Overview of Particle Air Pollution
($PM_{2.5}$ and $PM_{10}$)

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What is Particle Air Pollution?

• Particulate matter (PM), also called particle pollution, is a general term for extremely small particles and liquid droplets in the atmosphere

• PM\(_{2.5}\) (fine particles): \(d \leq 2.5\ \mu m\)

• PM\(_{10}\) (coarse particles): \(d \leq 10\ \mu m\)

• **Primary** sources:
  – Incomplete combustion
  – Automobile emissions
  – Dust
  – Cooking

• **Secondary** sources:
  – Chemical reactions in the atmosphere
There are many sources of particle pollution.
sizes and composition of particulate matter

anthropogenic:
• sulfates
• nitrates
• ammonia
• carbon
• lead
• organics

natural:
• soil
• dust
• seasalt
• bioaerosols

aerosol aerodynamic diameter (1 \( \mu m = 1 \times 10^{-6} m \))
Why Is it Important to Communicate Information about Particle Pollution to the Public?

• Exposure to particle pollution is a public health hazard
• When inhaled, particle pollution can travel deep into the lungs and cause or aggravate heart and lung diseases
• Exposure to particle pollution causes increases in:
  – Doctor and emergency room visits
  – Hospital admissions
  – Use of prescription medication
  – Absences from work and school
Particle Pollution Affects the Lungs

• People are exposed to particle pollution when they breathe

• Effects of **short-term (acute)** exposure:
  – Coughing
  – Shortness of breath
  – Tightness of the chest
  – Irritation of the eyes

• Effects of **long-term (chronic)** exposure:
  – Reduced lung function
  – Development of respiratory diseases in children
  – Aggravation of existing lung diseases
  – Premature death of people with lung disease
Particle Pollution Affects the Heart

• Inhaled particles can pass from the lungs into the bloodstream and affect the cardiovascular system.

• Effects of short-term (acute) exposure:
  – Irregular heart beat
  – Nonfatal heart attacks

• Effects of long-term (chronic) exposure:
  – Aggravation of existing heart diseases
  – Premature death of people with heart disease
Certain Groups Are Most at Risk from Exposure to Particle Pollution

• Children
  – Lungs are still developing
  – Spend more time at high activity levels

• Senior citizens
  – May have undiagnosed heart or lung diseases

• People with existing heart or lung diseases
  – Particle pollution aggravates these diseases

• People who exercise or work outdoors
  – Breathe faster and deeper than sedentary adults
Famous Particle Air Pollution Episodes

Denora, Pennsylvania, USA
October 26-31, 1948
air pollution kills 20 people

London, England
December 4-9, 1952
air pollution kills 4000 people

Donora at noon

London at 10:30 AM
Pyramid of Health Effects from Air Pollution

Proportion of Population Affected

Adversity of Effects

Death

Visits to emergency room, hospitalization

Visits to doctors, absences from school and work

Use of medication, asthma attacks

Lung inflammation, coughing, increased susceptibility to infection, cardiac effects
Communicating Health Effects

• Morbidity
  – Increased frequency of chronic bronchitis, respiratory hospital admissions, restricted activity days, etc.

• Disability-Adjusted Life Year (DALY)
  – Indicates how a disease can alter the ability of people to live a normal life compared to those with no disease
  – Expresses years of lost life

• Mortality (number of deaths)
Examples of Health Effects for Europe

• Air pollution causes 1.8 – 6.4% of deaths of European children age 0-4 years
• Air pollution causes 100,000 deaths and 725,000 years of lost life (DALY) in European cities
• PM$_{2.5}$ pollution caused 350,000 premature deaths in 2000
• European citizens have a decrease in average life expectancy of 9 months due to air pollution
Annual Impacts of Air Pollution in the U.S.

• Human exposure to outdoor air pollution costs between $40 to $50 billion
• 50,000 to 120,000 premature deaths are associated with exposure to air pollution
• People with asthma experience more than 100 million days of restricted activity
• Costs associated with treating asthma exceed $4 billion
• About 4,000 people die of asthma
Summary

• Particulate matter (PM) is a general term for very small solid and liquid particles in the atmosphere.

• There are many different sources of PM, including natural and anthropogenic (man-made) sources.

• PM is hazardous to human health – it causes acute and chronic effects to the respiratory and cardiovascular systems.

• PM causes a variety of human health and economic impacts each year (e.g., mortality, morbidity, DALYs, lost income from work absences, costs of health care).