

# Making the Connection: Health-Based Standards

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# Outline of Presentation

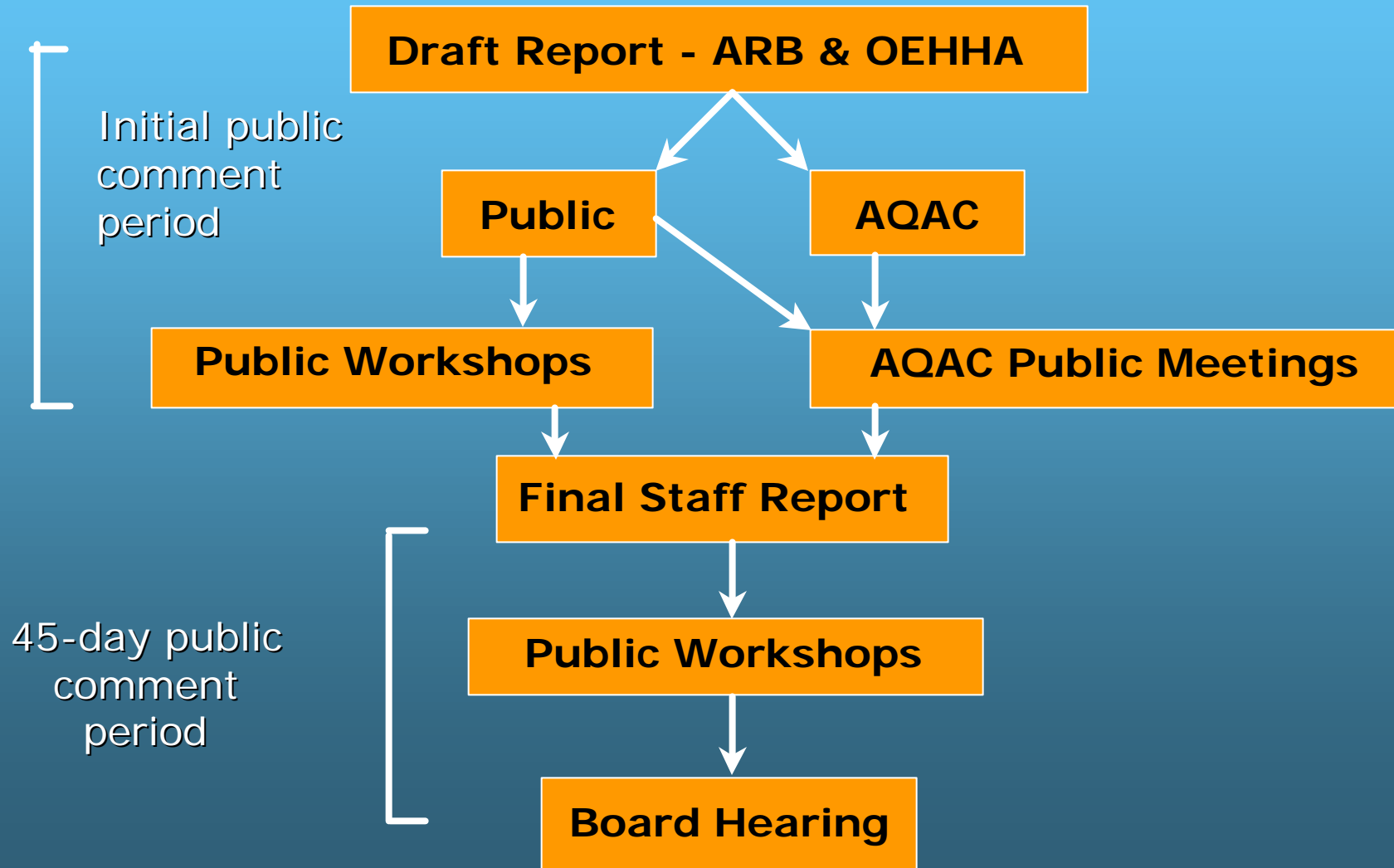
- **Health Protection and the Standards Setting Process**
- **Sensitive Groups**
- **Pollutants of Concern in the Valley**
- **Health impacts of Particulate Pollution**
  - **Studies used in Standards Setting**
- **Ozone Health Impacts**
  - **Ozone Standard**

# Ambient Air Quality Standards

# WHAT IS AN AMBIENT AIR QUALITY STANDARD?

- Legal definition of clean air
- Establish maximum allowable levels to protect your health and welfare
- Elements:
  - Definition of the pollutant
  - Averaging time
  - Concentration
  - Monitoring method
- Based solely on health and welfare

# The Standard Review Process



# Air Quality Advisory Committee (AQAC) Review

- **Required by State law**
- **Members appointed by University of California President**
- **Purpose of AQAC review:**
  - **Assess adequacy of scientific basis for proposed standards**
  - **Assess adequacy of proposed standards to protect public health**

# Ambient Air Quality Standards

- **Children's Environmental Health Protection Act**
- **Criteria Pollutants**
- **Priorities**
  - **Particulate Matter**
  - **Ozone**
  - **Nitrogen Dioxide**



# California Ambient Air Quality Standards

PM10	24 Hour	50 ug/m <sup>3</sup>	CO	8 Hour	9.0 ppm
	Annual	20 ug/m <sup>3</sup>		1 Hour	20 ppm
PM2.5	Annual	12 ug/m <sup>3</sup>		8 Hour (Lake Tahoe)	6 ppm
Ozone	1 Hour	0.09 ppm	SO <sub>2</sub>	24 Hour	0.04 ppm
	8 Hour	0.070 ppm		1 Hour	0.25 ppm
NO <sub>2</sub>	1 Hour	0.25 ppm			



# Health Benefits of Meeting the State Ambient Air Quality Standards\*

	Combined PM2.5 and Ozone Health Effects (numbers of cases)	
	SJV	Statewide
Mortality	1,400	8,800
Hospital Admissions	1,200	7,700
School Absences	880,000	4,700,000
Work loss days	200,000	1,400,000

\* Based on 1999-2000 air quality data

# Our Focus is On Sensitive Populations

- **Elderly**
- **Children**
- **Pre existing Disease**
- **Exposure**



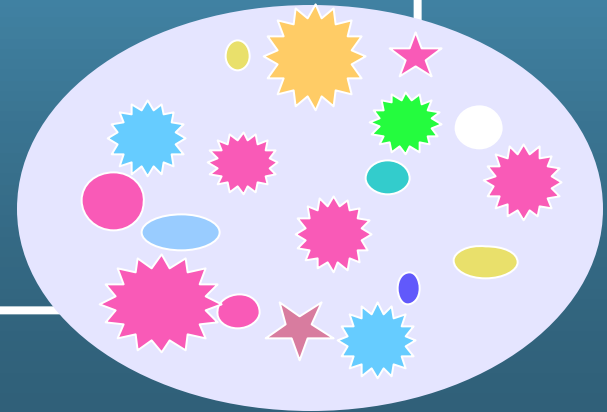
# Sources and Levels of Pollutants of Concern

- **Particulate Matter**
  - Sources
  - Secondary Particulate Matter
  - Size Fractions
  - Levels in the Valley
- **Ozone**
  - Atmospheric Formation
  - Levels in the Valley

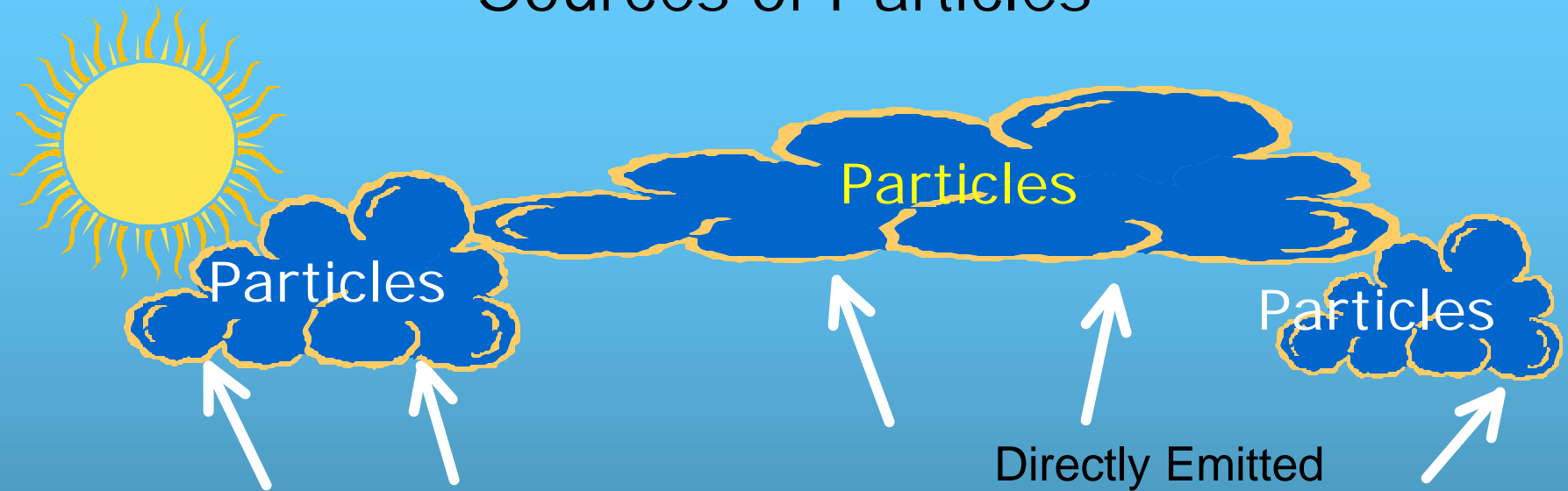
# What is Particulate Matter?

A complex mixture that may contain:

Soot      Smoke      Metals  
Elemental and Organic Carbon  
Nitrates      Sulfates      Acids  
Pollen      Vegetation  
Dust      Water  
Tire Rubber



# Sources of Particles



Gas-to-particle Conversion  
(Secondary PM)

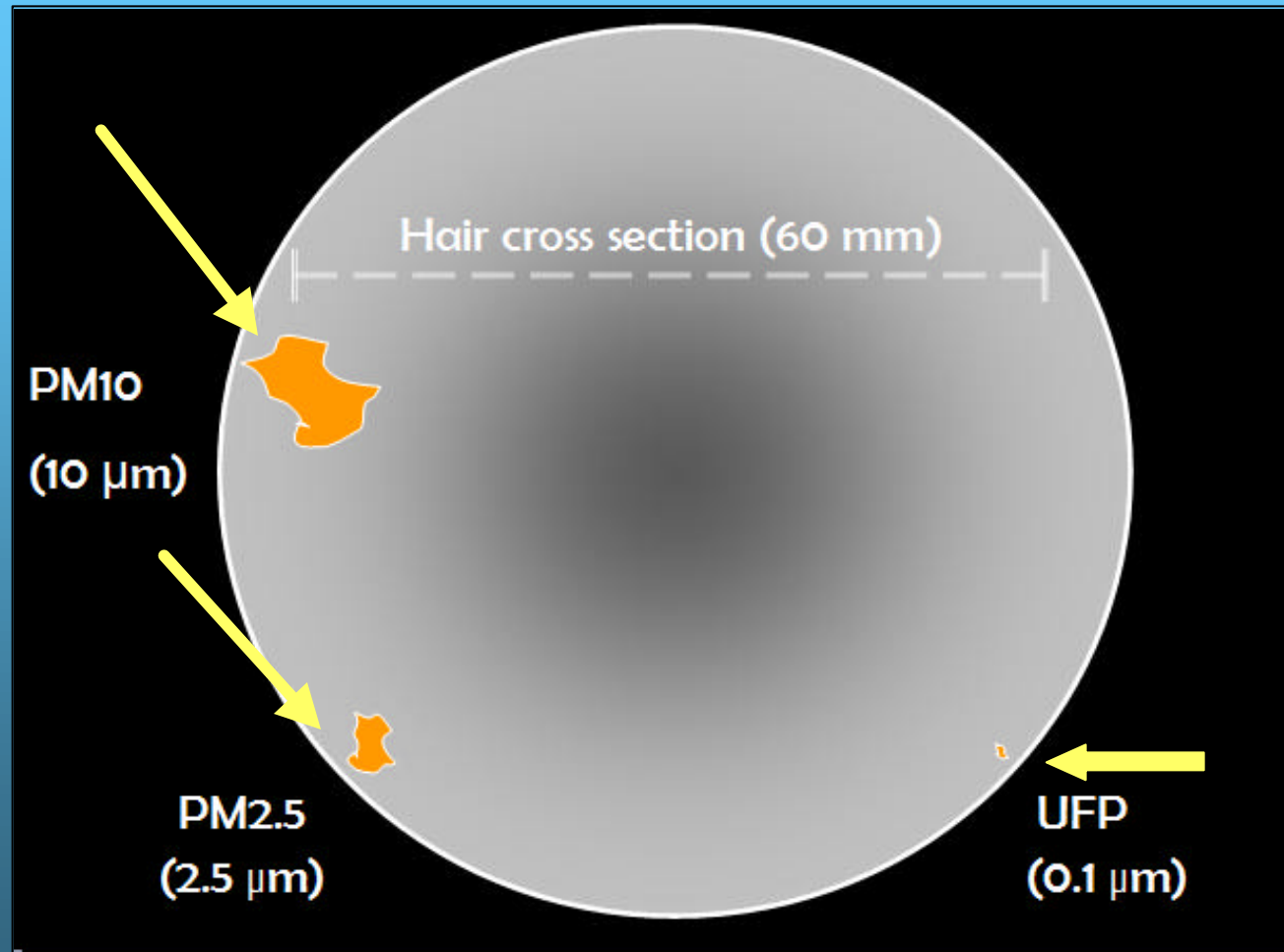
fuel combustion  
livestock  
sewage  
biogenic hydrocarbons

Directly Emitted  
(Primary PM)

fuel combustion  
mechanical abrasion  
(brake wear, tire wear)  
road dust (paved, dirt)  
agricultural activities  
fugitive dust  
biological (pollen, fungi)  
sea salt  
meat cooking

# RELATIVE SIZES OF PARTICLES

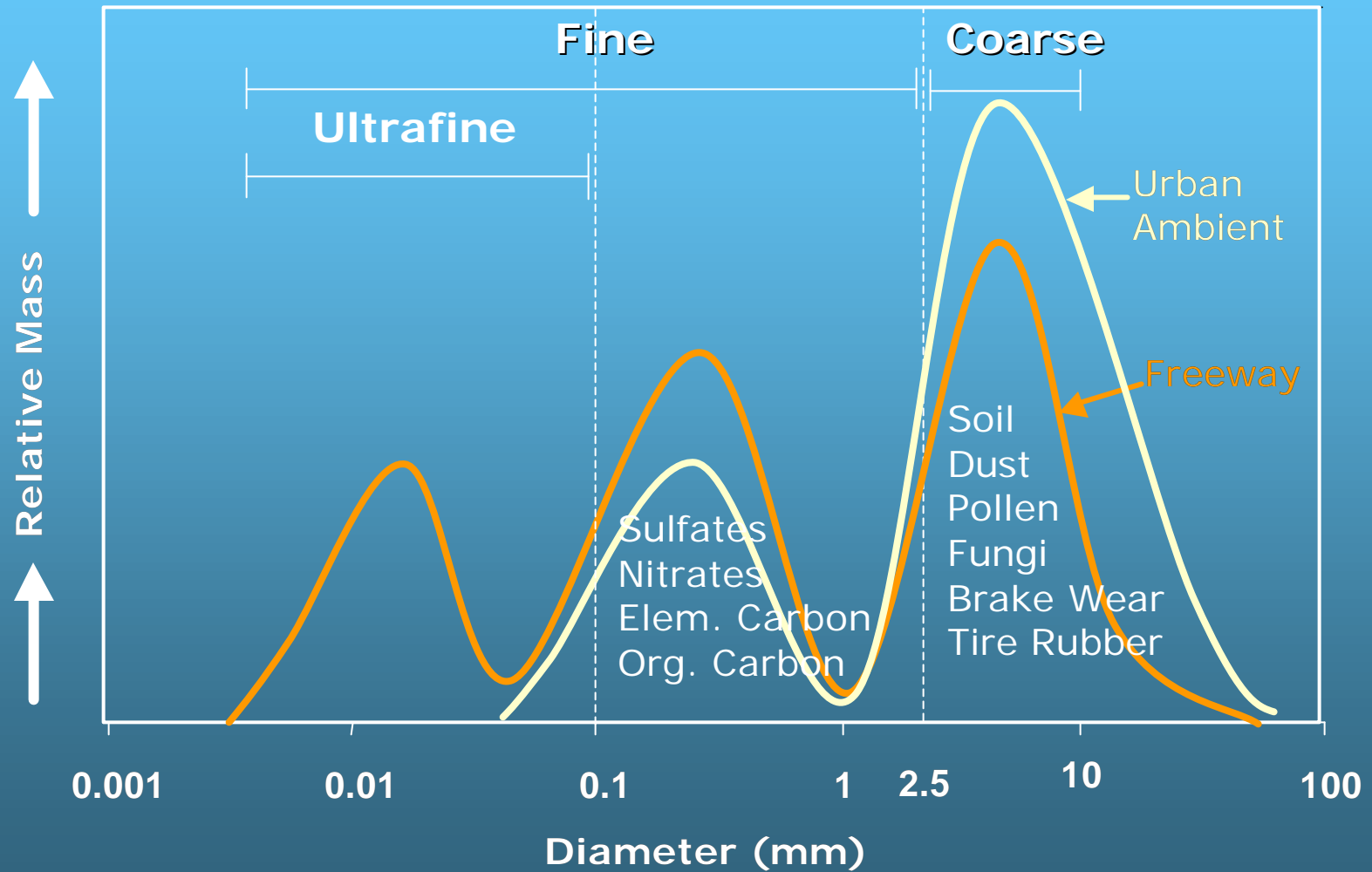
PM in the air has 3 size ranges



PM10 = Coarse + Fine + Ultra-Fine

PM2.5 = Fine + Ultra-Fine

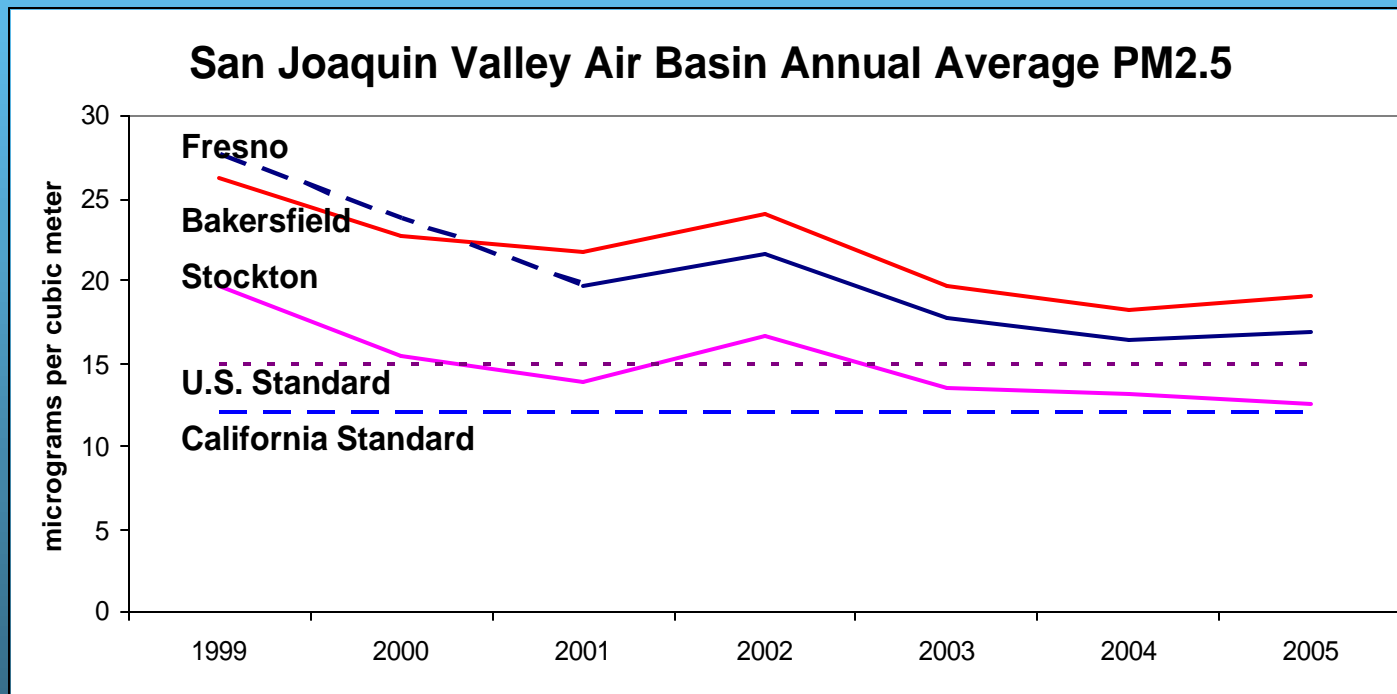
# Distribution of Mass by Particle Size



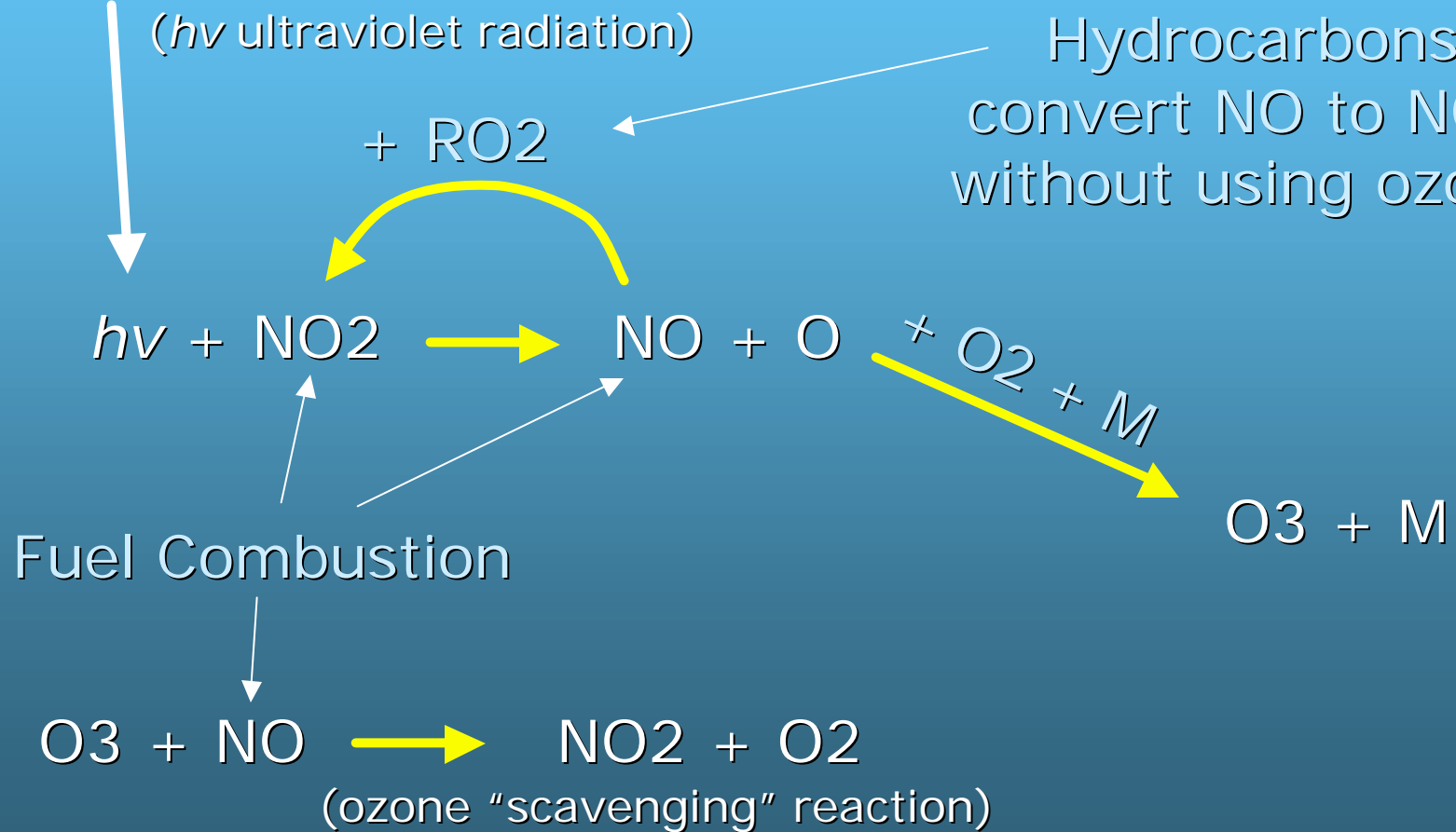
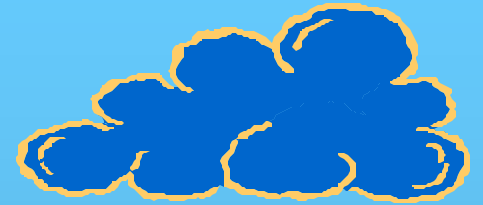




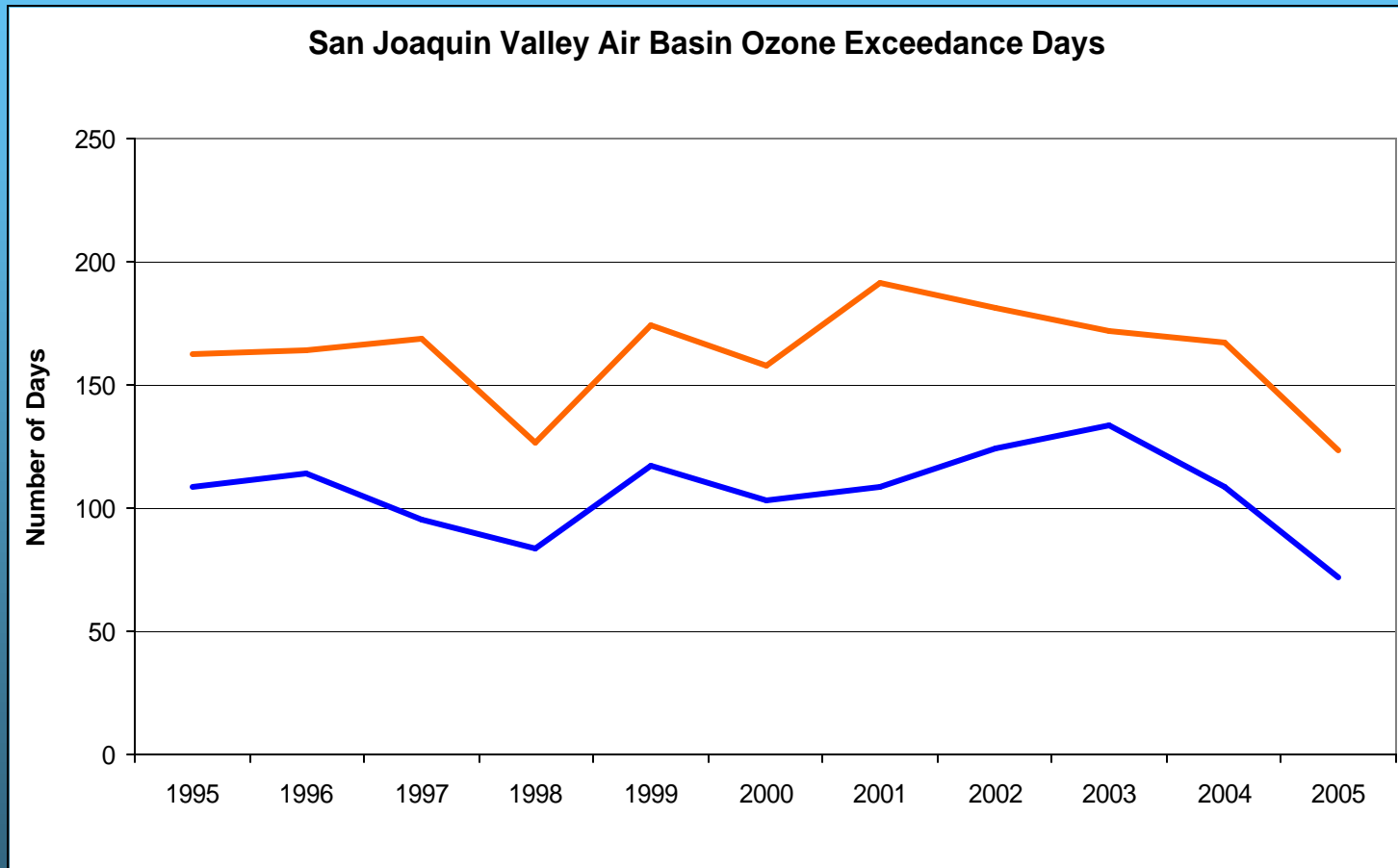
# PM levels in the Valley



# Ozone Formation



# Ozone in the Valley



# Health Effects Studies

- **Controlled human exposure studies**
- **Controlled animal exposure**
- **Epidemiology**

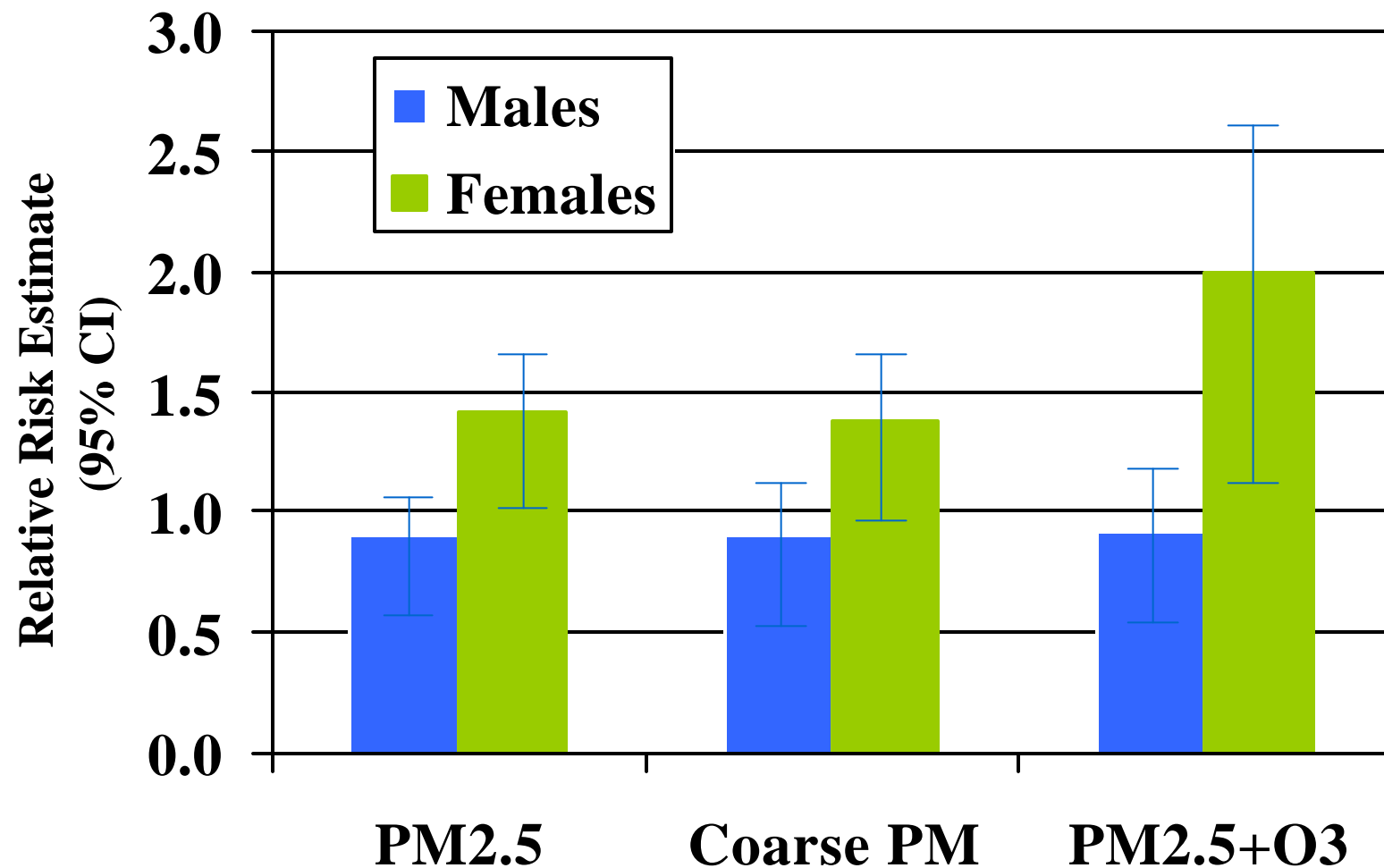
# Health Impacts of PM

- **Disease Impacts**
  - **Mostly Cardiovascular Impacts**
  - **Inflammation**
- **Premature Death**
  - **Key Health Studies**
  - **Recent Findings**
  - **Studies used in Standards**

# Cardiovascular Impacts

- **Acute Effects**
- **Chronic Effects**
- **Traffic Effects**

# Particulate Air Pollution and Fatal Coronary Heart Disease: Women may be at Greater Risk



# Chronic Cardiovascular Impacts of PM Pollution

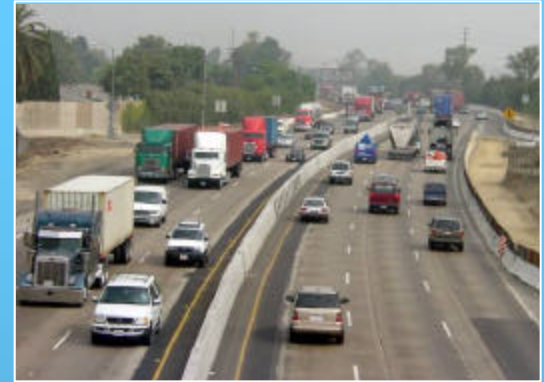
- **Cardiovascular disease (heart disease and stroke)**
  - **Leading cause of death in US**
  - **Heart disease kills 30% of Californians**
- **Atherosclerosis is the primary cause of heart disease and stroke**
- **Atherosclerosis is an inflammatory disease**
- **Ambient levels of particle pollution (PM<sub>2.5</sub>) may contribute to atherosclerosis through an inflammatory response**
- **Atherosclerosis results from a complex process and this response may be the result of a combination of various urban pollutants interacting with host factor**

Kunzli, N.; Jerrett, M.; Mack, W. J.; Beckerman, B.; LaBree, L.; Gilliland, F.; Thomas, D.; Peters, J., and Hodis, H. N. Ambient air pollution and atherosclerosis in Los Angeles. Environ Health Perspect. 2005 Feb;

113(2):201-6.



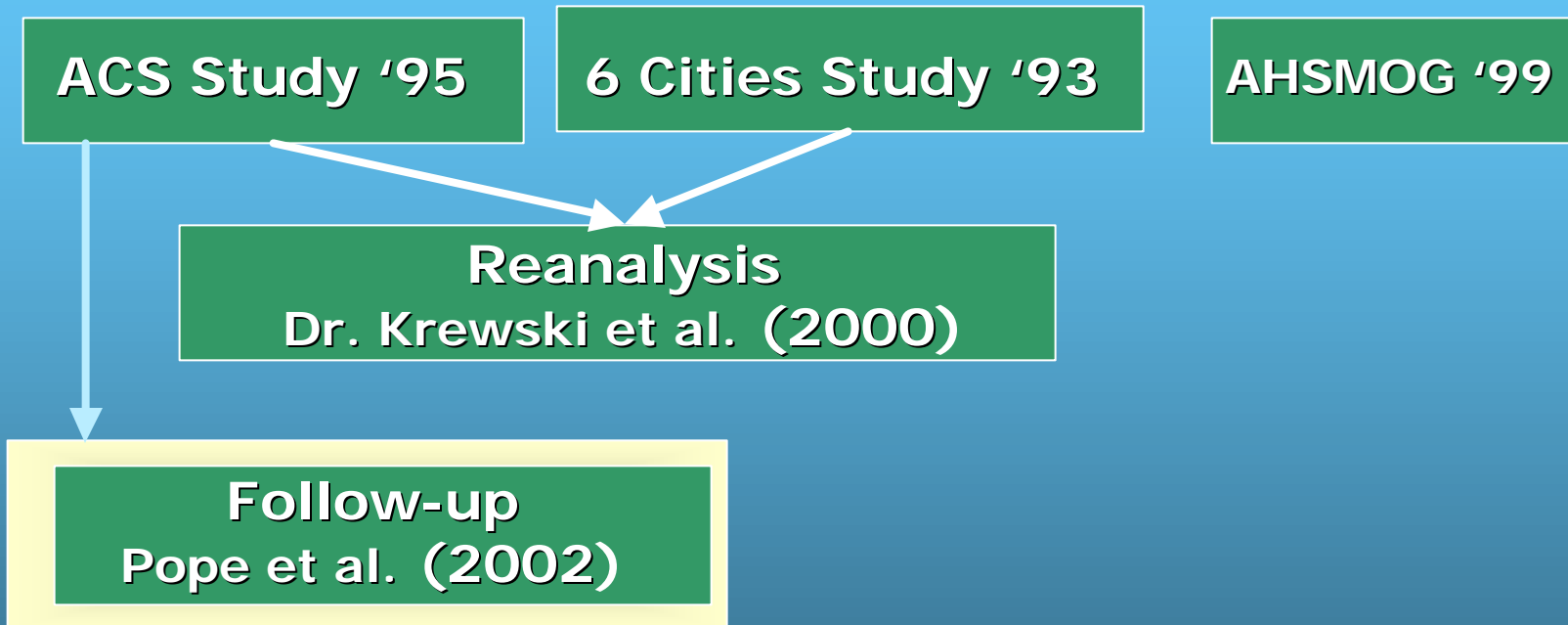
# Traffic Effects



- Long-term exposure to PM associated with increased deaths from heart and lung disease, including lung cancer
- Living near a major roadway associated with increased death from heart and lung disease
- In-vehicle exposures important to overall exposure to vehicle-related pollutants

# Epidemiology Studies PM Premature Death

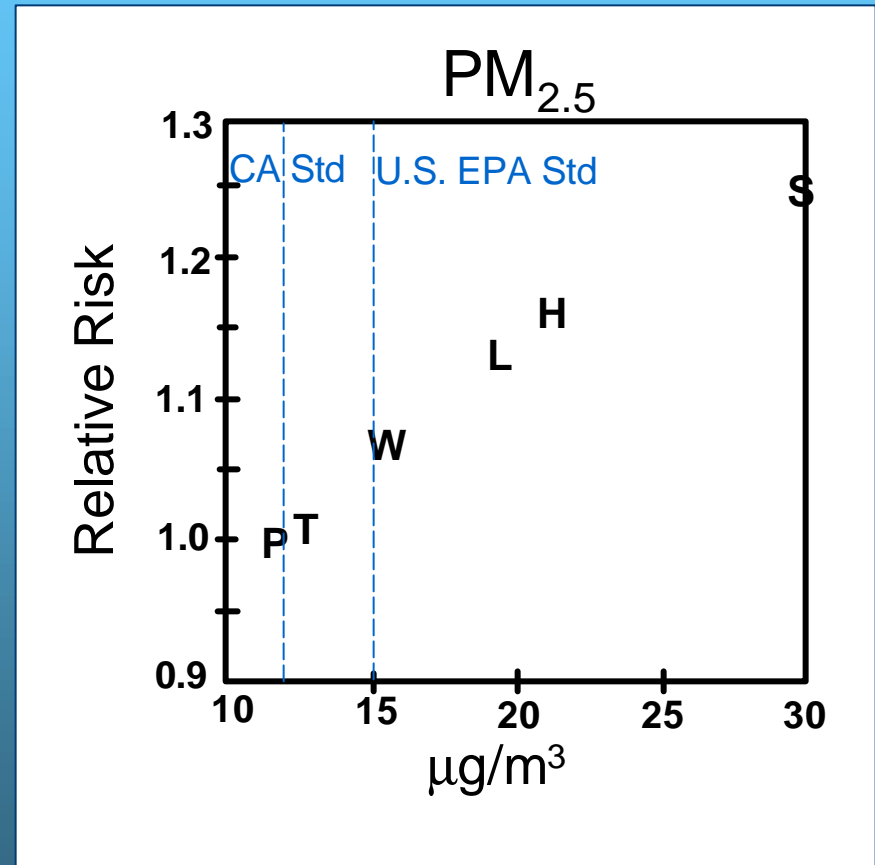
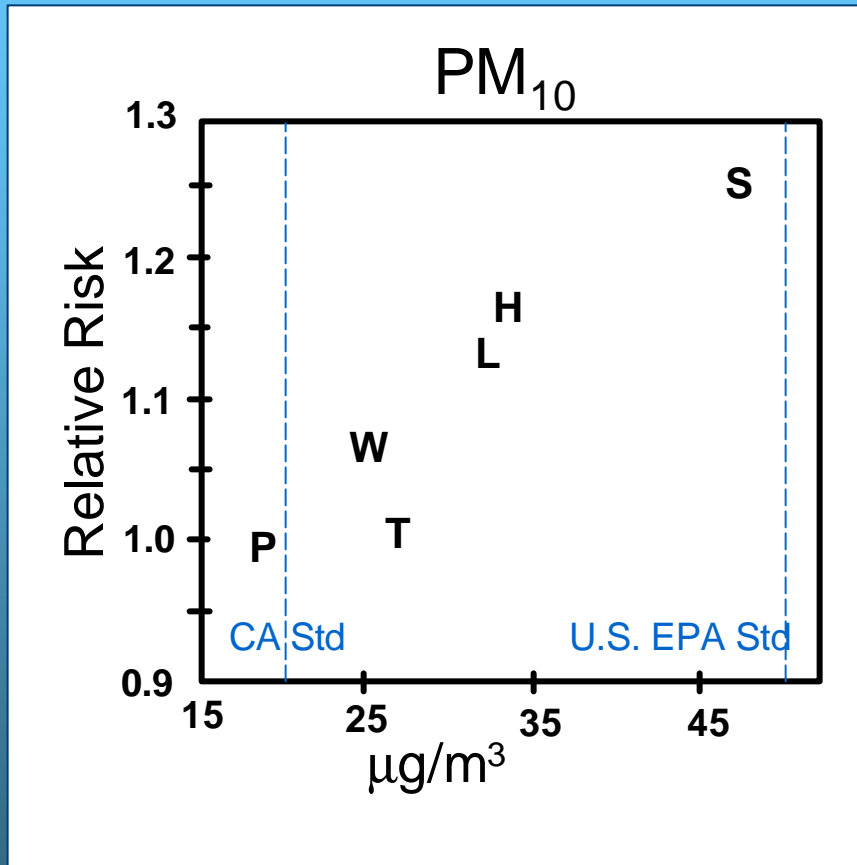
# Progression of Key Health Studies



## ■ Follow-up study:

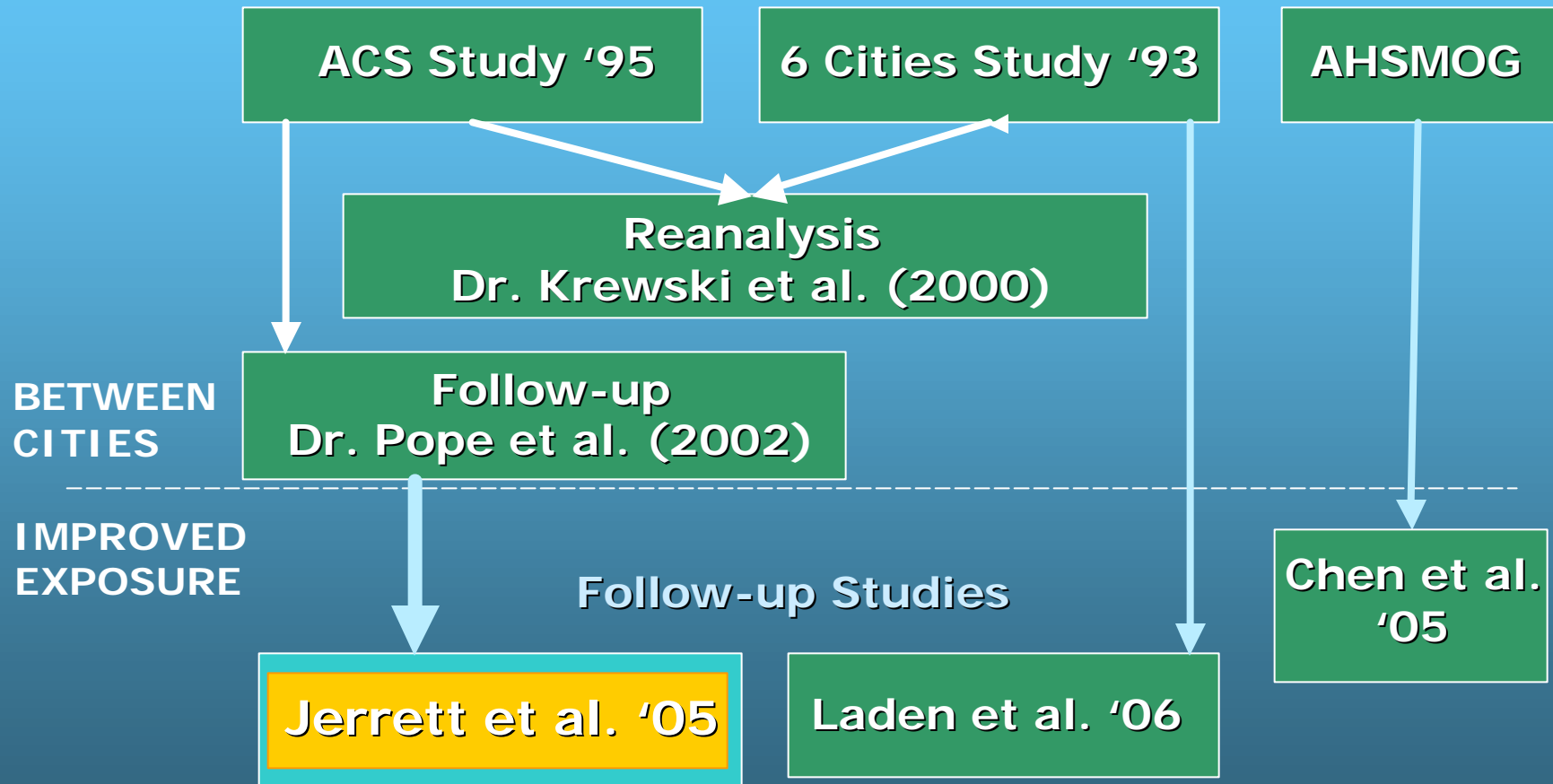
- Yielded a higher risk of 6% for all cause of premature death for each increase of 10 ug/m<sup>3</sup> increase of PM<sub>2.5</sub>.
- Lung cancer association

# Death Risk and Long-term PM Harvard Six-Cities Study

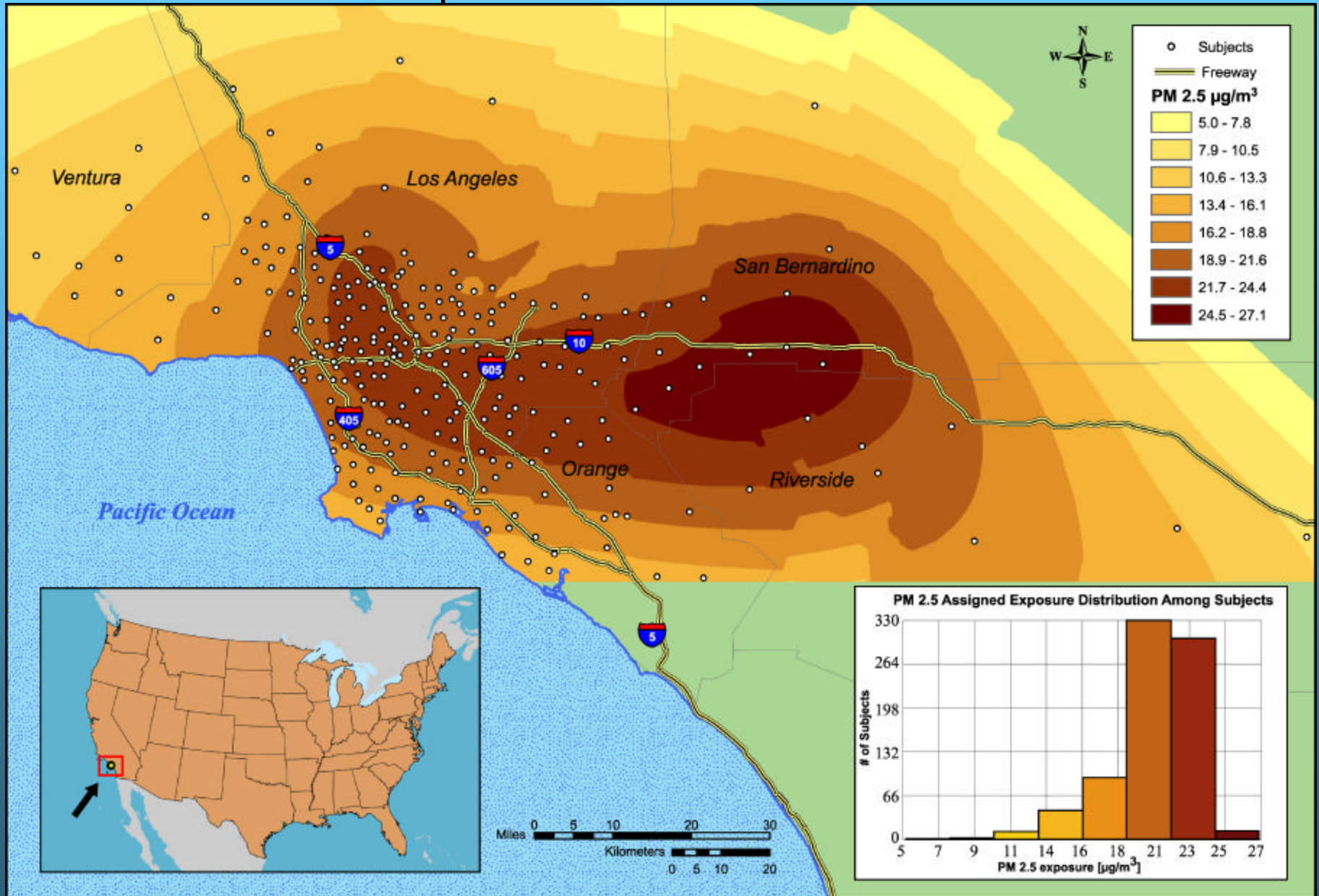


Dockery et al., 1993

# Follow-up Studies



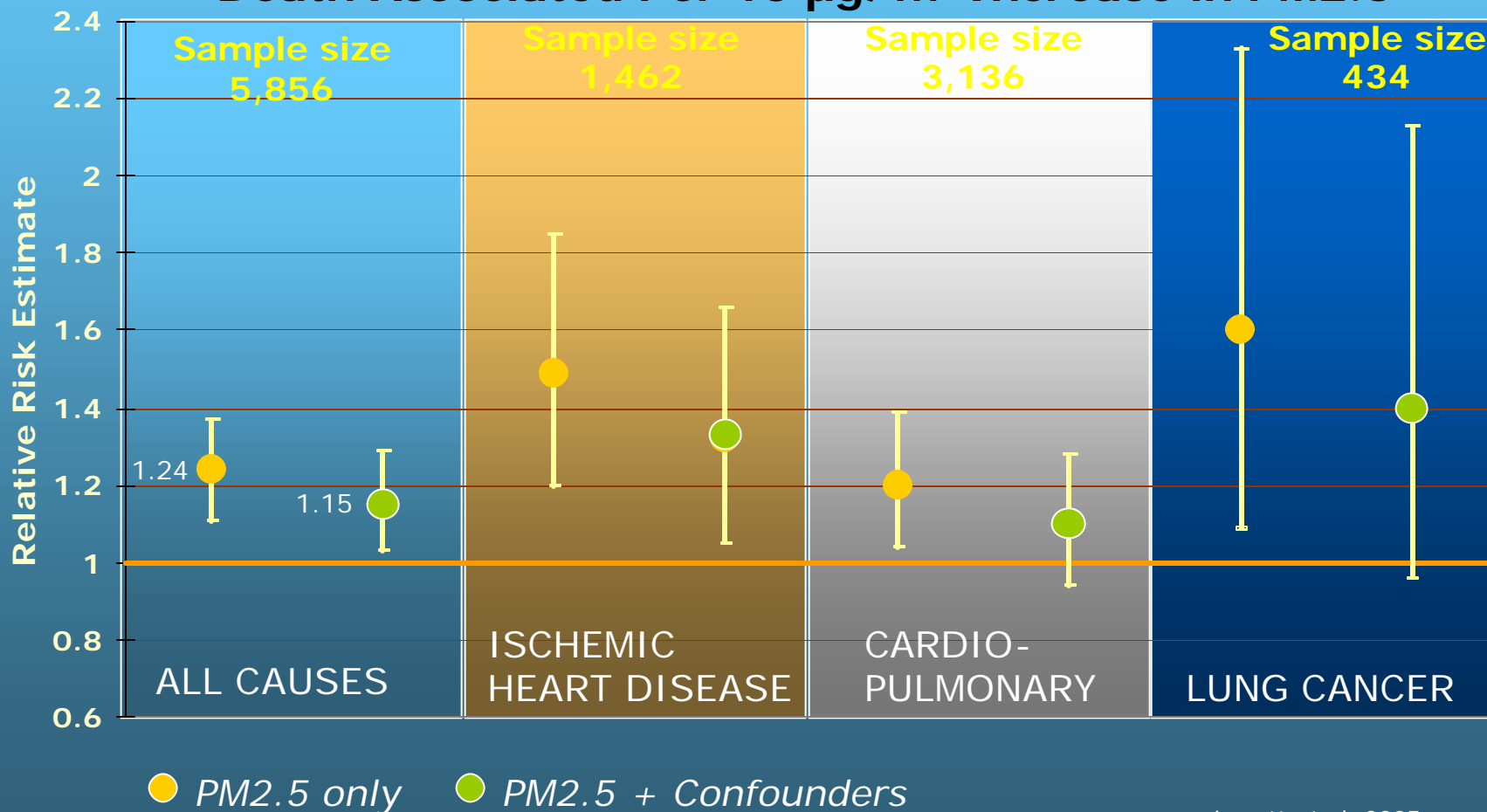
# Exposure Surface PM2.5



Jerrett et al. 2005

# Jerrett's Results

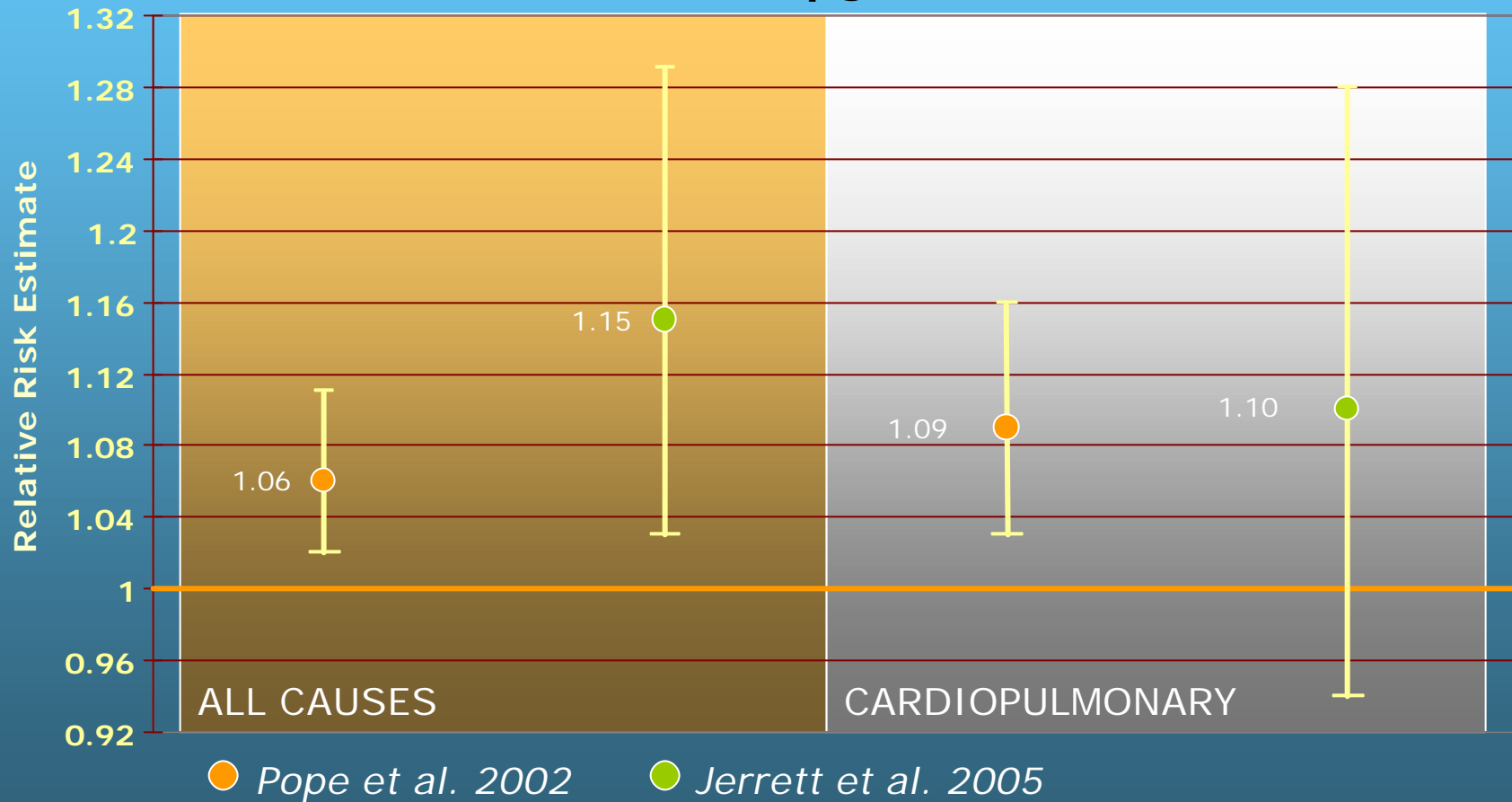
## Death Associated Per 10 $\mu\text{g}/\text{m}^3$ Increase in PM2.5



# Comparison of Results

National (Pope et al.) versus LA (Jerrett et al.)

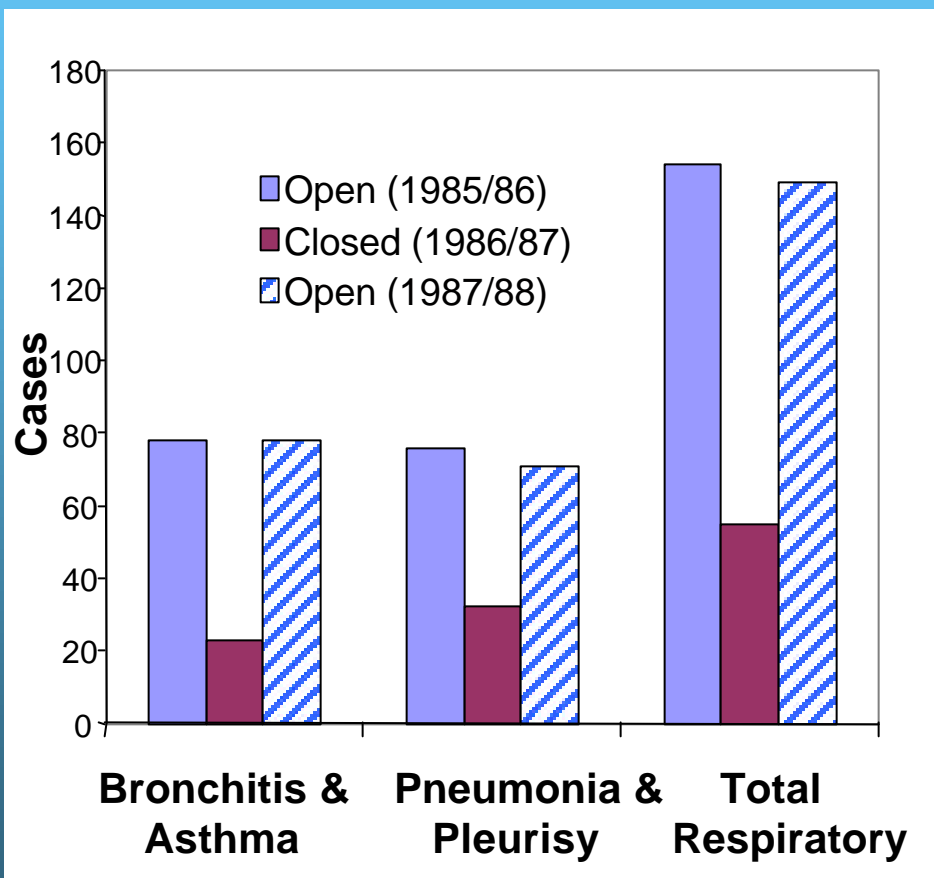
## Death Associated Per 10 $\mu\text{g}/\text{m}^3$ Increase in PM<sub>2.5</sub>





# Health Benefits of PM Control Intervention Studies

## Winter Hospital Admissions for Children



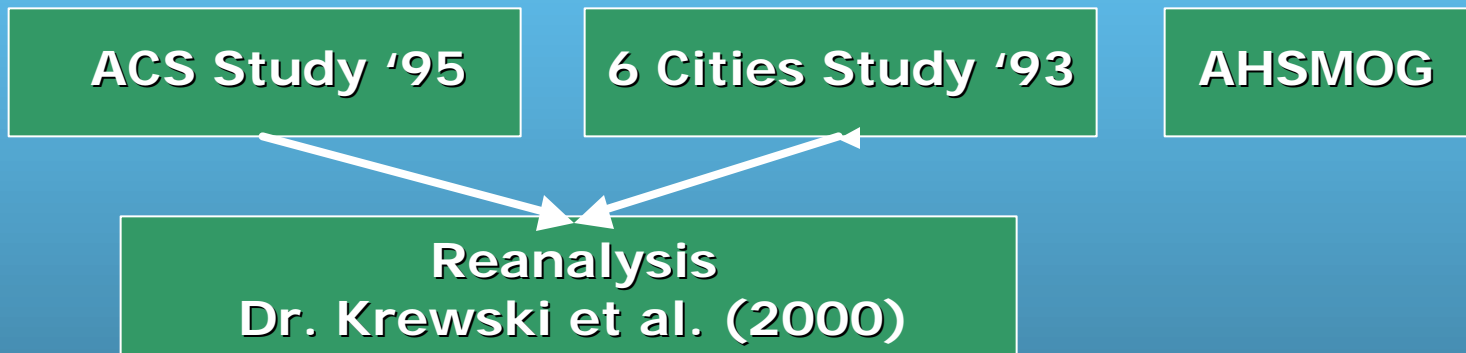
Utah Valley Steel Mill Closure

- Other Interventions
- CHS relocation (improved lung function growth)
- Dublin coal ban
- Erfurt, Germany reunification
- Hong Kong sulfur reduction
- Ongoing
- Los Angeles (1980-2000)
- An Opportunity?
- Diesel retrofits

# PM Standards Based Mainly on Epidemiological Data

- **Represent real-world exposures and health outcomes**
- **Can examine different population segments (e.g. children, asthmatics, elderly)**
- **For gaseous pollutants, air quality standards based in part on controlled exposure studies**
- **Since PM composition is complex, epidemiological studies are more relevant**

# Basis of the Particulate Matter Standards



# Existing Annual Average Standards for Particulate Matter

<b>Organization</b>	<b>PM measure</b>	<b>Concentration (mg/m<sup>3</sup>)</b>
<b>U.S.EPA</b>	<b>PM10</b>	<b>--</b>
<b>European Union</b>	<b>PM10</b>	<b>40</b>
<b>European Union</b>	<b>PM10</b>	<b>20</b>
<b>California</b>	<b>PM10</b>	<b>20</b>
<b>U.S. EPA</b>	<b>PM2.5</b>	<b>15</b>
<b>California</b>	<b>PM2.5</b>	<b>12</b>

# Particulate Matter Health Effects Summary

- **PM responsible for most of the serious health effects known from exposure to ambient air pollutants**
  - Message is not “more people are dying” but rather “air pollution is the hidden cause of deaths that were previously attributed to other causes”
  - PM related mortality is associated with cardiovascular changes
- **Annual-average standards most important to attain**
  - U.S. EPA standards not health-protective
- **Exposure and toxicity of particles appear to vary**
- **Future research includes health effects of ultrafine particles**

# What Are the Health Effects of Ozone?

## ■ Disease

- Reduced lung function
- Respiratory symptoms
- Airway inflammation
- Increased hospital and ER usage
- Increased school absenteeism
- Asthma induction in active children (needs confirmation)

## ■ Death

- Recent findings

## Controlled Human Studies

(1 to 3 Hours): Lowest Concentrations Showing Effects

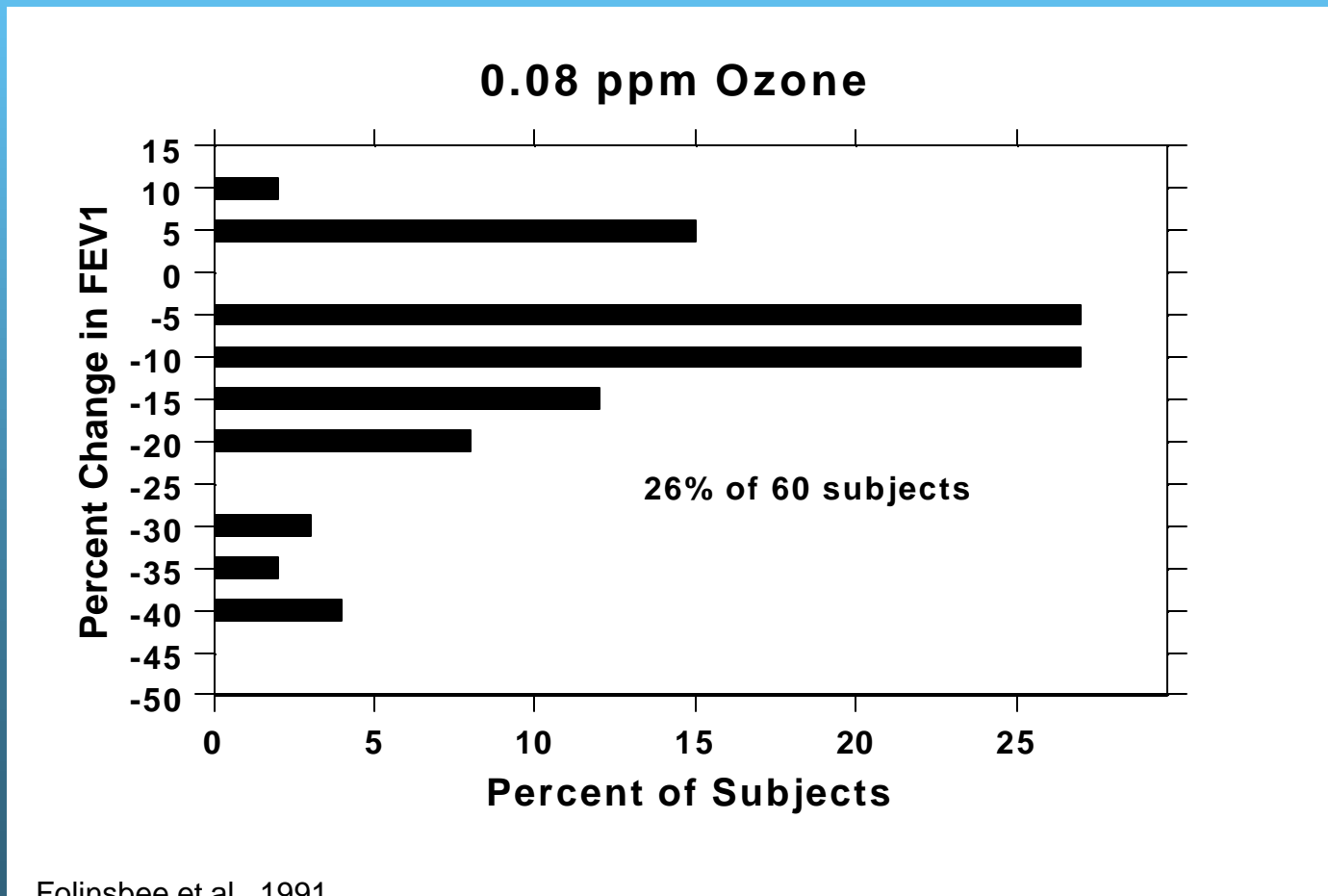
1. Decreased Lung Function: 0.12 ppm
2. Increased Respiratory Symptoms: 0.12 ppm
3. Increased Airway Resistance: 0.18 ppm
4. Airway Inflammation: 0.20 ppm

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

1. Decreased Lung function: 0.08 ppm
2. Increased respiratory symptoms: 0.08 ppm
3. Increased airway reactivity: 0.08 ppm
4. Airway inflammation: 0.08 ppm
5. No effects reported at 0.04 ppm



# Some Individuals Are Particularly Responsive (6.6 hr exposure)



Folinsbee et al., 1991

# Basis for Ozone Standard Recommendations

## Basis for 1-Hour Standard

The current 1-hr standard is 0.09 ppm

- Controlled human exposure studies report lung function and symptoms effects at 0.12 ppm
- Epidemiologic studies suggest adverse effects below 0.12 ppm, but relevant averaging time and concentration difficult to determine
- Studies on ER visits for asthma suggest a lowest effect level between 0.075 and 0.11 ppm

## Basis for 8-Hour Standard

The 8-hr standard is 0.070 ppm

- Controlled human exposure studies report symptoms, lung function changes, and airway responsiveness effects at 0.08 ppm
- 26% of individuals exhibited large changes with 6.6 hr exposure to 0.08 ppm
- Studies at 0.04 and 0.06 ppm reported no significant effects

# Ozone Health Effects

- **Disease Effects**
  - Asthma Effects
  - Reduced Lung Function
- **Death**
  - New association of Ozone and mortality
  - Study of 29 cities in Europe implicates summer ozone concentration (Gryparis et al. 2004)
  - Study of 95 largest U.S. cities implicates both summer and all-year ozone concentrations (Bell et al. 2004)
    - Controlled for PM10 and weather
    - Multi-day concentrations increase effect
  - Levy 2004

# Conclusion

- **Particulate Matter and Ozone are responsible for most of the health impacts seen with pollutant exposure**
- **Ambient Air Quality Standards are set to protect the most sensitive citizens**
- **The Standards are under continual review**
- **More Research is needed to define the Health impacts of air pollution**

Thank you

