9

ATMOSPHERE COMPOSITION AND STRUCTURE

Earth is a unique planet because the life is found only on this planet. The air has a special place among the conditions necessary for life. The air is a mixture of several gases. The air encompasses the earth from all sides. The air surrounding the Earth is called the atmosphere. The atmosphere is an integral part of our Earth. It is connected with the earth due to the gravitational force of the earth. It helps in stopping the ultra violet rays harmful for the life and maintain the suitable temperature necessary for life.

The air is essential for the survival of all forms of life on the earth. You cannot imagine any kind of life in the absence of it. The atmosphere is like a large protective cover. Besides many gases, water vapour and dust particles are also found in the atmosphere. Due to these all kinds of changes take place in the atmosphere you will study in this lesson. The composition and structure of the atmosphere and the cyclic process of main gases.

OBJECTIVES

After studying this lesson, you will be able to :-

- explain the composition of atmosphere.
- tell the characteristics of different layers of the atmosphere.
- explain the importance of atmosphere.
- explain the cyclic process of main gases of the atmosphere – nitrogen, oxygen and Carbon dioxide.
- describe the importance of cyclic process of important gases of the atmosphere such as nitrogen, oxygen and carbon dioxide.

9.1 COMPOSITION OF ATMOSPHERE

The atmosphere is made up of different types of gases, water rapour and dust particles. The composition of the atmosphere is not static. It changes according to the time and place.

(A) Gases of the atmosphere:

The atmosphere is the mixture of different types of gases, including water vapour and dust particles. Nitrogen and Oxygen are the two main gases of the atmosphere. 99 percent part of it is made up of these two gases. Other gases like organ, carbon dioxide, hydrogen, nion, helium etc. form the remaining part of atmosphere. The details of different gases of the atmosphere are given in the table No. 9.1 and Fig. No. 9.1

Table 9.1 : Amount of gases in the dry and air of the atmosphere.

Serial No.	*Gas*	*Amount (in percentage)*	
A.	**Main**		
1.	Nitrogen	78.1	99%
2.	Oxygen	20.9	
B.	**Secondary**		
1.	Organ	0.9	0.99%
2.	Carbon Dioxide	0.03	
3.	Hydrogen	0.01	
4.	Nion	0.0018	
5.	Helium	0.0005	
6.	Ozone	0.00006	
7.	Others		

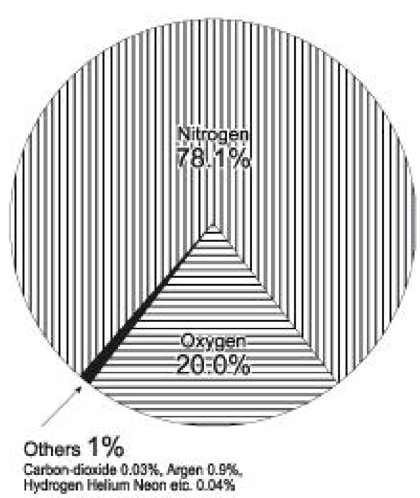


Fig. 9.1 Composition of Atmosphere

Ozone Gas

The amount of ozone gas in the atmosphere is very little. It is limited to the ozone layer but it is very important. It protects the living beings by absorbing the ultra-violet rays of the sun. If there was no ozone gas in the atmosphere, there would not have been existence of living beings and plants on the earth surface.

(B) Water vapour

Gaseous form of water persent in the atmosphere is called water vapour. Water vapour present in the atmosphere has made life possible on the earth Water vapour is the source of all kinds of precipitation. Its maximum amount in the atmosphere could be upto 4 percent. Maximum amount of water vapour is found in hot-wet regions and its least amount is found in the dry regions. Generally, the amount of water vapour goes on decreasing from low latitudes to high latitudes.

In the same way, its amount goes on decreasing with increasing altitude. Water vapour reaches in the atmosphere through evaporation and transpiration. Evaporation takes place in the oceans, seas, rivers, ponds and lakes while transpiration takes lace from the plants, trees and living beings.

(c) Dust Particles

Dust particles are generally found in the lower layers of the atmosphere. These particles are found in the form of sand, smoke and oceanic salt. Sand particle have important place in the atmosphere. These dust particles help in the condensation of water vapour. During condensation water vapour gets condensed in the form of droplets around these dust particles. Due to this process the clouds are formed and precipitation is made possible.

Importance of the Atmosphere:

(i) Oxygen is very important for the living beings.

(ii) Carbon dioxide is very useful for the plants.

(iii) Dust particles present in the atmosphere create suitable conditions for the precipitation.

(iv) The amount of water vapour in the atmosphere goes on changing and directly affects the plants and living beings.

(v) Ozone protects all kinds of life on the earth from the harmful ultra violet rays of the sun.

INTEXT QUESTIONS 9.1

(i) Which are the two main gases of the atmosphere?

(a) ______________________ (b) ___________________________

(ii) In which region the maximum amount of water vapour is found?

____

(iii) What is the main function of ozone gas?

____

9.2 STRUCTURE OF THE ATMOSPHERE

The atmosphere is an integral part of the earth. It surrounds the earth from all sides. Generally it extends upto about 1600 kilometres from the earths surface. 97 percent of the total amount of weight of the atmosphere is limited upto the height of about 30 kilometres. The atmosphere can be divided into five layers according to the diversity of temperature and density.

(a) Troposphere
(b) Stratosphere
(c) Mesosphere
(d) Ionosphere
(e) Exosphere

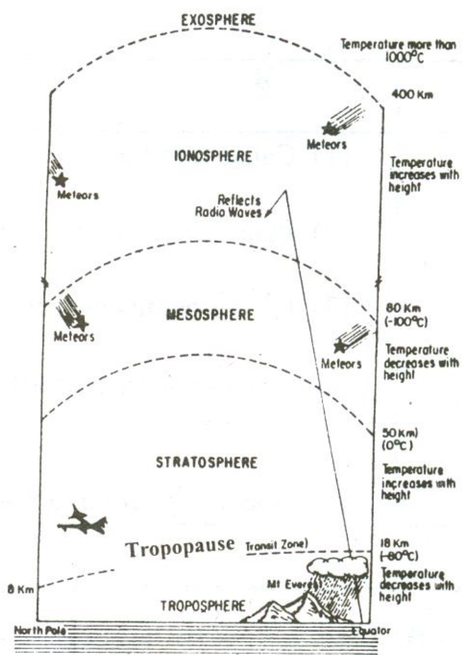


Fig. 9.2 Structure of the atmosphere

(a) TROPOPHERE :-

(i) This is the lowest layer of the atmosphere.

(ii) The height of this layer is about 18 kms on the equator and 8 kms on the poles. The main reason of higher height at the equator is due to presence of hot convection currents that push the gases upward.

(iii) This is the most important layer of the atmosphere because all kinds of weather changes take place only in this layer. Due to these changes development of living world take place on the earth. The air never remains static in this layer. Therefore this layer is called changing sphere or troposphere.

(iv) The environmental temperature decreases with increasing height of atmosphere. It decreases at the rate of 1^0C at the height of 165 metre. This is called Normal lapse rate.

(v) The upper limit of the troposphere is called tropopause. This is a transitional zone. In this zone characteristics of both the troposphere and ionosphere are found.

(b) STRATOSPHERE

(i) This layer is above the troposphere.

(ii) This layer is spread upto the height of 50 kms from the Earth's surface. Its average extent 40 kms.

(iii) The temperature remains almost the same in the lower part of this layer upto the height of 20 kms. After this the temperature increases slowly with the increase in the height. The temperature increases due to the presence of ozone gas in the upper part of this layer.

(iv) Weather related incidents do not take place in this layer. The air blows horizontally here. Therefore this layer is considered ideal for flying of aircrafts.

(c) MESOSPHERE

(i) It is the third layer of the atmosphere spreading over stratosphere.

(ii) It spreads upto the height of 80 kms. from the surface of the earth. It's extent is 30 kms.

(iii) Temperature goes on decreasing and drops upto – 100^0C.

(iv) 'Meteors' or falling stars occur in this layer.

(d) IONOSPHERE

(i) This is the fourth layer of the atmosphere. It is located above the mesosphere.

(ii) This layer spreads upto the height of 400 kms. from the surface of the earth. The width of this layer is about 300 kms.

(iii) The temperature starts increasing again with increasing height in this layer.

(iv) Electrically charged currents flows in the air in this sphere. Radio waves are reflected back on the earth from this sphere and due to this radio broadcasting has become possible.

(e) EXOSPHERE

(i) This is the last layer of the atmosphere located above ionosphere and extends to beyond 400 km above the earth.

(ii) Gases are very sparse in this sphere due to the lack of gravitational force. Therefore, the density of air is very less here.

- Change of weather take place only in troposphere.
- Change of weather conditions donot take polace in stratosphere. This is an ideal layer for flying aeroplanes.
- Ions are found in abundance in ionosphere. Ionosphere reflects back the radio waves to the earth and make possible the communication system.
- Density of air is the least in the exosphere.

INTEXT QUESTIONS 9.2

1. Define tropopause.

____

2. Why is there a difference in the height of troposphere?

____

3. In which two spheres the temperature increases with the height?

____

4. From which sphere are the radio waves reflected?

____

5. In which layer of the atmosphere, the density of the air is the least?

____

6. In which layer of the atmosphere is the ozone gas found?

____

9.3 CYCLIC PROCESS OF THE ATMOSPHERIC GASES

The cycle of main gases found in the atmosphere is given below:-

(a) Carbon cycle

(b) Oxygen cycle

(c) Carbon dioxide cycle

(a) CARBON CYCLE

1. The element of carbon is present in the atmosphere in the form of carbon dioxide. The source of carbon for all living beings is atmosphere.
2. Green plants receive carbon dioxide from the atmosphere which is used for making food with the help of the sun light. This is called photosynthesis. By this process the plants create 'carbohydrates' in the form of food. Carbohydrates thus, produced by plants are used as a food by all Living beings.

3. Carbon dioxide gets dissolved in the water bodies and gets collected in the form of lime on the earth. After dissolution of lime stone, carbon dioxide again reaches in the atmosphere. This process is called carbonization. In this way carbon dioxide goes on moving between the atmosphere and water-bodies of the earth.

4. Carbon dioxide produced by breathing of plants and animals, disintegration of plants and animals and by burning fossil fuels like coal, petroleum and natural gas again returns back to the atmosphere.

In this way, the process of receiving of carbon-dioxide from the atmosphere and going back to it from the surface of the earth keeps on going continuously. It keeps the balance between the carbon and biosphere.

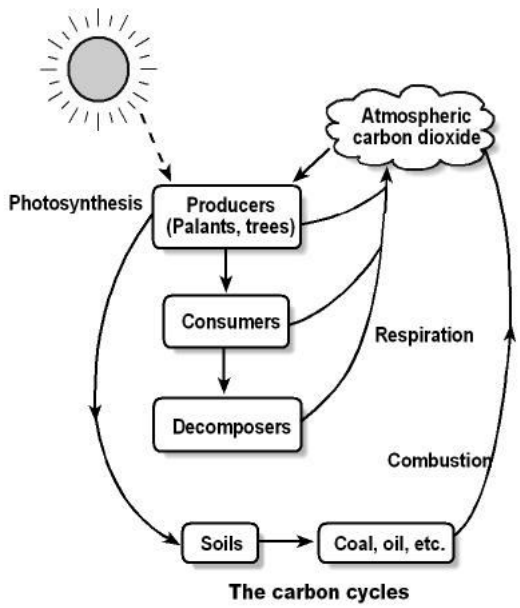


Fig. 9.3 : Carbon cycle

(b) OXYGEN CYCLE

1. The amount of oxygen in the atmosphere is about 21% and all living beings use oxygen present in the atmosphere for breathing.

2. For the burning of fuels like wood, coal, gas etc. oxygen is essential and carbon dioxide gas is produced by their burning.

3. The main sources of oxygen in the atmosphere are plants and trees. Higher the number of trees and plants, the availability of oxygen will be more.

4. Oxygen produced through photosynthesis by the green plants goes back to the atmosphere. In this way the process of oxygen cycle goes on continuously.

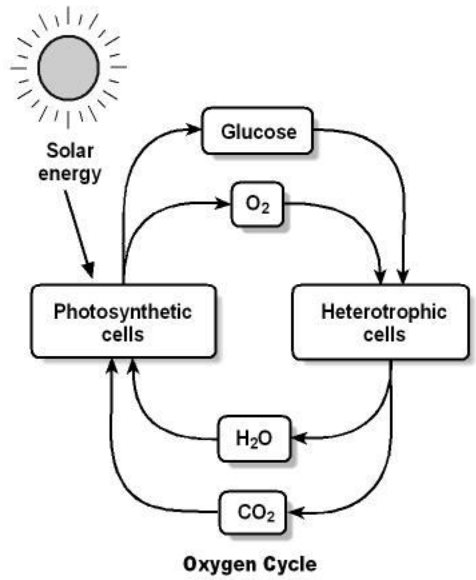


Fig. 9.4 Oxygen cycle

(c) NITROGEN CYCLE

Nitrogen is an important element for life. The amount of nitrogen gas in the atmosphere is 78%. The main source of nitrogen are nitrates present in the soil. From the atmosphere, nitrogen enters into bio components through the biological and industrial processes. Nitrogen compounds from the plants are transferred to the animals through food chain. The process of transformation of nitrogen gas of the atmosphere into nitrogen components is called nitrogen Fixation. Bacteria's decompose dried plants and dead animals. It produces nitrogen gas which goes back into the atmosphere. In this way the cycle of nitrogen gas is completed.

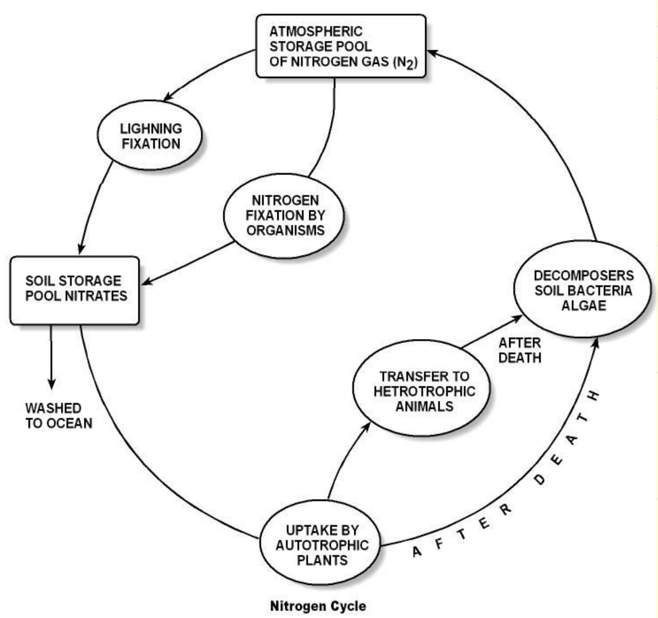


Fig. 9.5 Nitrogen cycle

- The main source of carbon is carbon dio-oxide gas found in the atmosphere.
- The main source of oxygen in the atmosphere are plants and trees.
- Oxygen is used for breathing and for burning fuels.
- Nitrogen is very essential for life on the earth. The main source of nitrogen in the plants are nitrates present in this soil.

INTEXT QUESTIONS 9.3

(i) What is the main source of carbon?

____

(ii) What is the main source of oxygen?

____

(iii) What is the percentage of nitrogen in the atmosphere?

____

WHAT YOU HAVE LEARNT

The atmosphere is made up of different kinds of gases which surrounds the earth. Two important gases nitrogen and oxygen together are found on the 99% part of the atmosphere. The atmosphere is composed of troposphere, stratosphere, mesosphere, ionosphere and exosphere. All weather related incidents take place in the troposphere whereas stratosphere is considered to be ideal for flying of aeroplanes. Radio waves are reflected back on the earth from the ionosphere. This has made possible the radio broadcast.

The element of carbon in the atmosphere is found in the form of carbon dio-oxide gas. The main sources of carbon are petroleum, wood, coal and gases. The main sources of oxygen in the atmosphere are plants and trees. Oxygen is very important for breathing and for the burning of fuels. The main source of nitrogen for the plants is nitrate present in the soil. Nitrogen gas is produced by decomposition of plants and animals and goes back to the atmosphere.

TERMINAL QUESTIONS

(1) Which is called atmosphere?
(2) Distinguish between troposphere and stratosphere.
(3) State the importance of ozone gas.
(4) Explain the cycle process of nitrogen gas.
(5) Explain the oxygen cycle with the help of a diagram.

(6) Describe the structure of the atmosphere with the help of a diagram.

(7) Write notes on the following.
   - (i) Carbon cycle.
   - (ii) Importance of atmospheric is gases.
   - (iii) Water vapour.
   - (iv) Dust particles.

ANSWERS TO INTEXT QUESTIONS

9.1

(i) Nitrogen and Oxygen

(ii) Hot-wet region

(iii) Absorption of harmful ultra-violet rays of the sun.

9.2

(i) See para 9.1(a)

(ii) See para 9.2(a)

(iii) See para 9.3(c)

(iv) Ionosphere

(v) Exosphere

(vi) Stratosphere

9.3

(i) Fossil fuels – Coal, petroleum and natural gas

(ii) Plants and trees

(iii) 78 percent

HINTS TO TERMINAL QUESTIONS

1. See 9.1
2. See 9.2 (a and b)
3. See ozone gas under 9.1(A)
4. See 9.3(c)
5. See 9.3(b)
6. See 9.2
7. (i) See 9.3(a)
   (ii) See 9.1
   (iii) See 9.1(b)
   (iv) See 9.1(c)

10

INSOLATION AND TEMPERATURE

In the previous lesson we have studied that the air surrounding the earth is called the atmosphere. The atmosphere is made up of different types of gasses, water vapour and dust particles. Atmosphere is essential for survival of plant and animal life. They also require optimum temperature to keep themselves warm and grow. Have you ever thought 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 answer to all these and other related questions in this lesson.

OBJECTIVES

After studying this lesson, you will be able to :

- 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 map, 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.

10.1 INSOLATION (Solar Radiation)

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 or (two units of energy out of 1,00,00,00,000 units of energy radiated by the sun) 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. (daily sunlight period)

(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. 10.1)

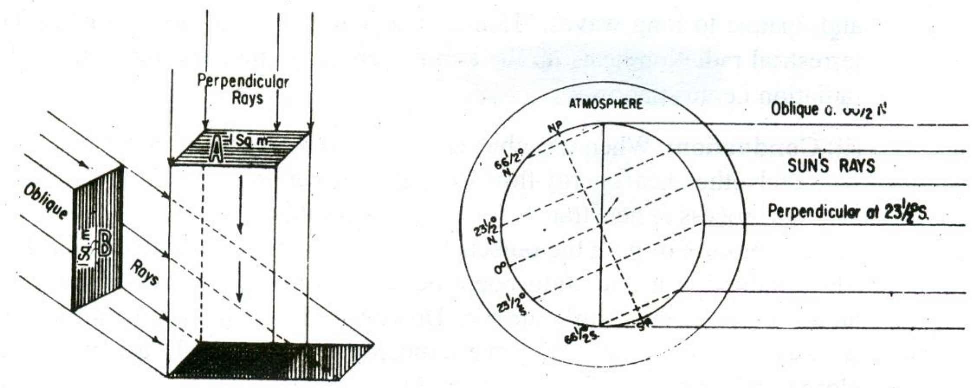


Fig. 10.1 : Effect of Angle of Incidence on Insolation

(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 in 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 :** Radiation is the process by which solar energy reaches the earth and the earth loses energy to outer space. 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 10.1

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

10.2 HEAT BUDGET

The insolation is made up of energy transmitted directly through the atmosphere and scattered energy. 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.

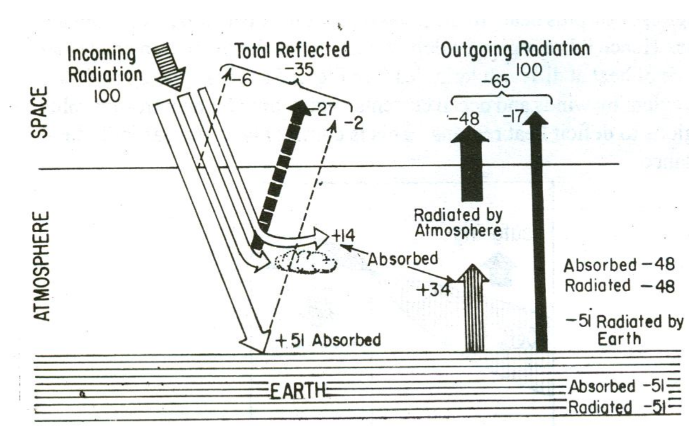


Fig. 10.2 : Heat Budget (balance between insolation and terrestrial radiation)

Let us suppose that the total heat (incoming solar radiation) received at the top of the atmosphere is 100 units (see fig. 10.2) 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 absorbed 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.

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. 10.3 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.

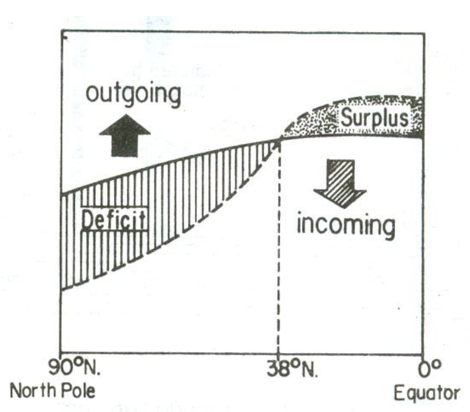


Fig. 10.3 Latitudinal Heat Balance

10.3 GLOBAL WARMING

Global warming is one of the major environmental problem our earth is facing. Scientist see its close association with depletion of Stratospheric 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 of atmosphere has increased by about 0.5^0C in the last 1000 years. Large scale deforestation, fossil fuel burning, burning of 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 10.2

1. Define the following terms:

   (a) Heat Budget:

   ____

   (b) Latitudinal Heat Balance:

____

(c) Global Warming

____

2. Answer the following questions very briefly:

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

____

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

____

(c) Name the regions of surplus heat

____

(d) Which is the region of deficit heat?

____

10.4 TEMPERATURE AND ITS DISTRIBUTION

Temperature indicates the relative degree of heat of a substance. 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. The celsius scale, named after the swedish astronomer. Anders Celsius, is accepted internationally by Scientists for reporting air temperature. The historical temperature records of several English-speaking countries include values on the Fahrenheit scale, Fahrenheit temperatures may be converted to their celsius equivalents by the formula $C = \frac{5}{9}(F - 32)$. 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 vertically. 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 over the surface of the earth is called its horizontal distribution. On maps, the horizontal distribution of temperature is commonly shown by "Isotherms", lines connecting points that have equal temperatures. An isotherm is made of two words 'iso' and 'therm', 'Iso' means equal and 'therm' means" temperature. 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. 10.1). 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 generally 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.

Not withstanding 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 a 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 Kolkata is not as cold as Guangzhou (Canton) in winter though both are situated almost on the same latitude. (fig. 10.4).

As we move upwards from sea level, we experience gradual decrease in temperature. Temperature decreases at an average rate of 6^0C per 1000 m. 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.10.4). It is worth remembering that the rate of decrease of temperature with altitude varies with time of day, season and location.

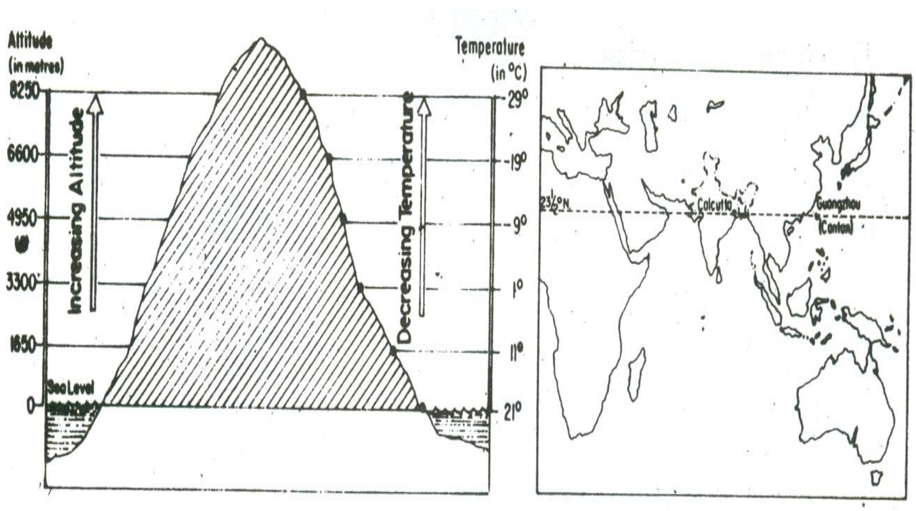


Fig. 10.4 Effect of Altitude on Temperature

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 tempeeture 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.10.5).

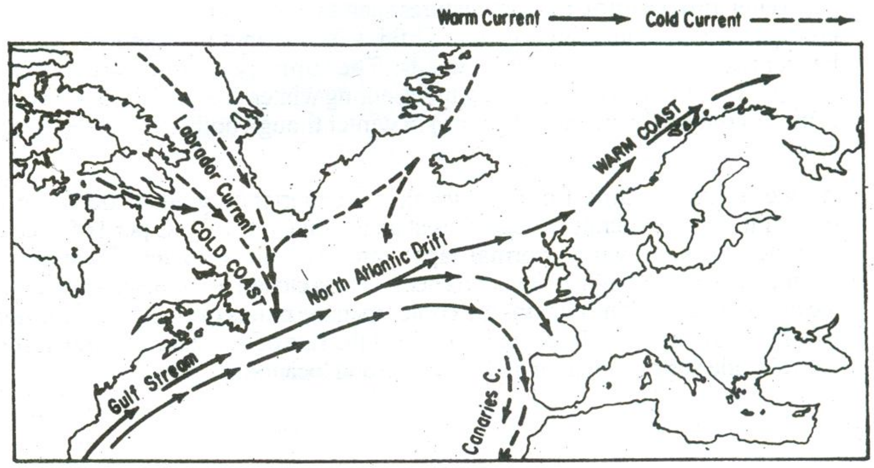


Fig. 10.5 Effect of Warm and Cold Ocean Current

(iii) 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 then 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 less 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 ray 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 Himalaya 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 Himalaya for example, not facing the sun are exposed to cold northernly winds are obviously colder. On the other hand the southern slopes of the Himalaya 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 Himalaya 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 closes them. In northern hemisphere landmass arc cooler than oceans. During this time North-east Asia experiences lowest temperatures. (see fig. 10.6)

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 they exist north of equator.

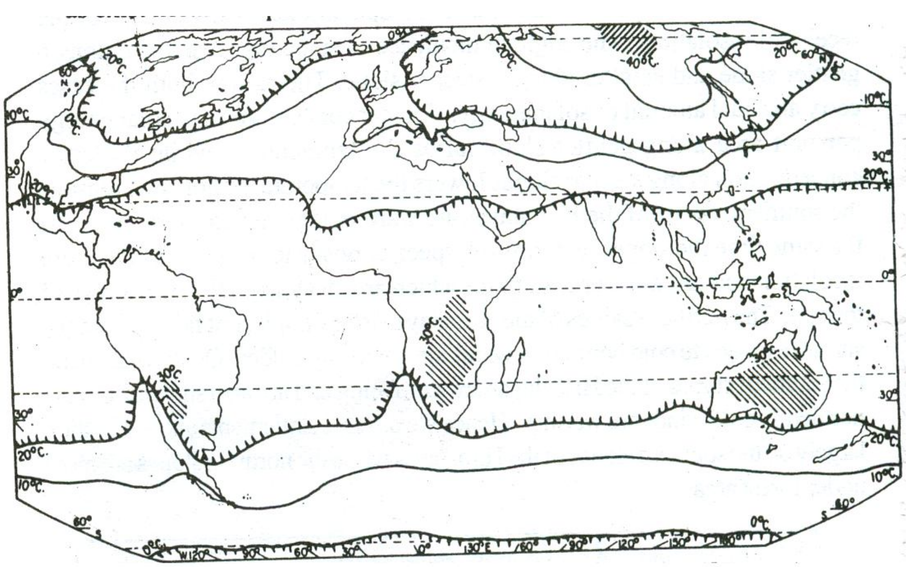


Fig. 10.6 Horizontal Distribution of Temperature (January)

(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. 10.7)

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.

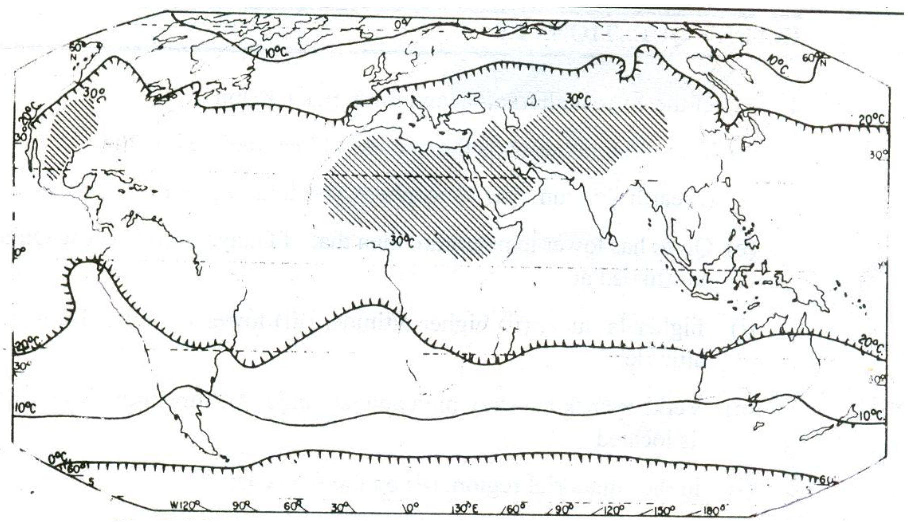


Fig. 10.7 Horizontal Distribution of Temperature (July)

lsotherms are wide spaced over oceans while they are closely spaced over landmasses.

A comparison between the January and July isotherm maps reveals the 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 value 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 10.3

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

The permanent snow on high mountains, even in the tropics, indicate the decrease of temperature with altitute. Observations reveals that there is a fairly regular decrease in temperature with an increase in altitude. The average rate of temperature decrease upward in the troposphere is about 6^0C per km, extending to the tropopause. This vertical gradient of temperature is commonly referred to as the standard atmosphere or normal lapse rate, but is varies with height, season, latitude and other factors. Indeed the actual lapse rate of temperature does not always show a decrease with altitude.

(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 6^0C per 1000m metres ascend.
- The phenomenon in which temperature increases with increasing altitude temporarily and locally under certain conditions is known as inversion of temperature.

INTEXT QUESTIONS 10.4

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 6^0C per

(i) 561 metres, (ii) 1000 m, (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. Tick (√) the true statements and cross (x) on the false ones

(a) Cold air is light.

(b) Cold air is dense.

(c) Clear sky dry air and absence of winds causes rapid radiation leading to the phenomenon of inversion of temperature.

(d) Inversion of temperature occurs very frequently in plain

(e) Apple growers of the Himachal Pradesh avoid lower slopes

(f) The cool and dense air sliding down the mountain slopes pushes the comparatively warm and light air of valleys of words.

(g) Inversion of temperature occurs locally and temporarily.

WHAT YOU HAVE LEARNT

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. The 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 back from the earth. There is a balance between the receipt of insolation and the. terrestrial radiation on earth' s surface. It is known as heat budget. Global warming is the world wide increase of atmospheric temperature due to depletion of ozone layer and increase in carbon dioxide

Temperature measures the intensity of heat. Distribution of temperature varies both horizontally and vertically. Certain factors control its distribution. They are latitude, land and water contrast, winds, ocean currents, altitude and aspect of slope. Horizontal distribution of temperature is shown on a map with 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 6^{0}C per 1000m 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. 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.
3. Describe the factors that influence the horizontal distribution of temperature.
4. Mark and label the following on an outline map of world.
   (a) 30°C isotherm in July
   (b) Verkhoyansk
   (c) The Sahara
   (d) Borneo island
5. Why do different parallel of latitude receive different amount of insolation?
6. Draw a diagram to explain the heat budget of the earth.

ANSWER TO INTEXT QUESTIONS

10.1

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

10.2

1. (a) see 10.2 (b) see 10.2 (c) see 10.3
2. (a) 51% (b) 6% (c) Tropical Region (d) Polar region

10.3

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

10.4

1. (a) altitude (b) 1000 metres (c) inversion of temperature
2. (a) False, (b) True, (c) True, (d) False’, (e) True, (f) True, (g) True

HINTS TO 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) 6°C at every 1000 metres altitude.
2. (a) Please refer to para to 10.4 (a) (I)
   (b) Please refer to para 10.2
   (c) Please refer to para 10.4 (a) (II)
   (d) Please refer to para 10.2 (a)
3. Please refer to para 10.4 (a)
4. Please see maps of this lesson
5. Please see para 10.1 (i)
6. Please see Fig. 10.2

11

PRESSURE AND WINDS

We do not ordinarily think of air as having too much weight. But air has weight and it exerts pressure. Let us take an empty bicycle tube and weight it. Now fill tube with air and weight it again. You will find that the weight of the air filled tube is more than when it was empty. If you go on filling air in the tube a situation comes when the tube bursts. The bursting of the tube occurs due to increase in air pressure in the tube. Similarly, the air around us exerts pressure. But we do not feel the weight of the atmosphere because we have air inside us which exerts an equal outward pressure that balances the inward pressure of the atmosphere. Atmospheric pressure is important to us because it is related to winds and it helps to determined, weather conditions of a place. In this lesson you will study air pressure, its distribution, winds and their types.

OBJECTIVES

After studying this lesson, you will be able to :

- give reasons for the decrease of air pressure with increase in altitude;
- describe with examples the effect of low air pressure at high altitude on the daily life of man;
- explain the relationship between the spacing of isobar and pressure gradient;
- establish relationship between the temperature and the existence of equatorial low pressure and the polar high pressure;
- give reason for the existence of sub-tropical high pressure and sub-polar low pressure belts;
- explain the distribution of atmospheric pressure with the help of isobar maps of the world for the months of January and July;

- establish the relationship between pressure gradient and speed of winds
- explain the influence of coriollis effect on the direction of winds of both the hemispheres;
- draw diagram showing pressure belts and planetary winds;
- distinguish between (a) planetary and monsoon winds (b) land and sea breezes (c) valley and mountain breezes and (d) cyclones and anti-cyclones:
- describe the characteristics of Important local winds

11.1 MEASUREMENT OF AIR PRESSURE

The atmosphere is held on the earth by the gravitational pull of the earth. A column of air exerts weight in terms of pressure on the surface of the earth. The weight of the column of air at a given place and time is called air pressure or atmospheric pressure. Atmospheric pressure is measured by an instrument called barometer. Now a days Fortin's barometer and Aneroid barometer I are commonly used for measuring air pressure.

Atmospheric pressure is measured as force per unit area. The unit used for measuring pressure is called millibar. Its abbreviation is 'mb'. One millibar is equal to the force of one gram per square centimetre approximately. A pressure of 1000 millibars is equal to the weight of 1.053 kilograms per square centimetre at sea level. It is equal to the weight of a column of mercury which is 76 centimetre high. The international standard pressure unit is the "pascal", a force of one Newton per square meter. In practice atmospheric pressure is expressed in kilopascals, (one kpa equals 1000 Pa).

- The weight of a column of air at a given place and time is called air pressure.
- Barometer is the instrument which measures air or atmospheric pressure.
- The unit of measurement of atmospheric pressure is millibar (kilopascals).
- One millibar is equal to the force of nearly one gram per square centimetre.

The mean atmospheric pressure at sea level is 1013.25 millibars. However the actual pressure at a given place and at a given time fluctuates and it generally ranges between 950 and 1050 millibars

11.2 DISTRIBUTION OF AIR PRESSURE

Distribution of atmospheric pressure on the surface of the earth is not uniform. It varies both vertically and horizontally.

(a) Vertical Distribution

Air is a mixture of various gases. It is highly compressible. As it compresses, its density increases. The higher the density of air, the greater is the air pressure and vice versa. The mass of air above in the column of air compresses the air under it hence its lower layers are more dense than the upper layers; As a result, the lower layers of the atmosphere have higher density, hence, exert more pressure. Conversely, the higher layers are less compressed and, hence, they have low density and low pressure. The columnar distribution of atmospheric pressure is known as vertical distribution of pressure. Air pressure decreases with increase in altitude but it does not always decrease at the same rate. Dense components of atmosphere are found in its lowest parts near the mean sea level. Temperature of the air, amount of water vapour present in the air and gravitational pull of the earth determine the air pressure of a given place and at a given time. Since these factors are variable with change in height, there is a variation in the rate of decrease in air pressure with increase in altitude. The normal rate of decrease in air pressure is 34 millibars per every 300 metres increase in altitude; (see figure 11.1). The effects of low pressure are more clearly experienced by the people living in the hilly areas as compared to those who live in plains. In high mountainous areas rice takes more time to cook because low pressure reduces the boiling point of water. Breathing problem such as faintness and nose bleedings are also faced by many trekkers from outside in such areas because of low pressure conditions in which the air is thin and it has low amount of oxygen content.

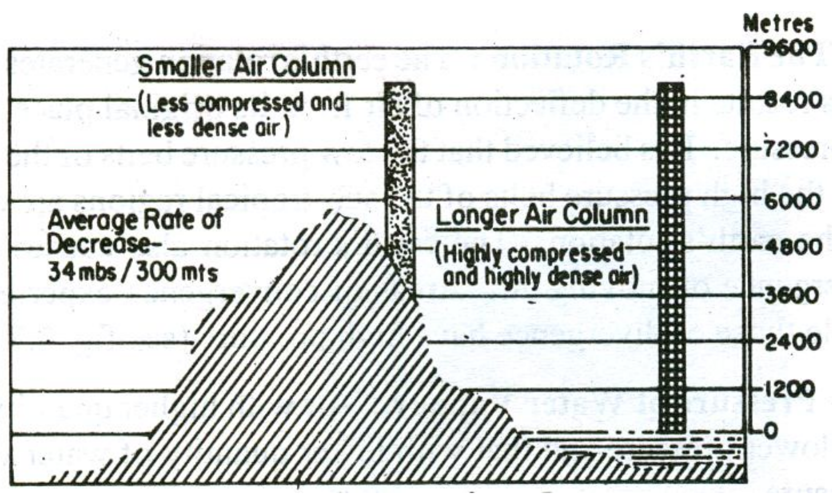


Fig 11.1 Vertical Distribution of Air Pressure

(b) Horizontal Distribution

The distribution of atmospheric pressure over the globe is known as horizontal distribution of pressure. It is shown on maps with the help of isobars. An isobar is a line connecting points that have equal values of pressure. Isobars are analogous to the contour lines on a relief map. The spacing of isobars expresses the rate and direction of change in air pressure. This charge in air pressure is referred to pressure gradient. Pressure gradient is the ratio between pressure difference and the actual horizontal distance between two points. Close spacing of isobars expresses steep pressure gradient while wide spacing indicates gentle pressure gradient (see fig. 11.5)

The horizontal distribution of atmospheric pressure is not uniform in the world. It varies from time to time at a given place; it varies from place to place over short distances. The factors responsible for variation in the horizontal distribution of pressure are as follows:

(i) Air temperature

(ii) The earth's rotation

(iii) Presence of water vapour

(i) Air Temperature: In the previous lesson, we have studied that the earth is not heated uniformly because of unequal distribution of insolation, differential heating and cooling of land and water surfaces. Generally there is an inverse relationship between air temperature and air pressure. The higher the air temperature, the lower is the air pressure. The fundamental rule about gases is that when they are heated, they become less dense and expand in volume and rise. Hence, air pressure is low in equatorial regions and it is higher in polar regions. Along the equator lies a belt of low pressure known as the "equatorial low or doldrums". Low air pressure in equatorial regions is due to the fact that hot air ascends there with gradual decrease in temperatur causing thinness of air on the surface. In polar region, cold air is very dense hence it descends and pressure increases. From this we might expect, a gradual increase in average temperature thords equator. However, actual readings taken on the earth's surface at different places indicate that pressure does not increase latitudinally in a regular fashion from equator to the poles. Instead, there are regions of high pressure in subtropics and regions of low pressure in the subpolar areas.

(ii) The Earth's Rotation: The earth's rotation generates centrifugal force. This results in the deflection of air from its original place, causing decrease of pressure. It is believed that the low pressure belts of the sub polar regions and the high pressure belts of the sub-tropical regions are created as a result of the earth's rotation. The earth's rotation also causes convergence and divergence of moving air. Areas of convergence experience low pressure while those of divergence have high pressure (see fig. 11.7).

(iii) Pressure of Water Vapour : Air with higher quantity of water vapour has lower pressure and that with lower quantity of water vapour has higher pressure. In winter the continents are relatively cool and tend to develop high pressure centres; in summer they stay warmer than the oceans and tend to be dominated by low pressure, conversely, the oceans are associated with low pressure in winter and high pressure in summer.

- An isobar is a line connecting points that have equal values of pressure.
- Pressure gradient is the ratio between pressure difference and horizontal distance between two points.
- On an average air pressure decreases by 34 millibars per 300 metres increase in height.

INTEXT QUESTIONS 11.1

1. Name the three factors which influence horizontal distribution of air pressure:

   (a)__________________(b)________________(c)__________________

2. Name the two instruments used to measure air pressure:

   (a)________________________(b)______________________________

3. What is the mean atmospheric pressure at sea level?

   ____

4. Select the best alternative for each and mark tick (√) on it :

   (a) A pressure of 1000 millibars is equal to the weight of a column of mercury having height of

   (i) 65 cm; (ii) 70 cm; (iii) 76 cm; (iv) 80cm

   (b) Areas where moving air converge have

   (i) high pressure. (ii) low pressure; (iii) both high and low pressure (iv) no pressure at all

   (c) Air with lower quantity of water vapour has (i) higher pressure (ii) lower pressure; (iii) no pressure (iv) none of the above

11.3 PRESSURE BELT

The horizontal distribution of air pressure across the latitudes is characteriesd by high or low pressure belts. This is however, a theoretical model because pressure belts .are not always found as such on the earth. We will see it later how the real condition departs from the idealized model. and examine why these differences occur.

These pressure belts are: (i) The Equatorial Low Pressure Belt;. (ii) The Sub tropic High Pressure Belts; (iii) The Sub-polar Low Pressure Betts; (iv) The Polar High Pressure Belts (see fig. 11.2)

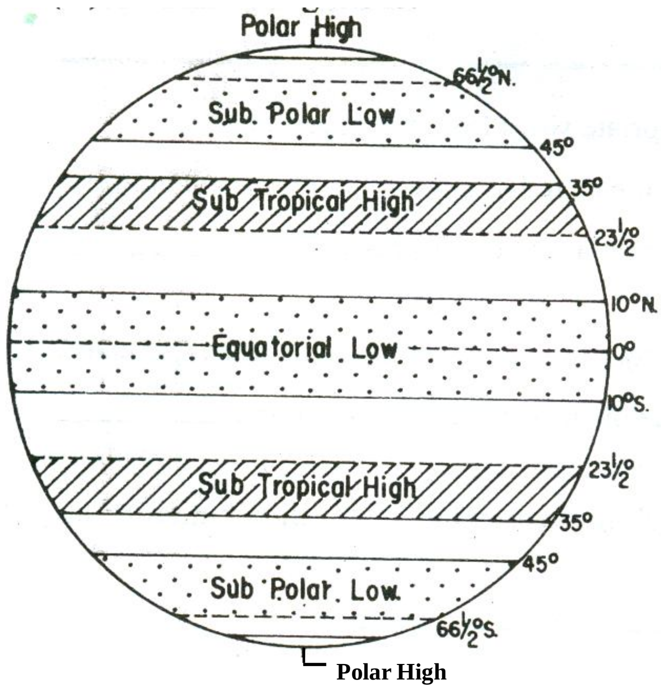


Fig. 11.2 Pressure Belts

(i) The Equatorial Low Pressure Belt

The sun shines almost vertically on the equator throughout the year. As a result the air gets warm and rises over the equatorial region and produce equatorial low pressure. This belt extends from equator to 10^0N and 10^0S latitudes. Due to excessive heating horizontal movement of air is absent here and only conventional currents are there. Therefore this belt is called doldrums (the zone of calm) due to virtual absence of surface winds. These are the regions of convergence because the winds flowing from sub tropical high pressure belts converge here. This belt is also known as-Inter Tropical Convergence Zone (ITCZ).

(ii) The Sub-tropical High Pressure Belts

The sub-tropical high pressure belts extend from the tropics to about 35^0 latitudes in both the Hemispheres. In the northern hemisphere it is called as the North sub-tropical high pressure belt and in the southern hemisphere it is known as the South sub-tropical high pressure belt. The existence of these pressure belts is due to the fact that the up rising air of the equatorial region is deflected towards poles due to the earth's rotation. After becoming cold and heavy, it descends in these regions and get piled up. This results in high pressure. Calm conditions with feeble and variable winds are found here. In olden days vessels with cargo of horses passing through these belts found difficulty in sailing under these calm conditions. They used to throw the horses in the sea in order to make the vessels lighter. Henceforth these belts or latitudes are also called 'horse latitudes'. These are the regions of divergence because winds from these areas blow towards equatorial and sub-polar low pressure belts.

(iii) The Sub-polar low Pressure Belts

The sub-polar low pressure belts extend between 45^0N and the Arctic Circle in the northern hemisphere and between 45°S and the Antarctic Circle in the southern hemisphere. They are known as the North sub-polar low and the South sub-polar low pressure belts respectively. Winds coming from the sub-tropical and the polar high belts converge here to produce cyclonic storms or low pressure conditions. This zone of convergence is also known as polar front.

(iv) The Polar High Pressure Belts

In polar regions, sun never shines vertically. Sun rays are always slanting here resulting in low temperatures. Because of low temperature, air compresses and its density increases. Hence, high pressure is found here. In northern hemisphere the belt is called the North polar high pressure belt while it is known as the South polar high pressure belt in the southern hemisphere. Winds from these belts blow towards sub-polar low pressure belts.

This system of pressure belts that we have just studied is a generalised picture. In reality, the location of these pressure belts is not permanent. They shift northward in July and southward in January, following the changing position of the sun's direct rays as they migrate between the Tropics of Cancer and Capricorn. The thermal equator (commonly known as the belt of highest temperature) also shifts northwards and southwards of the equator. With the shifting of thermal equator northwards in summer and southwards in winter, there is also a slight shift in pressure belts towards north and south of their annual average location.

- Sub-tropical high pressure belts are also called horse latitudes.
- Subsidence and piling of air in sub-tropical belts cause high pressure.
- Convergence of subtropical and polar winds result in the formation of cyclones in the sub-polar regions.
- High pressure belts are dry while low pressure belts are humid.
- With the movement of sun northwards and southwards thermal equator also shifts northwards and southwards.
- Pressure belts also shift northwards and southwards with the shift of thermal equator.

11.4 SEASIONAL DISTRIBUTION OF PRESSURE

The variation of pressure from place to place and from season to season over the earth plays an important role in affecting the weather and climate. Therefore we study pressure distribution through isobar maps. While drawing isobar maps, the pressures of all places are reduced to sea level to avoid the effect of altitude on air pressure.

(i) January Conditions

In January, with the south-ward apparent movement of the Sun, the equatorial low pressure belt shifts a little south of the mean equatorial position (see fig. 11.3). Areas of lowest pressure occurs in South America, Southern Africa and Australia. This is because the land tends to get hotter rapidly than water. Sub-tropical high pressure cells are centered over the ocean in the southern hemisphere. The belt of high pressure is interrupted by the continental land masses where the temperature is much higher. They are well developed in eastern part of the ocean where cold ocean currents dominate.

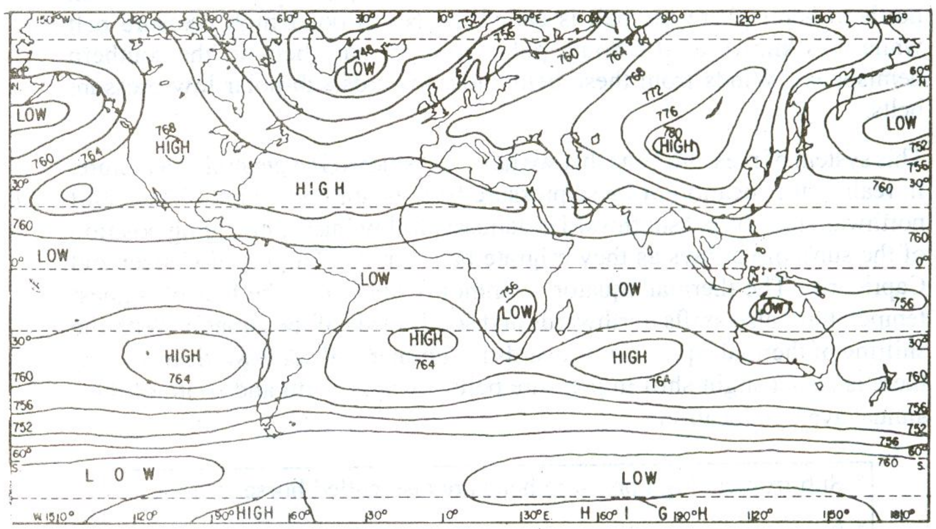


Fig. 11.3 Distribution of Air Pressure (January)

In the northern hemisphere, ridges of high pressure occur in the sub-tropical latitudes over the continent. A well developed high pressure cell occurs in the interior parts of Eurasia. This is due to the fact that land cools more rapidly than oceans. Its temperatures are lower in winter than the surrounding seas. In the southern hemisphere, the sub-polar low pressure belt circles the earth as a real belt of low pressure and is not divided into cells, because there is virtually no landmass. In northern hemisphere two cells of low pressure namely Iceland low and Aleutian low develop over the North Atlantic and the North Pacific oceans respectively.

(ii) July Conditions

In July, the equatorial low pressure belt shifts a little north of the mean equatorial position because of the northward apparent movement of the Sun. All the pressure belts shift northwards in July. (see fig. 11.4)

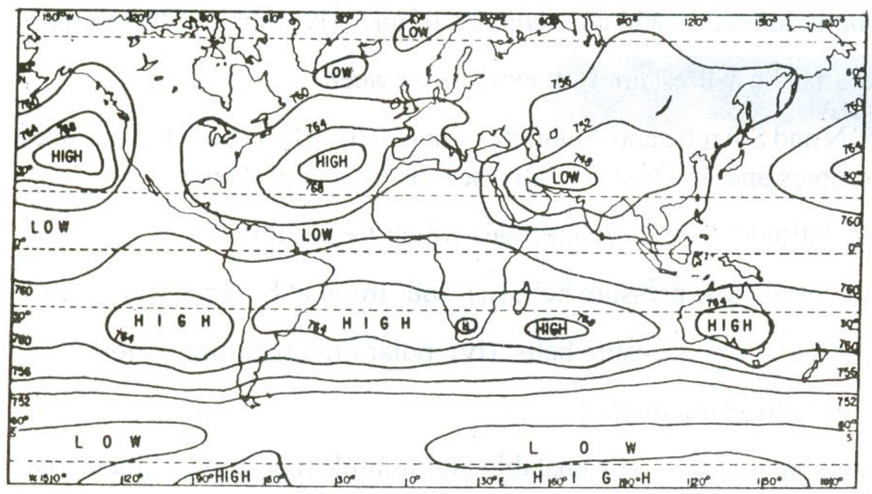


Fig. 11.4 Distribution of Air Pressure (July)

The Aleutian and Icelandic lows disappear from the oceans while the landmasses, which developed high pressure during winter months, have extensive low pressure cells now. In Asia, a low pressure develops. The sub-tropical hights of the northern hemisphere are more developed over the oceans - Pacific and Atlantic. In the southern hemisphere, the sub-tropical high pressure belt is continuous. Sub-polar low forms a continuous belt in the southern hemisphere while in northern hemisphere, there is only a faint oceanic low.

INTEXT QUESTION 11.2

1. Complete each of the following with suitable endings:

   (a) The belt of highest temperature is known as____________

   (b) In drawing isobar maps the factor eliminated is that of ___________

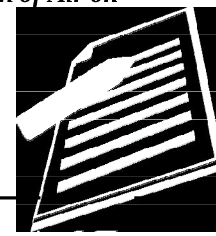
   (c) Higher the density of air, higher is its ________________

   (d) Higher the temperature of air, lower is its________________

2. Select the best alternatives for each of the following:

   (a) Earth's rotation causes:

   (i) deflection of air from its original direction.(ii) convergence of air. (iii) both deflection and convergence of air. (iv) none of the above.



(b) Equatorial Low Pressure Belt extends between:

(i) 45° N and S Arctic and Antarctic Circles. (ii) 10° N and 10° S latitudes. (iii) tropics and 35° N and S latitudes. (iv) none of them.

(c) 'Horse latitudes' are those latitudes which lie within:

(i) equatorial low pressure belt. (ii) sub- tropical high pressure belts. (iii) sub-polar low pressure belts. (iv) polar high pressure regions.

(d) Belts of high pressure are:

(i) unstable and dry. (ii) unstable and humid. (iii) both of the above. (iv) none of the above.

11.5 WINDS

We have just studied that air pressure is unevenly distributed. Air attempts to balance the uneven distribution of pressure. Hence, it moves from high pressure areas to low pressure areas. Horizontal movement of air in response to difference in pressure is termed as wind while vertical or nearly vertical moving air is called air current. Both winds and air currents form the system of circulation in the atmosphere.

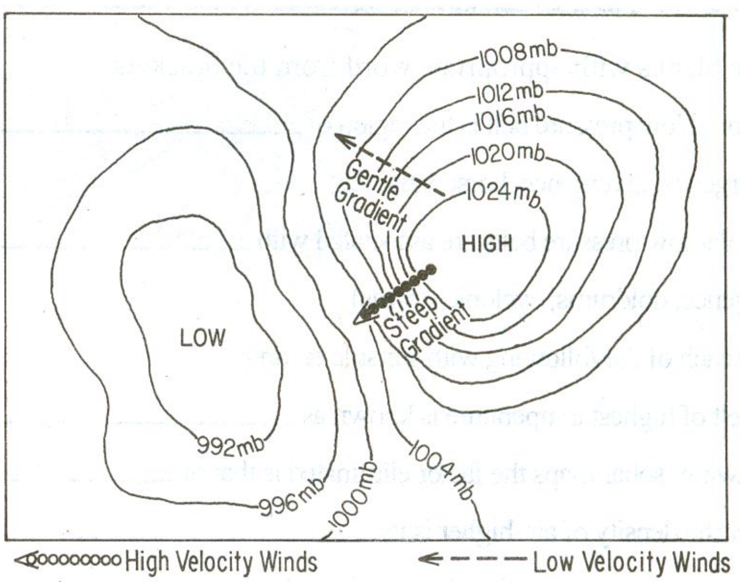


Fig. 11.5 Relationship between Pressure Gradient and Winds

(i) Pressure Gradient and Winds

There is a close relationship between the pressure and the wind speed. The greater the difference in air pressure between the two points, the steeper is the pressure gradient and greater is the speed of the wind. The gentler the pressure gradient slower is the speed of the wind. (see fig. 11.5).

(ii) The Coriolis Effect and Wind

Winds do not cross the isobars at right angles as the pressure gradient directs them. They get deflected from their original paths. One of the most potent influences on wind direction is the deflection caused by the earth's rotation on its axis. Demonstrated by Gaspaved de Coriolis in 1844 and known as the Coriolis effect or coriolis force. Coriolis force tend to deflect the winds from there original direction. In northern hemisphere winds are deflected towards their right, and in the southern hemisphere towards their left (see fig. 11.6) This is known as Farrel's law. The Coriolis force is absent along the equator but increases progressively towards the poles.

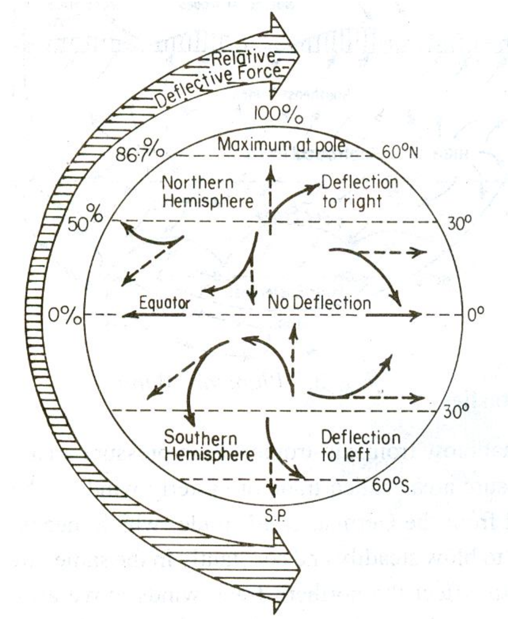


Fig. 11.6 Deflection of Winds by Coriolis Force

11.6 TYPE OF WINDS

For ages man has observed that in some areas of the earth the winds blow predominantly from one direction throughout the year; in other areas the wind direction changes with the season and in still others the winds are so variable that no pattern is discernible. Despite these difference, the winds are generalized under three categories.

(a) planetary winds or permanent winds

(b) periodic winds and

(c) local winds

(a) Planetary Winds

Planetary or permanent winds blow from high pressure belts to low pressure belts in the same direction throughout the year. They blow over vast area of continents and oceans. They are easterly and westerlies and polar easterlies. (see fig. 11.7)

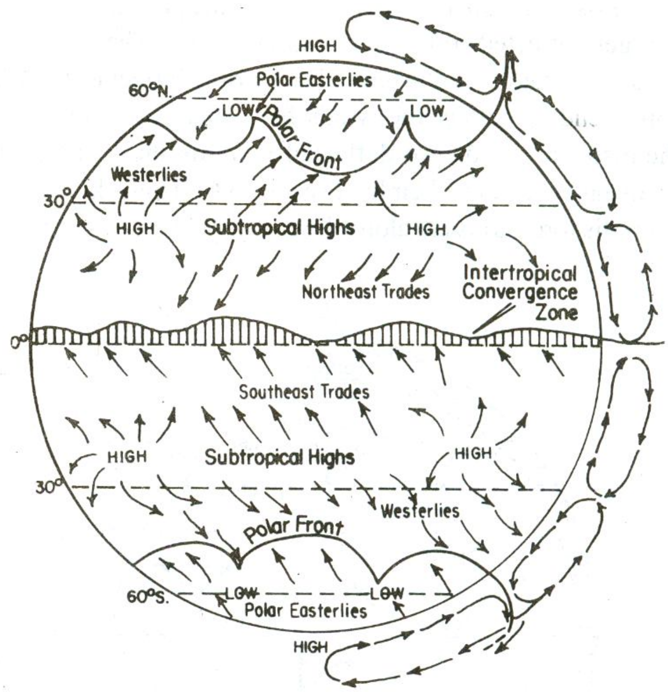


Fig 11.7 : Planetary Winds

(i) The Easterlies

The winds that blow from sub-tropical high pressure areas towards equatorial low pressure areas called trade or easterly winds: The word trade has been derived from the German word 'trade' which means track. To blow trade means 'to blow steadily and constantly in the same direction'. Because of the Coriolis effect the northern trade winds move away from the sub-tropical high in north-east direction. In southern hemisphere the trade winds diverge out of the sub-tropical high towards the equatorial low from the south-east direction As the trade winds tend to blow mainly from the east, they are also known as the Tropical easterlies. (see fig. 11.7)

(ii) The Westerlies

The winds that move poleward from the sub-tropical high pressure in the northern hemisphere are detected to the right and thus blow from the south west. These in the southern hemisphere are deflected to the left and blow from the north-west. Thus, these winds are called westerlise (see fig. 11.7)

(iii) Polar Easterlies

Polar easterlies blow from polar regions towards sub-polar low pressure regions. Their direction in the northern hemisphere is from north-east to south-west and from south-east to north-west in the southern hemisphere.

- In northern hemisphere winds, are deflected towards their right and in the southern hemisphere towards their left. This is known as Ferrel's law.

INTEXT QUESTIONS 11.3

1. Name Planetary winds:

   (a) ______________(b)________________(c)_________________

2. What is Ferrel's law?

   ____

3. Choose the correct alternative for each of the following:

   (a) Winds blow from high pressure to

   (i) low pressure, (ii) high pressure, (iii) both low and high pressures (iv) none of them.

   (b) Winds are deflected from their original path due to

   (i) Coriolis effect, (ii) pressure gradient, (iii) their speed, (iv) high pressure

   (c) Winds are caused primarily by

   (i) Coriolis effect, (ii) pressure difference (iii) rotation of the earth, (iv) humidity difference.

   (d) The Coriolis force at the equator is

   (i) maximum, (ii) medium, (iii) nil, (iv) none of the above.

(b) Periodic Winds

The direction of these winds changes with the change of seasons. Monsoon winds are the most important periodic winds.

Monsoon Winds

The word 'Monsoon' has been derived from the Arabic word 'Mausim' meaning season. The winds that reverse their direction with the change of seasons are called monsoon winds. During summer the monsoon winds blow from sea towards land and during winter from land towards seas. Traditionally these winds were explained as land and sea breezes on a large scale. But this explanation does not hold good now. Now a days the monsoon is generally accepted as seasonal modification of the general planetary wind system. The Asiatic monsoon is the result of interaction of both planetary wind system and regional factors, both at the surface and in the upper troposphere (see fig. 11.8)

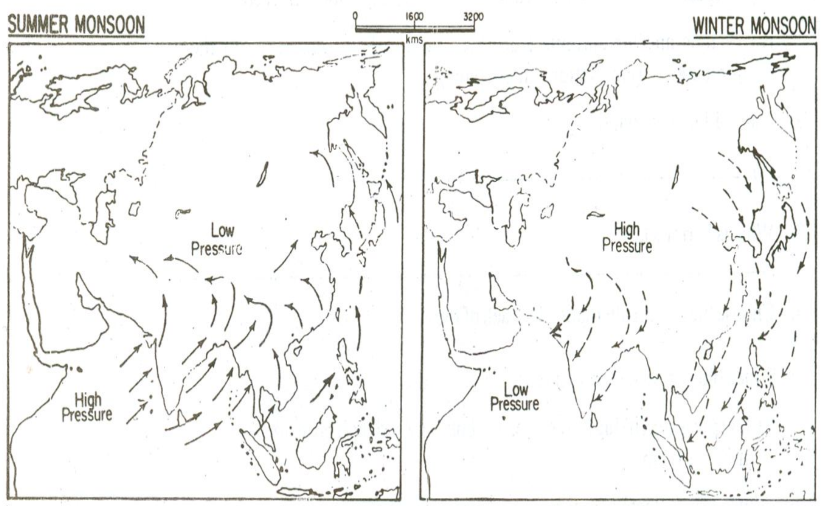


Fig. 11.8 The Monsoon Winds

India, Pakistan, Bangladesh, Myanmar(Burma), Sri Lanka, the Arabian Sea, the Bay of Bengal, South-east Asia, North Australia, China and Japan are important regions where monsoon winds are prevalent.

- Winds which reverse their direction with the change of seasons are called monsoons.

(c) Local Winds

Till now we were discussing the major winds of the earth's surface, which are vital for understanding the climatic regions. But we are all aware that there are winds that affect local weather. Local winds usually affect small areas and are confined to the lower levels of the troposphere. Some of the local winds are given below :

(i) Land and Sea Breezes

Land and sea breezes are prevalent on the narrow strips along the coasts or a lake. It is a diurnal (daily) cycle, in which the differential heating of land and water produces low and high pressures. During the day when landmass gets heated more quickly than the adjoining sea or large lake; air expands and rises. This process produces a local low pressure area on land. Sea breeze then develops, blowing from the water (high pressure) towards the land (low pressure). The sea breeze begins to develop shortly before noon and generally reaches its greatest intensity during mid-day to late afternoon. These cool winds have a significant moderating influence in coastal area.

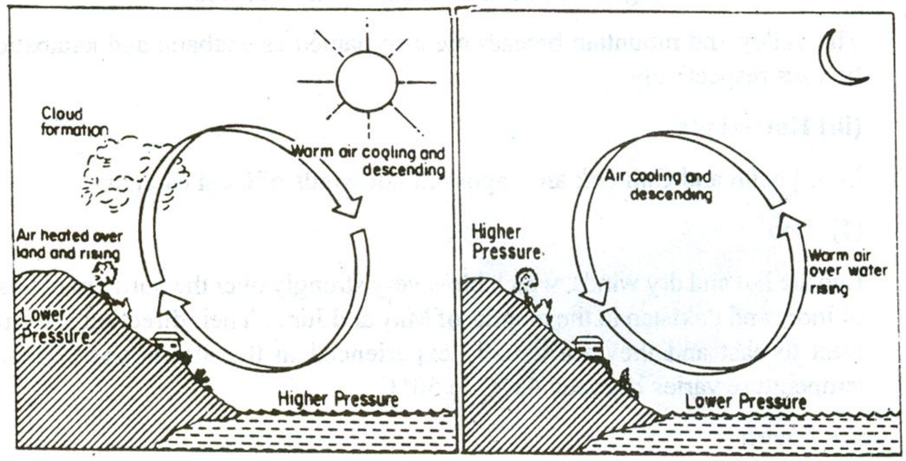


Fig 11.9 Sea and Land Breezes

At night, the land and the air above it cools more quickly than the nearby water body. As a result, land has high pressure while the sea has comparatively a low pressure area. Gentle wind begins to blow from land (high pressure) towards sea (low pressure). This is known as land breeze (see fig. 11.9)

(ii) The Mountain and Valley Breezes

Another combination of local winds that undergoes a daily reversal consists of the mountain and valley breezes. On a warm sunny day the mountain slopes are heated more than the valley floor.

Hence, the pressure is low over the slopes while it is comparatively high in the valleys below. As a result gentle wind begins to blow from valley towards slopes and it assumes the name of valley breeze (see fig. 11.10).

After sunset, the rapid radiation takes place on the mountain slopes. Here, high pressure develops more rapidly than on the valley floor. Cold arid heavy air of mountain slopes starts moving down towards the valley floor. This is known as the mountain breeze (see fig. 11.10).

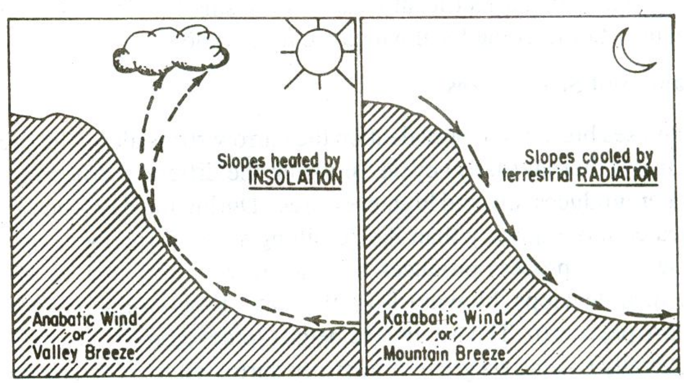


Fig. 11.10 : Mountain and Valley Breezes

The valley and mountain breezes are also named as anabatic and katabatic breezes respectively.

(iii) Hot Winds

Loo, Foehn and Chinook are important hot winds of local category.

(1) Loo

Loo are hot and dry winds, which blow very strongly over the northern plains of India and Pakistan in the months of May and June. Their direction is from west to east and they are usually experienced in the afternoons. Their temperature varies between 45°C to 50°C.

(2) Foehn

Foehn is strong, dusty, dry and warm local wind which develops on the leeward side of the Alps mountain ranges. Regional pressure gradient forces the air to ascend and cross the barrier. Ascending air sometimes causes precipitation on the windward side of the mountains. After crossing the mountain crest, the Foehn winds starts descending on the leeward side or northern slopes of the mountain as warm and dry wind. The temperature of the winds vary from 15°C to 20°C which help in melting snow. Thus making pasture land ready for animal grazing and help the grapes to ripe early.

(3) Chinook

Chinook is the name of hot and dry local wind which moves down the eastern slopes of the Rockies in U.S.A. and Canada. The literal meaning of chinook is ‘snow eater’ as they help in melting the snow earlier. They keep the grasslands clear of snow. Hence they are very helpful to ranchers.

(iv) Cold Winds

The local cold winds originate in the snow-capped mountains during winter and move down the slopes towards the valleys. They are known by different names in different areas.

(1) Mistral

Mistrals are most common local cold winds. They originate on the Alps and move over France towards the Mediterranean Sea through the Rhone valley. They are very cold, dry and high velocity winds. They bring down temperature below freezing point in areas of their influence. People in these areas protect their orchards and gardens by growing thick hedges and build their houses facing the Mediterranean sea.

INTEXT QUESTIONS 11.4

1. Choose the correct alternative for each of the following:

   (a) Foehn winds are

   (i) wet and dry (ii) cold, (iii) both wet and cold, (iv) none of them.

   (b) Chinooks are similar to

   (i) Foehn, (ii) Mistral, (iii) both of them, (iv) none of them.

2. Where from the Foehn wind originates.

   ____

3. Name the local wind which originate on the snow capped rockies and move down the eastern slopes.

4. Write hot or cold against each of the following

   (a) Loo ______________

   (b) Mistral ______________

   (c) Chinok _____________

11.7 TROPICAL AND TEMPERATE CYCLONES

(1) Air Mass

An air mass is an extensive portion of the atmosphere having uniform characteristics of temperature, pressure and moisture which are relatively homogeneous horizontally.

An air mass develops when the air over a vast and relatively uniform land or ocean surface remains stationary for long time to acquire the temperature or moisture from the surface. The major source regions of the air masses are the high latitude polar or low latitude tropical regions having such homogeneous conditions. Air masses, therefore, are of two kinds-polar and tropical air masses. Polar air mass is cold and tropical air mass is warm. When cold air mass and warm air mass blow against each other, the boundary line of convergence separating the two air masses is termed as front. When the warm air mass, moves upward over the cold air mass the front formed in such a situation is called warm front. On the contrary, when the cold air mass advances faster and undercuts the warm air mass and forces the warm air upwards, the front so formed is called cold front. The frontal surface of cold front is steeper than that of a warm front (see fig 12.5). A prevailing air mass in any region - polar, tropical, maritime or continental largely controls the regions general weather.

(2) Cyclones

Typical cyclones are elliptical arrangement of isobars having low pressure at the centre with a convergence of winds within them. The wind direction in the cyclones is anti clockwise in the northern hemisphere and clockwise in the southern hemisphere. Cyclones are of two types - the temperate or mid latitude cyclones and the tropical or low latitude cyclones (see fig. 11.11)

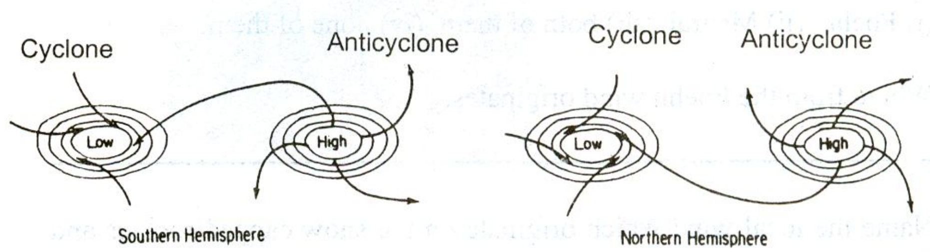


Fig. 11.11 : Movement of Wind associated with Cyclones and Anticyclone in Northern and Southern Hemisphere

(a) Temperate Cyclones

Temperate cyclones are formed along a front in mid-latitudes between 35° and 65° N and S. They blow from west to east and are more pronounced in winter season.

Atlantic Ocean and North West Europe are major regions of temperate cyclones. They are generally extensive having a thickness of 9 to11 kilometers and with 1040-1920 km short and long diametres respectively. Each such cyclone alternates with a high pressure anticyclone. The weather associated with the cyclone is drizzling rain and of cloudy nature for number of days. The anticyclone weather is sunny, calm and of cold waves.

(b) Tropical Cyclones

Tropical cyclones are formed along the zone of confluence of north-east and south-east trade winds. This zone is known as the Inter Tropical Convergence Zone (ITCZ). Cyclones generally occur in Mexico, South-Western and North Pacific Ocean, North Indian Ocean and South Pacific Ocean. These cyclones differ from temperate cyclones in many ways. There are no clear warm and cold fronts as temperature seldom differs in Inter Tropical Convergence Zone. They do not have well-defined pattern of winds and are energised by convectional currents within them. Generally, these are shallow depressions and the velocity of winds is weak. These are not accompanied by anticyclones. The arrangement of isobars is almost circular. These are not extensive and have the diametres of 160-640km. However, a few of them become very violent and cause destruction in the regions of their influence. They are called hurricanes in the Carribean Sea, typhoons in the China, Japan and phillipines, cyclones in the Indian Ocean and willy-willies in Northern Australia (see fig. 11.12)

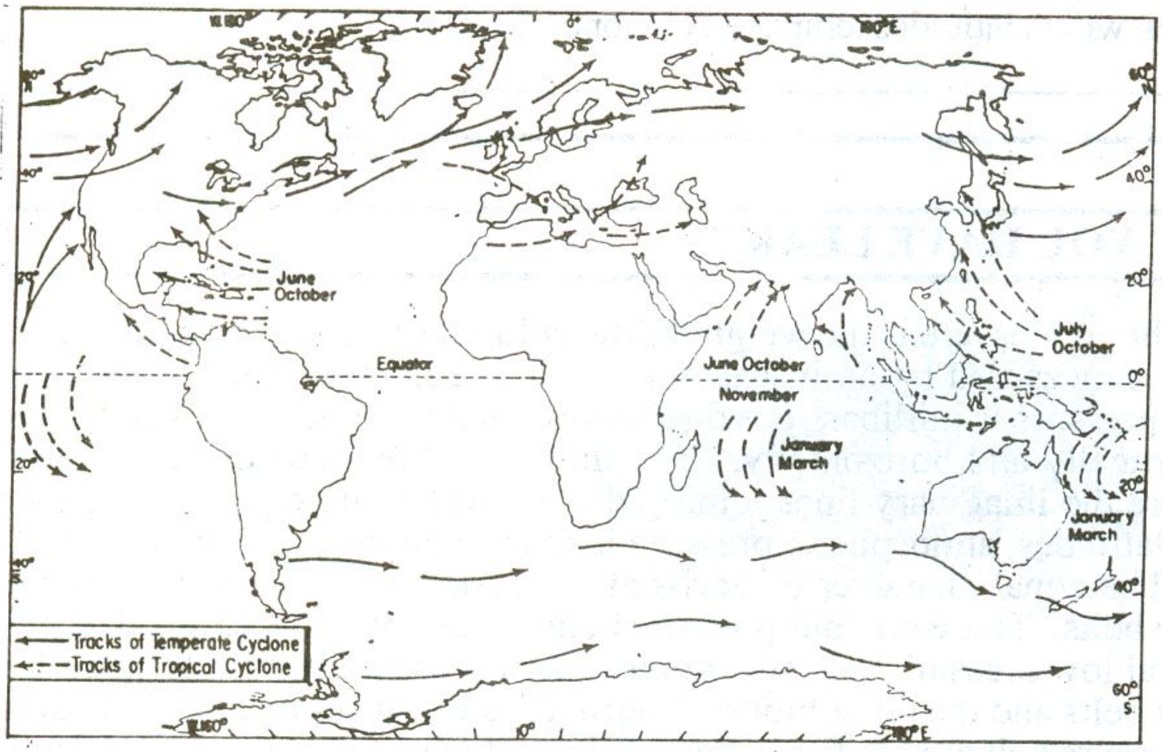


Fig. 11.12 : Tracks of Temperate and Tropical Cyclones

Tropical cyclones often cause destruction on the coasts. You would have heard cyclones striking Indian coasts in summer and autumn months. They cause heavy loss of life and property in these regions. The steeper pressure gradient causing strong high velocity winds and torrential rainfall bursting upon a restricted area combine to create distructive storms. However about 8 to 48 km. area around their centre called the eye of these stormy cyclones remains calm and rainless. If this eye is detected, it is possible for the modern science to stop further development of these strong cyclones and thus protecting us from them.

- An air mass is a large body of air having uniform temperature and moisture contents.
- The boundary line separating two air masses is termed as front.
- Temperate cyclones are prevalent in mid-latitudes while tropical cyclones develop in tropical regions.

INTEXT QUESTIONS 11.5

1. What is air mass?

____

2. Which type of cyclones cause heavy loss to life and property?

____

3. In which latitudes temperate cyclones develop?

____

WHAT YOU HAVE LEARNT

Atmospheric pressure is the weight of the column of air at a given place and time. It is measured by an instrument called barometer. Unit of measurement of pressure is millibar. The distribution of atmospheric pressure varies both vertically and horizontally. It is shown on the maps through isobars which are the imaginary lines joining the places having equal air pressure. In high latitudes, atmospheric pressure is more than the pressure at low latitudes. The zonal character of horizontal pressure is commonly known as pressure belts. There are four pressure belts spread over the earth. They are equatorial low pressure belt, sub-tropical high pressure belts, sub-polar low pressure belts and the polar highs. Thermal factor causes difference in pressure. Pressure belts are not fixed, they shift northwards in summer and south wards in winter with the apparent movement of the sun. Pressure gradient is the difference in horizontal pressure between regions of high pressure and region of low pressure. The difference in air pressure causes movement of air called wind. There are wind systems that blow regularly on a daily pattern. Examples include the land and sea breezes, the mountain and valley breezes and winds warmed as a result of compression. There is a close relationship between pressure gradient and wind speed. Due to Coriolis force, winds deflect from their original course. In Northern Hemisphere they deflect towards their right and in Southern Hemisphere towards their left. This is known as the Ferrel's law. Winds are grouped under planetary, Periodic and local winds. Planetary winds blow in the same direction throughout the year, while the other types of winds get modified due to certain reasons. Monsoon are seasonal winds while local winds below generally on diurnal basis. Air masses are horizontal large bodies of air which have uniform temperatures and moisture contents. The boundary line between two different air masses is called a front. Air masses and front cause temperate cyclones in mid-latitudes. Another type of cyclones are tropical cyclones which originate on tropical oceans and influence the coastal areas. Sometimes they turn violent and cause heavy loss to life and property.

TERMINAL QUESTIONS

1. Answer the following questions in about 30 words each.

(a) What is an atmospheric pressure?

(b) How is atmospheric pressure measured?

(c) What are the following?

(i) Millibars

(ii) Isobars.

(d) What is the effect of altitude on air pressure?

2. Distinguish between the following in 50 words each:

(a) Air current and wind.

(b) Planetary winds and periodic winds.

(c) Foehn and Mistral.

(d) Katabatic and Anabatic Breezes.

3. Give reasons for the following in 100 words:

(a) Low pressure is prevalent in sub-polar regions

(b) Sea breezes blow during day time.

(c) Winds change their direction in both the hemisphere.

4. Define the following:

(a) Air mass (b) front

5. What are temperate cyclones? How do they differ from tropical cyclones?

6. What is the role of coriolis force in the deflection of winds?

7. Explain the following terms:

(a) Horse latitudes (b) Doldrums

8. On an outline map of the world mark and label the following.

(a) Prominent areas of low pressure in January.

(b) Prominent areas of high pressure in July in Northern Hemisphere

ANSWER TO INTEXT QUESTIONS

11.1

1. (a) Air temperature (b) The earth's rotation (c) Presence of water vapour
2. (a) Fortin's barometer (b) Aneriod barometer
3. 1013.25 Millibar
4. (a) 76 cm (b) low pressure (c) Higher pressure

11.2

1. (a) thermal equator (b) altitude

   (c) the air pressure (d) pressure/density

2. (a) (i), (b) (ii), (c) (ii), (d) (iv).

11.3

1. (a) Trade winds (b) Westerlies

   (c) Polar easterlies

2. Winds or moving bodies turn towards their right in the northern hemisphere and towards their left in the Southern hemisphere. It is known as Ferrule's law.

3. (a) (i), (b) (i), (c) (ii), (d) (iii)

11.4

1. (a) (iv) (b) (i)

2. On the leeward side of the Alps Mountains.

3. Chinook

4. (a) Hot, (b) cold, (c) Hot

11.5

1. A large body of air which has uniform temperature and moisture contents is called air mass.

2. Tropical and polar

3. Mid latitudes

HINTS TO TERMINAL QUESTIONS

1. (a) The weight of the air column at a place at a given time.

   (b) Air pressure is measured by an instrument called barometer.

      (i) The unit used for measuring air pressure. It is approximately equal to the force of one gram per square centimeter.

      (ii) Isobars are lines connecting points that have equal values Pressure.

   (d) Pressure decreases with increase in attitude.

2. (a) please refer to para 11.5

   (b) please refer to para 11.6 (a) and (b)

(c) please refer to para 11.6 (c) (iii) (2) and (iv) (1)

(d) please refer to para 11.6 (c) (ii)

3. (a) please refer to para 11.3 (iii)

(b) please refer to para 11.6 (c) (i)

(c) please refer to para 11.5 (ii)

4. (a) Air mass: a large body of air having uniformity of temperature, pressure and moisture.

(b) Front: the boundary line of convergence separating two different air masses.

5. Please refer to para 11.7 (2) (a) and (b)

6. Please refer to para 11.5 (ii)

7. (a) Horse latitudes is the region of sub-tropical high pressure belts of Northern hemisphere.

(b) Doldrums are the regions of calm in equatorial areas where winds are negligible and ascending air current are prominent.

8. Please see maps 11.3 and 11.4

12

HUMIDITY AND PRECIPITATION

In our previous lesson while discussing the composition of the atmosphere, we noted that water vapour, though a minor component, is a very important constituent of the atmosphere. In this lesson, we will study the role of water vapour in producing day to day weather changes.

OBJECTIVES

After studying this lesson, you will be able to :

- distinguish between absolute and relative humidity;
- establish relationship between temperature (absolute and relative humidity)
- infer conditions in which the relative humidity of a given sample of air increases or decreases;
- distinguish between saturated and unsaturated air;
- identify the factors affecting the rate of evaporation;
- explain the latent heat and its importance;
- describe the various forms of condensation;
- explain conditions conducive to precipitation;
- distinguish among the three types of precipitation (rainfall) with the help of diagrams;
- describe the salient features of distribution of precipitation in the world with reference to regional and seasonal variations;
- identify factors affecting rainfall distribution.

12.1 WATER VAPOUR IN THE ATMOSPHERE

Water vapour is a highly variable component of the atmosphere. Its proportion varies from zero to four percent by volume of the atmosphere. Water can exist in the air in all the three states of matter i.e. solid (ice-crystals), liquid (droplets of water) and gaseous (water vapour). Most commonly water exists in air as tasteless, colourless, transparent gas known as water vapour. The presence of water in the atmosphere has made life possible on the earth. Let us examine its significance for life on the earth.

(i) We have noted in the lesson 10, that water vapour in the atmosphere absorbs a significant portion of both incoming solar energy and outgoing earth radiation. In this way, it prevents great losses of heat from the earth's surface and helps to maintain suitable temperatures on the earth.

(ii) The amount of water vapour present in the air affects the "rate of evaporation.

(iii) The amount of water vapour present in a volume of air decides the quality of latent heat or energy stored in it for producing atmospheric changes;

(iv) The amount of water vapour present in the air of a place or in a region indicates the potential capacity of that air for precipitation.

(v) The amount of water vapour present in the air also affects standing crops favourably. On the other hand hot dry winds damage standing crops as in the case of rabi crops of North- Western India.

(vi) Air, poor in water vapour content, makes our body skin dry and rough. It is because of this fact that we use cream to protect our faces from dry air of cold winters or hot summers.

- The water vapour present in the atmosphere absorbs radiation, controls the rate of evaporation, releases latent heat for weather changes, decides the potentiality for precipitation, affects standing crops and our body skin, hence is of great significance.

12.2 HUMIDITY

How does water changes into water vapour? The heat energy radiated from the sun changes water into water vapour. This invisible water vapour present in gaseous form in the atmosphere at any time and place is termed as humidity. In other words, we can say that the term humidity refers to the amount of water vapour present in a given air. It indicates the degree of dampness or wetness of the air. Humidity of the air is mainly expressed in the following two ways:

(i) Absolute humidity

(ii) Relative humidity

(i) Absolute Humidity

Absolute humidity is the ratio of the mass of water vapour actually in the air to a unit mass of air, including the water vapour. It is expressed in gram per cubic metre of air. For example, if the absolute humidity of air is 10 grams it means that one cubic metre of that air holds 10 grams of moisture in the form of water vapour. Absolute humidity is variable and changes from place to place and with change in time.

The ability of an air to hold water vapour depends entirely on its temperature. The capacity of holding water vapour of an air increases with the increase in its temperature. For example, at 10°C, one cubic metre of an air can hold 11.4 grams of water vapour. If the temperature of the same air increases to 21°C, the same volume of air can hold 22.2 grams of water vapour. The Figure 12.1 shows the relationship between temperature and the maximum amount of water vapour that an air can hold at a given temperature. A cursory glance at this figure indicates how the water holding capacity of the air increases with increase in temperature. Change in temperature and pressure conditions of an air results in the change of its volume and consequently there is change in its absolute humidity. Hence, there is a need of some more reliable measure of humidity.

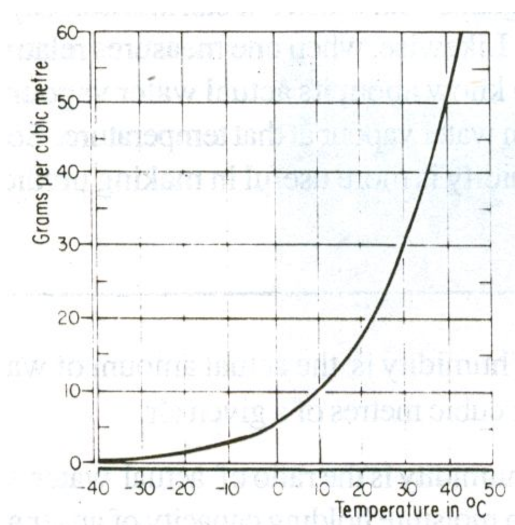


Fig 12.1 Maximum Absolute Humidity for a Wide Range of Temperature

(ii) Relative Humidity

Relative humidity is the most important and reliable measure of atmospheric moisture. It is the ratio of the amount of water vapor actually in a volume occupied by air to the amount the space could contain at saturation.

$$\text{Relative humidity} = \frac{\text{Vapour pressure in the air}}{\text{Saturation vapour pressure}}.$$

From Figure 12.1, it is quite clear that air can hold a definite maximum quantity of water vapour at a given temperature. When this situation is attained, we say the air is fully saturated. The temperature at which a given sample of air becomes fully saturated is called the dew point or saturation point The relative humidity of an air at saturation point is hundred percent. Since the concept of relative humidity is very important in understanding this lesson let us illustrate it with the help of an example. It is clear in Fig 12.1 that an air can hold 22.2 grams of water vapour at 21^0C temperature. If this air is holding 11.1 grams of water vapour at the same temperature i.e. 21^0C, the relative humidity of the air will be 11.1/22.2x100 or 50 percent. And, if the same air is actually holding 22.2 grams of water vapour at 21^0C, the relative humidity of air will be 22.2/22.2x100 or 100 percent. The air become saturated when its relative humidity is cent percent. If the relative humidity of air is less than 100 percent, the air is said to be unsaturated.

The relative humidity increases when the temperature of the air goes down or when more moist air is added to it. The relative humidity decreases when the temperature of the air increases or when less moist air is added to it

In order to make it clear that relative humidity is a better measurement of water vapour in atmosphere than absolute humidity, yet another example can be cited. Suppose, there is a tumbler containing 250 grams of water, one cannot tell how much portion of the tumbler is filled with water till one knows its maximum water containing capacity. When one comes to know that the tumbler can contain maximum of 500 grams of water, one can immediately tell that the tumbler is half filled with water. Likewise, when one measures relative humidity of an air, one not only needs to know about its actual water vapour content but also its total capacity to contain water vapour at that temperature. So, now you can understand why relative humidity is more useful in making predictions about atmospheric conditions.

- Absolute humidity is the actual amount of water vapour present in grams per cubic metres of a given air.
- Relative humidity is the ratio of actual water vapour content to the maximum moisture holding capacity of an air at a given temperature and it is expressed in percentage (RH.=A.H/Max. capacity X 100)
- The temperature at which a given sample of air becomes fully saturated is called dew point or saturation point.

INTEXTQUESTIONS 12.1

1. Name the three forms in which water can exist in the atmosphere.

   (a)________________ (b)______________ and (c)_____________

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

   (a) The amount of water vapour present in the atmosphere.

   ____

   (b) The weight of actual water vapour present per volume of air.

   ____

   (c) The ratio of the amount of the water vapour actually is a volume occupied by air to the amount the space could contain of saturation.

   ____

   (d) The air that contains moisture to its full capacity is called

   ____

   (e) The temperature at which a sample of air becomes saturated.

   ____

12.3 EVAPORATION

Evaporation is the process of which water changes from its liquid state to gaseous form. This process takes place at all places, at all times and at all temperatures except at dew point or when the air is saturated. The rate of evaporation is affected by several factors. Important among them are as under:

(i) Accessibility of water bodies

The rate of evaporation is higher over the oceans than on the continents.

(ii) Temperature

We know that hot air holds more moisture than cold air. So, when the temperature of an air is high, it is capable of holding more moisture in its body than at a low temperature. It is because of this that the rate of evaporation is more in summers than in winters. That is why wet clothes dry faster in summers than in winters.

(iii) Air moisture

If the relative humidity of a sample of air is high, it is capable of holding less moisture. On the other hand if the relative humidity is less, it can take more moisture. Hence, the rate of evaporation will be high. Aridity or dryness of the air also increases the rate of evaporation. During rainy days, wet clothes take more time to dry owing to the high percentage of moisture content in the air, than on dry days.

(iv) Wind

Wind also affects the rate of evaporation. If there is no wind, the air which overlies a water surface will get saturated through evaporation. This evaporation will cease once saturation point is reached. However, if there is wind, it will blow that saturated or nearly saturated air away from the evaporating surface and replace it with air of lower humidity. This allows evaporation to continue as long as the wind keep blowing saturated air away and bring drier air.

(v) Cloud cover

The cloud cover prevents solar radiation and thus influences the air temperatures at a place. This way, it indirectly controls the process of evaporation.

It is interesting to note that about 600 calories of heat is used for converting each gram of water into water vapour. A calorie is unit of heat energy spent in raising temperature of one gram of water by 10^0C. The heat energy used for changing the state of water or a body from liquid to gaseous state or from solid (ice) to liquid (water) state without changing its temperature is called latent heat. It is a sort of hidden heat. The effect of which is not seen on the thermometer. The latent heat consumed in changing water into gaseous form is released when water vapour changes into water or ice. The release of latent heat in the air is an important source of energy for causing changes in weather.

A special case of evaporation is transpiration, which entails a loss of water from leaf and stem tissues of growing vegetation. The combined losses of moisture by evaporation and transpiration from a given areas are termed evapo-transpiration.

- The evaporation is the process of changing water into water vapour.
- The rate of evaporation is affected by the accessibility of water, temperature, aridity of air, wind and cloud cover.
- The heat energy used for changing the state of water, or a body from liquid to gaseous state or from solid to liquid state without changing its temperature is called latent heat.

12.4 CONDENSATION

Condensation is the process by which atmospheric water vapour changes into water or ice crystals. It is just reverse of the process of evaporation. When the temperature of saturated air falls below dew point, the air cannot hold the amount of humidity which it was holding earlier at a higher temperature. This extra amount of humidity changes into water droplets or crystals of ice depending upon the temperature at which condensation takes place.

(a) Process of condensation

The temperature of the air falls in two ways. Firstly, cooling occurs around very small particles of freely floating air when it comes in contact with some colder object. Secondly, loss in air temperature takes place on a massive scale due to rising of air to higher altitudes. The condensation takes place around the smoke, salt and dust particles which attract water vapour to condense around them. They are called hygroscopic nuclei. When the relative humidity of an air is high, a slight cooling is required to bring the temperature down below dew point. But when the relative humidity is low and the temperature of the air is high, a lot of cooling of the air will be necessary to bring the temperature down below dew point. Thus, condensation is directly related to the relative humidity and the rate of cooling.

- Condensation is a process of changing water vapour into tiny droplets of water or ice cystals.
- Condensation takes place when temperature of air falls below dew point and is controlled by relative humidity of the air and rate of cooling.

(b) Forms of condensation

Condensation takes place in two situations, firstly, when dew point is below freezing point or below 0° C and secondly, when it is above freezing point. In this way, the forms of condensation may be classified into two groups:

(i) Frost, snow and some clouds are formed when dew point is below freezing point.

(ii) Dew, mist, fog, smog and some clouds are formed when dew point is above freezing point.

The forms of condensation may also be classified on the basis of place where it is occurring, for example, on the ground or natural objects such as grass blades and leaves of the plants or trees, in the air close to the earth's surface or at some height in the troposphere.

(i) Dew: When the atmospheric moisture is condensed and deposited in the form of water droplets on cooler surface of solid objects such as grass blades, leaves of plants and trees and stones, it is termed as dew. Condensation in dew form occurs when there is clear sky, little or no wind, high relative humidity and cold long nights. These conditions lead to greater terrestrial radiation and the solid objects become cold enough to bring the temperature of air down below dew point. In this process the extra moisture of the air gets deposited on these objects. Dew is formed when dew point is above freezing point. Dew formation can be seen if the water is poured into a glass from the bottle kept in a refrigerator. The outer cold surface of the glass brings the temperature of the air in contact with the surface down below dew point and extra moisture gets deposited on the outer wall of the glass.

(ii) **Frost:** When the dew point is below freezing point, under above mentioned conditions, the condensation of extra moisture takes place in the form of very minute particles of ice crystals. It is called frost. In this process, the air moisture condenses directly in the form of tiny crystal of ice. This form of condensation is disastrous for standing crops such as potato, peas, pulses, grams, etc. It also creates problems for road transport system.

(iii) **Mist and Fog:** When condensation takes place in the air near the earth's surface in the form of tiny droplets of water hanging and floating in the air, it is called mist. In mist the visibility is more than one kilometer and less than two kilometers. But when the visibility is reduced to less than one kilometer, it is called fog. Ideal conditions for the formation of mist and fog are clear sky, calm and cold winter nights.

(iv) **Smog:** Smog is a fog that has been polluted and discoloured by smoke, dust, carbon monoxide, sulphur dioxide and other fumes. Smog frequently occurs in large cities and industrial centres. It causes respiratory illness.

(v) **Cloud:** Clouds are visible aggregates of water droplets, ice particles, or a mixture of both along with varying amounts of dust particles. A typical cloud contains billions of droplets having diameters on the order 060.01 to 0.02 mm; yet liquid or solid water accounts for less than 10 parts per million of the cloud volume. Clouds are generally classified on the basis of their general form or appearance and altitude. Combining both these characteristics, clouds may be grouped as under.

Low clouds: The base level of low clouds varies from very near the ground to about 2000m. The basic type of this family is the status, a low, uniform layer resembling fog but not resting on the ground.

Stratocumulus clouds form a low, gray layer composed of globular masses or rolls which are usually arranged in groups, lines, or waves.

Clouds with vertical development fall into two principal. **Categories:** cumulus and cumulonimbus. Cumulus clouds are dense, dome-shaped and have flat bases. They may grow to become cumulonimbus, the extent of vertical development depending upon the force of vertical currents below the clouds as well as upon the amount of latent heat of condensation liberated in the clouds as they form.

To an observer directly beneath, a cumulonimbus cloud may cover the whole sky and have the appearance of Nimbostratus, The word nimbus (or prefix nimbo) applies to a cloud from which rain is falling. It derives from the Latin for "violent rain".

Medium clouds: These clouds are formed at altitudes between 2000 to 6000 metres. This group of clouds include altocumulus and altostratus.

High clouds: These clouds are formed above the altitude of 6000 metres and include cirrus, cirrostratus and cirrocumulus (see fig. 12.2).

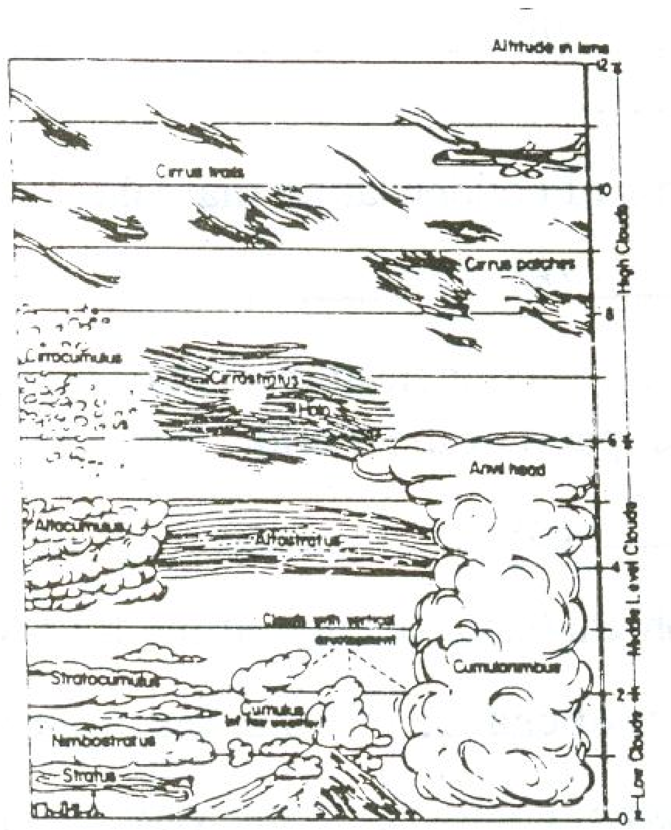


Fig. 12.2 : Cloud types are grouped into families according to height and form

- Forms of condensation include dew, frost, mist, fog, smog and clouds.
- Frost and some clouds are formed when condensation takes place below freezing point.
- Clouds are grouped into three types on the basis of appearance and altitude.

INTEXT QUESTIONS 12.2

(1) List five factors which affect the rate of evaporation.

(a) ______________________ (b) ________________

(c) ______________________ (d) ________________

(e) ______________________

(2) Name the forms of condensation that take place on the solid objects.

(a) ______________________ (b) ________________

(3) Name two forms of condensation that occur in the air just above the ground in most parts of the world.

(a) ______________________ (b) ________________

(4) Give geographical term for each of the following:

(a) The process of change of water into water vapour____________

(b) The process of change of water vapour into liquid or solid state

____

(c) A mass of tiny droplets of water or ice crystals hanging in the air at some height______________________________________

(d) Type of clouds formed due to convection and look like wool pack

____

(e) Type of clouds which are chief rain producer_______________

12.5 PRECIPITATION

Precipitation is defined as water in liquid or solid forms falling to the earth. It happens when continuous condensation in the body of air helps the water droplets or ice crystals to grow in size and weight that the air cannot hold them and as a result these starts falling on the ground under the force of gravity.

Forms of precipitation

The precipitation falls on the earth in various forms of droplets of water, ice flakes and solid ice balls or hail and at times droplets of water and hail together. The form that precipitation takes is largely dependent upon the method of formation and temperature during the formation. The forms of precipitation are as follows:

(i) **Drizzle and Rainfall :** Drizzle is a fairly uniform precipitation composed exclusively of fine drops of water with diameter less than 0.5 mm. Only when droplets of this size are widely spaced are called rain.

(ii) Snowfall: When condensation takes place below freezing point (-0° C), the water vapour changes into tiny ice crystals. These tiny ice crystals grow in size and form ice flakes which become big and heavy and start falling on the ground. This form of precipitation is called snowfall. Snowfall is very common in Western Himalaya and mid and high latitude regions in winter.

(iii) Sleet: Sleet is frozen rain, formed when rain before falling on the earth, passes through a cold layer of air and freezes. The result is the creation of solid particles of clear ice. It's usually a combination of small ice balls and rime.

(iv) Hail : Hail is precipitation of small balls or pieces of ice (hail stones) with diameters ranging from 5 to 50mm, falling either separately or agglomerated into irregular lumps. Hailstones are comprised of a series of alternating layers of transparent and translucent ice.

- Falling down of atmospheric moisture on the earth's surface is called precipitation.
- The precipitation in the form of tiny droplets of water and bigger water droplets are known as drizzle and rainfall respectively.
- When the precipitation is in the form of big ice balls, it is called Snow fall.

12.6 TYPES OF RAINFALL

We know, when a mass of moist air ascends to high altitudes it cools down to lower temperatures. In doing so it attains dew point which leads to condensation and precipitation. Thus the cooling of air occurs mainly when it rises. There are three important ways in which a mass of air can be forced to rise and each of these ways produces its own characteristic precipitation or rainfall.

(a) Convectional Rainfall

Excessive heating of the earth's surface in tropical region results in the vertical air currents. These currents, lift the warm moist air to higher strata of atmosphere. When-the temperature of such a humid air starts falling below dew point continuously, clouds are formed. These clouds cause heavy rainfall which is associated with lightning and thunder. This type of rainfall is called conventional rainfall. It is very common in equatorial region where it is a daily phenomenon in the afternoon (see fig. 12.3)

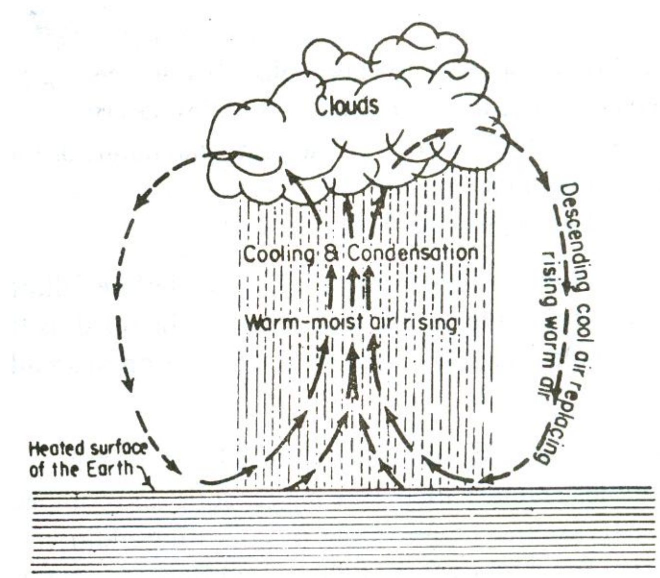


Fig. 12.3 Conventional Rainfall

(b) Orographic or Relief Rainfall

Orographic rainfall on formed where air rises and cools because of a topographic barrier. When their temperature fall below dew point, clouds are formed. These clouds cause widespread rain on the windward slopes of the mountain range. This type of rain is called orographic rainfall. However when these winds cross over the mountain range and descend along the leeward slopes, they get warm and cause little rain. Region lying on the leeward side of the mountain receiving little rain is called rainshadow area (see figure 12.4). A famous example of orographic rainfall is Cherrapunji on the southern margin of the Khasi Hills in Meghalaya India.

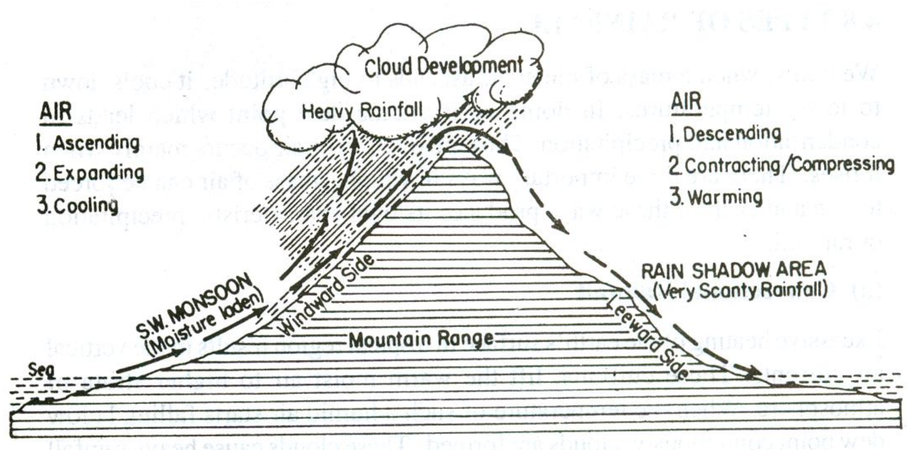
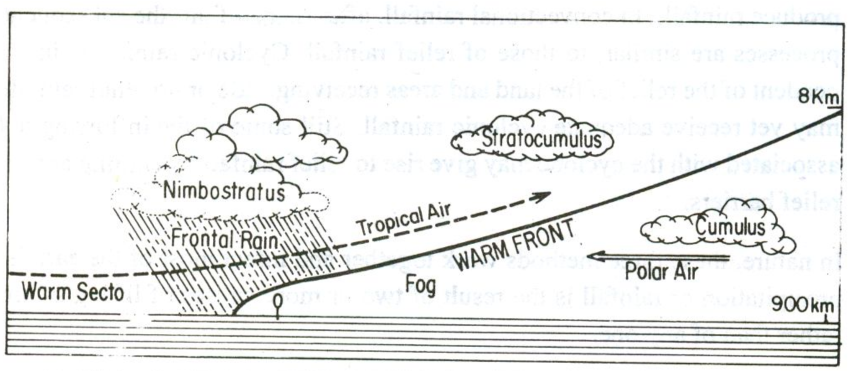


Fig 12.4 Orographic Rainfall

(c) Convergence or Cyclonic Rainfall

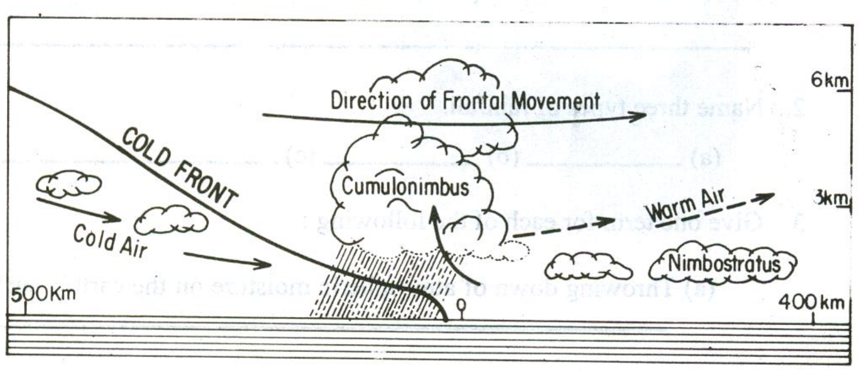
Convergence rainfall, produced where air currents converge and rise. In tropical regions where opposing air currents have comparable temperatures, the lifting is more or less vertical and is usually accompanied by convention. Convectioned activity frequently occurs along fronts where the temperature of the air masses concerned are quite different. Mixing of air along the front also probably contributes to condensation and therefore to the frontal rainfall. When two large air masses of different densities and temperature meet, the warmer moist air mass is lifted above the colder one. When this happens, the rising warm air mass condenses to form clouds which cause extensive down pour. This rainfall is associated with thunder and lightning. ‘This type of rainfall is also called frontal rainfall. This type of rainfall is associated with both warm and cold fronts, (fig. 12.5) It is generally steady and may persist for a whole day or even longer.

(a) Rainfall Associated with a warm Front



(b) Rainfall Associated with a Cold Front

Fig. 12.5 Cyclonic Rainfall



In all these types, the cooling of large masses of humid air is essential to produce rainfall. In conventional rainfall, after rising of air, the subsequent processes are similar, to those of relief rainfall

In nature, these three methods work together and infact most of the earth's precipitation or rainfall is the result of two or more causes of lifting of air rather than of anyone.

- On the mode of occurrence, the rainfall is classified into conventional, orographic and convergence.

INTEXT QUESTIONS 12.3

1. List the various forms of precipitation.

   ____

2. Name three types of rainfall.

   (a)________________(b)________________(c)________________

3. Give one term for each of the following:

   (a) Throwing down of atmospheric moisture on the earth's surface

   ____

   (b) Frozen raindrops and melted snow falling on the earth's surface

   ____

   (c) The plane of contact between two air masses of varying characteristics

   ____

   (d) Precipitation in the form of ice balls

   ____

   (e) Rainfall caused by uplift of the air due to excessive heating

   ____

4. Below are given true and false statements. Mark 'T' if the statement is true and 'F' if it is false:

   (a) Precipitation is the process of converting water vapour into liquid or solid state______________________________

   (b) Precipitation in the form of ice flakes is called snowfall ______

   (c) Area lying on the leeward side of a mountain range receive scanty rainfall______________________________

   (d) Orographic rainfall is caused by ascend of warm moist air due to excessive heating____________________

12.7 DISTRIBUTION OF PRECIPITATION

The spatial distribution of precipitation is not uniform all over the world. The average annual precipitation for the world as a whole is about 97.5 centimeters but the land receives lesser amount or rainfall than the oceans. The annual precipitation shows marked difference on the land. Different places of the earth's surface receive different amount of annual precipitation and that too in different seasons.

The main features of the distribution of precipitation can be explained with the help of global pressure and wind belts. distribution of land and water bodies and the nature of relief features. Before arriving at any conclusion regarding the causes for regional and seasonal variation, let us first see regional and seasonal distribution patterns of precipitation.

(a) Regional Variations

On the basis of average amount of annual precipitation. We can recognize the following precipitation regions in the world. (see fig. 12.6)

(i) **Regions of Heavy Precipitation:** The regions which receive over 200 centimeters of annual precipitation are included in this category. These regions include equatorial coastal areas of tropical zone and west-coastal regions of temperate zone.

(ii) **Regions of Moderate Precipitation:** The regions which receive 100 to 200 centimeters of annual precipitation are included in this category. These regions lie adjacent to the regions of heavy precipitation. Eastern coastal regions of subtropical zone and coastal regions of the warm temperate zone are included in this category.

(iii) **Regions of Less Precipitation :** This category includes regions which receive precipitation between 50 to 100 centimeters. These regions lie in the interior parts of tropical zone and eastern interior parts of temperate zone.

(iv) **Regions of Scanty Precipitation:** The areas lying in the rain shadows (leeward) side of the mountain ranges, the interior parts of continents, the western margins of continents along tropics and high latitudes receive precipitation less than 50 centimeters. These regions include tropical, temperate and cold deserts of the world.

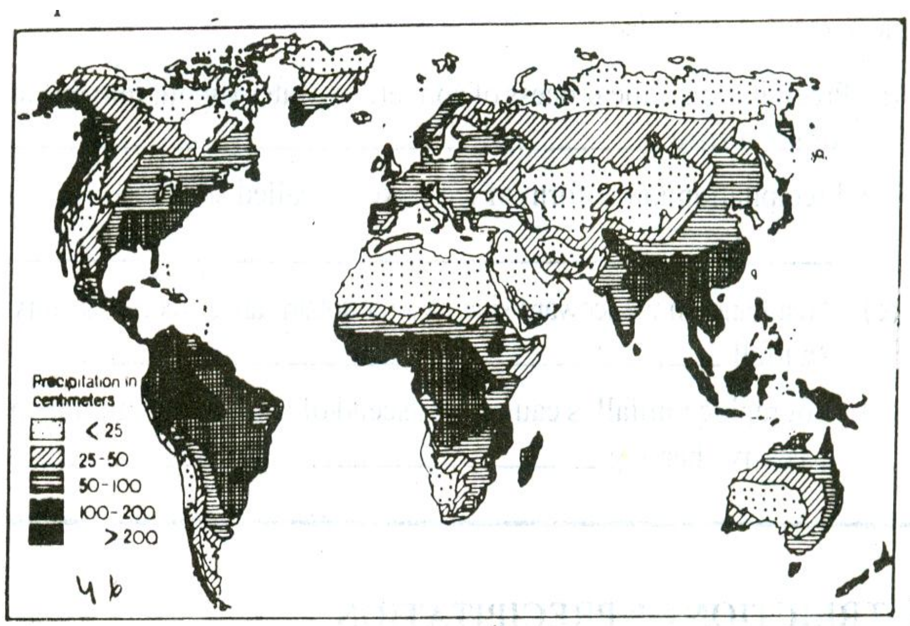


Fig. 12.6 Distribution of Mean Precipitation in the world

Now let us carefully study the map showing the annual average precipitation distribution of the world (fig. 12.6) in order to come to the following conclusions.

(1) Precipitation is greatest in the equatorial region and decreases towards the poles.

(2) Precipitation is heaviest in the coastal regions and decreases towards the interior of the continents.

(3) Eastern coastal areas of tropical lands and western coastal areas of temperate lands receive heavy precipitation including equatorial regions.

(4) Precipitation is very heavy on the windward side of highlands; very dry condition prevail on the leeward side.

(5) Coastal areas adjacent to cold currents are drier than coastal areas near warm currents.

(6) The western margin of tropical land and polar region receive scanty rainfall. The main reason being that easterlies become dry winds and polar winds are cold and dry.

(b) Seasonal Variations

The regional variations in the distribution of precipitation in different parts of the world are based on average annual precipitation which do not give us any correct picture of the nature of precipitation specially of those regions where seasonal fluctuations in the amount of precipitation are very common, for example arid, semi arid or sub-humid regions. Therefore, it is important to study seasonal variations of precipitation in the world. The facts related to this are as follows:

(i) The equatorial regions and the western parts of temperate lands receive precipitation throughout the year. The former receive conventional type of rain while the later gets cyclonic cum orographic type through westerlies.

(ii) About 2 per cent land areas of the world receive precipitation only in winter. These include Mediterranean regions of the world and Coromandel Coast of India. Due to the seasonal shift in pressure and planetary wind systems, these regions (Mediterranean) do not get precipitation in summer as they come under sub-tropical high pressure belts and trade winds which become dry while reaching to the western margins of continents.

(iii) The remaining parts of the world receive precipitation only in summer. It makes us clear that most parts of the world experience marked seasonal variation in precipitation. Seasonal distribution of precipitation provides us idea to judge its effectiveness. For example, the scanty precipitation during short growing season in high latitudes is more effective than that of heavy precipitation in lower latitudes. Likewise, precipitation in the form of dew, fog and mist in some parts like Central India and Kalahari desert has an appreciable affect on standing crops and natural vegetation.

(c) Factors Affecting Rainfall Distribution

(i) Moisture supply to the atmosphere is the main factor in determining the amount of rainfall in any region. Equatorial and rest of the tropical region have highest evaporation and hence highest supply of moisture. Coastal areas have more moisture than interior parts of continents. Frigid regions have very low evaporation hence very scanty precipitation.

(ii) Wind direction in the belts of trades and westerlies winds is very important. Winds blowing from sea to land cause rainfall. Land bearing winds are dry. Winds blowing from higher to lower latitudes will get heated and give no rain while those blowing from lower to higher latitudes will get cooled and cause rainfall. Sub-tropical deserts have very little rainfall because they have off-shore winds.

(iii) Ocean currents : Warm current are associated with warm moist winds which cause rainfal1, cold current have cold dry wind and hence no rainfall.

(iv) Presence of mountain across the direction of wind causes more rainfall on the windward side and creates rain shadow on the leeward side.

(v) Pressure belts are closely related with wind direction and rainfall. Areas of low pressure attract rain bearing winds while areas of high pressure do not.

- The distribution of precipitation in different parts of the world shows marked regional and seasonal variation.
- Factors affecting rainfall distribution are: moisture supply, wind direction, ocean currents, presence of mountains and pressure belts.

INTEXT QUESTIONS 12.4

1. Name any two regions of heavy precipitation.

____

2. Name any two regions of scanty precipitation.

____

3. Name the regions where precipitation is heavy throughout the year.

 ____

4. Name the regions which receive precipitation only in winters.

 ____

5. Name five factors affecting rainfall distribution in the world.

 (a)________(b)____________(c)__________(d)__________

WHAT YOU HAVE LEARNT

Water vapour is highly variable. It is an important component of atmosphere. It is responsible for global heat balance, atmospheric phenomena and sustaining plant and animal life on our planet. The water vapour present in the atmosphere is called humidity, which is expressed as absolute humidity and relative humidity. Of these, the relative humidity is most reliable measure. Water vapour enters into atmosphere through a process called evaporation. Temperature of the air controls the amount of moisture it can hold at a given volume. The air which holds the moisture to its full capacity is called saturated air and the temperature at which it reaches saturation point is termed as dew point. Condensation is a process of changing of water vapour into liquid or solid state. It happens when temperature of an air falls below dew point. Condensation occurs near the ground as dew, mist, or fog and at higher levels of clouds.

Falling down of atmospheric moisture is called precipitation which occurs due to continuous condensation. Drizzle, rainfall, snowfall, sleet and hail are various forms of precipitation. The rainfall occurs in three different ways conventional, orographic and cyclonic.

The distribution of precipitation in the world shows marked regional and seasonal variation. Some regions receive heavy rainfall while others scanty precipitation. Some regions receive precipitation throughout the year while others only in the winter or summer. Several factors affect rainfall distribution.

TERMINAL QUESTIONS

1. Explain the importance of water vapour present in the atmosphere.
2. What is evaporation? Discuss the factors which affect the rate of evaporation. Give examples in support of your answer.

3. Explain the process and forms of condensation.
4. How does precipitation occur? Discuss the various forms of precipitation.
5. Differentiate between:
   - (a) Evaporation and condensation;
   - (b) Absolute humidity and relative humidity;
   - (c) Saturated air and unsaturated air;
   - (d) Rainfall and precipitation;
   - (e) Sleet and hail;
   - (f) Conventional and orographic rainfall.
6. Discuss in detail the regional and seasonal distribution of precipitation in the world.
7. Give reasons for each of the following:
   - (a) Equatorial regions receive precipitation throughout the year.
   - (b) Mediterranean regions receive rainfall only in winter.
   - (c) Amount of precipitation decreases from coastal areas to interior, parts of continents.
   - (d) Tropical deserts are found on the western parts of continent.
   - (e) Evaporation decreases towards poles.
8. On the given outline map of the world, show the following with appropriate symbols:
   - (a) Two areas getting precipitation above 200 cms.
   - (b) Two areas of scanty precipitation in lower latitudes.
   - (c) Two regions getting precipitation only in winter.
   - (d) Cold deserts of the world.

ANSWER TO INTEXT QUESTIONS

12.1

1. (a) Liquid (b) Solid (c) Gaseous
2. (a) humidity (b) absolute humidity (c) relative humidity (d) saturated air (e) dew point

12.2

1. (a) Temperature (b) air moisture (c) winds (d) cloud cover (e) accessibility of water bodies
2. (a) dew (b) frost
3. (a) mist (b) fog
4. (a) evaporation (b) condensation (c) cloud (d) cumulus (e) cumulonimbus.

12.3

1. Drizzle, rainfall, sleet and hail
2. (a) Conventional (b) Orographic (c) Cyclonic
3. (a) Precipitation (b) Sleet (c) Front (d) Hail (e) Conventional rainfall
4. (a) F (b) T (c) T (d) F

12.4

1. Equatorial, eastern sub-tropical and western coastal temperate regions.
2. Western margins along tropics and interior parts of continents in temperate zone and polar region.
3. Equatorial regions
4. Mediterranean regions
5. (a) Moisture supply (b) wind direction (c) ocean currents (d) presence of mountains (e) pressure belts

HINTS TO TERMINAL QUESTIONS

1. Please refer to section 12.1
2. Please refer to section 12.3
3. Please refer to section 12.4
4. Please refer to section 12.5
5. See under the respective headings.
6. Please refer to section 12.7
7. (a) Due to the uniform high temperature throughout the year in the equatorial region, there is much evaporation, conventional air currents are set up, followed by heavy rainfall of conventional type.

(b) In summer the sun is overhead at the Tropic of Cancer, the belt of influence of the westerlies is shifted a little poleward. The Mediterranean Region falls under the sub-tropical high pressure belt and trade winds. Trade winds become dry before reaching the western margin of continents. Hence no rainfall in summer. But during winter, the Mediterranean region comes under the influence of westerlies due to their shift towards south. Thus the region gets rainfall in winter only.

(c) Precipitation decreases from coastal areas to interior parts because rain bearing winds loose their moisture as they go interior.

(d) The aridity of the tropical deserts located in the western part of continents is mainly due to the effects of off shore Trade winds.

(e) Evaporation decreases towards poles due to low temperatures.

(f) Please see maps.