EDEN IAS - GEOGRAPHY CLASS NOTES

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GEOGRAPHY CLASS - 5

Atmosphere

- Atmosphere is a thick gaseous envelope surrounding the Earth from all sides and attached to the Earth through the force of gravity.
- Over 80% of atmospheric gases are held by gravity with in 20 kilometers of the Earth's surface.
- The physical and chemical structure of the atmosphere, the way that the gases interact with solar energy, and the physical and chemical interactions between the atmosphere, land, and oceans all combine to make the atmosphere an integral part of the Earth system

Significance of Atmosphere

- Acts as a filter because it absorbs the harmful Ultraviolet radiation.
- Source of various life supporting gases such as oxygen, carbon dioxide etc.
- Supports life forms in biosphere.

Extent of Atmosphere

- Though the exact attitude of atmosphere is not known, but it is estimated that it extends till 10,000 km above the Earth's surface.
- The vertical distribution of atmospheric layers is not uniform.
- Almost 98% of atmospheric mass is limited to an altitude of 30 km from the surface of Earth.

Composition of the Atmosphere

- The atmosphere is composed of gases, water vapour and dust particles.
- The proportion of gases changes in the higher layers of the atmosphere in such a way that oxygen will be almost in negligible quantity at the height of 120 km.
- Similarly, carbon dioxide and water vapour are found only up to 90 km from the surface of the earth.

a) Gases

- Carbon dioxide is meteorologically a very important gas as it is transparent to the incoming solar radiation but opaque to the outgoing terrestrial radiation.
- It absorbs a part of terrestrial radiation and reflects back some part of it towards the earth's surface. It is largely responsible for the **Green House Effect**.
- The volume of other gases is constant but the volume of carbon dioxide has been rising in the past few decades mainly because of the burning of fossil fuels. This has also increased the temperature of the air.
- **Ozone** is another important component of the atmosphere found between 10 and 50 km above the earth's surface and acts as a filter and absorbs the ultra-violet rays radiating from the sun and prevents them from reaching the surface of the earth.

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Gases	Composition %	Significance
Nitrogen	78.08%	Acts as dilutent and is generally chemically inactive.
Oxygen	21%	Inhaled by biotic components for survival. Oxygen is also essential for combustion of burning matter.
Argon	0.93%	Inert gas.
Carbon dioxide	0.03%	Being a greenhouse gas, it maintains the temperature of the lower atmosphere.
Neon	0.00%	Inert gas
Helium	0.00%	Inert gas

b) Water Vapour

- Water vapour is also a variable gas in the atmosphere, which decreases with altitude.
- In the warm and wet tropics, it may account for four per cent of the air by volume, while in the dry and cold areas of desert and polar regions, it may be less than one per cent of the air.
- Water vapour also decreases from the equator towards the poles. It also absorbs parts of the insolation from **the sun and preserves the earth's radiated heat.**

c) Dust Particles

- Atmosphere has a sufficient capacity to keep small solid particles, which may originate from different sources and include sea salts, fine soil, smoke-soot, ash, pollen, dust and disintegrated particles of meteors.
- Dust particles are generally concentrated in the lower layers of the atmosphere; yet, convectional air currents may transport them to great heights.
- The higher concentration of dust particles is found in subtropical and temperate regions due to dry winds in comparison to equatorial and polar regions.
- Dust and salt particles act as hygroscopic nuclei around which water vapour condenses to produce clouds.

Structure of Atmosphere: Various Layers

A) Troposphere

- It extends upto an average altitude of 18 km from the Earth's surface. Thickness varies from 8 km at the poles to 18 km at the equator.
- At every 165 m, there is a drop of 1 °C (or 6.4 °Cper km). This is called Normal Lapse Rate of Temperature.
- Tropopause separates troposphere from stratosphere.
- This layer accounts for practically the entire water vapour, all dust particles and most of the Carbon dioxide contained in the atmosphere. Due to this all weather phenomena such as condensation, precipitation and storms etc occur in the troposphere only.

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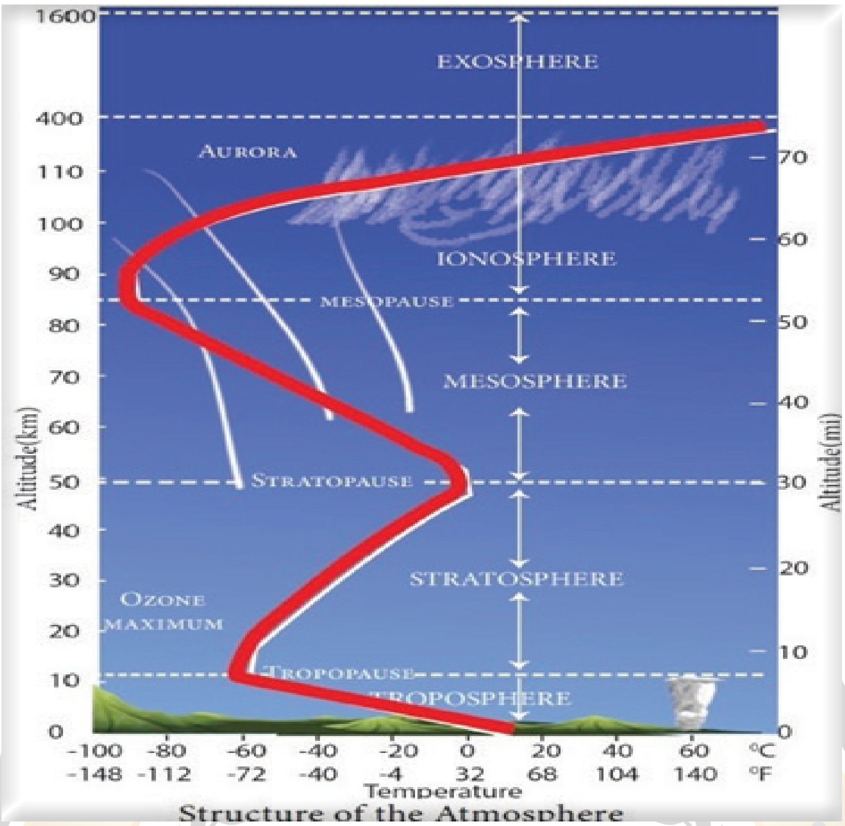
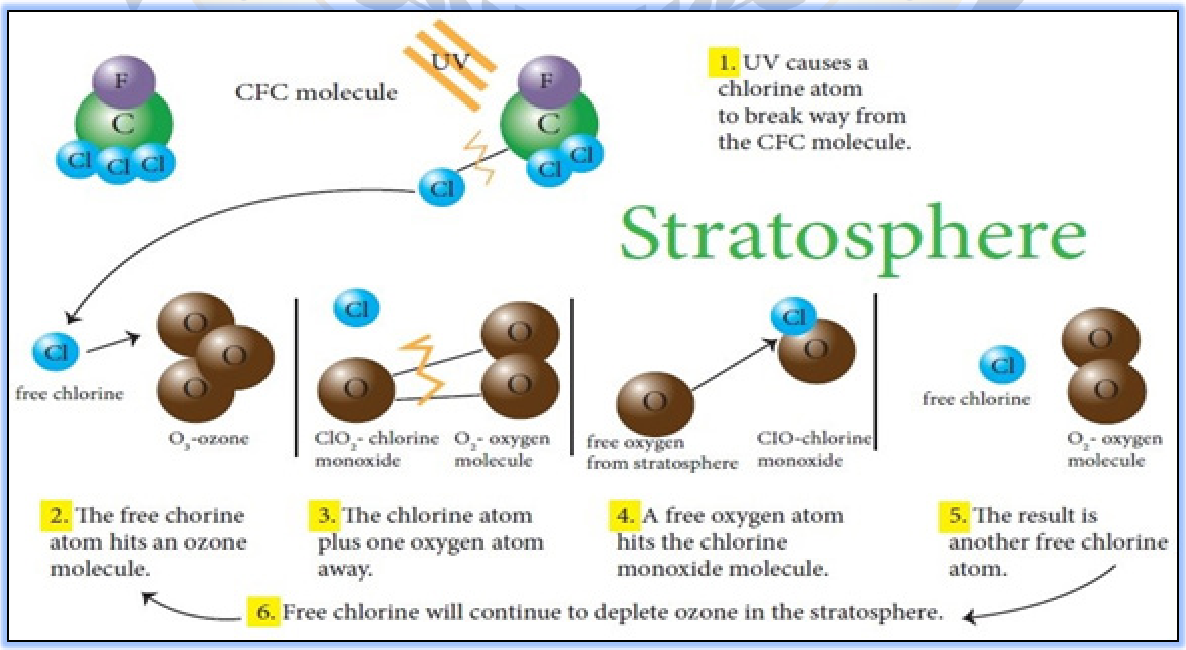


Structure of the Atmosphere

B) Stratosphere

- The stratosphere extends up to about 50 km, where stratopause separates it from the mesosphere.
- In this layer, the temperature increases with increase in height. This phenomenon is known as temperature inversion.
- The temperature rises in this layer from about–60 °C at the tropopause to 0 °C at stratopause.
- The part of the stratosphere, in which there is a concentration of ozone is often called ozonosphere. It absorbs ultraviolet radiation, which is harmful for life forms in the biosphere.
- Stratosphere is free from dust particles and also from atmospheric turbulence. Hence, this layer is considered ideal for flying of jet aircrafts.



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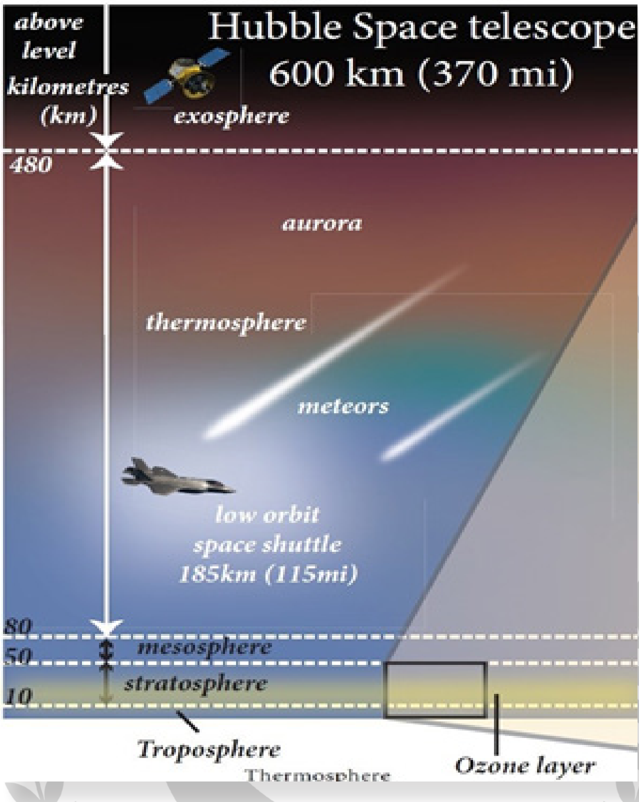
C) Mesosphere

- Mesosphere extends above the stratopause up to a height of about 80 km.
- In this layer, the temperature decreases with height like in the troposphere and it falls from about 0 °C at its base to about – 100 °C at an height of 80 km. It is considered the coldest layer of the atmosphere.
- The upper limit of the mesosphere is marked by the Mesopause, a transitional layer separating it from the ionosphere.
- Meteoroids burn in this layer which prevents them from colliding with the Earth's surface.



Ionosphere

- Ionosphere is located above the mesosphere and extends up to about 600 km.
- This layer is called ionosphere because it contains electrically charged ions that reflect the radio waves back to the Earth which makes radio communication possible.
- Absorption of solar radiation by ionised particles causes an increase in temperature with increasing height in the ionosphere.

D) Thermosphere

- The zone between the 85 km and 600 km above the surface is often called Thermosphere. In this layer, the temperature increases with increasing altitude.
- The upper limit of the thermosphere, the Thermopause is generally taken at an altitude of about 600 km.
- The day temperature at 600 km altitude exceed 1400 C while night temperature remain about 225 °C.
- The upper part of the thermosphere contains only the lighter gases like helium and hydrogen.

E) Exosphere and Magnetosphere

- The outermost part of the atmosphere of the Earth is called Exosphere.
- This zone of the atmosphere is about 10,000 km thick.
- The upper limit of the exosphere is uncertain as this layer acts as a transitional layer between the Earth's atmosphere and the outer space. The outer part of the exosphere is called Magnetosphere.

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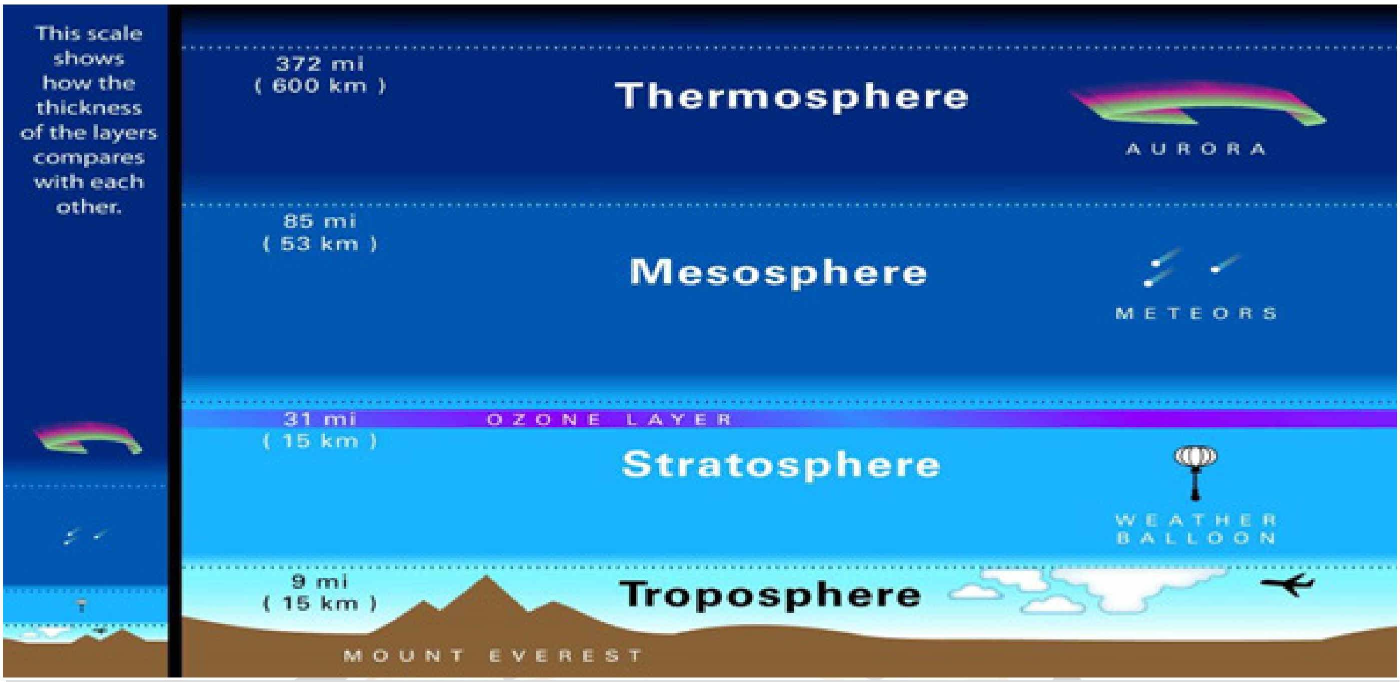


Chemical Composition of the Atmosphere

On the basis of chemical composition, the atmosphere is divided into-

a) Homosphere

- The atmosphere upto 80 km altitude is known as Homosphere.
- There is a homogeneous composition of various gases like nitrogen, oxygen, argon, CO2 etc. in the Homosphere. Due to growing industrialisation, the homogeneity of this layer has been disturbed.

b) Heterosphere

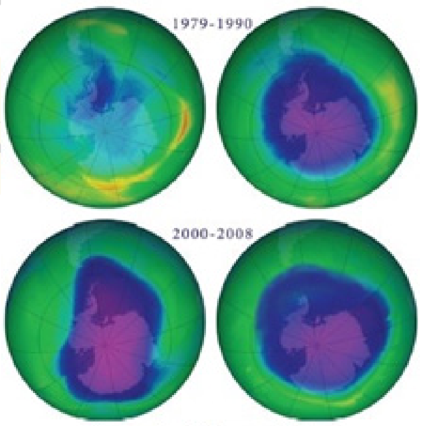
- This layer starts from 80 km and coincides with the thermosphere.
- There are distinct layers of gases in the atmosphere, which are arranged according to their mean molecular weights. Four distinct layers of gases are formed – N2, O, He, H.

Ozone and Ozone Depletion

- Ozone (O3) is form of oxygen that combines three atoms into each molecule.
- It absorbs and filters the harmful ultraviolet B radiation coming from the sun. This way the ozone layer protects all life on earth.
- However, ozone is harmful when it develops near the ground.
- It causes health problems like asthma and other respiratory illness.

Ozone Depletion

- A steady decline in the concentration of ozone in the earth's stratosphere (the ozone layer) is called ozone depletion.
- Ozone depletion occurs when chloro fluoro carbon (CFC) and halon gases, formerly found in aerosol spray cans and refrigerants are released into the atmosphere and they cause chemical reactions that break down ozone molecules and reduce the concentration of them.
- Nitrogen oxide released by emitted by supersonic aircrafts can also destroy the ozone molecules to break down.
- Ozone-depleting substances are present throughout the stratospheric ozone layer because they are transported great distances by atmospheric air motions.



Spread of Ozone hole

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- The severe depletion of the Antarctic ozone layer known as the "ozone hole" occurs because of the special atmospheric and chemical conditions that exist there and nowhere else on the globe.
- The very low winter temperatures in the Antarctic stratosphere cause polar stratospheric clouds (PSCs) to form.
- Special reactions that occur on PSCs, combined with the relative isolation of polar stratospheric air, allow chlorine and bromine reactions to produce the ozone hole in Antarctic springtime.

Impacts

- Depletion of the ozone layer has consequences on human, animal, plants and micro-organisms.
- This typically results from higher UV levels reaching us on earth. Research confirms that high levels of UV rays cause non-melanoma skin cancer.
- To protect the ozone layer for our future generation, avoid using products which are emitting pollutants such as aerosol sprays, blowing agents for foams and packing materials, as solvents and as refrigerants.

Insolation

- The surface of the earth is heated by the sun's rays in the form of short wave radiation. The heat received by the earth is called 'Solar Radiation' or 'Insolation'. Insolation is measured with the help of Pyranometers. Heating of atmosphere is an indirect process.
- The processes are-

a) Terrestrial radiation

The solar radiation reflected by the earth's surface is called 'Terrestrial radiation'. Terrestrial radiation supplies more heat energy to the atmosphere due to its long wave length.

b) Conduction

The heat energy from the earth's surface is transferred to the lower atmosphere which is directly in contact with the surface by the process of conduction.

c) Convection and advection

The movement of air molecules in vertical and horizontal direction is called as 'convection and advection' respectively. This movement carries heat energy to the various parts of the earth and at different altitudes.

- The amount of insolation depends on following factors:
  - The area and nature of the surface.
  - The inclination of the rays of the Sun.
  - Distance between the Earth and the Sun.
  - Length of the day.
  - The transparency of the atmosphere.
- As the angle of the Sun's rays decreases poleward, the amount of insolation received also decreases in that direction.
- The Earth's surface does not absorb all the energy that it receives. The proportion of the solar radiation reflected back from the surface is called Albedo.
- On an average, insolation is highest near the equator, marginally lower at the tropics and lowest at the poles.

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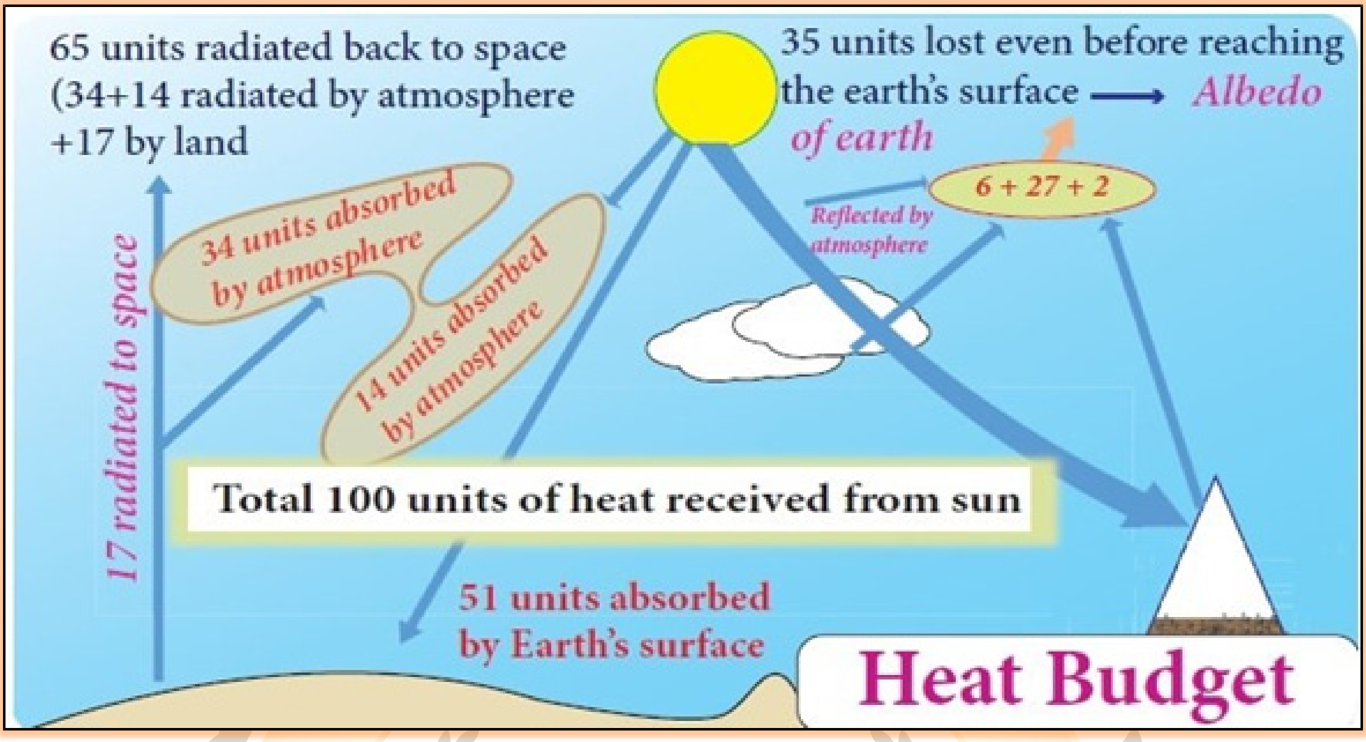
Heat Budget of the Earth



- The Earth receives energy continuously from the Sun but its temperature is still almost constant.
- This is because the atmosphere loses an amount of heat equal to the amount of heat gain through insolation.
- This mechanism of maintaining the balance between incoming and outgoing heat in the atmosphere is called the Heat Budget or Heat Balance.
- Let us assume that 100 units of energy reach the top of the atmosphere of the Earth. 14 units are absorbed directly by the atmosphere and 35 units are lost to space through reflection.
- Out of the total 51 units given up by the surface in the form of terrestrial radiation, the atmosphere (mainly CO2 and water vapour) absorbs about 34 units and the remaining 17 units escape to space.
- In this way, the atmosphere receives a total of 14 + 34 = 48 units and this amount is radiated back to space by the atmosphere.
- The total loss of energy to space thus amounts to 100 units. 35 units reflected by the atmosphere, 17 units lost as terrestrial radiation and 48 units from the atmosphere.
- In this way, no net gain or loss of energy occurs on the Earth's surface.
- At equator, the amount of incoming radiation is more than outgoing radiation, whereas the amount of outgoing radiation is more than incoming radiation in polor regions. The transport of surplus heat from equator to poles is known as 'Meridional Transport of Heat'.

Atmospheric Pressure

- Air is a mixture of several gases having their own weight. The pressure exerted by air due to its weight is called atmospheric pressure on the Earth's surface.
- Atmospheric pressure is neither the same for all the regions nor the same for one region all the time.
- Atmospheric pressure is affected by various factors such as altitude, temperature and Earth's rotation.

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Influence on the Atmospheric Pressure

Altitude Air pressure increases, when air descends. This is due to the decrease in volume of the air. When air raises its volume increases and the pressure of its molecules is spread over a larger area so, its pressure decreases.

Distribution of Temperature

Distribution of temperature varies both horizontally and vertically. Let us study it under

A) Horizontal Distribution of Temperature
B) Vertical Distribution of Temperature

A) Horizontal Distribution of Temperature

- Distribution of temperature across the latitudes over the surface of the earth is called horizontal distribution of temperature. On maps, the horizontal distribution of temperature is commonly shown by isotherms.
- **Isotherms** are line connecting points that have an equal temperature at mean sea level.

Factors Affecting the Horizontal Distribution of Temperature

The horizontal distribution of temperature on the earth's surface varies from place to place. Following are the factors affecting the horizontal distribution of temperature of the earth:

- **Latitude**
  - o The angle formed by the solar radiation to the ground is called 'angle of incidence'. The solar radiation passes vertically along the equator.
  - o The angle of incidence decreases from equator towards the poles. The area heated by the solar radiation increases towards the poles and therefore, temperature decreases from the equator to the poles.
  - Distribution of land and water
  - o Land is heated and cooled at a faster rate due the conduction process whereas water is heated and cooled at slower rate due to convection process.
  - o Water takes 2.5 times of heat energy to heat a unit area compared to land. Thus, the land will have higher temperature than the water in summer and vice versa during the winter.
  - o So, more land mass in northern hemisphere (15.28C) leads to higher average temperature than the southern hemisphere (13.38C).
- **Ocean currents**
  - o Warm ocean currents carry warm water from the tropical region towards the poles and increase the temperature while cold ocean currents carry cold water from Polar Regions and reduce the temperature along the coasts.
- **Prevailing winds**
- o Warm winds like trade wind and westerly, that carry higher heat energy, increase the temperature while cold polar easterlies carry lower heat energy from polar region reduces the temperature.
- **Cloudiness**
- o The cloudy sky obstructs the solar radiation from the sun to earth and reduces the temperature.
- o But the clear sky during the day allows more solar radiation to reach the earth's surface and increases the temperature.
- o Meanwhile clear sky at night allows more terrestrial radiation to escape.
- o For example, the tropical hot deserts experience higher temperature at day and lower temperature at night.

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- **Nature of the surface**
  - o The reflection from surface varies based on the nature of land cover. The more reflection from the snow surface leads to low temperature accumulation.
  - o But the dense forest, which reflects less heat energy and absorbs more heat energy, leads to higher temperature.
- **Mountain barriers**
  - o If a wind or air mass blows towards the mountain, it influences the distribution of temperature on either side of the mountain.
  - o For example, polar easterlies and blizzards are obstructed by Himalayas in Asia and Alps in Europe respectively. This leads to lower temperature in the northern slopes and higher temperature in the southern slopes of the respective mountains.

B) Vertical Distribution of Temperature

We all know that the temperature decreases with increasing altitude from the surface of the earth. The vertical decrease in temperature of troposphere is called as 'Normal Lapse Rate' or 'vertical temperature gradient' at which the temperature reduces at the rate of 6.5 8C per 1000 meter of ascent.

Factors Affecting the Vertical Distribution of Temperature

This is influenced by the following factors:

a) Amount of terrestrial radiation reaching the altitude and
b) Density of air to absorb the heat energy at higher altitude.

As both the above said factors decrease with altitude, the temperature also decreases

Inversion of Temperature

The condition at which the temperature increases with altitude is called as 'inversion of temperature'. In this condition, warm air lies over cold air.

The conditions for inversion of temperature are:

- **Long winter nights:** The bottom layer of the atmosphere in contact with the ground is cooled and the upper layer remains relatively warm.
- **Cloudless sky:** The higher amount of terrestrial radiation reaches the higher altitude which leads to lower temperature at low level due to clear sky.
- **Dry air near the surface:** the dry air absorbs less terrestrial radiation and allows them to escape into space.
- **Snow covered ground:** During night, due to terrestrial radiation and higher albedo, most of the heat is lost to the atmosphere and the surface is cooled.
- **Formation of fronts:** the movement of warm air over the cold air during the formation of the various fronts leads to inversion condition.
- **Mountain wind:** The subsidence of cold mountain wind at the early morning leads to the displacement of warm air from the valley to higher altitude. This type of inversion is called as 'valley inversion'.

Adiabatic Lapse Rate:

- Lapse rate is the rate of fall in temperature of atmosphere with elevation.
- Adiabatic Lapse Rate is the rate of fall in temperature of a rising or a falling air parcel adiabatically.
- **Adiabatic or adiabatically:** Heat **doesn't** enter or leave the system. All temperature changes are internal.
- Adiabatic Lapse rate is governed by Gas law (According to gas law Pressure 'P' is directly proportional to Temperature 'T' when Volume 'V' is a constant).

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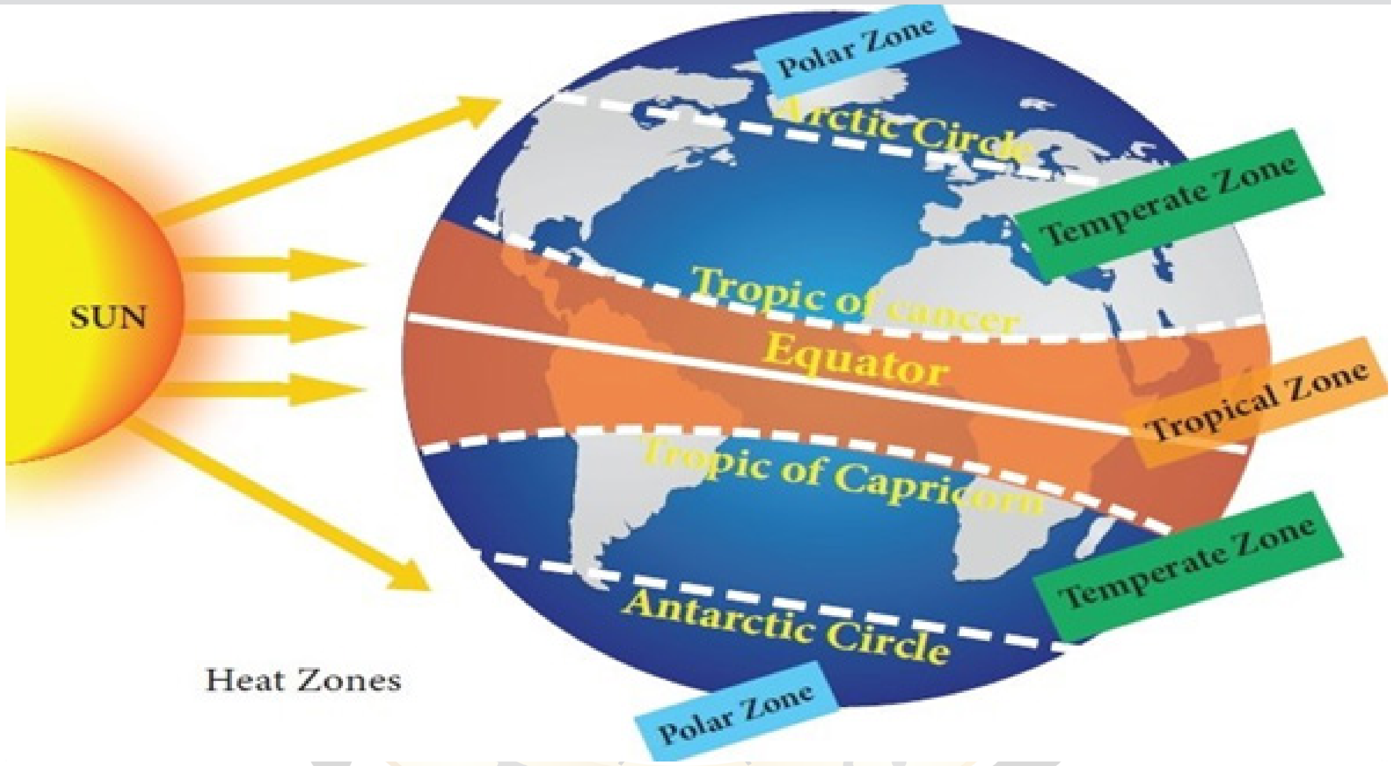
Latent heat of condensation

- Latent heat of condensation is the driving force behind all tropical cyclones.
- It is the heat released or absorbed during phase change.
- Latent heat, characteristic amount of energy absorbed or released by a substance during a change in its physical state that occurs **without changing its temperature.**
- The latent heat associated with melting a solid or freezing a liquid is called the **heat of fusion;** that associated with vaporizing a liquid or a solid or condensing a vapour is called the **heat of vaporization.**
- The latent heat is normally expressed **as the amount of heat (in units of joules or calories) per mole or unit mass of the substance undergoing a change of state.**
- For example, when a pot of water is kept boiling, the temperature remains at 100 °C until the last drop evaporates, because all the heat being added to the liquid is absorbed as latent heat of vaporization and carried away by the escaping vapour molecules.
- Similarly, while ice melts, it remains at 0 °C, and the liquid water that is formed with the latent heat of fusion is also at 0 °C.

Heat Zones of the World



The earth has been divided into three heat zones according the amount of insolation received. These are the Torrid Zone, the Temperate zone and the Frigid Zone.

A) Torrid Zone (23 ½ °N to 23 ½ °S)

- The zone lying between the Tropic of cancer and Tropic of Capricorn is called 'Torrid zone'.
- The sun's rays are vertical throughout the year and it receives maximum insolation. Thus, this is the hottest zone.

B) Temperate Zone (23 ½ °N to 66 ½ °N and 23 ½ °S to 66 ½ °S)

- The temperate zone lies between the Tropic of Cancer and Arctic Circle in the northern hemisphere and the Tropic of Capricorn and Antarctic circle in the southern hemisphere.
- This region never experiences over head sun light but experiences longer days and shorter nights during summer and vice versa during winter.
- This region experiences moderate temperature and is therefore called as 'Temperate zone'.

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C) Polar Zone (Frigid Zone – 66 ½ °N to 90°N and 66 ½ °S to 90°S)

- The region between North pole and Arctic Circle in the northern hemisphere and South pole and Antarctic Circle in the southern hemisphere is called 'Polar Zone'.
- This region always receives more oblique rays of the sun and so the temperature is very low. It is the coldest zone.
- This region experiences 24 hours of day and night during peak summer and winter respectively.

Green House Effect:

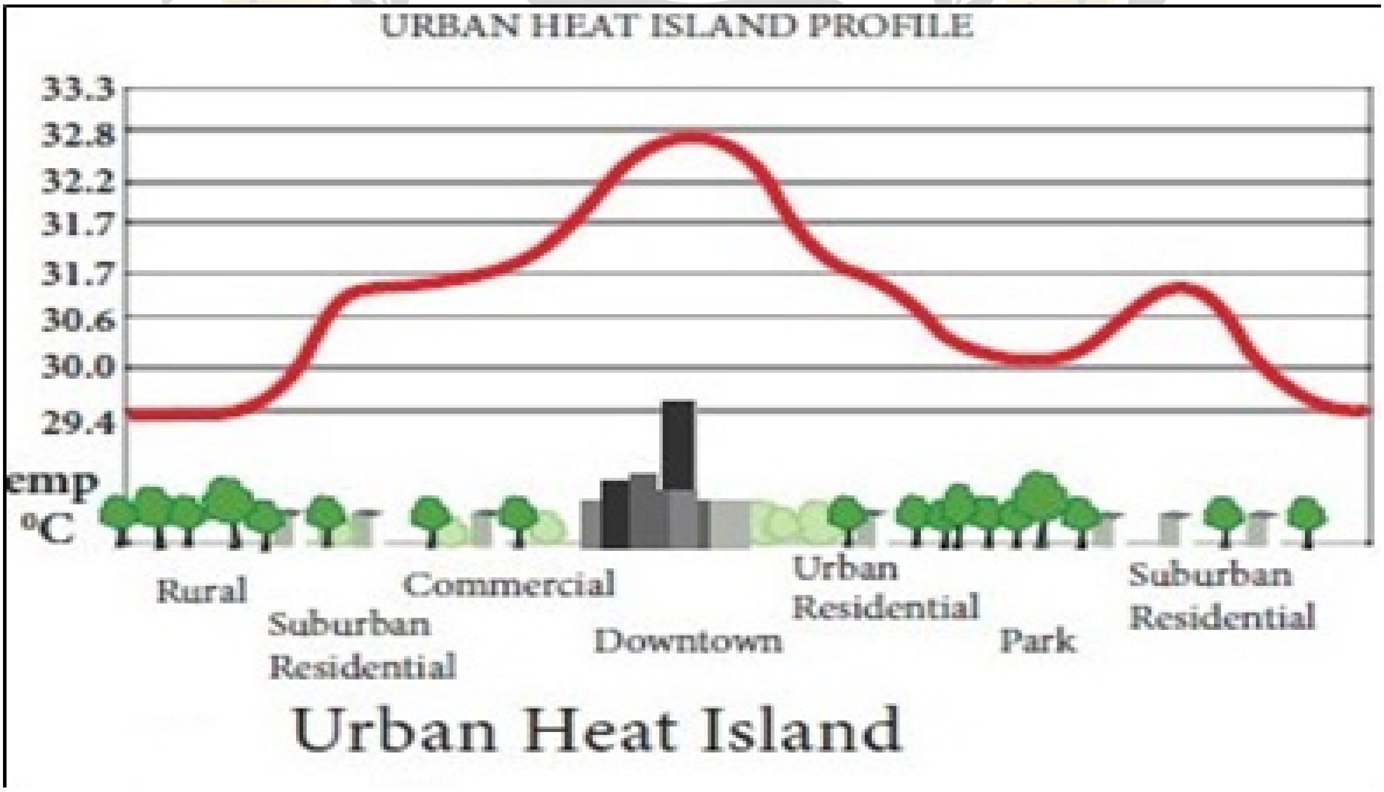
- As seen in the heat budget, the longer wavelengths are absorbed by greenhouse gases in the atmosphere, increases the temperature of atmosphere.
- These greenhouse gases act like a green house and retains some of the heat energy would otherwise be lost to space.
- The retaining of heat energy by the atmosphere is called the 'greenhouse effect'.

Global Warming

- Global warming is observed in a century scale.
- The temperature increase over theyearshas been due to the green house gas concentration such as carbon dioxide (CO2), water vapour, methane and ozone.
- Greenhouse gases are those gases that contribute to the greenhouse effect.
- The largest contributing source of greenhouse gas is the burning of fossil fuels leading to the emission of carbon dioxide from industries, automobiles and domestic.

Urban Heat Island (UHI)

- An urban heat island is an urban area or metropolitan area that is significantly warmer than its surrounding rural area due to high concentration of high rise concrete buildings, metal roads, sparse vegetation cover and less exposure of soil.
- These factors cause urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures.



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Ways to reduce the impact of urban heat island:

- Increase shade around your home: Planting trees and other vegetation, provides shade and cooling effect through evapotranspiration and it lowers the surface and air temperature.
- Install green and cool roofs.
- Use energy-efficient appliances and equipments.
- Shift all industries away from the urban area.
- Reduce emission from automobiles.

Atmospheric Humidity

- The moisture in the atmosphere is derived from water bodies through evaporation and from plants through transpiration.
- Thus, there is a continuous exchange of water between the atmosphere, the oceans and the continents through the processes of evaporation, transpiration, condensation and precipitation. Water vapour present in the air is known as humidity. It is expressed quantitatively in different ways-

a) Absolute Humidity

- The actual amount of the water vapour present in the atmosphere is known as The Absolute humidity.
- It is the weight of water vapour per unit volume of air and is expressed in terms of grams per cubic metre.
- The ability of the air to hold water vapour depends entirely on its temperature.
- The absolute humidity differs from place to place on the surface of the earth.

b) Relative Humidity

- The percentage of moisture present in the atmosphere as compared to its full capacity at a given temperature is known as the relative humidity.
- With the change of air temperature, the capacity to retain moisture increases or decreases and the relative humidity is also affected.
- It is greater over the oceans and least over the continents

Saturation

The air containing moisture to its full capacity at a given temperature is said to be saturated. It means that the air at the given temperature is incapable of holding any additional amount of moisture at that stage. The temperature at which saturation occurs in a given sample of air is known as dew point.

Evaporation and Condensation

- The amount of water vapour in the atmosphere is added or withdrawn due to evaporation and condensation respectively.
- Evaporation is a process by which water is transformed from liquid to gaseous state. Heat is the main cause for evaporation. The temperature at which the water starts evaporating is referred to as the latent heat of vapourisation.
- Increase in temperature increases water absorption and retention capacity of the given parcel of air. Similarly, if the moisture content is low, air has a potentiality of absorbing and retaining moisture.
- Movement of air replaces the saturated layer with the unsaturated layer. Hence, the greater the movement of air, the greater is the evaporation.
- The transformation of water vapour into water is called condensation. Condensation is caused by the loss of heat.
- When moist air is cooled, it may reach a level when its capacity to hold water vapour ceases. Then, the excess water vapour condenses into liquid form. If it directly condenses into solid form, it is known as sublimation.

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- In free air, condensation results from cooling around very small particles termed as hygroscopic condensation nuclei.
- Particles of dust, smoke and salt from the ocean are particularly good nuclei because they absorb water.
- Condensation also takes place when the moist air comes in contact with some colder object and it may also take place when the temperature is close to the dew point.
- Condensation, therefore, depends upon the amount of cooling and the relative humidity of the air.
- **Condensation is influenced** by the volume of air, temperature, pressure and humidity. Condensation takes place:
  (i) when the temperature of the air is reduced to dew point with its volume remaining constant;
  (ii) when both the volume and the temperature are reduced;
  (iii) when moisture is added to the air through evaporation.
- However, the most favourable condition for condensation is the decrease in air temperature.

Forms of water vapor

- After condensation the water vapor or the moisture in the atmosphere takes one of the following forms — dew, frost, fog and clouds.
- Forms of condensation can be classified on the basis of temperature and location.
- Condensation takes place when the dew point is lower than the freezing point as well as higher than the freezing point.

a) Dew

- When the moisture is deposited in the form of water droplets on cooler surfaces of solid objects (rather than nuclei in air above the surface) such as stones, grass blades and plant leaves, it is known as dew.
- The ideal conditions for its formation are clear sky, calm air, high relative humidity, and cold and long nights.
- For the formation of dew, it is necessary that the dew point is above the freezing point.

b) Frost

- Frost forms on cold surfaces when condensation takes place below freezing point (00C), i.e. the dew point is at or below the freezing point.
- The excess moisture is deposited in the form of minute ice crystals instead of water droplets.
- The ideal conditions for the formation of white frost are the same as those for the formation of dew, except that the air temperature must be at or below the freezing point.

c) Fog and Mist

- When the temperature of an air mass containing a large quantity of water vapour falls all of a sudden, condensation takes place within itself on fine dust particles. So, the fog is a cloud with its base at or very near to the ground.
- Because of the fog and mist, the visibility becomes poor to zero. In urban and industrial centres smoke provides plenty of nuclei which help the formation of fog and mist.
- Such a condition when fog is mixed with smoke, is described as smog.
- The only difference between the mist and fog is that mist contains more moisture than the fog.
- In mist each nuceli contains a thicker layer of moisture.
- Mists are frequent over mountains as the rising warm air up the slopes meets a cold surface.
- Fogs are drier than mist and they are prevalent where warm currents of air come in contact with cold currents.
- Fogs are mini clouds in which condensation takes place around nuclei provided by the dust, smoke, and the salt particles.

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d) Clouds

- Cloud is a mass of minute water droplets or tiny crystals of ice formed by the condensation of the water vapour in free air at considerable elevations.
- As the clouds are formed at some height over the surface of the earth, they take various shapes.
- According to their height, expanse, density and transparency or opaqueness clouds are grouped under four types : (i) cirrus; (ii) cumulus; (iii) stratus; (iv) nimbus.

Thankyou All the best for Prelims!!!!!!