



**JECRC Foundation**



**JAIPUR ENGINEERING COLLEGE  
AND RESEARCH CENTRE**

# **JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTER**

**Class – 3Year 5th Semester B.Tech Civil Engineering**

**Subject – Air & Noise pollution and Control**

**Ch – Air Pollution (unit 1)**

**Presented by –Narendra Sipani Assistant Professor**

# VISSION AND MISSION OF INSTITUE

## Vision-

To become a renowned centre of outcome based learning, and work towards academic, professional, cultural and social enrichment of the lives of individuals and communities.

## Mission-

**M1.** Focus on evaluation of learning outcomes and motivate students to inculcate research aptitude by project based learning.

**M2.** Identify, based on informed perception of Indian, regional and global needs, areas of focus and provide platform to gain knowledge and solutions.

**M3.** Offer opportunities for interaction between academia and industry.

**M4.** Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders can emerge in a range of professions.

# VISSION AND MISSION OF DEPARTMENT

## **Vision-**

To become a role model in the field of Civil Engineering for the sustainable development of the society.

## **Mission-**

**M1.**To provide outcome base education.

**M2.**To create a learning environment conducive for achieving academic excellence.

**M3.**To prepare civil engineers for the society with high ethical values.

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- REACTIONS OF POLLUTANTS IN THE ATMOSPHERE AND THEIR EFFECTS-SMOKE, SMOG AND OZONE LAYER DISTURBANCE GREENHOUSE EFFECT.

# AIR POLLUTION

□ Air is essential for life itself, without it we could survive only a few minutes. It constitutes immediate physical environment of living organisms.

The atmosphere is layered in to four distinct which are:

Troposphere,

Stratosphere

Mesosphere

Thermosphere.

□ Air pollution consists of gases, liquids, or solids present in the atmosphere in high enough levels to harm humans, other organisms, or materials may be defined as any atmospheric condition in which certain substances are present in such concentrations that they can produce undesirable effects on man and his environment. <https://www.youtube.com/watch?v=Tds3k97aAzo>

## CONT...

- ❑ Any substance introduced into the environment that adversely affects the usefulness of a resource.
- ❑ Pollution happens because no process is 100% efficient; each process produces pollution.
- ❑ Air pollution is also defined as the of one or more contaminants or combinations in such quantities and of such durations as may be or tend to be injurious to human, animal or plant life, or property, or which unreasonably interferes with the comfortable enjoyment of life or property or conduct of business.

<https://nptel.ac.in/courses/105/102/105102089/>

# AIR POLLUTANTS

- ❑ Substance dwelling temporarily or permanently in the air.
- ❑ Alters the environment by interfering with the health, the comfort, or the food chain, or by interfering with the property values of people.
- ❑ A pollutant can be solid (large or sub-molecular), liquid or gas.
- ❑ It may originate from a natural or anthropogenic source (or both).

<https://nptel.ac.in/courses/105/102/105102089/>

[https://youtu.be/4AuwG2G\\_ERU](https://youtu.be/4AuwG2G_ERU)



# CLASSIFICATION OF AIR POLLUTANTS

Pollutants can be grouped into two categories:

## **(1) Primary pollutants**

Those which are emitted directly from identifiable sources

## **(2) Secondary pollutants**

Those which are produced in the atmosphere when certain chemical reactions take place among primary pollutants.

<https://nptel.ac.in/courses/105/102/105102089/>

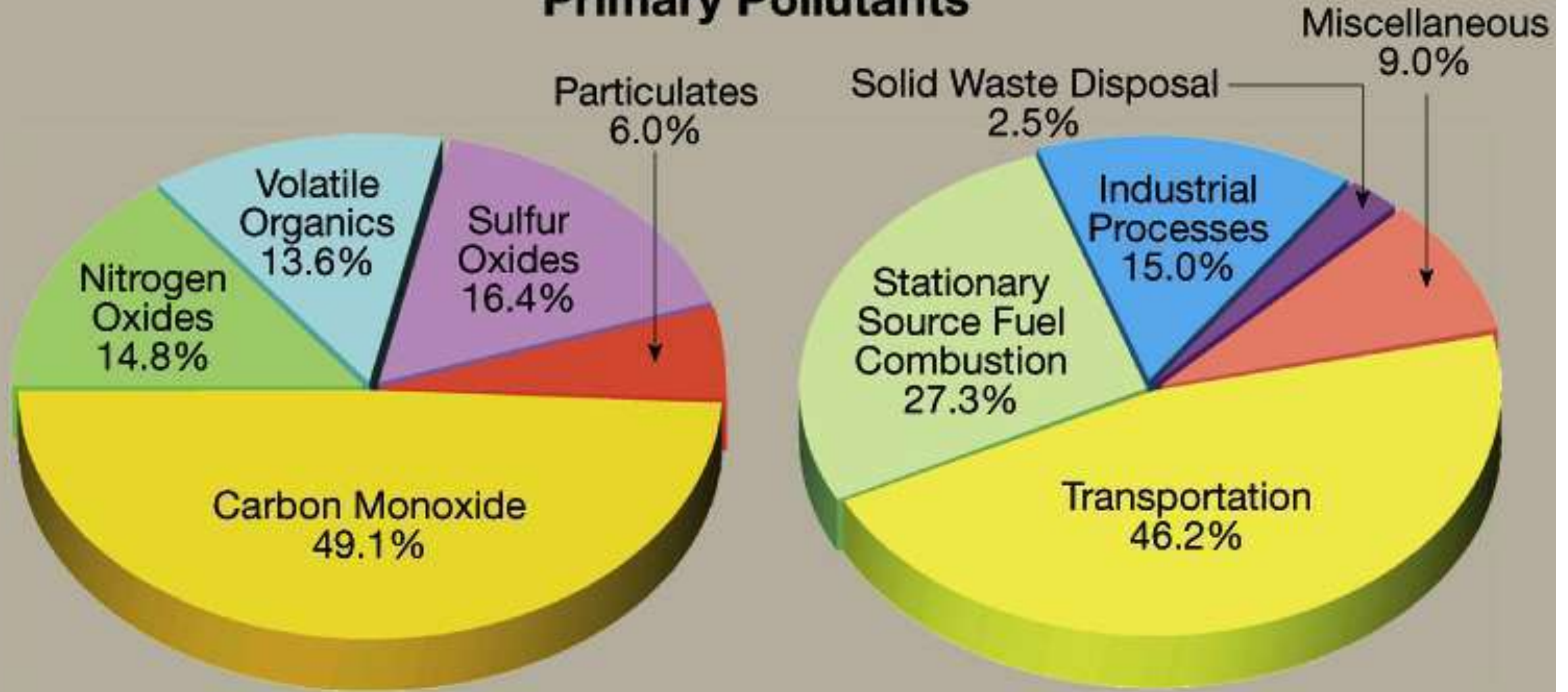


# PRIMARY POLLUTANTS

The major primary pollutants include:

- Particulate matter (PM)
- Sulfur dioxide
- Nitrogen oxides
- Volatile organic compounds (VOCs)
- Carbon monoxide, and
- Lead.

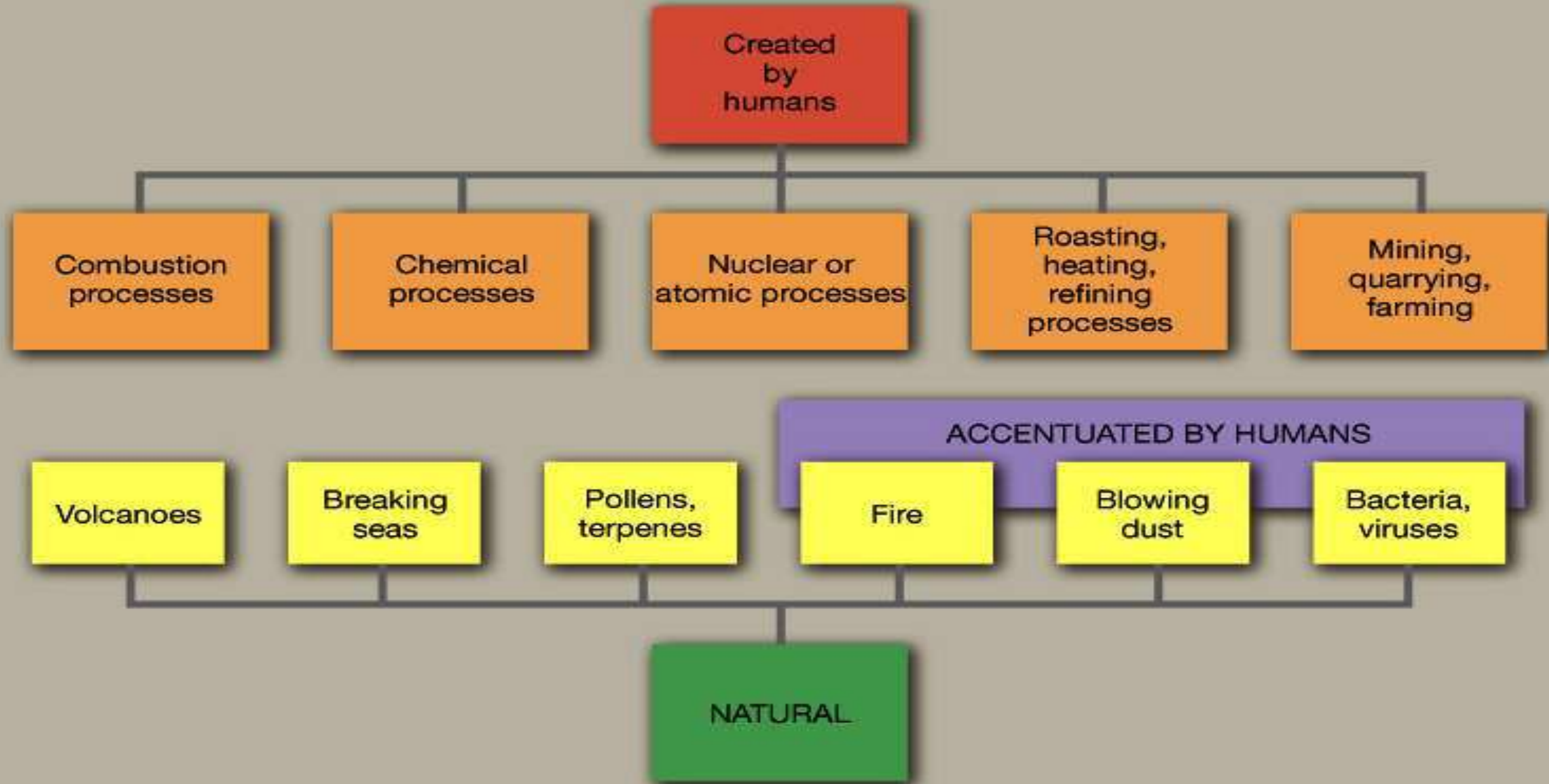
# Primary Pollutants



What They Are

Where They Come From

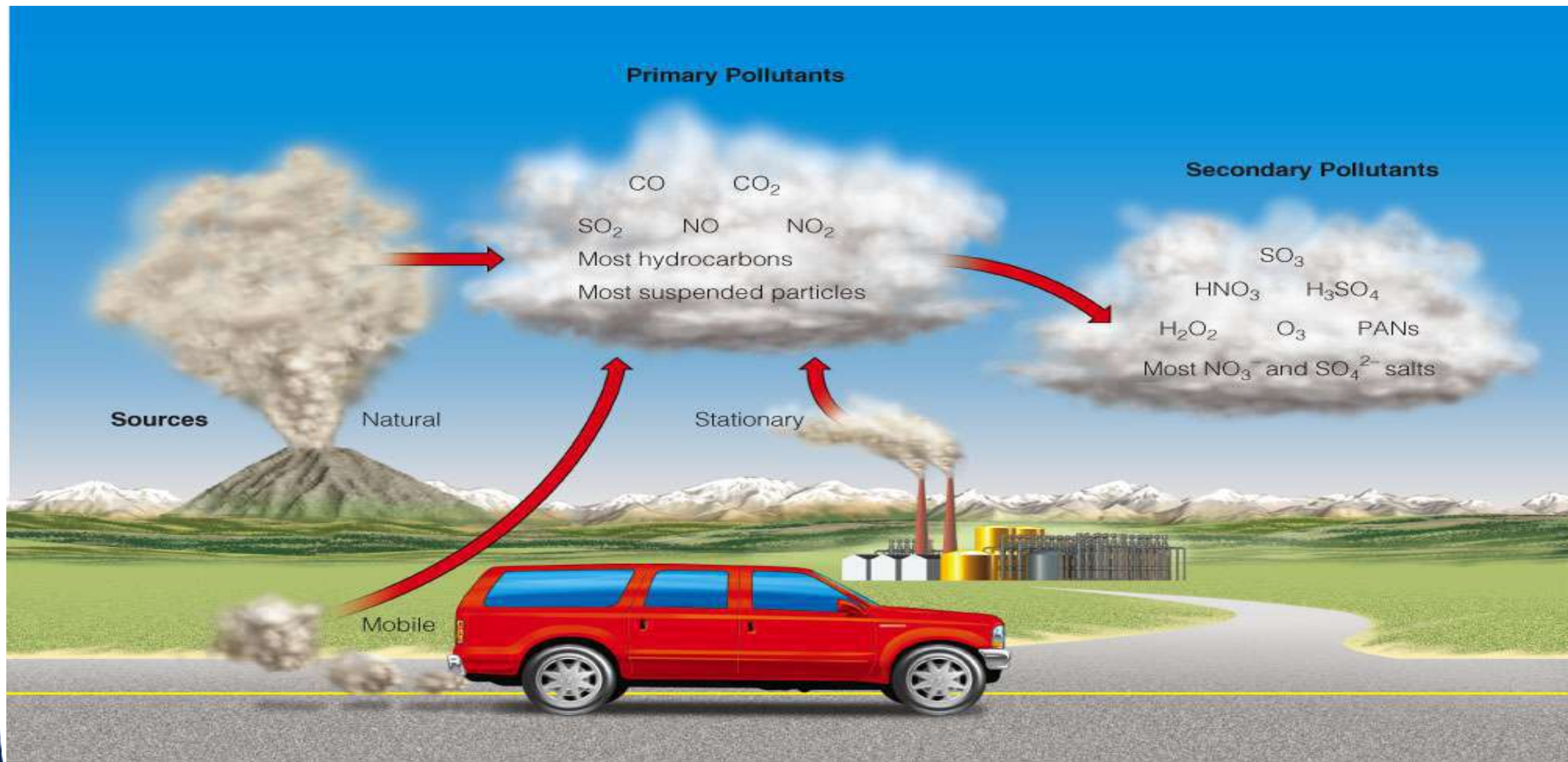
# SOURCES OF PRIMARY POLLUTANTS



# SECONDARY POLLUTANTS

- ❑ Some primary air pollutants react with one another or with other chemicals to form secondary pollutants.
- ❑ Atmospheric sulfuric acid is one example of a secondary pollutant.
- ❑ Air pollution in urban and industrial areas is often called smog.
- ❑ Photochemical smog, a noxious mixture of gases and particles, is produced when strong sunlight triggers photochemical reactions in the atmosphere.
- ❑ The major component of photochemical smog is ozone.





# SOURCES OF AIR POLLUTION

The main sources of air pollution are-

## **(a)AUTOMOBILES:**

- Motor vehicles are a major source of air pollution throughout the urban areas.
- They emit hydrocarbons, carbon monoxide, lead, nitrogen oxides and particulate matter.
- In strong sunlight, certain of these hydrocarbons and oxides of nitrogen may be converted in the atmosphere into "photochemical" pollutants of oxidizing nature.

## **(b) INDUSTRIES:**

- ❑ Combustion of fuel to generate heat and power produces smoke, sulphur dioxide, nitrogen oxides and fly ash.
- ❑ Petrochemical industries generate hydrogen fluoride, hydrochloric acid and organic halides.
- ❑ Many industries discharge carbon monoxide, carbon dioxide, ozone, hydrogen sulphide and sulphur dioxide.
- ❑ Industries discharge their wastes from high chimneys at high temperature and high speed.



### **(C)DOMESTIC SOURCES :**

❑ Domestic combustion of coal, wood or oil is a major source of smoke, dust, sulphur dioxide and nitrogen oxides.

### **(D) TOBACCO SMOKE:**

❑ The most direct and important source of air pollution affecting the health of many people.

❑ Even those who do not smoke may inhale the smoke produced by others ("passive smoking").

### **(e) MISCELLANEOUS:**

- ❑ These comprise burning refuse, incinerators, pesticide spraying, natural sources (e.g., wind borne dust, fungi, molds, bacteria) and nuclear energy programs.
- ❑ All these contribute to air pollution.

## 5 MAJOR POLLUTANTS

1. CARBON MONOXIDE
2. SULPHUR DIOXIDE
3. NITROGEN DIOXIDE
4. PARTICULATE MATTER
5. GROUND LEVEL OZONE

# 1. CARBON MONOXIDE

- ❑ It is colorless , odorless gas , a product of incomplete combustion of carbon containing materials, such as in automobiles, industrial process, heating facilities and incinerators
- ❑ Some widespread natural non biological and biological sources have also been identified.
- ❑ Concentrations in urban areas depend on weather and traffic density.

## 2. SULPHUR DIOXIDE

- ❑ It is one of the several forms in which sulphur exists in air.
- ❑ The others include  $\text{H}_2\text{S}$ ,  $\text{H}_2\text{SO}_4$  and sulphate salts.
- ❑ Sulphur dioxide results from the combustion of sulphur containing fossil fuel, and when coal and fuel oil are burned.
- ❑ Domestic fires can also produce emissions containing sulphur dioxide.
- ❑ Acid aerosol - sulphuric acid ( $\text{H}_2\text{SO}_4$ ) is a strong acid that is formed from the reaction of sulphur trioxide gas ( $\text{SO}_3$ ) with water.

### 3. NITROGEN DIOXIDE

- Nitric oxide (NO) is produced by combustion.
- Nitrogen dioxide (NO<sub>2</sub>), which has greater health effects, is a secondary pollutant created by the oxidation of NO under conditions of sunlight, or may be formed directly by higher temperature.
- Combustion in power plants or indoors from gas stoves.

#### **(4) PARTICULATE MATTER :**

- ❑ Represents a complex mixture of organic and inorganic substances.
- ❑ Mass and composition tend to divide into two principal groups :
  - coarse particles larger than  $2.5 \mu\text{m}$  in aerodynamic diameter
  - fine particles smaller than  $2.5 \mu\text{m}$  in aerodynamic diameter.
- ❑ The smaller particles contain the secondarily formed aerosols combustion particles and recondensed organic and metal vapors.
- ❑ The large particles usually contain earth's crustal material and fugitive dust from roads and industries.



## 5. GROUND LEVEL OZONE

- ❑ This is formed when pollutants such as nitrogen oxides and volatile organic compounds (VOCs) react in sunlight.
- ❑ High levels can cause breathing problems, reduce lung function and trigger asthma symptoms.
- ❑ Ground level ozone can also seriously damage crops and vegetation.
- ❑ Ozone is a powerful greenhouse gas and contributes to global warming both directly and by reducing carbon uptake by vegetation.
- ❑ [https://www.youtube.com/watch?v=jwj7Pw\\_KC4](https://www.youtube.com/watch?v=jwj7Pw_KC4)

# COMBUSTION PROCESSES AND POLLUTANT EMISSION

**Combustion** is a chemical process in which a substance reacts rapidly with oxygen and gives off heat.

For combustion to occur three things must be present: a fuel, oxygen, and heat.

Differs from fire.

Emissions of many air pollutants have been shown to have variety of negative effects on public health and the natural environment.

# Stages of combustion: flaming stages

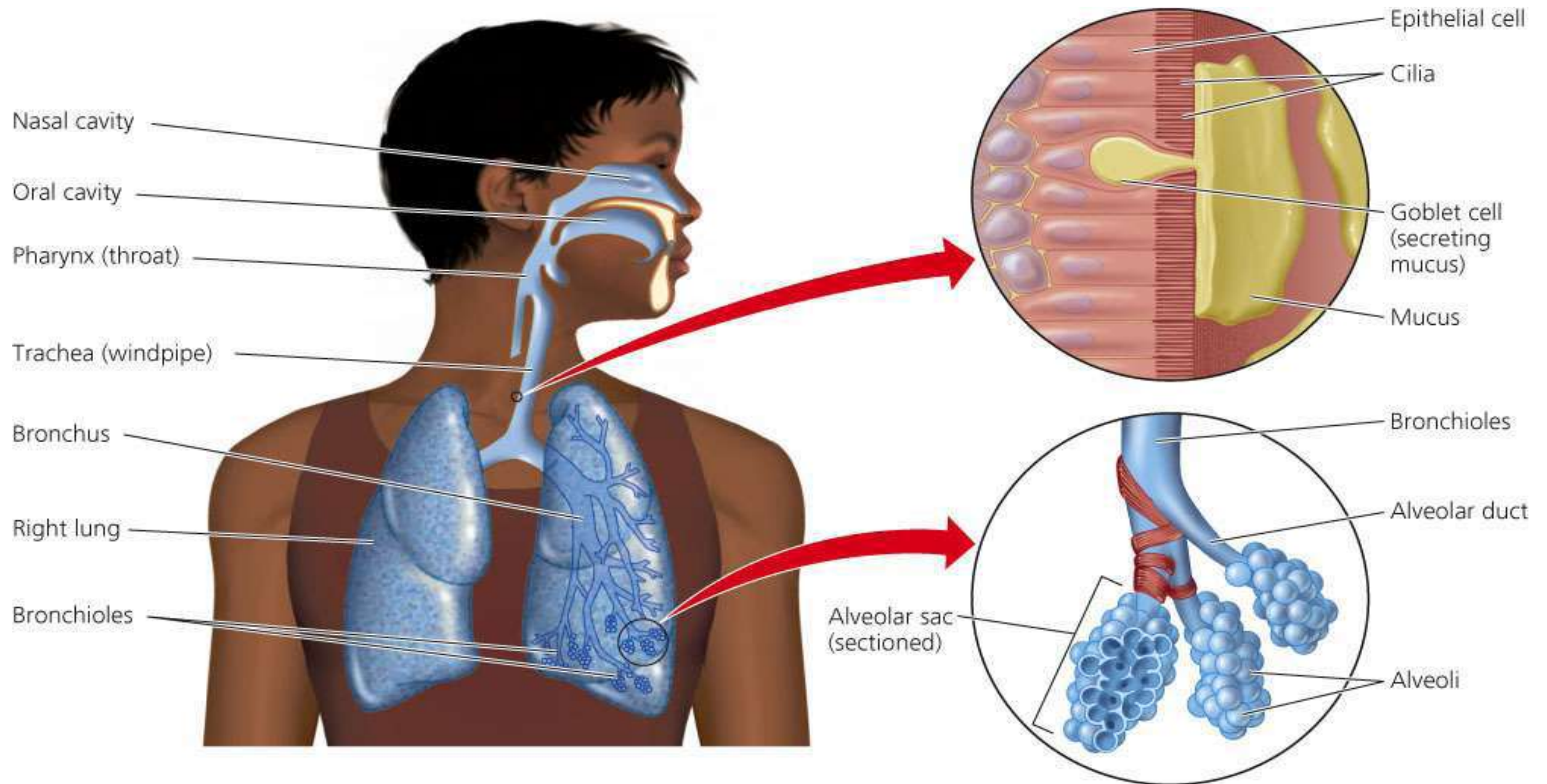
- **Pre-heating** -temperature of the fuel is raised to the point where gases start to volatize
- **Pre-ignition** -volatile materials in the fuel are vaporized
- **Flaming** -the ignition temperature of the fuel is reached and combustion begins
- **Transition** -fuel is partially consumed by combustion while flaming continues in portions of the fuel resulting in initiation of smoldering and smoke generation
- **Smoldering** -combustion of the fuel is essentially complete where oxygen is available and smoldering continues resulting in smoke generation
- **Glowing** a stage of combustion where oxygen is limited.

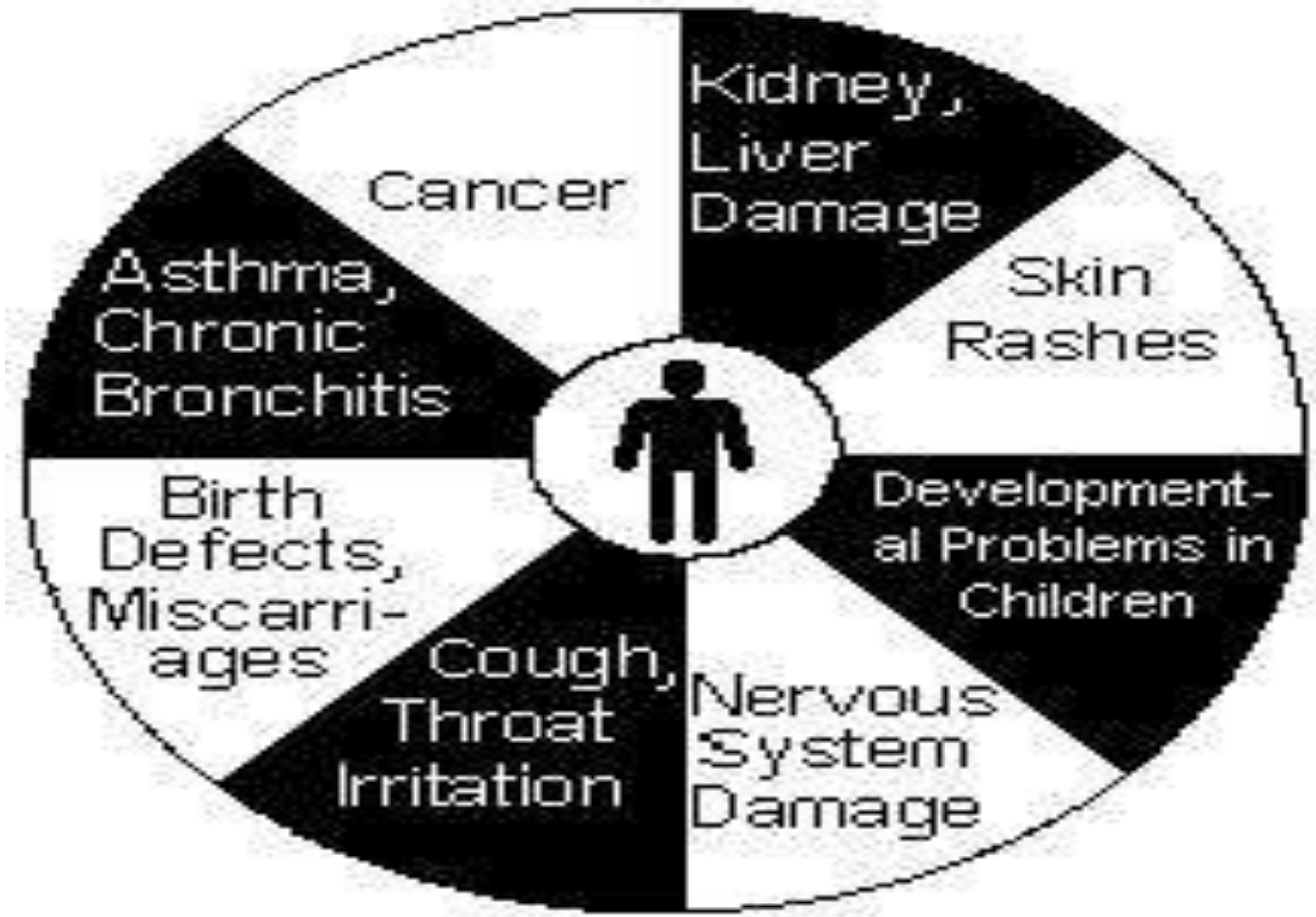
# EFFECTS OF AIR POLLUTION ON HEALTH

- Premature death
- Aggravated asthma
- Acute respiratory symptoms
- Chronic bronchitis
- Decreased lung function (shortness of breath)
- People with existing heart and lung disease, as well as the elderly and children, are particularly at risk



# EFFECT OF AIR POLLUTION ON HUMAN



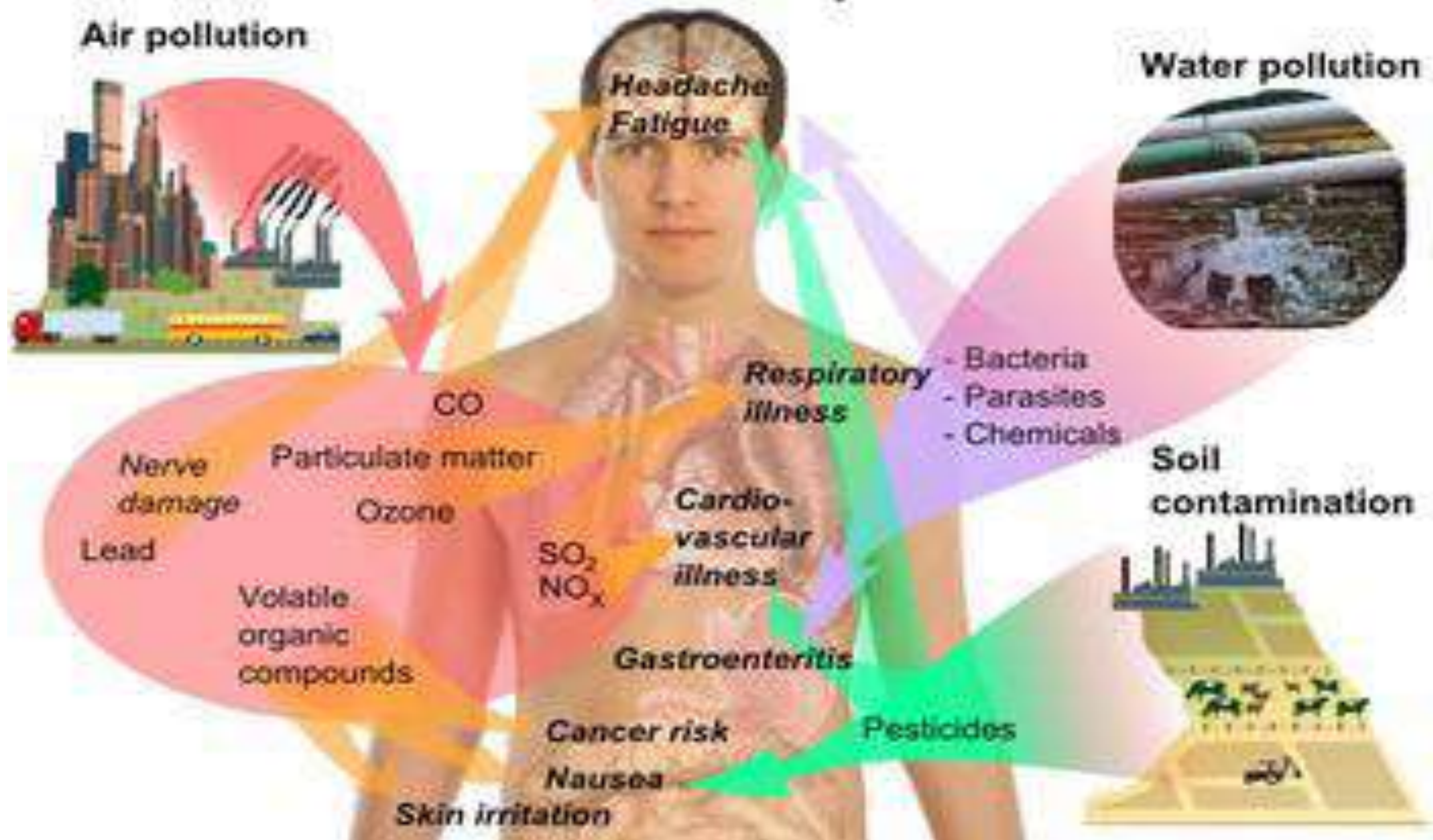




- ❑ Around 30-40% of cases of asthma and 20-30% of all respiratory disease.
- ❑ Effect our health in many ways with both short term and long term effect.
- ❑ Short term effect are: irritation to nose, eye, throat, bronchitis, headache etc.
- ❑ Long term affect are: lung disease, chronic respiratory problem, damage to heart, brain, eyes etc.
- ❑ Eye irritation due to  $\text{NO}_x$ ,  $\text{O}_3$ , PAN, particulates.
- ❑ Nose and throat due to  $\text{SO}_2$ ,  $\text{NO}_x$  etc.
- ❑ Gaseous pollutants like  $\text{H}_2\text{S}$ ,  $\text{SO}_2$ ,  $\text{NO}_2$  and hydrocarbons cause odor nuisance.
- ❑ Irritation of respiration tract caused by  $\text{SO}_x$ ,  $\text{NO}_x$ ,  $\text{CO}$ ,  $\text{O}_3$ .
- ❑ Increase in mortality.
- ❑ High conc. of  $\text{SO}_2$ ,  $\text{NO}_2$  and SPM causes bronchitis and asthma.
- ❑  $\text{CO}$  and  $\text{NO}$  react with hemoglobin and reduce  $\text{O}_2$  carrying capacity of blood.
- ❑ <https://www.youtube.com/watch?v=yo4Ibtf6AqU&feature=youtu.be>



# Health effects of pollution





# EFFECT OF AIR POLLUTON ON PLANTS

- ❑ Decrease yield in agriculture.
- ❑ Suppressed growth of vegetables.
- ❑ Leaf injury and damage to young plants.
- ❑ Decreased growth rate and increased death rate.
- ❑ Cause a widespread damage to natural vegetation and economic crops
- ❑ Many species are susceptible to damage even at low concentrations
- ❑ Gaseous pollutants are actively metabolized by some plants and these plants are employed as indicators of air pollutants

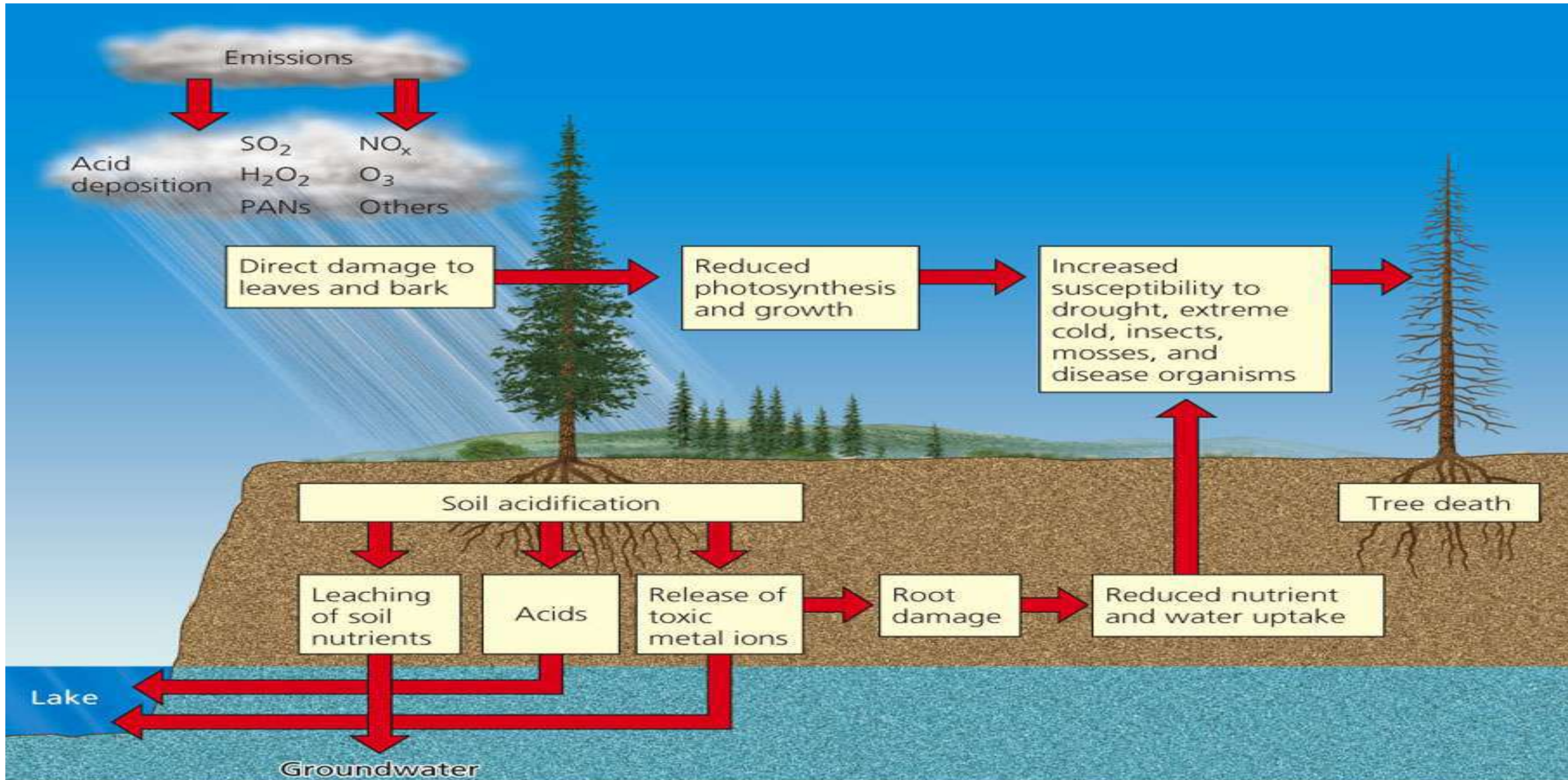




# TREES DAMAGED BY SULPHUR EMISSIONS







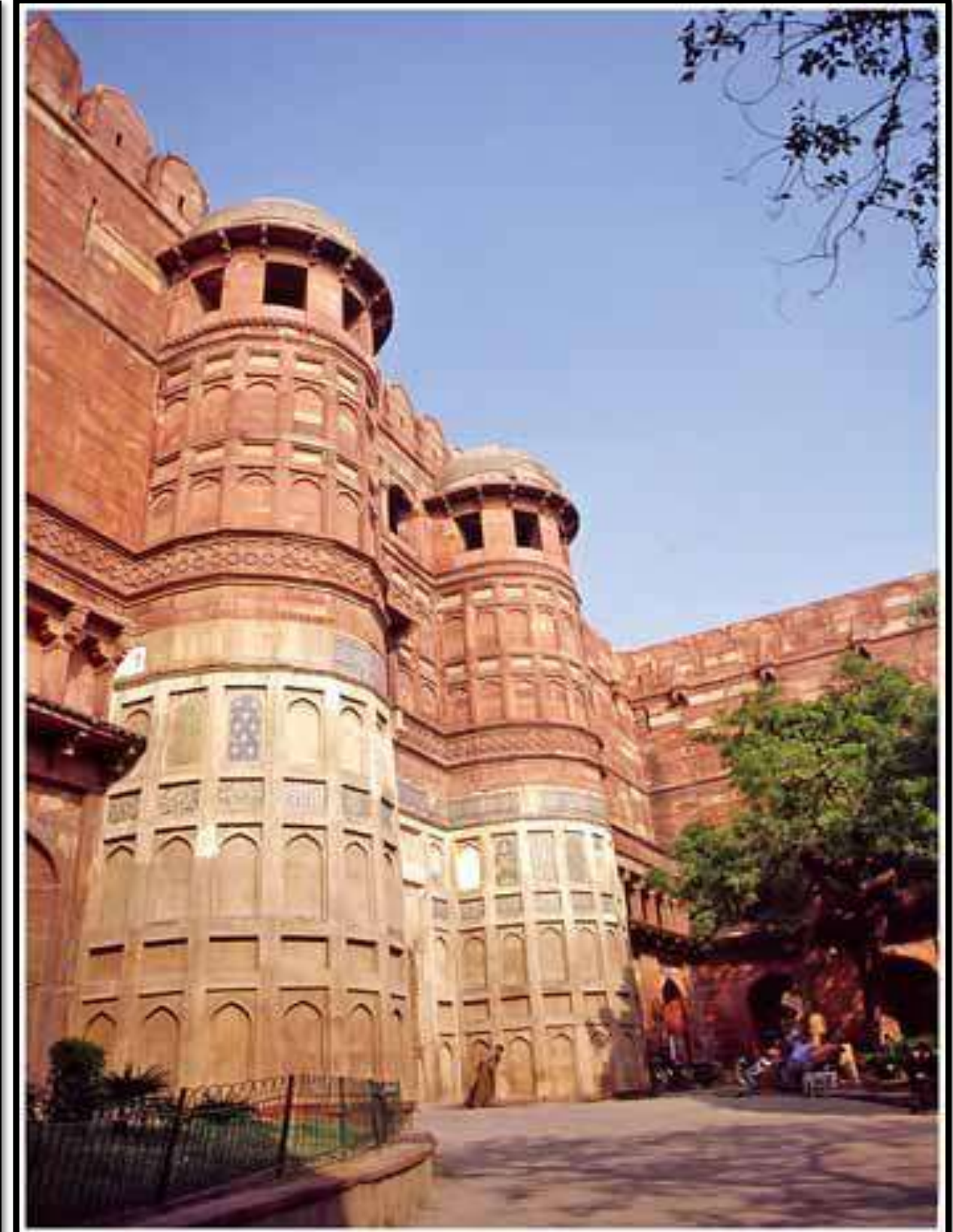
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# EFFECTS OF AIR POLLUTION ON MATERIALS

- ❑ Corrosion of metals due to  $\text{SO}_2$  in presence of oxygen and moisture is converted into  $\text{H}_2\text{SO}_4$  acid.
- ❑  $\text{H}_2\text{SO}_4$  acid react with limestone, marble and other building materials to cause deterioration.
- ❑ Soiling and eroding of building materials.
- ❑  $\text{SO}_2$ ,  $\text{O}_3$ ,  $\text{H}_2\text{S}$  and aerosols damage protective coating and paints of the surface.
- ❑  $\text{O}_3$  and PAN causes cracking of rubber and various electrical insulations.
- ❑ Deterioration of art work due to SPM.







# Effect on Environment due air pollution

- Global warming
- Climate change
- Acid rain formation
- Ozone depletion
- Photochemical Smog
- Aerosol formation

# Harmful effect of pollutants in air

**Table 1.** Harmful effects of the pollutants in air

S.No	Pollutant	Source/Cause	Effect
1.	Carbon monoxide	Automobile exhaust, photochemical reactions in the atmosphere, biological oxidation by marine organisms, etc.	Affects the respiratory activity as haemoglobin has more affinity for Co than for oxygen. Thus, CO combines with HB and thus reduces the oxygen-carrying capacity of blood. This results in blurred vision, headache, unconsciousness & death due to asphyxiation (lack of oxygen).
2.	Carbon dioxide	Carbon Burning of fossil fuels, depletion of forests (that remove excess carbon dioxide and help in maintaining the oxygen-carbon dioxide ratio).	Global warming as it is one of the greenhouse gases.
3.	Sulphur dioxide	Industries, burning of fossil fuels, forest fires, electric generation plants, smelting plants, industrial boilers, petroleum refineries and volcanic eruptions.	Respiratory problems, severe headache, reduced productivity of plants, yellowing and reduced storage time for paper, yellowing and damage to limestone and marble, damage to leather, increased rate of corrosion of iron, steel, zinc and aluminium.
4.	Hydrocarbons	Automobile exhaust and industries, leaking fuel tanks, leaching from toxic waste dumping sites and coal tar lining of some water supply pipes.	Carcinogenic (may cause leukemia)
5.	Polynuclear Aromatic Compounds (PAC) & Polynuclear Aromatic Hydrocarbons (PAH)	Refrigerators, air conditioners, foam shaving cream, spray cans and cleaning solvents.	
6.	Chlorofluoro carbons (CFCs)	Automobile exhausts, burning of fossil fuels, forest fires, electric generation plants, smelting plants, industrial boilers, petroleum refineries and volcanic eruptions	Destroy ozone layer which then permits harmful UV rays to enter the atmosphere. Forms photochemical smog, at higher concentrations causes leaf damage or affects the photosynthetic activities of plants and causes respiratory problems in mammals.
7.	Nitrogen Oxides	Automobile exhausts, burning of fossil fuels, forest fires, electric generation plants, smelting plants, industrial boilers, petroleum refineries and volcanic eruptions	Irritation of eye, throat and respiratory tract, damage to clothes, paint and rubber articles, damage to leaves and stomatal tissue in plants.
8.	PAN - peroxyacetyl nitrate	Photochemical reactions of hydrocarbons and nitrogen oxides.	Toxic effect in man.
9.	Particulate matter	Combustion of leaded gasoline products	
10.	Lead halides (lead pollution)	Mining activities	Asbestosis - a cancerous disease of the lungs
11.	Asbestos particles	Stone cutting, pottery, glass manufacturing and cement industries.	Silicosis, a cancerous disease.
12.	Silicon dioxide	Flowers	Allergy
13.	Biological matter like the pollen grains	Microbes	Infectious diseases
14.	Fungal spores, bacteria, virus, etc		



# SMOKE

**Smoke** is a collection of airborne particulates and gases emitted when a material undergoes combustion or pyrolysis

- Smoke is a collection of tiny solid, liquid and gas particles. Although smoke can contain hundreds of different chemicals and fumes, visible smoke is mostly carbon (soot), tar, oils and ash.
- Smoke occurs when there is incomplete combustion (not enough oxygen to burn the fuel completely)
- Unwanted by-product of fires.
- Smoke inhalation is the primary cause of death in victims of indoor fires.

# SMOG.

- ❑ Smog is another common secondary pollutant.
- ❑ Smog definition: Smog is a mixture of fog and smoke which occurs in some busy industrial cities.
- ❑ Smog which occurs mainly because of air pollution, can also be defined as a mixture of various gases with dust and water vapor.
- ❑ Smog also refers to hazy air that makes breathing difficult.



<https://images.app.goo.gl/spLGuHVd4SSuYDZM8>





Sunlight

Brown  
photochemical  
smog

Nitrogen oxides and volatile  
organic compounds



What is all  
www.what-is-all.com

# GREENHOUSE GASES

Gases that trap heat like a blanket surrounding the Earth.

□ A normal concentration of these gases keep our planet at a steady temperature, but the temperature can rise if we have too many in the atmosphere.

□ Greenhouse gases:

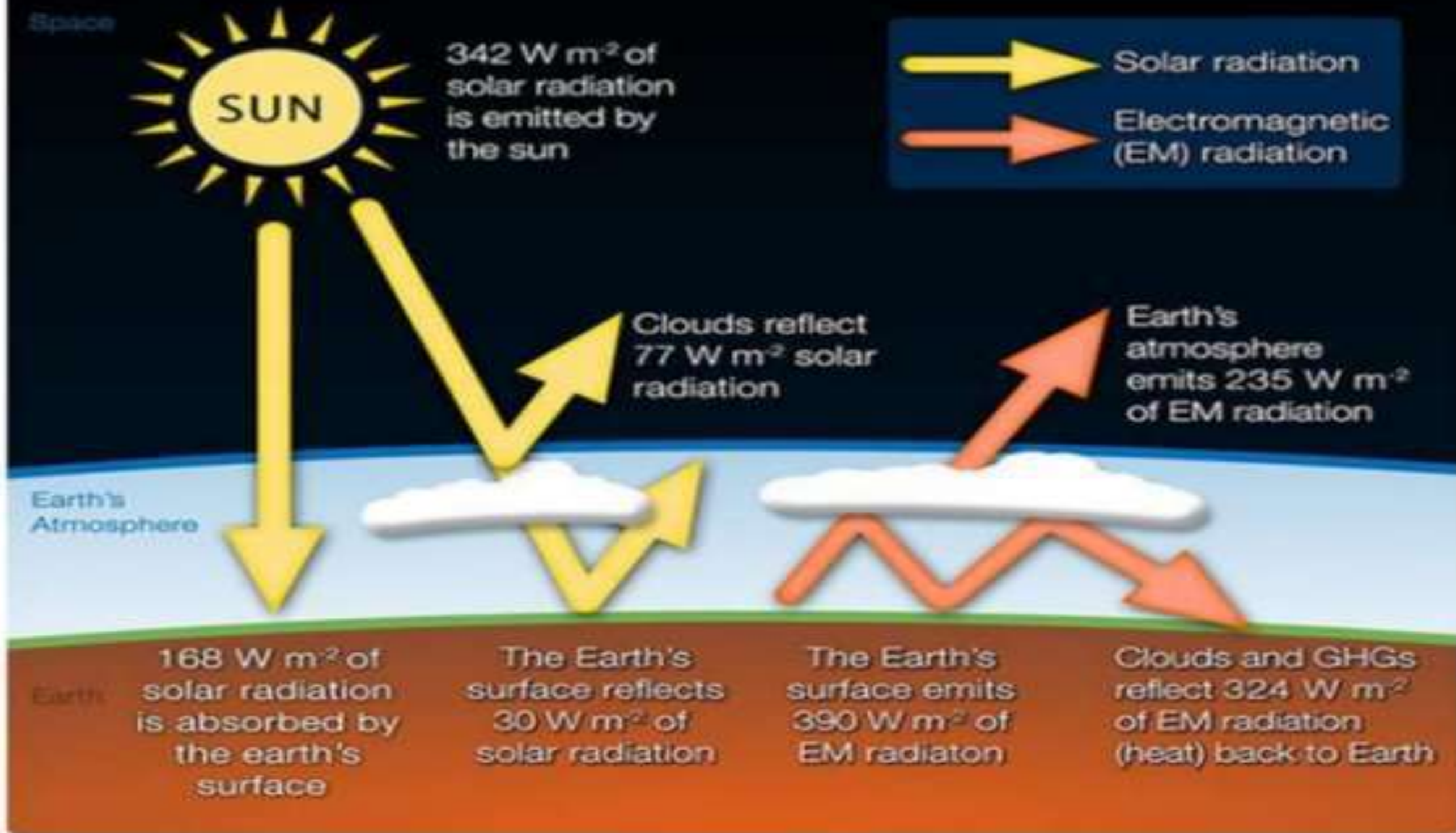
– Carbon dioxide (CO<sub>2</sub>): normal combustion

– Methane: coal production, landfills, livestock

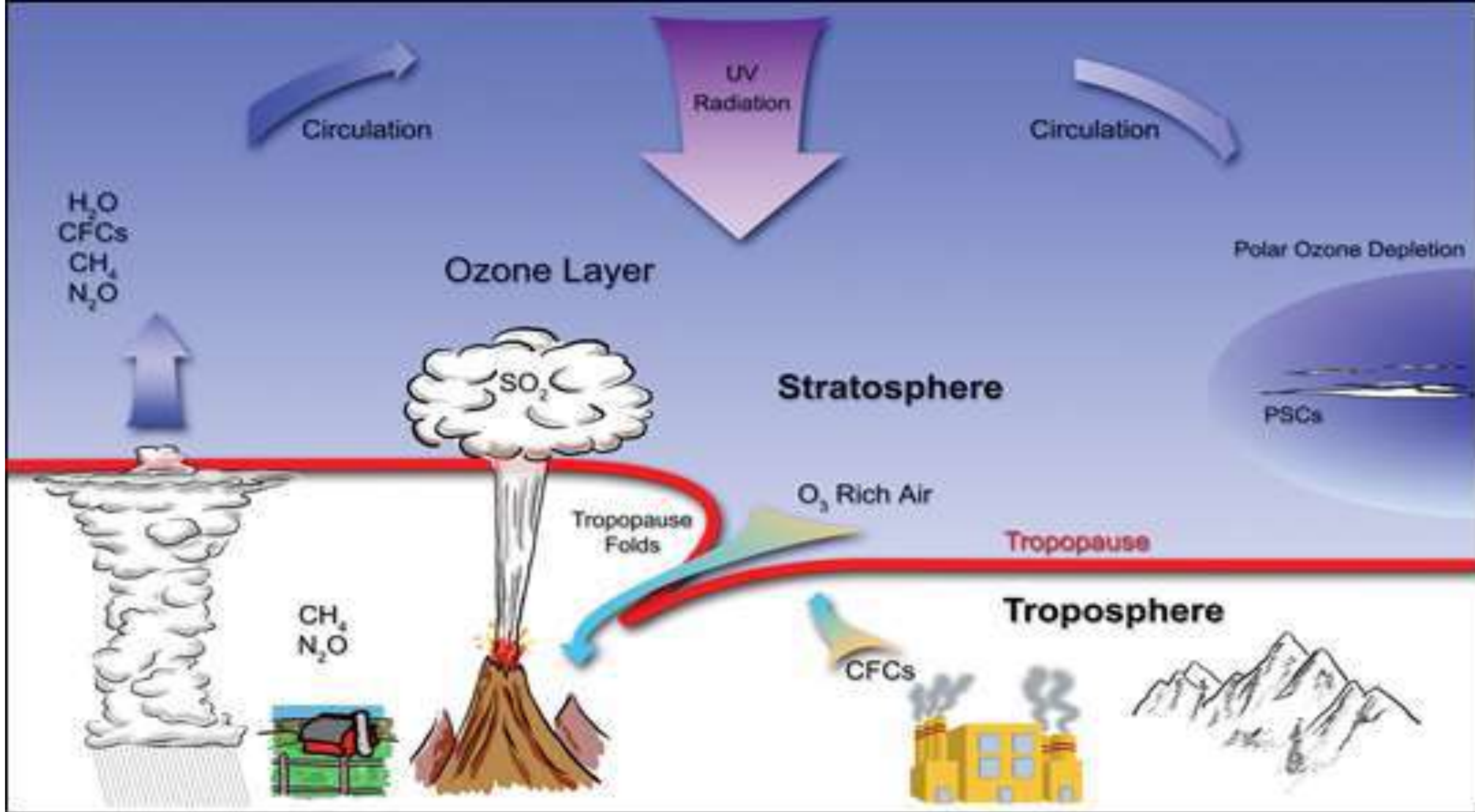
– Water Vapors: airplanes and from surface water that evaporates as the Earth becomes warmer!



# The Greenhouse Effect







## SELECTED GREENHOUSE GASES

### **Carbon Dioxide (CO<sub>2</sub>)**

Source: Fossil fuel burning, deforestation

Anthropogenic increase: **30%**

Average atmospheric residence time: **500 years**

### **Methane (CH<sub>4</sub>)**

Source: Rice cultivation, cattle & sheep ranching, decay from landfills, mining

Anthropogenic increase: **145%**

Average atmospheric residence time: **7-10 years**

### **Nitrous oxide (N<sub>2</sub>O)**

Source: Industry and agriculture (fertilizers)

Anthropogenic increase: **15%**

Average atmospheric residence time: **140-190 years**

# OZONE LAYER DEPLETION

- ❑ Ozone is made of three oxygen atoms
- ❑ The oxygen we find in our atmosphere is made up of two oxygen atoms
- ❑ Because of its chemical formulation, a single atom of oxygen (O) is unstable.
- ❑ *Ozone exists in earth's stratosphere and is responsible for protecting humans from harmful ultraviolet (UV) rays. Earth's ozone layer is depleting due to the presence of chlorofluorocarbons, hydro chlorofluorocarbons in the atmosphere. As ozone layer will go thin, it will emit harmful rays back on earth and can cause skin and eye related problems. UV rays also have the capability to affect crops.*

Atomic  
oxygen



Diatomic  
oxygen



Ozone



The COMET Program

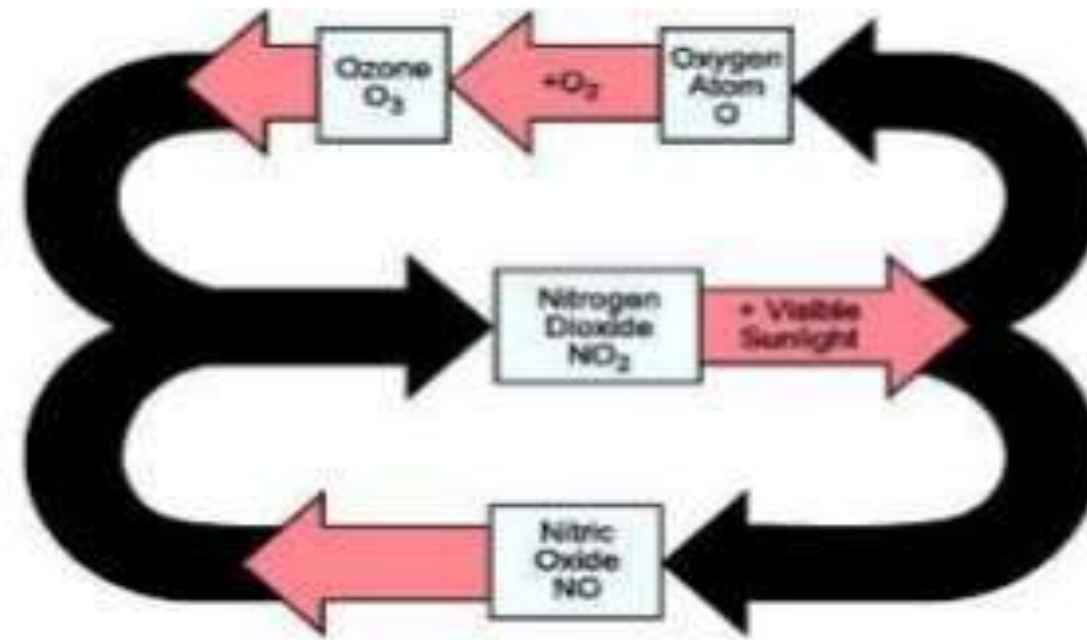


# Ground Level Ozone Formation



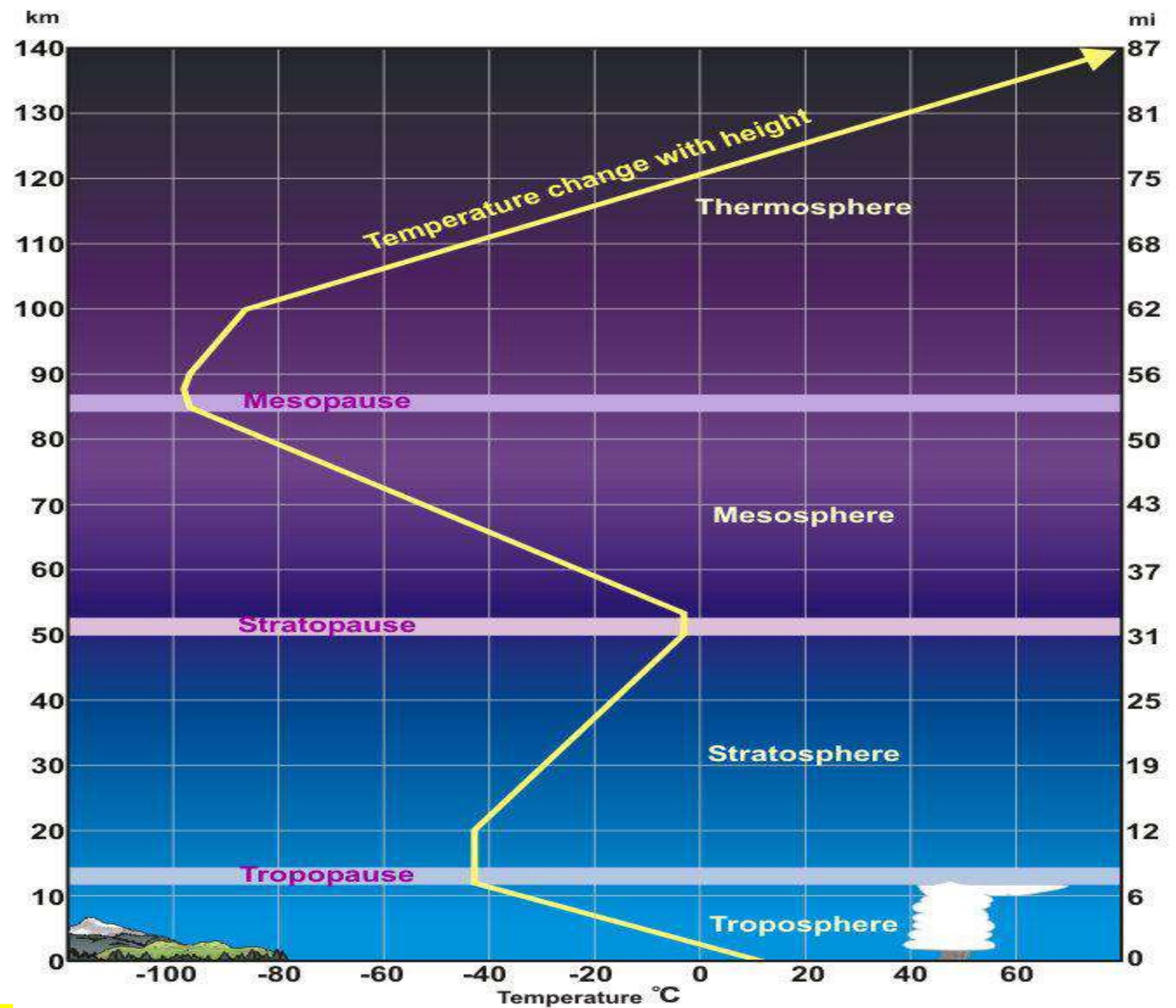
Pollutants "bake" together in direct sunlight forming ozone.





Ozone production from NO<sub>x</sub> pollutants:  
Oxygen atoms freed from nitrogen dioxide by the action of sunlight attack oxygen molecules to make ozone. Nitrogen oxide can combine with ozone to reform nitrogen dioxide, and the cycle repeats

# POSITION OF OZONE LAYER



# STRATOSPHERIC AND TROPOSPHERE OZONE

- ❑ In the troposphere, ground level ozone is a major air pollutant and primary constituent of photochemical smog.
- ❑ In the stratosphere, the ozone layer is an essential protector of life on earth as it absorbs harmful UV radiation before it reaches the earth

Ozone: Good up high -Bad nearby

STRATOSPHERIC OZONE

GROUND-LEVEL OZONE  
 $\text{NO}_x + \text{VOC} + \text{SUN LIGHT} = \text{OZONE}$

Industrial Sources

Mobile Sources

Area Sources

Biogenic Sources

Air pollution = Ground-level ozone + CO (Carbon monoxide) +  $\text{SO}_x$  (Sulphur oxides) + PM (Particulate Matter) +  $\text{NO}_x$  (Nitrogen oxides) + VOC (Volatile Organic Compounds)

## How is Stratospheric ozone formed?

□ Ozone is formed naturally in the upper stratosphere by short wavelength ultraviolet radiation.

□ Wavelengths less than ~240 nanometers are absorbed by oxygen molecules (O<sub>2</sub>), which dissociate to give O atoms.

□ The O atoms combine with other oxygen molecules to make ozone:

□  $O_2 + h\nu \text{ (light)} \rightarrow O + O \text{ (wavelength} < 240 \text{ nm)}$

□  $O + O_2 \rightarrow O_3$

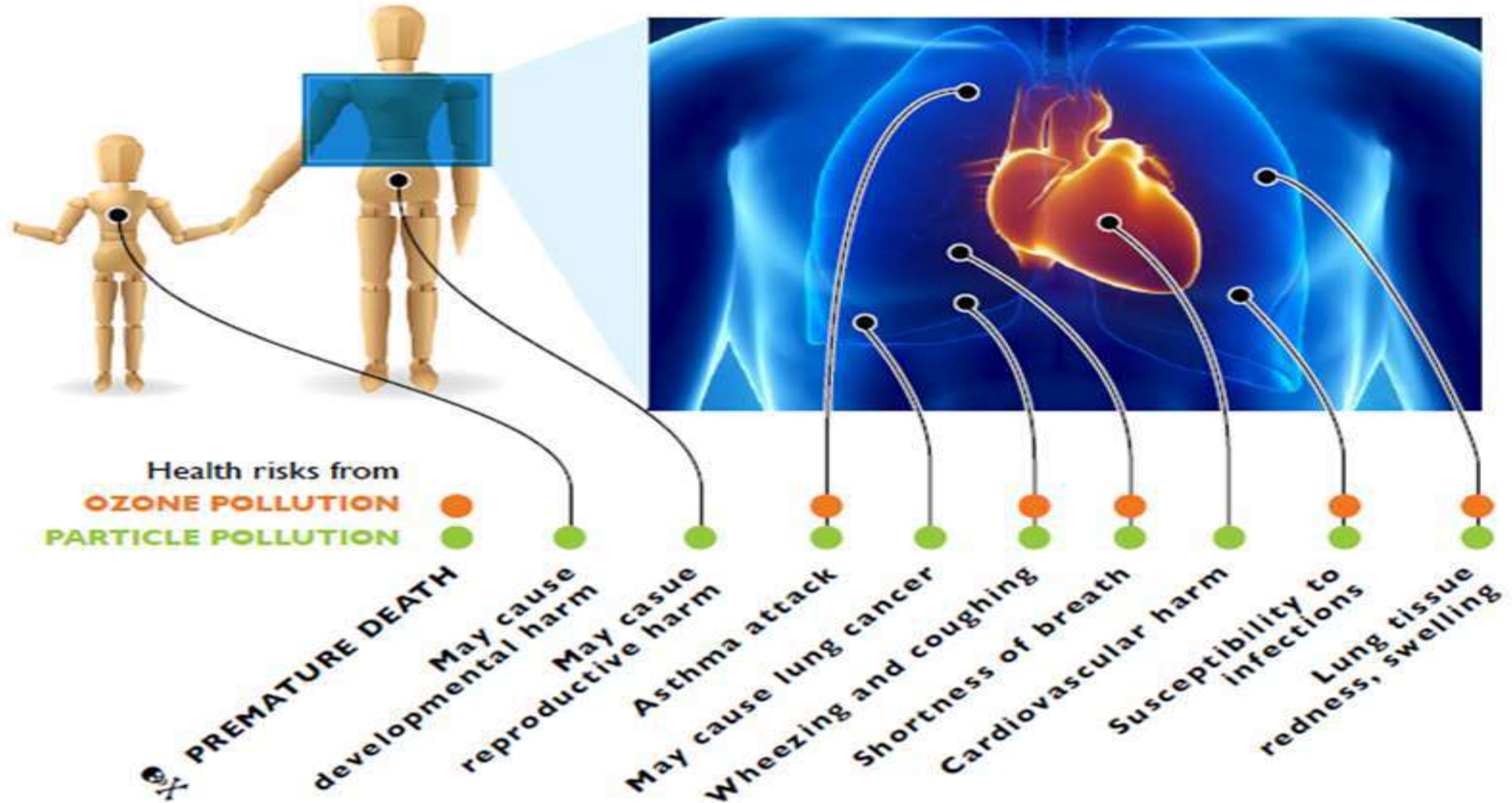


## **Global Warming Can Increase Ozone Depletion**

- ❑ Continued global warming will accelerate ozone destruction and increase stratospheric ozone depletion.
- ❑ Ozone depletion gets worse when the stratosphere (where the ozone layer is), becomes colder.
- ❑ Because global warming traps heat in the troposphere, less heat reaches the stratosphere which will make it colder.
- ❑ Greenhouse gases act like a blanket for the troposphere and make the stratosphere colder.
- ❑ In other words, global warming can make ozone depletion much worse right when it is supposed to begin its recovery during the next century.

# EFFECT OF GROUND LEVEL OZONE

**Air pollution remains a major danger to the health of children and adults.**



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*Thank  
you!*

**STAY HOME, STAY SAFE**