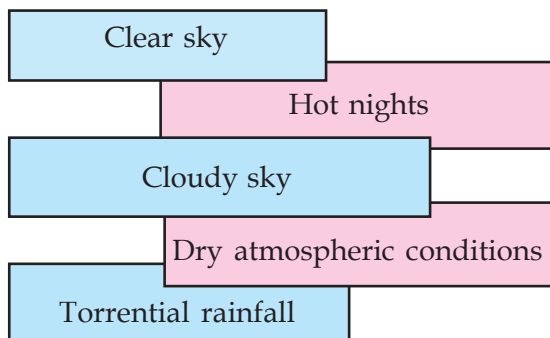


ATMOSPHERIC PHENOMENA

You must have understood about the structure of the atmosphere, atmospheric composition and the manner in which atmosphere heats up.



The above terms are commonly used by us to refer to the atmospheric conditions. Should we not know how these conditions are formed in the atmosphere?

Troposphere is the atmospheric layer in which climatic phenomena such as rain, snow and wind are experienced.

Weather and climate

The atmospheric condition experienced over a region in a short time span is known as weather. All places do not experience the same weather. Not all regions experience atmospheric phenomena such as rainfall, snow, wind, cyclone and thunder and lightning in the same manner.

The climate of a region is determined on the basis of the average of atmospheric temperature, atmospheric pressure, humidity, rainfall, velocity of wind and direction of wind over a period of about 35 years. It means that the average weather experienced by a region over a long period is its climate.

A part of the solar radiation is absorbed by the earth's surface and the atmosphere. The heat absorbed in this manner is gradually released later. You have understood from the earlier classes that the terrestrial radiation of long wavelength returning from the earth's surface to the

Apart from temperature the other factors influencing the atmospheric condition are atmospheric pressure and humidity. Let us find out the effect of each of these on the atmosphere.

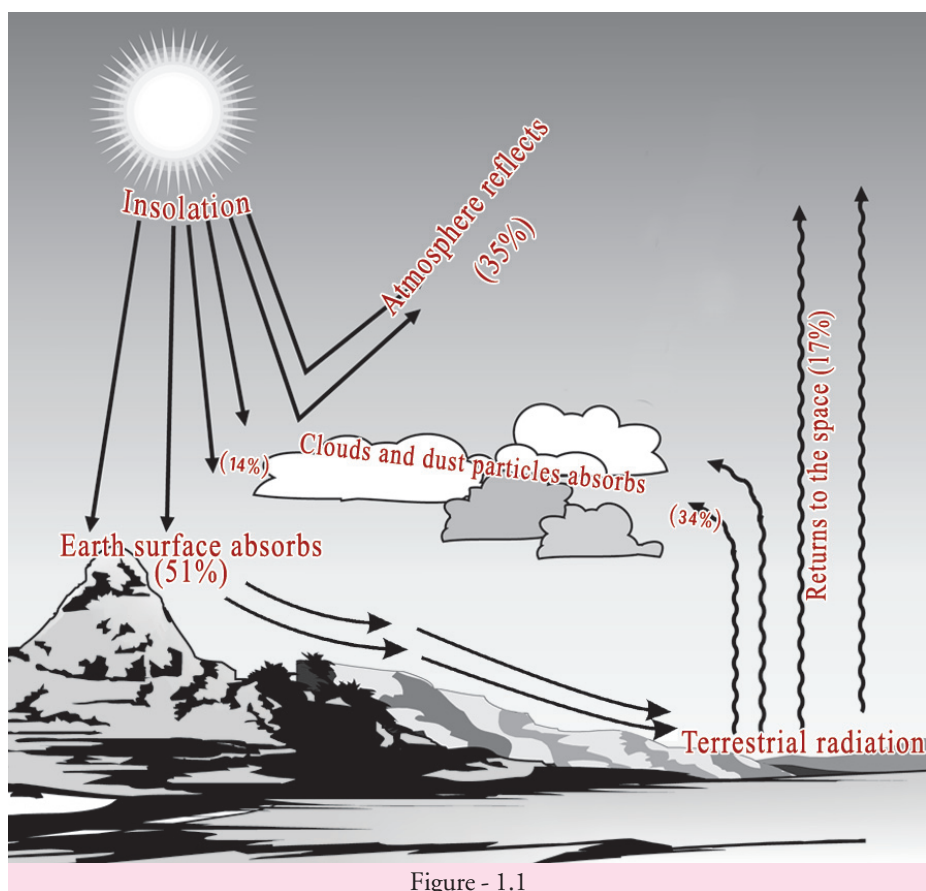


Figure - 1.1

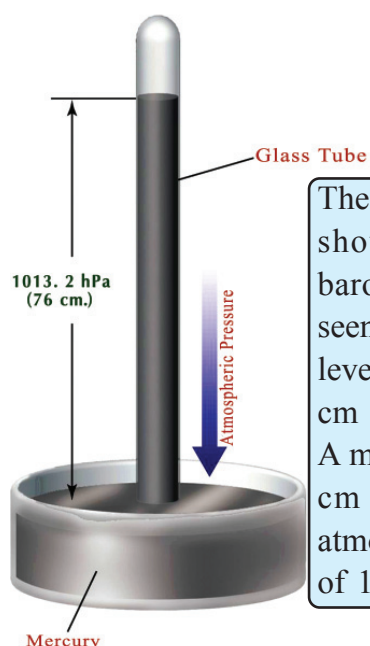
atmosphere heats up the atmosphere. The process of maintaining balance in the atmospheric temperature is shown in the above diagram (Fig.1.1).

If the total radiation from the sun reaching the earth is considered to be 100 per cent, 35 per cent of it returns to the outer space after getting reflected from different regions of the atmosphere. Clouds and dust particles in the atmosphere absorb 14 per cent. Only the remaining 51 per cent reaches the earth's surface. This heats the surface following which it returns to the outer space as long wave terrestrial radiation.

Atmospheric pressure

Like any other substance, air also has weight. The weight exerted by air on the earth's surface is called atmospheric pressure. It is because of gravitational attraction that air remains on the earth. This air exerts weight on the earth. This has been estimated as 1034 grams per square centimetre at the sea level.

The instrument used for the measurement of atmospheric pressure is the mercury barometer. Apart from the mercury barometer, the aneroid barometer is also used for the measurement of atmospheric pressure.



The figure (Fig. 1.2) shows a mercury barometer. It can be seen that the mercury level is standing at 76 cm in the barometer. A mercury level of 76 cm indicates an atmospheric pressure of 1013 hPa.

Figure - 1.2

Hecto Pascal (hPa) is the unit used for the measurement of atmospheric pressure. It has been estimated that the average atmospheric pressure at the sea level is 1013.2 hPa.

Atmospheric pressure experienced is not uniform everywhere on the earth. Atmosphere may experience increase or decrease in pressure. If the pressure in a region is more than that of its surroundings, then we say that it is high pressure there and if it is less, we say that it is low pressure.

Atmospheric pressure is represented in maps using flow lines. These imaginary lines drawn on maps connecting points of equal atmospheric pressure are called Isobars.

Observe the Isobars represented in the figure (Fig. 1.3).

Is atmospheric pressure experienced in the same manner everywhere on the earth? Find out from the Fig. (1.3).

Have you not visited the places Ooty and Kodaikanal which are over 2000 m above the sea level? Do you not experience clogging of ears and slight breathing

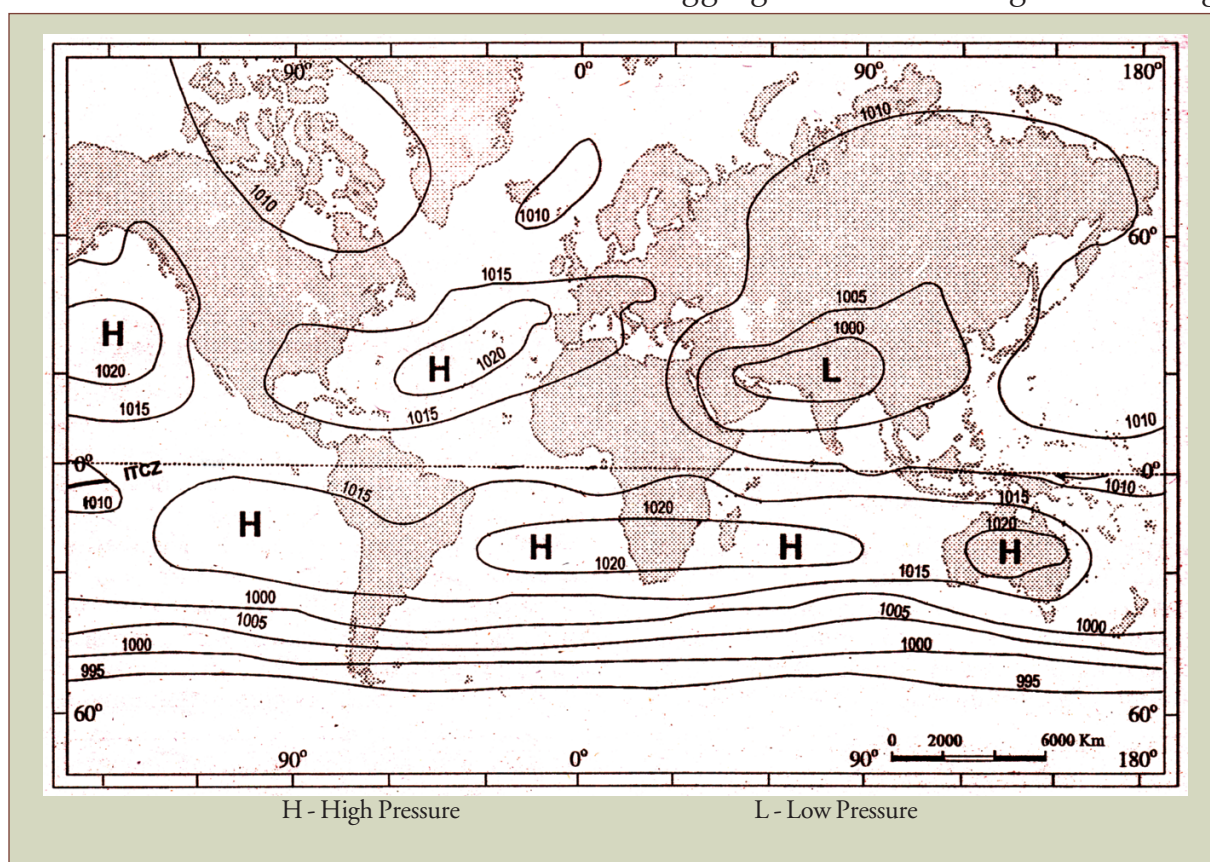


Figure - 1.3

difficulty as you travel up from the foot of the mountains?

It takes some time for the human body to adjust to the differences in atmospheric pressure. Due to this we experience discomfort such as clogging of ears and breathing difficulty.

The factors responsible for changes in atmospheric pressure are:

- Temperature
- Altitude of a place
- Humidity

Temperature and atmospheric pressure

In places where more solar energy is received, the air gets heated up. The heated air loses its density as a result of which it expands and rises up. This results

in a lowering of pressure. As air becomes cooler, it becomes denser. Since dense colder air sinks down an increase in pressure is felt. As temperature increases pressure becomes low and as temperature decreases, pressure becomes high.

- In what way would Equatorial regions and Polar regions experience atmospheric pressure?

Let us find out what changes occur in atmospheric pressure as a result of varying altitude. Observe the figure (Fig. 1.4). The figure shows atmospheric pressure differences in regions up to 10 kilometres height above the sea level.

- From the picture find out the region which experiences maximum pressure.

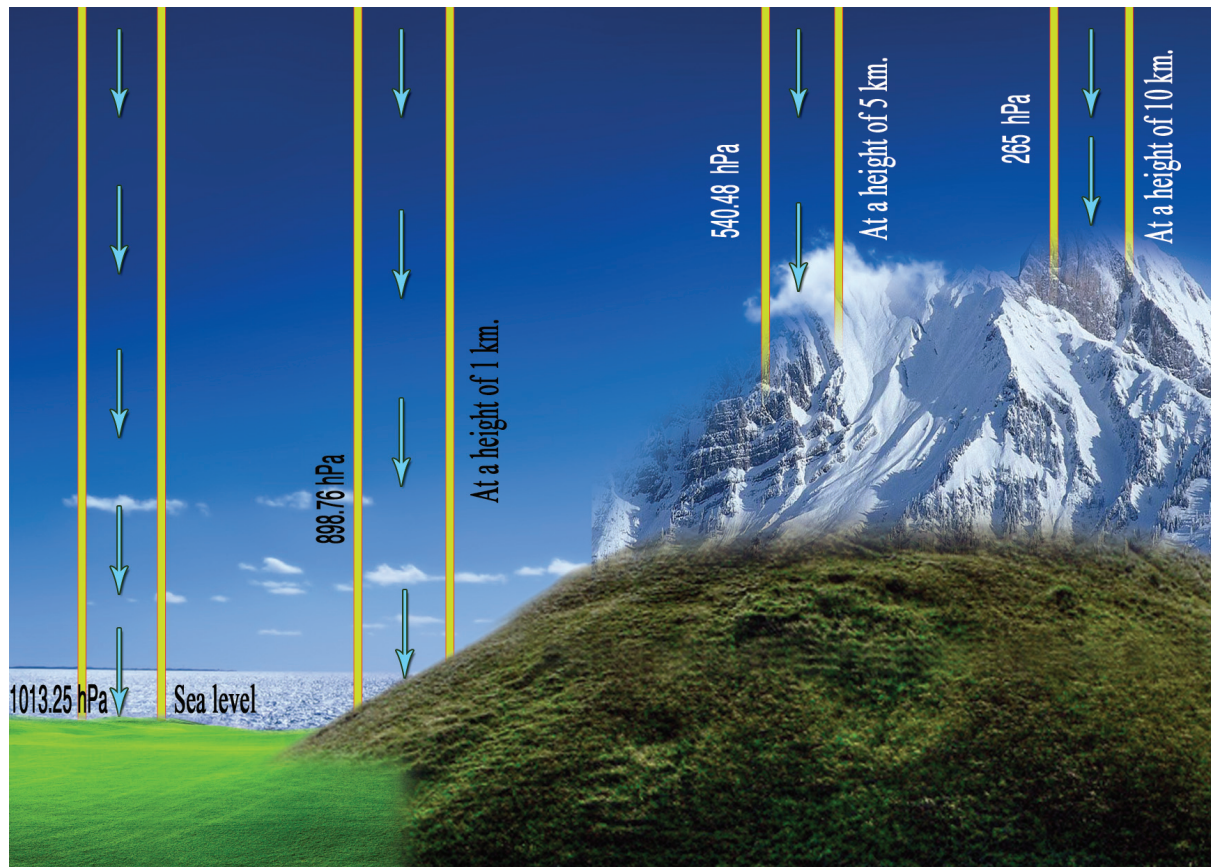


Figure - 1.4

Did you not understand that as we go up pressure decreases? This is because of the decrease in the density of air with increase in height.

Humidity and atmospheric pressure

The content of water vapour in atmospheric air is called humidity. Water vapour reaches the atmosphere through evaporation. Increase in the content of water vapour in air leads to a decrease in the atmospheric pressure.

- Air in coastal regions would show a higher humidity in comparison with that in inland areas. What could be the reason for this?

Global pressure belts

Generally the earth experiences the same atmospheric pressure between certain latitudes. These latitudinal zones are called global pressure belts.

Differences in the amount of solar radiation experienced over different parts of the earth cause the formation of different pressure belts.

Following are the different pressure belts of the earth.

1. Equatorial low pressure belt
2. Subtropical high pressure belt (Northern Hemisphere)
3. Subpolar low pressure belt (Northern Hemisphere)
4. Polar high pressure belt (Northern Hemisphere)
5. Subtropical high pressure belt (Southern Hemisphere)
6. Subpolar low pressure belt (Southern Hemisphere)
7. Polar high pressure belt (Southern Hemisphere)

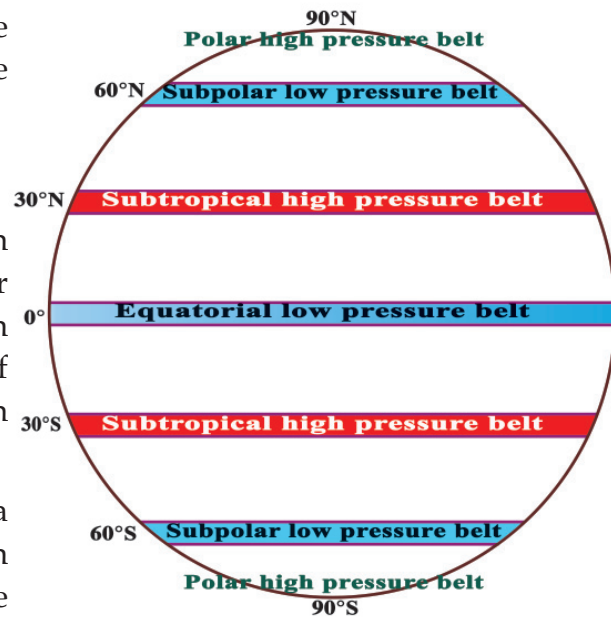


Figure - 1.5 - Global pressure belts

Examine the figure (Fig 1.5) and understand the position of the pressure belts.

Equatorial low pressure belt

This pressure belt extends upto about 5° to 10° on either sides of the equator. Here high temperature is experienced throughout the year. Haven't you understood that as temperature rises pressure decreases? It means that as a result of the higher temperature here the air expands and rises vertically. This is the reason for the formation of low pressure in this region. This low pressure region characterised by a low horizontal movement of air is called doldrum.

Subtropical high pressure belts

Subtropical high pressure belts extend approximately over 30° north and south latitudes (Fig. 1.5.) High pressure belts develop over here as the hot air that rises up from the equatorial regions gets deflected due to the Coriolis effect and concentrates in these regions.

Subpolar low pressure belts

From the figure find out the latitudes between which the subpolar low pressure belt extends. These are regions where low temperature is experienced. As a result of the strong Coriolis effect in this region winds blowing from the polar regions are deflected away. Hence this exists as a low pressure region.

Polar high pressure belts

Since the temperature received in this region is the lowest, the air would be cooler. Cold air exerts a high pressure here. Along with this the air deflected from the subtropical belt is concentrated here. This is the reason why polar regions have developed into high pressure belts.

Changes in the position of the global pressure belts

According to the changing seasons the position of the pressure belts in the northern and southern hemispheres changes 10° to the north or 10° to the south. On March 21st and September 23rd the sun's rays fall vertically over the equator. During these days the equatorial low pressure belts would be spread upto 5° on either sides of the equator. Subtropical

high pressure belts would be in 30° latitudes in these hemispheres.

After 21st March the sun's transit would be in the northern hemisphere. On June 21st the sun's rays fall vertically over the Tropic of Cancer. During this period all pressure belts move 5° to 10° northwards from their original positions. On September 23rd the sun's rays fall vertically over the equator. Along with that all pressure belts reach their original positions. After 23rd September the sun passes into the southern hemisphere and on December 22nd the sun's rays fall vertically over the Tropic of Capricorn. In this period all pressure belts move 5° to 10° southwards from their original positions. You can understand the position of the pressure belts during different seasons from the Figure (Fig. 1.6).

Atmospheric pressure and winds

Haven't you understood that atmospheric pressure is not the same everywhere? Rise and fall in the pressure causes the horizontal movement of air in the atmosphere. The horizontal movements of air from high pressure regions to low pressure regions are called winds.

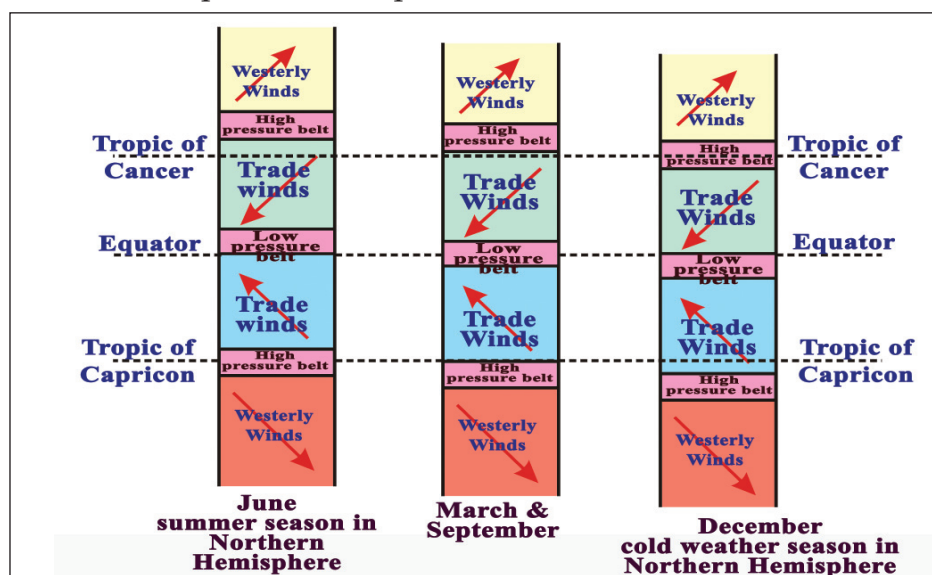


Figure - 1.6

The movement of air in a vertical direction is called air current.

Take a look at some of the general characteristics of winds.

- Names are given to winds mostly on the basis of the direction from which they blow.

For example the wind blowing from the land is called land breeze and the wind blowing in a south easterly direction is called South easterly winds.

- As the winds from the oceans are saturated with water vapour they give rain. The wind free of water vapour would be dry.
- Due to the earth's rotation a change in the direction of winds occurs.

The factors that influence the speed and direction of winds are:

- Pressure gradient force
- Coriolis effect
- Friction

In the figure (Fig. 1.7) A and B indicate pressure gradient force. Let us see how this influences the force of wind.

At A the distance between the pressure lines is greater. Because of that the wind blowing there would be of less strength.

At B the pressure lines are seen closer. This leads to a vertical pressure gradient. Due to this the wind blowing here would be stronger.

Coriolis Effect

It is observed that due to the earth's rotation any freely moving body on the earth's surface gets deflected to the right of its direction of movement in the northern hemisphere and to the left of its direction in the southern hemisphere. The reason for this deflection in the movement is known as the Coriolis effect.

Admiral Ferrell was an American scientist who studied the Coriolis effect. The law formulated by Ferrell on the deflection of winds under the influence of the Coriolis effect as indicated above is known as the Ferrell's Law.

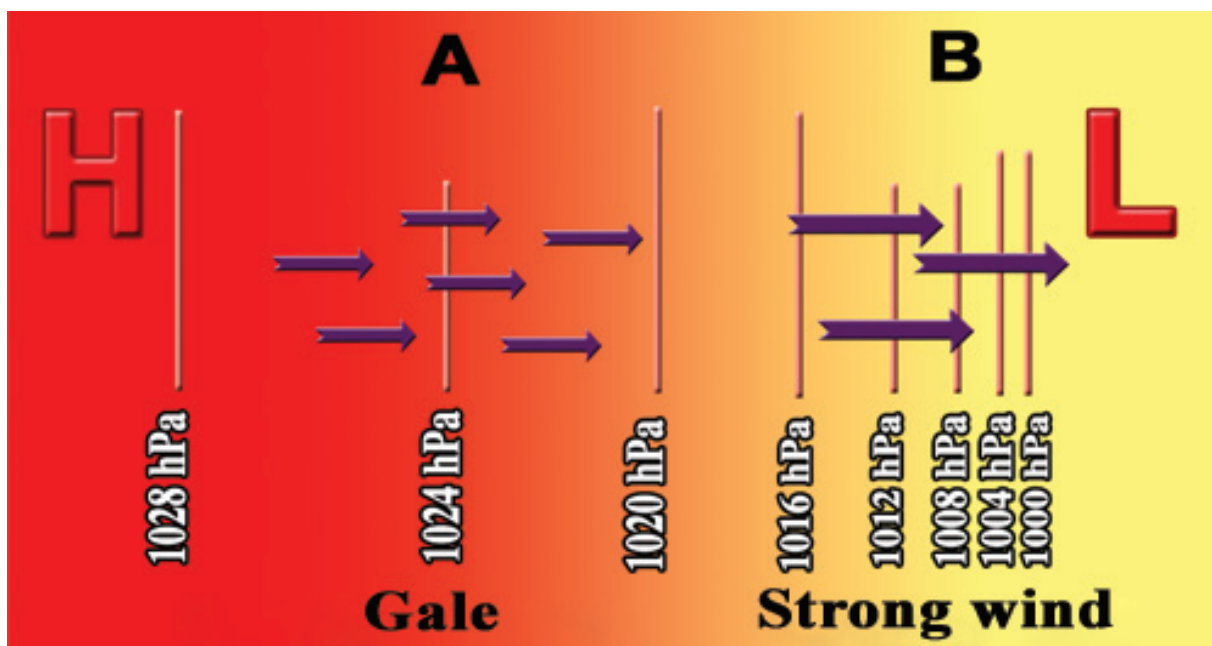


Figure - 1.7

Friction

Wind blows at high speeds over parts of the earth's surface that are flat. The reason for this is that in flat portions of the earth's surface wind undergoes only less friction. In irregular surfaces wind is subjected to greater friction. Due to this the velocity of wind decreases.

Different types of winds blow on the earth's surface. They can be classified in the following manner:

- Planetary winds or permanent winds
- Periodic winds or seasonal winds
- Local winds
- Variable winds

Permanent winds blow in the same direction throughout the year. Winds that result from the uneven heating and cooling of vast lands and water bodies are called periodic winds. Local winds form as a result of the heating or cooling of the air over a particular region.

Permanent winds

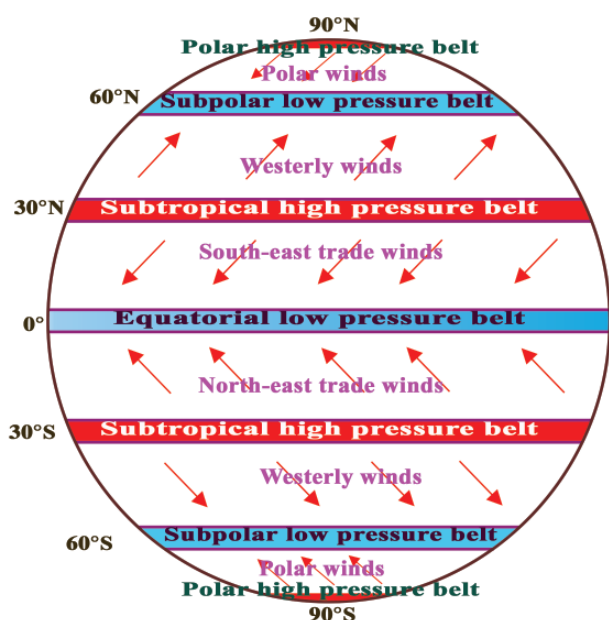


Figure - 1.8

The winds blowing approximately in the same direction between specific pressure belts permanently are called permanent winds. Trade winds, Westerly winds and Polar winds are permanent winds.

Global pressure belts are the basis for permanent winds. From the given figure (Fig 1.8) find out the permanent winds and the pressure belts between which they blow.

Trade winds

Trade winds are winds blowing from the subtropical high pressure belts to the equatorial low pressure belts. These winds blow as the north east winds in the northern hemisphere and the south east winds in the southern hemisphere. These are winds which blow in the same direction with the same velocity throughout the year, especially in the oceanic regions. Trade winds which carry water vapour from the oceans cause rainfall in the eastern coasts of the continents. As it moves towards the west it loses water vapour and hence doesn't cause rainfall in the western coasts of the continents. Subtropical deserts are situated in the western parts of continents.

During ancient times these winds helped travellers who sailed the seas for business in sail boats. Since they are steady winds blowing in the same direction they got the name Trade winds.

- Trade winds are called the north east trade winds in the northern hemisphere and the south east trade winds in the southern hemisphere. Why?

Westerly winds

The winds blowing from the subtropical high pressure belts towards the subpolar

low pressure belts are called the westerly winds. In the northern hemisphere the westerly winds blow from the south western direction to the north eastern direction. But in the southern hemisphere they blow from the north western direction to the south eastern direction (Fig 1.8). Since they blow from the western direction, they are called the westerly winds.

In the southern hemisphere as we go southwards the westerly winds blow strongly. This is due to the absence of big continents and the pressure of vast oceans. The ancient sailors gave the names 'Roaring forties', 'Furious fifties' and 'Screaming sixties' to these winds.

Polar winds

These are winds blowing from the polar high pressure belts to the subpolar low pressure belts. The polar winds are colder and stronger. These winds are also called easterly winds. From the figure (Fig. 1.8) find out why they are called so.

Periodic winds

In certain regions winds blow in a particular direction over short periods or throughout particular seasons. These are periodic winds. These winds form because of the uneven heating and cooling of the land and the oceans. Monsoon winds are examples for periodic winds.

Monsoon winds

The term monsoon has derived from the Arabic word 'Mausim' meaning seasons. Monsoonal winds blow over South Asia, South East Asia, Australia and East Africa. It was during the time when monsoonal

winds became active that merchants used to travel by sail boats for trade purposes in the Indian Ocean.

Since during summer time continental regions are heated up faster in comparison with adjoining oceans, low pressure develops there. During summer, low pressure develops in southern and south eastern Asia in this manner. However, in comparison with land region the Indian Ocean experiences a high pressure. This pressure difference causes winds to blow from the Indian Ocean to the continent. As the wind which blows in a south east direction in the southern hemisphere crosses the equator, it changes its direction to the south west due to the Coriolis effect. These are the south west monsoon winds.

During winter the land regions of the northern hemisphere cool down. In relation to the oceans of the southern hemisphere where the sun's rays fall vertically, the land regions of the northern hemisphere become cooler and as a result a high pressure region. This difference causes winds to blow from the land to the ocean. In the northern hemisphere these winds blow from the north east direction. Due to this it is called the north east monsoon. This wind causes rain in the eastern coast of India and in the states of Tamil Nadu, Andhra Pradesh, Karnataka and Kerala.

You must have understood that monsoon winds are formed according to the seasonal changes. The winds that are formed in the coastal regions due to the uneven heating and cooling of the land and the oceans over shorter periods are called the land breeze and the sea breeze.

Land breeze and Sea breeze

The land and the sea do not heat or cool in the same manner. During the day time the land gets heated quickly and at night time it cools very fast. On the other hand, the ocean water gets heated and cooled very slowly.

It is this uneven heating and cooling that causes the land and the sea breezes.

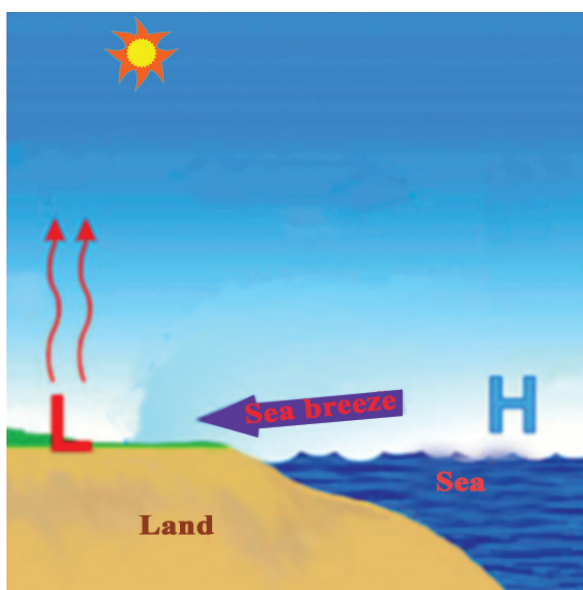


Figure - 1.9 A

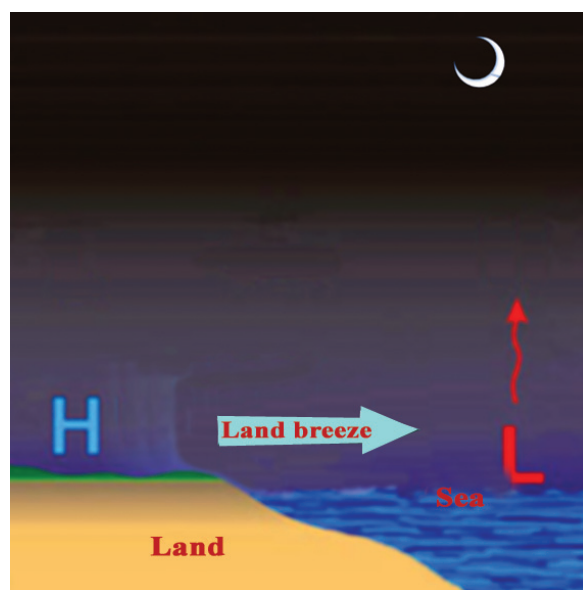


Figure - 1.9 B

Based on the figures (Figs. 1.9 A and 1.9 B) fill up the table given below

| | Fig 1.9A | Fig. 1.9B |
|--|------------|-----------|
| Higher temperature being felt | In the sea | On land |
| Higher pressure being experienced | | |
| Low pressure being experienced | | |
| Wind blowing (From where to where) | | |
| Wind being known as (Based on the direction from which it blows) | | |

Variable winds

Variable winds are winds which have quite different characteristics from the ones you have studied till now. The

direction and the extent of such winds have a variable nature. Cyclones and anticyclones are variable winds.

Cyclones

The heating up of the atmospheric air of a region increasingly in relation to its surrounding regions causes sudden pressure changes. This pressure difference creates cyclones.

Cyclones have low pressure at the central part and high pressure in the surrounding regions.

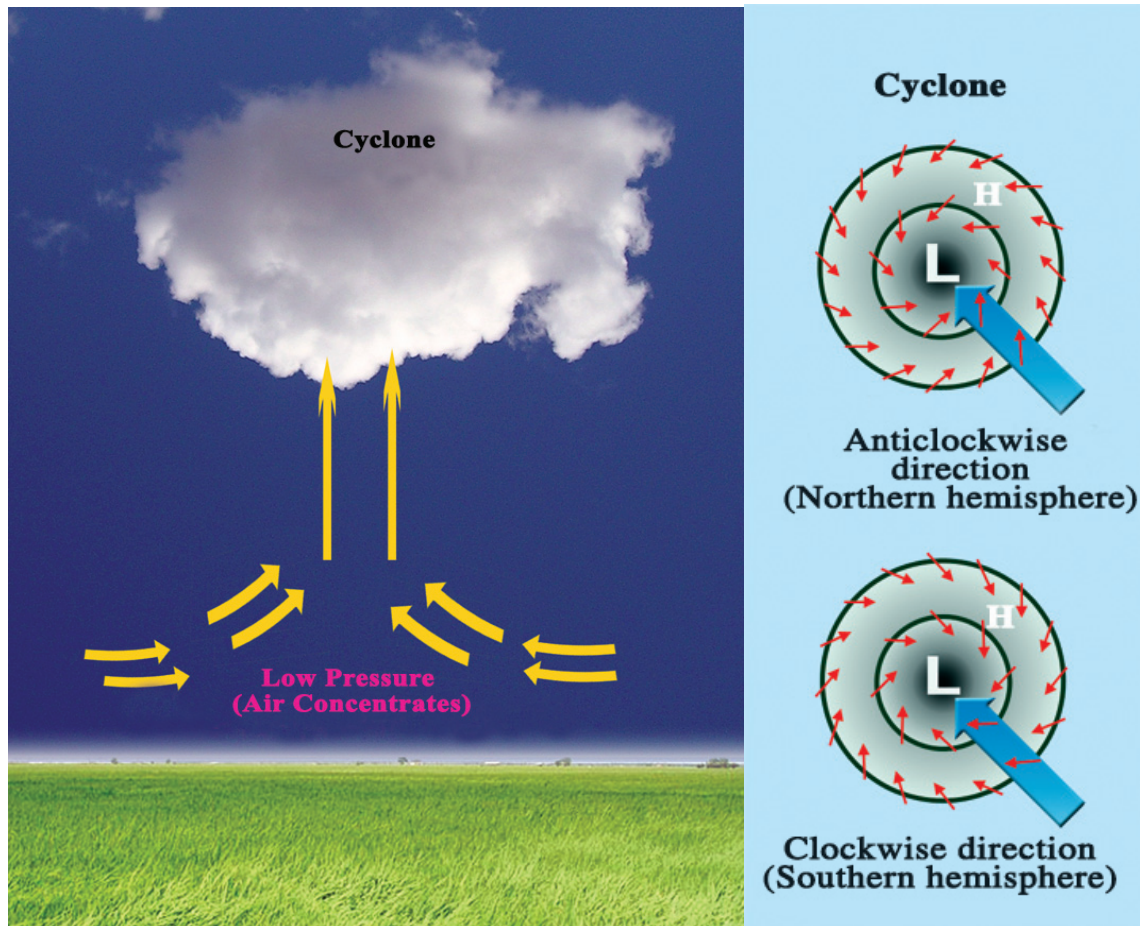


Figure - 1.10

Anticyclones

Another type of variable wind that forms in the atmosphere is called anticyclone. Answer the questions below examining the figure (Fig. 1.11).

- What are the conditions under which anticyclones are formed?
- How does the wind direction in anticyclones in both hemispheres differ from that of cyclones?

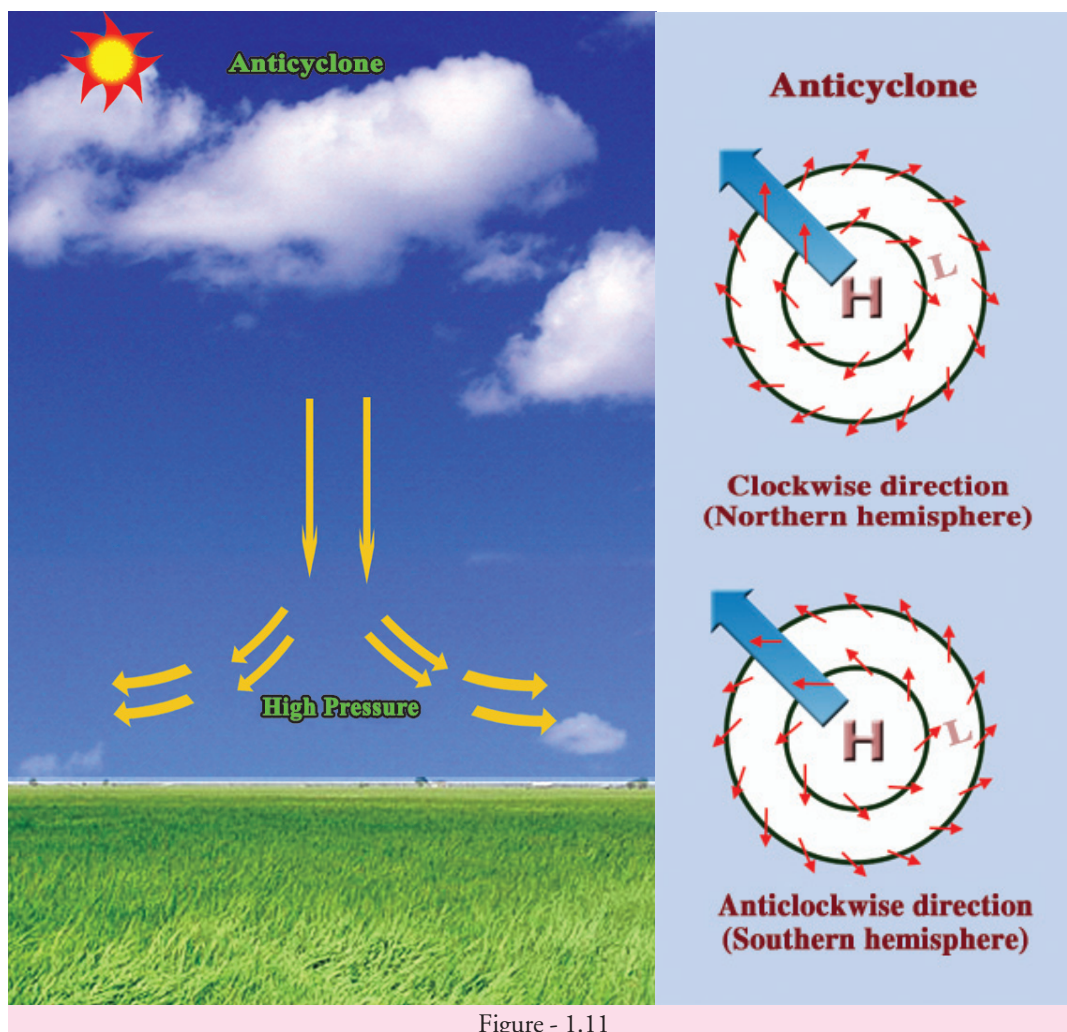


Figure - 1.11

Local winds

The winds formed as a result of the local differences in atmosphere are known as local winds. Such winds blow locally. These are known by different names in different places. Let us examine some of the important local winds and their peculiarities.

Loo : Hot dry winds that blow in the afternoons over the northern plains of India during the months of May and June

Chinook : The hot and dry winds that blow over the eastern slopes of the Rocky mountain chain of North America are called chinook. This wind which blows during the

winter time causes the melting of the snow in the Prairies region.

Mistral : The cold winds that blow in the southern slopes of the Alps mountains of Europe are called mistral. The influence of mistral is considerable in Southern France.

Foehn : The hot dry winds that blow over the northern slopes of the Alps mountains are called Foehn. This wind results in the melting of the snow in the eastern slopes and the growth of grass there. This helps cattle rearing in this region.

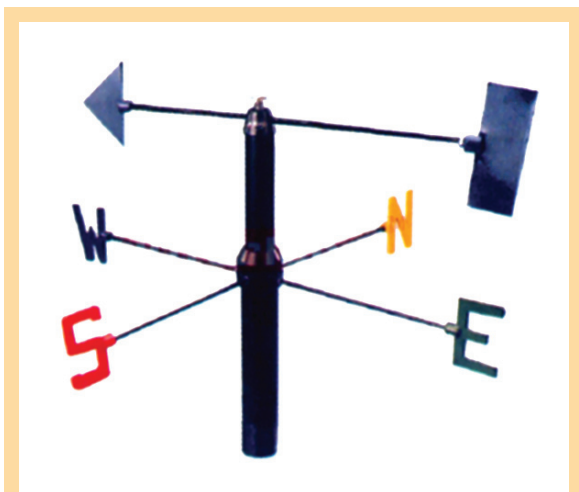


Figure - 1.12 - Wind vane
Instrument used for the determination of wind direction



Figure - 1.13 - Anemometer
Instrument used for the determination of wind velocity

By now you must have understood about the factors which affect the atmospheric conditions such as the atmospheric temperature and atmospheric pressure. Like these factors, humidity is another important factor which affects the atmospheric condition. Let us find out what humidity is and how it affects the atmospheric conditions.

Humidity

The content of water vapour in the atmosphere is called humidity. Humidity is not the same in all places and during all times. Differences in places and time create variations in humidity. Water vapour reaches the atmosphere through the process of evaporation. The factors that influence evaporation are:

- Availability of water: In places of greater water availability, the rate of evaporation would be relatively high.
- Temperature: Rise in temperature increases evaporation.
- Nature of air : Dry air can accommodate more water vapour.

The air at a particular temperature is able to absorb a fixed amount of water vapour. This measure is called the saturation point. When air is saturated with water vapour and it cools down below a certain limit, the water vapour begins to condense. The process of conversion of water vapour that reaches the atmosphere by evaporation into water droplets is called condensation. The temperature at which air gets fully saturated with water vapour is called dew point.

The ratio between the amount of water vapour that the atmospheric air can hold at a particular temperature and the amount of water vapour present in the atmospheric air at a particular time is called the relative humidity.

Different forms of condensation

Dew:

When air saturated with vapour comes into contact with cold surfaces, the water

vapour in it condenses into water droplets on the surfaces to form dew. We can see this on grasses in the morning after very cold nights.

Mist:

When water vapour condenses and remains in the air above the earth's surface, it is known as mist. This can be seen close to the earth's surface like clouds in the atmosphere. Mist is common in mountainous regions. Mist can be seen spread out in vast open regions.

Fog:

Like mist, fog also occurs near the earth's surface due to the condensation of water vapour. Fog can be seen commonly over water bodies.

In places covered by fog, visibility would be very low. This is denser than mist.

Clouds:

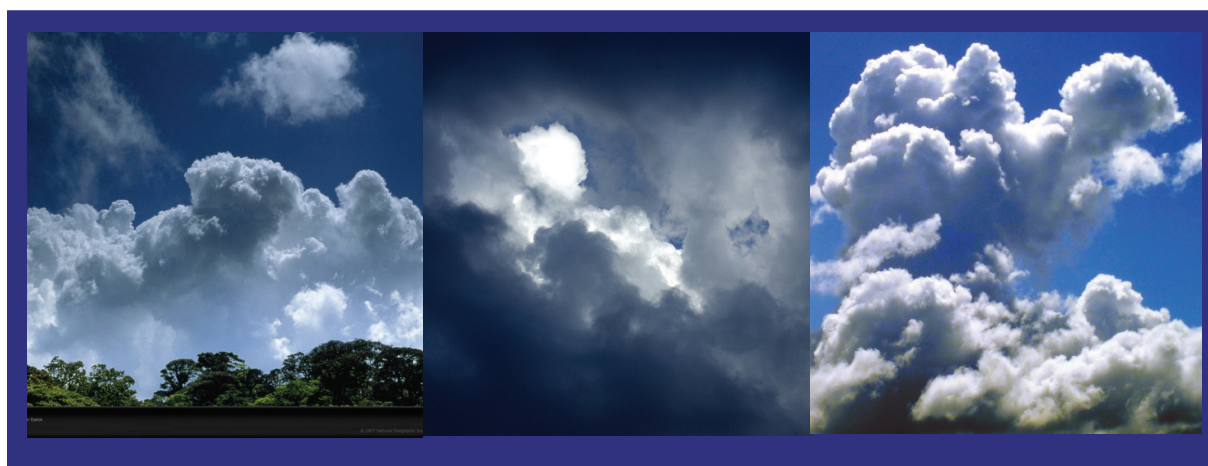
The water saturated air that rises up due to heating, if gets cooled down to below the dew point, condenses to form clouds. An important factor in cloud formation is

fine dust particles. These are dust particles that remain in the atmosphere. Since they cause condensation, they are referred to as the condensation nuclei.

Clouds can be seen in different shapes. Based on their shapes clouds can be classified into the following types:

- Cirrus clouds - White in colour and seen like bundles of feather
- Stratus clouds - Seen as white sheets in horizontal planes
- Cumulus clouds - Seen like ash coloured tall mounds
- Nimbus clouds - These are rain bearing clouds. These clouds, seen in ash or black colour are spread over the lower levels of the atmosphere.

Due to the continuous condensation process the size of water droplets in clouds increases. As a result they cannot remain in the atmosphere. These get released from the clouds and fall into the surface of the earth as precipitation. Snow, hail and rain are the different forms of precipitation.



Snow

Snow is the form of precipitation seen in colder regions and mountainous regions. When condensation occurs below zero degree centigrade, water vapour assumes granular form. Grains formed in this fashion combine to form layers of snow.

Hail

Blocks of snow fall along with rain. These are called hail stones. Rainfall mixed with snow and hail is referred to as sleet.

Rainfall

As a result of the continuous condensation in clouds, the size of water droplets increases. Large water droplets cannot remain suspended in the air and they fall on the earth as rain. On the basis of the formation of rain, it can be mainly classified into three. Let us examine them.

Convective rainfall

The surface air that is heated up rises in the atmosphere along with water vapour. At higher altitudes they become cooler and condense to fall down as rain. This type of rainfall is called Convective rainfall (Fig. 1.15). This rainfall which

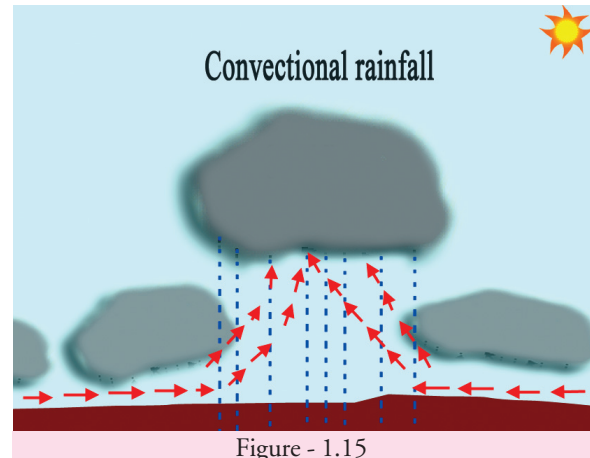


Figure - 1.15

occurs normally in the afternoons along with lightning and thunder is also referred to as torrential rainfall.

- Convective rainfall is generally common in equatorial regions. Why?
- Does torrential rainfall occur in Kerala?

Orographic rainfall

In the given figure (Fig. 1.16) it can be seen that on the mountain side marked as A the air saturated with water vapour coming from sea rises up after hitting the mountain. The air which rises up becomes cooler and condenses to fall as rain on the mountain slope facing the wind direction. This is called orographic rainfall.

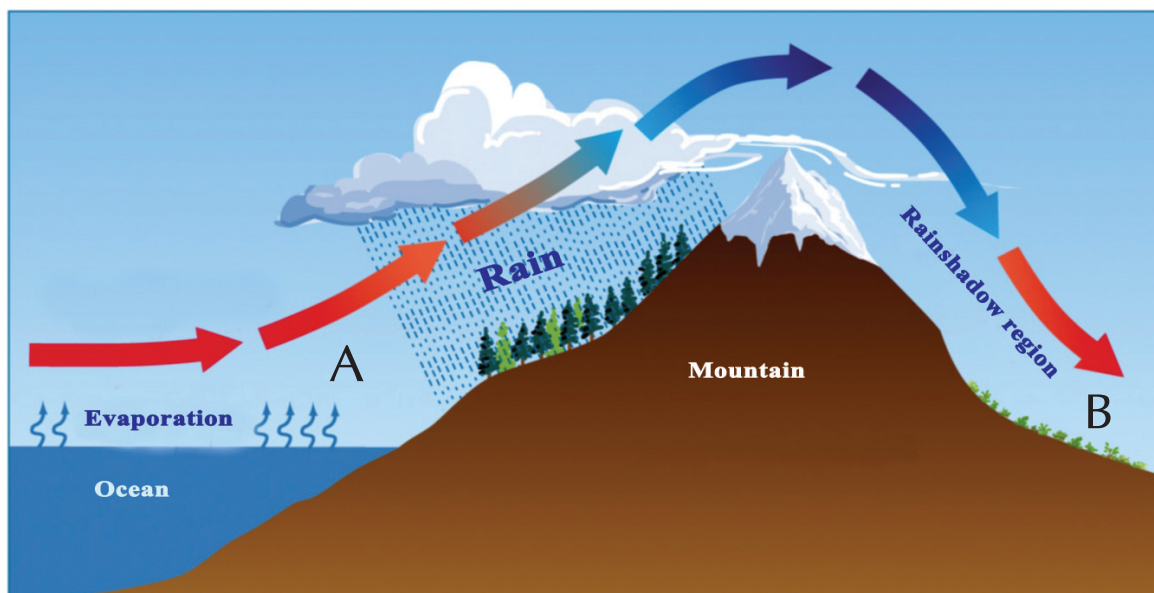


Figure - 1.16

Since the wind that reaches side B of the mountain is devoid of water vapour, this region does not get rainfall. As a result this becomes a rain shadow region.

- Does Kerala receive orographic rainfall? If so, on which mountain slope?

Cyclonic rainfall

By this time you have understood how cyclones are formed. Rainfall associated with cyclones is called cyclonic rainfall.

Hot air and cold air meet in the central region of cyclones. During this time the cold air pushes up the hot air. When the air rises up the water vapour in it condenses and falls down as rain.

Have you not understood the various factors that affect the atmospheric conditions, the manner in which they affect and the nature of changes?

Now you must be able to say why the atmospheric condition is not the same on all days.



Follow up activities

1. How does the change in the position of the equatorial low pressure belt affect the climate of India?
2. Observe the changes in the atmospheric condition from June to May. Give your findings in the table below:

| Atmospheric condition | Experienced months | Time | | |
|--------------------------------------|--------------------|--------------|-----------------------|--------------|
| | | Morning time | During the entire day | Evening time |
| Snow | | | | |
| Rain with thunder and lightning | | | | |
| Continuous rainfall for several days | | | | |
| Dry atmospheric condition | | | | |
| Strong winds | | | | |