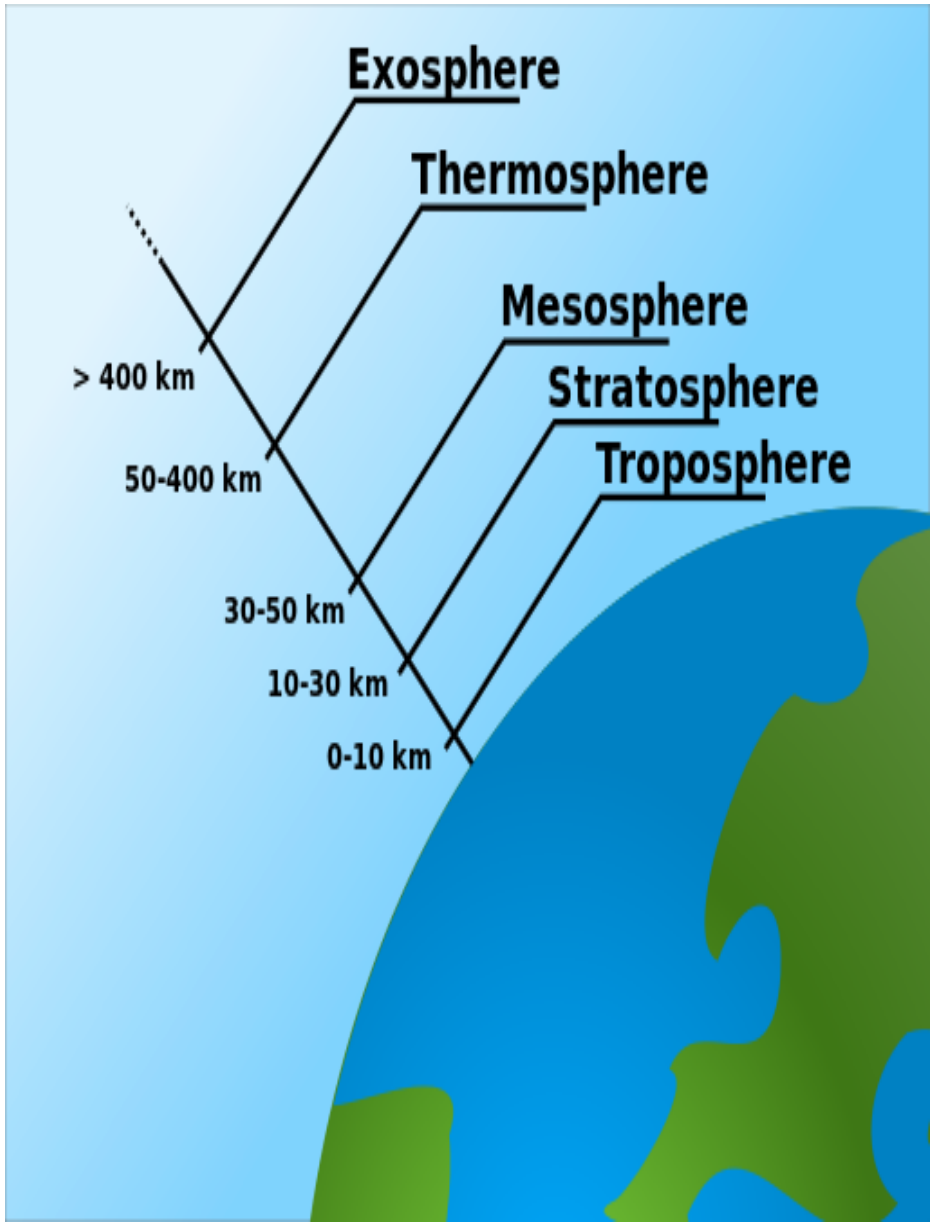
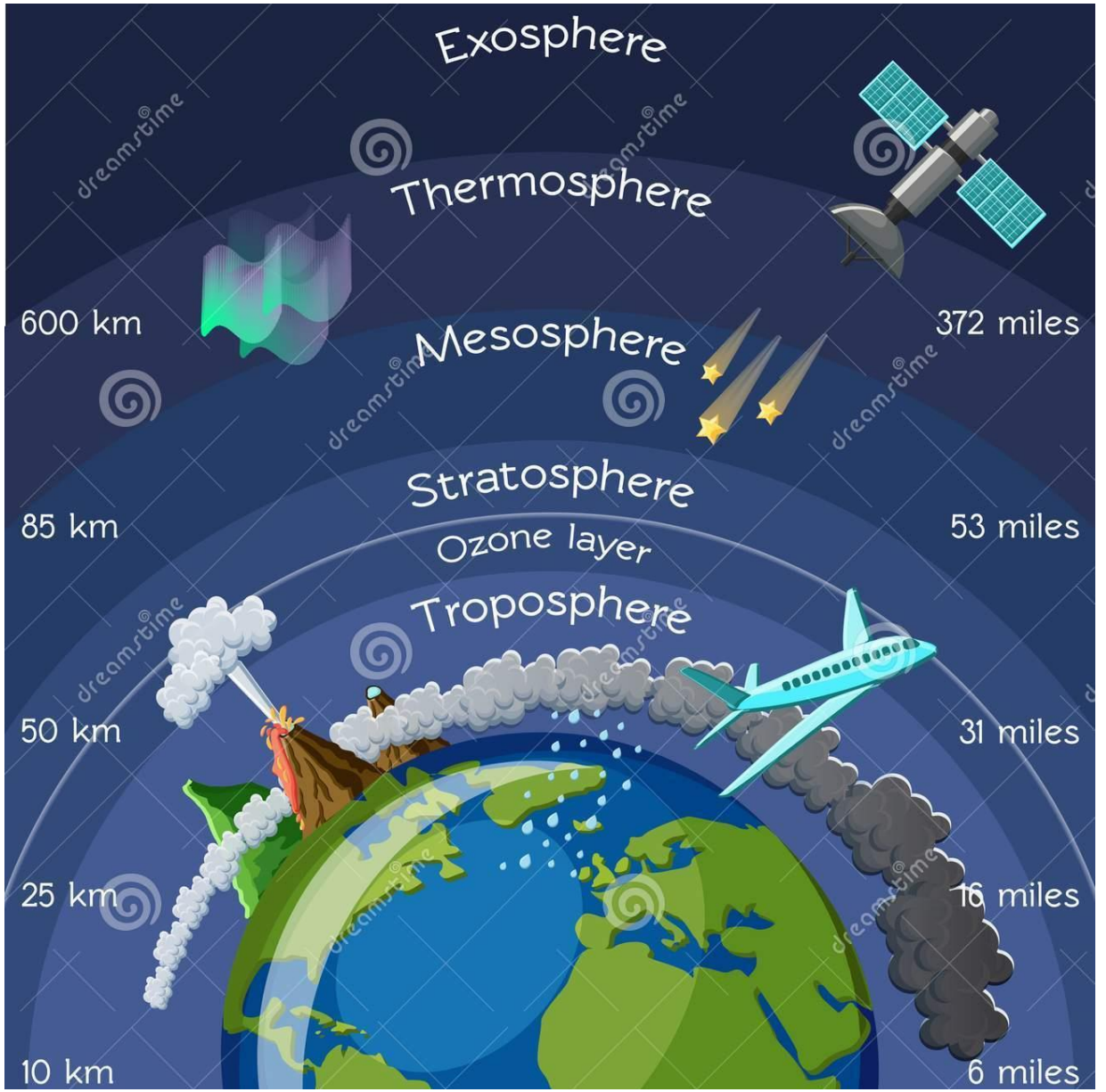
Air Pollution: Inorganic Gases

- **Atmosphere**

- An atmosphere (from Ancient Greek ἀτμός (atmós) 'vapour, steam', and σφαῖρα (sphaîra) 'sphere') is a layer of gas or layers of gases that envelope a planet and is held in place by the gravity of the planetary body.
- An atmosphere is a layer of gas or layers of gases that envelope a planet and is held in place by the gravity of the planetary body.
- An atmosphere is the layers of gases surrounding a planet or other celestial body. These gases are found in layers (troposphere, stratosphere, mesosphere, thermosphere, and exosphere) defined by unique features such as temperature and pressure.

Atmosphere


Exosphere
Thermosphere
Mesosphere
Stratosphere
Troposphere
> 400 km
50-400 km
30-50 km
10-30 km
0-10 km


Exosphere
Thermosphere
600 km
372 miles
Mesosphere
Stratosphere
85 km
53 miles
Ozone layer
Troposphere
50 km
31 miles
25 km
16 miles
10 km
6 miles

Composition of Earth Atmosphere

Current Composition

The concentrations of gases in the earth atmosphere is now known to be (ignoring water vapor, which varies between near zero to a few percent):

CONSTITUENT	CHEMICAL SYMBOL	MOLE PERCENT
Nitrogen	N_2	78.084
Oxygen	O_2	20.947
Argon	Ar	0.934
Carbon Dioxide	CO_2	0.035
Neon	Ne	0.00182
Helium	He	0.00052
Methane	CH_4	0.00017
Krypton	Kr	0.00011
Hydrogen	H_2	0.00005
Nitrous Oxide	N_2O	0.00003
Xenon	Xe	0.00001
Ozone	O_3	trace to 0.00080

The unit of percentage listed here are for comparison sake. For most atmospheric studies the concentration is expressed as parts per million (by volume). That is, in a million units of air how may units would be that species. Carbon dioxide has a concentration of about 350 ppm in the atmosphere (i.e. 0.000350 of the atmosphere or 0.0350 percent).

Historical background

- Earth thought to have formed about 4.5 billion years ago.
- The original atmosphere made up of hydrogen and helium. These are fairly common in the universe and most of these gases were lost to space.
- Original atmosphere stripped away by the solar wind. The early earth was not protected by a magnetic field. Thus, the current atmosphere is secondary one and was formed from the degassing of volcanoes.
- Gases emitted were : H_2, S_2, Cl_2, N_2, CH_4, CO_2, SO_2, CO, H_2O

Historical background

- The earth was cool enough that H_2O vapor condensed to form the ocean. CO_2 dissolved in the water of ocean. O_2 came from the photosynthesis process:

$$6CO_2 + 12\ H_2O \rightarrow C_6\ H_{12}\ O_6 + 6O_2 + 6\ H_2O$$

- Thus, from the secondary atmosphere modern atmosphere was formed.

Air and Air Pollution

- Air is a mixture of gases that exists in a relatively thin layer around the earth. Composition of air is constant from ground level to 50 miles.
- Pollution is any departure from purity. Air pollution may be defined as any atmospheric condition in which substances are present at concentration high enough above their normal ambient level to produce a measurable effect on man, animals, vegetation or materials.
- Air pollution refers to the release of pollutants into the air—pollutants which are detrimental to human health and the planet as a whole.
- Air pollution is the presence of substances in the atmosphere that are harmful to the health of humans and other living beings, or cause damage to the climate or to materials.

Air Pollution in Bangladesh some examples

Types of Air Pollutants

- Primary Pollutants: which together contribute more than 90% of global air pollution as primary pollutants are COX (CO, CO2), NOX (NO, NO2), HC, SOX (SO2, SO3), Particulate Matter.
- Secondary Pollutants: The products which are formed from the primary pollutants through a chemical change in the environment are referred to as secondary pollutants

$$SO_2 + O_2 \rightarrow SO_3 + H_2O \rightarrow H_2SO_4$$

Sources of Air Pollution

Name	Chemical formula	Source
Oxides of nitrogen	NO, N_2O, NO_2	• NO_2 primarily gets in the air from the burning of fuel. NO_2 forms from emissions from cars, trucks and buses, power plants, and off-road equipment and combustion process • The primary source of atmospheric nitric oxide (NO), particularly in urban areas, is combustion of fossil fuels • Sources of (N_2O) nitrous oxide emissions include agriculture, energy use, industrial processes, and waste management
Oxides of sulfur	SO_2 (95%) SO_3	• Volcanic eruption, • Vegetative decay, • Fuel (mostly cool containing sulfur), • Industrial process, • Transportation. • Combustion of coal • Petroleum products, petroleum refining
Oxides of carbon	CO,CO_2	• Transportation, • Industrial process, • Biomass burning, • Combustion of fossil fuel, • Incomplete combustion, • Decomposition of living matters
Hydrogen sulfide	H_2S	• Anaerobic biological decay
Amonia	NH_3	• Anaerobic biological decay, • Industrial processes.

Sources of Air Pollution

Name	Chemical formula	Source
Toxic metals like	As, Hg, Cd, Pb	• Industrial processes.
Organic compounds like aldehydes, ketones, hydro carbons,	CH_4, C_2H_6, C_2H_4, HCHO, CH_3COCH_3	• Decomposition of living matters, • The growth and decomposition plants, • Organic solvents, • Paints etc.
Ozone (Secondary) Pollutant	O_3	• Secondary pollutant formed from photochemical reaction.
Gases, water vapors and CFCs	H_2O vapor, $CFCl_3$, CF_2Cl_2, CF_2ClH, CCl_4	• Industrial process, • Refrigeration, • Evaporation etc.
Radioactive gases Krypton, Xenon, Radon	Kr, Xe, Rn	• Natural process.

Sources of Air Pollution

Name	Chemical formula	Source
Particulate matters	PMs	• Vehicular emission, • Emission from industries, • Cement industries, • Brick fields, • Biomass burning • fire • Unpaved roads • Desert storm • Sea spray • Emission from solid wastes dumped on earth, • Waste incineration, etc.
Volatile organic compounds (VOCs) Propane, Butane, Pentane, Hexane, Benzene, Toluene, Xylene, Acetone,	C_3H_8, C_4H_{10}, C_5H_{12}, C_6H_{14}, C_6H_6, $C_6H_5CH_3$, $C_6H_4(CH_3)_2$, RCOR	• Adhesives • Solvents • Building materials • Combustion appliances • Paints • Varnishes • Tobacco smoke, etc.

Air Pollutants and Health Effect

Air Pollutants	Health Effects
Particulate Matter (PM_{10}, $PM_{2.5}$)	Loss of lung function, chronic respiratory and cardiovascular diseases
Nitrogen Dioxide (NO_2)	Bronchitis and pneumonia, increase respiratory infections, reduces lung function, asthma
Carbon Monoxide (CO)	Reduces the delivery of oxygen, severe headache cardiovascular symptom, decrease of visual perception, manual dexterity
Sulphur Dioxide (SO_2)	Loss of lung function
Ozone (O_3)	Respiratory illnesses, asthma
Lead (Pb)	Interfere with the cardiovascular and reproductive systems

Health and Biological Effects of Atmospheric Pollution

Effects of:

-SOx

-NOx

-Carbon Monoxide (CO)

- Particulate Matters (PM)

- Environmental Fluoride (F)

- Volatile Organic Compounds (VOCs)

Bangladesh Ambient Air Quality Standards

Air Pollutants	Standards (mg/m^3) (ECR,1997)	Standards (mg/m^3) (Air Pollution (Control) Rules, 2022)	Averaging Times
CO	10 mg/m3	05 mg/m3	08 Hours
	40 mg/m3	20 mg/m3	01 Hour
Pb	.50 µg/m3 (Annual)	0.25 µg/m3	Annual
		0.50 µg/m3	24 Hours
NO2	100 $\mu g/m^3$	40 µg/m3	Annual
		80 µg/m3	24 Hours
PM 10	50 µg/m3	50 µg/m3	Annual
	150 µg/m3	150 µg/m3	24 Hours
PM 2.5	15 µg/m3	35 µg/m3	Annual
	65 µg/m3	65 µg/m3	24 Hours
O3	235 µg/m3	180 µg/m3	1 Hour
	157 µg/m3	100 µg/m3	8 Hour
SO2		250 $\mu g/m^3$	1 Hour
		80 $\mu g/m^3$	24 Hours
NH3		100 $\mu g/m^3$	Annual
		400 $\mu g/m^3$	24 Hours

Effects of SOx

➢ **Effects on plants**

- SO_2 and SO_3 are the two sulfur oxides (SO_X) that are important air pollutants Effects of SO_x on human health.
- Based on quantities emitted into atmosphere, SO_2 is considered the most dangerous of all gaseous pollutants
- Primary effect upon respiratory tract, producing – Irritation, Increasing air way resistance

➢ **Effects on plants**

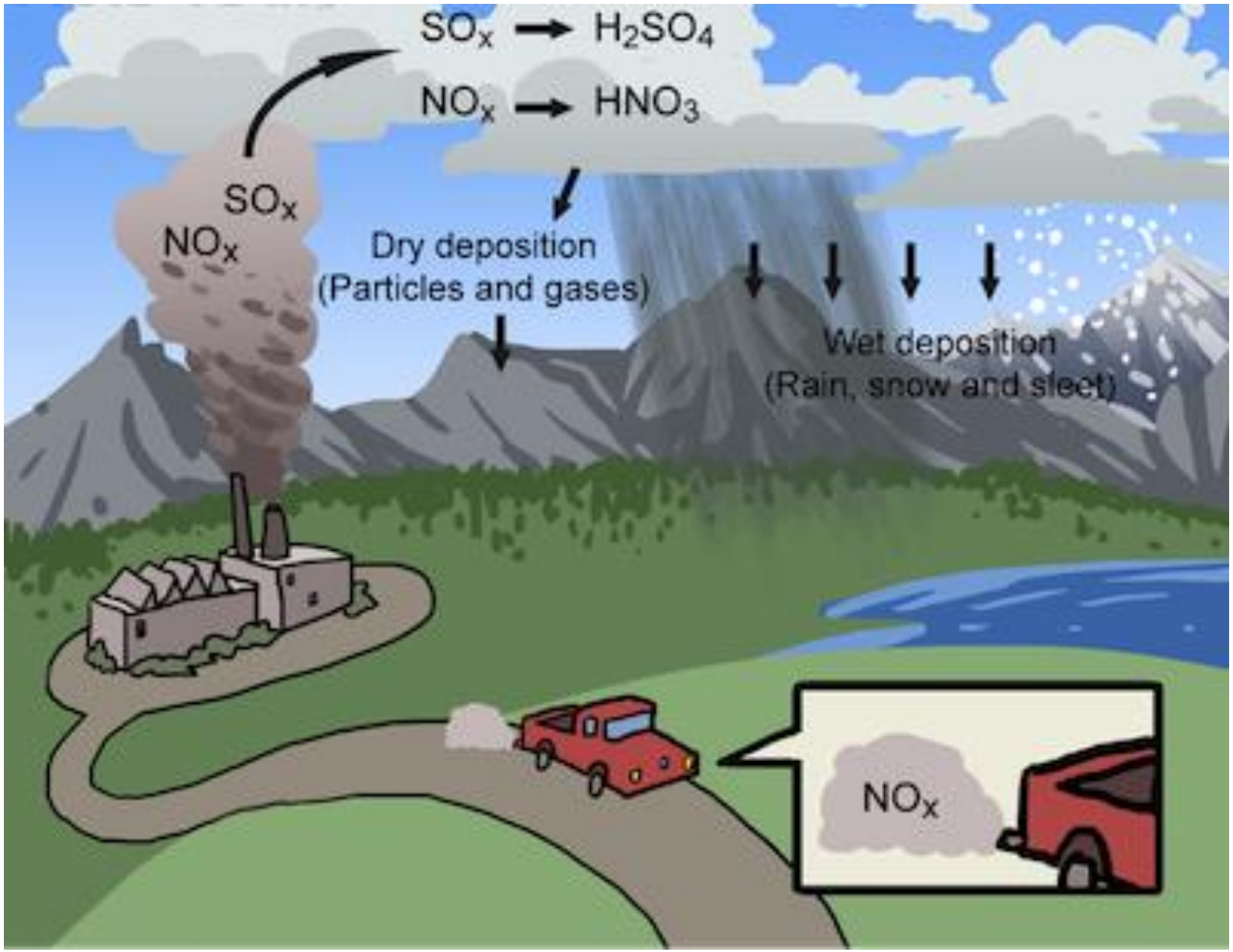
- Affect photosynthesis, transpiration, respiration, metabolism process and enzyme system
- Acute exposure to high levels of gas kills leaf tissue. The edges of the leaves and the areas between the leaf veins are particularly damaged.
- Chronic exposure of plants to SOx causes chlorosis (a bleaching or yellowing of the normally green portion of the leaf).
- Plants injury increases with increasing relative humidity. During day light most damage occurs (because stomata is open)

Acid rain deposition

- The P^H value of normal rainwater is 5.6 . When rainwater reaches the P^H value 4 or less, it is termed as acid rain. When acid rain is deposited, called wet deposition, on soil. It effects agricultural productivity by changing the P^H of soil. Soil P^H is widely varying parameter (6-8) (agricultural soil).
- Acid rain, or acid deposition, is a broad term that includes **any form of precipitation with acidic components**, such as sulfuric or nitric acid that fall to the ground from the atmosphere in wet or dry forms. This can include rain, snow, fog, hail or even dust that is acidic.

$$SO_3 + H_2O \longrightarrow H_2SO_4$$
$$HCl + H_2O \longrightarrow HCl$$
$$CO_2 + H_2O \longrightarrow H_2CO_3$$
$$4\,NO_2 + O_2 + 2\,H_2O \longrightarrow 4\,HNO_3$$

Formation of Acid Rain in atmosphere



Effects of acid rain

- It increases the leaching of nutrients from plant foliage.
- Removes basic nutrients from the soil e.g., calcium. Changes in rates of metabolism of organisms which depends on acid and base catalysis.
- Acidification of lakes and rivers (water bodies)
- Corrosion of basic materials such as limestone or marble stone accelerated. This is called stone leprosy.
- Acid rain causes extensive damage to building and sculpture materials of marble, limestone, slate etc. (which consists of $CaCo_{3,}$ or $CaCo_{3.}MgCo_{3}$). This carbonates are converted into sulphates and dissolve.

Effect on Building Materials

- Air Pollutants can affect buildings on the roadside particularly, in varieties of ways, like by soiling the material, by depositing black shoot on the building. The color on the painted surface can be damaged and it depends on the concentration of the pollutant and the distance of the building from the roadside.
- It has been studied that if the distance is 300 m from the roadside, and if the relative loading is, say 0.03 at this distance from the road, the effect would be more than 30 times (1.0) higher if the distance is 5m.

This religious medieval sculpture, made of sandstone, has been degraded by the acidification of air and rains. The sculpture is located in Dresden, at the corner of Bautzner Straße and Eck Glacisstraße.

Effects of Hydrocarbons

- Harmful effect of hydrocarbon is the formation of photochemical smog in presence of intense sunlight. Photochemical smog is characterized by brown hazy fumes which -

  - irritate eye and lungs
  - lead to the cracking of rubber
  - expensive damage to plant life
  -complete collapse of cell, change in growth pattern and crop yield and quality.

Effects of NO_x on Plants

- Plants absorb gaseous NO_x through stomata. Among the NOX's NO_2 is the most important air pollutant because of its relatively high toxicity and its ubiquity in ambient air
- The absorbed NO_2 is converted to nitrate (NO_3^-) and nitrite (NO_2^-) ions before the plant can metabolize it.
- NO_2^- induced Plant injury may be due to either acidification or a photo-oxidation process.
- Decreased photosynthesis may caused due to competition for NADPH between the processes of nitrite reduction and carbon assimilation in chloroplasts.

Effect of Nox on human

- It absorbs UV light energy and is then broken down to NO and atomic O
- The energetic O atom reacts with molecular oxygen to form O_3
- NO_2 pollution may be an important aspect of indoor air pollution
- Gas cooking and heating of homes, when not well vented, can increase NO2 exposure
- Has been reported to cause bronchitis and pneumonia, as well as increase susceptibility to respiratory infection and impair immune responses
- Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing),
- Longer exposures to elevated concentrations of NO_2 may contribute to the development of asthma and potentially increase susceptibility to respiratory infections
- Long term exposure can decrease lung function
- NO_2 along with other NO_x reacts with other chemicals in the air to form both particulate matter and ozone. Both of these are also harmful when inhaled due to effects on the respiratory system

Health Effects Associated with NO_2 Exposure in Epidemiological Studies

Health effect	Mechanism
Increased incidence and severity of respiratory infections	Reduced efficacy of lung defenses
Reduced lung function	Airway and alveolar injuries
Respiratory symptom	Airway injury
Worsening clinical status of persons with asthma, chronic obstructive pulmonary disease or other chronic respiratory conditions	Airway injury

Source: adapted from Romieu, in Urban Traffic Pollution, Ecotox/WHO/E&FN Spon, London, 1999, p.9.

Effects of Nox on human

Concentration (ppm)	Duration	Effects
0.063-0.1	2-3 years	Increased incidents of acute respiratory disease.
5-100	Up to 1 hour	Inflammation of lung tissue for 6-8 weeks
100-200	Up to 1 hour	Bronchitis-fatal result with in 3-5 weeks.
500-more	2-10 days	Death.

Effects of Carbon Monoxide (CO)

- CO is an odorless, colorless, and tasteless gas found in high concentrations in the urban atmosphere.
- Toxic potential exist at high concentrations in urban environments
- Early exposures resulted from - wood burning fires and coal for heating
- Other anthropogenic sources include: Combustion of carbon containing fossil fuels, explosion, fires in mines Transportation; Agricultural burn;
- Among anthropogenic sources transportation accounts for almost two third of CO.

Sources of carbon monoxide (CO)

The principal sources of carbon monoxide in the environments are:

- Incomplete combustion carbon containing fuels (7%)
- Combination of hydroxyl radicals with methane derived from decomposition of living matter and ocean (80%)
- The growth (seed germination) and decomposition of plants containing chlorophyll (3%)
- Desorption from ocean (10%)

Other sources of CO_USEPA

- Unvented kerosene and gas space heaters;
- leaking chimneys and furnaces; back-drafting from furnaces;
- Gas water heaters;
- Wood stoves, and fireplaces; gas stoves;
- Generators and other gasoline powered equipment;
- Automobile exhaust from attached garages; and
- Tobacco smoke.
- Incomplete oxidation during combustion in gas ranges and unvented gas or kerosene heaters may cause high concentrations of CO in indoor air.
- Worn or poorly adjusted and maintained combustion devices (e.g., boilers, furnaces) can be significant sources, or if the flue is improperly sized, blocked, disconnected, or is leaking.
- Auto, truck, or bus exhaust from attached garages, nearby roads, or parking areas can also be a source.

Effects of Carbon Monoxide (CO)

- CO formed through one of the following three processes:
  - Incomplete combustion of carbon-containing fuels,
  - Reactions between CO_2 and carbon-containing materials at high temperature, and
  - Dissociation of CO_2 at high temperatures.

$$2C+O_2 \Longrightarrow 2CO$$

$$2CO+O_2 \Longrightarrow 2CO_2$$

$$CO_2+C \Longrightarrow 2CO$$

$$CO_2 \xrightarrow{\text{High Temperature}} CO+O$$

Effects of Carbon Monoxide (CO)

- A constant supply of O_2 is needed in order for physiological functions to proceed normally in the body.
- Oxygen is carried to body tissue by hemoglobin (Hb), a complex component of red blood cells that consists of two pairs of proteins (a and b chains), which themselves are bonded around an iron.
- Hemoglobin picks up O_2 in the lungs, forming a complex called oxyhemoglobin (HbO_2), as shown below:

$$Hb + O_2 \longrightarrow HbO_2$$

$$HbO_2 \longrightarrow Hb + O_2$$

The Hb is then returned to the lungs for a new supply of O2

- CO enters the bloodstream and reduces the ability of the RBC'S to deliver O2 to the body's organs and tissues. CO involves in formation of carboxyhemoglobin (COHb or HbCO)

$$CO + Hb \rightleftharpoons HbCO$$

Effects of Carbon Monoxide (CO)

- The chemical affinity of CO for Hb is more than 200 times greater than that of O_2
- In the presence of CO, HbO_2 readily releases the bound O_2 and picks up CO to form HbCO

$$HbO_2 + CO \rightleftharpoons HbCO + O_2$$

- Because the binding sites of each polypeptide chain on the hemoglobin molecule cannot be occupied by the O_2 and CO at the same time,
- it is apparent that CO can tie up a substantial quantity of Hb when HbCO is formed.
- Consequently, Hb will not be able to transport O_2 to tissues, thus severely impairing bodily function, especially of the heart and central nervous system

Effects of CO on humans_USEPA

- At low concentrations, fatigue in healthy people and chest pain in people with heart disease;
- At higher concentrations, impaired vision and coordination; headaches; dizziness; confusion; nausea;
- Can cause flu-like symptoms that clear up after leaving home. Fatal at very high concentrations.
- Acute effects are due to the formation of carboxyhemoglobin in the blood, which inhibits oxygen intake.
- At moderate concentrations, angina, impaired vision, and reduced brain function may result.
- At higher concentrations, CO exposure can be fatal.

Air Pollution: Particulate Matter (PM)

➢Formation of particulate matters

Physical Processes

- Particulate air pollution refers to the presence of small solid and liquid aerosols suspended in the atmosphere.
- The physical dimensions and chemical properties of these aerosols vary greatly.
- Particles above approximately 1 mm in size are generally formed by the disintegration of larger particles (Dispersion process). Dust are solid dispersion aerosols, which may be formed through a variety of natural and human activities.
- Some examples: Volcanic eruption, wind-blown dust from dry soil, coal grinding, rock crushing, stone cutting and polishing, high-power drilling of tunnel rocks, and manufacture of pottery. Vehicular emission, diesel power generator or brick kiln, construction activities
- Sea spray is also a source of particulate matter and can contribute up to 80 % of particle levels in the air in coastal areas. This is **mostly salt, whipped into the air by strong winds**.

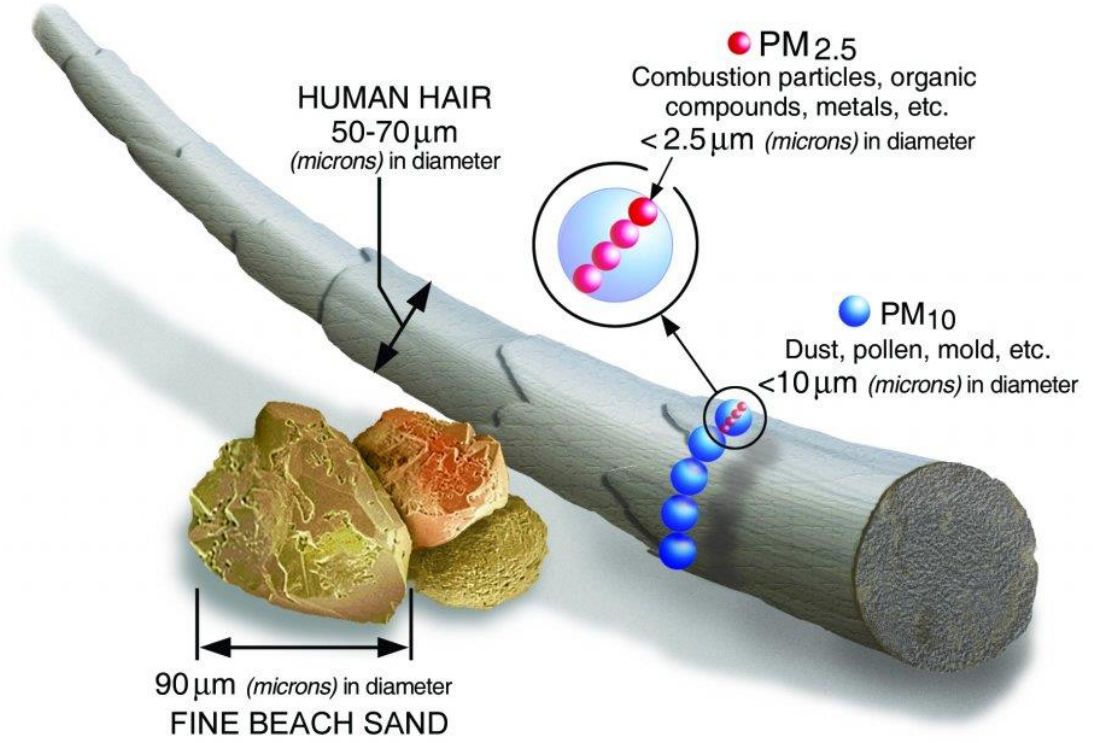
Particulate Matter (PM) Basics

PM stands for particulate matter (also called particle pollution): the term for a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope.

PM10 : inhalable particles, with diameters that are generally 10 micrometers and smaller; and

PM2.5 : fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller.

How small is 2.5 micrometers? Think about a single hair from your head. The average human hair is about 70 micrometers in diameter – making it 30 times larger than the largest fine particle.



Source: USEPA

Formation of particulate matters

Chemical Processes

- Both inorganic and organic particles are produced through various chemical processes. Metal oxides form a major class of inorganic particles in the atmosphere. They are produced whenever fuels containing metals are burned. For instance, particulate iron oxide is produced in the combustion of coal that contains iron sulfide (FeS_2) as contaminant.
- Sulfuric acid (H_2SO_4) mists are formed from the oxidation of atmospheric sulfur dioxide (SO_2)
- The sulfuric acid thus formed can react with basic air pollutants, such as ammonia (NH_3), calcium oxide (CaO), lead oxide (PbO), or aluminum oxide (Al_2O_3) forming various sulfates.

Health Effects of particulate matters

- Fly-ash particles are generally composed of stable elements or compounds that are usually not considered directly toxic in concentrations found in ambient air. However, subtle toxicity has been recognized under some conditions.
- In particular, many trace elements have important biological activity and are, therefore, potential health hazards.
- The toxicity of PM generally arises from any of the following factors. The particles may themselves be toxic, e.g., particles containing toxic metals and nonmetals, such as Pb, Cd, Ni, mercury (Hg), arsenic (As), etc.
- Alternatively, the particles may adsorb toxic chemicals, such as carcinogens, and enhance their effect by either increasing their penetration into the lungs, or prolonging their residence time in the respiratory tract.
- Finally if there are large quantities present in the respired air, particles may overtax the mucociliary apparatus, thus decreasing the rate of removal of toxic chemicals from the lung.

Environmental Fluoride

- Fluorine is the lightest element in Group VII of the periodic table
- F is the most phytotoxic air pollutant because it can damage plants at extremely low concentrations. High levels of waterborne F are also hazardous to both human and animal health.
- Examples: dental and skeletal fluorosis – abnormal or poisoned tooth and bone conditions mainly due to consumption of high levels of F in drinking water.

Environmental Fluoride: Sources

- Fluoride found in the environment is derived from both natural and anthropogenic sources.
- Natural sources of F include volcanism, aerosols from ocean spray, and soil particles blown into the atmosphere.
- Anthropogenic sources are found mostly in industrial facilities.
- F emitted into the atmosphere from these sources consists of both gaseous and particulate forms, and as such can contribute F to surface waters.

Environmental Fluoride: Effects on Plants

- Hydrogen fluoride (HF) is the most phototoxic air pollutant. The high toxicity of F and its compounds is due to their rapid absorption and the inherent toxicity of the element.
- F Can cause injury to susceptible plants at concentrations below 1 ppb (0.8 ug/m^3) for exposure periods of 7 days or less.
- Exposure to F can result in marked increases in foliage F levels. The extent of increases depends upon factors such as duration of exposure, atmospheric F levels, and species or variety of plants.
- F- induced effects in plants may be viewed based on four levels of biologic organization: cellular, tissue or organ, organism and ecosystem.

Environmental Fluoride: Effects on Animals

- Animals normally ingest small amounts of F in their rations without observable adverse effects, but excessive intake can be detrimental
- Common sources of excessive F intake include: forages subjected to air borne contamination or grown in soils containing high F levels, water containing high levels of F and feed supplement containing high levels of F
- The effect of F on domestic animals may be acute or chronic, depending on the levels to which animals were exposed.
- Acute: physiological effects(gastroenteritis, muscular weakness, pulmonary congestion, nausea, vomiting, diarrhea etc.
- Chronic: dental and skeletal fluorosis.

Volatile Organic compounds

- Volatile Organic compounds (VOCs) are those organic compounds which have a boiling-point within the range 50-100 to 240 - 260˚C
- They include a large number of major air pollutants, emitted from both industrial and non-industrial facilities
- Chemically, VOCs include aliphatic and aromatic hydrocarbons, halogenated hydrocarbons, some alcohols, esters, and aldehydes

Volatile Organic compounds: Sources

- Both natural and anthropogenic sources contribute to VOC emissions
- Natural sources include petroleum, forest fires, etc.
- Main anthropogenic sources include high-temperature combustion of fuels, emissions from crude and refined oil, municipal incineration, burning of crops before or after harvesting as an agricultural practice, emissions from powerboats, and others.

Examples of Volatile Organic Compounds

Group	Examples
Aliphatics	Pentane, hexane, heptane, cyclohexane, octane, nonane, eicosane, dodecane, 2,4- dimethylhexane
Aromatic	Benzene, dichlormethane, trichloroethylene, tetrachloroethylbenzene,
hydrocarbons	Toluene, xylenes, naphthalene, styrene
Halogenated	Chloroform, dichlormethane, trichlotoethylene, tetrachloroethylene,
hydrocarbons	Dichlorobenzenes
Alcohols	2-Butylalcohol, 1-dodecanol
Aldehydes	Decanal, nonanal
Esters	Ethyl acetate, 1-hexyl butanoate

Volatile Organic compounds: Health Effects

- Alkanes act primarily by solubilizing or emulsifying fats, mucus membranes, and cholesterols. At low concentrations, alkanes are simple irritants and can cause inflammation, redness, itching and swelling of the skin, mucous membranes, nose, trachea, and bronchioles.
- They also produce anesthesia and narcosis in the central nervous system (CNS).
- At high concentrations, acute eczema of the skin and pulmonary edema may develop, as well as, unconsciousness or death through asphyxiation caused by paralysis of the portion of the brain responsible for respiration.

Volatile Organic compounds: Health Effects

- Alkanes have also been found to penetrate rapidly into the fatty cells of the myelin sheath that surrounds nerve fibers, where they dissolve the cells and cause degeneration of the axons, interrupting the transference of nerve impulses.
- In animal experiments, the cis-isomers have been found to cause weakness, nausea, vomiting due to their adverse effects on the gastrointestinal tract and tremor and cramps due to their effects on the CNS.
- Benzene is associated with the development of leukemic cancer in humans. At high concentrations, inhalation of air containing approximately 64 g/m^3 of benzene can be fatal within few minutes. It affects CNS, exposure causes skin irritation, fluid accumulation in the lungs (edema), excitation, depression, and may eventually lead to respiratory failure and death.