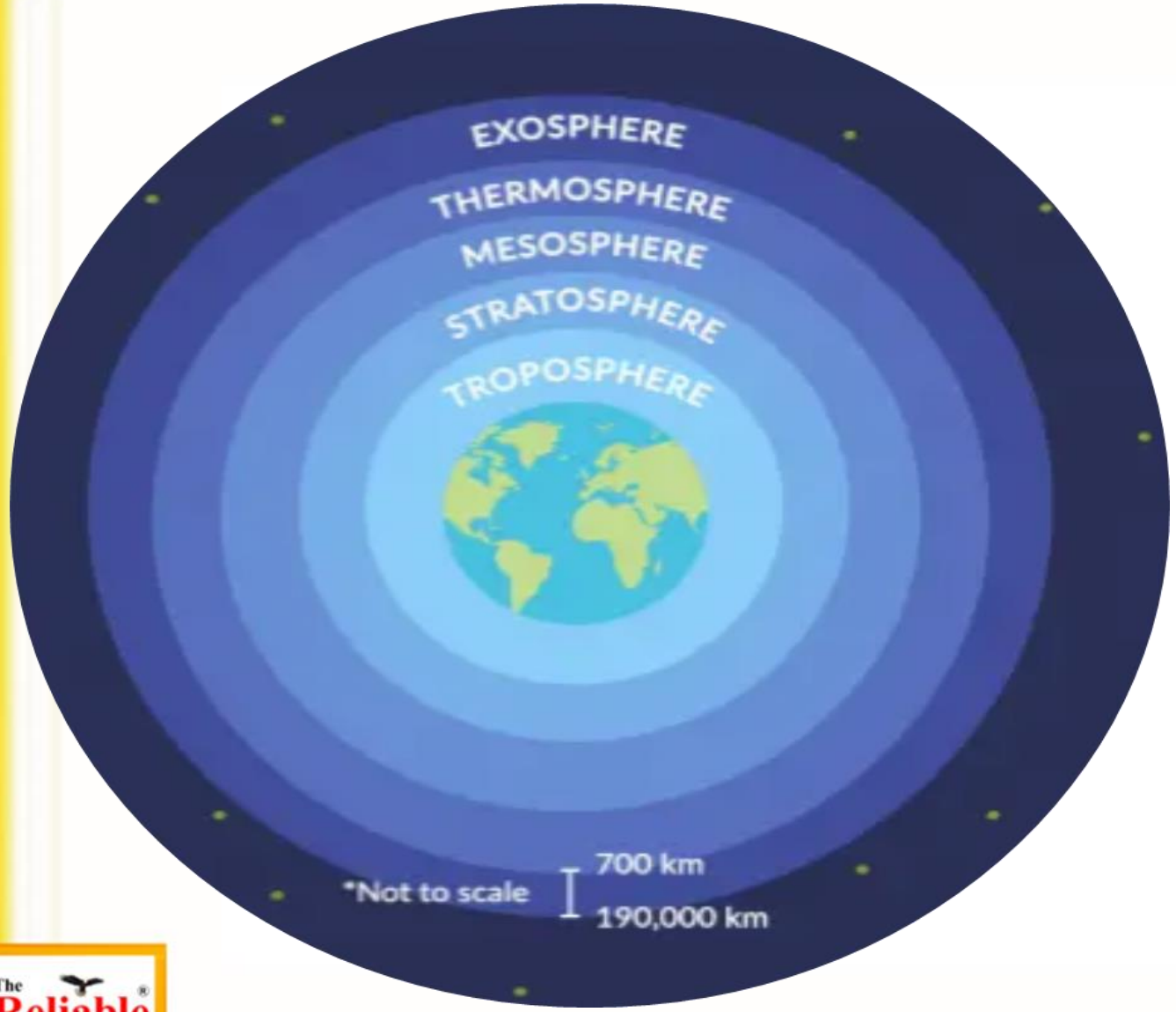
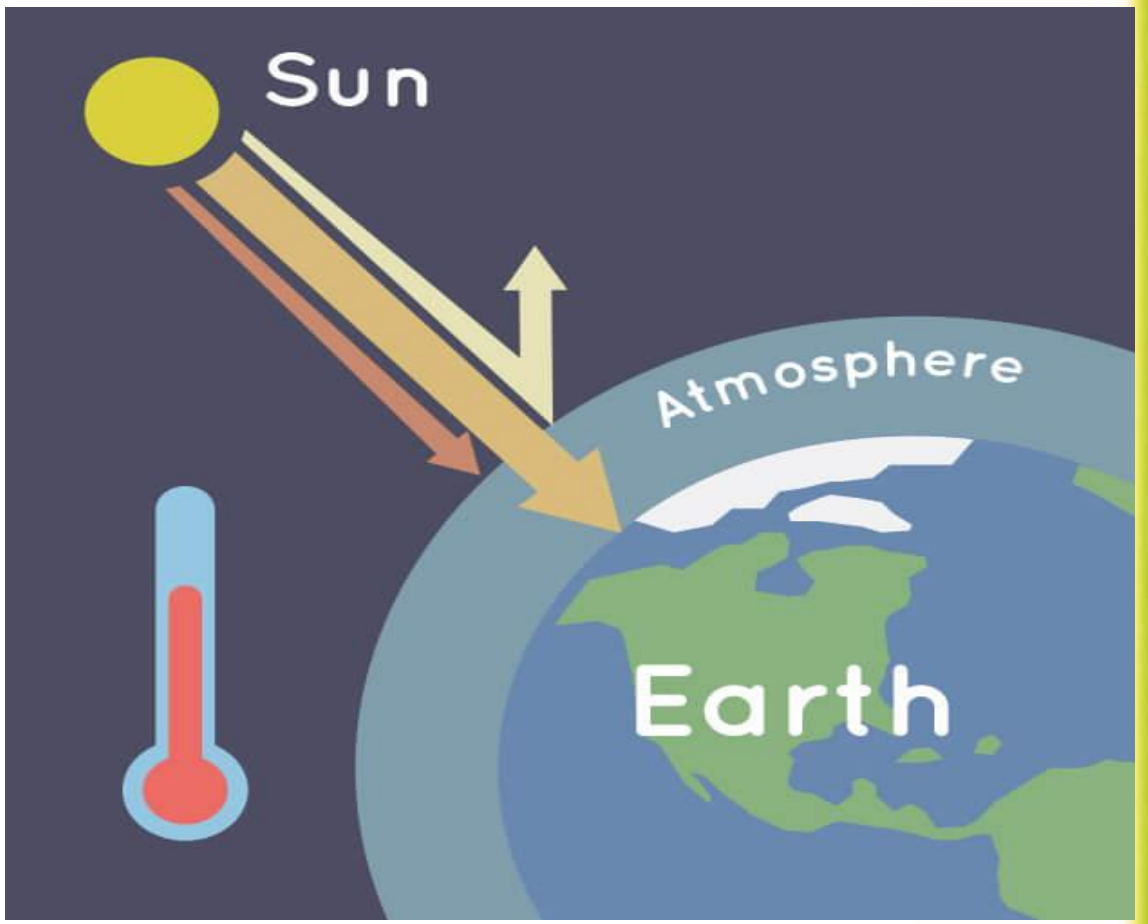
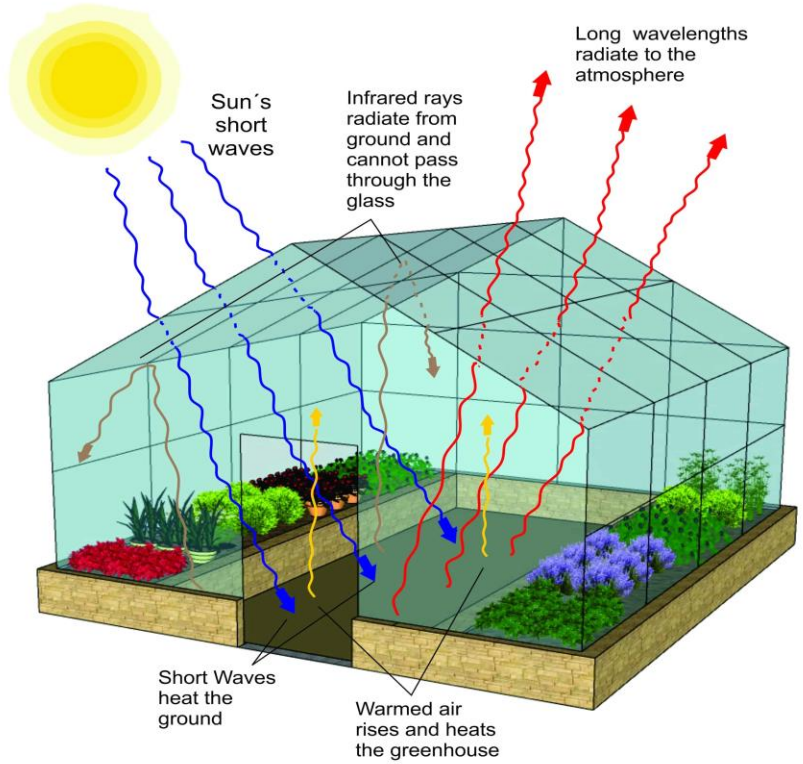
- FACULTY NAME:
  - KANHAIYA JHA
- SUBJECT:
  - GEOGRAPHY
- TOPIC NAME:
  - EARTH'S ATMOSHPHERE

ATMOSPHERE : STRUCTURE & COMPOSITION

- Our earth is surrounded by a huge blanket of air called atmosphere.
- All living beings on this earth depend on the atmosphere for their survival.
- It works as a large greenhouse which protect us from harmful radiations of Sun and makes earth's temperature liveable.
- Without this blanket of protection, we would be baked alive by the heat of the sun during day and get frozen during night.

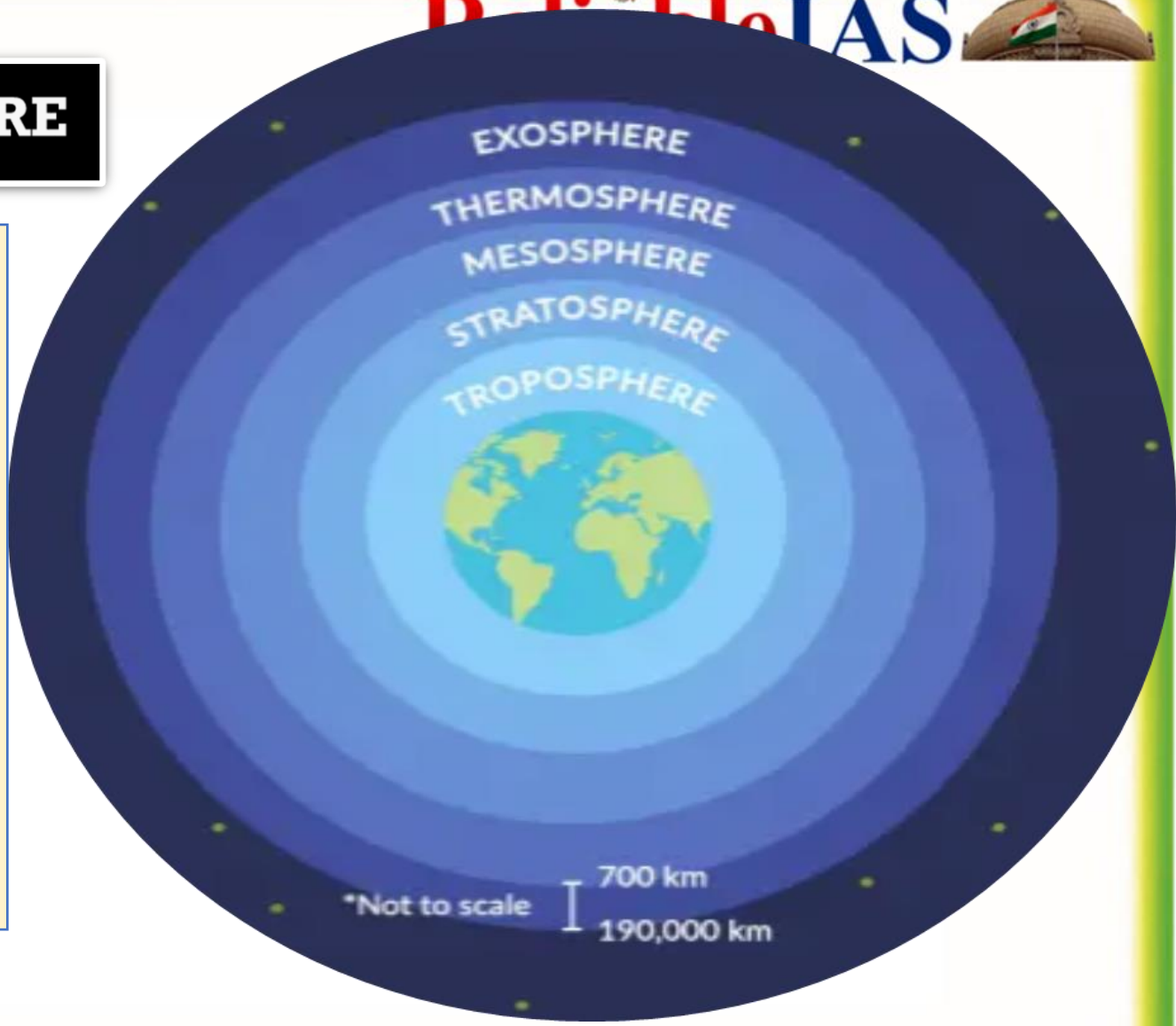

EXOSPHERE
THERMOSPHERE
MESOSPHERE
STRATOSPHERE
TROPOSPHERE
*Not to scale
700 km
190,000 km


Sun
Atmosphere
Earth


Sun´s short waves
Infrared rays radiate from ground and cannot pass through the glass
Long wavelengths radiate to the atmosphere
Short Waves heat the ground
Warmed air rises and heats the greenhouse

COMPOSITION OF THE ATMOSPHERE

- An atmosphere is the mixture of gases surrounding earth .
- **Due to the gravitational force of Earth** atmosphere exist around the earth.
- Being the physical quantity**, Air have their own mass and weight**.
- In atmosphere different gases have different mass that's why Earth' gravitational force attract them differently. **(Differentiation of Density**



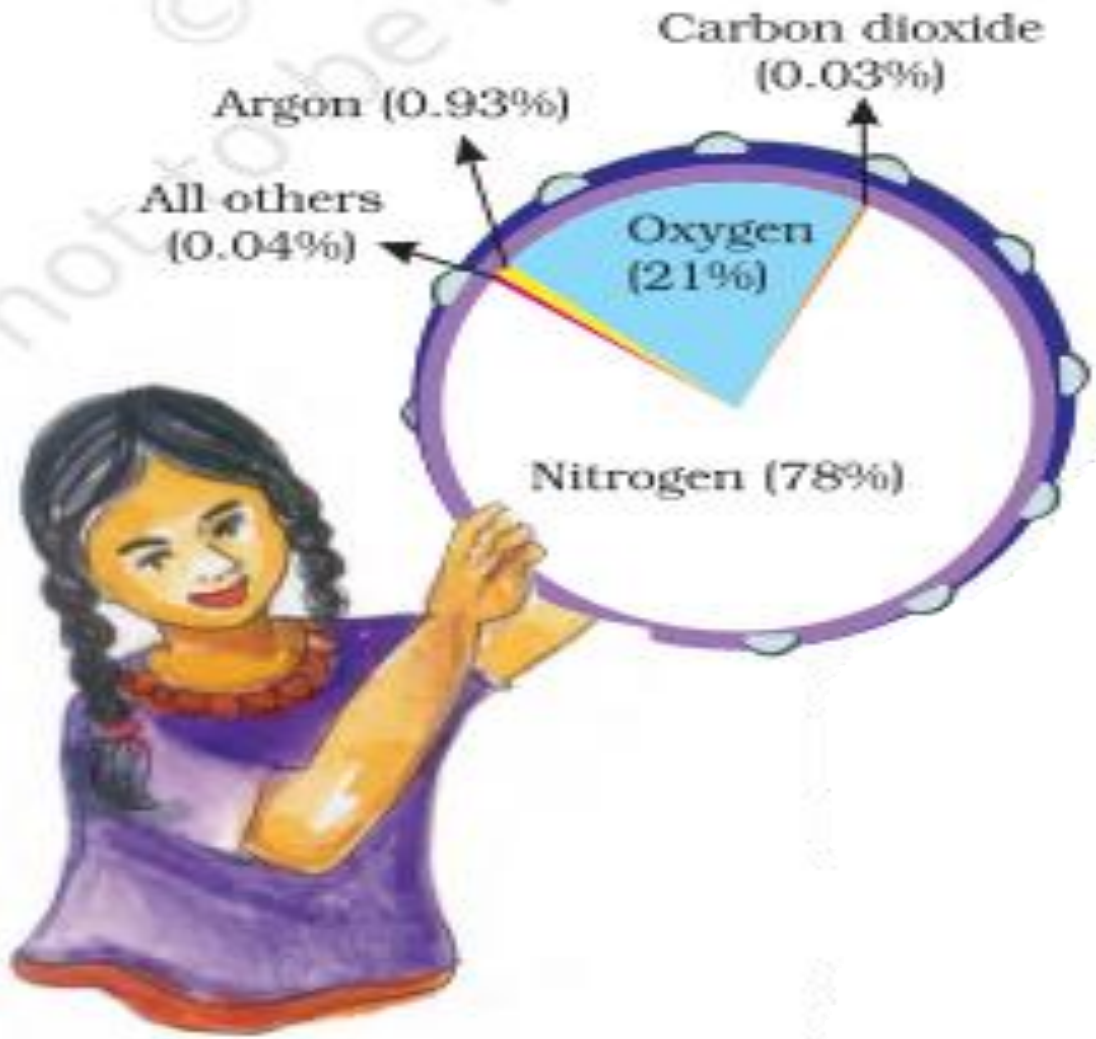


Fig. 4.1: Constituents of Air

SOLID MATERIAL	LIQUID MATERIAL	GASEOUS MATERIAL	
Dust (pm 2.5 & pm 10)	Water vapour	Nitrogen	78%
Salt particle		Oxygen	21%
smoke		argon	0.93 %
Pollen		Carbon dioxide	0.03%
		ozone	0.0000001%
		Hydrogen	0.00005 %

GREENHOUSE GASES

1. Carbon dioxide (CO_2)
2. Methane (CH_4)
3. Nitrous oxide (N_2O).
4. water vapor (is the most abundant greenhouse gas; little amount produced by human)
5. Ozone .
6. Industrial gases:
    1. Hydrofluorocarbons (HFCs)
    2. Perfluorocarbons (PFCs)
    3. Sulfur hexafluoride (SF_6)
    4. Nitrogen trifluoride (NF_3).

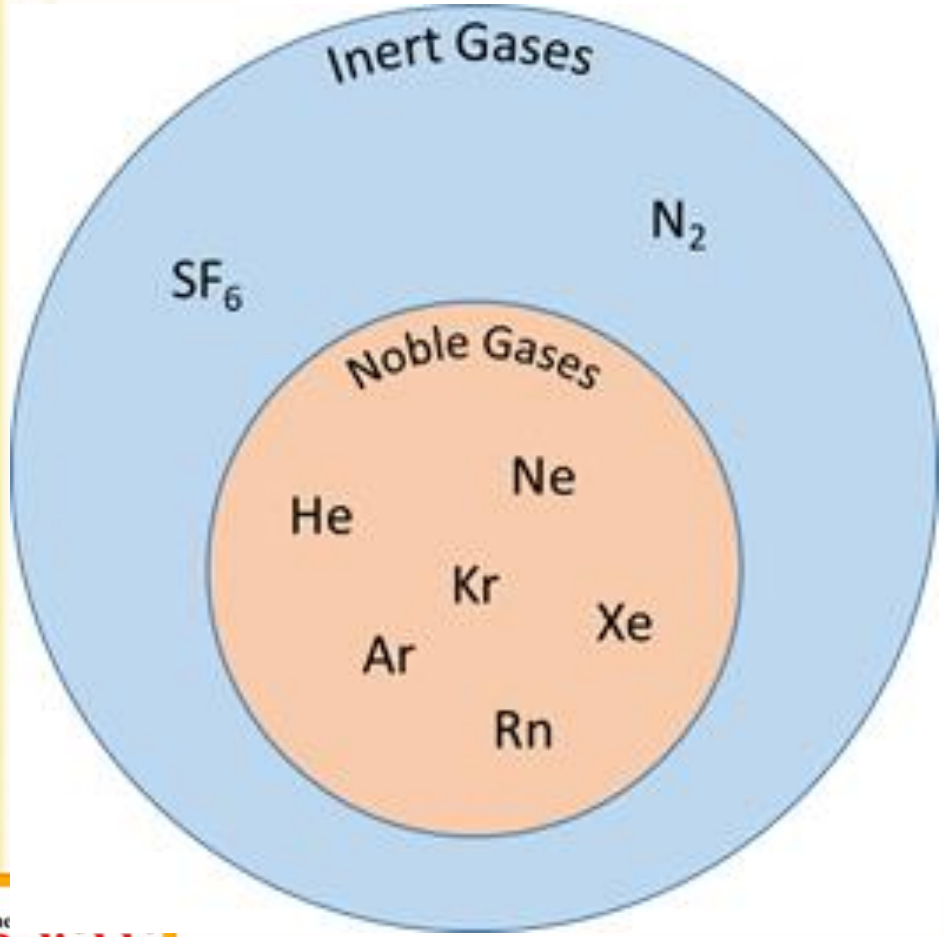
***Hydrogen is indirect greenhouse gas**.

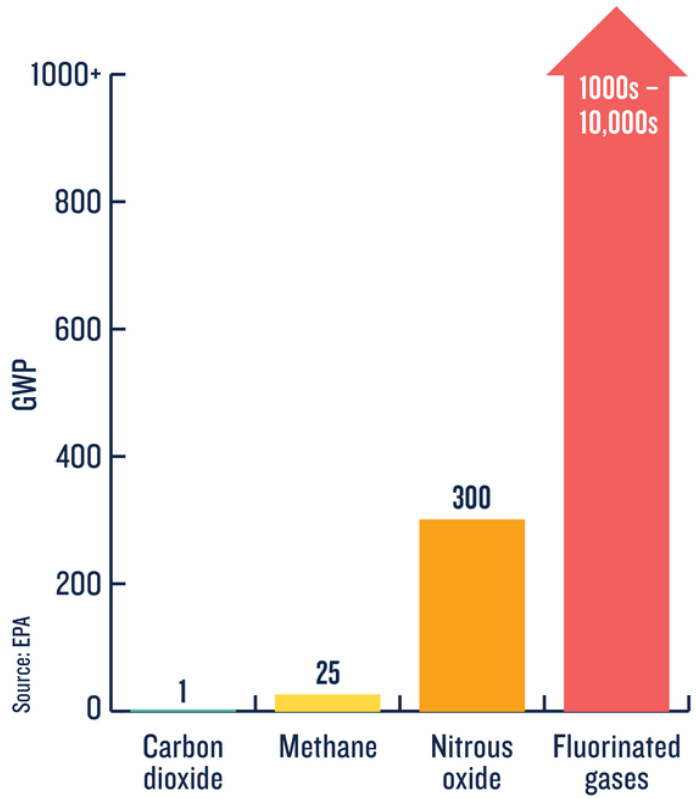
- **Not a greenhouse gases**
    1. oxygen
    2. nitrogen and
    3. Argon(Inert/ Nobel Gas) .

➢ **Radon is a radioactive element and noble gas, and is not found in the atmosphere.**

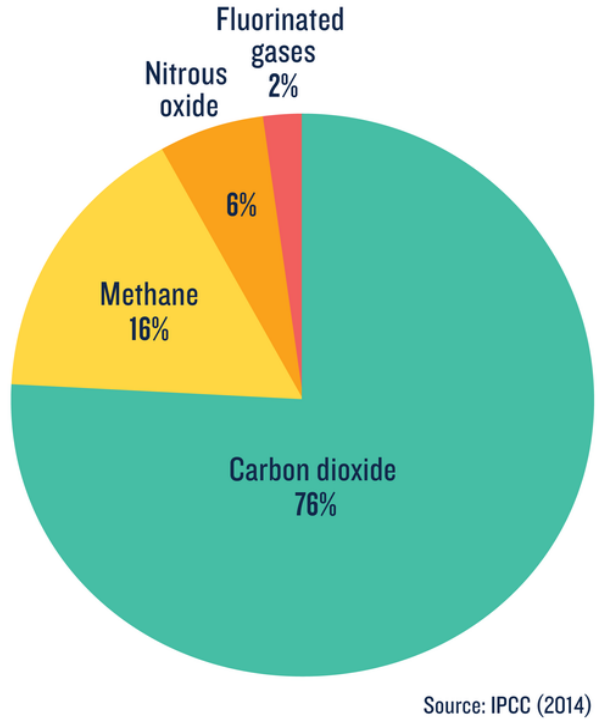
➢ It is found in rocks containing uranium ores and is produced by the radioactive decay of radium.

HOW GREENHOUSE GASES WARM OUR PLANET





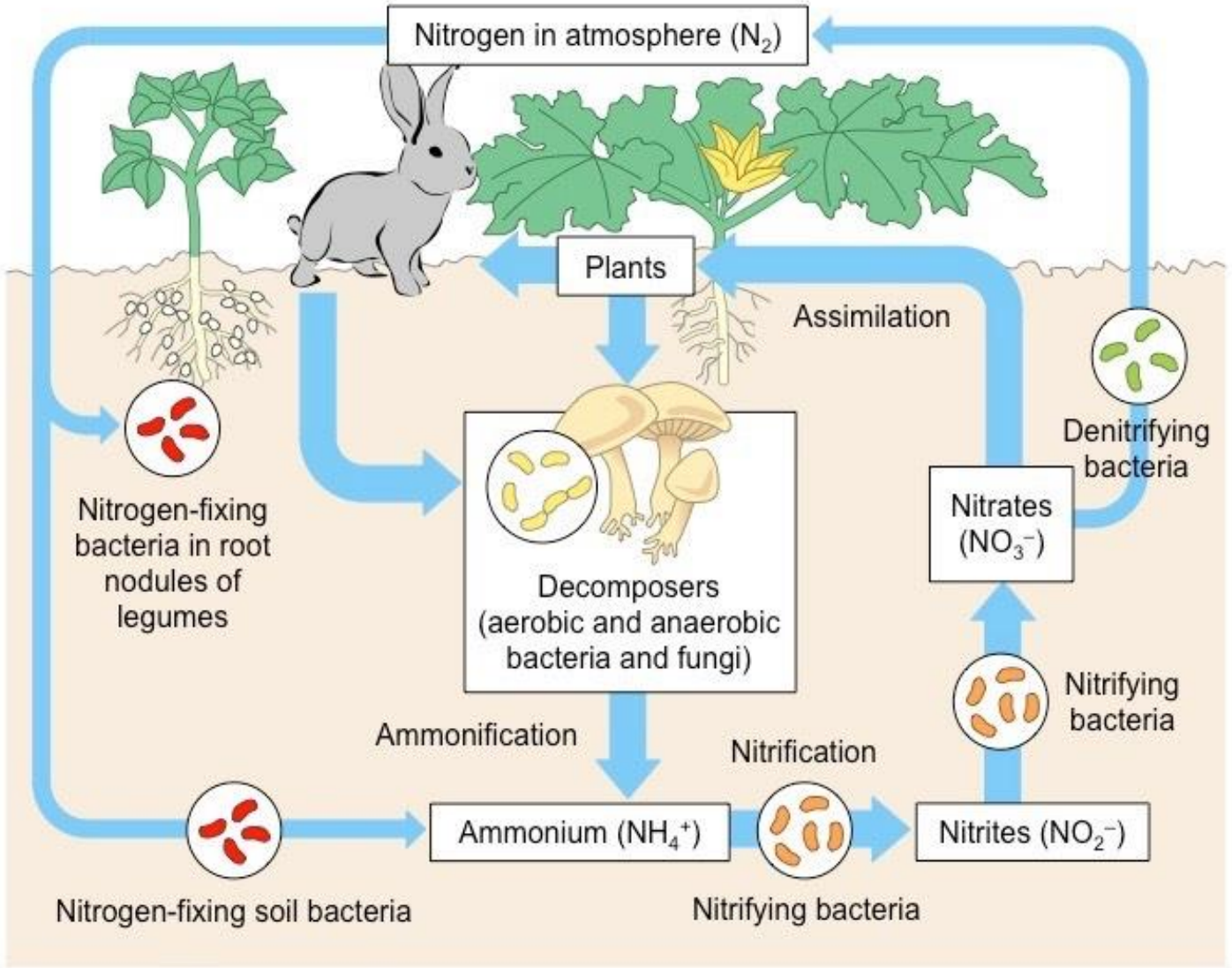
The global warming potential (GWP) of human-generated greenhouse gases is a measure of how much heat each gas traps in the atmosphere, relative to carbon dioxide.



How much each human-caused greenhouse gas contributes to total emissions around the globe.

NITROGEN

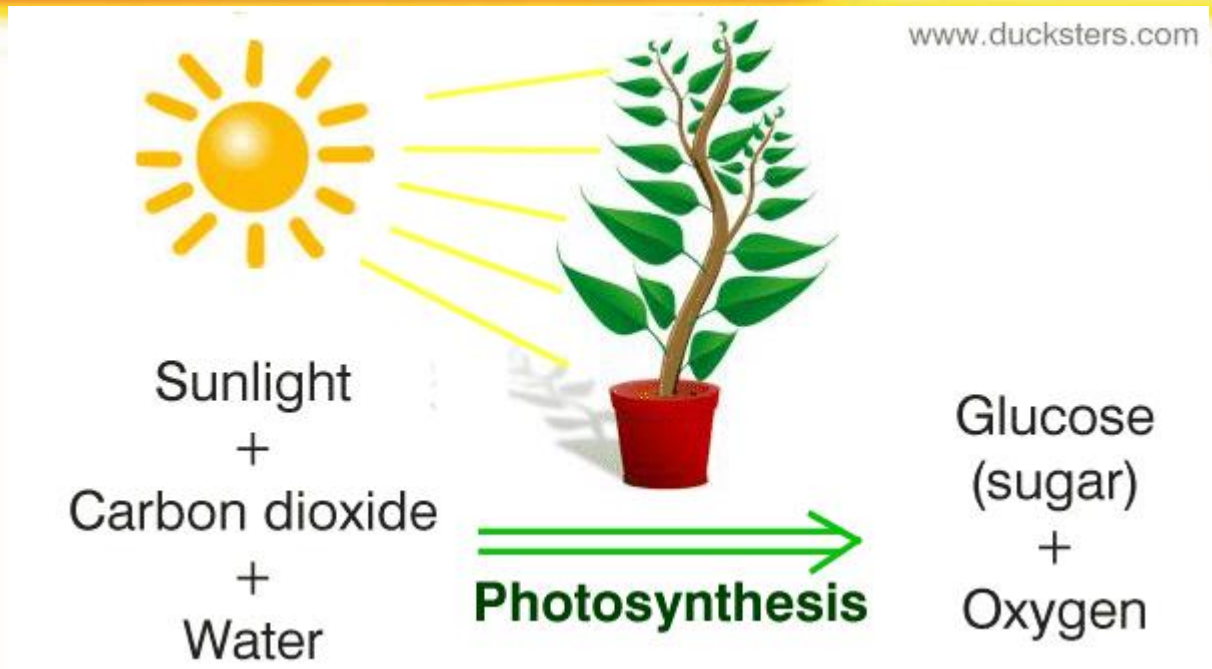
- **Nitrogen(78%)** is the most plentiful gas in the air.
- Plants need nitrogen for their survival. However , they can not take nitrogen directly from the air.
- Bacteria, that live in the soil and roots of some plants, take nitrogen from the air and change its form so that plants can use it.
- Plant takes it inform of **Nitrates.**
- It also works as a **fire- extinguisher.**

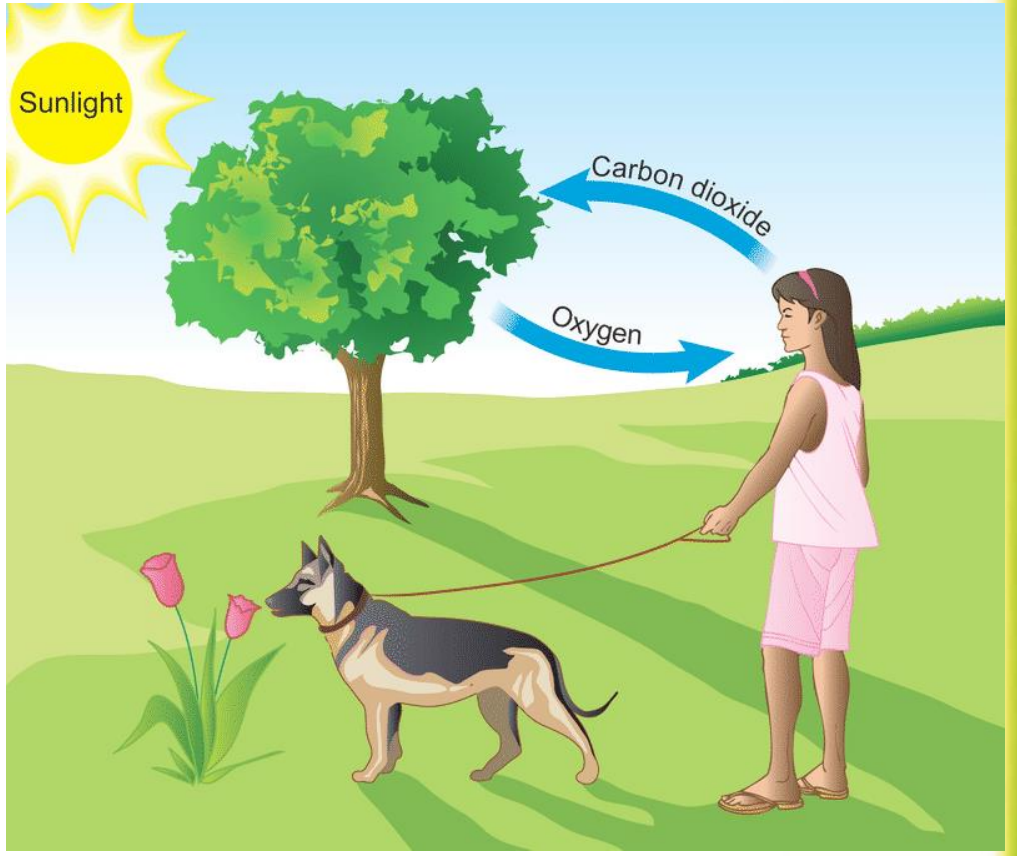

Nitrogen in atmosphere (N_2)
Plants
Assimilation
Nitrogen-fixing bacteria in root nodules of legumes
Decomposers (aerobic and anaerobic bacteria and fungi)
Denitrifying bacteria
Nitrates (NO_3^-)
Nitrifying bacteria
Ammonification
Nitrification
Ammonium (NH_4^+)
Nitrites (NO_2^-)
Nitrogen-fixing soil bacteria
Nitrifying bacteria

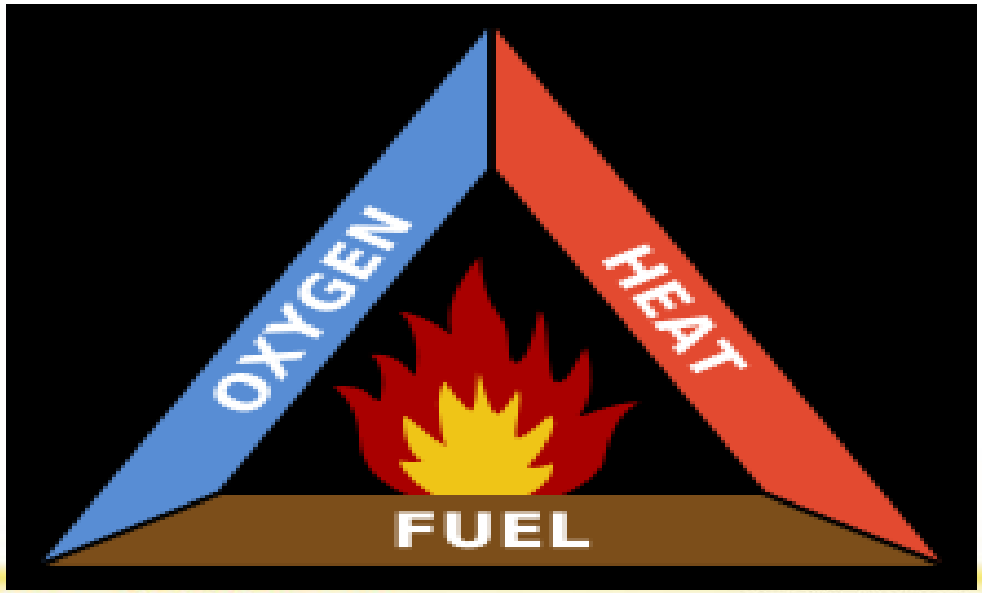

FIRE
SAFETY SG
FIRE EXTINGUISHER
9KG ABC POWDER
43A 183B
USE UPRIGHT
PULL OUT SAFETY PIN
AIM NOZZLE AT
BASE OF FIRE
SQUEEZE LEVEL TO DISCHARGE
RELEASE LEVEL TO STOP
A
B
CAUTION: USE WITH CARE FOR LIVE ELECTRICAL EQUIPMENT

Oxygen

- **Oxygen(21%)** is the second most plentiful gas in the air.
- It is Life-saving gas
- **It plays a critical role in respiration, the energy-producing chemistry that drives the metabolisms of most living things**
- Green plants produce oxygen during **photosynthesis**. In this way oxygen content in the air remains constant.
- The **fire triangle**
  - Heat , fuel, and an oxidizing agent (usually oxygen) is the three ingredients of fire. In absence of oxygen no fire occurs.

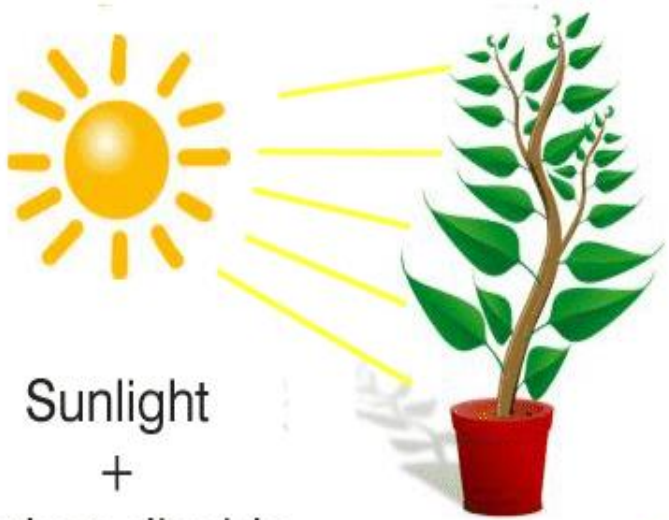

www.ducksters.com
Sunlight
+
Carbon dioxide
+
Water
Photosynthesis
Glucose
(sugar)
+
Oxygen


Sunlight
Carbon dioxide
Oxygen


OXYGEN
HEAT
FUEL

Carbon dioxide

- **Carbon dioxide (0.03%)**is another important gas.
- **Carbon dioxide released in the atmosphere creates a green house effect by trapping the heat radiated from the earth.** It is therefore called a greenhouse gas and without it the earth would have been too cold to live in.
- Green plants use carbon dioxide to make their food and release oxygen during photosynthesis. While Humans or animals release carbon dioxide.
- The amount of carbon dioxide released by humans or animals seems to be equal to the amount used by the plants which make a perfect balance.
- However, the balance is upset by burning of fuels, such as coal and oil. They add billions of tons of carbon dioxide into the atmosphere each year. As a result, the increased volume of carbon dioxide is affecting the earth's weather and climate
- when the level of carbon dioxide in the atmosphere increases due to factory smoke or car fumes, the heat retained increases the temperature of the earth. **This is called global warming.**
- This rise in temperature causes the snow in coldest parts of the world to melt. As a result the sea level rises, causing floods in the coastal areas. There may be drastic changes in the climate of a place leading to extinction of some plants and animals in the long run.



Sunlight
+
Carbon dioxide
+
Water

Photosynthesis

Glucose
(sugar)
+
Oxygen

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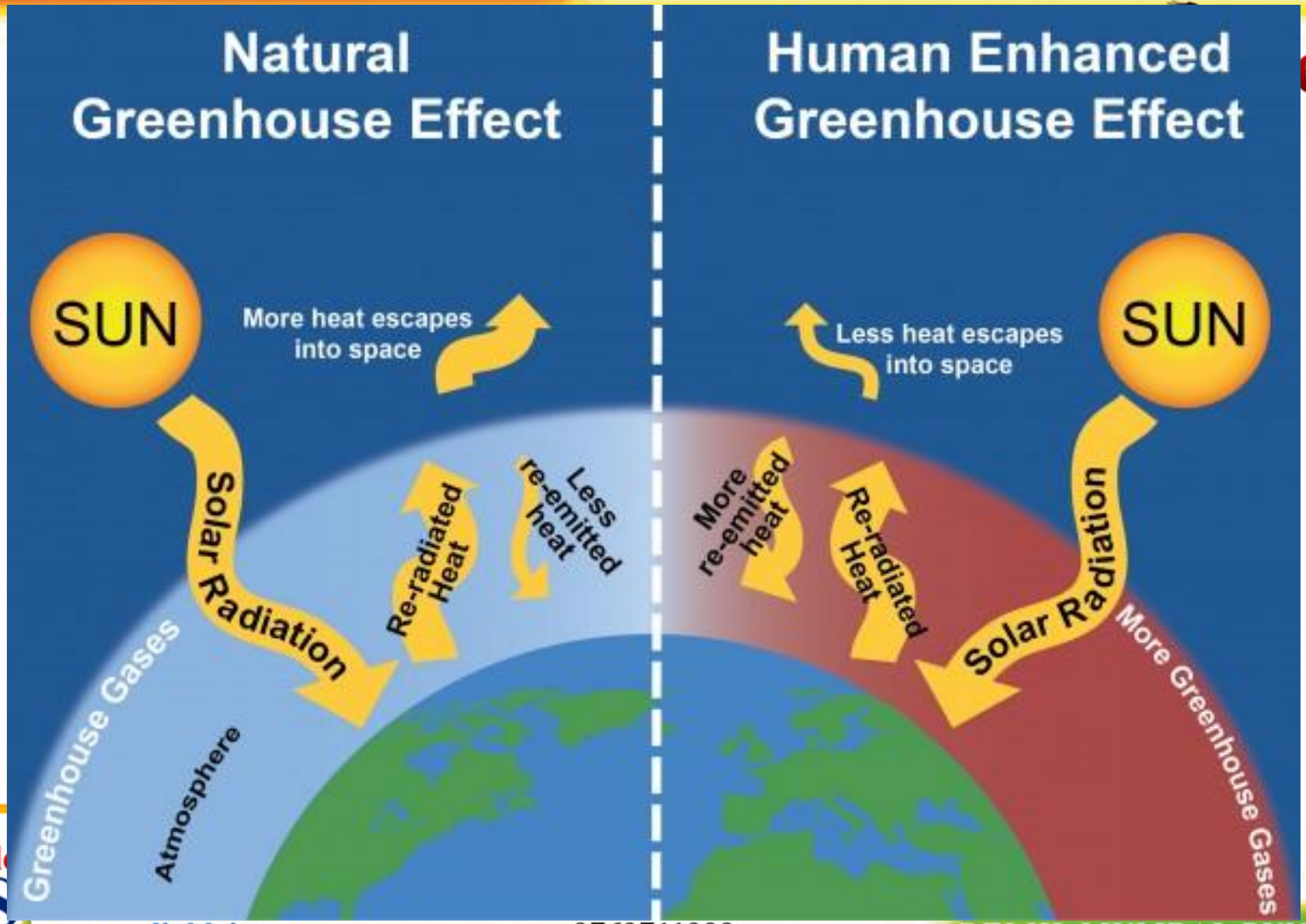
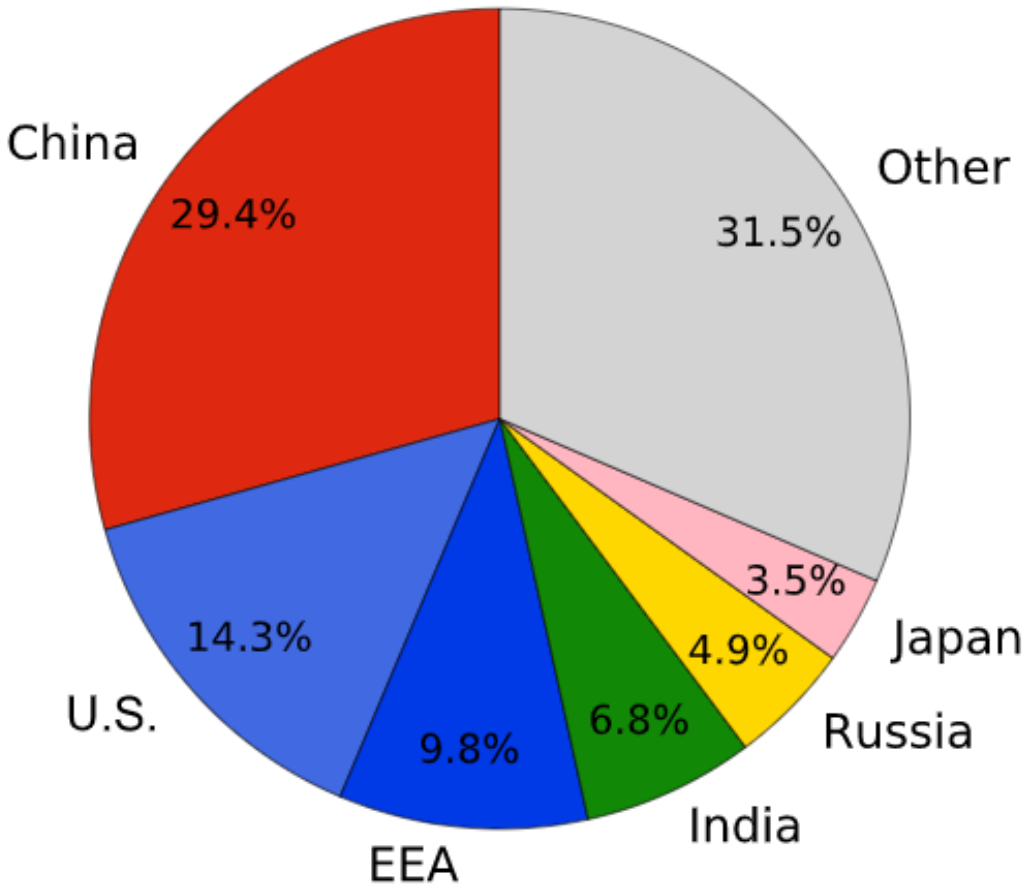
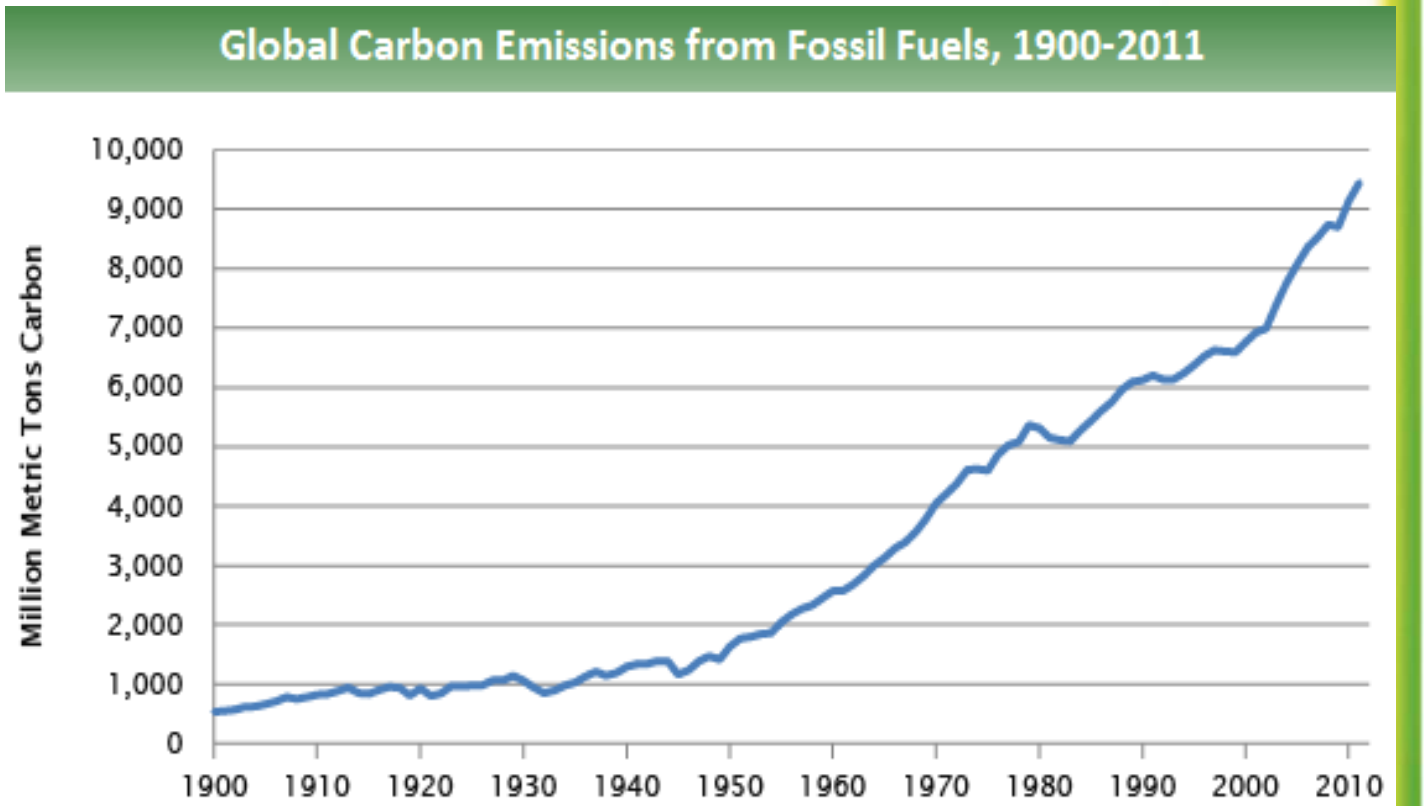
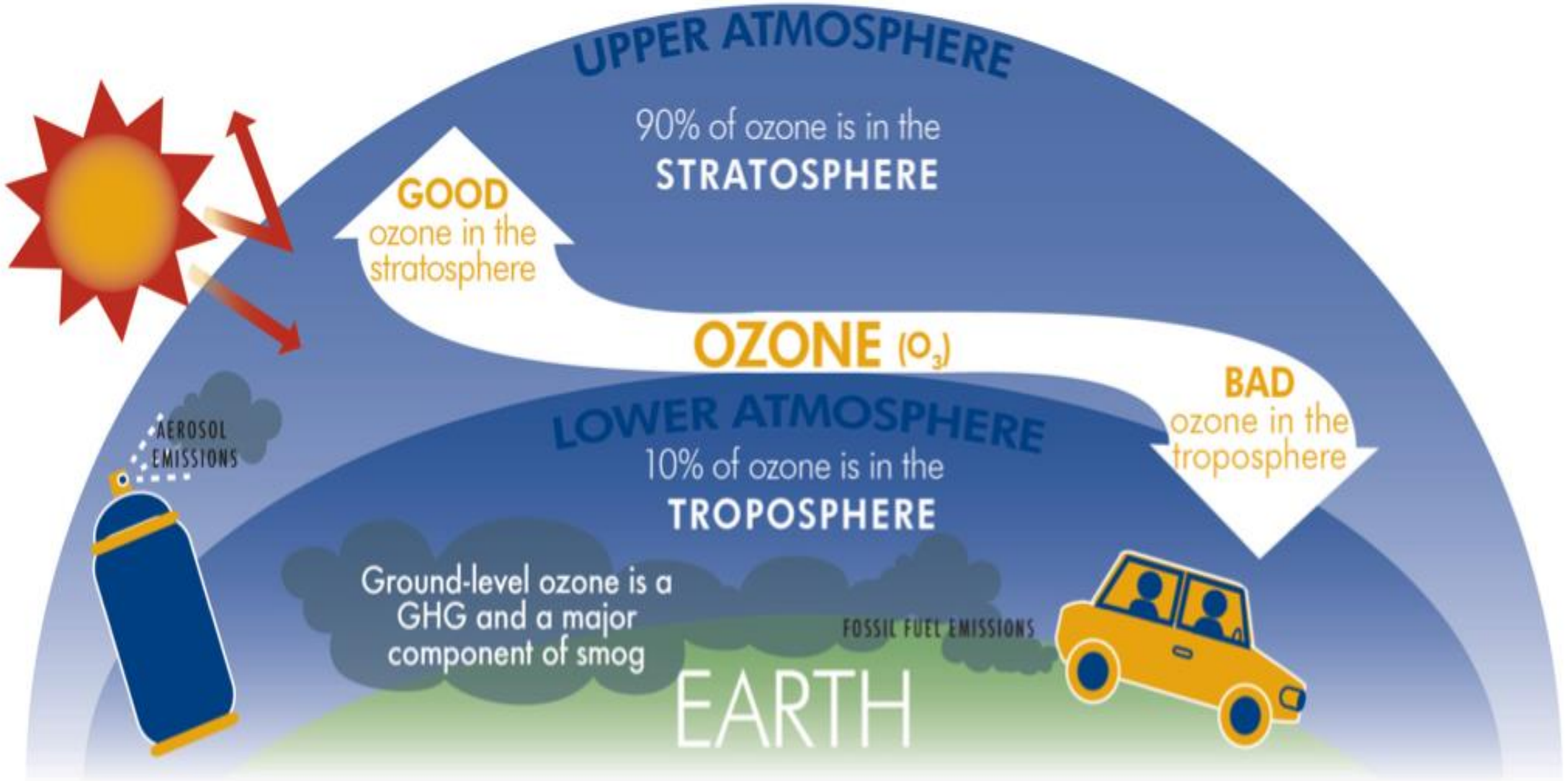



China
29.4%
Other
31.5%
3.5%
Japan
4.9%
Russia
14.3%
U.S.
9.8%
6.8%
India
EEA


Global Carbon Emissions from Fossil Fuels, 1900-2011
Million Metric Tons Carbon
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

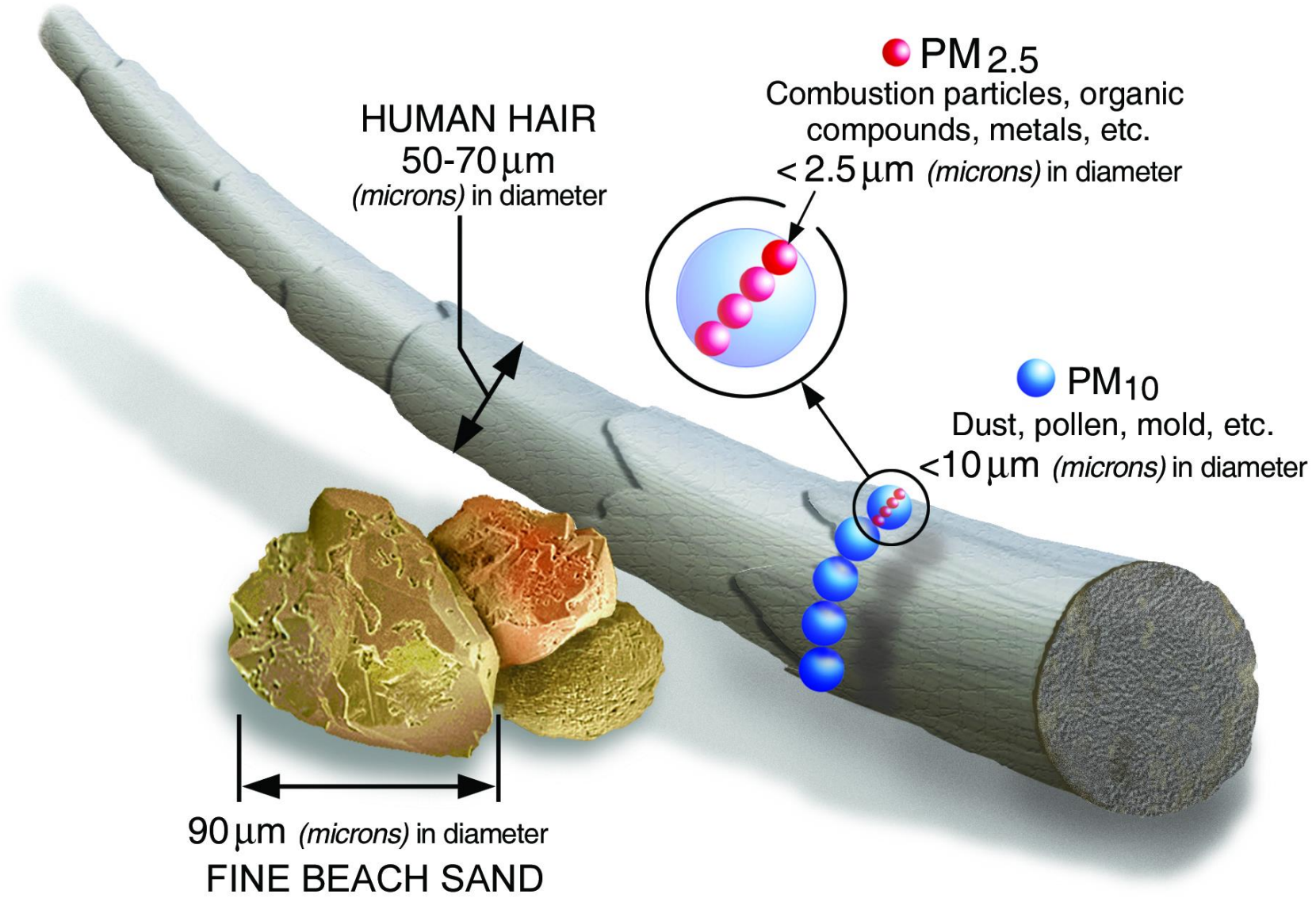
Ozone (O3)

- Is a highly reactive gas composed of three oxygen atoms.
- It is a poisonous gas with a strong(pungent) odor (fishy smell).
- More than 100 ppm of ozone in breathing air causes headache and breathing trouble
- It is both a natural and a man-made product that occurs in the Earth's upper atmosphere (the stratosphere) and lower atmosphere (the troposphere).
- Depending on where it is in the atmosphere, ozone affects life on Earth in either good or bad ways
- Stratospheric ozone is formed naturally through the interaction of solar ultraviolet (UV) radiation with molecular oxygen (O2).
- Tropospheric or ground-level ozone – what we breathe – is formed primarily from photochemical reactions between two major classes of air pollutants, volatile organic compounds (VOC) and nitrogen oxides (NOx)

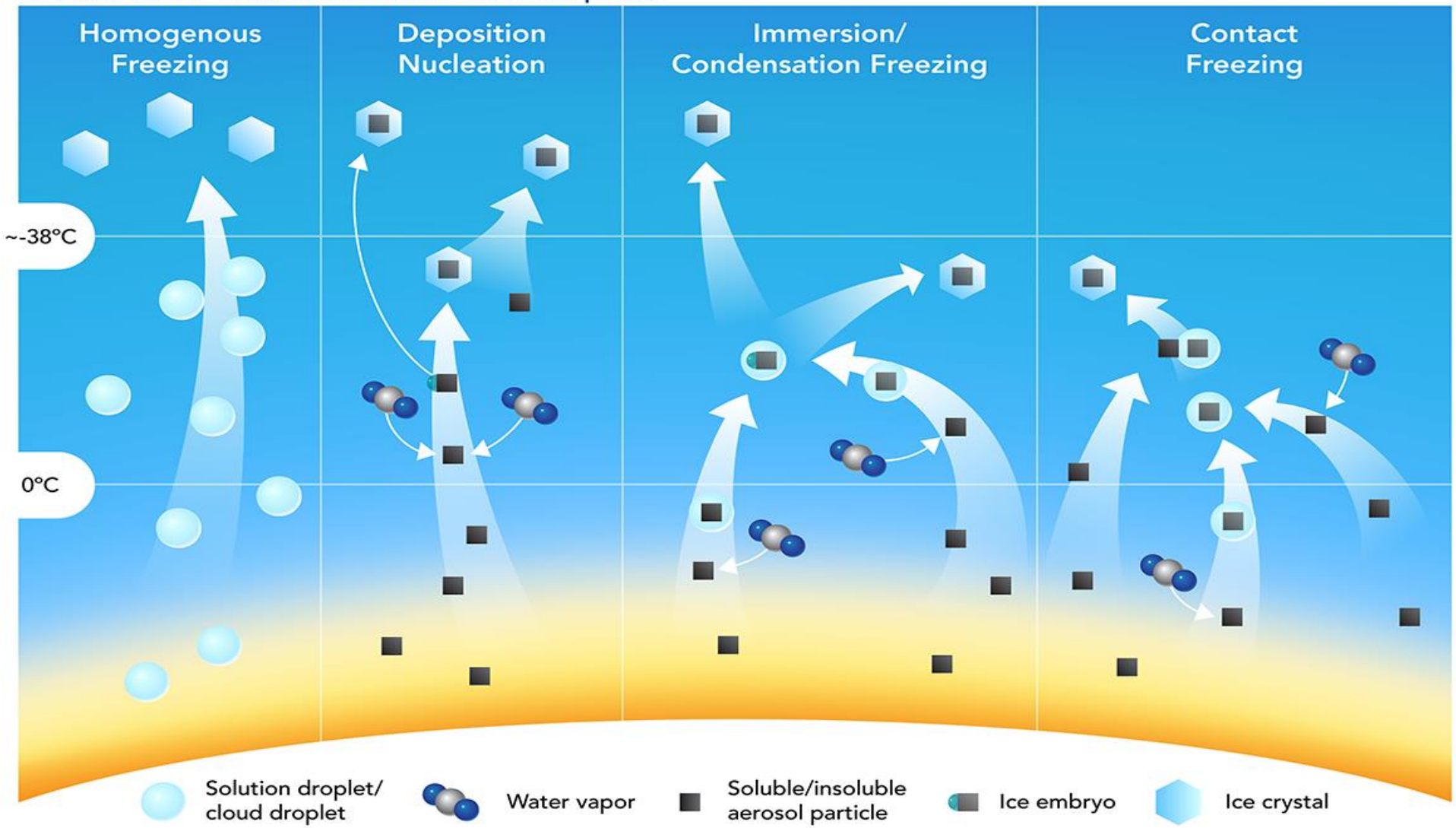

UPPER ATMOSPHERE
90% of ozone is in the
STRATOSPHERE
GOOD
ozone in the
stratosphere
OZONE (O_3)
BAD
ozone in the
troposphere
LOWER ATMOSPHERE
10% of ozone is in the
TROPOSPHERE
AEROSOL
EMISSIONS
Ground-level ozone is a
GHG and a major
component of smog
FOSSIL FUEL EMISSIONS
EARTH

Solid particle

- It includes salt particles, volcanic dust and organic dust (**pollen). On the basis of size solid particles are classified into two major groups pm10 and pm 2.5.**
- **Solid particles act as a hygroscopic nuclei, providing a solid base/ platform for condensation.**
- **Hence, solid particle(hygroscopic nuclei) is essential for cloud formation.**
- **In the lower atmosphere near Earth's surface, these particles are pollutants.**

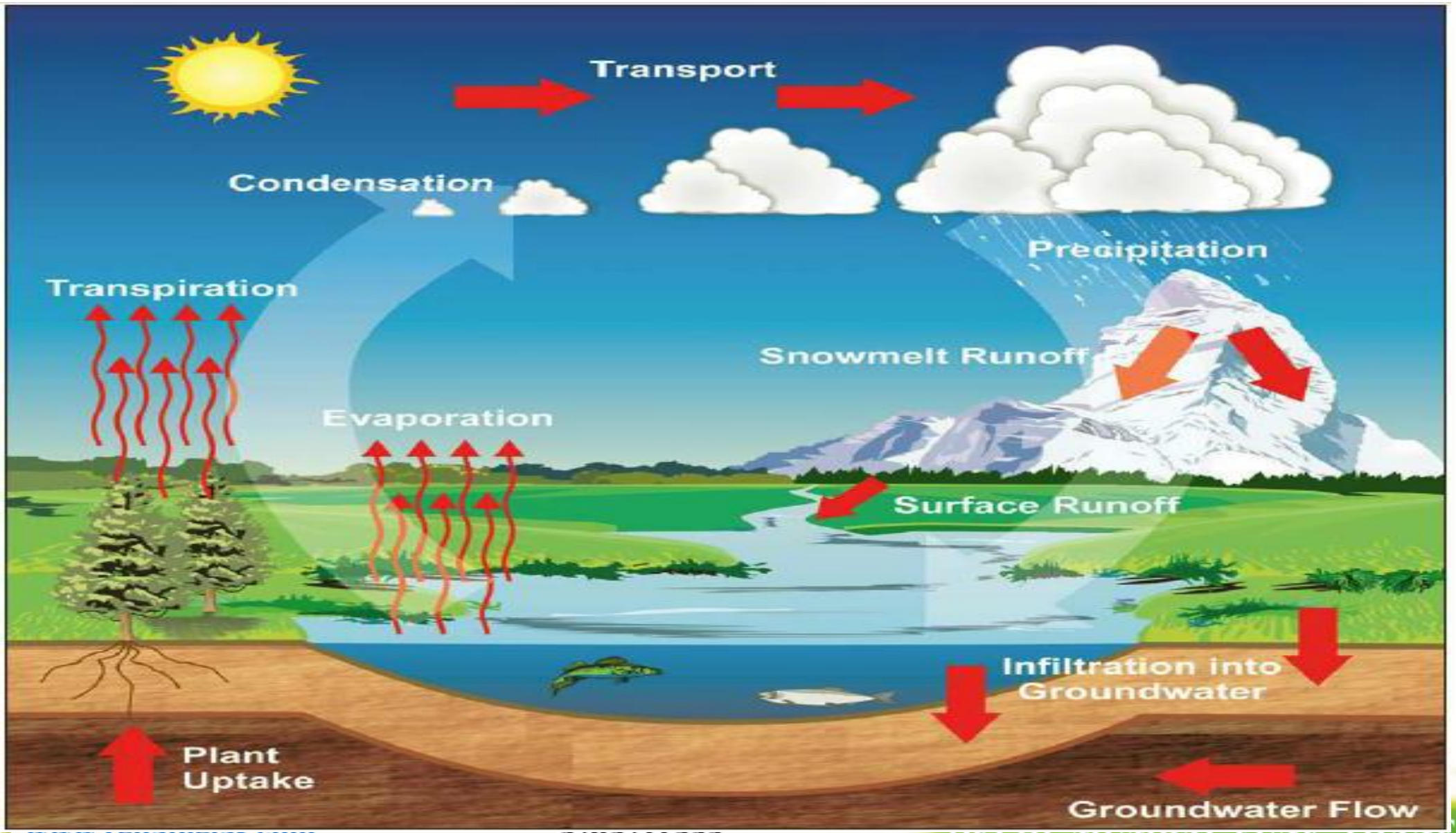

PM2.5
Combustion particles, organic compounds, metals, etc.
<2.5 µm (microns) in diameter
HUMAN HAIR
50-70 µm
(microns) in diameter
PM10
Dust, pollen, mold, etc.
<10 µm (microns) in diameter
90 µm (microns) in diameter
FINE BEACH SAND

Ice Nucleation Mechanisms in the Atmosphere

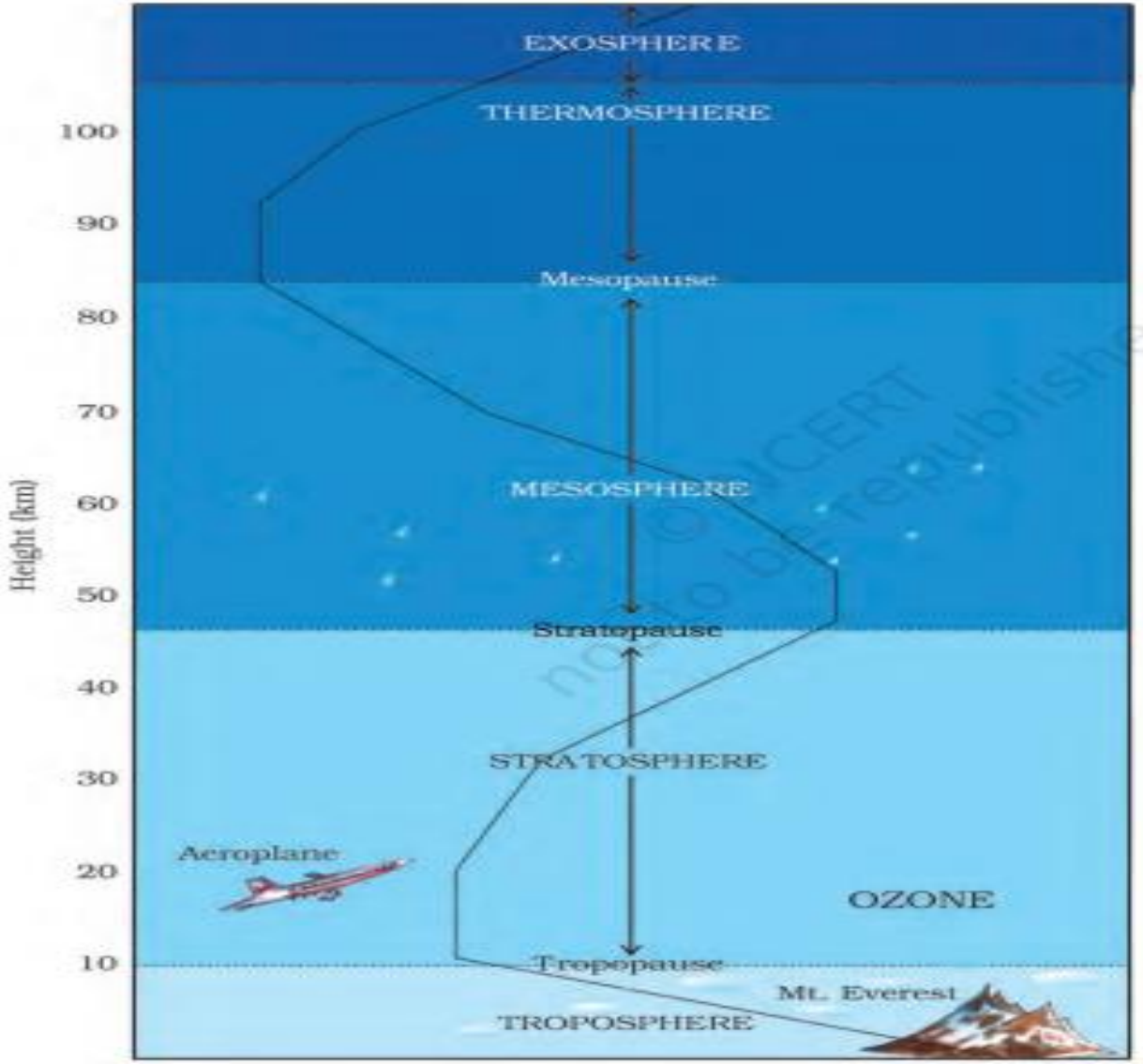


LIQUID

- In earth's atmosphere water is found in three different forms- solid liquid and gaseous. The amount of water vapour in the atmosphere is called humidity.
- Cloud, rainfall, cyclones and fog etc are the result of water vapour.
- About 90% of water found just upto the height of 5 km from earth surface.
- In Earth's greenhouse, water vapour is the main actor, as it absorbs Terrestrial radiation significantly.


Transport
Condensation
Precipitation
Transpiration
Snowmelt Runoff
Evaporation
Surface Runoff
Infiltration into Groundwater
Plant Uptake
Groundwater Flow

STRUCTURE OF THE ATMOSPHERE

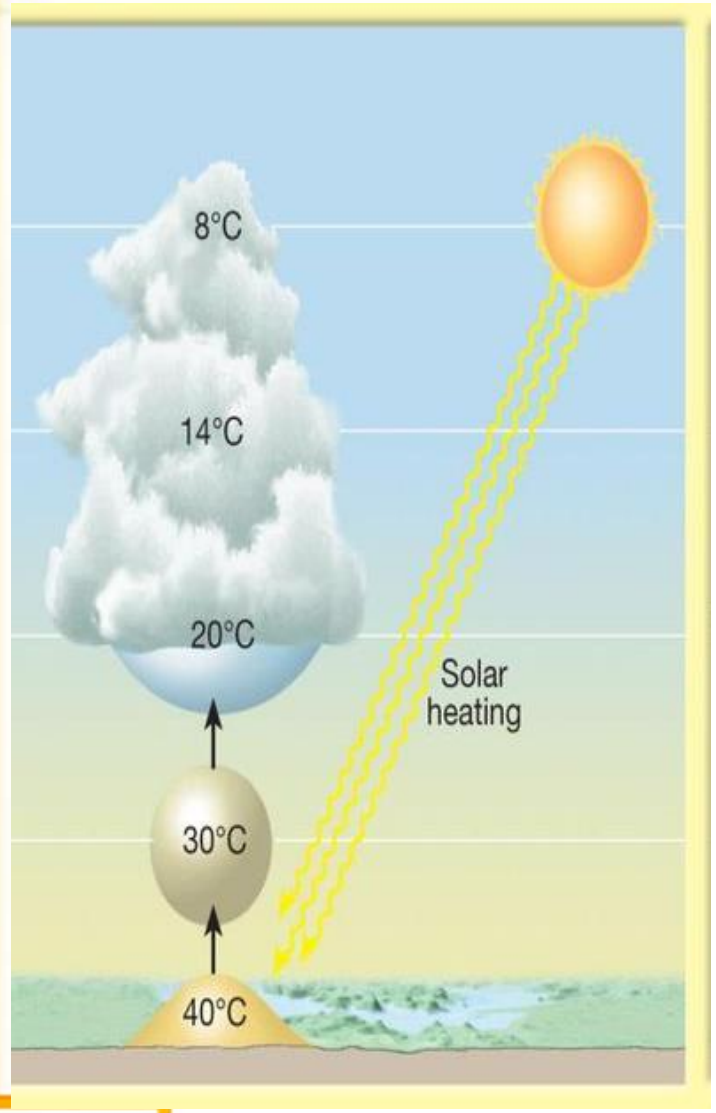


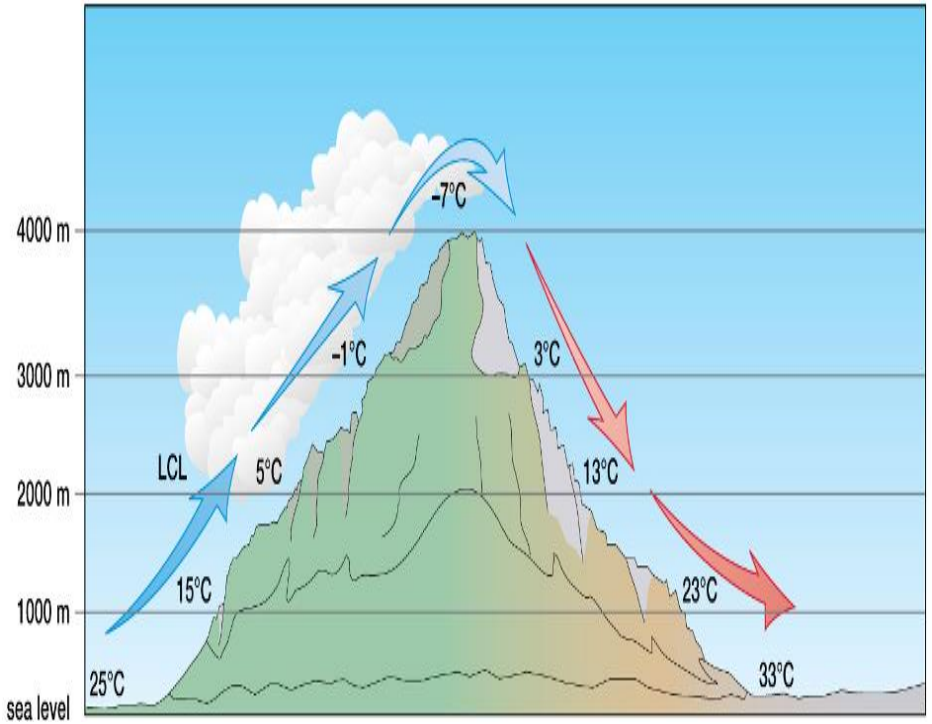
Atmosphere is divided into five layers-

1. Troposphere,
2. Stratosphere,
3. Mesosphere,
4. Thermosphere and
5. Exosphere.

TROPOSPHERE

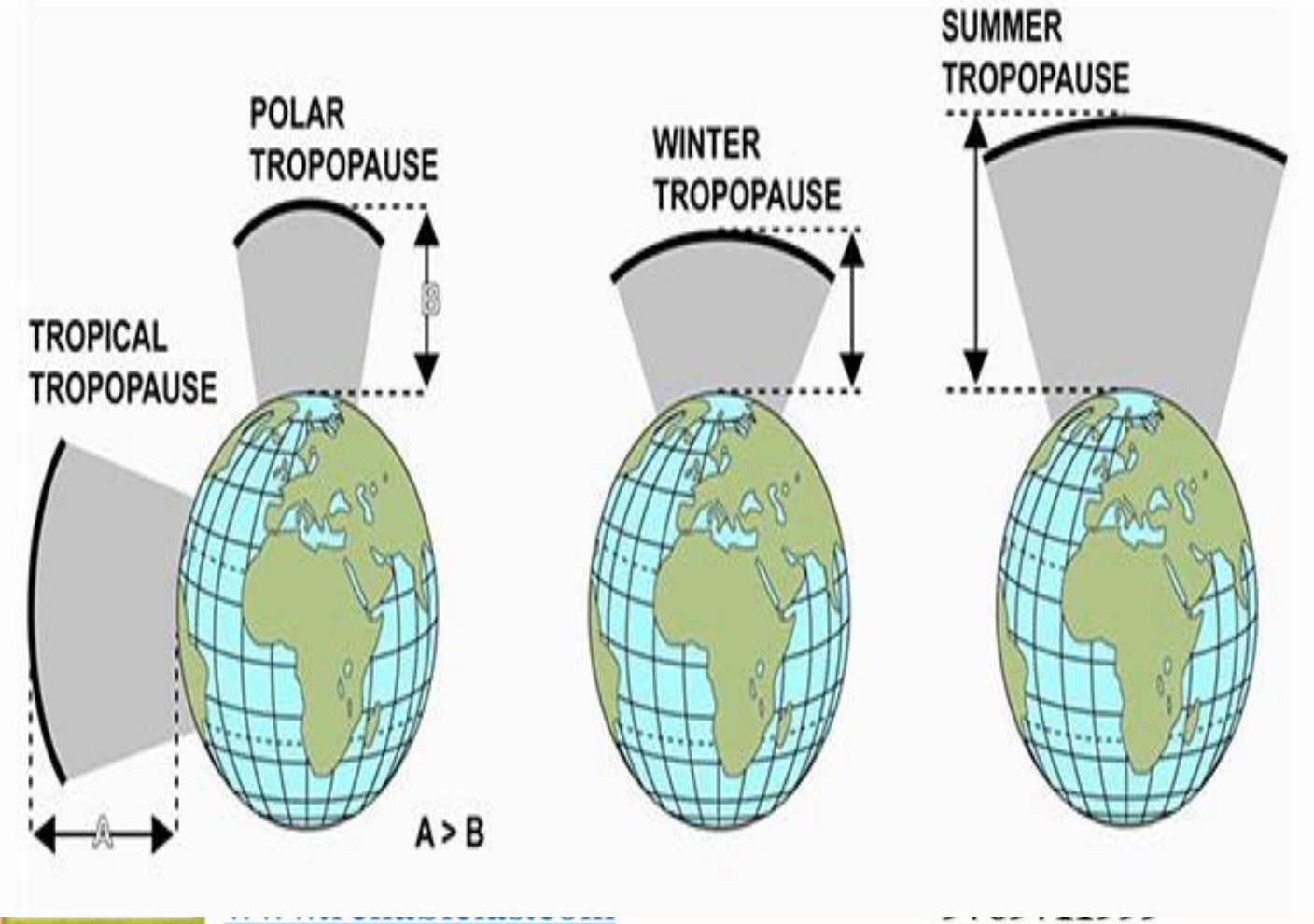
- Word ‘troposphere’ is derived from the Greek word ‘tropos’ meaning ‘mixing’.
- This layer is the most important layer of the atmosphere.
- Its average height is 13 km.
- Almost all the weather phenomena like rainfall, fog and hailstorm occur in this layer.
- Temperature decrease with increasing height at the rate of 6.5 degree C / km(or at a mean rate of 6.5 degree C /km), called normal lapse rate.
- The decrease occurs because air is compressible and its density decreases with height allowing rising air to expand and thereby cool.
- temperature at the top of troposphere is about minus 800 C over the equator and about minus 450 C over the poles.

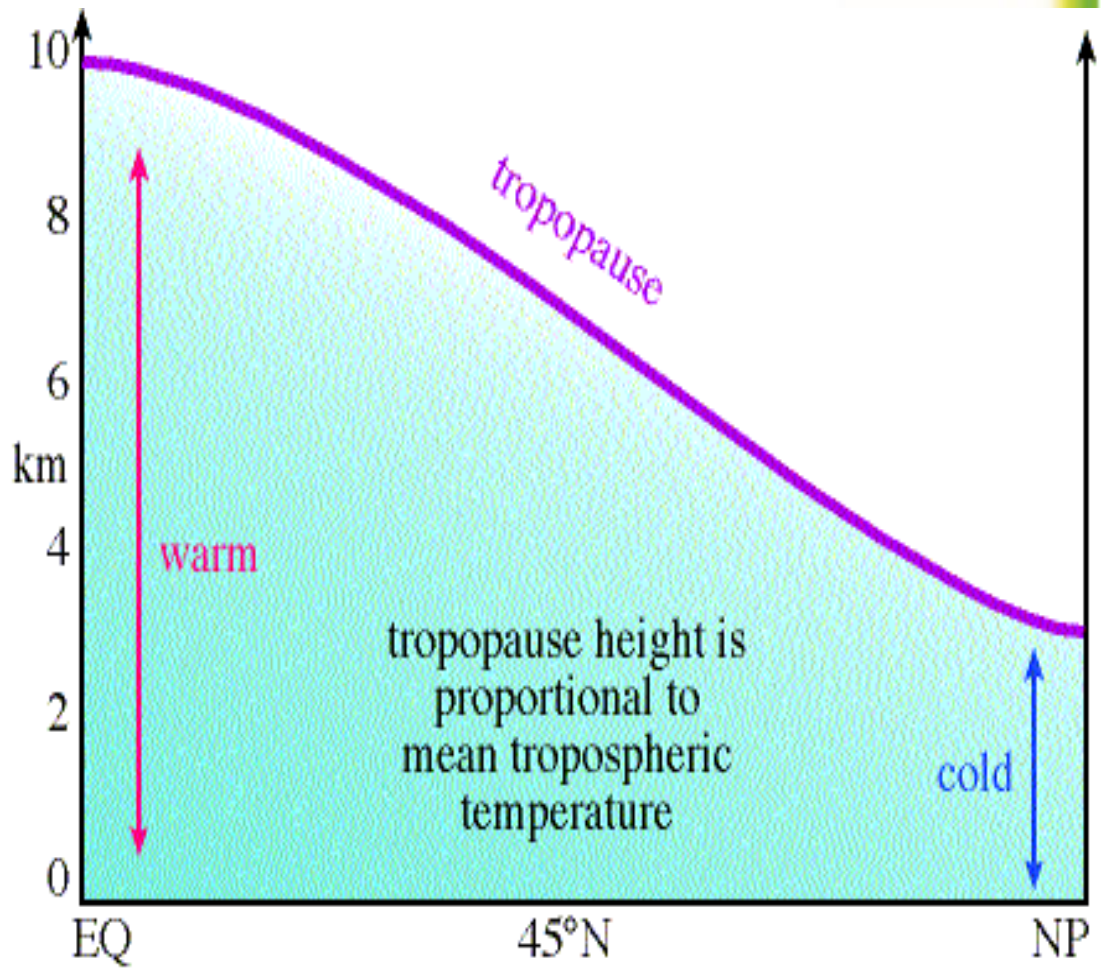

8°C
14°C
20°C
Solar heating
30°C
40°C


4000 m
3000 m
2000 m
1000 m
sea level
-7°C
-1°C
3°C
LCL
5°C
13°C
15°C
23°C
25°C
33°C


KILIMANJARO

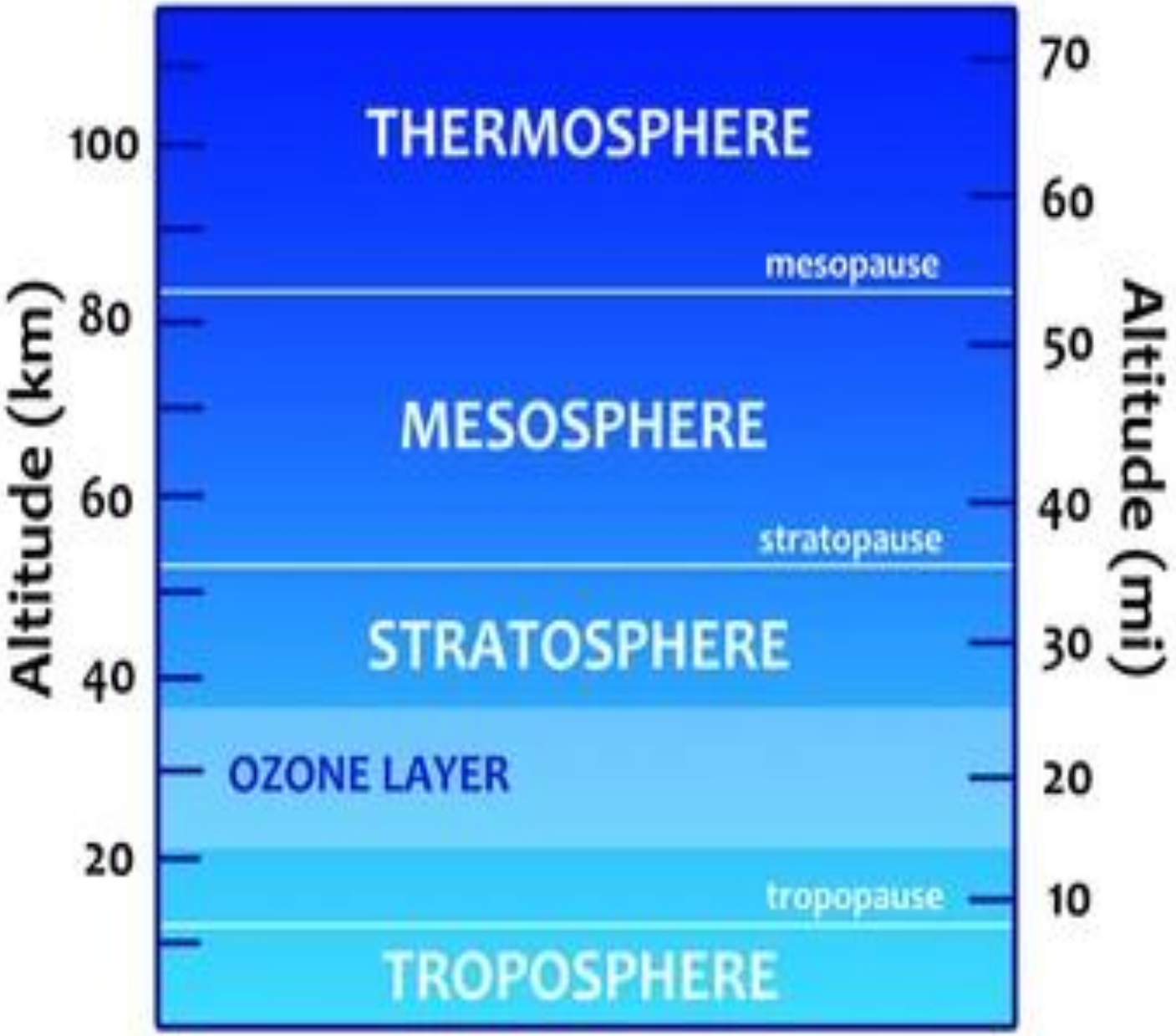
- At the top of the troposphere there is a shallow layer called the tropopause separating it from the next thermal layer of the atmosphere.
- Tropopause has its greatest height near the equator.

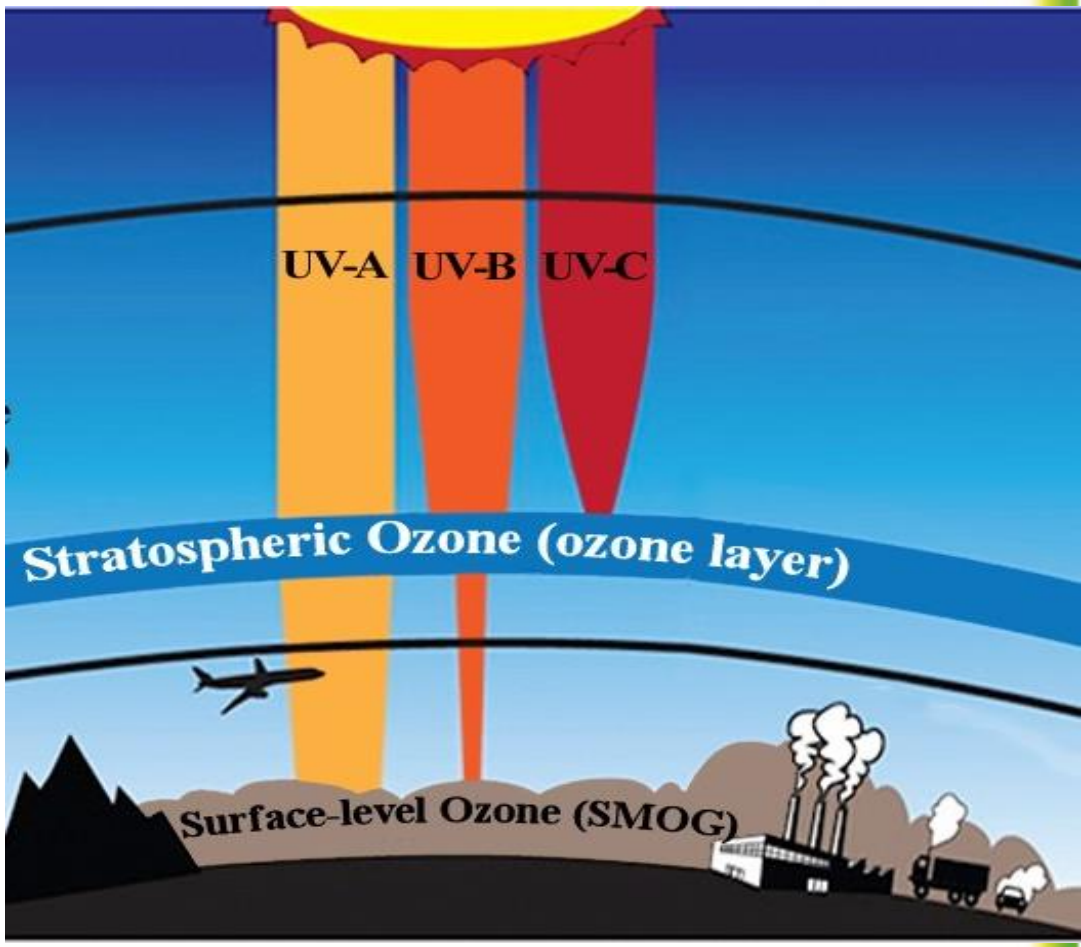


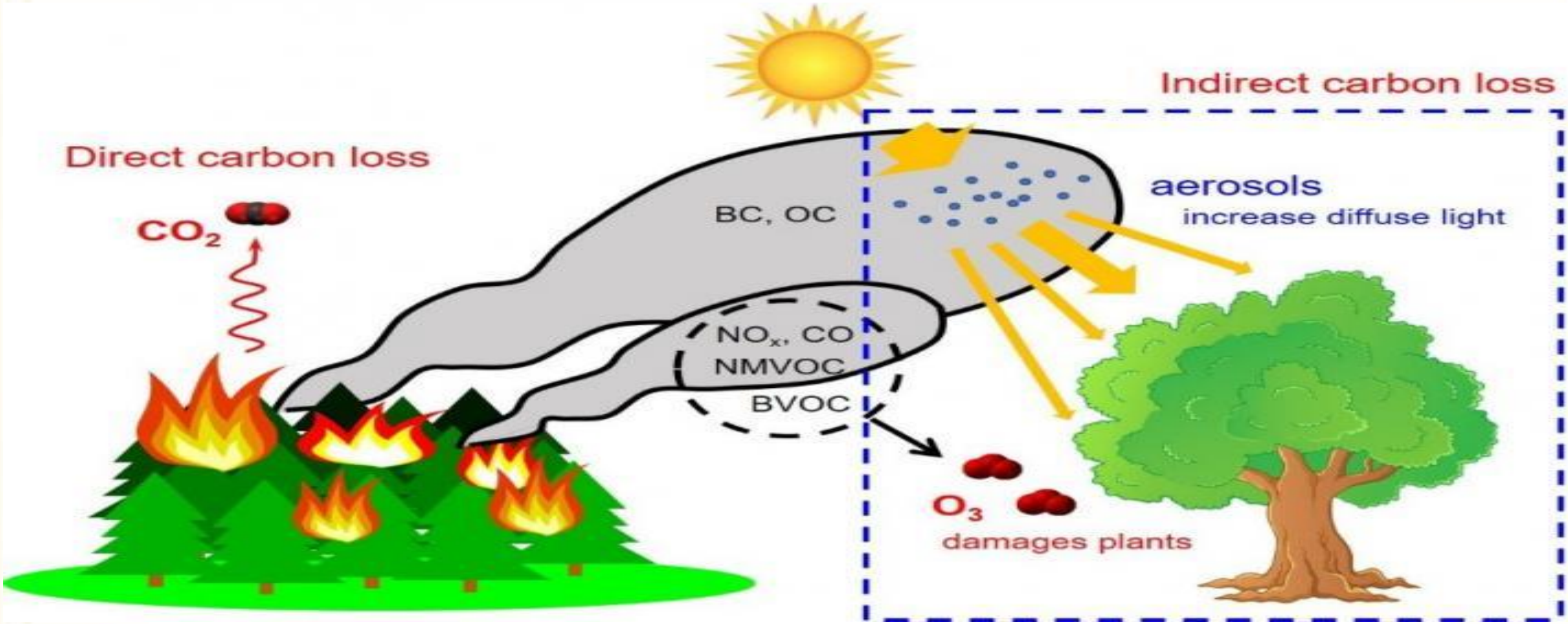


STRATOSPHERE

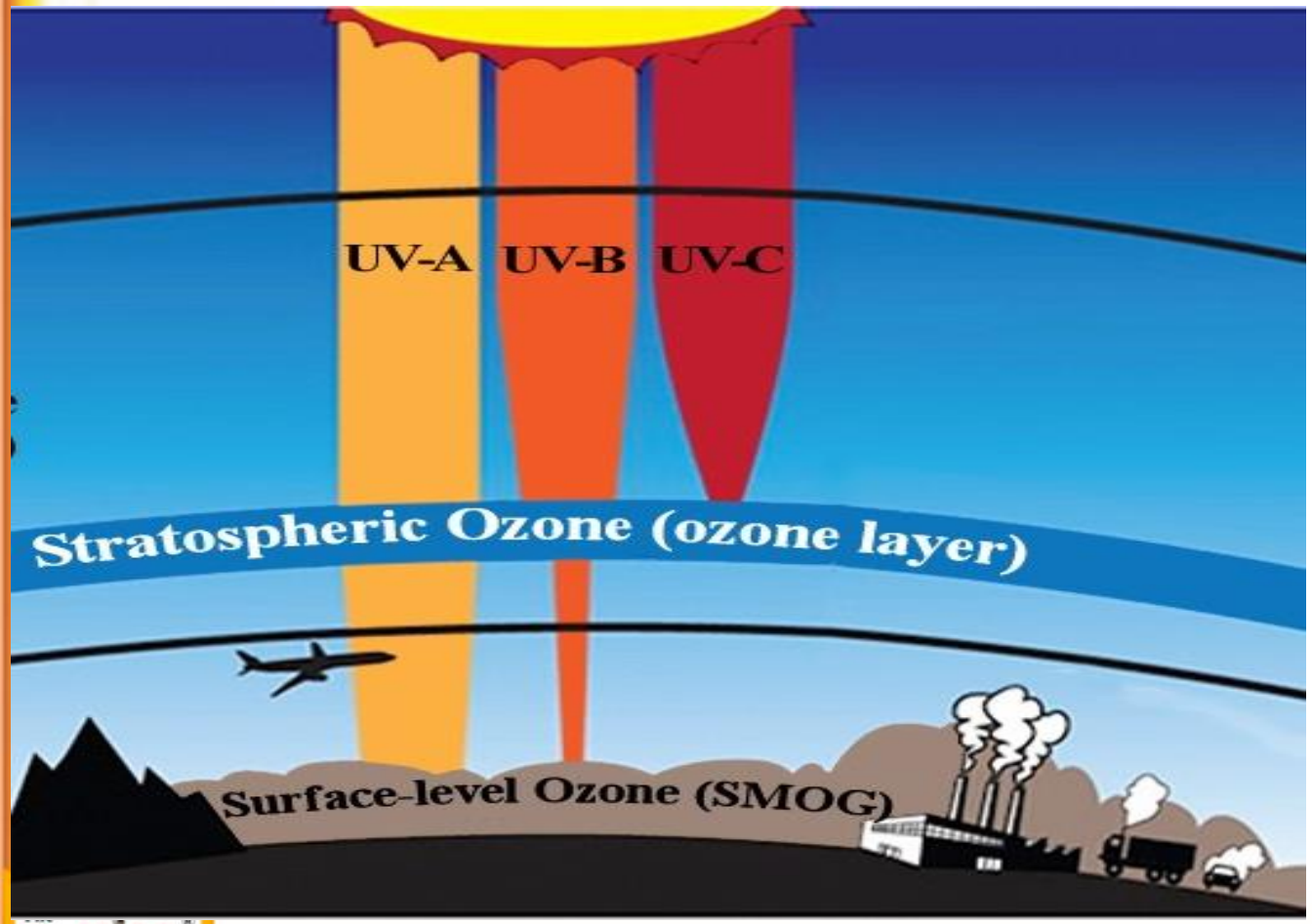
- It extends up to a height **of 50 km.**
- This layer is almost free from clouds and associated weather phenomenon , making conditions most ideal for flying aeroplanes.
- One important feature of stratosphere is that it contains a layer of ozone gas.
- The portion of the stratosphere having maximum concentration of ozone is called ozonosphere (around 15–30 km above the earth's surface).
- The rise in temperature with height in stratosphere is because of the absorption of ultra-violet by the ozone gas.
- Near Earth surface ozone is a pollutant. It is harmful to humans and its environment. Ozone molecules damages forests and crops; destroys nylon, rubber, and other materials; and injures or destroys living tissue. It is a particular threat to people who already have **respiratory problems**.

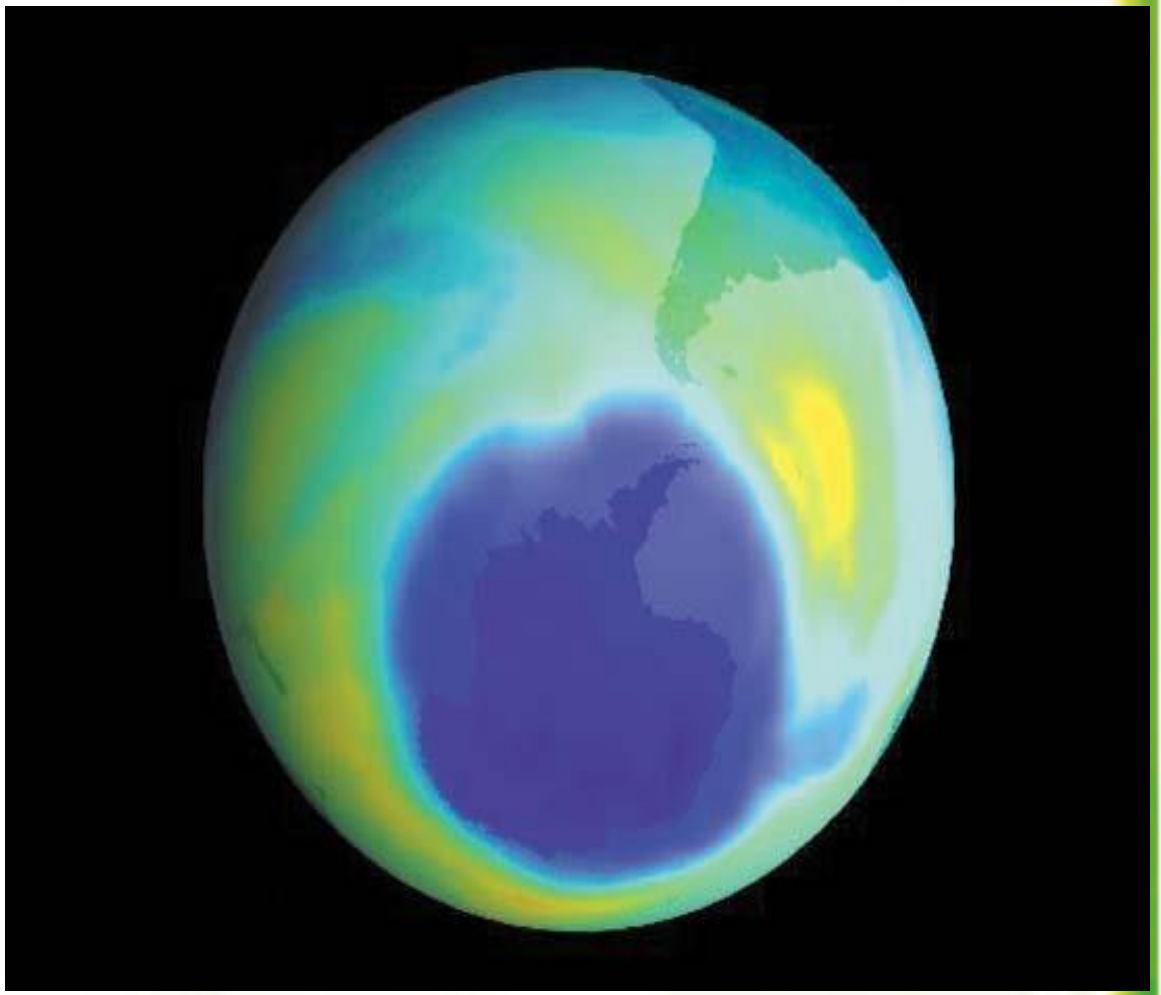

THERMOSPHERE
mesopause
MESOSPHERE
stratopause
STRATOSPHERE
OZONE LAYER
tropopause
TROPOSPHERE
Altitude (km)
100
80
60
40
20
Altitude (mi)
70
60
50
40
30
20
10

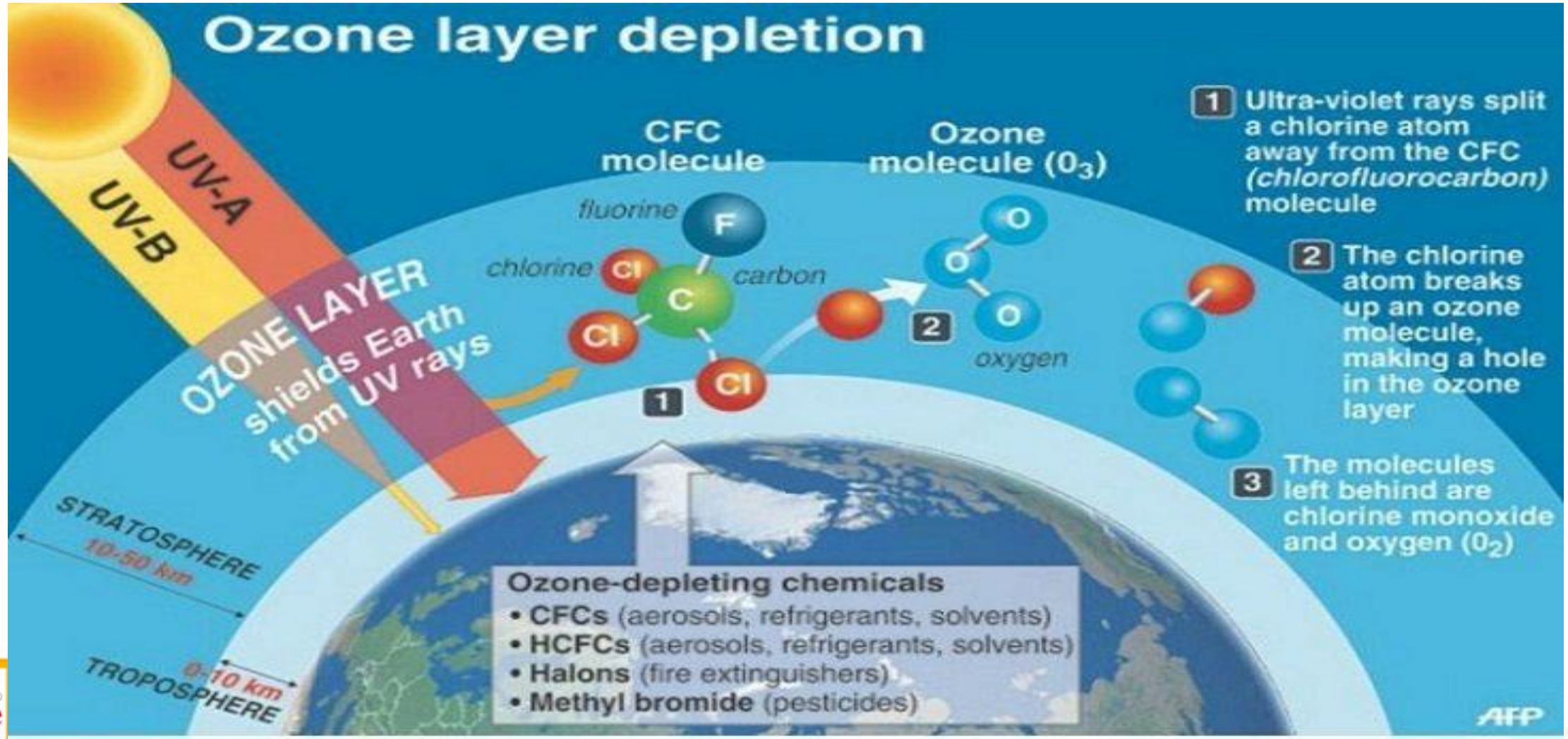

UV-A
UV-B
UV-C
Stratospheric Ozone (ozone layer)
Surface-level Ozone (SMOG)


Direct carbon loss
CO_2
BC, OC
NO_x, CO
NMVOC
BVOC
Indirect carbon loss
aerosols
increase diffuse light
O_3
damages plants

- Joe Farman, Brian Gardiner and Jonathan Shanklin Discovered ozone depletion over the Arctic
- Vienna Convention 1985 and Montreal protocol 1987 deals with ozone depletion.
- Kigali amendment 2016 signed to phase out HFCs.
- The main cause of Ozone Depletion is Chlorofluorocarbons (CFCs)which poses a serious threat to ozone layer.
- CFCs are synthetic industrial chemical compounds containing chlorine, fluorine, and carbon atoms.
- CFCs are widely used as cooling fluids in the refrigerating systems.
- CFCs when released in air are transported by the vertical atmospheric circulation and reach the ozone layer in the stratosphere.
- The CFCs absorb the ultra-violet radiation and decompose to chlorine oxide molecules and can convert the ozone into ordinary oxygen molecules.


UV-A
UV-B
UV-C
Stratospheric Ozone (ozone layer)
Surface-level Ozone (SMOG)

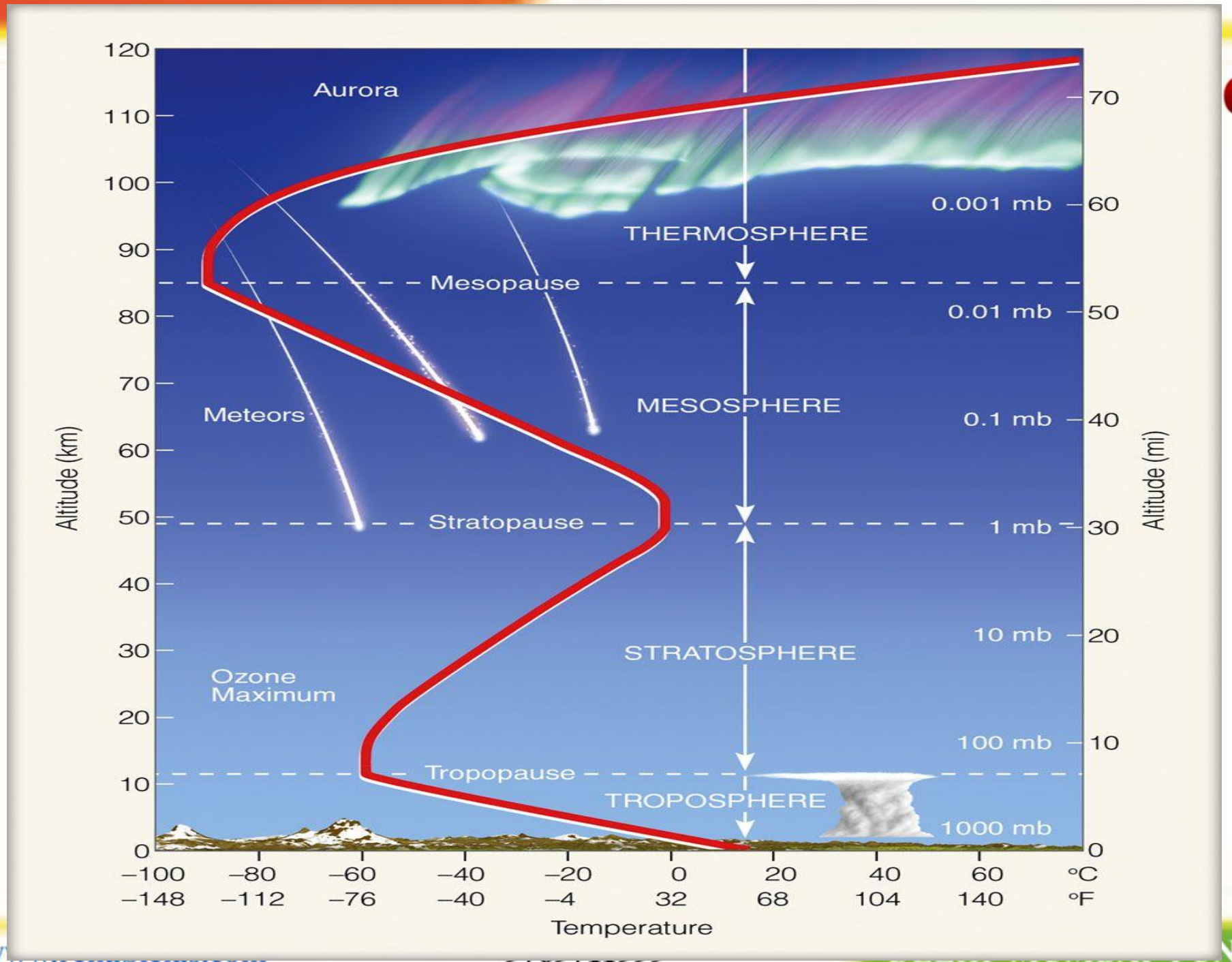



Ozone layer depletion
UV-A
UV-B
OZONE LAYER
shields Earth
from UV rays
CFC
molecule
fluorine
chlorine
carbon
F
Cl
C
Cl
Cl
1
Ozone
molecule (0_3)
O
O
O
2
oxygen
1 Ultra-violet rays split a chlorine atom away from the CFC (chlorofluorocarbon) molecule
2 The chlorine atom breaks up an ozone molecule, making a hole in the ozone layer
3 The molecules left behind are chlorine monoxide and oxygen (0_2)
STRATOSPHERE
10-50 km
0-10 km
TROPOSPHERE
Ozone-depleting chemicals
• CFCs (aerosols, refrigerants, solvents)
• HCFCs (aerosols, refrigerants, solvents)
• Halons (fire extinguishers)
• Methyl bromide (pesticides)
AFP

- Vitamin D **can be synthesized by UV light rays**
- Vitamin D is the **sunshine vitamin** that has been produced on this earth for more than 500 million years.
- During exposure to sunlight 7-dehydrocholesterol in the skin absorbs **UV B radiation** and is converted to previtamin D3 which in turn isomerizes into vitamin D3.

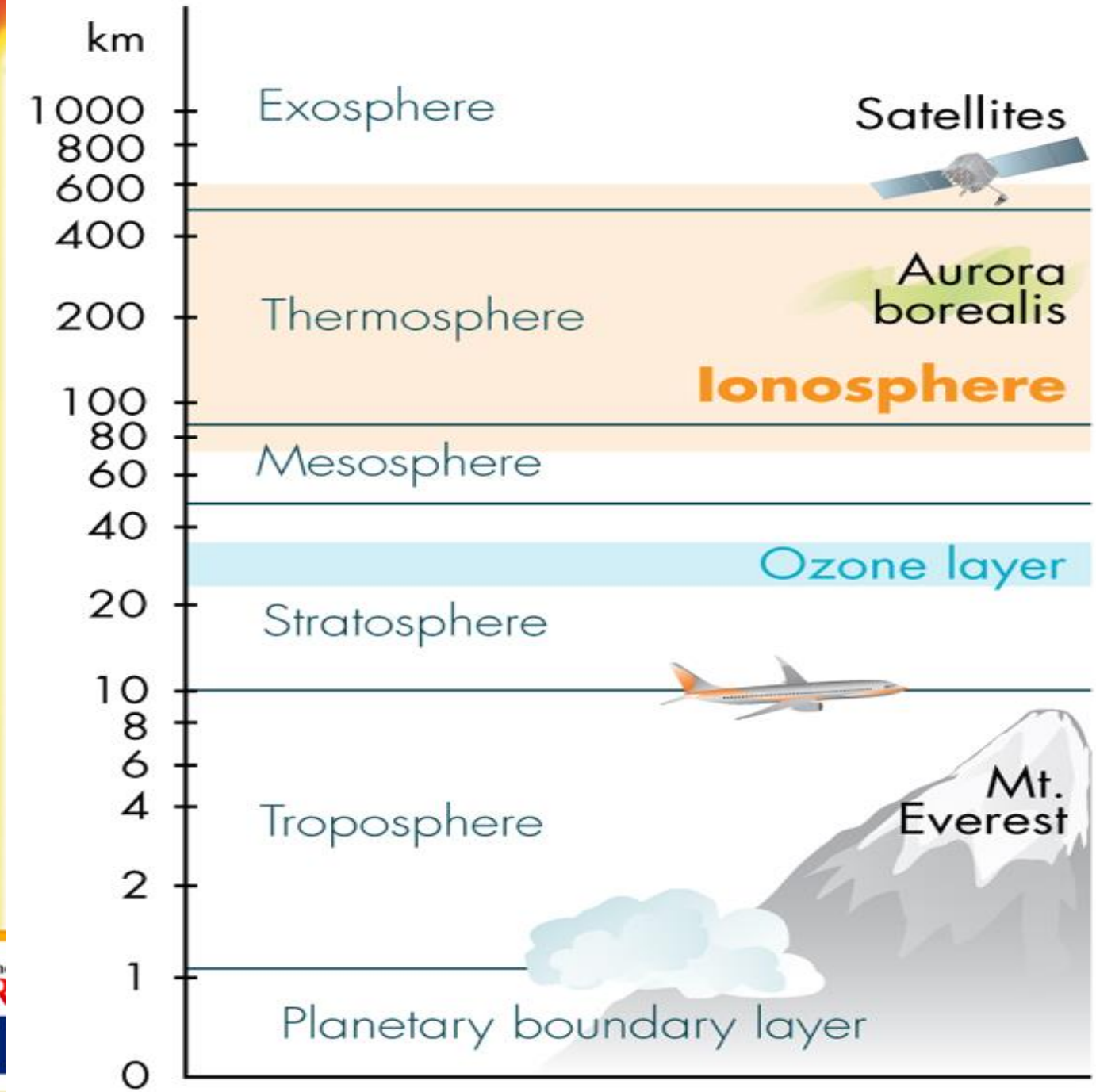
MESOSPHERE

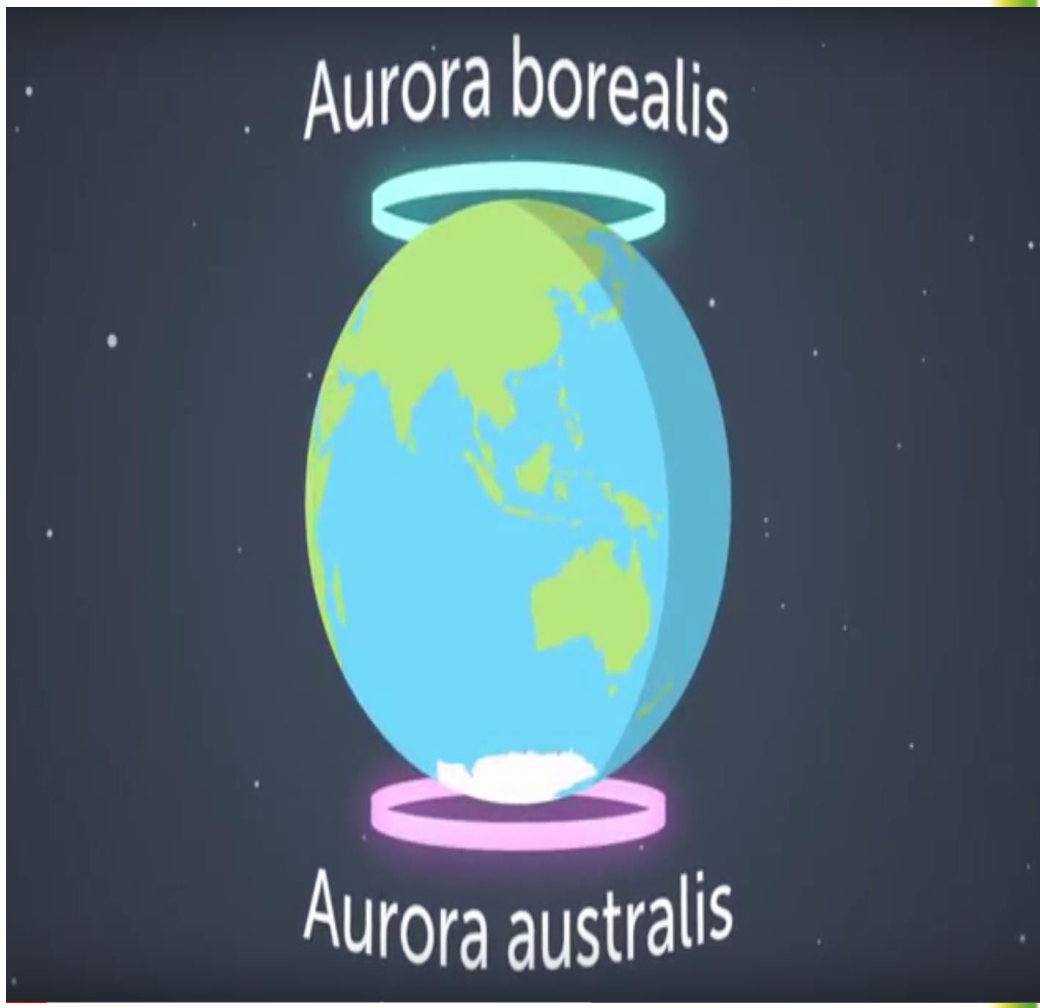
- This is the third layer of the atmosphere. It lies above the stratosphere.
- **It extends up to the height of 80 km.**
- **Meteorites burn** up in this layer on entering from the space.
- Minimum temperature of atmosphere found at mesopause - 100 degree C.
- **Noctilucent clouds** are the highest clouds in the Earth's atmosphere, 83 km and are observed slightly below the mesopause in the polar summertime.

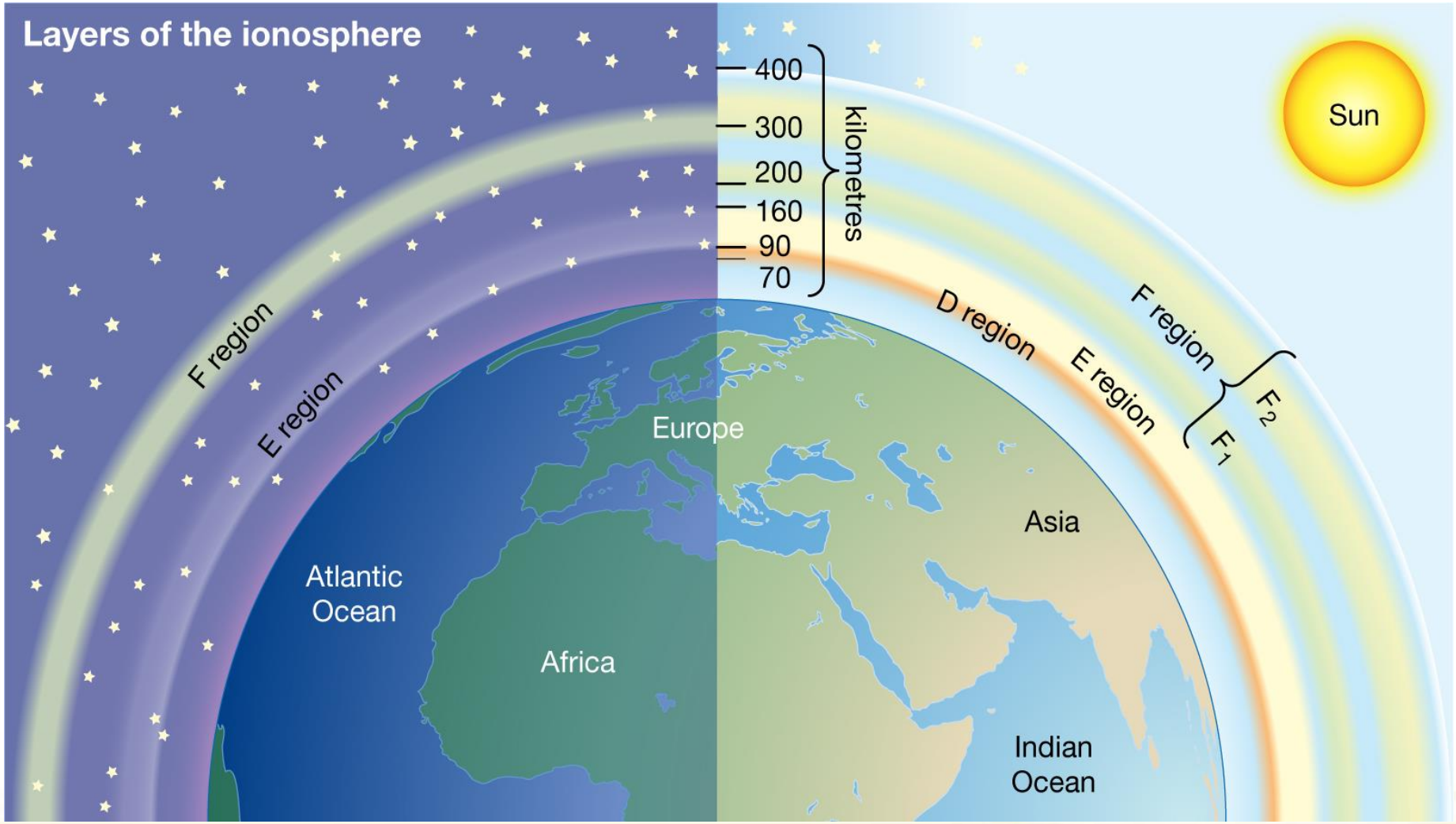


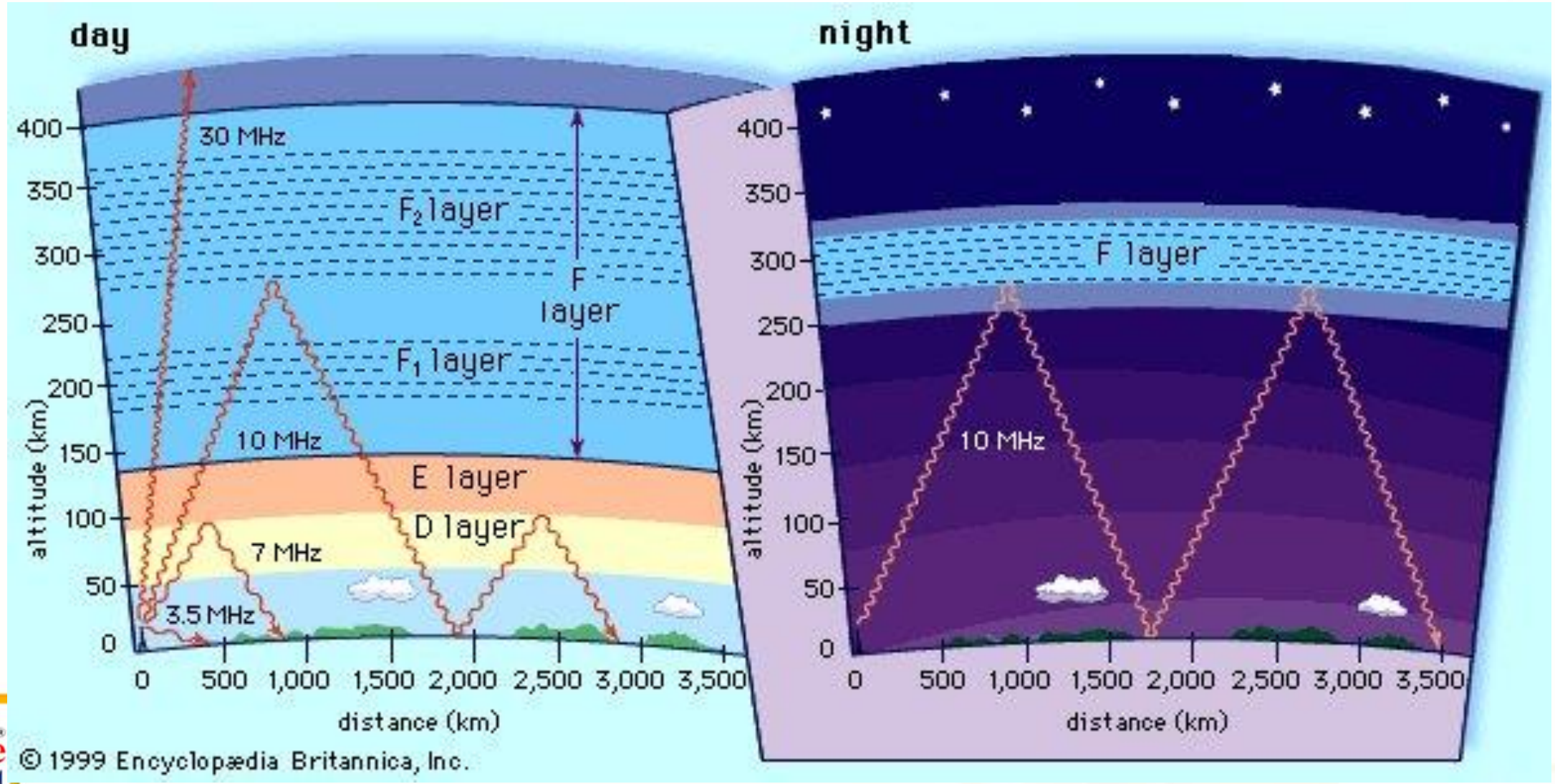
THERMOSPHERE:

- In thermosphere temperature rises very rapidly with increasing height.
- Ionosphere
- Ionosphere is a part of thermosphere.
- It extends **between 80-400 km.**
- Ionosphere is further divided into different layers, namely
  - D-layer (upto 99km)- reflects low frequency / high wave length
  - E-layer (90-130km)- kennely Heaviside layer; reflects medium & high frequency / medium and high wave length
  - F Layer- known as Appleton layer; reflects medium & high frequency
  - Sporadic E-Layer,F1 & F2 layer (150-380km) and
  - G-layer (>400km).- reflects short, medium & high frequency
- Layers such **as D-layer, E-layer**, exist only during day time and vanishes as soon as sun sets.
- **This layer helps in radio transmission.**
- **In fact, radio waves transmitted from the earth are reflected back to the earth by this layer.**
- **Aurora** and satellites occur in E- layer.






Layers of the ionosphere
400
300
200
160
90
70
kilometres
Sun
F region
E region
D region
E region
F region
F2
F1
Europe
Asia
Atlantic Ocean
Africa
Indian Ocean


day
night
400
350
300
250
200
150
100
50
0
altitude (km)
30 MHz
F2 layer
F layer
F1 layer
10 MHz
E layer
D layer
7 MHz
3.5 MHz
0
500
1,000
1,500
2,000
2,500
3,000
3,500
distance (km)
F layer
10 MHz
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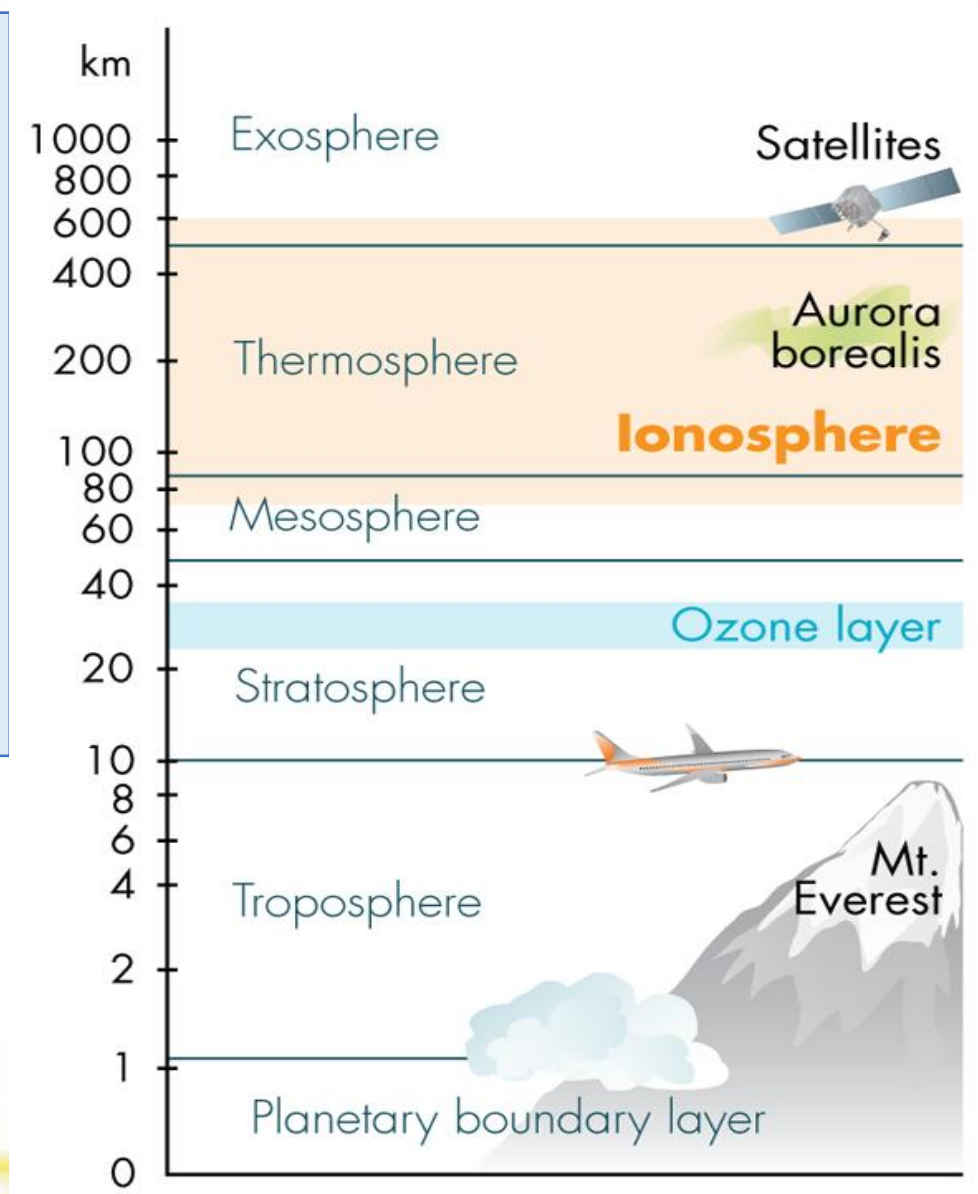
EXOSPHERE

- The upper most layer of the atmosphere is known as exosphere.
- 640-1000 km.
- Electric charged particle found in this layer.
- This layer has very thin air.
- Light gases like helium and hydrogen float into the space from here



CHEMICAL COMPOSITION

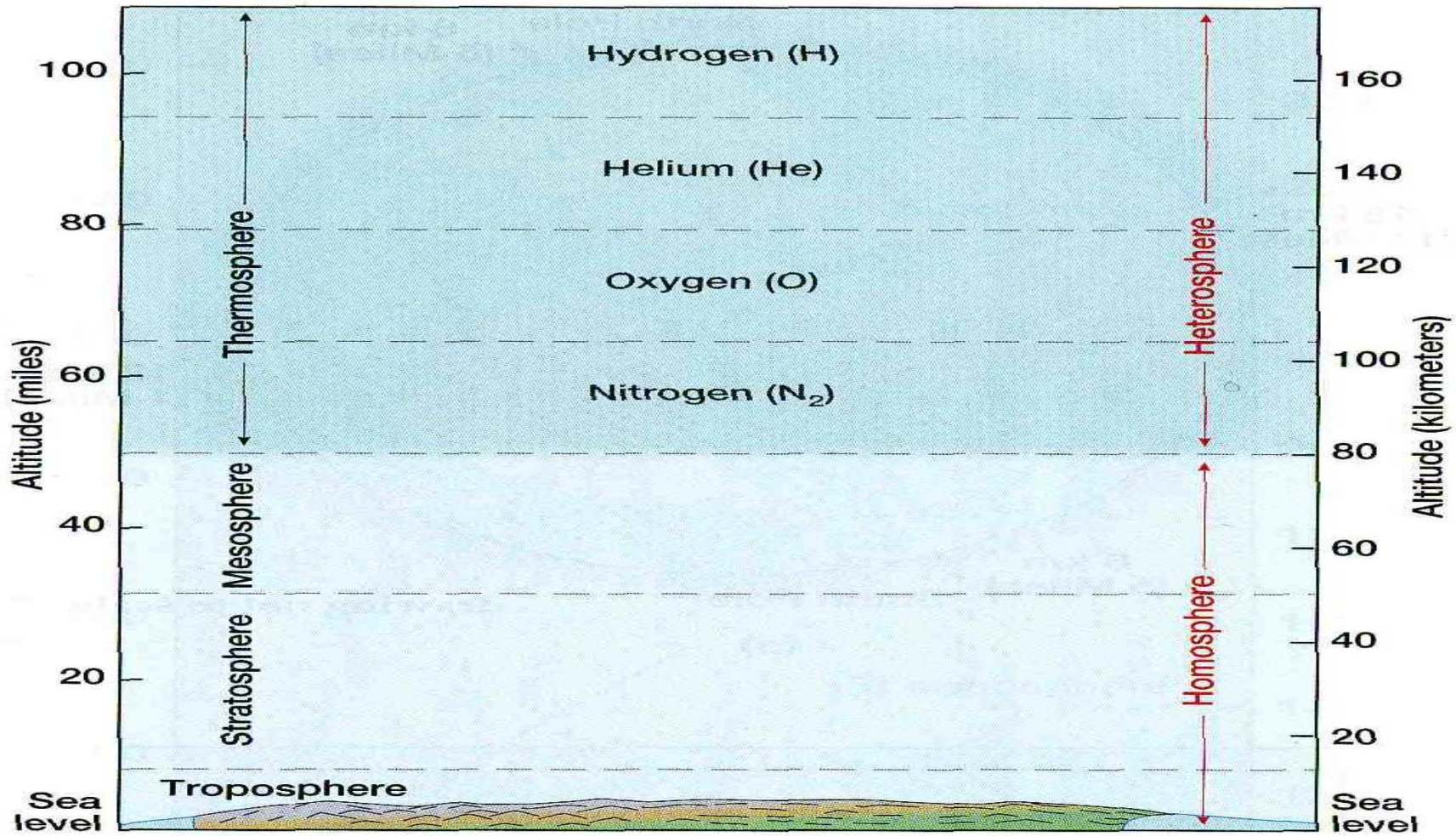


Figure 3-9 The homosphere is a zone of uniform vertical distribution of gases. In the heterosphere, however, the distribution lacks this uniformity.

- On the basis of chemical composition atmosphere can also be divided.
- According to International Space Symposium 1962, atmosphere can be divided into two broad layers, namely **Homosphere and Heterosphere**.
- Homosphereis the lower layer and extends up to **88 km**. from the earth's surface. The proportions of the component gases are uniform at different levels. Homosphere includes troposphere, stratosphere and mesosphere includes.

Heterosphere

- It extends beyond 88 km to more than 3500 km.
- Here, atmosphere is not uniform in its composition.
- It is also called to as thermosphere as temperature rises with height.
- In this sphere, atmosphere becomes quite thin.
- There are separate layers of gases found in this sphere, which are in increasing order :-
  - Nitrogen layer
  - Oxygen layer
  - Helium layer
  - Hydrogen layer