9 Temperature

The Earth receives both heat and light from the Suns rays. This is known as solar radiation. The Suns heat energy reaches the Earth in the form of radiation. Hence it is known as solar radiation or solar energy. When Suns rays reach the Earth, they pass through the atmosphers first pass on insolation to the Earths surface. Hence the Earths surface gets heated up first. Thereafter, atmosphere and water masses get heated through processes such as radiation, convection and conduction.

Insolation

The main source of the heat received by the Earths surface and atmosphere is the Sun. The Sun is approximately 15 crore km away from the Earth. Because of extremely high temperature and pressure in the Suns core, there the nuclear reaction occurs naturally. In this reaction fusion of hydrogen nuclei of the Suns matter occurs, releasing light and tremendous amount of energy. Hence the Suns surface temperature is estimated to be 6000 degree Celsius while that of its central part is about 1.5 degree Celsius. Out of the total heat emitted from the Sun, only two-billionth part reaches the Earth. The heat or heat energy received by the Earths surface and the atmosphere is called Insolation. Insolation is measured by Pyranometer and expressed in calories per minute per square cm. or kW/ square metre.

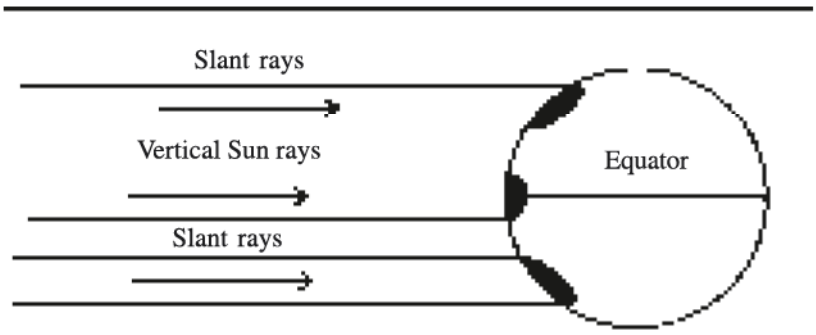
Factors affecting distribution of Insolation

Due to the unequal distribution of continents and oceans, diverse physical features and also as we go from the equator to the poles, there is variation in the amount of insolation. Factors responsible for this are :

(1) Angular length of the Sun's rays : Our Earth being almost spherical, angular length of the Suns rays is not the same everywhere. Hence insolation received is also not the same everywhere. The Suns rays fall vertically in tropical regions. Hence more amount of insolation is received here. In the mid-latitude regions as compared to low latitude regions and even more so in high (polar) latitude regions, the Suns rays fall more slantingly, and accordingly receive less insolation.

The Suns rays fall vertically on some slopes of mountainous regions, while there is shadow over opposite slopes. Hence slopes of mountainous regions influence distribution of insolation. In day time amount of insolation is more at noon while in morning and evening as the Suns rays are slanting, amount of insolation is less.

(2) Length of day : The duration of sunlight directly influences amount of insolation. Insolation is more where length of day is greater. Length of day is more in summer than in winter. Hence in summer season, amount of insolation is more, while it remains less in winter.



9.1 Vertical and Slanting Sun rays

(3) Density of atmosphere and height : The Suns rays pass through the atmosphere and directly reach the Earths surfare. When the Sun rays are passing through the atmosphere, 40 to 50 % insolation is absorbed in the atmosphere. A part of insolation is also reflected. Less insolation is absorbed in thin atmosphere while more insolation is absorbed in dense atmosphere. Atmosphere is thin at the equator, hence more insolation is received there, and it is dense at the poles, hence less insolation is received. Hence amount of insolation decreases as go from the equator to poles.

Slanting rays pass through greater area of the atmosphere, hence more insolation is absorbed. As a result, less insolation is received in middle and high latitude regions. In low latitude regions, Sun rays pass through less area of the atmosphere, hence less heat is absorbed and such regions receive more insolation. Also factors such as amount of clouds, water vapour and dust particles in the atmosphere influence insolation.

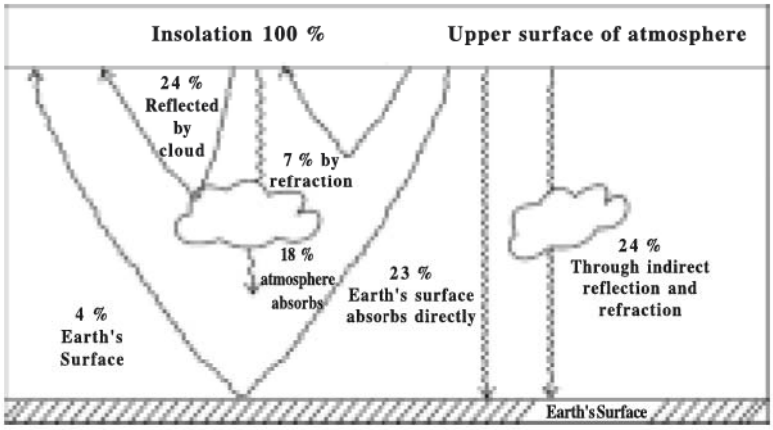
(4) Land and water : The Earths surface is made of land and water areas. Both surfaces receive same amount of heat from the Sun, still because of difference in matter, they dont heat up equally. Water being a liquid, solar heat received by it gets widely dispersed through ocean currents, waves, tides, etc. Also water being transparent, Sun rays can penetrate deep inside. The shiny water surface also partly reflects Sun rays. Hence water heats up slowly. Land being solid, heat received from the Sun does not get evenly distributed over entire surface. The opaque land surface fully receives the Suns heat. Hence land heats up rapidly. Hence, land and water have different heat absorbing capacities. Land and water areas being unevenly distributed over the Earths surface, this causes much variation in distribution of insolation.

(5) Amount of Sun spots : Black spots are seen on the Suns surface. They are known as **'Sunspots'**. When there are more Sunspots, more insolation is received by the Earth, and when they are less, less amount of insolation is received.

Heat Budget of the Earth

Of the Suns heat received at the upper surface of the atmosphere, about 18 % insolation is directly absorbed by the atmosphere. The Earths surface receives about 47 % insolation of the remaining. About 35 % insolation collides with clouds, dust particles, snow covered areas of Earths surface, areas of water bodies and returns to space without being absorbed. This **reflected insolation** is known as **'Albedo'**.

The atmosphere is not directly heated from the Suns direct heat. Heat from the Sun reaches the Earths surface as short wave radiation. These Sun rays first give heat to the Earths surface. As the surface heats up, its heat is dissipated in atmosphere in the form of long wave radiation. Hence, first of all, part of the atmosphere close to the Earths surface is heated up. Later on the heat spreads upwards in atmosphere. Due to this reason, as we go upwards from the surface in the Troposphere, air temperature falls.



9.2 Distribution of insolation in Atmosphere and at the Earth's surface

Heat of the Earths surface dissipates into the atmosphere through the processes of radiation, conduction and convection. In case of radiation, heat of the Earths surface dissipates in atmosphere in the form of long wave radiation. In conduction, heat flows from hot body to cold body and it continues till both bodies are equally heated. Similarly, the cool air in contact with the Earths surface obtains surface heat through the process of conduction. The air that has become hot due to conduction, becomes light and rises upwards. The sideways or cool upper air takes its place. It also heats up and rises. Thus, heat of the Earths surface dissipates up in the atmosphere. These are also known as convection currents.

Water vapour also plays an important role in heating the atmosphere. The water vapour formed by evaporation at the Earths surface possesses latent heat. Condensation of this moisture releases this latent heat which warms the atmosphere. The amount of Suns heat received by the Earths surface and its atmosphere through different processes after being used in various processes, remaining heat is returned back to space. Thus heat balance is maintained on the Earth.

Temperature

The level of atmospheric heat is temperature. It is measured in units of Celsius or Fahrenheit. Air temperature is measured by various kinds of thermometers and thermograph. In these days of modern technology temperature is measured by digital thermometer. Factors affecting temperature are as follows :

(1) Latitude : The Sun rays are always vertical in equatorial region. Hence temperature remains high throughout the year. As we go from equatorial to polar regions, the Sun rays become more slanting. Also, they have to pass through a larger part of the atmosphere. Hence in polar regions, less heat from Sun rays is experienced. In June, Sun rays are vertical over Tropic of Cancer (northern hemisphere), while in December, they are vertical over the Tropic of Capricorn (southern hemisphere). Hence these areas experience highest temperatures in respective months. In polar regions, Sun rays being very slanting temperature remains low.

(2) Height above sea level : Sun rays are first incident on the Earths surface, hence it heats up. Thereafter, the atmosphere in contact with the surface heats up. Hence, temperature falls with altitude.

(3) Distance from sea : Land heats and cools faster compared to water. Hence, summer temperatures of coastal areas remains lower while winter temperatures are mild. In continental areas far from the sea coast, winter temperatures are low, while summer temperatures are high.

(4) Distribution of land and water : Distribution of land and water is not uniform on the Earths surface. Also water heats and cools slowly compared to land, due to difference in physical properties. Hence vast continents and oceans spread across the Earths surface, do not experience uniform temperatures. Thus, continents and water bodies influence distribution of surface temperatures.

(5) Ocean currents : Warm and cold currents flow in oceans. They influence temperatures of respective coasts. Cold currents (Labrador, Benguela, California) flowing in lower latitudes, lower temperatures of coastal regions. Warm currents (Gulf Stream, Kuroshio) flowing in higher latitudes raise temperatures of coastal regions.

(6) Winds : Hot and dry winds blowing from deserts raise temperatures, while cold winds blowing from polar regions, lower temperatures in regions from where they blow. Besides local winds (sea and land breezes, loo, Norwester, Harmattan) influence temperatures of respective areas.

(7) Relief : Relief also influences temperature e.g., temperature remains high in areas with open rocks and desert regions. Temperature remains low in snow covered regions and those with vegetation cover.

Distribution of Temperature

There are oceans and continents on the Earths surface. There are deserts, snow covererd regions, plains, forests, mountains and such other natural regions on the continents. Different types of surfaces receive insolation in different amounts. Thus, atmospheric temperature also remains varied. Distribution of temperature can be studied in two ways :

(1) Horizontal distribution of temperature (2) Vertical distribution of temperature

(1) Horizontal distribution of temperature : Horizontal distribution of temperature on the Earths surface depends on factors such as latitude, distance from sea, ocean currents, wind direction and height of place, etc.

As we go from equator towards the poles, the Suns rays become slanting and hence temperature decreases. Areas near the sea coast have moderate temperature and continental areas away from the sea coast have extreme temperature. In case of continental land areas, diurnal and annual range of temperatures are higher, while temperature of land areas near the sea coast remains moderate.

Cold and warm ocean currents influence the temperature of adjoining coastal regions. Temperature of coastal regions from where cold currents flow gets low, while those from where warm currents flow goes high.

Also temperature is high in areas from where hot and dry winds blow, while it is low in those areas where cold and dry winds blow. Besides, amount of forest, altitude, types of soil, amount of clouds and such other factors also influence distribution of temperature.

(2) Vertical distribution of temperature : Under normal conditions, as we move upwards from the Earths surface, temperature falls by 6.5 degree Celsius for every one km ascent. This is known as **'Lapse rate'**. This decrease in temperature is observed in the Troposphere only. The Earths surface is first heated by the Suns rays and then the atmosphere heats up gradually. Thus the atmosphere is heated by various processes (convection, radiation, conduction). Thus temperature decreases upwards from the Earth's surface. Hence hill stations in mountainous regions have developed as tourist places. Hill stations like Shimla, Manali, Srinagar, Nainital, Darjeeling, Saputara, Pachmadhi, Mahabaleshwar, Mt. Abu, etc. are good examples.

Inversion of Temperature :

Sometimes temperature of atmosphere increases instead of decreasing as we go upwards. This is temperature inversion. It is experienced under influence of factors such as long winter nights, stable air, clear sky, windless night, snow covered regions, etc. Atmosphere nearer the Earths surface rapidly cools down and during this time, upper layers of atmosphere are relatively warm. Such conditions are known as inversion of temperature. Such temperature inversion is experienced in snow covered regions of north and south poles, high mountainous regions and valley regions.

EXERCISE

1. Answer the following questions in detail :

(1) Explain the effect of angular distance and length of day on distribution of insolation.

(2) Explain heat budget of the Earth.

(3) Mention the factors influencing distribution of temperature and explain effects of latitude and distance from sea.

(4) What is distribution of temperature ? Discuss the horizontal distribution of temperature.

2. Write to the point answer of the following questions :

(1) Solar radiation

(2) Inversion of temperature

(3) Density of atmosphere

(4) Vertical distribution of temperature

3. Answer the following questions in brief :

(1) There is less heat in polar regions_ Give reasons.

(2) Which are the factors influencing distribution of insolation ?

(3) Continental regions experience extremes of temperature Why ?

(4) Temperature decreases as we go above the Earths surface. Give reason.

4. Answer the following questions in one-two sentences :

(1) What is insolation ?

(2) Mention names of local winds.

(3) What is the unit of measuring insolation ?

(4) What are Sun spots ?

(5) What is lapse rate?

5. Select the correct option from the options given and write the answer :

(1) Which instrument is used to measure Insolation ?

(a) Thermometer (b) Barometer (c) Pyranometer (d) Lactometer

(2) Temperature of the Suns surface is estimated to be ?

(a) 5000° C (b) 6000° C (c) 1.5 crore ° C (d) 1000° C

(3) Which of the following is not a factor influencing temperature ?

(a) Longitude (b) Relief (c) Wind (d) Distance from sea

(4) Which of the following is not a factor influencing distribution of insolation ?

(a) Height above sea (b) Length of day

(c) Ocean currents (d) Distribution of land and water

Activity

- Collect figures for temperature broadcast on TV and display them on the School Board