

*Environmental Chemistry  
&  
Green Chemistry*

By

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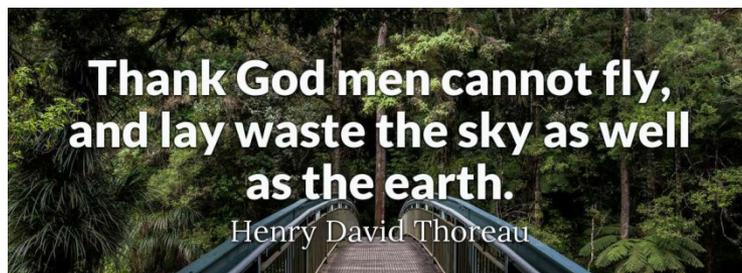


**The Earth does not belong to  
us: we belong to the Earth.**

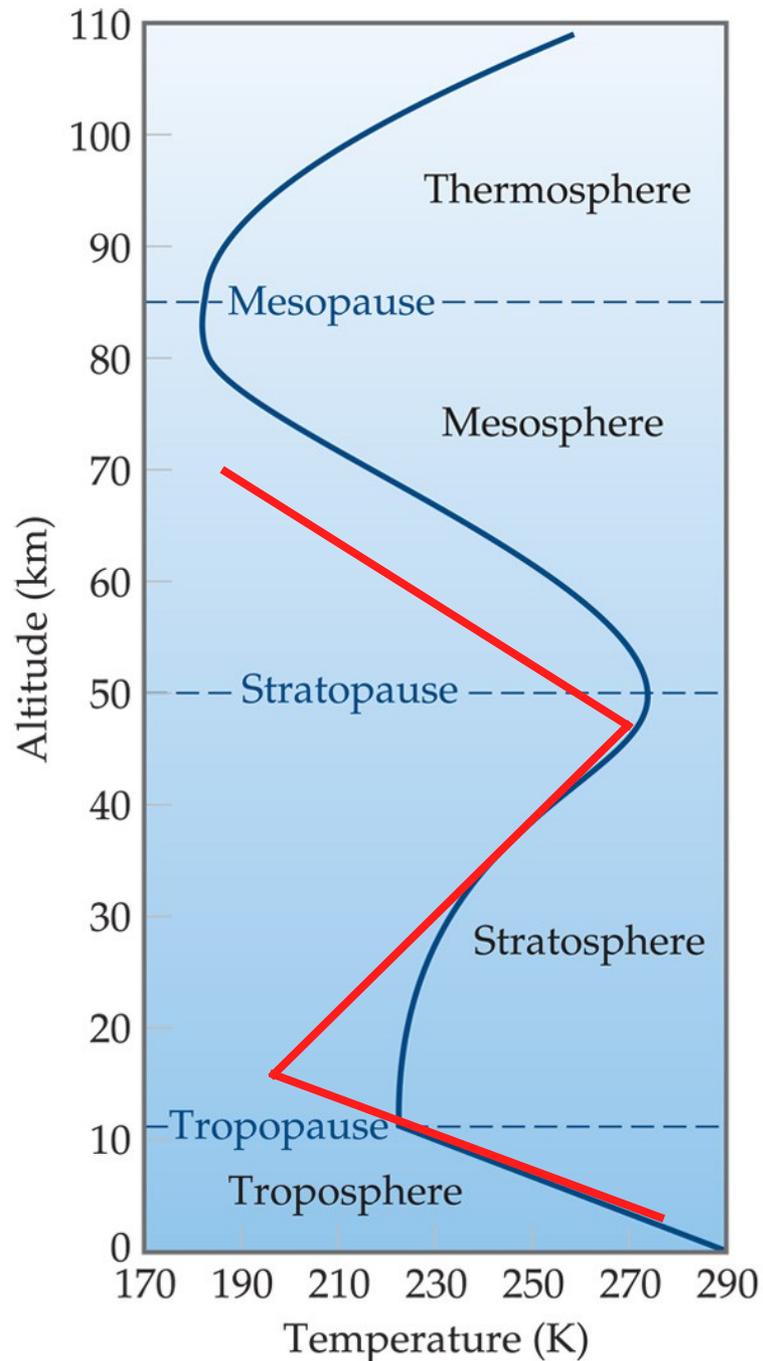
Marlee Matlin

# Environmental chemistry

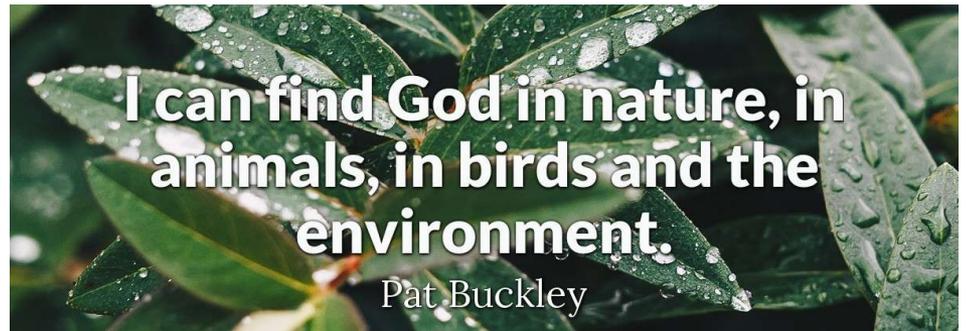
- Scientific study of the chemical and biochemical phenomena that occur in natural places.
- It should not be confused with green chemistry, which seeks to reduce potential pollution at its source.
- Study of the sources, reactions, transport, effects, and fates of chemical species in the air, soil, and water environments; and the effect of human activity and biological activity on these.
- Environmental chemistry is an interdisciplinary science that includes atmospheric, aquatic and soil chemistry, as well as heavily relying on analytical chemistry and being related to environmental and other areas of science.



# Atmosphere



- Temperature varies greatly with altitude.
- The profile makes a Z-shape from mesosphere to the ground
- Pressure is highest at the surface and decreases with height.
- Fluctuations in pressure are a driving force of weather.



# Composition of the Atmosphere

TABLE 18.1 Composition of Dry Air Near Sea Level

Component*	Content (mole fraction)	Molar Mass
Nitrogen	0.78084	28.013
Oxygen	0.20948	31.998
Argon	0.00934	39.948
Carbon dioxide	0.000375	44.0099
Neon	0.00001818	20.183
Helium	0.00000524	4.003
Methane	0.000002	16.043
Krypton	0.00000114	83.80
Hydrogen	0.0000005	2.0159
Nitrous oxide	0.0000005	44.0128
Xenon	0.000000087	131.30

\*Ozone, sulfur dioxide, nitrogen dioxide, ammonia, and carbon monoxide are present as trace gases in variable amounts.

- The composition of gases in the atmosphere is not uniform.
- Lighter gases tend to rise to the top.
- Gases are measured in ppm *volume* ( $\mu\text{L/L}$ )



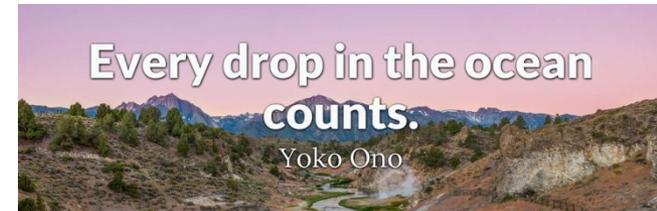
# Environmental Pollution

- Environmental pollution is the effect of undesirable changes in our surroundings that have harmful effects on plants, animals and human beings.
- A substance, which causes pollution, is known as pollutant.
- Pollutants can be solid, liquid or gaseous substances present in greater concentration than in natural abundance and are produced due to human activities or due to natural happenings.
- Pollutants can be degradable, like discarded vegetables which rapidly break down by natural processes.
- On the other hand, pollutants which are slowly degradable, remain in the environment in an unchanged form for many decades like DDT, plastic materials, heavy metals, many chemicals, nuclear wastes etc
- These cannot be degraded by natural processes and harmful to living organisms

**The environment is  
everything that isn't me.**

Albert Einstein

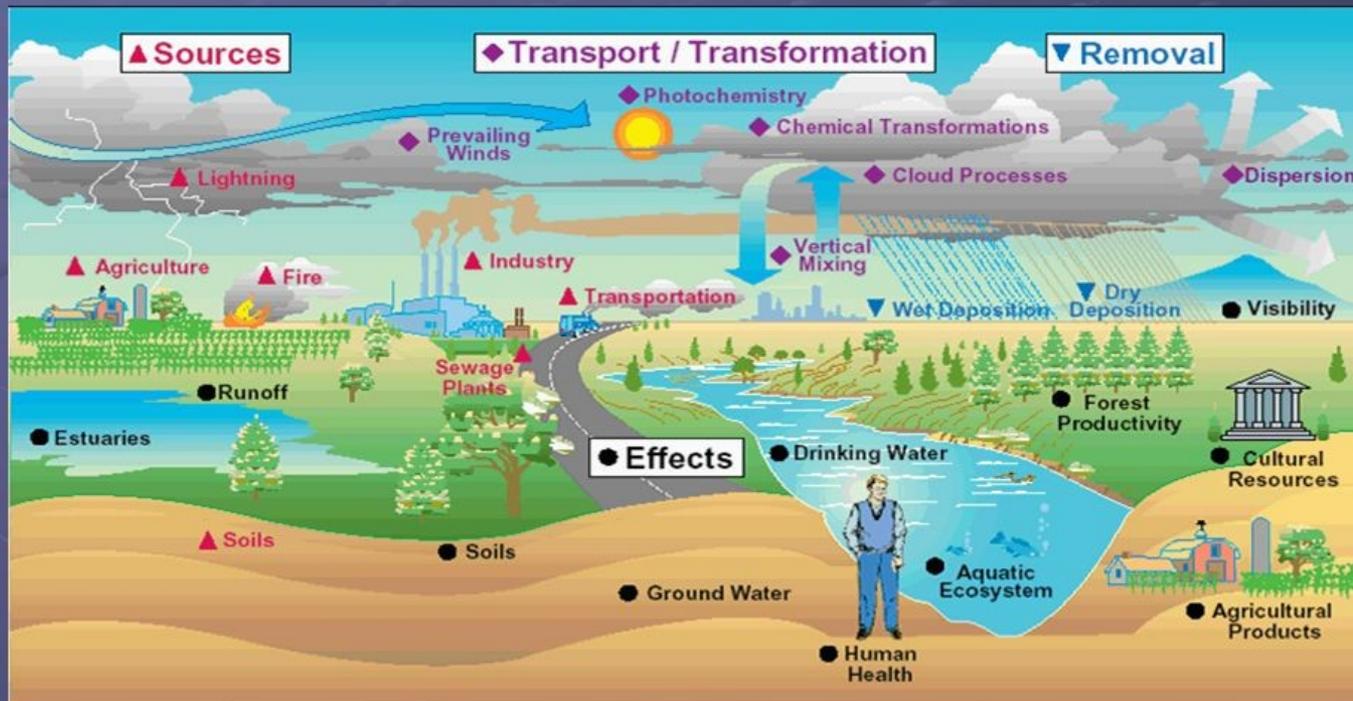




# Environmental Pollution

➤ In the process of environmental pollution, pollutants originate from a source and get transported by air or water or are dumped into the soil by human beings.

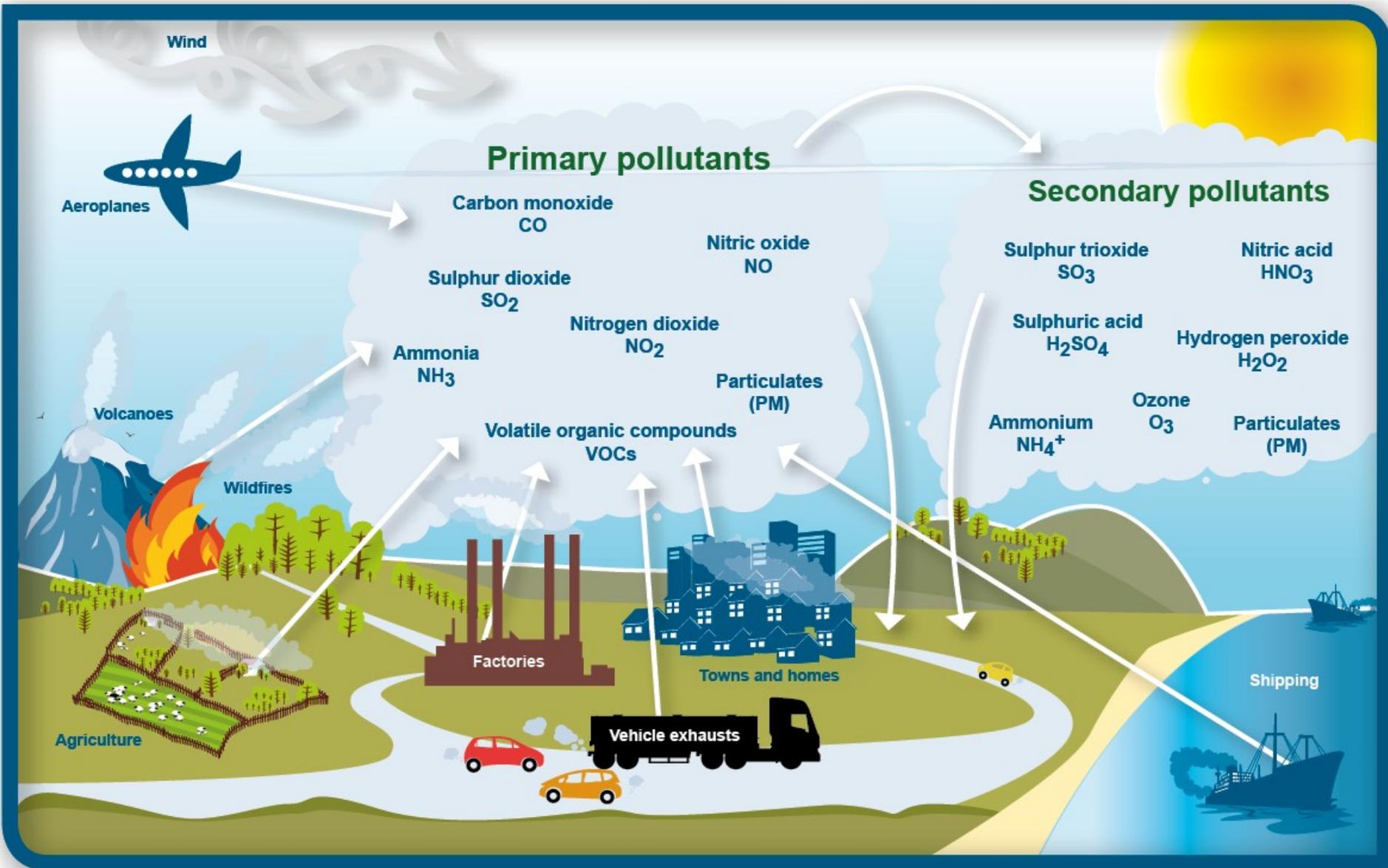
# Environmental Pollution



# ATMOSPHERIC POLLUTION

- The lowest region of atmosphere in which the human beings along with other organisms live is called troposphere.
- It extends up to the height of ~ 10 km from sea level.
- Above the troposphere, between 10 and 50 km above sea level lies stratosphere.
- Troposphere is a turbulent, dusty zone containing air, much water vapour and clouds.
- This is the region of strong air movement and cloud formation.
- The stratosphere, on the other hand, contains dinitrogen, dioxygen, ozone and little water vapour.

**Water and air, the two essential fluids on which all life depends, have become global garbage cans.**



**We may achieve climate, but weather is thrust upon us.**

## **Oxides of Sulphur:**

- Oxides of sulphur are produced when sulphur containing fossil fuel is burnt.
- Most common species, sulphur dioxide, is a gas that is poisonous to both animals and plants.
- It has been reported that even a low concentration of sulphur dioxide causes respiratory diseases e.g., asthma, bronchitis, emphysema in human beings.
- Sulphur dioxide causes irritation to the eyes, resulting in tears and redness.
- High concentration of  $\text{SO}_2$  leads to stiffness of flower buds which eventually fall off from plants.

## Oxides of Nitrogen:

- At high altitudes when lightning strikes, Nitrogen and oxygen combine to form oxides of nitrogen.
- $\text{NO}_2$  is oxidised to nitrate ion,  $\text{NO}_3^-$  which is washed into soil, where it serves as a fertilizer.
- In an automobile engine, (at high temperature) when fossil fuel is burnt, dinitrogen and dioxygen combine to yield significant quantities of nitric oxide ( $\text{NO}$ ) and nitrogen dioxide ( $\text{NO}_2$ ).
- The irritant red haze in the traffic and congested places is due to oxides of nitrogen.
- Higher concentrations of  $\text{NO}_2$  damage the leaves of plants and retard the rate of photosynthesis.
- Nitrogen dioxide is a lung irritant that can lead to an acute respiratory disease in children. It is toxic to living tissues also. Nitrogen dioxide is also harmful to

## **(c) Hydrocarbons:**

- Hydrocarbons are composed of hydrogen and carbon only and are formed by incomplete combustion of fuel used in automobiles.
- Hydrocarbons are carcinogenic, i.e., they cause cancer.
- They harm plants by causing ageing, breakdown of tissues and shedding of leaves, flowers and twigs.

## **Carbon monoxide:**

- Carbon monoxide (CO) is one of the most serious air pollutants.
- It is a colourless and odourless gas, highly poisonous to living beings because of its ability to block the delivery of oxygen to the organs and tissues.
- It is produced as a result of incomplete combustion of carbon.
- Carbon monoxide is mainly released into the air by automobile exhaust.
- Other sources, which produce CO, involve incomplete combustion of coal, firewood, petrol, etc.
- Do you know why carbon monoxide is poisonous? It binds to haemoglobin to form carboxyhaemoglobin

## **Carbon dioxide:**

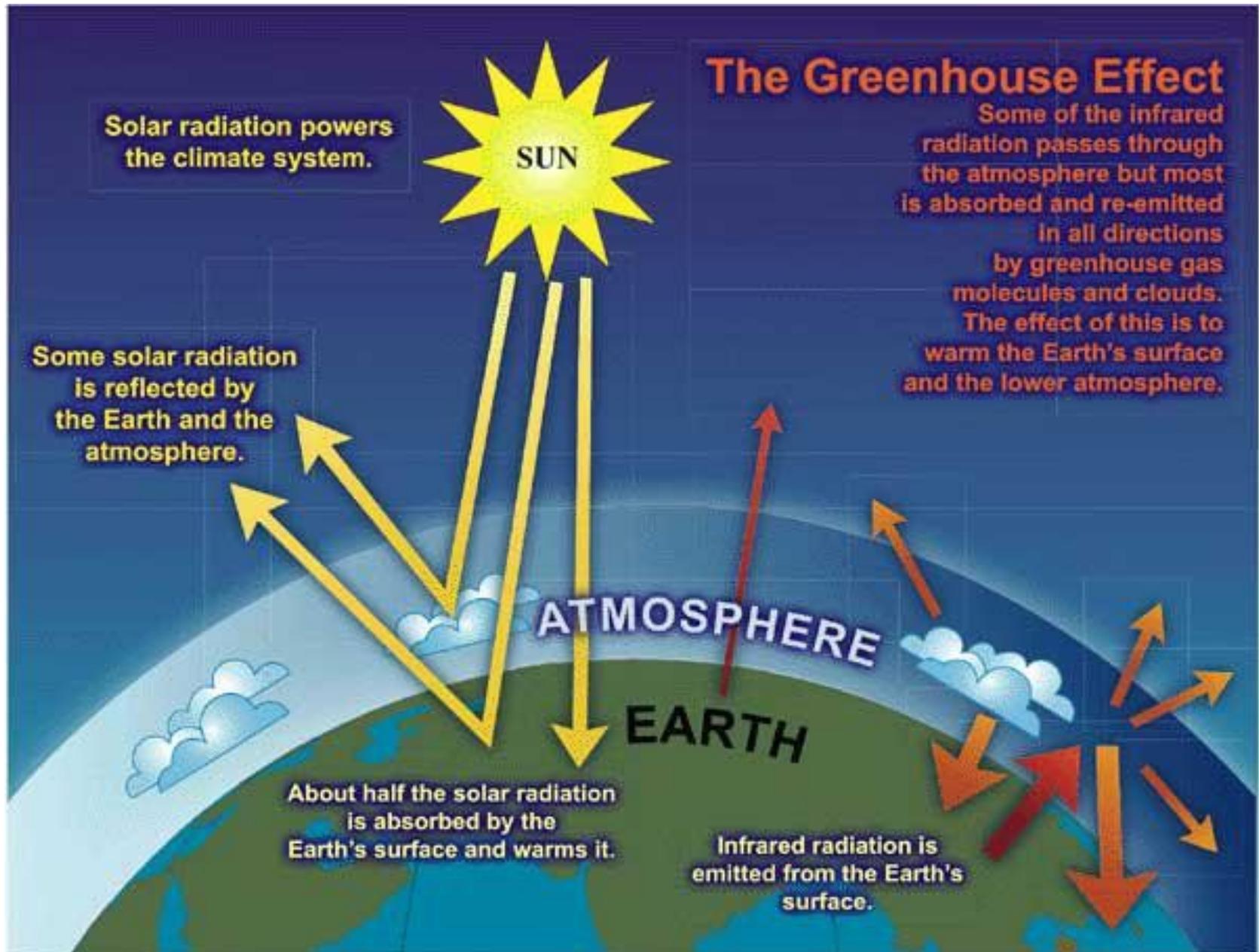
- Carbon dioxide (CO<sub>2</sub>) is released into the atmosphere by respiration, burning of fossil fuels for energy, and by decomposition of limestone during the manufacture of cement.
- It is also emitted during volcanic eruptions.
- Carbon dioxide gas is confined to troposphere only.
- Excess of CO<sub>2</sub> in the air is removed by green plants and this maintains an appropriate level of CO<sub>2</sub> in the atmosphere.
- Green plants require CO<sub>2</sub> for photosynthesis and they, in turn, emit oxygen, thus maintaining the delicate balance.
- Deforestation and burning of fossil fuel increases the CO<sub>2</sub> level and disturb the balance in the atmosphere.
- The increased amount of CO<sub>2</sub> in the air is mainly responsible for global warming.

# Greenhouse Effect



- The greenhouse effect is the process by which radiation from a planet's atmosphere warms the planet's surface to a temperature above what it would be without its atmosphere.
- If a planet's atmosphere contains radiatively active gases (i.e., greenhouse gases) they will radiate energy in all directions.
- The intensity of the downward radiation – that is, the strength of the greenhouse effect – will depend on the atmosphere's temperature and on the amount of greenhouse gases that the atmosphere contains.
- Earth's natural greenhouse effect is critical to supporting life.
- Human activities, mainly the burning of fossil fuels and clearing of forests, have strengthened the greenhouse effect and caused global warming.
- The term "greenhouse effect" arose from a faulty analogy with the effect of sunlight passing through glass and warming a greenhouse.

# Greenhouse Effect

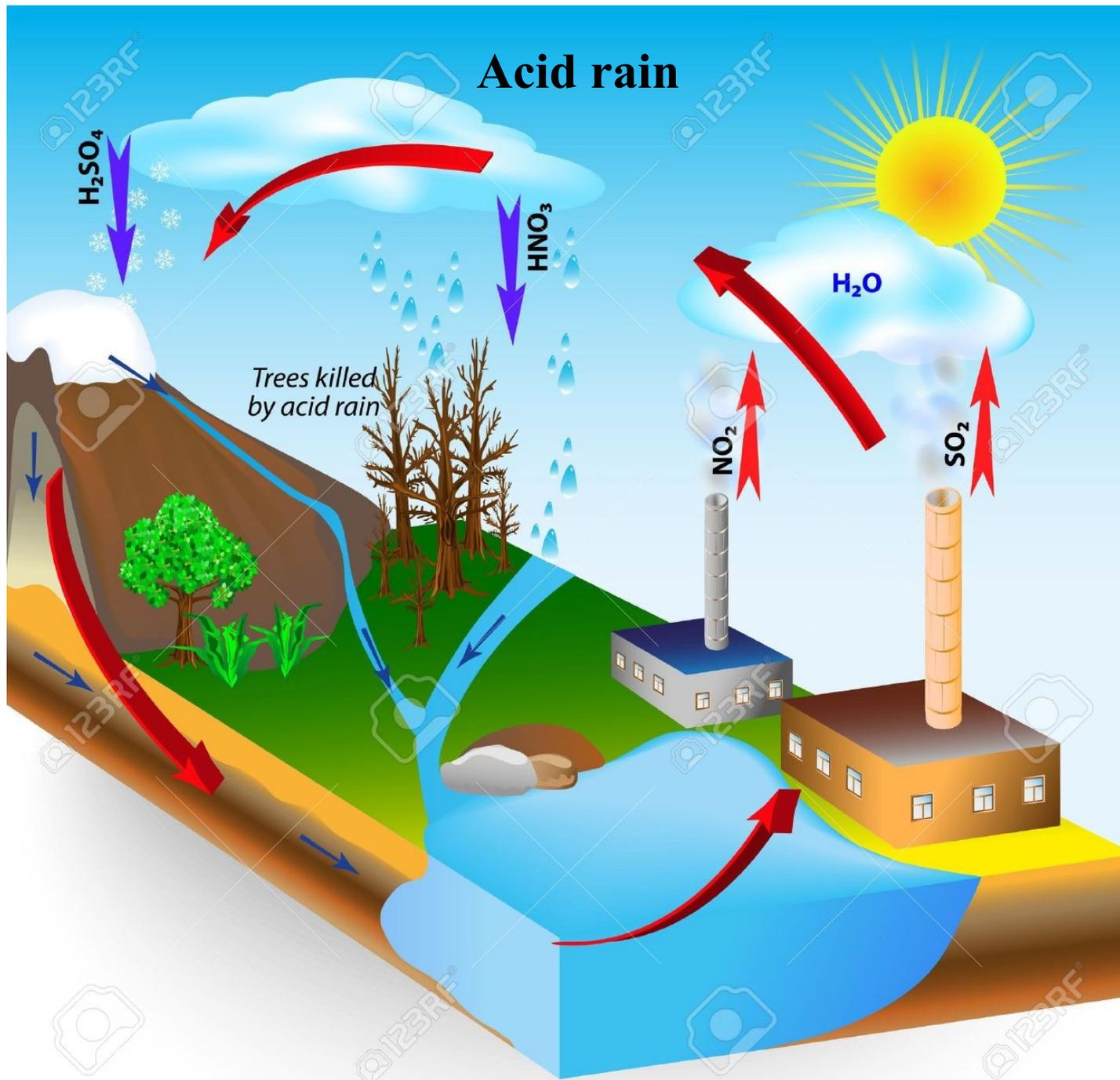


# Acid rain

- Acid rain is a rain or any other form of precipitation that is unusually acidic, meaning that it has elevated levels of hydrogen ions (low pH).
- Harmful effects on plants, aquatic animals and infrastructure.
- Sulphur dioxide and nitrogen oxide react with the water molecules in the atmosphere to produce acids.
- Nitrogen oxides can also be produced naturally by lightning strikes, and sulphur dioxide is produced by volcanic eruptions.
- Adverse impacts on forests, freshwaters and soils, killing insect and aquatic life-forms, causing paint to peel, corrosion of steel structures such as bridges, and weathering of stone buildings and statues as well as having impacts on human health.



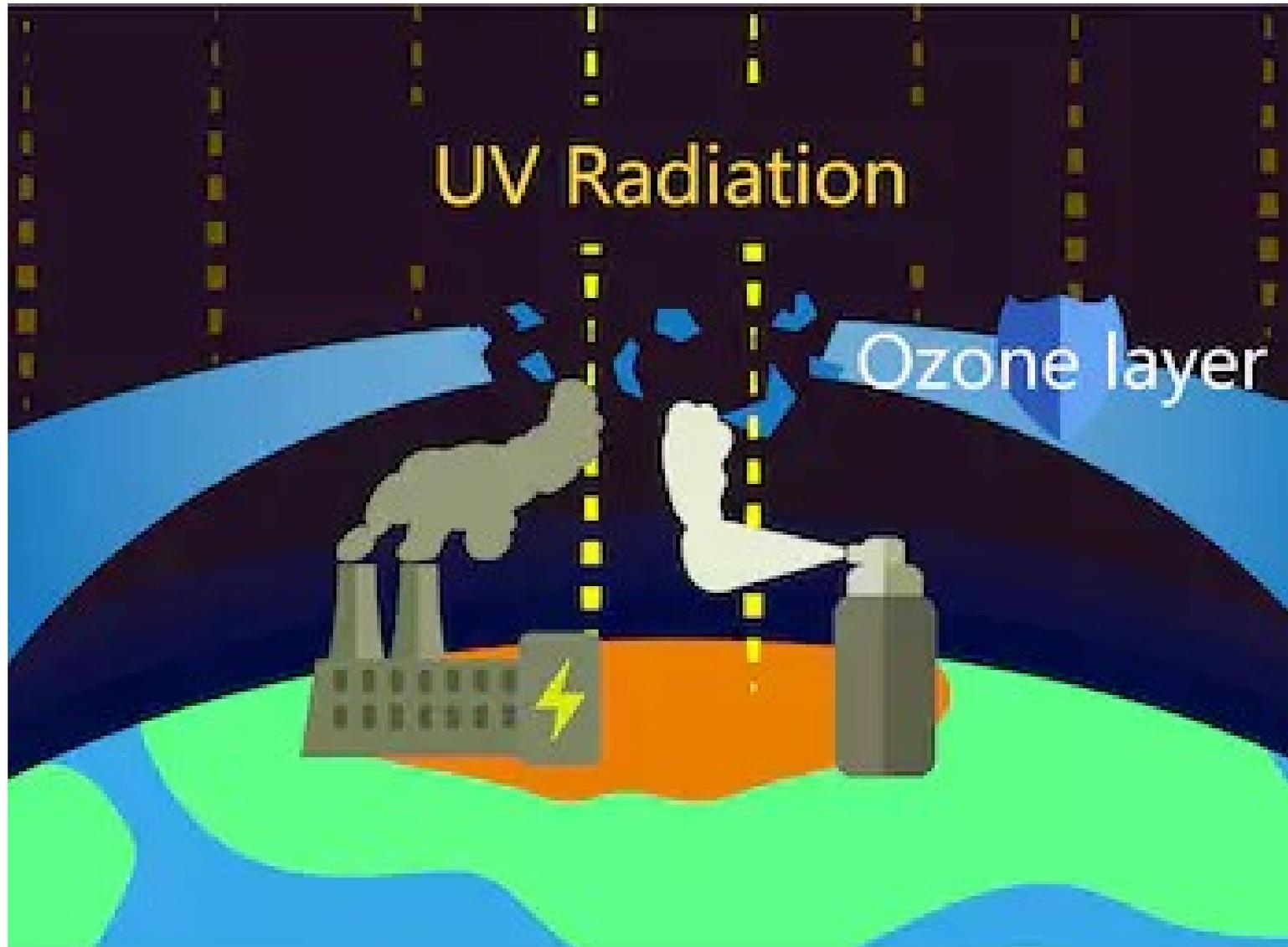
# Acid rain



# Ozone Hole

- Ozone depletion describes two related events observed since the late 1970s: a steady lowering of about four percent in the total amount of ozone in Earth's atmosphere (the ozone layer), and a much larger springtime decrease in stratospheric ozone around Earth's polar regions.
- The latter phenomenon is referred to as the ozone hole.
- The main cause of ozone depletion and the ozone hole is manufactured chemicals, especially manufactured halocarbon refrigerants, solvents, propellants and foam-blowing agents (chlorofluorocarbons (CFCs), HCFCs, halons), referred to as ozone-depleting substances (ODS).
- These compounds are transported into the stratosphere by the winds after being emitted from the surface.
- Once in the stratosphere, they release halogen atoms through photodissociation, which catalyze the breakdown of ozone ( $O_3$ ) into oxygen ( $O_2$ ). Both types of ozone depletion were observed to increase as emissions of halocarbons increased.

# Ozone Hole



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# Green Chemistry

- Green chemistry, also called sustainable chemistry, is an area of chemistry and chemical engineering focused on the designing of products and processes that minimize the use and generation of hazardous substances.
- Whereas environmental chemistry focuses on the effects of polluting chemicals on nature, green chemistry focuses on the environmental impact of chemistry, including technological approaches to preventing pollution and reducing consumption of nonrenewable resources.
- The overarching goals of green chemistry—namely, more resource-efficient and inherently safer design of molecules, materials, products, and processes—can be pursued in a wide range of contexts.





Anastas and Warner (1998)

## **Conclusion**

- Man is noted as the greatest polluter of the environment.
- Devastating activities such as extraction and processing of resources, increase in population that leads to dumping and scatter of garbage, increases industrial activities among others.
- These have resulted in pollution of air, water, soil, and sound.
- These have negatively impacted on environment hence their related impacts include disrupted ecosystem, destruction of aquatic life, disease, global warming and acid rains among others.
- Environmental pollution is has called for action of rehabilitation, protection, and conservation of the environment.

