

CHAPTER-23

ATMOSPHERE



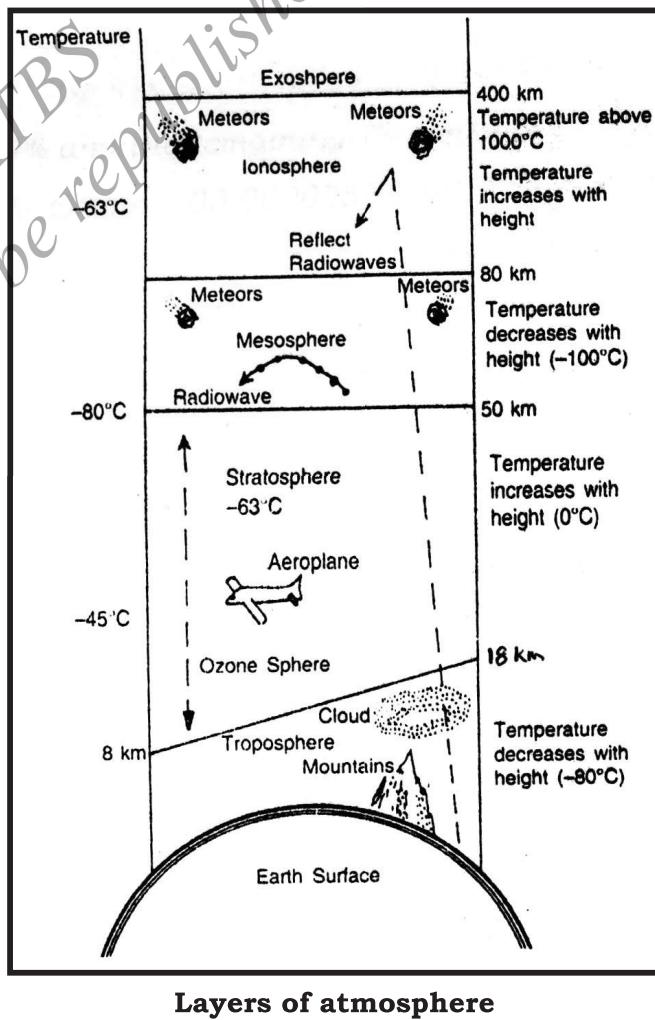
After studying this chapter you learn :

- The meaning, importance, composition and formation of atmosphere.
- About the components of atmosphere, temperature, pressure, winds humidity, clouds and their functions and effects.
- The differences between atmosphere and climate.

Do you know, how we are protected and helped by the envelope of air ?

M e a n i n g a n d importance: Atmosphere is a thin layer of gases, dust particles and water vapour surrounding the Earth. This layer of gases forms protective boundary between the outer space and the Earth's surface. The thickness of the atmosphere is around 1000 kms. Atmosphere is very important for all forms of life on the earth. Different gases of atmosphere help plants, animals and human beings. Atmosphere traps heat and makes Earth a planet for all the living organisms.

C o m p o s i t i o n o f atmosphere: The atmosphere is a mixture of different gases,



Layers of atmosphere

dust particles and water vapour. The important gases in the atmosphere are Nitrogen - 78.08%, Oxygen- 20.94% and the remaining 1% consists of Argon - 0.93%, Carbon dioxide - 0.03%, Ozone - 0.000005% etc. The atmosphere also contains dust particles which help us in the formation of water droplets. The water vapour in the atmosphere is the source of clouds and precipitation. The atmosphere traps heat and energy and has influence on the weather conditions of a place.

Layers of Atmosphere: The atmosphere may be divided into five important layers on the basis of its characteristic features. These are: Troposphere, Stratosphere, Mesosphere, Thermosphere (Ionosphere) and Exosphere.

Troposphere : Troposphere is the lowest layer of the atmosphere. It extends upto 18 kms at the equator and 8 kms near the poles. This layer has all the atmospheric elements such as temperature, pressure, winds, clouds, rainfall etc. All weather changes occur in the troposphere. Temperature and pressure decrease with the increase of altitude.

Stratosphere : Stratosphere is the second layer of the atmosphere. This layer extends upto 50 kms from the surface. It lies between troposphere and mesosphere. In this layer Ozone is the most important gas which absorbs 'ultraviolet rays' of the sun and protect all forms of life on the Earth. This layer is free from clouds and other important weather phenomenon and provides ideal flying conditions for jet aircrafts.

Mesosphere : Mesosphere is the third layer in the Earth's atmosphere. It extends up to 80 kms from the surface and lies above stratosphere. In this layer temperature decreases with the increase in altitude. This layer has the coldest temperature in the atmosphere.

Thermosphere : Thermosphere layer lies next to Mesosphere. In this layer temperature rises drastically. It is also called 'Ionosphere' as the gaseous atoms are ionized due to very high temperature. The ions found in this layer help in reflecting radio waves.

Exosphere : Exosphere is the top most layer of the atmosphere. In this layer elements of atmosphere are rare and pressure is extremely low.

Elements of Weather

Weather condition of a place is influenced by various elements such as temperature, pressure, wind, humidity, clouds, rainfall etc.

*Atmospheric condition of a place at a given time is called '**Weather**'. In contrast the average weather condition of an area over a long period of time is called '**Climate**'.*

TEMPERATURE

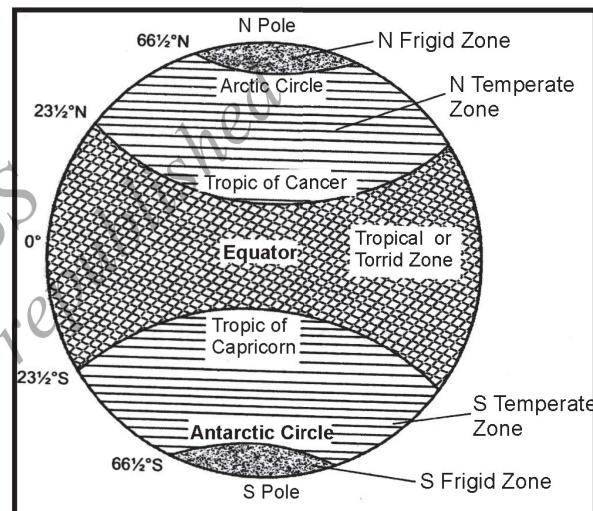
The Sun is the main source of energy to the Earth which supplies heat through insolation. Insolation means incoming solar radiation from the sun to the Earth. Temperature is recorded by an instrument called 'thermometer'. Centigrade and Fahrenheit are the important thermometers used to measure atmospheric temperature. The important factors that influence atmospheric temperature are latitude, altitude or height, distance from the sea, wind, ocean currents, relief, clouds, rainfall etc.

Normal lapse rate : It is the decreasing rate of temperature with the increase of altitude. The rate of decrease is 1° C for every 165 meters or 6.4° C for every 1000 meters of height (1 km).

Inversion of temperature : In some situations temperature also increases with increasing height. This takes place in mountain valleys during long winter nights with clear sky, dry air, no wind and snow covered surface.

Temperature Zones : The distribution of temperature is not uniform on the Earth's surface. On the basis of insolation, the globe is divided into three temperature zones. They are:

Torrid zone : This is the zone of high temperature. This region is found between 0° or Equator and Tropic of Cancer in



Temperature Zones

the north ($23\frac{1}{2}^{\circ}$ N) and the Equator and Tropic of Capricorn ($23\frac{1}{2}^{\circ}$ S) in the south. This region receives direct rays of the Sun.

Temperate zone : This is the region where the temperature is neither very hot nor cold. This region lies between $23\frac{1}{2}^{\circ}$ N to $66\frac{1}{2}^{\circ}$ N (Tropic of Cancer to Arctic circle) and $23\frac{1}{2}^{\circ}$ S to $66\frac{1}{2}^{\circ}$ S (Tropic of Capricorn to Antarctic circle).

Frigid zone : It is the coldest region. This zone is found between $66\frac{1}{2}^{\circ}$ N to 90° N (Arctic circle to North pole) and $66\frac{1}{2}^{\circ}$ S to 90° S (Antarctic circle to South pole). The temperature in this zone is very low due to slanting rays of the sun. In summer temperature is slightly high and in winter the temperature is low.

Isotherms : Isotherms are lines drawn on the map or globe connecting places having the same temperature.

Facts file :

Places of highest and lowest temperature

1. Al Aziziya of Libya in Africa has recorded the highest temperature (average $+58^{\circ}$ C) Whereas Verkhoyansk of Siberia has recorded the lowest temperature (average -24° C).
2. In India Ganganagar of Rajasthan recorded the highest temperature in summer (average $+54^{\circ}$ C) and Leh of Jammu and Kashmir has recorded the lowest temperature (average -10° C) in winter.
3. Vostok of Antarctica is considered as the coldest place (average temperature -89° C) on the Earth.

ATMOSPHERIC PRESSURE

Air has weight and it exerts pressure. This is called atmospheric pressure. Air pressure is measured by an instrument called Barometer. The unit used to show the pressure is millibar (mb). The average air pressure of the atmosphere at the sea level is 1013.25 mb. The atmospheric pressure is affected by many factors such as temperature, rotation of the Earth, altitude, water vapour etc. Temperature is the most important factor that influences atmospheric pressure. The regions which have high temperature record low pressure due to expansion of air, while the regions of low temperature have high pressure due to contraction of air. Thus temperature and pressure

are inversely related. The atmospheric Pressure decreases with the increase in altitude. The amount of decrease is about 34 mb per every 300 meters altitude.

Major pressure belts of the Earth

1. The Equatorial low pressure belt
2. North Sub- tropical high pressure belt
3. South Sub-tropical high pressure belt
4. North -Sub- Polar low pressure belt
5. South Sub-polar low pressure belt
6. North Polar high pressure belt
7. South Polar High pressure belt

Equatorial low pressure belt: The equatorial low pressure belt is a zone of high temperature and low pressure. It lies between 0° to 5° North and South of the equator. This region gets direct rays of the Sun almost throughout the year. Hence air is always very warm and hot. This is a calm region with very little wind. So it is known as 'Doldrum' means 'belt of calm' (equatorial calm). This region is also called Inter- Tropical Convergence Zone (ITCZ) where the trade winds converge.

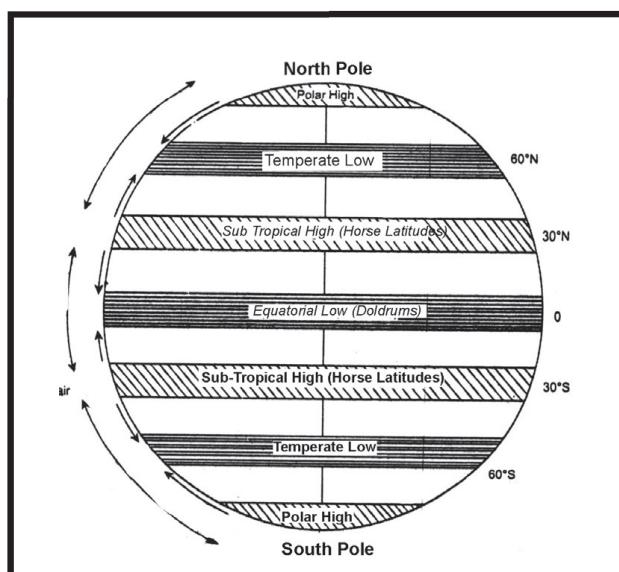
Sub-tropical high pressure belts: Sub-tropical high pressure belts are found between 30° and 35° north and south of the equator.

There are two sub-tropical high pressure belts. **(a) North sub-tropical high pressure belt:**

This belt is found between 30° to 35° north latitudes. This region is also popularly called 'Horse latitudes'. **(b) South sub-tropical high pressure belt:**

This belt is found between 30° to 35° of south latitudes.

Sub-polar low pressure belts: Sub-polar low pressure region is found between 60° to



Pressure belts of the world

65° north and south of the equator. There are two sub-polar low pressure belt (a) **North sub-polar low pressure belt** (60° north to 65° north). (b) **South sub-polar low pressure belt** (60° south to 65° south). These are stormy especially in winter.

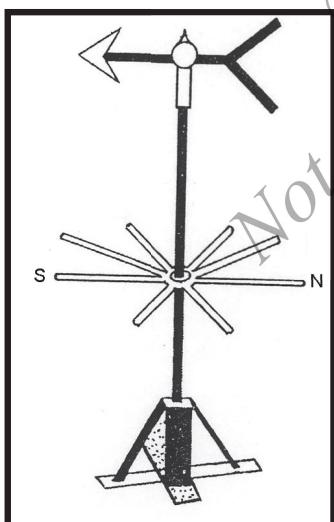
Polar high pressure belts: Polar high pressure belts region is found between 80° to 90° north and south latitudes in both hemisphere. These are extremely cold regions with very high pressure throughout the year.

Isobars: These are imaginary lines drawn on the map or globe connecting places having the same pressure.

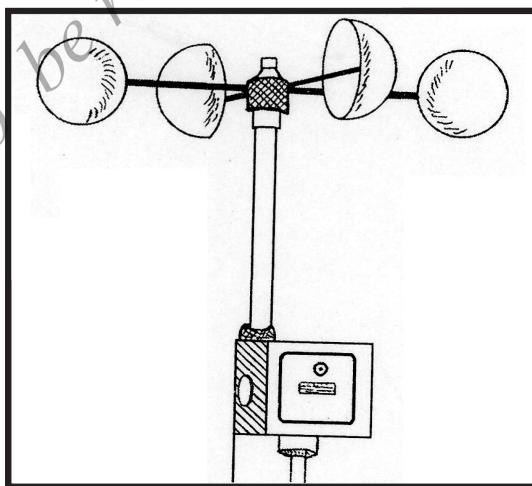
WIND

Wind is the horizontal movement of the air on the surface of the Earth. Wind blows on the Earth due to rotation of the Earth and difference in pressure.

The direction of the wind is shown by an instrument called 'wind vane' or 'weather cock'. 'Anemometer' is used to measure the speed of the wind.



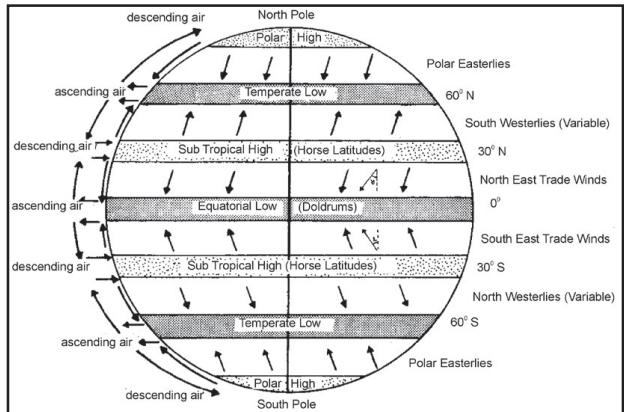
Wind Vane



Anemometer

Types of wind : Winds are classified into 4 major types. They are; Planetary winds, Seasonal winds, Local winds, Cyclones and Anti cyclones.

1. Planetary Winds: Planetary winds are also called 'Permanent winds' or 'Prevailing winds' or 'Regular winds' which blow more or less in the same direction through out the year. These winds play a major role in climate change, desert formation, guide navigation routes, etc. There are three types of planetary winds. Trade winds, Anti-trade winds and Polar winds.



Planetary Winds

Trade Winds : These winds blow from sub-tropical high pressure belts to equatorial low pressure region. The trade winds in the northern hemisphere blow from NE to SW direction (North East trade winds) and in the southern hemisphere they blow from SE to NW direction (South East trade winds).

Westerlies or Anti-trade Winds : These winds blow from sub-tropical high pressure belts to sub-polar low pressure belts. These are from south-west to north-east in northern hemisphere and north-west to south-east in the southern hemisphere. The westerlies of southern hemisphere are very strong over the oceans. Hence they are called 'Roaring forties' (40° south latitude), 'Furious fifties' (50° south latitude) and 'Shrieking sixties' (60° south latitude).

Polar winds : These are also called Easterlies. These winds blow from polar high pressure belts to sub-polar low pressure belts. They blow from North East to South West in the northern hemisphere and South East to North West in the southern hemisphere. These are the cold dry winds blowing from the polar ice-caps.

2. Seasonal Winds: Seasonal winds are also called periodic winds. These winds change their direction periodically or seasonally. The monsoon winds of India are the typical periodic winds. In India South west monsoon winds blow from SW to NE direction during June to September and North east monsoon winds blow from NE to SW direction from late September to middle of December.

3. Local Winds: Periodic winds are the result of variation in local temperature, pressure, humidity which in turn are attributed to the formation of air currents, crossing mountain ranges, valleys and other relief barriers. The important periodic and local winds are Land breeze, Sea breeze, Mountain breeze (Katabatic winds), Valley breeze (Anabatic winds) and other few winds are Loo (India), Chinook or Snow eater (USA), Fohn (Alps region), Mistral (France), Sirocco (Sahara region), Brick Fielder (Australia), Blizzard (Antarctica) etc.

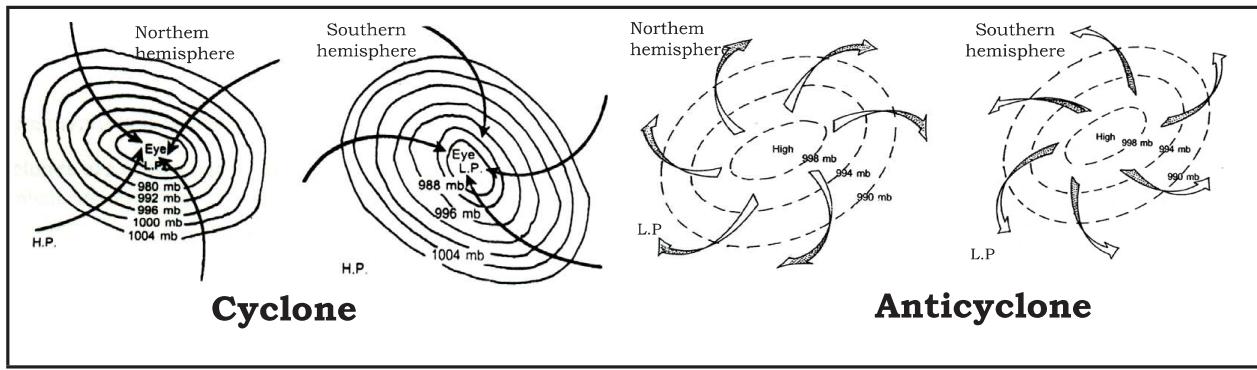
4. Cyclones and Anti-cyclones: These winds blow due to great variation in pressure. These are temporary but sometimes dangerous and destructive.

a. Cyclones: Cyclone is a small low pressure area in the centre surrounded by high pressure. The winds blow spirally towards the low pressure area. In the northern hemisphere the direction of cyclonic winds is anti-clockwise or counter clockwise and in the southern hemisphere it is clockwise. Cyclones are of two types:

- **Tropical cyclones:** These are found in the tropical region. They are very powerful and disastrous.
- **Temperate cyclones:** These are found in the temperate region. They are comparatively less strong and less dangerous.

Cyclones are called by different names in different regions. Japan and China – **Typhoon**, USA and Mexico – **Hurricane**, Australia – **Willy willes**, India – **Cyclone**, Russia – **Whirlpool**. In the last few years Indian coasts has experienced few disastrous cyclones. Some of them are Bola, Nargis, Nisha, Aila, Laila, Bijli, Jal etc.

b) Anti-Cyclones: An anti-cyclone is a high pressure area in the centre with winds blowing outwards, towards the low pressure areas. In the northern hemisphere the direction of anti-cyclone wind is clockwise and in the southern hemisphere it is anti-clockwise.



HUMIDITY

Humidity is the amount of water vapour or moisture present in the air. Humidity is measured by using an instrument called Hygrometer or Psychrometer.

Types: Humidity is expressed in different ways. Important among them are Absolute humidity, Relative humidity and Specific humidity.

- **Absolute humidity:** This refers to total amount of water vapour present in a given volume of air. It does not take temperature into consideration.
- **Relative humidity:** Relative humidity is the ratio between the actual amount of water vapour present in the air and the amount of water vapour the air can hold at that temperature. It is expressed in percentage.

The actual amount of water vapour in the air

$$\text{Relative humidity} = \frac{\text{Actual amount of water vapour}}{\text{Maximum amount of water vapour the air can hold}} \times 100$$

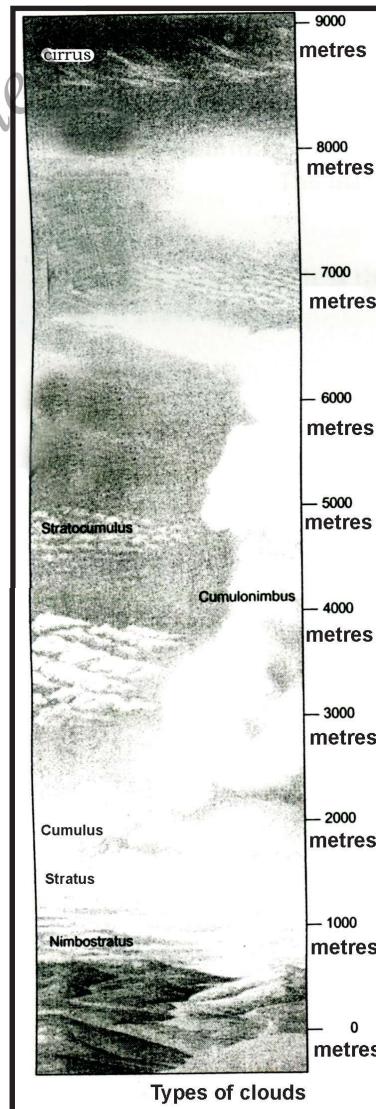
The maximum amount of water vapour the air can hold

- **Specific humidity:** It is the actual amount of water vapour present in a given mass of air.

CLOUDS

Cloud is a mass of small water drops or ice crystals, formed by the condensation of the water in the atmosphere, usually at a considerable height above the Earth's surface.

Types of clouds: Clouds are classified on the basis of their shapes and heights at which they occur. The important types of clouds are



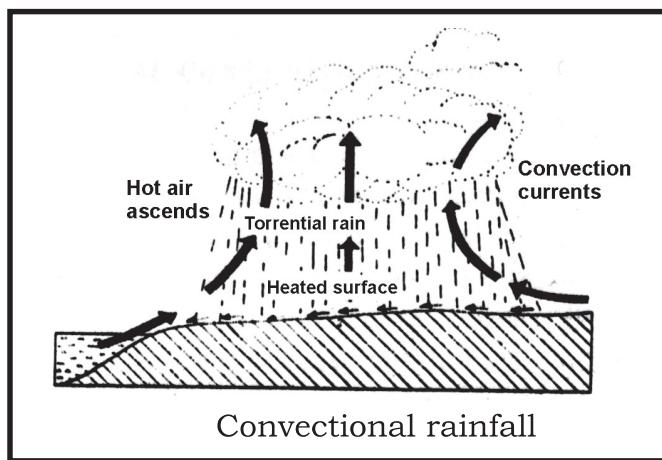
the Stratus, the Cumulus, the Cirrus and the Nimbus clouds.

- **Stratus:** Stratus clouds are usually low clouds occurring at less than 2 km of height. They appear as thin sheets or layers of large extent. Stratus clouds are associated with fair weather.
- **Cumulus:** Cumulus clouds are cauliflower-shaped clouds of great vertical extent. The base of cumulus clouds is nearly horizontal, while the top has a dome-shaped appearance. These are popularly called 'wool packs'. Cumulus clouds are rain-bearing clouds.
- **Cirrus:** Cirrus clouds are the highest clouds in the atmosphere. These clouds resemble 'curls of hair', have a feathery or fibrous appearance. They indicate fair weather and often give a brilliant sunset. They look like patches of cotton fibres floating in the air. Their popular name is 'mare's tail' or 'witch's broom'
- **Nimbus:** Nimbus clouds are rain clouds which occur at low levels. These clouds have the shape of stratus or cumulus. They are dark-grey or black in appearance. They cause heavy rainfall or snowfall. The Nimbo-stratus are thick, heavy, rain bearing clouds.

RAIN FALL

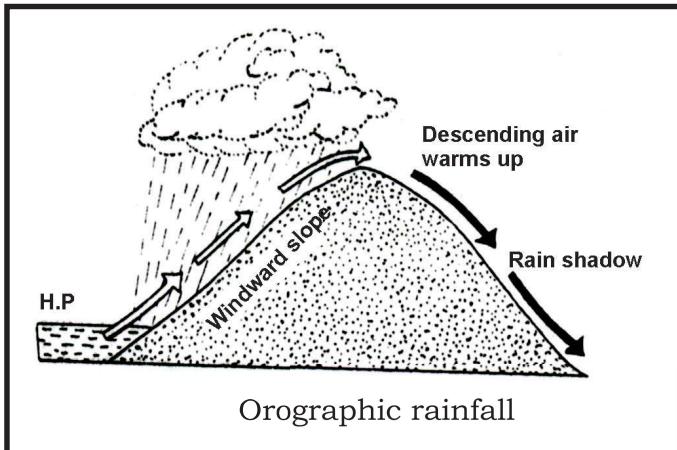
Precipitation in the form of water droplets is called rainfall. The total amount of rain received on a given area during a given time as measured by a rain gauge in MM or inches.

Types of Rainfall: Rainfall is of three types. They are Convectional rainfall, Orographic rainfall and Cyclonic rainfall.



Convectional rainfall: The rain caused by the process of convection is called convectional rainfall. In areas of high temperature, air rises up due to heating. This rising air cools, gets saturated, condensation takes place and later rainfall occurs. Convectional rainfall is very

common in the equatorial region and also in the tropical regions in summer. In the equatorial region, convectional rainfall is called 'afternoon rain', as it occurs mostly in the afternoon. It is accompanied by thunder and lightning.



Orographic rainfall:

Orographic rainfall is also called 'Mountain rainfall' or 'Relief rainfall'. When moisture laden air is obstructed by a mountain barrier, the air is forced to rise up. As the air rises upwards, it cools and gets saturated. Further cooling of this air causes

condensation resulting in orographic or mountain rainfall. The windward side of the mountain receives more rainfall, while the leeward side receives less. The leeward side is generally called the 'rain shadow region' eg., Mangalore is the windward side and Hassan the leeward side or rain shadow region.

Cyclonic rainfall: In a cyclone the air blows spirally inwards. In the tropical cyclones the air rises upwards in circular movement. So condensation takes place to cause heavy rainfall. The temperate cyclonic rain is also called frontal rain. When the warm air mass and the cold air mass meet, the warm air being lighter is forced to rise over the heavier cold air. The warm air after rising, cools and condenses, resulting in rainfall.

Distribution: The distribution of rainfall on the Earth depends on location and the climatic condition of that region. The most important heavy rainfall areas in the world are the equatorial region, the eastern margins of sub-tropical belts, the western margins between 40° and 60° N and S latitudes. Scanty rainfall regions are the polar areas, the western margins of sub-tropical regions and the tropical and temperate deserts.

Do you know?

1. **Mawsynram** of Meghalaya in India has recorded 1140 cm of rainfall per year. It is considered as the wettest or雨iest region on the Earth.
2. **Agumbe** of Karnataka is called 'Mawsynram of South India'.
3. **Royli** of Rajasthan in India receives lowest rainfall : 8 cm per year
4. **Nayakanahatti** of Chitradurga is considered the driest place in Karnataka.
5. **Atacama** desert of Chile is the driest region on the Earth. It has not received rainfall for the last 200 years.

Weather and Climate

The atmospheric conditions of a smaller area at a particular time is called weather. For example cloudy, sunny, fine weather, etc. The scientific study of weather is called 'Meteorology'. Climate is the average condition of the atmosphere over a long period of time of a larger area e.g., Equatorial climate, Tropical monsoon climate, Desert climate, Mediterranean climate, Tundra climate etc. The scientific study of climate is called 'Climatology'.

Factors affecting the climate of a place: The factors that influence the climate of a place or region are Latitude, altitude, winds, distance from the sea, distribution of land and water bodies, ocean currents, etc.

Exercises

I Fill in the blanks with suitable words :

1. The two major gases of the atmosphere are _____ and _____.
2. The lowest layer of the atmosphere is _____.
3. The average air pressure of the atmosphere at the sea level is _____.
4. Westerlies is also known as _____.
5. The scientific study of weather is _____.

II Answer the following questions :

6. What is atmosphere ?
7. Name the important layers of the atmosphere.
8. What is the significance of ozone layer?
9. What is Doldrum? Where is it found?
10. Name the different types of planetary winds.
11. What are local winds? Give any two examples.
12. Mention the different types of clouds.
13. Distinguish between weather and climate.

III Define the following :

- | | |
|-----------------------|-------------------------|
| 14. ionosphere | 17. horse latitudes |
| 15. normal lapse rate | 18. orographic rainfall |
| 16. torrid zone | 19. climatology |

IV Terms to remember :

- | | |
|------------------------------|---------------------|
| 20. insolation | 23. roaring forties |
| 21. inversion of temperature | 24. nimbus |
| 22. anemometer | 25. meteorology |

V Activities :

26. Draw the picture of planetary winds.
27. Draw a diagram showing different temperature zones on the basis of latitudes.

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