

**Climate and Weather**

- Weather refers to the state of Atmosphere of a place at a given Point of time.
- Climate is the accumulation of daily and seasonal weather events of a given location over a period of 30-35 years.

**The factors affecting the Climate:**

- Climate of India is affected by the factors of latitude, altitude, distance from the seas, Monsoon wind, relief features and jet stream.

**Latitude:**

- Latitudinally, India lies between 8°4'N And 37°6'N latitudes.
- The Tropic of cancer Divides the country into two equal halves.
- The area located to the south of tropic of cancer Experiences high temperature and no severe Cold season throughout the year whereas, the Areas to the north of this parallel enjoys sub-Tropical climate.

**Altitude:**

- When the altitude increases, the temperature decreases.
- Temperature decreases at the rate of 6.50C for every 1000 metres of Ascent.
- It is called normal lapse rate.
- Hence; places in the mountains are cooler than the places on the plains.
- Ooty and several Other hill stations of south India and of the Himalayan ranges like Mussourie, Shimla etc., are much cooler than the places located on the Great Plains.

**Distance from the Sea:**

- A large area of India, especially the peninsular region, is not very far from the sea and this entire area has a clear maritime influence on Climate.
- This part of the country does not have a Very clearly marked winter and the temperature is equable almost throughout the year.
- Areas Of central and north India experience much Seasonal variation in temperature due to the Absence of influence of seas.
- Here, summers are hot and winters are cold.

- The annual Temperature at Kochi does not exceed 30°C as its location is on the coast while it is as high as 40°C at Delhi, since it is located in the interior part.
- Air near the coast has more Moisture and greater potential to produce Precipitation.
- Due to this fact, the amount of rainfall at Kolkata located near the coast is 119 cm and it decreases to just 24 cm at Bikaner which is located in the interior part.

#### Monsoon Wind:

- The most dominant factor which affects the Climate of India is the monsoon winds.
- These are seasonal reversal winds and India remains in the influence of these winds for a considerable Part of a year.
- Though, the sun's rays are vertical Over the central part of India during the mid-June, the summer season ends in India by the End of May.
- It is because the onset of southwest Monsoon brings down the temperature of the Entire India and causes moderate to heavy Rainfall in many parts of the country.
- Similarly, the climate of southeast India is also influenced by northeast monsoon

#### Relief:

- Relief of India has a great bearing on Major elements of climate such as temperature, Atmospheric pressure, direction of winds and the amount of rainfall.
- The Himalayas acts as A barrier to the freezing cold wind blows from Central Asia and keep the Indian subcontinent Warm.
- As such the north India experiences Tropical climate even during winter.
- During Southwest monsoon, areas on the western slope Of the Western Ghats receive heavy rainfall.

- On the contrary, vast areas of Maharashtra, Karnataka, Telangana, Andhra Pradesh and Tamil Nadu lies in rain shadow or leeward side Of the Western Ghats receive very little rainfall.
- During this season, Mangalore, located on the coast gets the rainfall of about 280 cm Whereas the Bengaluru located on the leeward Side receives only about 50 cm rainfall.

#### **Jet Streams:**

- Jet streams are the fast-moving winds blowing in a narrow zone in the upper Atmosphere.
- According to the jet stream theory, the onset of southwest monsoon is driven by the shift of the sub-tropical westerly Jet from the plains of India towards the Tibetan plateaus.
- The easterly jet streams cause tropical depressions both during southwest Monsoon and retreating monsoon.

#### **Elements of weather and Climate:**

- Temperature, rainfall, Pressure, humidity and wind are the major elements of Weather and climate.

#### **Temperature:**

- Temperature is one of the key elements of weather and climate.
- The earth and its Atmosphere get heated from the sun through Insolation.
- The degree of heat present in the Air is termed as temperature.
- Apart from Sun's rays, the heat in air also depends the atmospheric mass to a small extent.
- Temperature varies with time due to changes in the level of radiation which reach the earth Surface.
- This is due to motions of the earth (The rotation and revolution) and inclination of the earth's axis.
- The temperature influences the level of humidity, the process of evaporation, Condensation and precipitation.
- Heat energy from solar radiation is received by the earth through three Mechanisms.

- They are radiation, conduction and convection.
- The Earth's atmosphere is heated more by terrestrial radiation than Insolation.
- Temperature varies both horizontally and vertically.
- Temperature decreases with increasing height is known as Lapse Rate which is 6.5 degree Celsius per 1000 meters in troposphere.

#### **Factors affecting the Distribution of temperature:**

- Latitude, altitude, nature of land, ocean Currents, prevailing winds, slope, shelter and Distance from the sea, natural vegetation and Soil are the major factors which affect the Distribution of temperature.

#### **Measuring Temperature:**

- The temperature of a unit volume of Air at a given time is measured in scales Like Celsius, Fahrenheit, and Kelvin.
- Meteorologist measures the temperature By the Thermometer, Stevenson screen and Minimum and maximum Thermometer.
- The energy received by the earth through Insolation is lost by outgoing radiation.
- Atmosphere is mainly heated by outgoing Radiation from 2 to 4pm.
- So, the maximum Temperature is recorded between 2 and 4 Pm regularly and minimum temperature is recorded around 4 am before sunrise.

#### **Mean Temperature:**

- The average of maximum and minimum temperatures within 24 hours is called mean Daily temperature  $[(87^{\circ}\text{F}+73^{\circ}\text{F})/2=80^{\circ}\text{F}]$ .
- Diurnal range of temperature is the Difference between the maximum and minimum temperatures of a day.
- Annual Range of temperature is the difference between the highest and lowest mean monthly Temperatures of a year.
- The distribution of Temperature is shown by means of Isotherms.
- Isotherms are imaginary lines which connect the same temperatures of different places.

### Heat zones of the earth:

- The fact that the earth is spherical in Shape results in different parts of the earth getting heated differently.
- Based on the heat Received from the sun, Earth is divided into three heat zones. They are
  - **Torrid Zone:**
    - It is a region between the tropic of cancer and the tropic of Capricorn.
    - This region receives the direct rays of the sun and gets the maximum heat from the sun.
    - This zone Known as the torrid or the tropical zone
  - **Temperate zone:**
    - This zone lies between the Tropic of Cancer and the Arctic Circle in the Northern Hemisphere and between the Tropic of Capricorn and the Antarctic circle in the Southern Hemisphere.
    - This zone gets the Slanting rays of the sun and the angle of the Sun's rays goes on decreasing towards the Poles.
    - Thus, this zone experiences moderate Temperature.
  - **Frigid Zone:**
    - The Frigid Zone lies between the Arctic Circle and the North Pole and between the Antarctic circle and the South Pole.
    - This Region also known as Polar region.
    - Since it receives the extremely low temperature throughout the year, these regions are covered with snow.

### Air Pressure:

- The weight of air above a given area on the Earth's surface is called atmospheric pressure or air pressure.
- The air pressure is measured by Barometer.
- The standard air pressure at sea Level is 1013.25mb.
- At the earth's surface the Pressure is 1.03kg.per sq. cm.

- The variation in Standard atmospheric pressure is found both horizontally and vertically.
- Based on the level of pressure, it is categorised into low pressure and high pressure.
- Low pressure area is an area in the atmosphere where the pressure is lower than its surrounding areas.
- In this situation, the Wind from the surroundings blows towards the Centre of low pressure.
- High pressure is an area of atmosphere where the barometric pressure is higher than its surrounding areas.
- In this Case, the wind from the centre of high pressure blows towards the surrounding low pressure Areas.
- Low pressure system is marked as “L” on weather map, whereas the high-pressure system is marked as “H”.
- Low pressure systems are also called as a depression and cyclones.
- High pressure system is called anti cyclones.
- Low pressure leads to cloudiness, wind, and Precipitation.
- High pressure leads to fair and calm weather.
- Isobar is used to show the Distribution of air pressure.
- Humans are not sensitive to small variation in air pressure.
- But the small variations in pressure that do exist largely determine the wind and storm patterns of the earth.
- The distribution of atmospheric Pressure is controlled by altitude, atmospheric Temperature, air circulation, earth rotation, Water vapour, atmospheric storms.
- Measuring air pressure Meteorologist uses barometer/aneroid Barometer to measure the air pressure.
- Barograms are used for recording continuous Variation in atmospheric pressure.

### Humidity:

- Humidity refers to the degree of water Vapour present in the atmosphere in gaseous form in particular time and place.
- It ranges from 0-5 percent by volume in atmosphere.
- Climatically it is an important constituent of the atmosphere and its quantity depends on the Level of temperature.
- So, the level of humidity Decreases towards poles from equator.
- Humidity is expressed in different ways.

### Specific humidity:

- It is a ratio of the water vapour content of the mixture to the total air content on a mass basis.
- It is expressed in grams of vapour per kilogram of air.

### Absolute Humidity:

- It is the mass or weight of water vapour present per unit volume of air.
- It is expressed usually in grams per cubic Meter of air.

### Relative humidity:

- It is a ratio between the actual amounts of water vapour present.
- In the air and the maximum amount of water vapour it can hold at a given temperature.
- It is expressed as a percentage.
- Generally, warm air holds more water vapour than the cold air.
- When relative Humidity reaches 100%, the air gets saturated.
- In this condition the temperature is said to be at dew-point.
- Further cooling will condense the Water vapour into the clouds and rain.
- Relative Humidity affects human health and comfortness.
- Very high and very low humidity are injurious to health.
- It also affects the stability of different Objects, buildings and electrical applications.

### Measurement of Humidity:

- Hygrometer is used to measure the Humidity. (Which comprises wet and dry bulb-Plate side by side in the Stevenson screen)

**Wind:**

- The horizontal movement of air is called Wind.
- Vertical movement of air is said as air Current.
- The winds move from high pressure to Low pressure.
- Unlike other elements a wind is made up of a series of gusts and eddies which can only be felt and not seen.
- Winds get their name from the direction from which they blow i.e, wind blows from south west is called Southwest wind.
- The wind systems are broadly categorized into three as follows.
  - **Planetary winds**
  - **Seasonal winds**
  - **Local winds**
- Planetary winds are the ones which Blow almost in the same direction throughout the year.
- So, they are called as Permanent or Planetary winds.
- Trade winds, Westerlies and Polar easterlies are the types of prevailing Winds.
- Seasonal winds are those which Change their direction according to season in a year.
- They are called as monsoon winds.
- These winds blow from sea to land during summer and land to sea during winter.
- Local Winds are the winds blow over a small area only during a particular time of a day or a short period of a year.
- Land and sea breezes are example of these winds
- The Beaufort scale is a scale for measuring Wind speed.
- It is based on observation rather than accurate measurement.
- It is the most widely used system to measure wind speed today.
- The scale was developed in 1805 by Francis Beaufort, an officer of the Royal Navy and first officially used by HMS Beagle.

**Measuring wind direction and Speed:**

- Meteorologist measures wind direction using wind vane or weather cock. wind Speed is measured by anemometer.
- Wind Rose is a diagram used to depict the direction and periods (No. of days) of prevailing winds on map.
- Meteorograph or triple register is an instrument which records wind speed and Direction, sunshine and precipitation.
- It also provides graphic representation.

**Monsoon:**

- The word ‘monsoon’ has been derived from the arabic word ‘Mausim’ which means ‘season’.
- Originally, the word ‘monsoon’ was used By Arab navigators several Centuries ago, to describe a System of seasonal reversal of winds along the Shores of the Indian Ocean, especially over the Arabian Sea.
- It blows from the south-west to North-east during summer and from the north-East to south-west during winter.
- Meteorologists have developed a number of concepts about the origin of monsoons.
- According to the Dynamic concept, Monsoon Wind originates due to the seasonal migration of planetary winds and pressure belts following the position of the sun.
- During summer solstice, the sun’s rays fall vertically over the Tropic of Cancer.
- Therefore, all the pressure and wind Belts of the globe shift northwards.
- At this time, Inter -Tropical Convergence Zone (ITCZ) also moves northward, and a major part of Indian landmass comes under the influence of Southeast trade winds.
- While crossing equator this wind gets deflected and takes the direction of southwest and becomes south-west monsoon.
- During the winter season, the pressure and Wind belts shift southward, thereby establishing the north-east monsoon (trade winds) over this Region.

- Such systematic change in the direction of planetary winds is known as monsoon.

### Seasons:

The meteorologists recognize the four distinct seasons in India. They are;

- Winter season (January – February).
- Summer season (March – May).
- Southwest monsoon or Rainy season (June – September).
- Northeast monsoon season (October – December).

### Winter season:

- During this period, the vertical ray of the Sun falls over tropic of Capricorn which is far away from India.
- Hence, India receives the slanting Sun's rays which results in low temperature.
- The cold weather season is characterized by Clear skies, fine weather, light northerly winds, Low humidity and large day time variations of Temperature.
- During this season a high pressure Develops over north India and a north-westerly Wind blows down the Indus and Ganges valleys.
- In south India, the general direction of wind is from east to west.
- The rain during this season generally occurs over the Western Himalayas, Tamil Nadu and Kerala.
- Western disturbances and associated trough in westerlies are main rain bearing System in northern part of the country.
- The jet Stream plays a dominant role in bringing these disturbances to India.
- Western disturbances cause rainfall in Punjab, Haryana and Himachal Pradesh, and snowfall in the hills of Jammu and Kashmir.
- This rainfall is very useful for the cultivation of winter wheat.

### Summer season:

- During this season, the vertical rays of the Sun fall over the peninsular India.
- Hence, there is a steady increase in temperature from south to north.

- It is practically hot and dry in the Entire country in the initial part of this season.
- Weather over the land areas of the country is Influenced by thunderstorms associated with Rain and sometimes with hail mostly in the Middle and later part.
- During this season, temperature starts Increasing all over the country and by April, the interior parts of south India record mean Daily temperatures of 30°C–35°C.
- Central Indian land mass becomes hot with day-time Maximum temperature reaching about 40°C At many locations.
- Because of the atmospheric pressure Conditions, the winds blow from southwest to Northeast direction in Arabian Sea and Bay of Bengal.
- They bring pre monsoon showers to the West coast during the month of May.
- There are Few thunder showers called “Mango Showers” Which helps in quick ripening of mangoes along the coast of Kerala and Karnataka.
- “Norwesters” or “Kalbaisakhis” are the Local storms with thunder that blow from north Western part and rain lasting for short durations.
- It occurs over the eastern and north eastern Parts over Bihar, West Bengal and Assam during April and May.
- They approach the stations from the north westerly direction.

#### **Southwest monsoon or Rainy Season:**

- The southwest monsoon is the most Significant feature of the Indian climate.
- The onset of the southwest monsoon takes place normally over the southern tip of the country by the first week of June, advances along the Konkan coast in early June and covers the Whole country by 15<sup>th</sup> July.
- The monsoon is influenced by global phenomenon like El Nino.
- Prior to the onset of the southwest Monsoon, the temperature in north India Reaches upto 46°C.

- The sudden approach of Monsoon wind over south India with lightning and thunder is termed as the ‘break’ or ‘burst of monsoon’.
- The monsoon wind strikes against the southern tip of Indian land mass and gets divided into two branches.
- One branch starts From Arabian Sea and the other from Bay of Bengal.
- The Arabian Sea branch of southwest Monsoon gives heavy rainfall to the west coast of India as it is located in the windward side of the Western Ghats.
- The other part which advances towards north is obstructed by Himalayan Mountains and results in heavy rainfall in north.
- As Aravalli Mountain is located parallel to the wind direction, Rajasthan and western part do not get much rainfall from this branch.
- The Bay of Bengal branch moves towards Northeast India and Myanmar.
- This wind is trapped by a chain of mountains namely Garo, Khasi and Jaintia are mainly responsible for the heaviest rainfall caused at Mawsynram located In Meghalaya.
- Later on, this wind travel towards west which results in decrease in rainfall from East to west.
- Over all about 75% of Indian Rainfall is received from this monsoon.

#### **Northeast monsoon season:**

- The southwest monsoon begins to retreat from north India by the end of September due to the southward shifting pressure belts.
- The Southwest monsoon wind returns from Indian Landmass and blows towards Bay of Bengal.
- The Coriolis force deflects this wind and makes it to blow from northeast.
- Hence, it is known as Northeast monsoon or post-monsoon season.
- The season is associated with the establishment of the north-easterly wind system over the Indian subcontinent.
- Andhra Pradesh, Tamil Nadu, Kerala and south interior Karnataka Receive good amount of rainfall accounting for 35% of their annual total.

- Many parts of Tamil Nadu and some parts of Andhra Pradesh and Karnataka receive rainfall during this season due to the storms forming in the Bay of Bengal.
- Large scale losses to life and property occur due to heavy rainfall, strong winds and storm surge in the coastal regions.
- The day time temperatures Start falling sharply all over the country.
- Mawsynram, the place which Receives highest rainfall (1141 cm) in the world.
- It is located in Meghalaya.

#### **Distribution of rainfall:**

- The average annual rainfall of India is 118 cm.
- However, spatial distribution of rainfall in the country is highly uneven.
- The Western coast, Assam, South Meghalaya, Tripura, Nagaland and Arunachal Pradesh are the heavy rainfall areas which get more than 200 cm rainfall.
- The whole of Rajasthan, Punjab, Haryana, Western and Southwestern parts of Uttar Pradesh, Western Madhya Pradesh, the Entire Deccan Trap or Plateau region east of Western Ghats except for a narrow strip along Tamil Nadu coast receive a low rainfall of less than 100 cm.
- The rest of the areas receive a Rainfall ranging between 100 and 200 cm.

#### **Hydrologic Cycle:**

- Water is one of the most important Elements on the earth.
- All plants and animals Need water for survival.
- Apart from drinking, Water is required for domestic, agriculture, Industrial purposes etc.
- Water is very essential for carrying out almost all economic activities.
- So, water is an indispensable Element without which life form on the earth is not possible.

#### **Water on the Earth:**

- About 71% of the earth's surface is covered by water.
- The quantity of water Present on the earth is about 326 million Cubic miles.

- It is hard to visualise this massive quantity of water.
- Most of the water on the earth is saline and is found in Seas and oceans.
- The salt water constitutes about 97.2% and the fresh water is only about 2.8%. out of this 2.8%, about 2.2% is available as surface water and the Remaining 0.6% as groundwater.
- From this 2.2% of surface water, 2.15% is available in the form of glaciers and icecaps, 0.01% In lakes and streams and the remaining 0.04% is in other forms.
- Only about 0.25% of the total ground water of 0.6% can be economically extracted with the present Drilling technology.
- Water resources are useful or potentially Useful to humans.
- Water in India is available in three sources.
- They are precipitation, Surface water and groundwater.

#### **Hydrologic Cycle or Water Cycle:**

- Hydrology is the science which deals with the various aspects of water such as its Occurrence, distribution, movement and Properties on the planet earth.
- Availability Of water on the earth is not uniform.
- Some Places are very rich and some places are poor in water resources.
- Hydrologic cycle is a global sun-driven Process where water is transported from Oceans to atmosphere, from atmosphere to Land and from land back to oceans.
- The water Cycle can be considered as a closed system for the earth, as the quantity of water involved in the cycle is invariable, though its distribution Varies over space and time.
- Evaporation takes place from the surface water and transpiration from the plants.
- Water Vapour gets condensed at higher altitudes by Condensation nuclei and form clouds.
- The Clouds melt and sometimes burst resulting in precipitation of different forms.

- A part of Water from precipitation flows over the land Is called runoff and the other part infiltrates into the soil which builds up the groundwater.
- Hydrologic cycle is a circulation of water.
- It is a continuous process and takes place naturally.
- The three important phases of the Hydrologic cycle are:
  - Evapotranspiration
  - Precipitation
  - Runoff.

### Components of Hydrologic Cycle:

- There are six main components in hydrologic cycle. They are:
  - Evapotranspiration,
  - Condensation,
  - Precipitation,
  - Infiltration,
  - Percolation,
  - Runoff.

### Evapotranspiration:

- It is defined as the total loss of water from the earth through evaporation from the surface water bodies and the transpiration from vegetation.
- In cropped area, it is difficult to determine the evaporation and transpiration separately.
- Therefore, it is collectively called as evapotranspiration.
- The following part explains the process of Evaporation and transpiration separately.

### Evaporation:

- Evaporation refers to the process in which the liquid form of water changes into gaseous form.
- Water boils at 100°C (212°F) temperature but, it actually begins to Evaporate at 0°C (32°F); and the process takes Place very slowly.
- Temperature is the prime Element which affects the rate of evaporation.
- There is a positive relationship between these two variables.

- Areal extent of surface water, wind and the atmospheric humidity are the other variables which affect the rate of Evaporation.
- The atmosphere gets nearly 90% of Moisture from the oceans, seas, lakes and Rivers through evaporation and 10% of the Moisture from plants through transpiration.
- On a global scale, the amount of water gets Evaporated is about the same as the amount of Water delivered to earth as precipitation.
- This Process varies geographically, as the evaporation is more prevalent over the oceans than Precipitation, while over the land, precipitation Routinely exceeds evaporation.
- The rate of Evaporation is low during the periods of calm Winds than during windy times.
- When the air is calm, evaporated water tends to stay close to the water body.
- During windy, the water vapour is driven away and is replaced by dry air which Facilitates additional evaporation.

#### **Transpiration:**

- Transpiration refers to the process by which the water content in the plants is released into the atmosphere in the form of water Vapour.
- Much of the water taken up by plants Is released through transpiration.
- The rate of Transpiration is also affected by the temperature, Wind and humidity.
- The rate of transpiration is also affected by nature of vegetation and the Method of cultivation of crops.

#### **Condensation:**

- It refers to the process in which the Gaseous form of water changes into liquid Form.
- Condensation generally occurs in the Atmosphere when warm air rises, cools and loses its capacity to hold water vapour.
- As a Result, excess water vapour condenses to form Cloud droplets. Condensation is responsible for the formation of clouds.

- These clouds Produce precipitation which is the primary Route for water to return to the earth's surface in the water cycle. Condensation is the opposite of evaporation.
- Forms of Condensation Dew, frost, fog, mist and clouds are the Different forms of condensation.

**Dew:**

- It is a water droplet formed by the condensation of water vapour on a Relatively cold surface of an object.
- It forms when the temperature of an object drops below the dew point temperature.

**Frost:**

- The ice crystals formed by deposition of water vapour on a relatively cold surface of an object is known as frost.
- It forms when the temperature of an object drops below the freezing point of temperature.

**Fog:**

- Fog is the suspended tiny water droplets or ice crystals in an air layer next to the earth's surface that reduces the Visibility to 1,000 m or lower.
- For aviation purposes, the criterion for fog is 10 km or less.

**Mist:**

- Mist is the tiny droplets of water hanging in the air.
- These droplets form when the water vapour in the air is rapidly cooled, causing it to change from invisible gas to tiny visible water droplets.
- Mist is Less dense than fog.

**Clouds:**

- Clouds consist of tiny water droplets/ice particles which are so small and light in weight.
- Clouds are formed by microscopic drops of water or by small ice crystals.
- The sizes of the droplets generally range from a couple of microns to 100 microns.

- When the size of the water Droplets exceeds 100 microns, it becomes Rain drops.

### **Precipitation:**

- Precipitation refers to all forms of water that fall from clouds and reaches the earth's Surface.
- For the occurrence of precipitation, Cloud droplets or ice crystals must grow Heavy enough to fall through the air.
- When the droplets grow large in size, they tend to Fall.
- While moving down, by collecting some small droplets, they become heavy enough to Fall out of the cloud as raindrops.

### **Forms of Precipitation:**

- The form of precipitation in a region Depends on the kind of weather or the climate of the region.
- The precipitation in the warmer parts of the world is always in the form of rain or drizzle.
- In colder regions, precipitation May fall as snow or ice.
- Common types of Precipitation are rain, sleet, freezing rain, hail and snow.

### **Rain:**

- The most common kind of Precipitation is rain.
- The precipitation in the form of water droplets is called rain.
- The precipitation in which the size of rain Drops are  $<0.5$  mm in diameter is known as drizzle and the rain drops with  $>0.5$  mm in diameter is known as rain.
- Generally, Drizzle takes place from stratus clouds.

### **Sleet:**

- The precipitation which takes place in the form of mixture of water droplets and tiny particles of ice (5mm in diameter) is known as sleet.
- Sometimes raindrops Fall through a layer of air below  $0^{\circ}\text{C}$ , the Freezing point of water.
- As they fall, the Raindrops freeze into solid particles of ice.

- So, the mixture of water droplets and ice Particles would fall on the earth surface.

#### **Freezing Rain:**

- Sometimes raindrops falling through cold air near the ground do not freeze in the air.
- Instead, the raindrops Freeze when they touch a cold surface.
- This is called freezing rain and the drops of water are usually greater than 0.5 mm in Diameter.

#### **Hail:**

- The precipitation which consists of round pellets of ice which are larger than 5 Mm in diameter is called hail or hailstones.
- Hail forms only in cumulonimbus clouds during thunderstorms.
- A hailstone starts as an ice pellet inside a cold region of a Cloud.
- Strong updrafts in the cloud carry the hailstone up and down through the Cold region many times.

#### **Snow:**

- Often water vapour in a cloud is converted directly into snow pieces due to Lowering of temperature.
- It appears like a powdery mass of ice.
- The precipitation in the form of powdery mass of ice is known as snowfall.
- It is common in the polar and high mountainous regions.

#### **Infiltration:**

- Water entering the soil at the surface of the ground is termed as infiltration.
- Infiltration allows the soil temporarily to Store water, making it available for plants use and organisms in the soil.
- Infiltration is an important process where rain water soaks into the ground, through the soil and underlying Rock layers.
- Some of this water ultimately Returns to the surface through springs or low Spots down hills.
- Some of the water remains underground and is called groundwater.

- The rate of infiltration is influenced by the Physical characteristics of the soil, vegetative Cover, moisture content of the soil, soil Temperature and rainfall intensity.
- The terms Infiltration and percolation are often used interchangeably.

#### **Percolation:**

- Percolation is the downward movement of infiltrated water through soil and rock Layers.
- Infiltration occurs near the surface of the soil and delivers water from the surface into the soil and plant root zones.
- Percolation Moves the infiltrated water through the soil Profile and rock layers which lead to the Formation of ground water or become a part of sub-surface run-off process.
- Thus, the Percolation process represents the flow of Water from unsaturated zone to the saturated Zone.

#### **Runoff:**

- Runoff is the water that is pulled by Gravity across land's surface.
- It replenishes Groundwater and surface water as it percolates into an aquifer (it is an underground layer of water-bearing rock) or moves into a River, stream or watershed.
- It comes from unabsorbed water from rain, snowmelt Irrigation or other sources, comprising a significant element in the water cycle as well As the water supply when it drains into a Watershed.
- Runoff is also a major contributor to the Erosion which carves out canyons, gorges and related landforms.
- The rate of runoff that can happen depends on the amount of rainfall, Porosity of soil, vegetation and slope.
- Only About 35% of precipitation ends up in the sea or Ocean and the other 65% is absorbed into the soil.

#### **Types of Runoffs:**

- Based on the time interval between the Instance of rainfall and generation of runoff, the runoff may be classified into following three types

- **Surface Runoff:**

- It is the portion of rainfall, which enters the stream immediately after the rainfall.
- It occurs, when the rainfall is longer, heavier and exceeds the rate of infiltration.
- In this Condition the excess water makes a head over the ground surface, which tends to Move from one place to another following Land gradient and is known as overland Flow.
- When the overland flow joins the Streams, channels or oceans, it is termed as surface runoff or surface flow.

- **Sub-Surface Runoff:**

- The water that has entered the subsoil and moves laterally without joining the water-table to the streams, rivers or oceans is known as subsurface runoff.
- The sub-surface runoff is usually referred as interflow.

- **Base Flow:**

- It is a flow of underground water from a saturated ground water zone to a water channel.
- It usually appears at a downstream location where the channel elevation is lower than the groundwater table.
- Groundwater provides the stream flow during dry periods of small or no precipitation.