E-CONTENT

UDAI PRATAP COLLEGE, VARANASI-221002, INDIA

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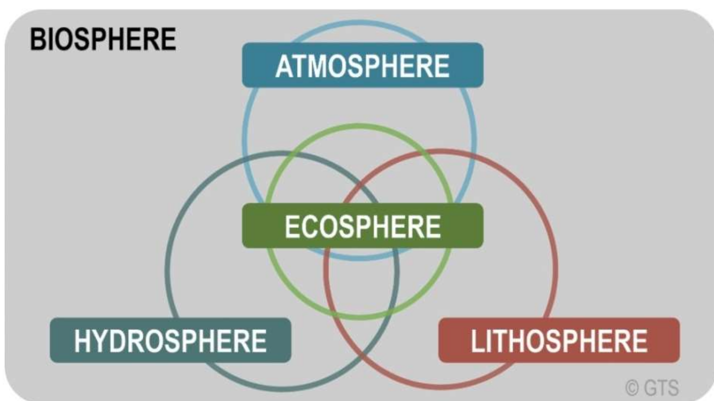
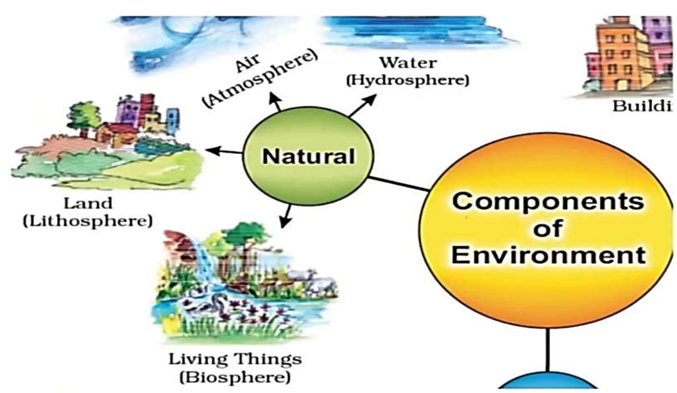
Topic:ATMOSPHERE

Name:Prof. Ajai Kumar Singh,Department of Botany, Faculty of Science,
Mobile No. 9450538149, E-mail: ajaiupcollege@gmail.com



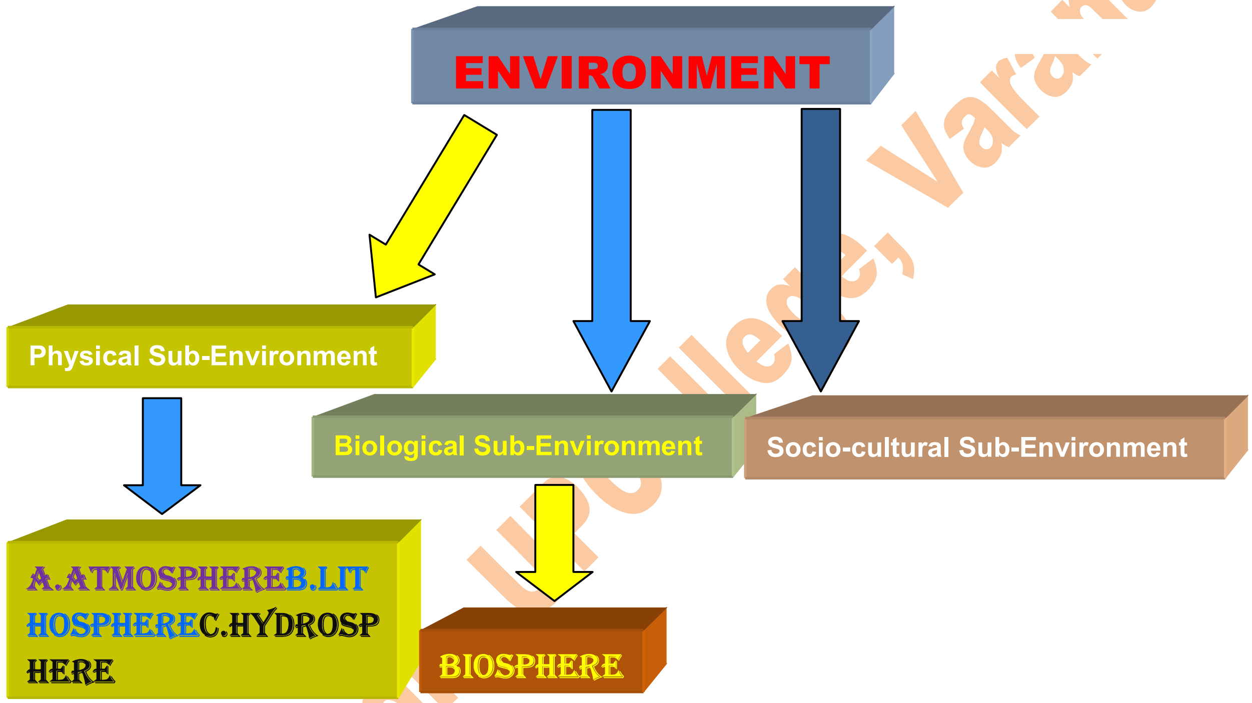


Components of Environment

Environmental studies is an interdisciplinary field that examines human interactions with the natural environment.

- *All Systems surrounding an organism constitute its Environment*

System Approachin environmental science focuses on viewing the environment as a complex system with interconnected components. This approach emphasizes the interactions between different elements such as **Atmosphere, Hydrosphere, Lithosphere and Biosphere**.



ATMOSPHERE

The gaseous envelope surrounding the Earth is known as the terrestrial Atmosphere.By virtue of its composition the Atmosphere regulates the temperature and provides shielding effect from harmful wave lengths of the solar radiation, thus making the life on earth possible.

NATIONAL ATMOSPHERIC RESEARCH LABORATORY [NARL], TIRUPATI, ANDHRA PRADESH, INDIA
NARL is engaged in fundamental and applied research in the field of Atmospheric Science. The research institute was started in 1992.

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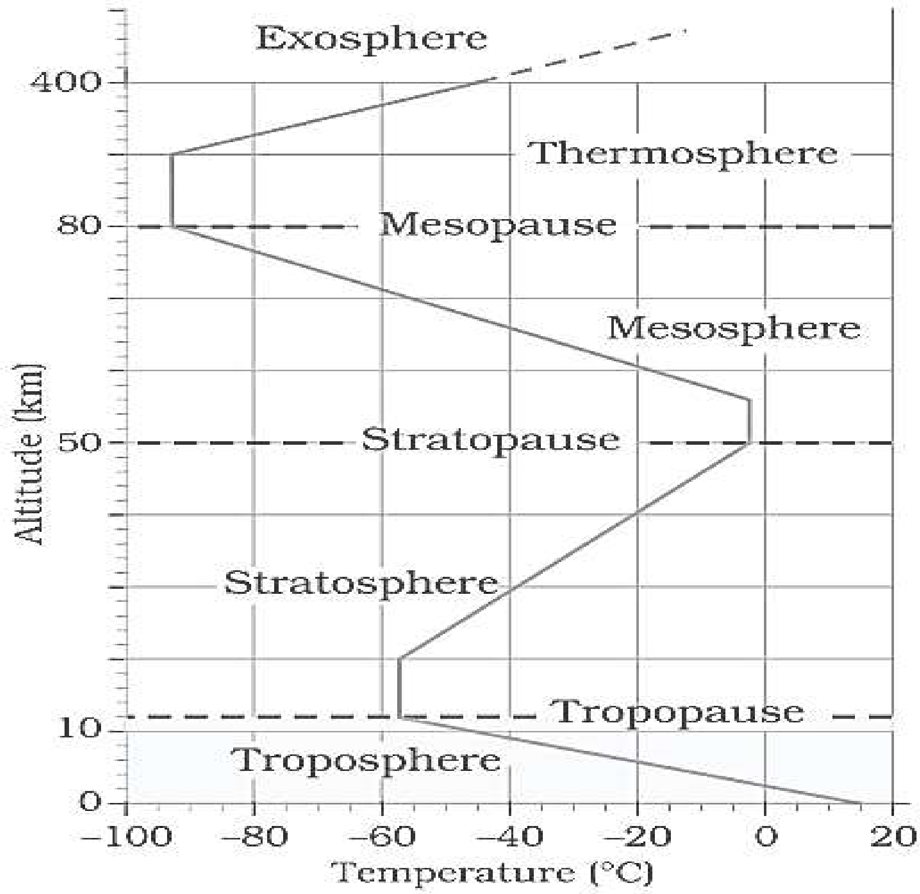
National Atmospheric Research Laboratory [NARL], Andhra Pradesh

Solar panels and Radio communication System at NARL

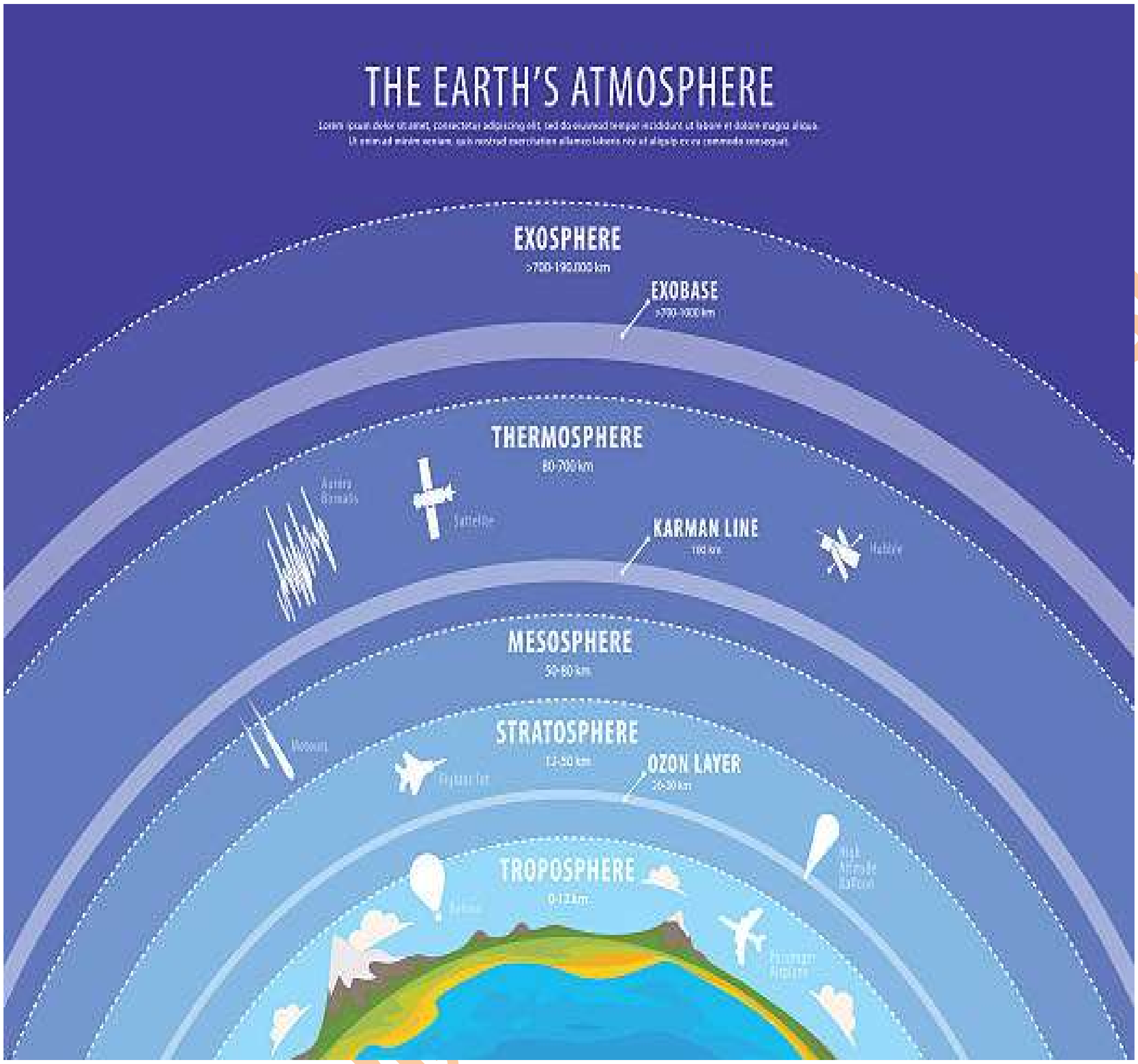
Physical Structure:

- Seventy five percent of the Earth's Atmosphere lies in 15 Km of the surface.
- Ninety-nine percent of the Earth's Atmosphere lies below 30 Km of the surface.
- Total Mass of Atmosphere=5,500 Trillion Tonnes or 5.7 x 10^5 Tonnes of Air.
- Density of Atmosphere α 1/Altitude

❖ Temperature Range – 100 to 1200^{0}C, depending upon the altitude.



REGION	ALTITUDE	TEMP. RANGE	CHEMICAL ONSTITUTION
Troposphere	**0-20 Km**	**15-56^{0}C**	**N_2, CO_2, H_2O**
Tropopause	**20-30 Km**		
Stratospher	**30-50 Km**	**-56 to -2^{0}C**	**O_3**
Stratopause	**50-60 Km**		
Mesosphere	**60-75 Km**	**-2 to -92^{0}C**	**O_2^+, NO^+**
IONOSPHERE			
Mesopause	**75-82 Km**		
Thermosphere	**82-300 Km**	**-92 to 1200^{0}C**	**O_2^+, O^+, NO^+**
Exosphere	**300-1000 Km**		
Outer space	**>1000 Km**		



<u>**ATMOSPHERE**</u>

a. **Lower Atmosphere** (upto 50 Km)
b. **Upper Atmosphere**

<u>**ATMOSPHERE**</u>

a. **Homosphere**(Lower region relatively homogeneous)
b. **Heterosphere**(More variation in composition)**-** Heterosphere bears <0.01% of the mass of the atmosphere. It filters the lethal Gamma and X-rays which otherwise ionise the living matter.
c. **Magnetosphere:Magnetosphere shields the earth from eruptions of charged particles from the Sun. It is the area just above the Ionosphere, and controlled by Earth's Magnetic field, occasionally develops cracks.**
According to a study the Magnetosphere develops cracks that may lost for hours. The breach allows charged electrons and ions from the sun, force called the SOLAR WIND, to stream into Earth's upper atmosphere and dump load of magnetic energy.

The Earth's atmosphere is divided into several layers based on temperature and increasing altitude.

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These layers include the **Troposphere, Stratosphere, Mesosphere, Thermosphere**, and the **Exosphere.**

A.Troposphere:

The troposphere is the lowest layer of the atmosphere where most weather phenomena occur.

It extends from the Earth's surface to about 10 km in altitude.

The temperature decreases with height in this layer, and it contains about 75% of the atmosphere's air and nearly all of its water vapour.

The boundary layer at the bottom experiences turbulence due to interactions with the Earth's surface, while the top of the troposphere is known as the ***Tropopause***.

This sphere is the lowermost layer where organisms operate.

Rate of temperature drop 6.4^0C/1000m. or 10^C/165m-known as **Normal Laps Rate.**

All water vapour available in troposphere and it encloses all storms and precipitation. It is the region of Sulphates and strong air movements with cloud formation. It is the mixture of several gases.

It is the sphere in which man and other organisms live and have more density of N_2, O_2, and particles.

This region has 70% mass of Atmosphere and homogeneous in absence of particles.

B. Stratosphere (Ozonosphere):

Above the troposphere lies the stratosphere, which extends up to about 50 km above Earth's surface.

The temperature in this layer increases with height due to the absorption of ultraviolet radiation by ozone molecules.

The stratosphere contains much of the atmospheric ozone that protects life on Earth from harmful UV rays.

Human activities, such as releasing CFCs (chlorofluorocarbons), have led to ozone depletion, particularly evident in regions like the Antarctic ozone hole.

Ozone Layer: 16-40 Km and absorbs UV-B rays.

Ozone layer acts as Umbrella or Blanket and absorb UV radiation, help to maintain the temperatureof the Earth or reduces the cooling rate. Its thickness around 3mm.

In this layer the heat is formed by a cycle of chemical changes in the ozone layer which converts all, the incoming high energy UV-rays to heat.

Chief gases of this region are N_2, O_2, O_3, H_2O etc.

The absorption of UV radiation in the Stratosphere prevents **all radiations below 290 nm and mostly between 290-320nm**from reaching the Earth. IR radiations also absorbed and reemitted by Ozone adds to the temperature rise.

The layer is stratified layer in which gases lie divided in layers according to their specific weight. Water vapour is very less hence no cloud formation and precipitation.

If pollutants are injected some how, it cause long term global hazards.

Clouds are almost absent and very little dust and water vapour.

The air move horizontally.

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Temperature above equator -80^{0}C and at Poles -45^{0}C.
Ozone Hole formation for the first time reported in 1980.

C.Mesosphere:

Beyond the stratosphere is the mesosphere, extending to around 85 km above the Earth's surface where temperatures decrease again with height.
The **mesopause** marks a minimum temperature point of around -90°C in this layer.
The mesosphere also hosts high-altitude clouds like **Noctilucent** clouds that can be visible after sunset.
It is the region of coldest temperature in atmosphere (upto -100^{0}C) at the height of 80 Km.

D. Thermosphere and Ionosphere:

Above the mesopause lies the thermosphere, where temperatures rise with increasing altitude due to absorption of solar radiation.
This region is responsible for phenomena like **Auroras** and contains ionized gases that form part of the ionosphere.
Ions and Radicals-both +ve ions and electrons, dominate the Ionosphere.
Ions are formed due to UVR.
The temperature become very high due to high energy radiations.
Air has low density.
It is an electrically charged layer.
Any dense object in this layer will be extremely hot in day and very cold at night.
Gases exists in atomic form and in the upper part ionization of air occurs (i.e. formation of electrically charged particles or ions, that is why called Ionosphere.
It has great role in long range Radio communication.

E. Exosphere:

Starting at around 500 km above Earth's surface is the exosphere, which transitions into outer space and where molecules can escape into space.

- **Above 400 Km, Oxygen less than 10%.**
- **Oxygen stable in Thermosphere and responsible for 'Air Glow' [The reflecting power of Earth's Atmosphere to incoming Solar radiation make our earth Glow. It is a faint electromagnetic radiation, emitted by earth atmosphere.**
- **Lacks atoms except H_2 and He.**
- **Also known as 'Helium zone' due to abundance of Helium.**

[HETEROSPHERE:

a. **Thermosphere-**Temperature rises rapidly and indefinitely.
b. **Molecular Nitrogen Layer:** Range 33-75 Km, mainly having molecular Nitrogen.
c. **Atomic Oxygen Layer:** Above Nitrogen layer, 75-350 Km.
d. **Helium Layer:** Having abundant Helium, 250-1200 Km.
e. **Hydrogen Layer:** Abundance of Hydrogen, Range 1200-3500 Km.]

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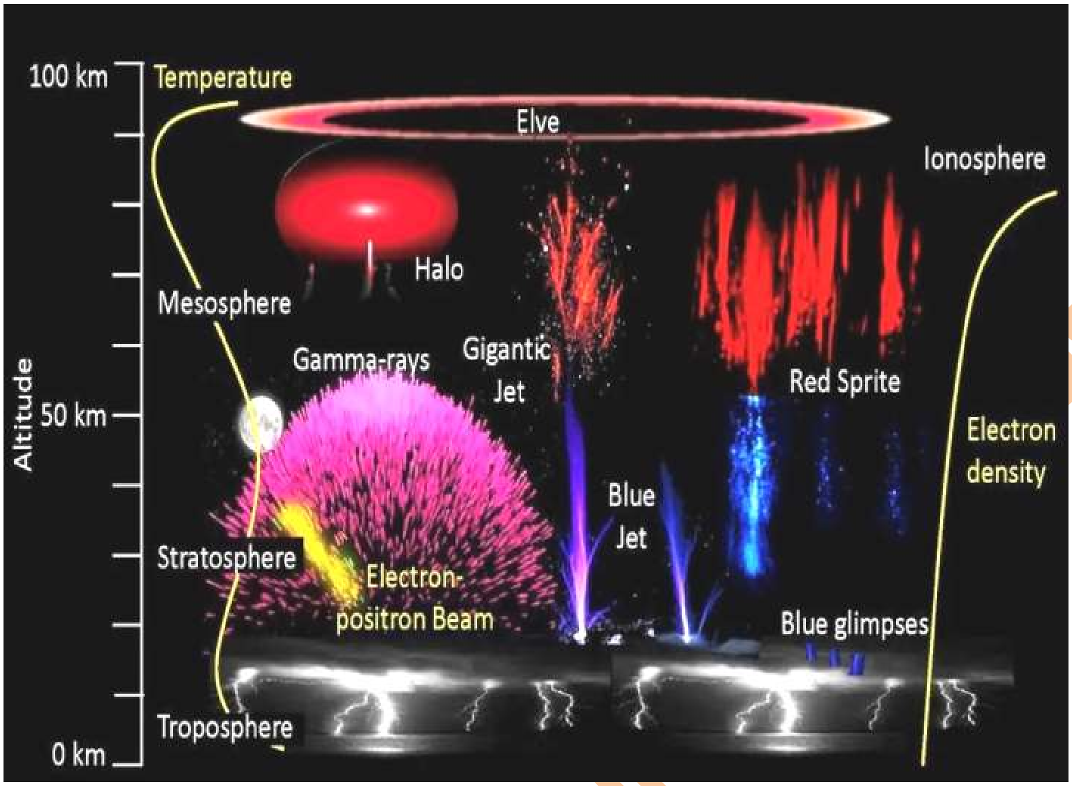

Physical Properties of the Atmosphere

- The physical properties of Earth's atmosphere include Pressure, Temperature, Density, and Composition.
- The atmosphere exerts pressure on objects within it and on the Earth's surface. At sea level, the average atmospheric pressure is 101325 pascals.
- Temperature in the atmosphere varies with altitude, generally decreasing with height but with some variations in different layers.
- The density of air at sea level is approximately 1.2 kg/m³ and decreases as altitude increases.

Composition of Atmosphere

The three primary constituents of Earth's atmosphere are:

- Nitrogen-78% by volume. Molecular nitrogen not easily dissociated by UV rays. At high altitude, above 100 Km, atomic nitrogen is produced by Photochemical reaction. In atmosphere, it is found in oxide forms- Nitrous oxide (N_2O), Nitric oxide (NO) and Nitrogen dioxide (NO_2).
  N_2O mainly comes from microbial processes. NO and NO2 mainly from fossil fuel and important constituent of polluted air.
  FOSSILFUEL → NO & NO_2

MICROBES → N_2O **Photochemical decomposition** → **NO_2-Causes Ozone layer depletion & Acid rain**

- Oxygen (21%), and
- Argon (0.93%).

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- Water vapour makes up about 0.1% to 5% by volume but varies significantly depending on location and climate conditions. Water vapour absorbs IR rays and determine heat balance of earth. It causes cloud formation and precipitation. Water vapour mostly restricted in lower region (5 Km layer of air holds about 90% of water vapour.)
- **Particles** are important constituents of Troposphere
  - ✓ Size-0.1 to 10µ
  - ✓ Colloidal size particles in atmosphere known as 'AEROSOLS.'
  - ✓ Particles determine heal balance and reflect light **[smaller particles absorb heat and bigger particles reflect light.]**
  - ✓ Particles <0.2µ called '**AITKIN**,' causes water droplet formation, cloud formation and FOG. Serve as nuclei for ice crystals formation.
  - ✓ Bacteria, Fog, Pollen, Spores, Volcanic ash, are other atmospheric particles, mostly in lower layers.
  - ✓ Air also contain dust originated from Desert, Industries, Sea salt and particles from **Meteors.**
  - ✓ **DUST ZONE** ranges between 100-150 Km. It reduces the transparency of atmosphere. Amount of dust particles is more in subtropical and temperate areas due to dry and windy conditions than in equatorial and polar regions.
- Trace gases like CO_2, CH_4, Nitrous oxide, and O_3 play crucial roles in atmospheric processes. (*Over Oceans and in Polar regions the Air has less CO_2 concentration.*CO_2 and Water vapour absorb IR rays near earth surface and back to earth and cause heat [Green House Effect].
- Other noble gases like Neon, Helium, Krypton, and Xenon are also present in small amounts.
- In Ionosphere, at night in absence of UVR, the +ve ions like $\mathbf{O_2^+}$, $\mathbf{O^+}$, $\mathbf{NO^+}$ etc. recombine with electrons to form **Neutral species**.
- *Highly reactive free radicles* like **HO, CH3, ROO, SO_2, HCO** and **NO_2**are generated by electromagnetic radiations in Ionosphere. They may be Organic or Inorganic. They play important role in **Photochemical Smog formation.**
- **Because of these constituents the Atmosphere shows spatial and temporal variations.**

Apart from these major gases, WATER VAPOUR is also a significant component of the atmosphere.The concentration of water vapor in the atmosphere can vary significantly based on location and weather conditions. On average, water vapour accounts for around 1% at sea level and about 0.4% over the entire atmosphere.Water vapour content varies but plays a crucial role in weather patterns and climate regulation.

- The composition of Earth's atmosphere can be further influenced by natural sources like *Volcanic activity* and *Human activities* such as **Industrial pollution**. Various pollutants like Sulphur compounds (**Hydrogen sulphide** and **Sulphur dioxide**), **Chlorine compounds**, **Fluorine compounds**, elemental **Mercury vapour**, and other chemical compounds may be present in the atmosphere due to human activities.
- All constituents are important for climatic conditions and life sustenance on Earth.

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- ***IF THESE CONSTITUENTS ARE REMOVED FROM ATMOSPHERE, ITS COMPOSITION WOULD BE CONSTANT ALL OVER THE GLOBE.***

Atmospheric Phenomenon

Atmospheric optical phenomena are diverse and fascinating occurrences that result from the interaction of light from the sun or moon with elements in the atmosphere. These phenomena include a wide range of events such as **rainbows, halos, auroras, crepuscular rays**, and more. They are often caused by the scattering, reflection, or refraction of light by particles in the air, clouds, water droplets, or ice crystals. These interactions create stunning visual displays of light in our atmosphere.
These atmospheric optical phenomena showcase the beauty and complexity of light interactions with our atmosphere, providing both aesthetic pleasure and scientific insights into atmospheric physics.

Types of Atmospheric Optical Phenomena:

A. Rainbows:
They occur when sunlight is refracted, reflected, and dispersed by water droplets in the air after a rain shower. The result is a beautiful arc of colours opposite the sun in the sky.

B. Auroras:
Auroras, also known as the Northern lights (**Aurora borealis**) or Southern lights (**Aurora australis**), are colourful displays of light in the sky near the Earth's poles (Arctic and Antartic). Auroras are the result of charged particles from the Sun colliding with the Earth's magnetic field, causing ionization and excitation of atmospheric constituents, and subsequent radiation in various wavelengths.

C. Degree Halos: Large, beautiful circles that appear around the Sun or Moon if the light conditions are present in the atmosphere. Light from the Sun and Moon can be refracted off of ice crystals at high altitudes if the crystals are present, and then detected by the eye. The refraction angle for these halos is typically 22 degrees.

D.Crepuscular Rays: Crepuscular rays are beams of sunlight that appear to converge at a point in the sky due to perspective, even though they are parallel. These rays often shine through gaps in clouds or mountains, creating dramatic visual effects.

D. Alpenglow:
Alpenglow is a reddish glow observed on mountainsides just before sunrise or after sunset when direct sunlight is no longer visible but still illuminates high terrain. This phenomenon gives mountains a pinkish "glow" due to the pink light that appears in the sky, opposite of the sunset. This term was coined because the pink colour, making it look like they are glowing.

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E. Green Flashes:

Green flashes are rare optical phenomena that occur at sunrise or sunset when part of the sun suddenly changes colour to green for a brief moment due to atmospheric refraction. It lasts only seconds, and those who see it are said to be lucky.

F.Belt of Venus: The Belt of Venus is a pinkish band visible above the horizon opposite to where the sun sets or rises. The pink band rests on top of a darker grey or blue band which is the Earth's shadow. It is caused by backscattering of sunlight off particles in Earth's atmosphere.

Atmospheric Motion:

In the Earth's atmospheric circulation, there are three main cells in each hemisphere that play a crucial role in redistributing thermal energy across the planet. These cells include the Hadley cell, the Ferrel cell, and the polar cell. Each of these cells has distinct characteristics and contributes to the overall atmospheric motion and weather patterns on Earth.

Hadley Cell:

The Hadley cell is a closed circulation loop that starts at the equator where warm, moist air rises due to heating from the Earth's surface.

As this air moves poleward, it cools, becomes denser, and descends around the 30th parallel, creating a high-pressure area.

The descending air then flows back towards the equator along the surface, completing the loop of the Hadley cell.

The **Coriolis effect** causes the upper-level air to deviate eastward while lower-level air moves westward, resulting in **easterly winds** known as **trade winds.**

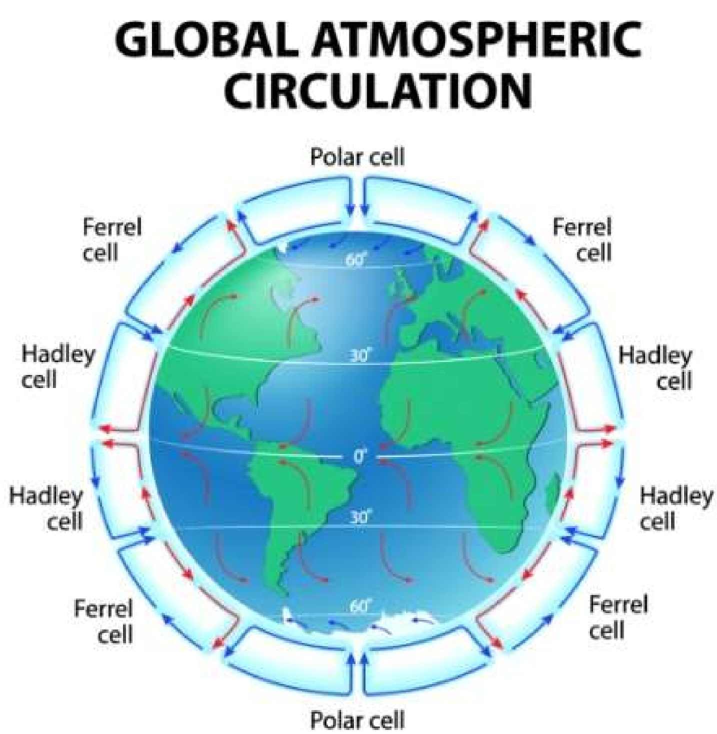
The Hadley cell shifts with seasons due to variations in solar heating, moving northward in June and July and southward in December and January.

Ferrel Cell:

The Ferrel cell is a secondary circulation feature located between the Hadley and polar cells.
Air rising at 60° latitude moves towards the poles while another portion moves towards the equator where it collides with air from the Hadley cell at 30° latitude.
This descending air strengthens high-pressure ridges beneath it and contributes to the overall circulation driven by both Hadley and polar cells.
The Ferrel cell is characterized by variable airflow and temperatures due to its weaker nature compared to other cells.
Winds within the Ferrel cell are westerly at lower levels due to deviations caused by conservation of angular momentum.

Polar Cell:

The polar cell operates at high latitudes where cool, dry air rises at 60° latitude and moves poleward after reaching the tropopause.
As this air reaches polar regions, it descends creating cold, dry high-pressure areas near the poles.
Surface winds within the polar cell are known as polar easterlies flowing from northeast to southwest near the north pole and southeast to northwest near the south pole.
The outflow of air from this cell creates **Rossby waves** that influence the path of the polar jet stream.
The interaction between these three major cells along with other longitudinal circulation features plays a significant role in shaping global weather patterns and heat transport mechanisms on Earth.



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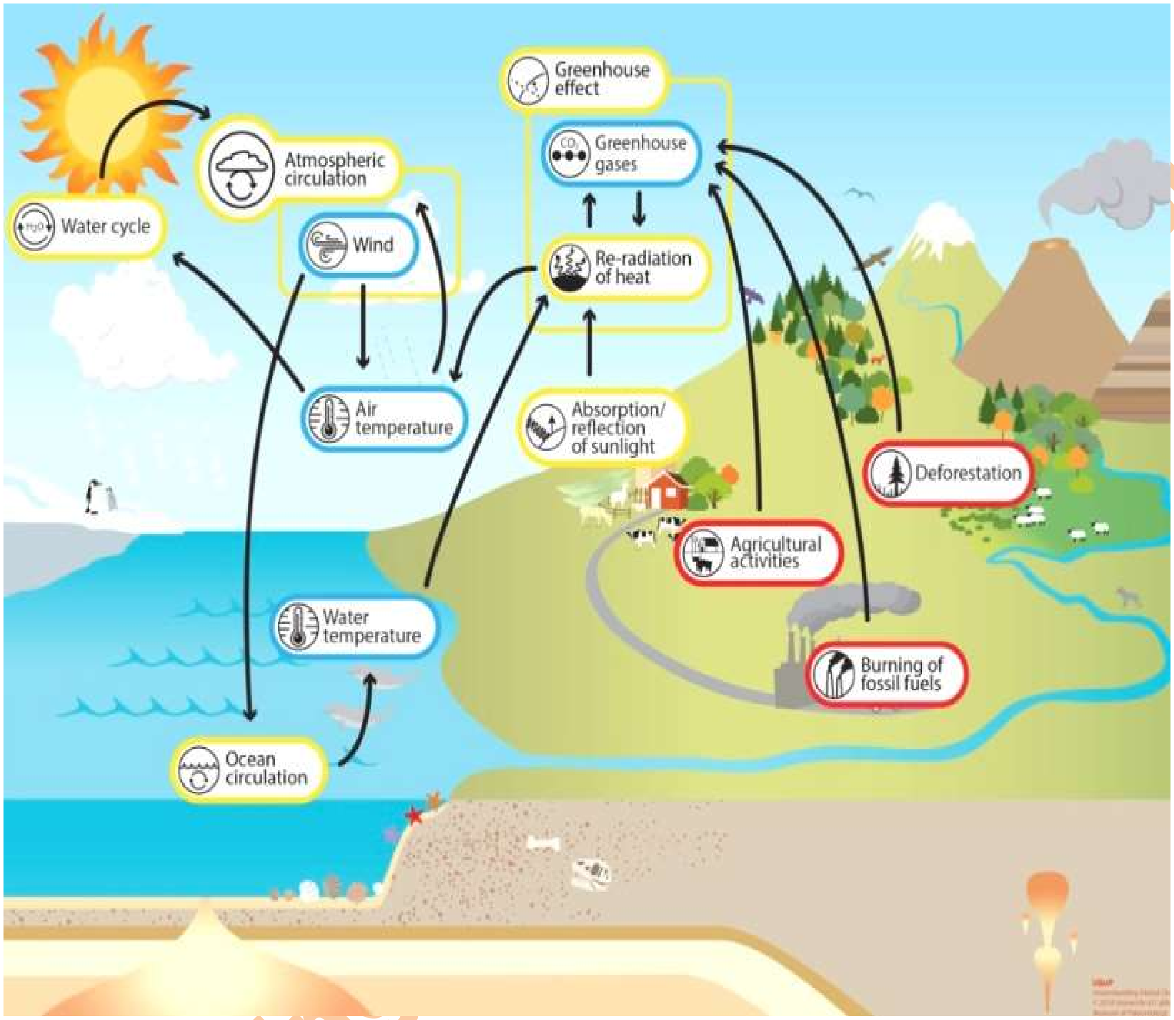


Atmospheric condensation

Condensation is the process where water vapour transforms into liquid water.
In the atmosphere, this process plays a crucial role in the formation of clouds and precipitation. When water vapour cools and reaches its dew point, it condenses into tiny droplets or ice crystals, which then grow and eventually fall back to Earth as precipitation. Condensation is essential for the water cycle and influences various weather phenomena such as thunderstorms, hurricanes, and tornadoes.

Water Vapour in the Atmosphere

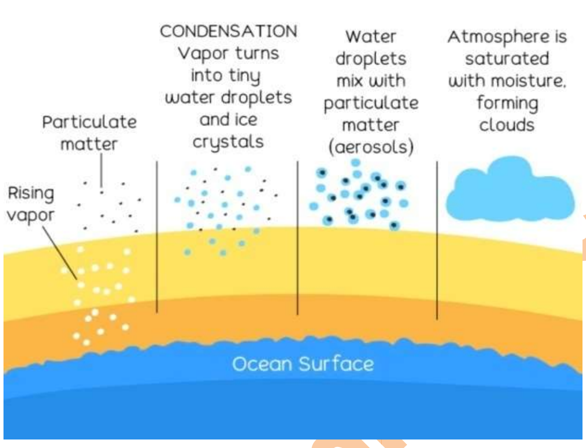
Water vapour exists in the atmosphere in its gaseous state and interacts with other atmospheric gases. It retains its unique characteristics while mixing with air. Water vapour stores significant amounts of energy acquired during evaporation, which is later released during condensation processes. This released energy contributes to the formation of severe weather events by powering thunderstorms and other intense winds through heat release from condensing water vapour.

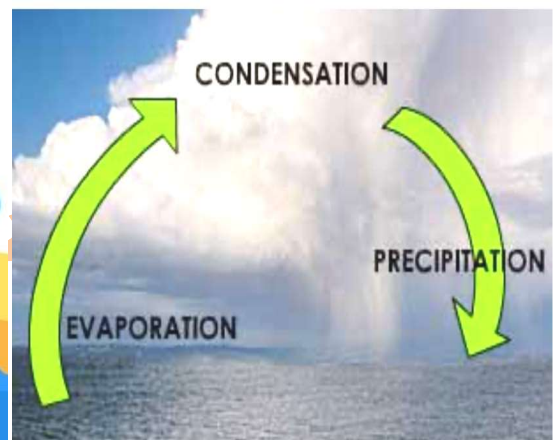
Sources of Atmospheric Moisture

The primary sources of atmospheric moisture include evaporation from bodies of water such as oceans, lakes, and rivers, as well as transpiration from plants. Evaporation involves the conversion of liquid water into water vapour, which then enters the atmosphere. Transpiration is the release of water vapour from plant leaves into the air. These processes contribute to the overall moisture content in the atmosphere and play a vital role in weather patterns and precipitation.

Variations in Absolute Humidity

Absolute humidity refers to the mass of water vapour present per unit volume of air. It varies depending on factors such as temperature and location. Warmer air can hold more moisture compared to colder air, leading to higher absolute humidity levels at higher temperatures. Understanding these variations is essential for predicting weather conditions and assessing atmospheric moisture content accurately.





Atmospheric precipitation

Atmospheric precipitation is any product of the condensation of atmospheric water vapour that falls from clouds due to gravitational pull. The main forms of precipitation include *drizzle, rain, sleet, snow, ice pellets, graupel,* and *hail*.

Precipitation occurs when a portion of the atmosphere becomes saturated with water vapour, reaching 100% relative humidity, causing the water to condense and fall. This process can be initiated by cooling the air or adding water vapour to it. Precipitation plays a crucial role in the water cycle by depositing fresh water on the planet.

Mechanisms of Producing Precipitation:

There are various mechanisms for producing precipitation, including **convective, stratiform,** and **orographic** rainfall.

Convective processes involve strong vertical motions that can lead to heavy precipitation quickly. In contrast, stratiform processes have weaker upward motions and less intense precipitation.

Precipitation can be categorized based on whether it falls as liquid water, liquid water freezing on contact with surfaces, or ice. Different types of precipitation can fall simultaneously.

Measurement

Liquid Precipitation: Rainfall is typically measured using a rain gauge and expressed in millimeters (mm) or inches. It can also be quantified as volume per collection area.

Solid Precipitation: Snowfall is measured in centimeters using a snow gauge. The snow can be melted to determine its water equivalent in millimeters.

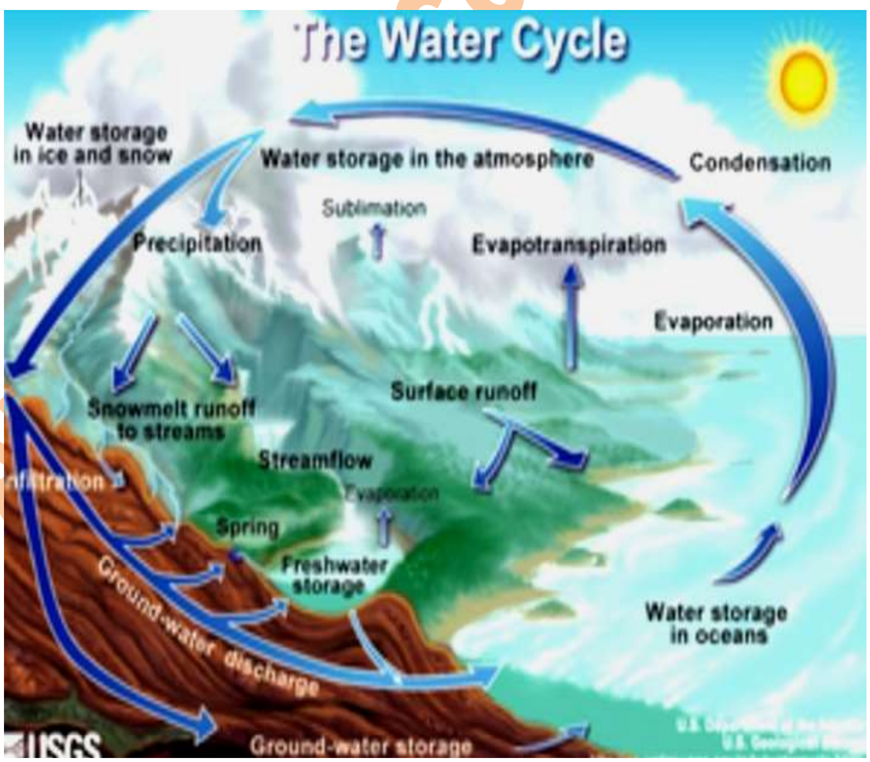
Air Becomes Saturated: Cooling air to its dew point is one way air becomes saturated and leads to precipitation. Various mechanisms like adiabatic cooling, conductive cooling, radiational cooling, and evaporative cooling contribute to this process.

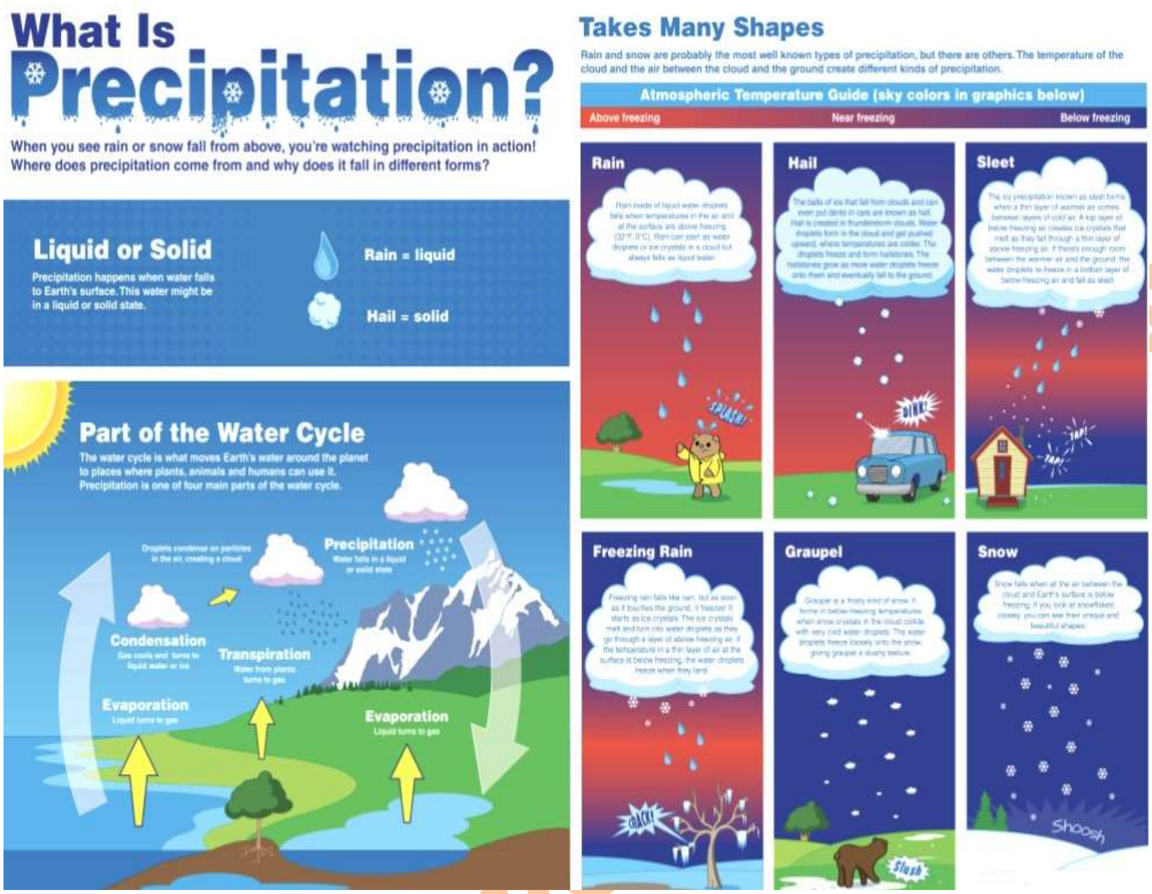
Adding Moisture to the Air:

Water vapour is added to the air through processes such as wind convergence into areas of upward motion, precipitation falling from above, evaporation from oceans or wetlands due to daytime heating, transpiration from plants, and lifting air over mountains.

Forms of Precipitation:

Raindrops form through coalescence when water droplets fuse together or freeze onto ice crystals. As these droplets grow larger and heavier due to coalescence, they eventually fall as raindrops.





Weather and climate

Weather refers to the short-term conditions of the lower atmosphere, such as precipitation, temperature, humidity, wind direction, wind speed, and atmospheric pressure. It can change rapidly over minutes, hours, days, or weeks.

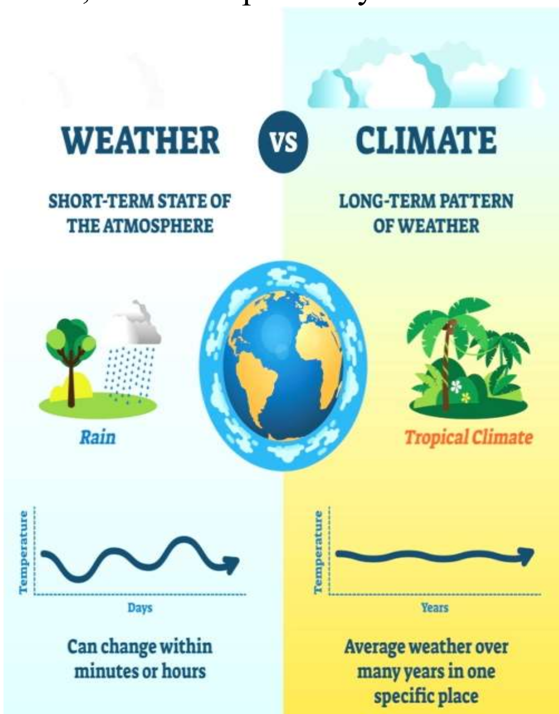
Climate describes the average weather conditions in a specific area over an extended period, typically 30 years or more. Climate represents long-term patterns and averages of weather elements like temperature, precipitation, and wind.

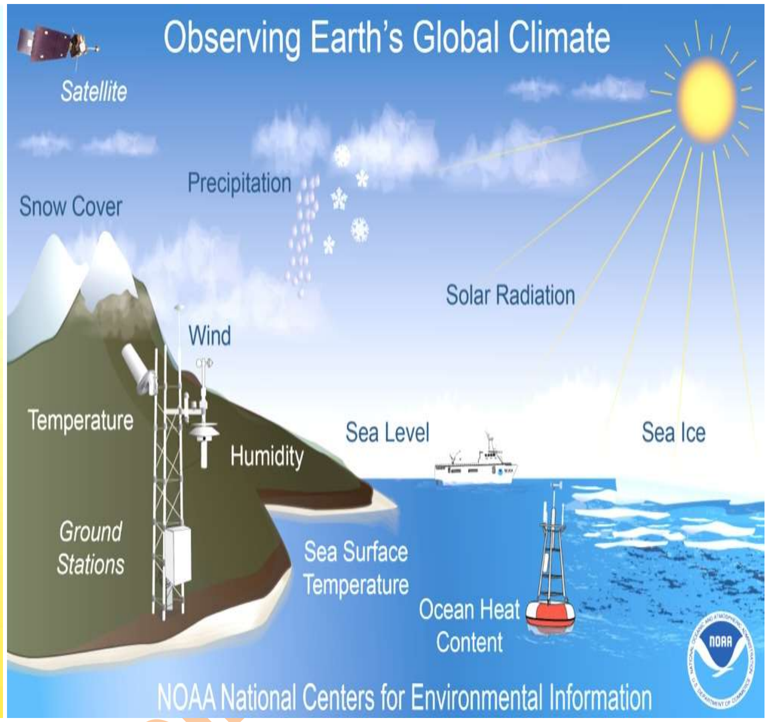
How do weather observations become climate data?

Weather observations collected from various sources like observers and automated stations are used to generate climate data. These observations are recorded at different intervals (hourly or daily) over time. By analyzing these long-term weather records spanning decades or more, scientists can derive insights into the climate of a particular region. These data help in understanding trends, patterns, and changes in climate conditions.

How does climate change affect weather patterns?

Climate change refers to shifts in long-term average weather conditions due to factors like greenhouse gas emissions and human activities. As global temperatures rise, it leads to alterations in weather patterns worldwide. Climate change can result in more frequent and intense extreme weather events such as heat waves, storms, droughts, and floods. Changes in climate influence local weather phenomena by impacting temperature variations, precipitation levels, and atmospheric dynamics.





ATMOSPHERIC WINDOW

The atmospheric window refers to a region of the electromagnetic spectrum that can pass through Earth's atmosphere.

It consists of three main components: the **OPTICAL, INFRARED**, and **RADIO WINDOWS**.

These windows allow electromagnetic energy from the Sun to reach Earth's surface and enable thermal radiation from the surface to escape into space. The atmospheric window plays a crucial role in various scientific and technological applications such as astronomy, remote sensing, and telecommunications.

In remote sensing, the atmospheric window is utilized to observe specific spectral bands that can pass through the atmosphere. *It acts as a selective passage for certain wavelengths of electromagnetic radiation while blocking others due to absorption by atmospheric components like water vapour, ozone, and carbon dioxide.*

This selective transmission of light through the atmosphere allows scientists to gather valuable information about Earth's surface and atmosphere.

Overall, the atmospheric window serves as a gateway for specific wavelengths of electromagnetic radiation to interact with Earth's environment.

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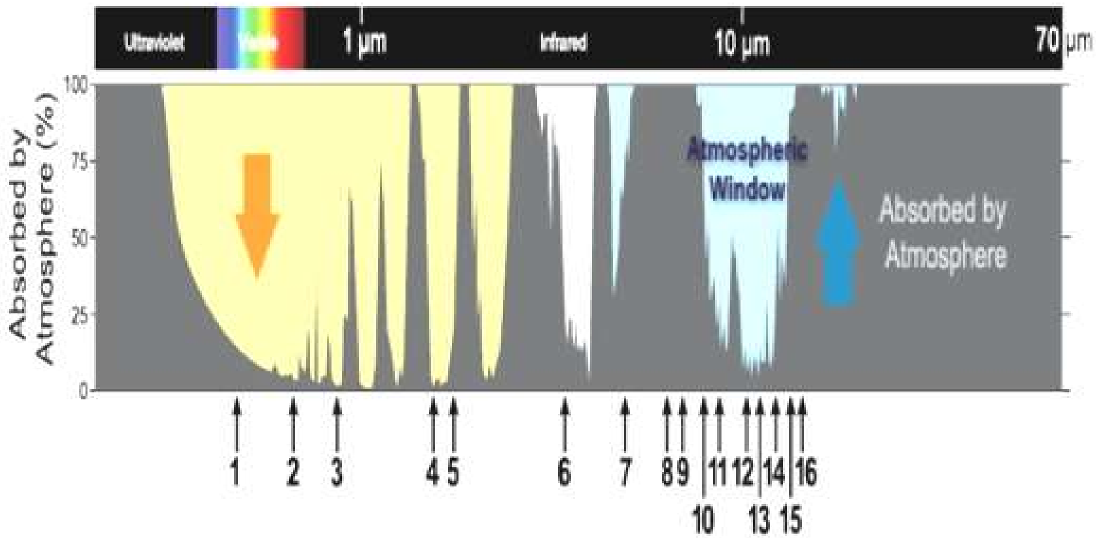
Ultraviolet
Visible
1 µm
Infrared
10 µm
70 µm
Absorbed by Atmosphere (%)
100
75
50
25
0
Atmospheric Window
Absorbed by Atmosphere
1
2
3
4
5
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7
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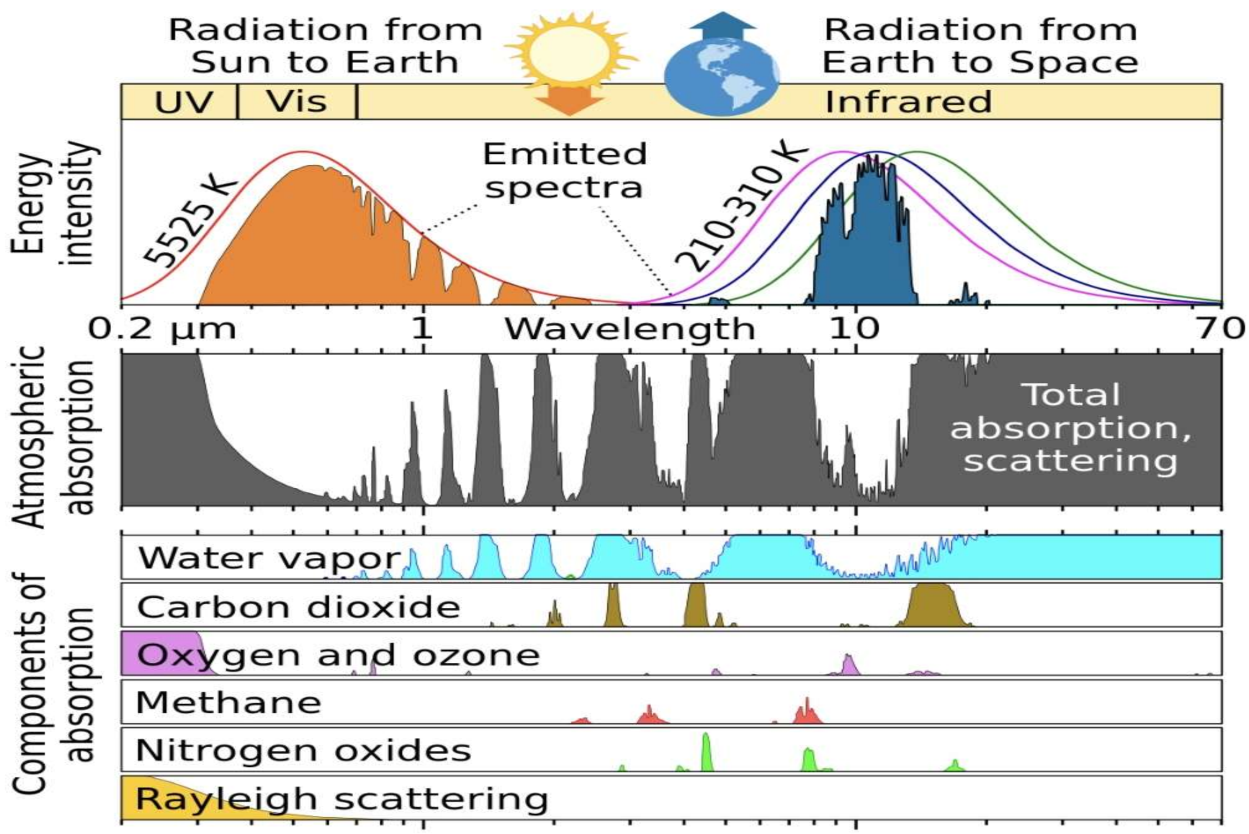
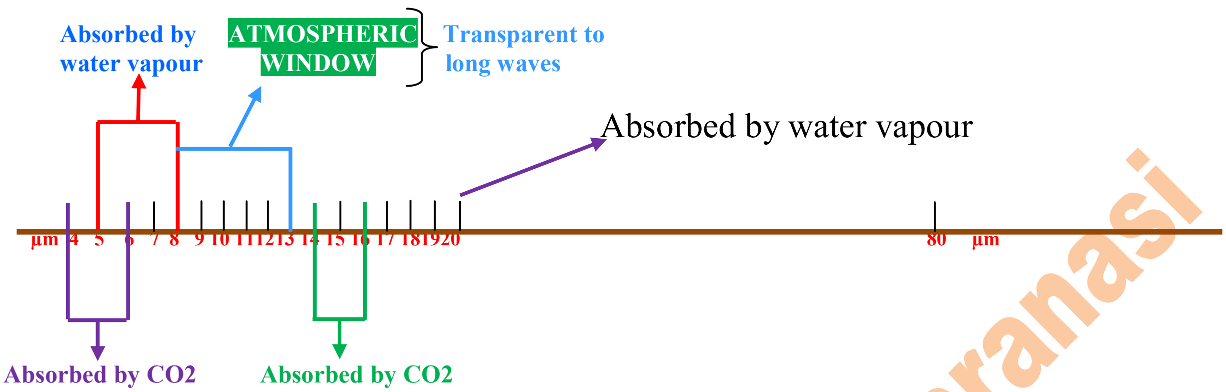

Radiation from Sun to Earth
Radiation from Earth to Space
UV
Vis
Infrared
Energy intensity
5525 K
Emitted spectra
210-310 K
0.2 µm
1
Wavelength
10
70
Atmospheric absorption
Total absorption, scattering
Components of absorption
Water vapor
Carbon dioxide
Oxygen and ozone
Methane
Nitrogen oxides
Rayleigh scattering

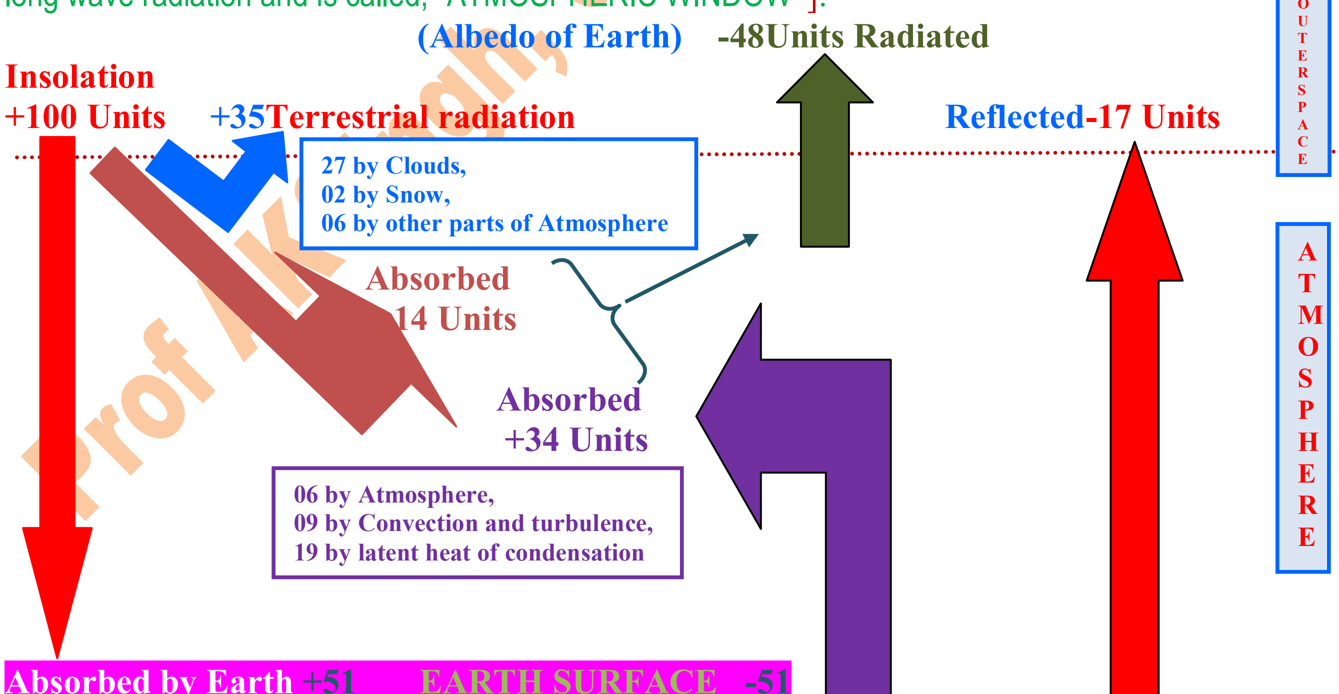


[The Sun emits short-wave radiations into the space; the earth radiations long-wave or infrared radiations, principally in the wavelength of 5 to 80 µm; with peak emission at 10 µm.

Although the atmosphere is transparent to short wave radiations of the Sun, it is only very partially transparent to the long wave radiations of the earth surface (Green House Effect). It absorbs nearly 94% of long-wave emission, allowing only 6% to escape directly to space. The radiant energy absorbed by the atmosphere is partially reradiated back to the earth's surface, thus increasing the energy in total received there and consequently increasing the temperature by some 38^0C (-20^0C to 18^0C) above the value it would have if there was no atmosphere.

Water vapour and CO2 are the two main Green House Gases that absorb the outgoing long wave radiations.

Water vapour absorbs principally in the wavelength of 5.5 to 8.0 µm and beyond 20 µm, while CO^2 absorbs at wave length 4-5 µm and 14-16 µm. The band between 8 to 13 µm is almost transparent to long wave radiation and is called, "ATMOSPHERIC WINDOW"].



Fate of Insolation in the Atmosphere

INSOLATION & HEAT BUDGET / HEAT BALANCE OF THE EARTH

- Incoming solar radiation is called Insolation.
- The earth's surface receives the radiant energy at the rate of two calories per cm^2 per m.
- The Sun radiates nearly half of its energy at wavelength of visible light.
- As the insolation enters the atmosphere
  - A part of it reflected;
  - Another part is absorbed;
  - Remaining (about 51%) of total insolation reaches the earth surface.
  - About 35% of insolation is lost by reflection;
  - Ozone layer absorbes UV-radiations;
  - Other gases and dust particles etc. in the atmosphere absorb about 14% of Insolation.
- The earth surface radiates heat as long waves. This is called *Terrestrial Radiation*.

As the amount of energy radiated by earth is equal to the amount of insolation absorbed by earth's surface, the terrestrial radiation may be estimated at 51 Units. Out of this, water vapour, CO2 and other gases in the lower layers of the atmosphere absorb 34 Units or nearly 70%. Remaining 17 Units are reradiated back to space.

It is apparent from figure that there is a delicate balance in the system and the average temperature of earth remains rather costant. This balance of incoming and outgoing radiation has been termed earth's HEAT BALANCE.

It is important to note that heating and cooling of atmosphere is not directly due to incoming insolation but depend on the terrestrial radiation (i.e. 34 Units of terrestrial radiation absorbed by the atmosphere). Forty eight Units absorbed by the atmosphere (14 Units from insolation plus 34 Units from terrestrial radiation) are also radiated back into space. Thus the total radiation returning from the earth and the atmosphere respectively is 17+48=65 Units, which balance the total of 65 Units received from the Sun. This is termed HEAT BUDGET or HEAT BALANCE of the Earth.

Prof AKSingh, UPCollege, Varanasi

FUNCTIONS OF THE ATMOSPHERE

The atmosphere serves several crucial functions that are essential for supporting life on Earth. [Without Atmosphere there would be no sound, no radio communication (long distance), lightening, Wind, Rain, Snow etc. Atmosphere is the source of CO_2, O_2 and N_2. Atmosphere is responsible for maintaining a narrow difference of day and night temperature]

These functions include:

A.Protection from Solar Radiation:

The atmosphere acts as a shield, protecting the Earth's surface from harmful ultraviolet (UV) radiation coming from the Sun. Ozone in the stratosphere absorbs much of this radiation, preventing it from reaching the surface where it could cause harm to living organisms.

The atmosphere allow only shortwave radiation to enter it and reach the earth surface. But it nearly opaque to long wave terrestrial radiation and thus keeps the earth's average temperature 350C warmer than it would otherwise be.

[**Absorption of Solar Radiation:**Certain components of the atmosphere absorb solar energy at different wavelengths, contributing to heating effects in specific atmospheric layers. For example, ozone absorbs UV radiation in the stratosphere, while water vapour absorbs infrared radiation in the lower troposphere.]

B.Insulation and Temperature Regulation:

The atmosphere acts as a natural insulator, trapping heat from the Sun and preventing it from escaping back into space too quickly. This *greenhouse effect* helps maintain relatively stable temperatures on Earth, making it habitable for various forms of life. Without this insulation provided by the atmosphere, temperatures on Earth would fluctuate significantly between day and night.

C.Supporting Weather Systems:

The atmosphere is responsible for driving air movement around the globe through convection processes. Variations in temperature and pressure within different atmospheric layers create wind patterns that influence weather systems such as storms, hurricanes, and precipitation. The interaction between warm air rising and cool air sinking generates atmospheric circulation that distributes heat across the planet.

D.Regulation of Climate:

By interacting with other components of Earth's systems such as oceans and land surfaces, the atmosphere plays a critical role in regulating global climate patterns. Changes in atmospheric composition can lead to shifts in climate conditions over long periods, impacting ecosystems and human societies worldwide.

E.Enabling Breathing:

The composition of gases in the atmosphere, particularly oxygen and nitrogen, is vital for sustaining life on Earth. Oxygen is essential for respiration in most living organisms, while nitrogen plays a crucial role in various biochemical processes. Additionally, carbon dioxide present in the atmosphere is utilized by plants during photosynthesis to produce oxygen and organic compounds.

F.Maintaining Pressure:

The weight of the overlying atmosphere creates atmospheric pressure at the Earth's surface, which is necessary for keeping liquid water stable and preventing it from evaporating into space. Atmospheric pressure also affects weather patterns and influences how gases behave within different layers of the atmosphere.

G.Transporting Water Vapour:
The atmosphere facilitates the movement of water vapour through processes like evaporation, condensation, and precipitation. This water cycle is vital for distributing freshwater across different regions and sustaining ecosystems worldwide. Atmosphere also serve as store house for water vapour which leads to precipitation. The presence of air and water (in different forms) on earth makes it a unique planet in the solar system.

H.Absorbing Sound Waves:
The atmosphere absorbs sound waves to some extent, allowing us to hear sounds transmitted through air. This property of the atmosphere is essential for communication among living organisms and plays a role in various natural processes.

I.Filtering Out Harmful Particles:
Particles such as dust, pollutants, and aerosols can be filtered out by the atmosphere before reaching the Earth's surface. This filtration helps maintain air quality and protects living organisms from potentially harmful substances.

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T H A N X

Prof AKSingh, U