2

INSOLATION AND TEMPERATURE

2.1 INTRODUCTION

In the previous lesson we have studied that our earth is the only living planet in the whole universe. It has a large variety of life–both plant and animal. They require oxygen and carbon dioxide respectively for their survival. They also require optimum temperature to keep themselves warm and to grow. Have you ever thought where does the oxygen and carbon dioxide come? What is the source of heat and energy received on the surface of the earth? Why does earth's surface get warm during the day and cool down during the night? Let us find answers to all these and other related questions in this lesson.

2.2 OBJECTIVES

After studying this lesson you will be able to :

- explain the importance of atmosphere for life on the earth with reference to its major constituents;
- explain the important characteristics of each layer of atmosphere with the help of a diagram;
- explain the importance of insolation and establish relationship between angle of incidence of sun's rays and the intensity of heat received from them at a place;
- explain the different processes involved in heating and cooling of the atmosphere (conduction, convection, radiation and advection);
- explain the heat budget with the help of a diagram;

- differentiate between solar radiation and terrestrial radiation;
- explain the causes of global warming and its effects;
- explain the various factors affecting the horizontal distribution of temperature;
- explain with the help of maps, the main characteristics of temperature distribution in the world in the month of January and July;
- explain the conditions in which inversion of temperature occurs.

2.3 ATMOSPHERE AND ITS IMPORTANCE

The blanket of air that surrounds the earth is known as atmosphere. The atmosphere extends above the earth's surface for about 1600 kilometres. Its density rapidly decreases with height. About 97 percent of the air is concentrated in the first 30 kilometres or so.

The atmosphere of the earth is a mixture of various gases which helps in supporting life on the earth. Atmosphere shields the earth from the strong ultraviolet rays of the Sun. It also helps to maintain a fairly even temperature so that it is neither too hot nor too cold for life on the earth. Atmosphere also protects the earth from the showers of meteors. As most of these meteors get burnt before reaching the earth's surface because of their friction with the atmosphere. Besides, atmosphere acts as a medium for transmitting sound waves on the earth. It makes air flights possible.

* Atmosphere is a blanket of air that surrounds the earth.
* Atmosphere sustains life on earth by regulating temperature and protectingit from meteors and strong ultraviolet rays of the sun.

2.4 COMPOSITION OF ATMOSPHERE

The air that we feel around us is a mixture of various gases. The pure dry air is composed of five main gases. They are nitrogen, oxygen, argon, carbon dioxide and water vapour. Both nitrogen and oxygen together make 99% of the atmosphere by volume (fig. 2.1). The remaining one percent consists of gases like argon, carbon dioxide, hydrogen, helium and ozone. Besides there are traces of water vapour, dust particles, smoke, salt and other impurities in varying quantities in the air. The composition of the atmosphere is not constant. It varies from time to time and from place to place. This variability is readily observed when we come from the rural countryside to the city and see increase in smoke. But the proportion of the main gases remains almost uniform upto a height of about 80 kilometres from the mean sea level.

* Nitrogen and oxygen together make 99% of the air.

* Composition of gases in the atmosphere is not constant it varies from time to time and place to place.

As already mentioned nitrogen, oxygen, carbon dioxide, water vapour and dust particles are the most important constituents of the atmosphere Life on earth would have been impossible in the absence of these gases A brief account of the importance of these gases for our life is given below.

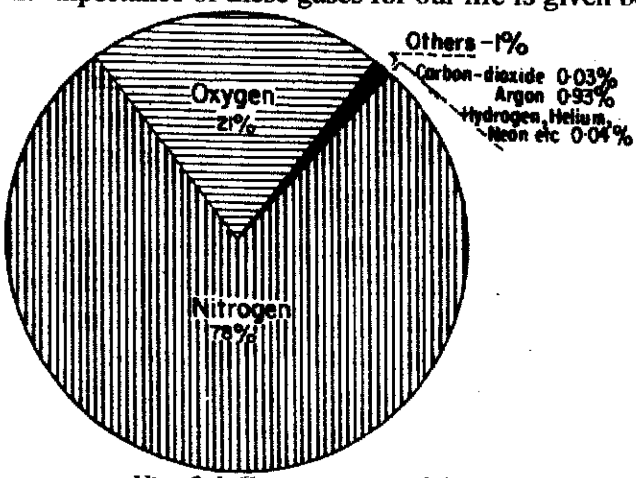

Fig. 2 1 Composition of the Air

(a) Nitrogen is the most plentiful of all the gases in the atmosphere Animals and most of the plants do not make use of nitrogen directly Some bacteria that live in the soil and in the roots of some plants such as peas, grams take nitrogen from the air and change it into forms that plants can readily use Animals eat plants and get the nitrogen in this way The waste products of animals and plants break down and release nitrogen.

(b) Oxygen is the second most plentiful gas found in the air Living beings use oxygen in respiration Oxygen is also used by decaying plants and animals material Green plants use oxygen and also produce it during the process of photosynthesis. The production of oxygen balances its consumption.

* Photosynthesis is the process by which green plants combine carbon dioxide and water in the presence of chlorophyll and light energy to form carbohydrates and release oxygen

(c) Carbon dioxide makes a very little part of the air but it is a very vital gas. Green plants use it during the process of photosynthesis. Animals consume plants as their food and release carbon dioxide as waste product Carbon dioxide is important for the climate, as it absorbs solar energy and the earths radiation and then emits a part of it towards the earth. This process helps to maintain the warmth of the earth. However, the burning of fuel such as coal and oil produce carbon dioxide in the air. As a result, the amount of carbon dioxide is increasing slightly each year. It is feared this increasing amount of carbon dioxide may affect the earth's weather by increasing its temperature.

(d) Water vapour is one of the most important and variable gases of the atmosphere. It varies from 4% of the air by volume in the warm and wet tropics to less then 1% in the dry deserts and polar regions. This amount of water vapour in the air decreases with increase in altitude. It also decreases from equator towards poles.

Water vapour absorbs heat coming from the sun and reduces its amount reaching the surface of the earth. It also preserves heat radiated from the earth. Thus, it acts as a blanket allowing the earth neither to become too hot nor too cold. Water vapour absorbs heat during evaporation and releases it during condensation and precipitation.

(e) Dust particles held in the air include tiny solid particles such as dust, salt, pollen, smoke, seeds and ash. As a result of gravitational pull of the earth they are mostly found in the lower layers of the atmosphere. Water vapour condenses around these particles to form clouds. Dust particles also help in the formation of smog (smoke & fog) and dense haze which reduce incoming sunlight and retard the heat from the earth to escape.

* Water vapour allows the earth to become neither too hot nor too cold.
* Water vapour condenses around dust particles to form cloud

INTEXT QUESTIONS 2.1

1. Fill in the blanks with suitable words from the brackets.

   (a) Atmosphere is a ____________ of air that envelops the earth. (blanket, layer)

   (b) Nitrogen makes ____________ per cent of air by volume. (99.78)

   (c) ____________ allows the earth neither to become too hot nor cold. (carbon dioxide, water vapour).

   (d) 97 per cent of the air is concentrated within ____________ kilometres above mean sea level. (30,80)

2. Mark tick (✓) on the correct statements and cross (x) on the false ones:

   (a) Green plants produce carbon dioxide.

   (b) Production of oxygen balances carbon dioxide's consumpion.

   (c) Amount of water vapour in the atmosphere increases with increase in altitude.

(d) Atmosphere is a mixture of various gases.

(e) Dust particles have no contribution in the formation of smog.

3. Match the items given in the following two columns correctly

A	B
(a) Carbon dioxide	(1) Cause rain fall
(b) Nitrogen	(2) Plants require it for their growth
(c) Dust particles	(3) Living beings use in respiration
(d) Water vapour	(4) Causes rise in the earth's temperature if in excess
(e) Oxygen	(5) Water vapour condenses around them

2.5 STRUCTURE OF THE ATMOSPHERE

The atmosphere can be divided roughly into the following five concentric layers each with a varying density and temperature. (fig. 2.2). The layers of the atmosphere are:

(a) The Troposphere

(b) The Stratosphere

(c) The Mesosphere

(d) The Ionosphere

(e) The Exosphere

(a) The Troposphere

It is the lower most layer of the atmosphere. Its thickness is 8 kilometres on the poles and 18 kilometres on the equator. The thickness of the troposphere on the equator is greatest because heat is transported to great heights by the strong convectional current. Distinct characteristics of troposphere are as follow:

(i) The temperature decreases in the troposphere with the increase in height at an average rate of 1^0 per 165 metres of height.

(ii) The water vapour and dust particles of the atmosphere are concentrated in this layer only. They are virtually non-existent in other layer of the atmosphere.

(iii)Since water vapour and dust particles play an important role in weather changes, therefore, all the weather phenomena like clouds, precipitation and storms occur in this layer.

(iv) All forms of life exist within this layer.

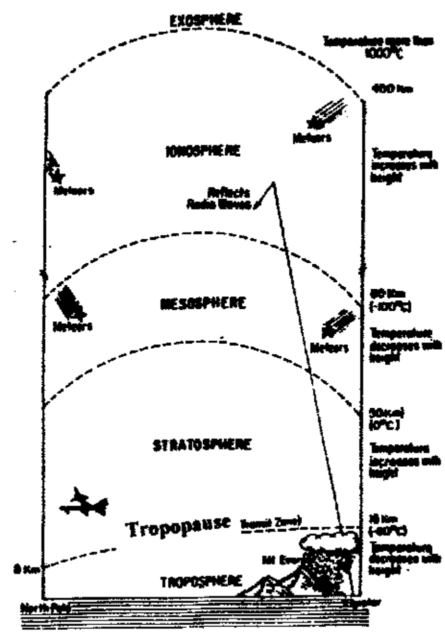

Fig. 2.2 Layers of the Atmosphere

(b) The Stratosphere

It lies beyond the troposphere. There is a transitional zone between troposphere and stratosphere called tropopause. Look at the diagram and note the thickness of the stratosphere. Its main characteristics are:

(i) Temperature is almost constant upto a height of 20 kilometres in the lower portion of this layer. Then it gradually increases with increase in height.

(ii) Ozone is present in the upper portion of the stratosphere. It prevents the harmful ultraviolet rays of the sun to reach the earth's surface. Ozone is also responsible for the increase in the temperature of the upper portion of this layer as it absorbs the ultraviolet rays.

(iii)The layer presents the ideal conditions for air flights due to the absence of weather phenomena.

(c) The Mesosphere

It is the third layer above the stratosphere. It extends upto an average height of 80 kilometres from the mean sea level. Temperature decrease again and reaches upto - 100°C at the height of 80 kilometres.

(d) The Ionosphere

This layer is located above the mesosphere. It contains electrically charged ions that reflect the radio waves back to the earth, thus making wireless communication possible. Temperature again begins to increase in this layer with increase in height due to radiation from the sun.

(e) The Exosphere

This is the uppermost layer of the atmosphere. The exact height at the top of exosphere is uncertain. It is a transition zone between the atmosphere and space. The density of the air is very low there.

INTEXT QUESTIONS 2.2

1. Answer the following question in one or two words.

   (a) What is the average thickness of the troposphere?

   ____

   (b) Which layer of the atmosphere contains electrically charged ions?

   ____

   (c) Name the layer of the atmosphere which absorbs the sun's harmful ultraviolet rays?

   ____

   (d) Name the upper most layer of the atmosphere.

   ____

2. Select the best alternative and mark (✓) on it :

(a) The layer which is ideal for air flight is

(i) ionosphere (ii) troposphere (iii) stratosphere (iv) exosphere.

(b) Most of the water vapour is restricted to

(i) exosphere (ii) troposphere (iii) stratosphere (iv) mesosphere.

(c) Most of the ozone gas of the atmosphere is occupied in

(i) troposphere (ii) stratosphere (iii) ionosphere (iv) tropopause.

(d) Tropopause is the zone separating

(i) earth's surface and troposphere (ii) troposphere and stratosphere (iii) stratosphere and ionosphere (iv) ozonosphere and exosphere.

2.6 INSOLATION

The sun is the primary source of energy on the earth. This energy is radiated in all directions into space through short waves. This is known as solar radiation.

Only two billionths (0.000000002) part of the total solar radiation reaches the earth's surface. This small proportion of solar radiation is of great importance, as it is the only major source of energy on the earth for most of the physical and biological phenomena.

Incoming solar radiation through short waves is termed as insolation. The amount of insolation received on the earth's surface is far less than that is radiated from the sun because of the small size of the earth and its distance from the sun. Moreover water vapour, dust particles, ozone and other gases present in the atmosphere absorb a small amount of insolation.

* Sun is the primary source of energy on earth.
* Insolation is the incoming solar radiation.

(a) Factors influencing Insolation

The amount of insolation received on the earth's surface is not uniform everywhere. It varies from place to place and from time to time. The tropical zone receive the maximum annual insolation. It gradually decreases towards the poles. Insolation is more in summers and less in winters.

The following factors influence the amount of insolation received.

(i) The angle of incidence.

(ii) Duration of the day.

(iii) Transparency of the atmosphere.

(i) The Angle of Incidence : Since the earth is round, the sun's rays strike the surface at different angles at different places. The angle formed by the sun's ray with the tangent of the earth's circle at a point is called angle of incidence. It influences the insolation in two ways. First, when the sun is almost overhead, the rays of the sun are vertical. The angle of incidence is large hence, they are concentrated in a smaller area, giving more amount of insolation at that place. If the sun's rays are oblique, angle of incidence is small and sun's rays have to heat up a greater area, resulting in less amount of insolation received there. Secondly, the sun's rays with small angle, traverse more of the atmosphere, than rays striking at a large angle. Longer the path of sun's rays, greater is the amount of reflection and absorption of heat by atmosphere. As a result the intensity of insolation at a place is less. (see fig. 2.3)

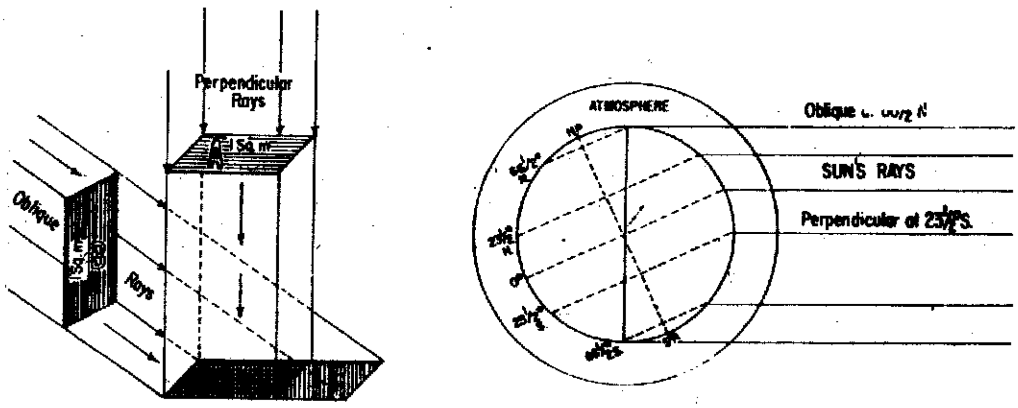

Fig. 2.3 Effect of Angle of Incidence on Insolation

(ii) Duration of the day : Duration of the day varies from place to place and season to season. It decides the amount of insolation received on earth's surface. The longer the duration of the day, the greater is the amount of insolation received. Conversely shorter the duration of the day leads to receipt of less insolation.

(iii) Transparency of the atmosphere : Transparency of the atmosphere also determines the amount of insolation reaching the earth's surface. The transparency depends upon cloud cover, its thickness, dust particles and water vapour, as they reflect,absorb or transmit insolation. Thick clouds hinder the insolation to reach the earth while clear sky helps it to reach the surface. Water vapour absorb insolation, resulting in less amount of insolation reaching the surface.

* Amount of insolation at a place depends upon angle of incidence, duration of the day and transparency of the atmosphere.

(b) Heating and cooling of the Atmosphere

Sun is the ultimate source of atmospheric heat and energy, but its effect is not direct. For example, as we climb a mountain or ascend in the atmosphere, temperature become steadily lower, rather than higher, as we might expect. This is because the mechanism of heating the atmosphere is not simple. There are four heating processes directly responsible for heating the atmosphere. They are: (i) Radiation (ii) Conduction (iii) Convection and (iv) Advection.

(i) Radiation: When the source of heat transmits heat directly to an object through heat waves, it is known as radiation process. In this process, heat travels through the empty space. The vast amount of heat energy coming to and leaving the earth is in the form of radiation. The following facts about radiation are worth noting.

(i) All objects whether hot or cold emit radiant energy continuously.

(ii) Hotter objects radiate more energy per unit area than colder objects.

(iii) Temperature of an object determines the waves length of radiation. Temperature and wave length are inversely related. Hotter the object shorter is the length of the wave.

(iv) Insolation reaches the earth's surface in short waves and heat is radiated from the earth in long waves.

You will be amused to know that atmosphere is transparent to short waves and opaque to long waves. Hence energy leaving the earth's surface i.e. terrestrial radiation heats up the atmosphere more than the incoming solar radiation i.e. insolation.

(ii) Conduction: When two objects of unequal temperature come in contact with each other, heat energy flow from the warmer object to the cooler object and this process of heat transfer is known as conduction. The flow continues till temperature of both the objects becomes equal or the contact is broken. The conduction in the atmosphere occurs at zone of contact between the atmosphere and the earth's surface. However, this is a minor method of heat transfer in terms of warming the atmosphere since it only affects the air close to the earth's surface.

(iii)Convection: Transfer of heat by movement of a mass or substance from one place to another, generally vertical, is called convection. The air of the lower layers of the atmosphere get heated either by the earth's radiation or by conduction. The heating of the air leads to its expansion. Its density decreases and it moves upwards. Continuous ascent of heated air creates vacuum in the lower layers of the atmosphere. As a consequence, cooler air comes down to fill the vacuum, leading to convection. The cyclic movement associated with the convectional process in the atmosphere transfer heat from the lower layer to the upper layer and heats up the atmosphere.

(iv) Advection: Winds carry the temperature of one place to another. The temperature of a place will rise if it lies on the path of winds coming from warmer regions. The temperature will fall if the place lies on the path of the winds blowing from cold regions. This process of horizontal transport of heat by winds is known as advection.

INTEXT QUESTION 2.3

1. Answer the following questions in one or two words:

   (a) By which process heat energy travels from the sun to the earth?

   ____

   (b) What part of solar radiation is received by the earth's surface?

   ____

   (c) Name the process in which heat is transferred by winds.

   ____

   (d) Name the three factors influencing the amount of insolation received at a place.

(i) __________ (ii) __________ (iii) __________

2. Select correct alternative for each of the following and mark (√) on it.

(a) Insolation comes to the earth's surface in -

(i) short waves, (ii) long waves, (iii) both of them, (iv) none of them

(b) Atmosphere is heated by -

(i) insolation, (ii) heat radiation from the earth, (iii) both of them, (iv) none of them.

(c) Even after the sunset the air near the earth's surface continues to receive heat by -

(i) insolation, (ii) terrestrial radiation, (iii) conduction, (iv) convection

2.7 HEAT BUDGET

Insolation is the amount of solar radiation that reaches the earth's surface through shortwaves. The earth also radiates heat energy like all other hot object. This is known as terrestrial radiation. The annual mean temperature on the surface of the earth is always constant. It has been possible because of the balance between insolation and terrestrial radiation. This balance is termed as a heat budget of the earth.

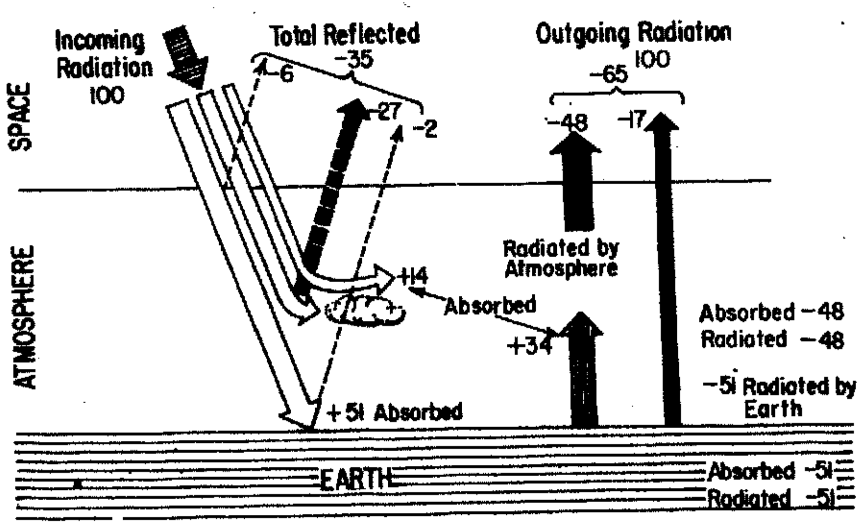

Fig. 2.4 Heat Budget (balance between insolation and terrestrial radiation)

Let us suppose that the total heat (incoming solar radiation) received at the top of the atmosphere is 100 units (see fig. 2.4,). Roughly 35 units of it are reflected back into space even before reaching the surface of the earth. Out of these 35 units, 6 units are reflected back to space from the top of the atmosphere, 27 units reflected by clouds and 2 units from the snow and ice covered surfaces.

Out of the remaining 65 units (100-35), only 51 units reach the earth's surface and 14 units are absorbed by the various gases, dust particles and water vapour of the atmosphere.

The earth in turn radiates back 51 units in the form of terrestrial radiation. Out of these 51 units of terrestrial radiation, 34 units are absorbed by the atmosphere and the remaining 17 units directly go to space. The atmosphere also radiates 48 units (14 units of incoming radiation and 34 units of outgoing radiation abosrbed by it) back to space. Thus 65 units of solar radiation entering the atmosphere are reflected back into the space. This account of incoming and outgoing radiation always maintains the balance of heat on the surface of the earth.

> * Heat budget is the balance between insolation (incoming solar radiation) and terrestrial radiation.

(a) Latitudinal Heat Balance

Although the earth as a whole, maintains balance between incoming solar radiation and outgoing terrestrial radiation. But this is not true what we observe at different latitudes. As previously discussed, the amount of insolation received is directly related to latitudes. In the tropical region the amount of insolation is higher than the amount of terrestrial radiation. Hence it is a region of surplus heat. In the polar regions the heat gain is less than the heat loss. Hence it is a region of deficit heat. Thus the insolation creates an imbalance of heat at different latitudes (see Fig. 2.5). This is being nullified to some extent by winds and ocean currents, which transfer heat from surplus heat regions to deficit heat regions. This is commonly known as latitudinal heat balance.

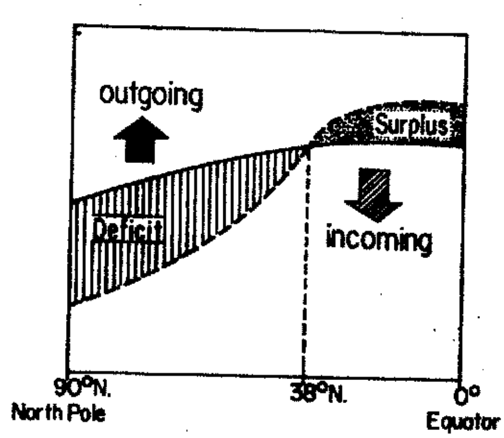

Fig. 2.5 Latitudinal Heat Balance

2.8 GLOBAL WARMING

Global warming is one of the major environmental problem our earth is facing. Scientist see its close association with depletion of ozone layer and increase in atmospheric carbon dioxide.

As you know that the upper portion of the stratosphere contains a layer of ozone gas. Ozone is capable of absorbing a large amount of sun's ultraviolet radiation thus preventing it from reaching the earth's surface. Scientist have realised that the thickness of the ozone layer is reducing. This is disturbing the balance of gases in the atmosphere and increasing the amount of ultraviolet radiation reaching the earth. Ultraviolet radiation is responsible for increasing the global temperature of the earth's surface besides it can severely burn human being's skin, increase the incidence of skin cancer, destroy certain microscopic forms of life and damage plants. There is a gradual increase in the carbon dioxide content of the atmosphere. It is estimated that the carbon dioxide content of the atmosphere has increased 25 per cent in the last hundred years. Carbon dioxide allows insolation to pass through but absorbs terrestrial radiation. Increase of carbon dioxide in the atmosphere has the effect of raising the atmospheric temperature. It is estimated that the temperature the atmosphere has increased by about 0.5^0 C in the last 1000 years. Large scale deforestation, burning garbages, combustion processes in factories and volcanic eruptions are some of the factors responsible for the increase of carbon dioxide in the atmosphere.

If the depletion of ozone layer and the increase in the carbon dioxide content continue, the time would come when the temperature of the atmosphere will rise to the extent that it would melt polar ice, caps increasing the sea level and causing submergence of coastal regions and islands. The phenomenon of world wide increase of atmospheric temperature due to depletion of ozone layer and the increase of carbon dioxide content is known as global warming.

* Latitudinal heat balance is the transfer of heat from lower to higher latitudes by winds and ocean currents to counter the imbalance created by insolation at different latitudes.
* Global warming is the world – wide increase of atmospheric temperature due to depletion of ozone layer and in the increase of carbon dioxide content.

INTEXT QUESTIONS 2.4

1. Define the following terms :

   (a) Heat Budget:

   ____

(b) Latitudinal Heat Balance :

(c) Global Warming

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2. Answer the following questions ver; briefly :

(a) What percentage of insolation is received by the earth?

(b) What part of the incoming solar radiation is reflected ck to space from the top of the atmosphere?

(c) Name the regions of surplus heat

(d) Which is the region of deficit heat?

2.9 TEMPERATURE AND ITS DISTRIBUTION

Heat is the energy which make things or objects hot while temperature measures the intensity of heat. Although quite distinct from each other, yet heat and temperature are closely related because gain or loss of heat is necessary to raise or lower the temperature. Moreover, difference in temperature determines the direction of flow of heat. This we can understand by studying temperature distribution.

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

(a) The horizontal distribution of temperature

(b) The vertical distribution of temperature

(a) Horizontal Distribution of Temperature

Distribution of temperature across the latitudes and longitudes over the surface of the earth is called its horizontal distribution. Isotherms are used to show horizontal distribution of temperature on the maps. An isotherm is made of two words 'iso' and 'therm'. 'Iso' means equal and 'therm' mean temperature. Hence isotherm is an imaginary line drawn on a map which joins places of equal temperature reduced to mean sea level. If you study an isotherm map you will find that the distribution of temperature is uneven.

The factors responsible for the uneven distribution of temperature are as follows :

(i) Latitude

(ii) Land and Sea Contrast

(iii) Relief and Altitude

(iv) Ocean Currents

(v) Winds

(vi) Vegetation Cover

(vii) Nature of the Soil

(viii) Slope and Aspect

(I) Latitude : You have already studied under 'insolation' that the angle of incidence goes on decreasing from equator towards poles (fig. 2.3). Higher the angle of incidence, higher is the temperature. Lower angle of incidence leads to the lowering of temperature. It is because of this that higher temperatures are found in tropical regions and they decrease at a considerable rate towards the poles. Temperature is below freezing point near the poles almost throughout the year.

(ii) Land and Sea Contrast : Land and sea contrast affects temperature to a great extent. Land gets heated more rapidly and to a greater degree than water during sunshine. It also cools down more rapidly than water during night. Hence, temperature is relatively higher on land during day time and it is higher in water during night. In the same way there are seasonal contrasts in temperature. During summer the air above land has higher temperature than the oceans. But the air above oceans gets higher temperature than landmasses in winter.

Notwithstanding the great contrast between land and water surfaces, there are differences in the rate of heating of different land surfaces. A snow covered land as in polar areas warms very slowly because of the large amount of reflection of solar energy. A vegetation covered land does not get excessively heated because of great amount of insolation is used in evaporating water from the plants.

(iii) Relief and Altitude : Relief features such as mountains, plateaus and plains control the temperature by way of modifying its distribution. Mountains act as barriers against the movement of winds. The Himalayan ranges prevent cold winds of Central Asia from entering India, during winter. Because of this Calcutta is not as cold as Guangzhou (Canton) in winter though both are situated on the same latitude. (fig. 2.6)

As we move upwards from sea level, we experience gradual decrease in temperature. Temperature decreases at an average rate of 1° C per 165 metres altitude. It is known as normal lapse rate. The air at lower elevations is warmer than that of higher elevations because it is closest to the heated surface of the earth. As a result mountains are cooler than the plains even during summers (see fig. 2.6). It is worth remembering that the rate of decrease of temperature with altitude varies with time of day, season and location.

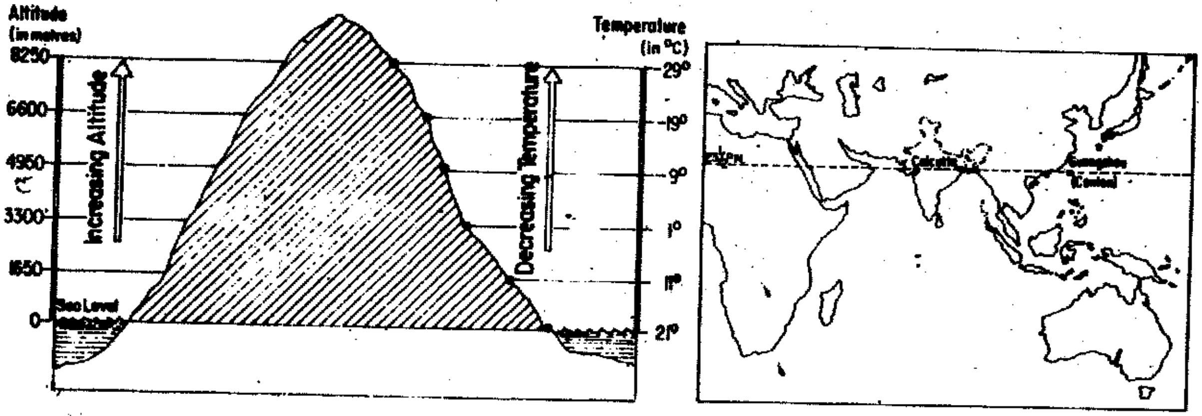

Fig. 2.6 Effect of Altitude on Temperature

Quito and Guayaquil are two cities of Ecuador (South America) situated near the equator and relatively close to each other. Quito is at 2800 metres high from mean sea level while Guayaquil is just at 12 metres altitude. However because of difference in altitude, Quito experiences annual mean temperature of 13.3° C while in Guayaquil it is 25.5° C.

(iv) Ocean Currents : Ocean currents are of two types — warm and cold. Warm currents make the coasts along which they flow warmer, while cold currents reduce the temperature of the coasts along which they flow. The North-Western European Coasts do not freeze in winter due to the effect of North Atlantic Drift (a warm current), while the Quebec on the coast of Canada is frozen due to the Cold Labrador Current flowing along it, though the Quebec is situated in lower latitudes than the North-West European Coast (see fig. 2.7).

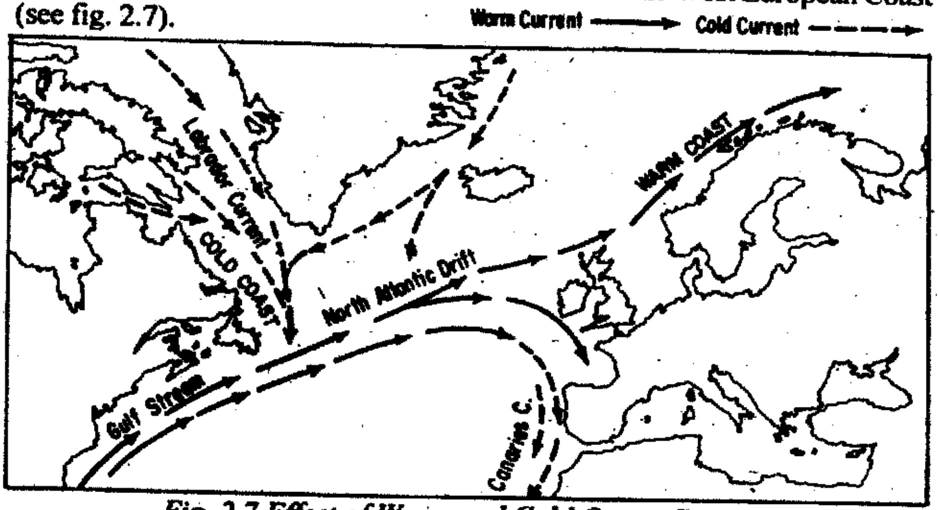

Fig. 2.7 Effect of Warm and Cold Ocean Current

(v) Winds : Winds also affect temperature because they transport heat from one region to the other, about which you have already studied under advection.

(vi) Vegetation Cover : Soil devoid of vegetation cover receives heat more rapidly than the soil under vegetation cover. Because vegetation cover absorbs much of sun's heat and the prevents quick radiation from the earth whereas the former radiates it more rapidly. Hence the temperature variations in dense forested areas are lower than those in desert areas. For example annual range of temperature in equatorial regions is about 5° C while in hot deserts it is as high as 38° C.

(vii) Nature of the Soil : Colour, texture and structure of soils modify temperature to a great degree. Black, yellow and clayey soils absorb more heat than sandy soils. Likewise heat radiates more rapidly from sandy soils than from black, yellow and clayey soils. Hence temperature contrasts are relatively lesser in black soil areas than those of sandy soils.

(viii) Slope and Aspect : Angle of the slope and its direction control the receipt of insolation. The angle of incidence of sun's rays is greater along a gentler slope and smaller along a steeper slope. The rays in both the cases carry an equal amount of solar energy. Greater concentration of solar energy per unit area along gentler slope raises the temperature while its lesser concentration along steeper slopes lowers the temperature. For such reasons the southern slopes of the Himalayas are warmer than the northern ones. At the same time the slopes, in terms of aspect, exposed to the sun receive more insolation and are warmer than those which are away from the direct rays of the sun. The northern slopes of the Himalayas for example, not facing from the sun are exposed to cold northernly winds are obviously colder. On the other hand the southern slopes of the Himalayas are sun-facing and are also shelter from the northernly cold winds are warmer. Hence we observe settlements and cultivation largely on the southern slopes of the Himalayas while the northern slopes are more under forest area.

> * Latitude, land and sea contrast, relief and altitude, oceans currents, winds, vegetation cover, nature of soil, slope and aspect control the distribution of temperature in the world.

The horizontal distribution of temperature over the globe can be studied easily from the maps of January and July months, since the seasonal extremes of high and low temperature are most obvious in both northern and southern hemispheres during these months.

(I) Horizontal Distribution of Temperature in January

In January, the sun shines vertically overhead near the Tropic of Capricorn. Hence it is summer in southern hemisphere and winter in northern hemisphere. High temperature is found over the landmasses mainly in three regions of the southern hemisphere. These regions are North-west Argentina, East-central Africa, and Central Australia. Isotherm of 30° C is enclosed them. In northern hemisphere landmass are cooler than oceans. During this time North-east Asia experiences lowest temperatures (see fig. 2.8)

As the air is warmer over oceans than over landmasses in the northern hemisphere, the Isotherms bend towards poles when they cross the oceans. In southern hemisphere, the position of the isotherms is just reverse. They bend towards poles when they cross the landmasses and towards equator when they cross oceans.

Large expanse of water exists in southern hemisphere. Hence, isotherms are regular and widely spaced in the southern hemisphere. While they are irregular and closely spaced in northern hemisphere due to large expanse of landmasses. For these reasons no extreme seasonal contrasts between land and water are found in middle and higher latitudes in the southern hemisphere as exist north of equator.

Fig. 2.8 Horizontal Distribution of Temperature (January)

(II) Horizontal Distribution of Temperature in July

During this period the sun shines vertically overhead near the Tropic of Cancer. Hence, high temperatures are found in the entire northern hemisphere. Isotherm of 30° C passes between 10° N and 40° N latitudes. The regions having this temperature include South Western USA, the Sahara, the Arabia, Iraq, Iran, Afghanistan, desert region of India and China. However, lowest temperature of 0°C is also noticed in the Northern Hemisphere during summer in the central part of Greenland (see fig. 2.9)

During summer in the northern hemisphere, isotherms bend equatorward while crossing oceans and polewards while crossing landmasses. In southern Hemisphere the position of isotherms is just opposite

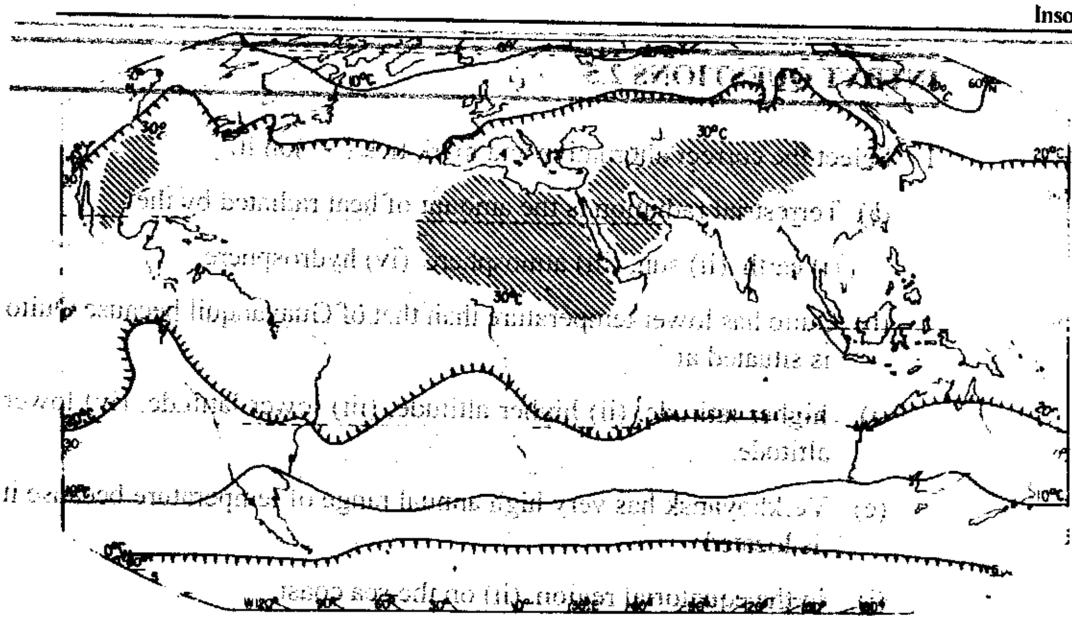

Fig 2 9 Horizontal Distribution of Temperature (July)

Isotherms are widel spaced over oceans while they are closely spaced ove landmasses

A comparison between the January and July isotherm maps reveals following important characteristics

The latitudinal shifting of highest temperature as a result of migration of the vertical rays of the sun

The occurance of highest values in the low latitudes and the lowest values in the high latitudes is due to the decreasing insolation from equator to the poles

In northern hemisphere the isotherms on leaving the land usually bend rather sharply towards poles in winter and towards the equator in the summer. This behaviour of the isotherms is due to the differential heating and cooling of landmasses. The continents are hotter in the summer and colder in the winter than the oceans.

Difference between the average temperatures of warmest and the coldest months is known as annual range of temperature. Annual range of temperature is larger in the interior parts of the continents in middle and high latitudes of the northern hemisphere. Verkhoyansk in Siberia records 66° C the highest annual range of temperature in the world. Its lowest average winter temperature is 50° C. Hence it is aptly called 'cold pole' of the earth.

- The difference between average temperature of the warmest and the coolest months is known as annual range of temperature.

INTEXT QUESTIONS 2.5

1. Select the correct alternative and mark tick (✓)on it:

   (a) Terrestrial radiation is the amount of heat radiated by the

   (i) earth, (ii) sun, (iii) atmosphere, (iv) hydrosphere

   (b) Quito has lower temperature than that of Guayanquil because Quito is situated at

   (i) higher latitude, (ii) higher altitude, (iii) lower latitude, (iv) lower altitude.

   (c) Verkhoyansk has very high annual range of temperature because it is located

   (i) in the equatorial region, (ii) on the sea coast,

   (iii) in the interior parts of Asia (iv) on mountain

2. Give a geographical term for each of the following statements:

   (a) The process of horizontal transport of heat by winds.

   ____

   (b) Imaginery lines on a map joining the places of equal temperature, reduced to sea level

   ____

   (c) Difference between the mean temperatures of the hottest and that of the coldest month.

(b) Vertical Distribution of Temperature

Distribution of temperature according to altitude is called vertical distribution of temperature. We have already studied it under para2.9 (iii). The normal decrease in temperature with increasing altitude for several kilometres in the lower atmosphere sometimes gets reversed. Hence it needs careful explanation which is given below.

(c) Inversion of Temperature

Long winter night, clear sky, dry air and absence of winds leads to quick radiation of heat from the earth's surface, as well as from the lower layers of the atmosphere. This results in the cooling of the air near the earth's surface. The upper layers which lose their heat not so quickly are comparatively warm. Hence the normal condition in which temperature decreases with increasing height, is reversed. The cooler air is nearer the earth and the warmer air is aloft. In other words, temperature increases with increasing height temporarily or locally This phenomena is termed as inversion of temperature. Sometimes the cold and dense air remains near the surface for number of days. So the phenomenon of inversion of temperature is also seen for days together.

The phenomenon of inversion of temperature is especially observed in intermontane valleys. During winters the mountain slopes cool very rapidly due to the quick radiation of heat. The air resting above them also becomes cold and its density increases. Hence, it moves down the slopes and settles down in the valleys. This air pushes the comparatively warmer air of valleys upwards and leads to the phenomenon of inversion of temperature. Sometimes the temperature falls below freezing point in the valleys leading even to the occurance of frost. In contrast, the higher slopes remain comparatively warmer. That is why mulberry planters of the Suwa Basin of Japan and the apple growers of Himachal Pardesh avoid the lower slopes of the mountains to escape winters frost. If you have been to any hill station you would have seen that most of the holiday resorts and the houses of affluent persons are built on the upper slopes.

* Temperature usually decreases with increasing altitude.
* The normal lapse rate is 1°C for every 165 metres ascend.
* The Phenomenon in which temperature increases with increasing altitude temporarily and locally under sustain conditions is known as inversion of temperature.

INTEXT QUESTIONS 2.6

1. Select the correct alternative for each of the following and mark tick (✓) on it

(a) Temperatures decrease with increase in -

(i) altitude (ii) depth, (iii) pressure, (iv) both altitude and depth

(b) The normal lapse rate is 1° C per

(i) 561 metres. (ii) 165 metres, (iii) 651 metres (iv) 156 metres

(c) The phenomenon in which temperature increases with increasing altitude is known as

(i) temperature anomaly, (ii) inversion of temperature, (iii) lapse rate, (iv) insolation

2. Ti k (✓) the true statements and cross (x) on the f lse ones

(a) Cold air is light.

(b) old air is dense.

(c) C ear sky dry air and absence of winds causes rap d radiation leading to the phenomenon of inversion of temperature.

(d) versio ot temperature occurs very frequently in plain.

(e) Applc g wers of the Himachal Pradesh avoid lower slopes

(f) The cool and dense air sliding down the mo n slopes pushes the comparatively warm and light air of valleys rds.

(g) Inversion of temperature occurs locally and temporarily.

WHAT YOU HAVE LEARNT

The blanket of air that surrounds the earth is known as its atmosphere. It i composed of various gases with the predominance of nitrogen and oxygen which constitute 99% of the atmosphere. The atmosphere has different layers. They are troposphere. stratosphere, mesophere, ionosphere and exosphere. Troposphere is important to man as all weather phenomena occur in this layer. Stratosphere is ideal for air flights and its ozone layer absorbs harmful ultraviolet rays and prevent them from reaching the earth. Ions of the ionosphere transmit sound waves back to the earth and thus help in making radio and wireless communication possible on earth.

Sun is the primary source of energy on earth. Sun's energy reaching the earth in short waves is called insolation. The amount of insolation depends upon angle of incidence, duration of the day and transparency of the atmosphere he processes involved in the heating and cooling of the atmosphere are radiation conduction, convection and advection. Radiation predominates other three processes. Terrestrial radiation is the amount of heat radiated bac from the earth. There is a balance between the receipt of insolation and th errestrial radiation on earth's surface. It is known as heat budget. Globa warming is the world wide increase of atmospheric temperature due to depletion of ozone layer and increase in carbon dioxide

mperature measures the intensity of heat. Distribution of temperature varies both ho izontally and vertically Certain factors control its distribution They are latitude, land and water contrast, winds, ocean currents, altitude and aspect f slope. Horizontal distribution of temperature is shown on a map w th the help of isotherms, the imaginery lines joining places of equal temperature. Temperature also decreases with increasing altitude. The rate at which it decreases in normal conditions is known as normal lapse of temperature. It is 1^0 C per 165 metres of height. The phenomenon of inversion of temperature occurs when temperature increases with increase in height. It is generally local and temporary in character.

TERMINAL QUESTIONS

1. Answer the following questions at the most in one sentence
   (a) What is meant by normal lapse rate?
   (b) What is insolation?
   (c) Define terrestrial radiation.
   (d) At which rate does temperature decrease with increase in altitude?
2. Distinguish between the following in 50 words each :
   (a) Troposphere and stratosphere.
   (b) Radiation and conduction
3. Write in about 50 words on each of the following
   (a) Distribution of temperature in the world in January
   (b) Heat Budget
   (c) Comparison between January & July isotherms.
   (d) Latitudinal heat balance.
4. Describe the factors that influence the horizontal distribution of temperature.
5. Mark and label the following on an outline map of world.
   (a) 30^0 C isotherm in July
   (b) Verkhoyansk
   (c) The Sahara
   (d) Borneo island
6. How do water vapour and dust particles influence the amount of insolation of a region?

7. **Why do different parallel of latitudes receive different amount of isolation?**

8. Describe the structure of the atmosphere stating the different characteristics of each of its layers.

9. Why is the atmosphere called the blanket or envelop of air?

10. Draw a diagram to explain the heat budget of the earth.

CHECK YOUR ANSWERS

INTEXT QUESTIONS

2.1

1. (a) Blanket (b) 78 (c) water vapour (d) 30
2. (a) False (b) False. (c) False (d) True (e) False
3. (a) 4, (b) 2, (c) 5, (d) 1, and (e) 3.

2.2

1. (a) 13 km. (b) Ionosphere (c) Stratosphere (d) Exosphere
2. (a) Stratosphere (b) Troposphere (c) Stratosphere (d) Troposphere and stratosphere.

2.3

1. (a) Radiation (b) Two billionths part (c) Advection

   (d) (i) Angle of incidence, (ii) Duration of the day and (iii) Transparency of the atmosphere
2. (a) short waves (b) heat radiation from the earth

   (c) terrestrial radiation

2.4

1. (a) see 2.7 (b) see 2.7 (c) see 2.8
2. (a) 51% (b) 6% (c) Tropical Region (d) Polar region

2.5

1. (a) earth (b) higher altitude (c) in the interior parts of Asia
2. (a) Advection (b) Isotherms (c) Annual range of temperature

2.6

1. (a) altitude (b) 165 metres (c) inversion of temperature
2. (a) False, (b) True, (c) True, (d) False, (e) True, (f) True, (g) True

TERMINAL QUESTIONS

1. **(a) The normal rate at which temperature decreases with increase in altitude.**

   (b) The portion of solar radiation that reaches the surface of the earth.

   (c) Heat radiated from the earth's surface.

   (d) 1°C at every 165 metres altitude.

2. **(a) Please refer to para 2.5 (a) 2.5 (b)**

   (b) Please refer to para 2.6 (b) (i) and (ii)

3. **(a) Please refer to para to 2.9 (a) (I)**

   (b) Please refer to para 2.7

   (c) Please refer to para 2.9 (a) (II)

   (d) Please refer to para 2.7 (a)

4. **Please refer to para 2.9 (a)**

5. **Please see maps of this lesson**

6. **Please see para 2.4**

7. **Please see para 2.6 (i)**

8. **Please see para 2.5 and Fig. 2.2**

9. **Please see para 2.3**

10. **Please see Fig. 2.4**