Lesson - 12

Insolation and Heat Budget

The atmospheric cover which is thousands of kilometres thick protects our earth from scorching solar radiation and extensive heat from the Sun. During night , the atmosphere does not allow the heat generated by Terrestrial radiation to be lost in space, thus keeping the environment warm. The earth is situated 15 million kms away from the Sun. The other sources of heat energy except for sun are negligible. The sun is a glowing gaseous body that radiates energy constantly. It takes 8 minutes 20 seconds for the sunrays to reach the earth's surface.

Insolation

The radiation which reaches the earth's surface from the sun is called Insolation, and the radiation emitted from all around the sun is termed as Solar radiation. The absorption of solar radiation by the earth is called Insolation. According to Critchfeild " Radiant energy from the sun that strikes the earth, is called insolation"

The solar radiation which is received by the earth is called insolation but the entire solar radiation does not reaches to the earth's surface, some portion of this solar radiation, gets absorbed by the atmosphere. The energy from the solar radiation reaches the earth's surface in form of short waves. According to Trewartha 'the amount of enery received by entire earth from the sun every minute is equal to the energy mankind uses for its various activities for the entire year.' Thus this solar energy received by the earth is responsible for all the physical and biological phenomenon. In this way the portion of solar radiation received by a particular place , for a particular period of time is called as insolation and its not uniform at every place. The Solar radiation is measured by " Pyranometer".

Distribution of temperature

The distribution of temperature is not uniform at all the places on the earth's surface. In comparison to the other factors which affect the distribution of temperature , lattitudes play the most dominant role. The ancient Greeks had the knowledge of the fact that the temperatures are higher at the equator and it tends to decrease towards the polar regions. On this basis , our earth is divided into 5 heat zones by them. We hardly differentiate between solar radiation and temperature but both are different and still they are interrelated, as temperature depends on solar radiation. Here temperature is referred to heat in the

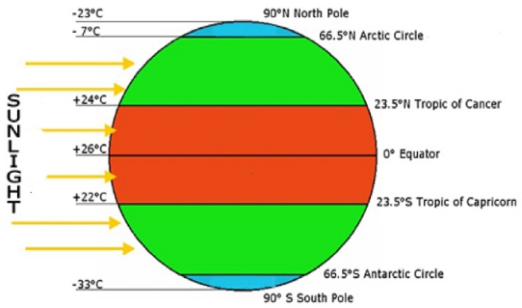

Fig. 12.1 : Temperature zones and horizontal distribution

atmosphere , which has its source from the Sun.

Horizontal distribution of temperature

Central distribution of temperature means latitudinal distribution of temperature. Changes in the temperature is observed as we move from equator towards the poles. Isotherms are imaginary lines joining the areas of similar temperature on the map.

The minimum and maximum temperatures are recorded in the months of January and July , respectively in the entire world. Therefore the months of January and July are chosen for the analysis of the temperature.

Isotherms of January

As the sun rays shines vertically in the southern hemisphere on Tropic of Capricorn, Summer season prevails in Southern hemisphere and Winter season prevails in Northern hemisphere. Therefore during this time period , the temperatures are more in Southern hemisphere in comparison to Northern hemisphere. The most coldest areas during this period lies in Siberia and Greenland. Isotherm of 25° C is drawn on Siberia. Isotherms of 30°C are drawn on the southern continents and the 10°C isotherm is parallel to the latitude in Southern hemisphere whereas 20°C isotherm is bent according to the distribution of continents and oceans. Isotherms are mostly curved due to uneven distribution of water and land in the northern hemisphere.

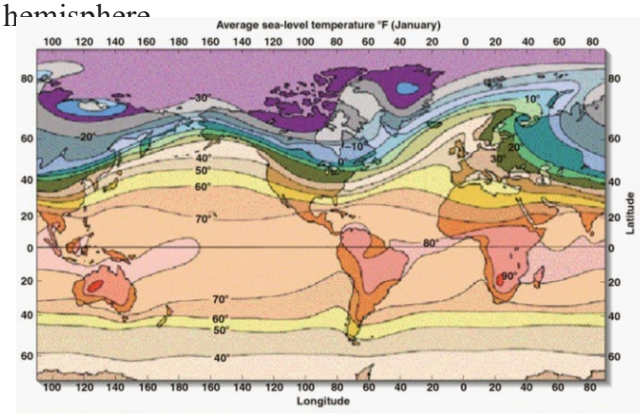

Fig. 12.2 : Isotherms in January

Isotherms of July

The sun shines vertically over the Tropic of Cancer in the month of July in Northern hemisphere. Therefore it is summer season in the Northern hemisphere and winter season in the southern hemisphere. The isotherm of 30°C passes over North Africa, South-West and Central Asia and from Columbian plateau in North America.

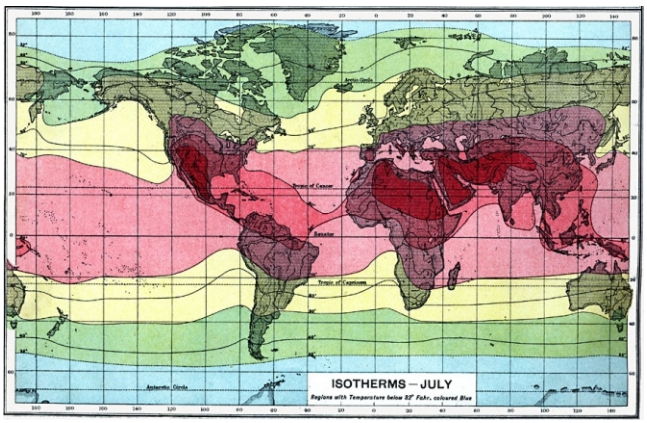

Fig. 12.3 : Isotherms in July

When we compare the isotherms of January with that of July, it is clear that the effect of summers is more extensive in the month of July. Antarctica observes negligible temperatures during this period. The isotherms are drawn almost parallel to the latitudes in the southern hemisphere.

Vertical distribution of temperature

By Vertical distribution of temperature we mean the distribution of temperature above the Earth's surface in different layers of atmosphere in terms of height. The scientist have proved the fact that with the increase in height there is a decrease in temperature. This is the main reason why the hilly regions are much cooler than the plains. There is a decrease of 1°C for every 165 m. This is called Normal lapse rate of temperature. This rate of decrease of temperature is not uniform everywhere, it tends to change with seasons, location and local irregularities. Normally the temperature decreases at the rate of 6.5°C per km. This rate of decrease in temperature continues till Troposphere. Beyond this the temperature changes with the change in atmospheric layers.

Temperature Anomalies

During temperature anomalies the

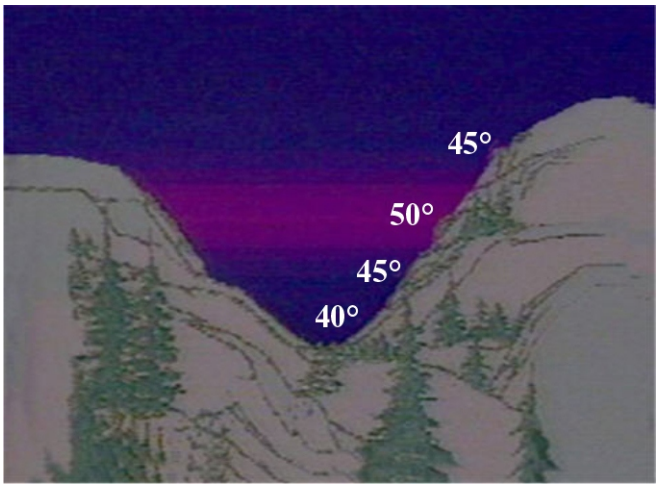

Fig. 12.4 : Temperature inversion in the valley

atmospheric conditions are stable. In normal conditions the temperature decreases with the increase in height but in some conditions with the increase in height, the temperature also increases. The condition in which the temperature increases with the increase in height is called temperature anomaly. The geographical conditions like long nights,clear sky, calm wind, dry wind and snowfall are the major factors of temperature anomaly. Under such conditions the heat radiation from the lower layers of the ground and wind occurs faster. As a result the lower layer of the air becomes denser and heavier as it cools down. The upper layers where radiation of heat is at a lower base is comparatively warmer. Under these conditions the temperature increases with the increase in height. This condition mostly prevails during winter season in intermontane valleys.This is the reason why the settlements and orchards are preferred in the upper slopes of the valley instead of lower. Apple plantation in Himachal Pradesh are situated in the upper regions of the valleys.

Factors affecting the distribution of temperature

1. Distance from the Equator

The equatorial regions receives maximum insolation as the sun shines vertically over the equator for the entire year. The sunrays starts getting more slant as we move away from the equator towards the pole. Therefore the amount of insolation received is also less. The temperature decreases below freezing point in the polar regions and it is mostly covered with snow.

2. Height above sea level.

The temperature decreases with the increase in height. Normally there is a decrease of 1°C for every 165 m or 6.5°C decrease for every 1 km. The temperature of Shimla is comparatively lower than Delhi because Shimla is situated at a higher altitude than Delhi. Therefore the mountainous regions are much colder than the plains.

3. Distance from the Sea

The land gets warmer and cooler faster than water. Therefore the areas which are closer to the sea have moderate temperatures. Whereas the areas which are further away from the sea have variations in temperature.

4. Ocean Currents

The temperature conditions of the coastal areas are greatly affected by the ocean currents. The coastal margins that experiences hot ocean currents observes rise in temperature, on the other hand cold ocean currents causes decrease in temperature. The warmer Gulfstream maintains the warmer temperature conditions on the coastal regions of Europe. Thus in this way the nature of ocean currents controls the temperature of the coastal margins.

5. Prevailing Winds

The temperature increases in the areas where warm winds prevails and the temperature decreases where colder winds blow. The temperature increases by the warm winds named 'Sirocco' prevailing in Italy from Sahara desert and 'Chinnook' that prevails in the plains of North America. Similarly the northern parts of India experience increase in temperature of about 45°C due to warm wind called 'Loo' during summer season.

6. Slope of the Land

The slopes of land that receives more solar radiation also causes increase in temperature. Where as the slopes which are on the opposite side of sunshine receives lesser solar radiation and have lesser temperatures. The temperatures are

comparatively higher on the southern slopes of Himalaya and Alps than the northern slopes.

7. Nature of the earth's surface

The vegetation and the snow cover on the earth's surface reflects back the maximum part of solar radiation. The temperature do not rise in these regions. On the contrary, areas which are covered with sand and are formed of Black soil observes maximum solar radiation, which causes increase in temperature. The process of reflection of the solar radiation from the earth's surface is called Albedo.

8. Clouds and Rainfall

The areas which are mostly cloudy and receives maximum rainfall does not witness increase in temperature as most of the sun rays are reflected back by the clouds. For example the Equatorial Regions are comparatively less warmer than the cloudless tropical deserts, despite the fact that the sun shines vertically over the equator for the whole year.

Heat Budget

The balance between the heat observed and its loss by the earth and its atmosphere is called heat budget. The temperature of the earth remains almost constant, because the amount of the radiation received by the earth and the heat lost through Terrestrial radiation is almost the same. The Earth receives 2 billionth part of the solar radiation, only one part of it reaches the earth's surface, the rest is absorbed by atmosphere and lost in reflection, refraction and other processes.

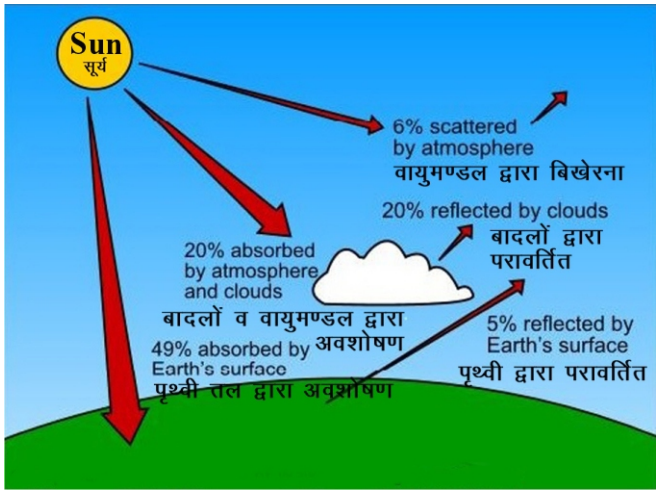

Fig. 12.5 : Heat Budget of the Earth

If we consider that the total amount of heat received by the atmosphere is 100 units, then the heat budget it will be as follows:- 35% of the heat received by the earth is reflected back into the space before it reaches the Earth surface, which is as follows-

In this way out of 100 units, only 51 units are received by the earth. 51% of the solar radiation absorbed by the earth is returned in the space in form of longwave radiation. From these 51%, 17% is reflected back to the space from the Earth and the 34% is absorbed by the atmosphere. From this 34% about 6% is observed by the atmosphere itself, 9% is observed in convection and 19% as latent heat of condensation. The 48% of the atmosphere, 14% from the sun and 34% by terrestrial radiation, thus(17+ 48= 65) is radiated to space by the atmosphere. Thus the total 65 units which is received by the earth is equal to the amount of heat which is radiated by the earth. This is the estimated heat budget of the earth ,which undergoes changes sometimes.

Important points

1. The source of energy for earth and its atmosphere is Sun.
2. There are three zones of latitudinal distribution (belts) of annual insolation on the earth's surface- Lower latitude, Mid latitude and Poles.
3. There are number of factors that affect the insolation on the earth surface like slanting rays of the sun, duration of the day, effect of land and sea, sun spots, atmosphere, height above sea level, structure of the slope, ocean currents etc.
4. The distribution of temperature according to latitudes is called horizontal distribution of temperature. The temperature distribution according to the height from the earth's surface is called vertical distribution of temperature.
5. Normally temperature decreases with the increase in height in troposphere but sometimes in special conditions temperature increases with the increase in height , this is

called inversion of temperature.

Exercise
Multiple choice questions

1. Solar radiation is measured by-
   A) Pyranometer
   B) Thermometer
   C) Barometer
   D) Centimetre

2. How long it takes for the sun rays to reach the earth?
   A) 5 mins
   B) 6 mins
   C) 7 mins
   D) 8 mins

3. The Solar Energy which is received by the earth is called-
   A) Terrestrial radiation
   B) Radiation
   C) Insolation
   D) Heat budget

4. By temperature inversion, we mean-
   A) Increase in temperature on earth surface
   B) Decrease in temperature in the sky
   C) Increase in temperature with the increase in height
   D) Decrease in the temperature with increase in height.

5. What is the total amount of solar radiation that reaches the earth?
   A) 51%
   B) 48%
   C) 35%
   D) 17%

Very short type questions

6. What is solar radiation?
7. What are isotherms?
8. What is the total distance between sun and the earth?
9. What are heat belts?
10. What is the major source of atmospheric heat?

Short type questions

11. What is albedo of the earth?
12. What is temperature inversion?
13. What is insolation?
14. What are the factors that affect solar insolation?
15. What is the difference between vertical and horizontal distribution of temperature?

Essay type questions

16. What is insolation? Explain the factors that affect the distribution of temperature.
17. Explain the heat budget of the earth.
18. Explain the distribution of temperature specially in reference to its horizontal and vertical distribution .

Answer key

1. A. 2. D. 3C. 4C. 5A