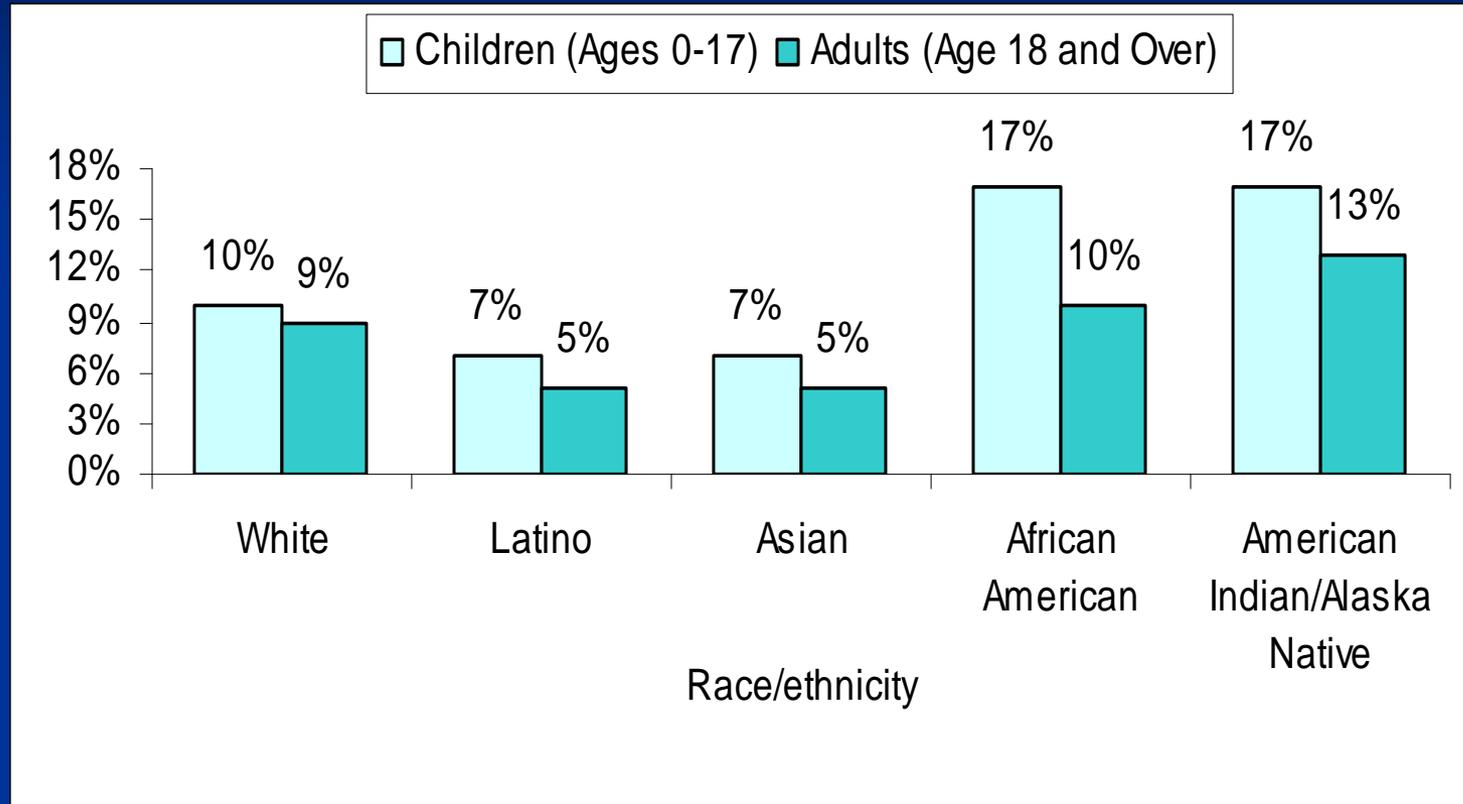
Sources: California Health Interview Survey 2003  
2003 National Health Interview Survey  
Statistics Canada



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# Prevalence of Active Asthma by Race/Ethnicity, California (2003)



Note: Active asthma refers to people who have been diagnosed with asthma and who reported they still had asthma and/or experienced an asthma attack in the past year.

Source: 2003 California Health Interview Survey

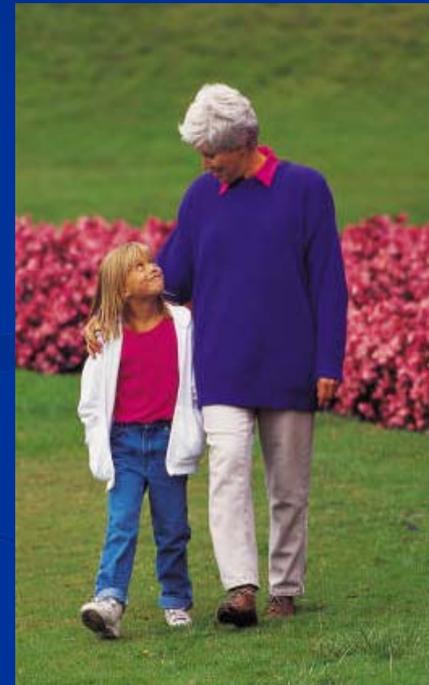


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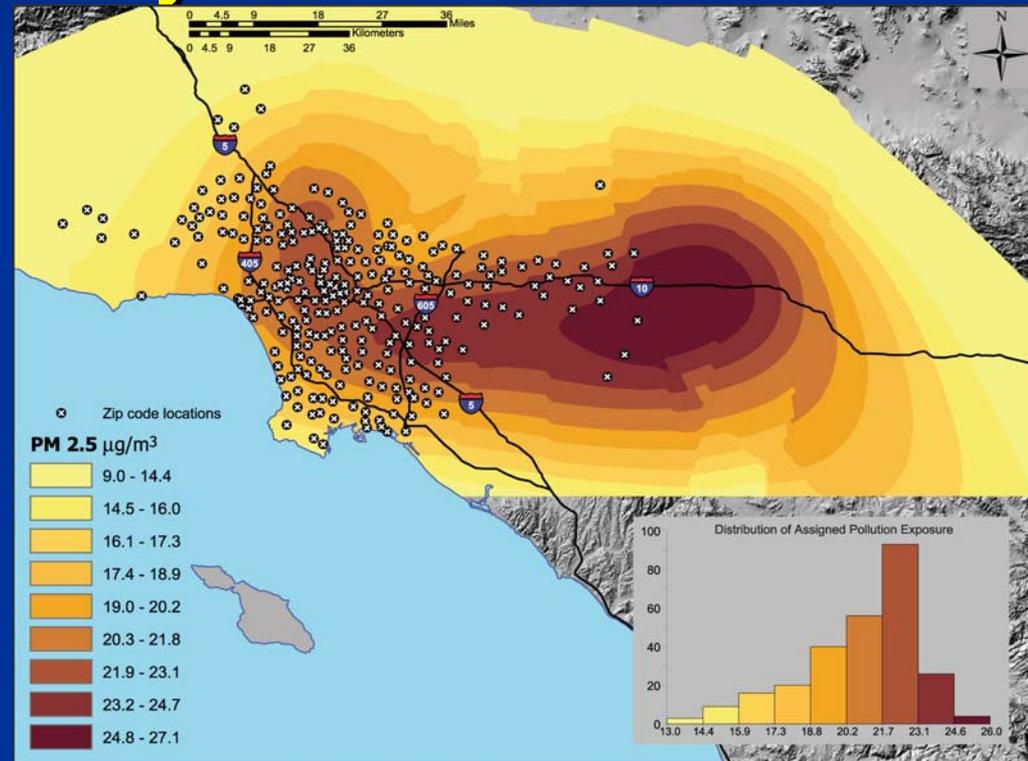
# Long-term PM Exposure Associated with Death in Older Adults

- **Harvard Six-Cities study** (Dockery et al., 1993; Krewski et al., 2000; Laden et al., 2006)
  - Over 8000 adults
  - Increased risk of mortality (up to 16%)
- **American Cancer Society study** (Jerrett et al., 2005; Krewski et al., 2000, 2009; Pope et al., 1995, 2002, 2004, 2009)
  - Over 550,000 adults from 151 U.S. cities
  - Increased risk of
    - Cardiopulmonary mortality (12%)
    - Lung cancer death (3-24%)



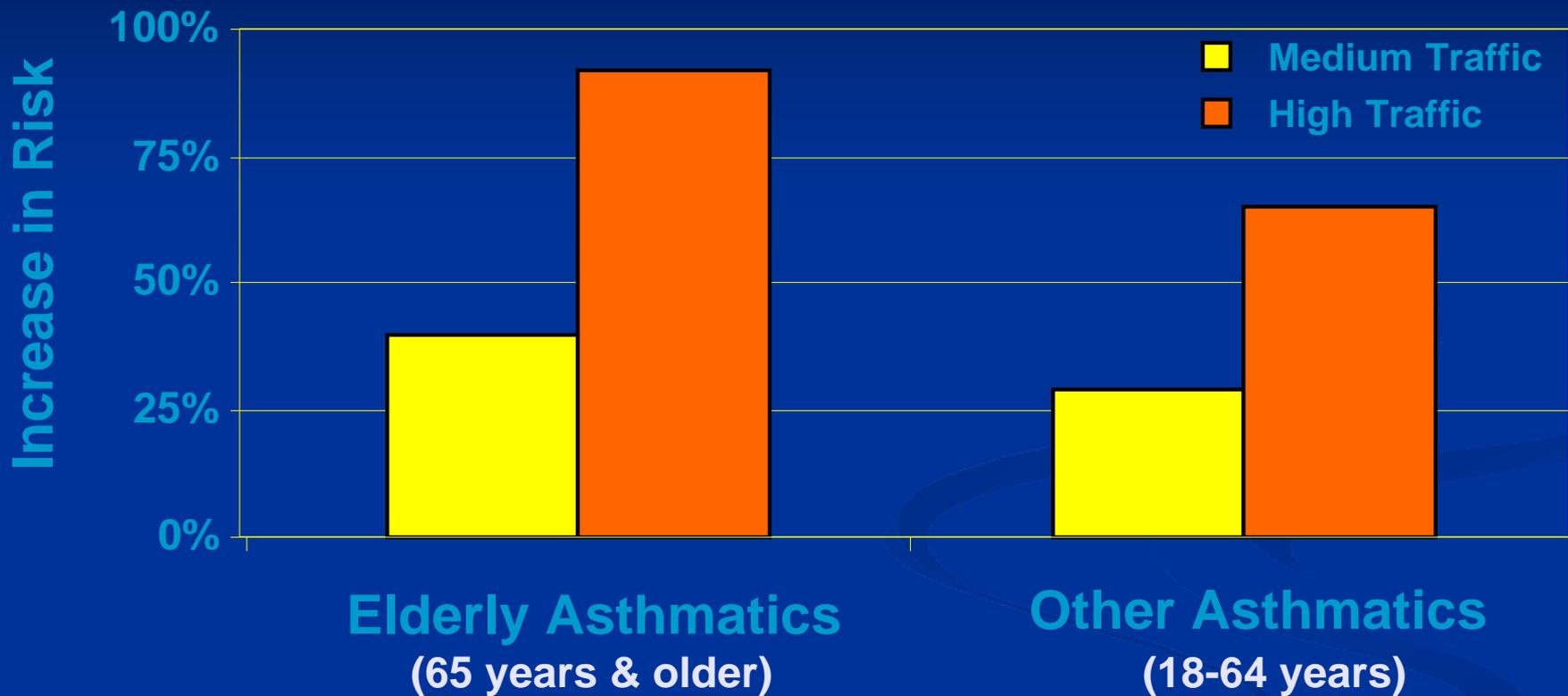
# Air Pollution and Mortality in Los Angeles American Cancer Society Study

- 3X increased risk of mortality
  - greater than previous National Study results
- Possibly due to higher traffic-related PM in LA
- Strongest association with ischemic heart disease
- lung cancer increased 44%



Jerrett, M.; et al. *Epidemiology*. 16(6):727-736 (2005).

# Traffic-Associated Increases of Asthma Exacerbations in Adults



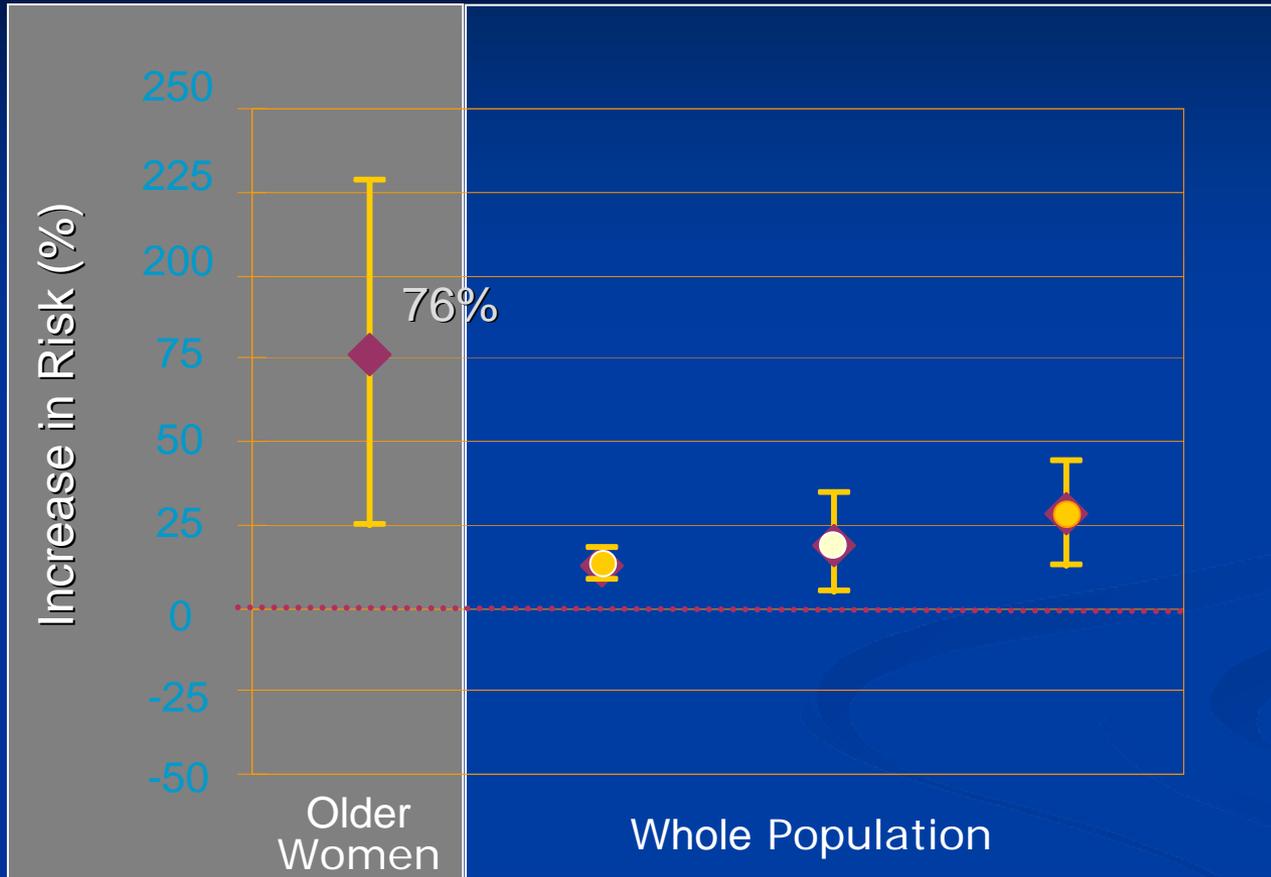
Meng YY, et al. 2007. Traffic and outdoor air pollution levels near residences and poorly controlled asthma in adults. *Annals of Allergy, Asthma, & Immunology*. 98(5):455-63.



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# Death from Cardiovascular Disease in Women

increased risk per 10  $\mu\text{g}/\text{m}^3$  increase in PM<sub>2.5</sub>



◆ Miller et al. 2007, Women's Health Initiative Study

● Krewski et al. 2000, American Cancer Society's Study

● Krewski et al. 2000, Six Cities Study

● Laden et al. 2006, Harvard Six Cities Study



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# Diesel Particulate Matter Exposure and Health

- Identified as a toxic air contaminant with the potential to cause cancer
- Contributes to outdoor PM2.5 levels
  - Associated with heart disease, lung cancer & premature death
- Studies found an increased risk for:
  - Heart disease and lung cancer deaths for drivers and dockworkers vs. general population
  - Lung cancer in workers in the trucking industry exposed to vehicle exhaust
  - Elevated risk of lung cancer with increasing years of work



Laden, F., et al. 'Cause-Specific Mortality in the Unionized U.S. Trucking Industry', *Environmental Health Perspectives* 115:1192-1196 (2007).  
Garshick, E., et al. 'Lung Cancer and Vehicle Exhaust in Trucking Industry Workers' *Environmental Health Perspectives* 116:1327-1332 (2008).



# Health Impacts in Infants

- Low birth weight: 36% increase in prevalence among those with traffic exposure and high CO <sup>1</sup>
- Premature birth: 27% increase in prevalence among those with traffic exposure and high CO <sup>1</sup>
- Cardiac birth defects: Up to 3X increase in risk with traffic-related pollutants <sup>2</sup>
- Increase in death in preterm or low birth weight infants exposed to PM10
  - 6% from all causes of death
  - 26% from sudden Infant Death Syndrome



Wilhelm M, et al. 2005. Local variations in CO and particulate air pollution and adverse birth outcomes in Los Angeles County, California, USA.. Environ Health Perspect. 113(9) 212-21

Ritz B, et al. 2002 Ambient air pollution and risk of birth defects in Southern California. Am J Epidemiol, 155:17-25

Ritz et al, "Air Pollution and Infant Death in Southern California, 1989–2000, PEDIATRICS Volume 118, Number 2, August 2006



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# Southern California Children's Health Study (CHS)

- 10+ year study followed ~ 5,500 children's exposures to air pollution
- Landmark study on children's health effects
- Adverse effects on asthma, lung function growth
- 100+ publications
- ARB originally funded



# CHS Findings: Asthma and Traffic Exposure

- Higher asthma prevalence near freeways
  - Increased wheezing & asthma medication use
- With long-term residence to traffic increases in risk for:
  - Ever had asthma
  - Current treatment for asthma
  - Wheezing

Gauderman WJ, et al. *Epidemiology*, 16:737-743 (2005)

McConnell R, et al. *Environ Health Perspect.* 114(5):766-772 (2006)



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# CHS Findings: Asthma

- Bronchitic symptoms related to air pollution only in asthmatics
  - Association with PM10, PM2.5, organic carbon, NO<sub>2</sub>, and O<sub>3</sub>
- Asthma causation related to high O<sub>3</sub> and exercise
- Asthma incidence related to traffic exposure at home and school

McConnell R, et al. Environ Health Perspec 107:757-760.(1999)

McConnell R, et al. Am J Respir Crit Care Med 168:790-797 (2003)

McConnell R, et al. Lancet. 359:386-91 (2002)

McConnell R, et al. Environ Health Perspect. 118(7):1021-1026(2010)



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# CHS Findings: Lung Function Growth

- 1% per year deficits in lung function associated with mix of pollutants (PM, NO<sub>2</sub>, acids, EC)
- Relocation to lower PM10 areas associated with increase in lung function growth
- Children living in areas of high air pollution had lower lung function at age 18
- Children living close to freeways had lower lung function growth at age 18

Gauderman WJ et al. Am J Respir Crit Care Med 162:1383-1390 (2000)

Gauderman WJ et al. Am J Respir Crit Care Med 166:76-84 (2002)

Avol EL et al. Am J Respir Crit Care Med 164:2067-2072 (2001)

Gauderman WJ et al. N Engl J Med 351(11):1-11 (2004)

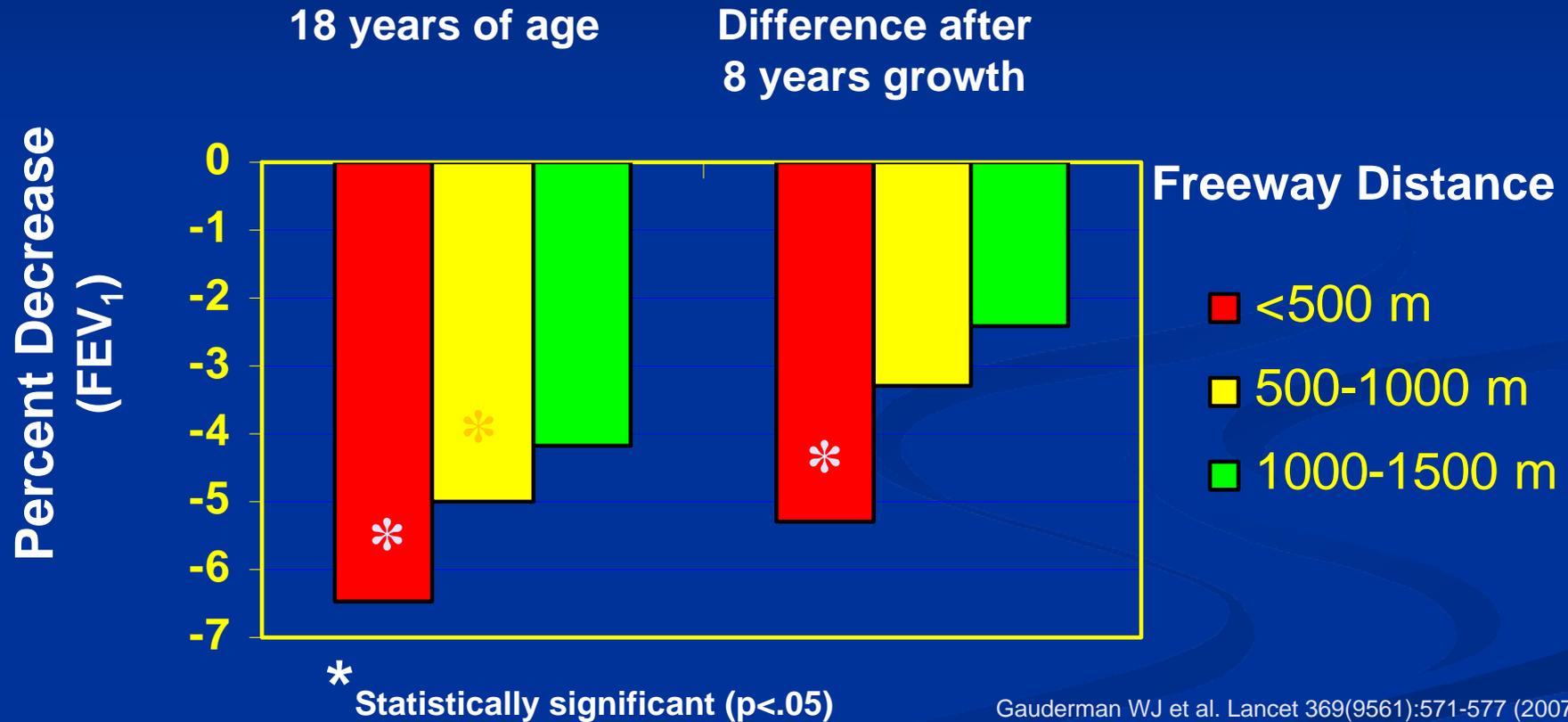
Gauderman WJ et al. Lancet 369(9561):571-577 (2007)



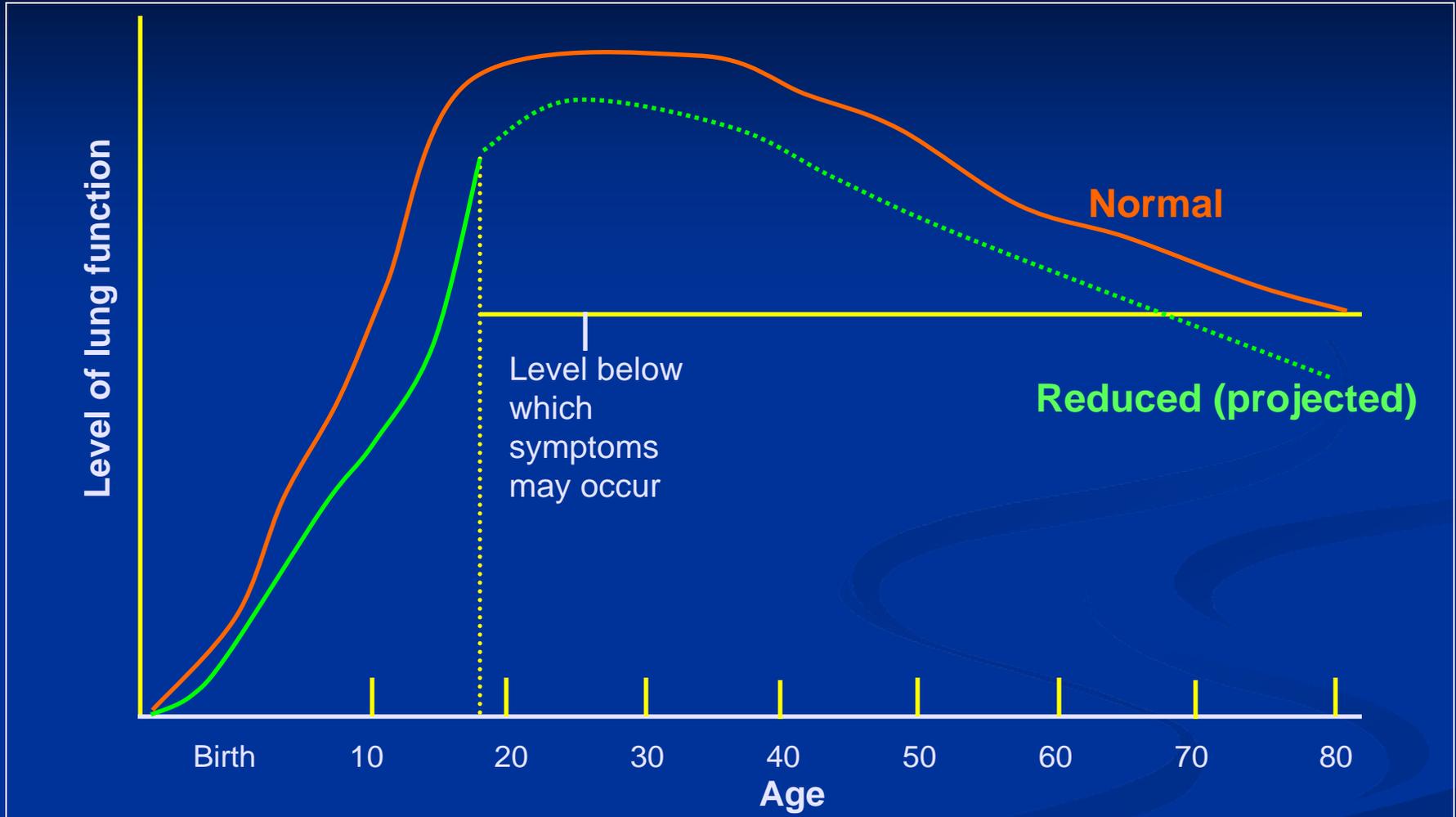
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# Traffic Associated Decreases in Lung Function at 18 Years and 8 Year Development



# Development of Lung Function



Adapted from Strachan et al 1997; Courtesy of USC



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# Fresno Asthmatic Children's Environment Study (FACES)

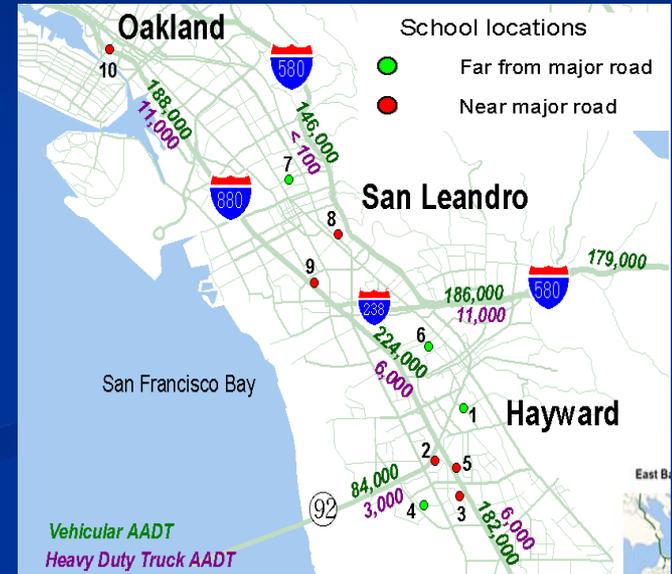
- Originally funded by ARB
- 8% reduced lung function in children most exposed to CO, PM and NO<sub>2</sub>
  - Sensitive subgroups include African-Americans, children whose mothers smoked during pregnancy
- Timing of exposure is important
  - PM, NO<sub>2</sub> – prenatal
  - CO – prenatal and first 6 years

Mortimer, et al., Epidemiology 19(4):550-557 (2008)



# Other Studies of Children and Asthma

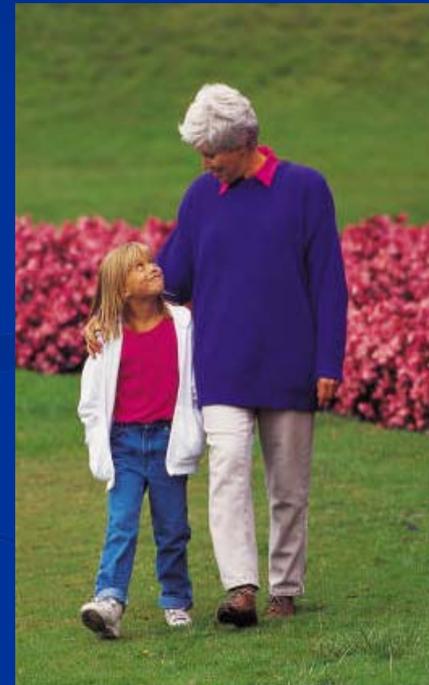
- East Bay Children's Study
  - 5 to 8% increase in asthma & bronchitis symptoms near roadways
  - Fresh traffic emissions may play a role in respiratory effects
- Huntington Park Study
  - Traffic impacts in asthmatic children



Brett C. Singer, et al. Atmospheric Environment 38:393–403 (2004)  
Kim, et al. American Journal of Respiratory and Critical Care Medicine 170:520-526 (2004)  
Delfino RJ, et al. Environmental Health Perspectives 111:647-656 (2003).  
Delfino RJ, et al. Journal of Exposure Analysis and Environmental Epidemiology 13: 348-363 (2003).

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# What Can You Do?

- Drive Less
- Drive Smart
- Choose Air Friendly Products
- Save Energy
- Recycle
- Keep Informed



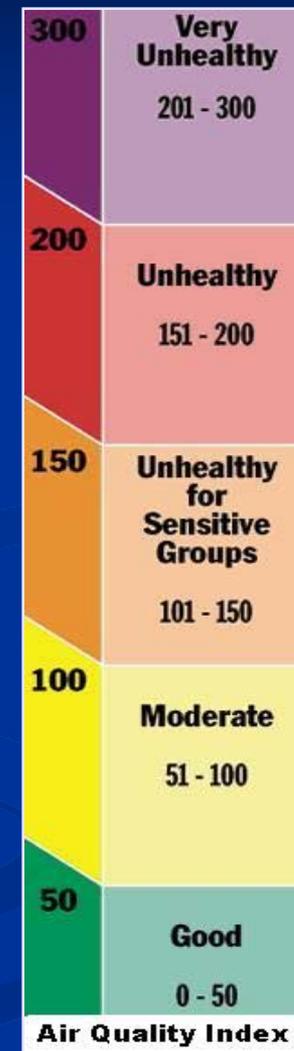
<http://www.arb.ca.gov/html/cando.htm>



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# ARB Mitigation Programs

- Ambient Air Quality Standards
- California's Diesel Risk Reduction Plan
  - Emission standards for heavy duty vehicles
  - Carl Moyer Program
- Motor vehicle emissions standards for cars/light trucks
- Goods Movement Emission Reduction Plan
- Climate Change Program
- Land use guidelines
- Health advisory press releases



# 85% Less Diesel PM by 2020

## (On- and Off-road Vehicles, Stationary Engines)

- New vehicle and engine standards (90% control)
- Low-sulfur (15 ppmw) diesel and alternative fuels
- Retrofits/re-powering with funding (\$65M per year)
- International Diesel Retrofit Advisory Committee
- Anti-idling measures
- Enforcement programs

[www.arb.ca.gov/diesel/dieselrrp.htm](http://www.arb.ca.gov/diesel/dieselrrp.htm)



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# Air Quality and Land Use Handbook: A Community and Health Perspective



**Adopted by ARB Governing Board April 2005**

**Provides information on localized air quality impacts and potential incompatible land uses**

**Makes advisory recommendations providing appropriate separation when siting new sensitive land uses**

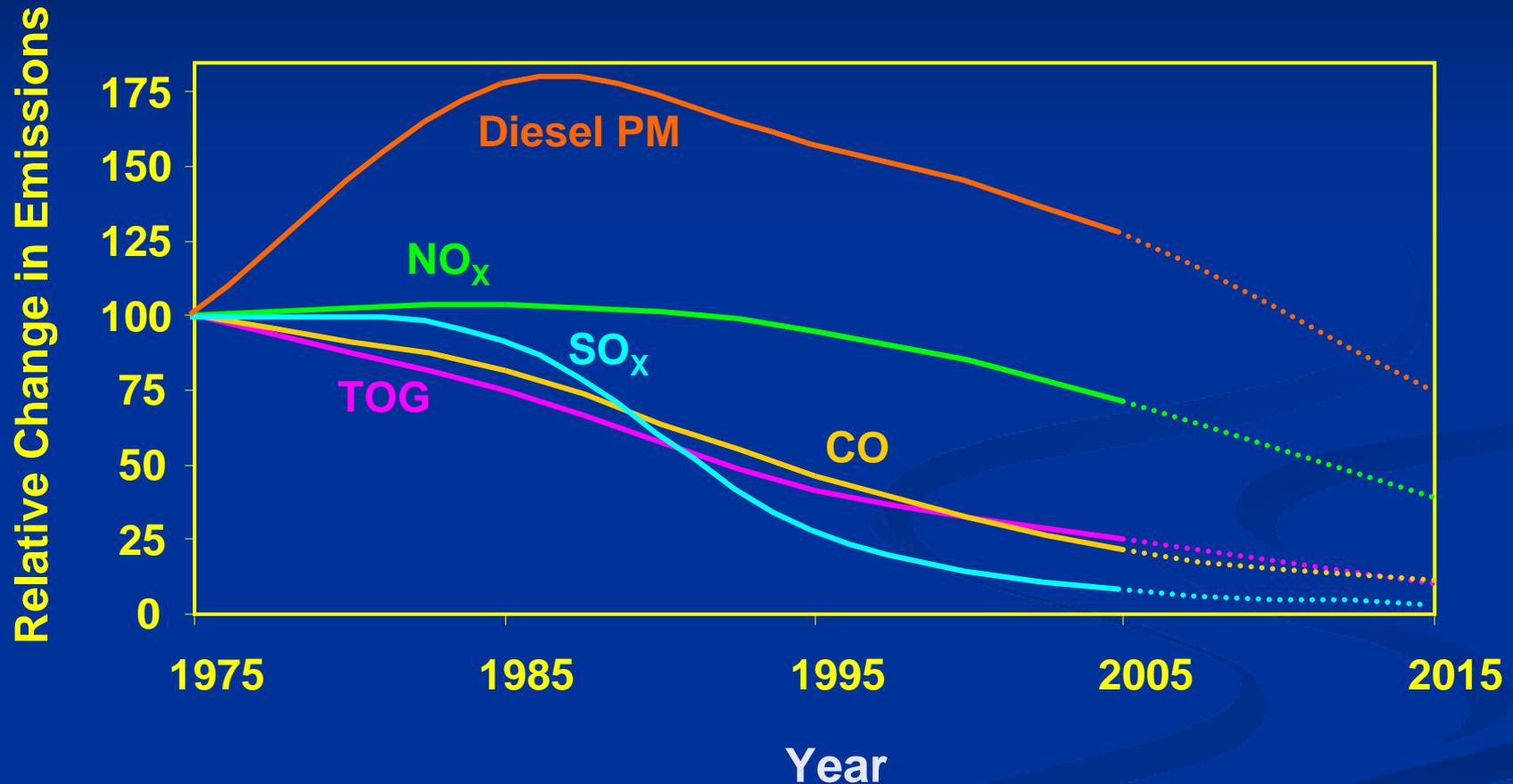
[www.arb.ca.gov/ch/landuse.htm](http://www.arb.ca.gov/ch/landuse.htm)



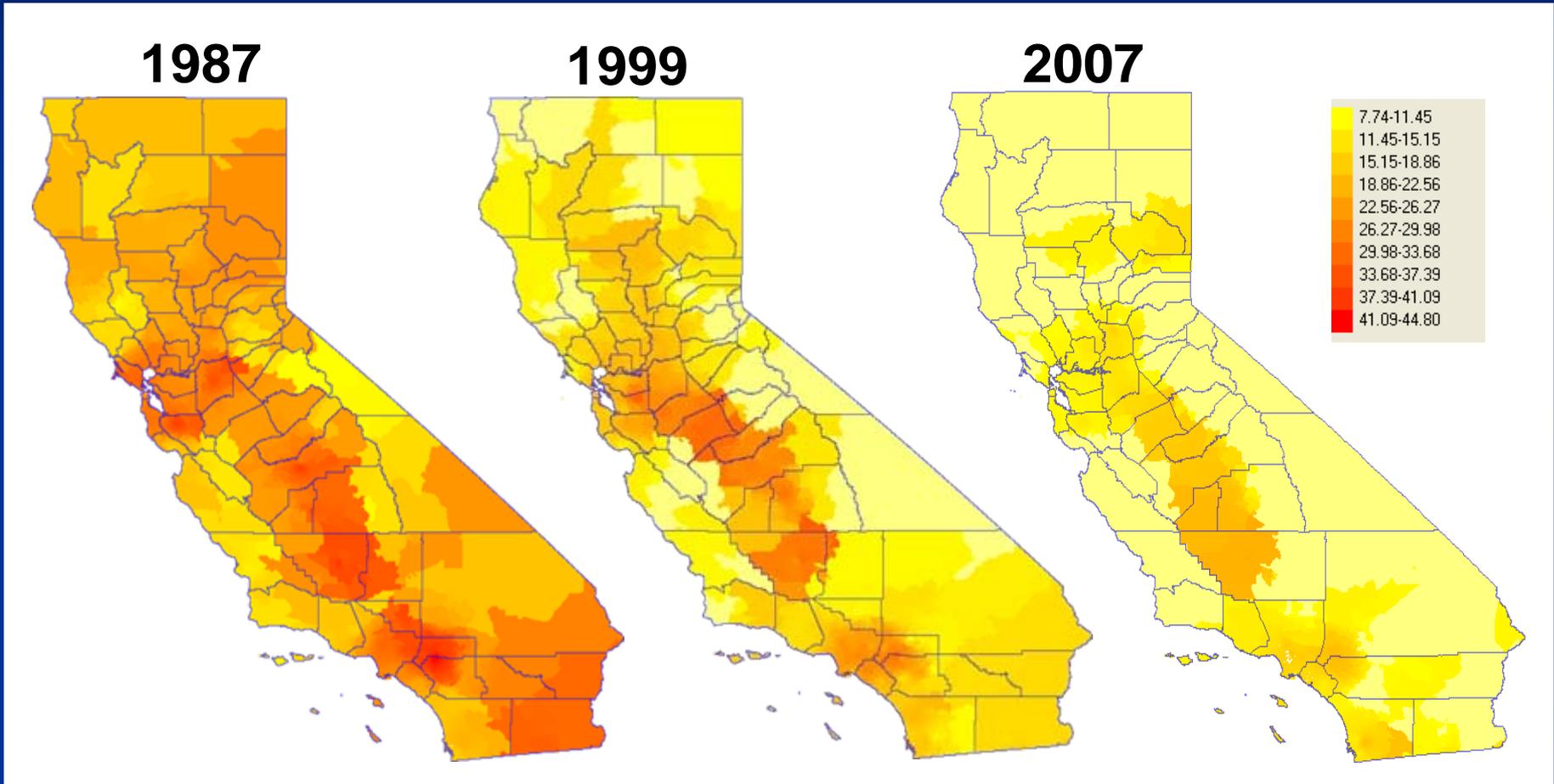
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# Trends in Emissions of Traffic-Related Pollutants



# PM2.5 Exposures 1987, 1999, and 2007



# Air Pollution Impacts

- Who are vulnerable?
  - Everyone at one time or another
- Why?
  - Age
  - Gender
  - Preexisting Disease
  - Exposures



# Thank you

Barbara L. Weller, PhD  
Manager, Population Studies Section  
Air Resources Board  
Research Division

[blweller@arb.ca.gov](mailto:blweller@arb.ca.gov)

916-324-4816



[www.arb.ca.gov](http://www.arb.ca.gov)



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