Air Quality

Air quality refers to the degree of purity or pollution of the air relative to established environmental and health standards. Assessing air quality involves measuring concentrations of gaseous and particulate pollutants and evaluating their impacts on human health, ecosystems, and climate. Understanding air quality is essential for students in atmospheric sciences, environmental engineering, and public health.

Particulate Matter (PM)

Particulate Matter (PM) refers to a complex mixture of solid particles and liquid droplets suspended in the air. These particles vary in size, shape, chemical composition, and origin and are considered among the most dangerous air pollutants.

Types of Particulate Matter

PM10: Particles with a diameter < 10 micrometers. Deposited mainly in the upper respiratory tract. Sources: dust, soil, industrial activities.

PM2.5: Fine particles with a diameter < 2.5 micrometers. Capable of penetrating deep into the lungs and entering the bloodstream. Sources: vehicle emissions, fossil-fuel combustion, industrial processes, atmospheric chemical reactions.

Ultrafine Particles (UFPs): Diameter < 0.1 micrometers (100 nanometers). Can penetrate cells and reach vital organs including the brain. Sources: combustion processes, especially incomplete combustion.

Health Risks of PM

Chronic inflammation of the respiratory system. Cardiovascular diseases. Increased risk of lung cancer. Premature mortality linked to long-term exposure.

Major Air Pollutants

Gaseous Pollutants: Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2), Ozone (O_3) (tropospheric), Carbon Monoxide (CO), Volatile Organic Compounds (VOCs).
Particulate Pollutants: PM10, PM2.5, Ultrafine particles.

Sources of Air Pollution

Anthropogenic Sources: Vehicle emissions, Power plants and industrial facilities, Waste burning, Fuel combustion (diesel, gasoline, coal), Emissions from paints, solvents, and consumer products (VOCs).

Natural Sources: Dust storms, Volcanic emissions, Wildfires, Biogenic VOCs from vegetation.

Air Quality Index (AQI)

The Air Quality Index is a numerical scale (0–500) used to communicate the level of air pollution and its health implications.
Categories: Good (Green) - No risk, Moderate (Yellow) - Minor effects, Unhealthy for Sensitive Groups (Orange) - Respiratory symptoms, Unhealthy (Red) - Health impacts, Very Unhealthy (Purple) - Significant health risks, Hazardous (Maroon) - Emergency conditions.

Health Impacts of Air Pollution

Asthma and bronchitis. Reduced lung function. Heart and vascular diseases. Increased hospital admissions. Long-term cancer risks. Premature deaths (particularly linked to PM2.5).

Environmental Impacts

Acid rain and soil degradation. Reduced agricultural productivity. Damage to buildings and monuments. Visibility reduction. Contribution to climate change and radiative forcing.

Strategies to Improve Air Quality

Expanding public transportation and electric vehicles. Transitioning to renewable energy sources. Enforcing industrial emission regulations. Reducing open waste burning. Installing advanced air monitoring systems. Increasing green spaces in urban areas.

Air quality assessment is a critical component of environmental and public health protection. Understanding the behavior of atmospheric pollutants—particularly particulate matter (PM)—is essential for developing effective mitigation strategies. Improving air quality requires coordinated efforts across governmental, industrial, and societal levels.