Atmospheric Chemistry

- **Atmospheric chemistry** is a branch of Atmospheric Science in which Chemistry of the Earth's atmosphere and that of other planets is studied.
- It is a multidisciplinary approach of research and draws on:
  - Environmental Chemistry
  - Physics
  - Meteorology
  - Computer Molding
  - Oceanography
  - Geology and
  - Volcanology and other discipline

Environment

Topic-ATMOSPHERE CHEMISTRY

EARTH'S ATMOSPHERE

Earth's atmosphere has a series of layers, each with its own specific traits.

Moving upward from ground level, these layers are named

- Troposphere
- Stratosphere
- Mesosphere
- Thermosphere and
- Exosphere.

The exosphere gradually fades away into the realm of interplanetary space.

Atmospheric Chemistry

EARTH'S ATMOSPHERE

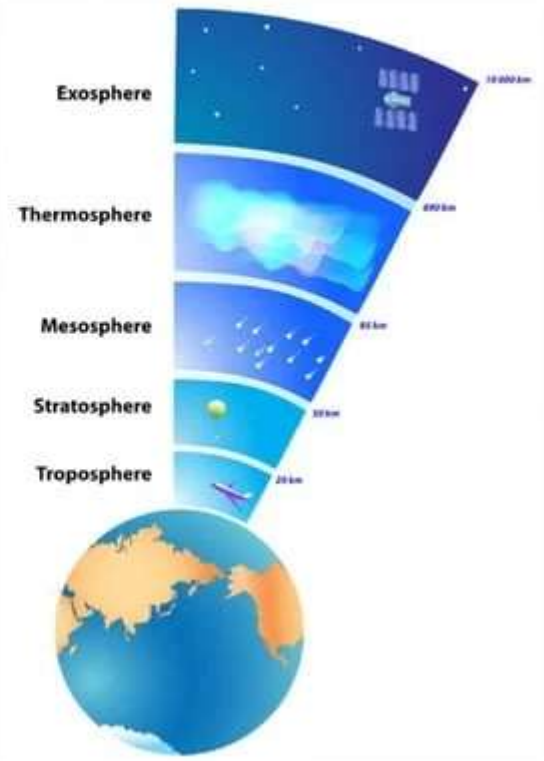
Exosphere
- 1600 km; Very high Temp.,
- H_2, HE, Outer Space

Thermosphere
- 90-500 km; -92 to 1200 °C Temp.,
- O_2, NO+

Mesosphere
- 50-90 km; -2 to -92 oC Temp,
- (Ionoshere: O'_2, O+ , NO+ , e-)

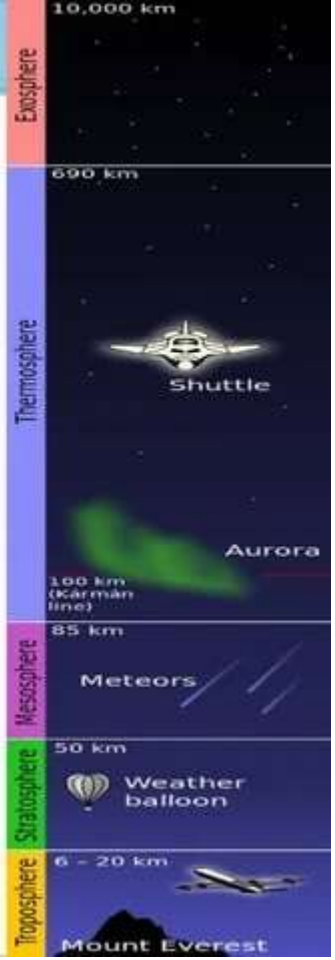
Stratosphere
- 11-50 km; -56 to -2 °C Temp,
- O_3(Ozone Layer: 15 km)

Troposphere
- 0-11 km; 15 to -56 °C Temp,
- N_2, O_2, CO_2, H_2O



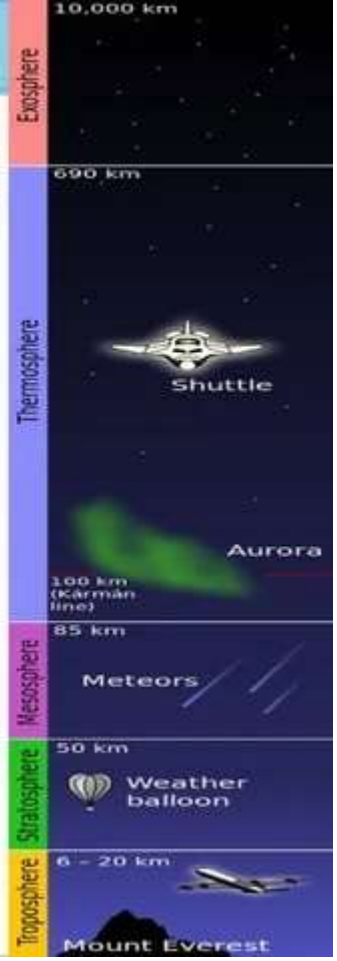
Troposphere

- The troposphere is the lowest layer of our atmosphere.
- Starting at ground level, it extends upward to about 10 km (6.2 miles or about 33,000 feet) above sea level.
- We humans live in the troposphere, and nearly all weather occurs in this lowest layer.
- Most clouds appear here, mainly because 99% of the water vapor in the atmosphere is found in the troposphere.
- Air pressure drops and temperatures get colder, as you climb higher in the troposphere.



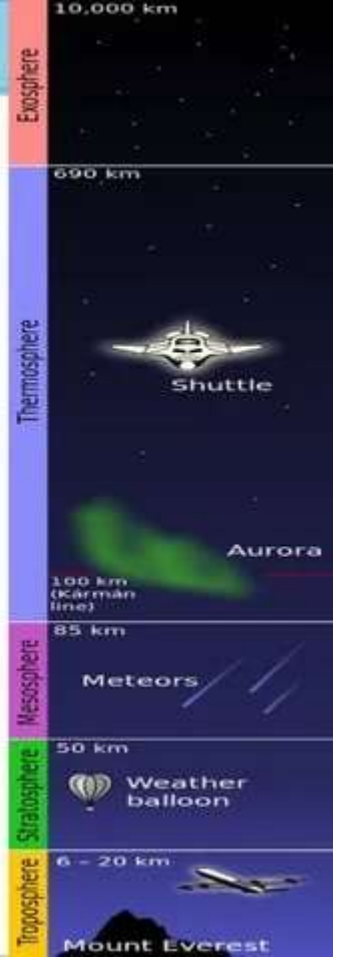
Stratosphere

- The stratosphere extends from the top of the troposphere to about 50 km (31 miles) above the ground.
- The infamous ozone layer is found within the stratosphere.
- Ozone molecules in this layer absorb high-energy **ultraviolet (UV)** light from the Sun, converting the UV energy into heat.
- Unlike the troposphere, the **stratosphere** actually gets **warmer** the higher you go!
- That trend of rising temperatures with altitude means that air in the stratosphere lacks the turbulence and updrafts of the troposphere beneath.
- Commercial passenger *jets fly* in the lower stratosphere, partly because this less-turbulent layer provides a smoother ride.
- The jet stream flows near the border between the troposphere and the stratosphere.



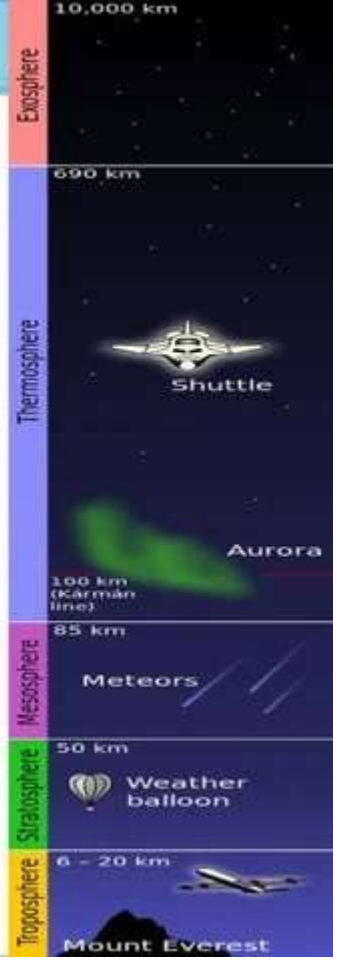
Mesosphere

- Above the stratosphere is the mesosphere.
- It extends upward to a height of about 85 km (53 miles) above our planet.
- Most meteors burn up in the mesosphere. Unlike the stratosphere, temperatures once again grow **colder** as you rise up through the mesosphere.
- The coldest temperatures in Earth's atmosphere, about -90° C (-130° F), are found near the **top** of this layer.
- The air in the mesosphere is far too thin to breathe; air pressure at the bottom of the layer is well below 1% of the pressure at sea level, and continues dropping as you go higher.



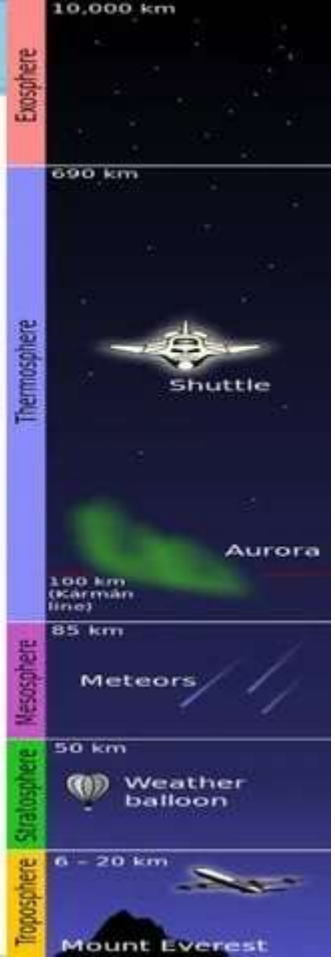
Thermosphere

- The layer of very rare air above the mesosphere is called the thermosphere.
- High-energy X-rays and UV radiation from the Sun are absorbed in the thermosphere, raising its temperature to hundreds or at times thousands of degrees.
- The air in this layer is so thin that it would feel freezing cold to us!
- The thermosphere is more like outer space than a part of the atmosphere. Many satellites actually orbit Earth within the thermosphere!
- The top of the thermosphere can be found anywhere between 500 and 1,000 km (311 to 621 miles) above the ground. Temperatures in the upper thermosphere can range from about 500 °C (932 °F) to 2,000 °C (3,632 °F) or higher.
- The aurora, the Northern Lights and Southern Lights, occur in the thermosphere.



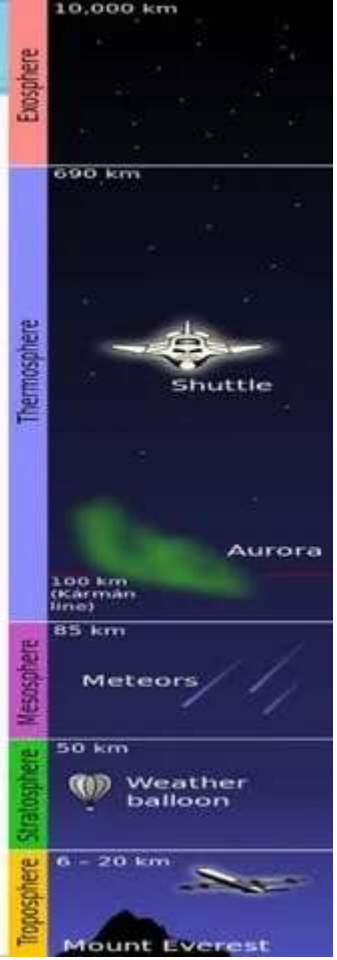
Exosphere

- Although some experts consider the thermosphere to be the uppermost layer of our atmosphere, other consider the exosphere to be the actual "final frontier" of Earth's gaseous envelope.
- As you might imagine, the "air" in the exosphere is very, very, very thin, making this layer even more space-like than the thermosphere.
- In fact, air in the exosphere is constantly - though very gradually - "leaking" out of Earth's atmosphere into outer space.
- There is no clear-cut upper boundary where the exosphere finally fades away into space.
- Different definitions place the top of the exosphere somewhere between 100,000 km (62,000 miles) and 190,000 km (120,000 miles) above the surface of Earth.
- The latter value is about halfway to the **Moon!**



Ionosphere

- The ionosphere is not a distinct layer like the other mentioned above.
- The ionosphere is a series of regions in parts of the mesosphere and thermosphere where high-energy radiation from the Sun has knocked electrons loose from their parent atoms and molecules.
- The electrically charged *atoms* and *molecules* that are formed in this way are called ions, giving the ionosphere its name and endowing this region with some special properties.



Atmospheric Chemistry

- The composition and chemistry of the Earth's atmosphere is of importance for several reasons.
- But, primarily because of the interactions between
  - Atmosphere and
  - Living organisms.
- The composition of the Earth's atmosphere changes as result of natural processes such as:
  - Volcano emissions
  - Lightning and
  - Bombardment by solar particles from corona.

Atmospheric Chemistry

- It has also been changed by human activity and some of these changes are **harmful** to:
  - Human health
  - Crops and
  - Ecosystems.
- Examples of problems which have been addressed by *atmospheric chemistry* include:
  - Acid rain
  - Ozone depletion
  - Photochemical smog
  - Greenhouse gases and
  - Global warming.

Acid rain

- This phenomenon came to attention in the 1970s
- Burning coal, oil and natural gas in power stations makes electricity, giving off *Sulphur dioxide gas*.
- Burning petrol and oil in vehicle engines gives off *Nitrogen oxides* as *gases*.
- Presence of H_2SO_4 (related to SO_2 from coal combustion) and HNO_3 (from NO_2)
- In the presence of lightning and thunderstorm, the nitrogen of the atmosphere combines with oxygen to form nitric oxide (NO), which in turn combines with oxygen to give nitrogen dioxide.

$$N_2 + O_2 \longrightarrow 2\,NO$$

$$2\,NO + O_2 \longrightarrow 2\,NO_2$$

- In the atmosphere, nitrogen dioxide reacts with water vapour producing nitric acid, which is washed down as acid rain.

$$3\,NO2 + H_2O \longrightarrow 2\,HNO_3 + NO$$

- The formation of *Nitric acid* and *Sulphuric acid* as *secondary pollutants* in the atmosphere leads to acid rain.

Acid rain

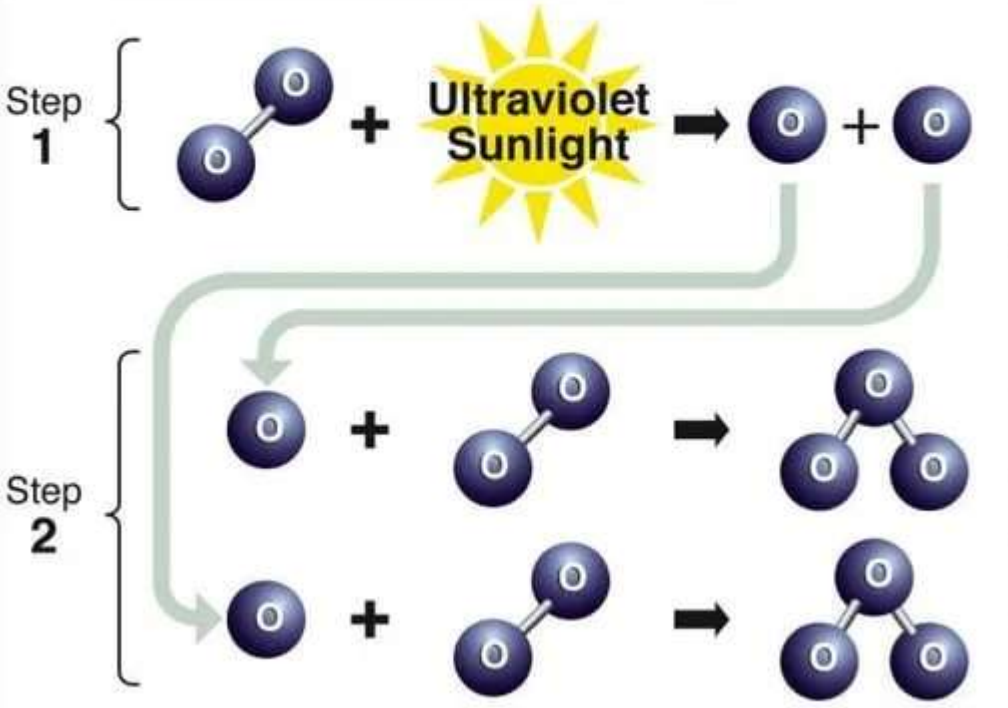
- All rain is acidic with or without air pollution.
- This is due to the natural presence of carbon dioxide in the atmosphere with dissolves in rain drops of rain water (even moisture present in the atmosphere does the same function) to form *Carbonic acid*.

$$CO_2 + H_2O \rightarrow H_2CO_3$$

- Due to the above reaction carbon dioxide can dissolve in water until the solution becomes saturated.
- This results in the rain water attaining an acidic pH of 5.6
- Due to this, the purest form of rain reaches the earth as an acidic solution of pH 5.6
- Acidity causes Environmental problems like
  - Destruction of vegetation
  - Marine life
  - Corrosion and
  - Etching of buildings that are exposed to atmosphere.

Ozone depletion

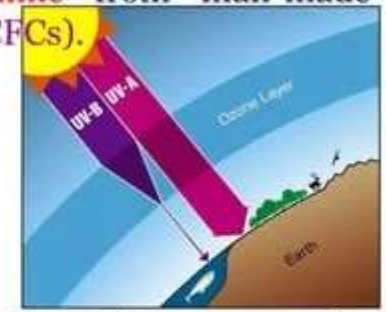
How ozone is formed?



Ozone depletion

Man-made causes of depletion of ozone layer:

- The main cause for the depletion of ozone is determined as excessive release of chlorine and bromine from man-made compounds such as chloro fluoro carbons (CFCs).
  - CFCs (chlorofluorocarbons)
  - Halogens
  - CH_3CCl_3 (Methyl chloroform)
  - CCl_4(Carbon tetrachloride)
  - HCFCs (hydro-chlorofluorocarbons)
  - Hydrobromofluorocarbons and
  - Methyl bromide are found to have direct impact on the depletion of the ozone layer.



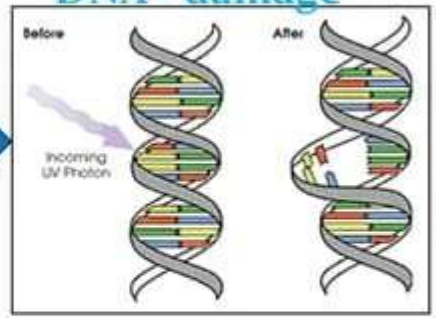
- These are categorized as *Ozone-Depleting Substances* (ODS).
- Chlorofluorocarbons are released into the atmosphere due to:
  - Cleaning Agents
  - Coolants in refrigerators
  - Packing material
  - Air conditioning
  - Aerosol spray cans etc.

Ozone depletion

Why is the ozone layer important?

UV- Radiation

DNA - damage

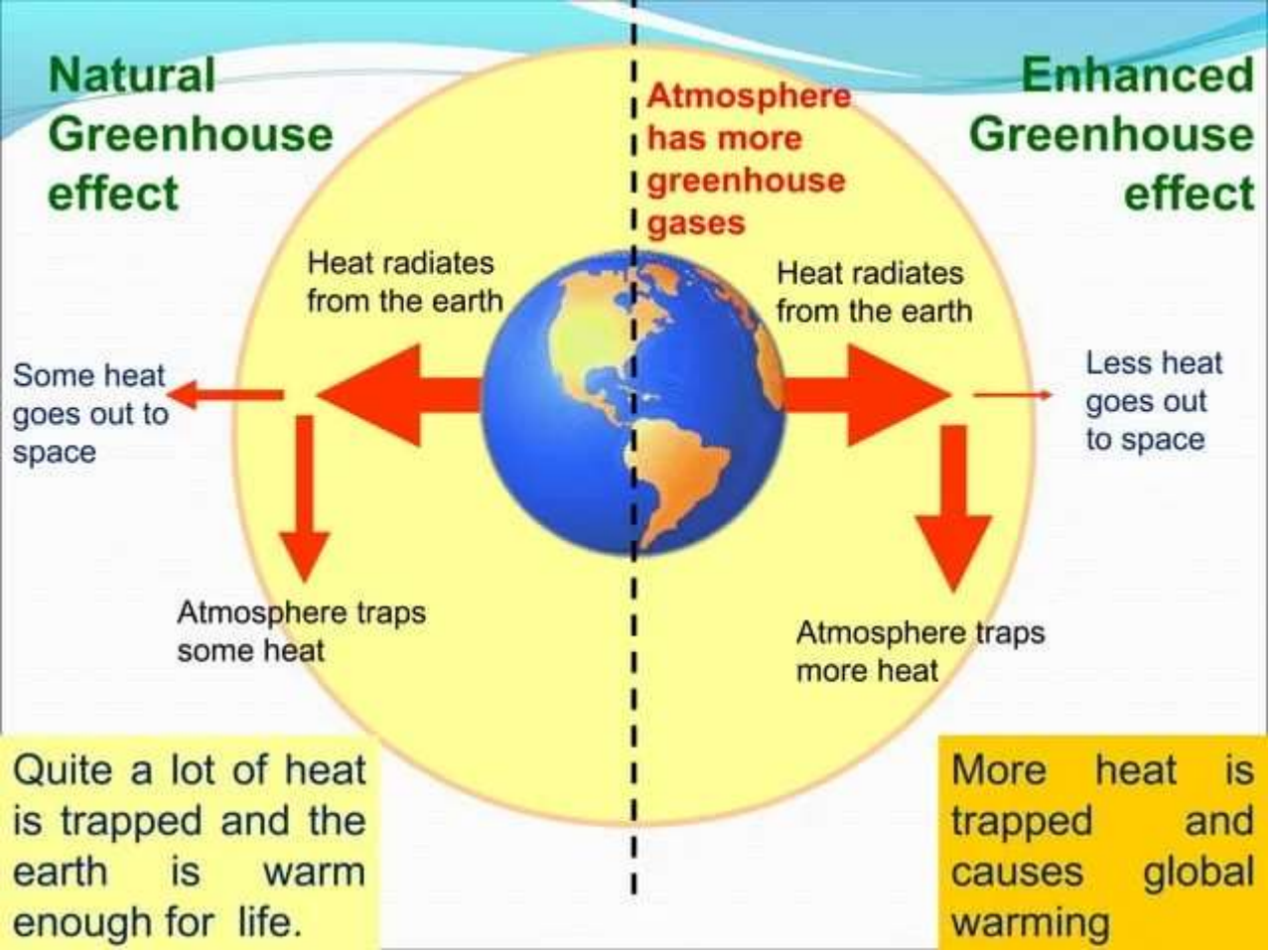


Skin Cancer

Greenhouse gases & Global warming

- The atmosphere is the air around the surface of the earth. It is made from a mixture of gases. We need it for animals and plants to survive.
- Some of the gases act like a blanket, trapping heat. These gases are called 'Greenhouse gases'.
- The main greenhouse gases are:
  - Carbon dioxide
  - Methane
  - Nitrous oxide
  - Ozone
  - Water vapour
  - Halocarbons

- This is known as the 'Natural Greenhouse Effect'.
- Without it, the earth would be much colder.
- The heating of the earth through human activities is called the 'Enhanced Greenhouse Effect' and this is causing the earth to heat up, or Global warming.
- Global warming doesn't just mean that the earth gets hotter, it means that the whole climate is changing.


Natural Greenhouse effect
Atmosphere has more greenhouse gases
Enhanced Greenhouse effect
Heat radiates from the earth
Heat radiates from the earth
Some heat goes out to space
Less heat goes out to space
Atmosphere traps some heat
Atmosphere traps more heat
Quite a lot of heat is trapped and the earth is warm enough for life.
More heat is trapped and causes global warming

THANK YOU