Unit III

Atmospheric Pressure: Major pressure belts – Planetry, seasonal and local winds – Monsoon. Atmospheric Humidity – condensation and clouds.

Atmospheric Pressure:

Atmospheric pressure, also known as barometric pressure (after the barometer), is the pressure within the atmosphere of Earth.

Major pressure belts:

Pressure Belts of Earth

On the earth's surface, there are seven pressure belts. They are the Equatorial Low, the two Subtropical highs, the two Subpolar lows, and the two Polar highs. Except for the Equatorial low, the others form matching pairs in the Northern and Southern Hemispheres. There is a pattern of alternate high and low-pressure belts over the earth. This is due to the spherical shape of the earth—different parts of the earth are heated unequally. The Equatorial region receives a great amount of heat throughout the year. Warm air being light, the air at the Equator rises, creating low pressure. At the poles the cold heavy air causes high pressure to be created/formed. It is also due to the rotation of the earth. In the Subpolar region around latitudes 60° to 65° North and South of the Equator, the rotation of the earth pushes up the bulk of the air towards the Equator, creating a low-pressure belt in this region.

(i) Equatorial Low-Pressure Belts

This low-pressure belt extends from 0 to 5° North and South of Equator. Due to the vertical rays of the sun here, there is intense heating. The air, therefore, expands and rises as convection current causing low pressure to develop here. This low-pressure belt is also called as doldrums because it is a zone of total calm without any breeze.

(ii) Subtropical High-Pressure Belts

At about 30°North and South of Equator lies the area where the ascending equatorial air currents descend. This area is thus an area of high pressure. It is also called as the Horse latitude. Winds always blow from high pressure to low pressure. So the winds from subtropical region blow towards the Equator as Trade winds and another wind blow towards Sub-Polar Low-Pressure as Westerlies.

(iii) Circum-Polar Low-Pressure Belts

These belts located between 60° and 70° in each hemisphere are known as Circum-Polar Low-Pressure Belts. In the Subtropical region, the descending air gets divided into two parts. One part blows towards the Equatorial Low-Pressure Belt. The other part blows towards the Circum-Polar Low-Pressure Belt. This zone is marked by the ascent of warm Subtropical air over cold

polar air blowing from poles. Due to the earth's rotation, the winds surrounding the Polar region blow towards the Equator. Centrifugal forces operating in this region create the low-pressure belt appropriately called the Circumpolar Low-Pressure Belt. This region is marked by violent storms in winter.

(iv) Polar High-Pressure Areas

At the North and South Poles, between 70° to 90° North and South, the temperatures are always extremely low. The cold descending air gives rise to high pressures over the Poles. These areas of Polar high pressure are known as the Polar Highs. These regions are characterized by permanent Ice Caps.

Shifting Of Pressure Belts

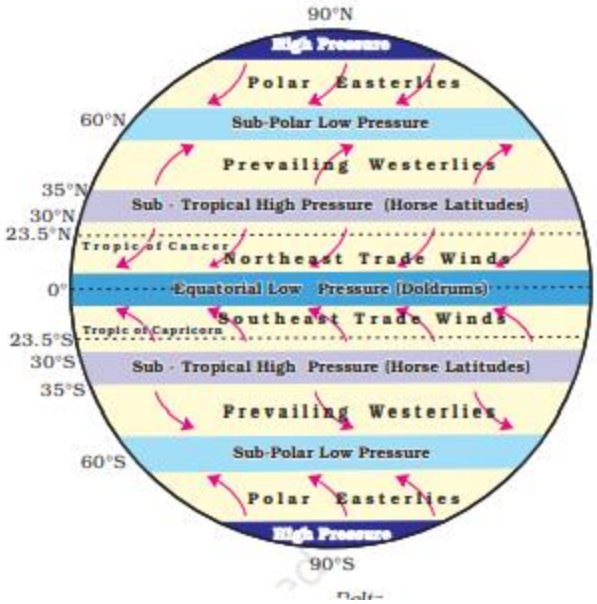
If the earth had not been inclined towards the sun, the pressure belts, as described above, would have been as they are. But it is not so, because the earth is inclined 23 1/2° towards the sun. On account of this inclination, differences in heating of the continents, oceans, and pressure conditions in January and July vary greatly. January represents winter season and July, summer season in the Northern Hemisphere. Opposite conditions prevail in the Southern Hemisphere. When the sun is overhead on the Tropic of Cancer (21 June) the pressure belts shift 5° northward and when it shines vertically overhead on Tropic of Capricorn (22 December), they shift 5° southward from their original position. The shifting of the pressure belts causes seasonal changes in the climate, especially between latitudes 30° and 40° in both hemispheres. In this region, the Mediterranean type of climate is experienced because of the shifting of permanent belts southwards and northwards with the overhead position of the sun. During winters Westerlies prevail and cause rain. During summers dry Trade Winds blow offshore and are unable to give rainfall in these regions. When the sun shines vertically over the Equator on 21st March and 23rd September (the Equinoxes), the pressure belts remain balanced in both the hemispheres.

Planetry, seasonal and Local winds:

Type of Wind – Permanent Winds

The winds that blow constantly throughout the year are called Permanent Winds. They also blow constantly in a particular direction. There are types of permanent winds:

1. **Trade Winds** – These are permanent winds flowing from east-to-west. It flows in the Earth's equatorial region (between 30°N and 30°S latitudes).
2. **Easterlies** – It is a prevailing wind blowing from the east. The trade winds in tropical regions and the prevailing winds in the polar regions are easterlies.
3. **Westerlies** – These are prevailing winds that flow from the west towards the east. It flows in the Earth's middle latitudes between 30 and 60 degrees latitude. Also called as anti-trades, these winds originate from the high-pressure areas in the horse latitudes and trend towards the poles and steer extratropical cyclones in this general manner.



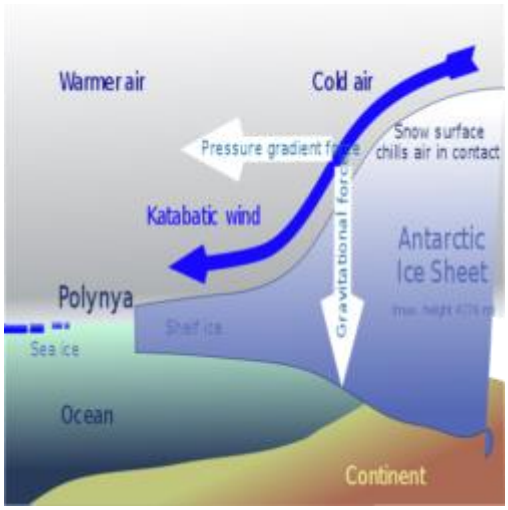
Type of Wind – Seasonal Wind

These are the winds that change their direction with onsets of different seasons. These are hence called as Seasonal Winds. A monsoon is a type of seasonal wind in low-latitude climates that seasonally changes direction between winter and summer. Monsoon is prevalent in India.

Type of Wind – Local Wind

These blow only during a particular period of the day or year in a small area. For example, land and sea breeze. The types of local wind are given below:

1. **Land Breeze** – It is a wind that flows from the land towards the sea. It flows often at night.
2. **Sea Breeze** – It is a wind that blows towards land from the direction of a large water body. Sea breeze develops due to differences in air pressure created by the differing heat capacities of water and dry land.
3. **Anabatic Winds** – (Mountain Breeze) These Winds are upslope winds driven by warmer surface temperatures on a mountain slope than the surrounding air column.
4. **Katabatic Winds** – (Valley Breeze) Katabatic winds are downslope winds created when the mountain surface is colder than the surrounding air and creates a downslope wind.



List of Names of Local Winds of the World

Name	Region
Abrolhos	Brazil
Alisio	Carribean
Alize	Central Africa and the Caribbean
Barguzin wind	Russia
Berg	South Africa
Harmattan	Central Africa
Ghibli	Libya
Loo	India, Pakistan
Pampero	Argentina, Uruguay
Föhn or foehn	Alps, North Italy
Chinook	Rocky Mountains
Roaring Forties	Southern Hemisphere
Southerly Buster	Sydney

Monsoons Introduction

The word ‘monsoon’ is believed to have originated from the Arabic word for season ‘mawsim’. Monsoons are basically seasonal winds that reverse their direction according to the change in season. They are hence, periodic winds. The monsoons travel from the sea to the land in summers and from land to the sea during winters, hence, are a double system of seasonal winds. Historically the monsoons have been very important because these winds were used by traders and seafarers to move from place to place. Though there is monsoon in the Indian subcontinent, central-western Africa, Southeast Asia and a few other places, the winds are most pronounced in the Indian subcontinent.

India gets southwest monsoon winds in the summers and northeast monsoons during the winters. The former arise because of the formation of an intense low-pressure system over the Tibetan Plateau. The latter arises due to the high-pressure cells that are formed over the Siberian and Tibetan plateaus.

Southwest Monsoon:

Cause: Intense low-pressure formation over the Tibetan Plateau because of intense heating during the summer season; permanent high-pressure cell in the South of the Indian Ocean (East to Northeast of Madagascar in summer).

SW monsoon winds bring heavy rainfall to most parts of the country.

Factors influencing the **onset of SW monsoons**:

1. Intense low-pressure formation over the Tibetan Plateau
2. The permanent high-pressure cell in the South of the Indian Ocean
3. Subtropical jet stream
4. African Easterly jet (Tropical easterly jet)
5. Inter-Tropical Convergence Zone (ITCZ)

Factors influencing **intensity of SW monsoons:**

1. Strengths of the low pressure over Tibetan plateau and the high pressure over the south Indian Ocean
2. Somali Jet
3. Somali Current
4. Indian Ocean dipole
5. Indian Ocean branch of the Walker Cell

The southwest monsoon arrives in two branches called the Bay of Bengal branch and the Arabian Sea branch. The Arabian Sea side monsoon creates a low-pressure area on the Thar Desert. It is quite stronger than the Bay of Bengal side monsoon.

The Arabian Sea Branch of the Southwest Monsoon first hits the Western Ghats of the coastal state of Kerala, India, thus making this area the first state in India to receive rain from the Southwest Monsoon.

During the South-West Monsoon, Tamil Nadu remains dry because it is located in a rain shadow area. Tamil Nadu has rain during the monsoon season due to the southwest trade winds which blow towards the northern hemisphere. Tamil Nadu receives rainfall in the winter season due to northeast trade winds.

Northeast Monsoon:

Cause: High-pressure cells over the Tibetan and the Siberian Plateaus

NE monsoon winds bring rainfall to the southeast coast of the country (Tamil Nadu coast and Seemandhra's south coast).

Factors responsible for the formation of the NE Monsoons:

1. Formation and strengths of the high-pressure cells over the Tibetan and the Siberian Plateaus during winters
2. Migration of the Inter-Tropical Convergence Zone (ITCZ) to the south of India
3. The high-pressure cells in the southern Indian Ocean migrating to the west and weakening.

Humidity, Condensation and Clouds

Humidity is the amount of water vapour in the atmosphere. Temperature of the air controls the capacity of the air to hold moisture. The maximum amount of moisture that can be hold by the air in the particular temperature is called as Humidity Capacity. As the volume increases with the temperature of the air, it can hold more moisture. So, humidity capacity increases with temperature. It is measured as weight of humidity or volume of the air.

Humidity of the air can be expressed in the following ways.

a. Absolute Humidity: This measures the total amount of water vapour present in the air at particular time. It is highly variable based on the surface on which the air moves. It is measured as weight of humidity/ volume of the air.

Hygrometer is used to measure the relative humidity of a region.

b. Relative Humidity (RH %): This is the ratio of Absolute humidity and humidity capacity in term of percentage. It reveals the condition of air to get saturated. This is controlled by both temperature and moisture content of the air. The condition is that when the temperature increases RH% decreases. But when absolute humidity increases RH% increases.

Process of Condensation

Condensation is the change of the physical state of water vapour (gas state) into water (liquid state). The following process explains mechanism of condensation in the atmosphere.

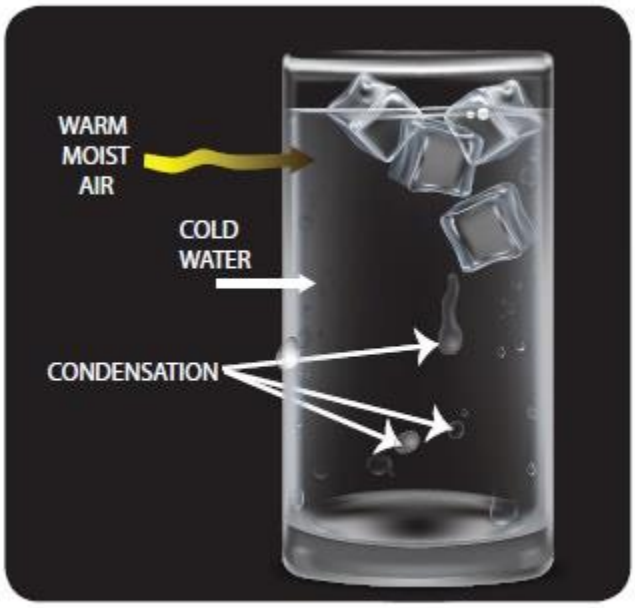


Figure 6.21 Process of Condensation

If an air reaches 100% relative humidity, it means that the air is completely filled with moisture content. It indicates that both the absolute humidity and the humidity capacity of the air are in same level. This condition is called ‘saturation of air’ which can be attained by reducing the temperature of the air or increasing the moisture content. The temperature at which the air gets saturated is called as ‘dew point’. The RH crosses the 100% when the temperature of the air drops below its dew point. This condition is called as ‘super saturation’ of the air. In this condition the air releases the excess moisture out of it in the form of tiny water droplets which floats and form clouds in the atmosphere.

If the same process occurs on the surface of the earth, it is called as ‘fog’ or cloud on the ground.

Clouds and its Types

Clouds are tiny water droplets suspended in the air formed due to the condensation.

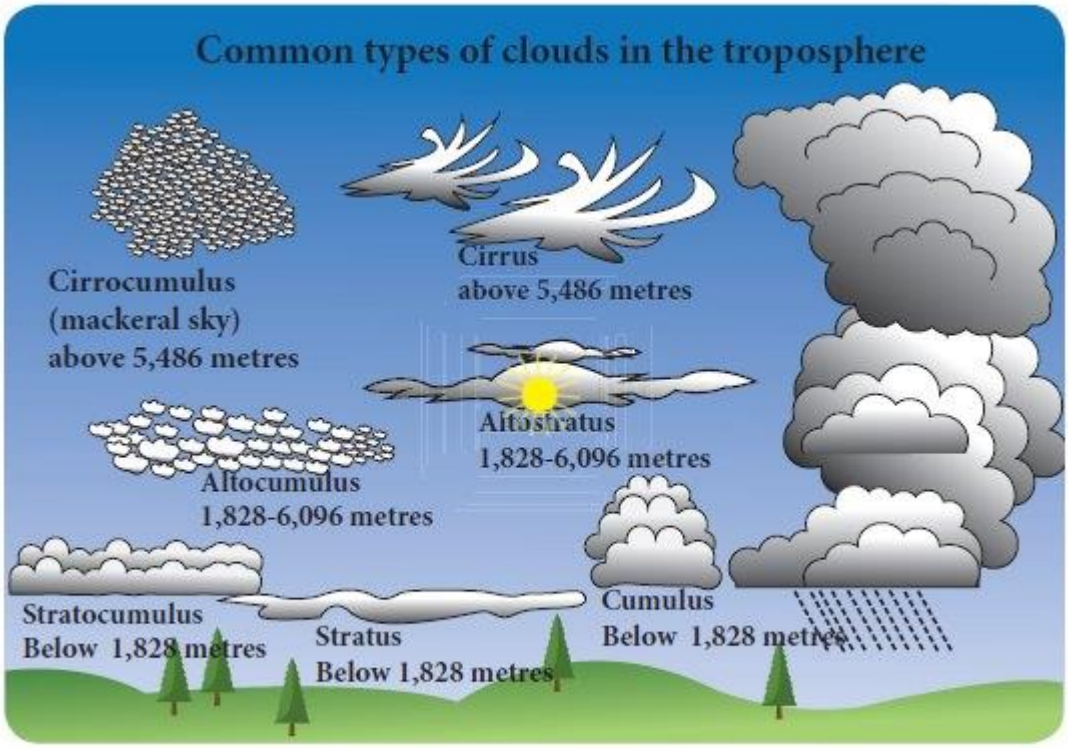


Figure 6.22 Types of Clouds

The clouds can be classified based on their form, height and appearance as follows: (Figure 6.22)

a. **High clouds:** Mainly cirrus (Ci) which are feathery form at 6 km above the ground.

i. Cirrus (Ci) – This looks fibrous and appears as wisps cotton in the blue sky. It indicates fair weather and gives brilliant sun set.

ii. Cirro Cumulus (Cc) – This appears as white globular masses, forming a mackerel sky.

iii. Cirro Stratus (Cs) – This resembles a thin white sheet. The sky looks milky and the sun and moon shines through this clouds and form a ‘halo’.

b. Middle Clouds: Mainly Alto (Alt) clouds at 2 km to 6 km above the ground.

- Altocumulus (Alt-Cu): These are woolly, bumpy clouds arranged in layers appearing like waves in the blue sky. They indicate fine weather.

- Altostratus (Alt-St): These are denser and have watery look.

c. Low Clouds: Mainly Stratus or sheet clouds below 2 km height.

Stratocumulus (St-Cu): This is rough and bumpy clouds with wavy structure.

- Stratus (St): This is very low cloud, uniformly grey and thick, appears like highland fog. It brings dull weather and light drizzle. It reduces the visibility and is a hindrance to air transportation.

- viii. Nimbostratus (Ni-St): This is dark dull cloud, clearly layered, as it brings rain, snow and sleet and it is called as rainy cloud.

d. Clouds with vertical extent: These are mainly cumulus clouds whose heights extend from 2 km to 10 km approximately.

- Cumulus (Cu): This is vertical cloud with rounded top and horizontal base, associated with convectional process in the tropical region. It also called as ‘fair weather cloud’.

- Cumulonimbus (Cu-Ni): This is over grown cumulus cloud with great vertical extent, with black and white globular mass. The cauliflower top spreads like an anvil. This is formed due to heavy convection in the tropical regions. It is accompanied by lightning, thunder and heavy rainfall.

Figure 6.23 Smog at New Delhi

Fog, Mist and Smog

'Fog' is defined as almost microscopic droplets of water condensed from super saturated air and suspended over or near the surface of the earth. Fogs reduce the visibility to less than 1 km. Fog occurs during calm or light wind conditions. It is more common in the areas near to the ocean due to the supply of more moisture by sea breeze. In the interior of the continents fog is formed due to reduction of temperature to extreme low during the winter nights.

If the fog has higher visibility due to lesser water drops near the surface it is termed as **'mist'.**

In large industrial areas the air is more polluted. If the fog forms in that area it mixes with the pollutants and turns into smog (smoke 1 fog 5 smog) which is more hazardous to the health of the people.

Hydrological Cycle

Continuous movement of water among the three spheres is known as **Hydrological Cycle**. Hydrological cycle involves evaporation, condensation, precipitation, advection, interception, evapo-transpiration, infiltration, percolation and runoff to the ocean (Figure 6.24).

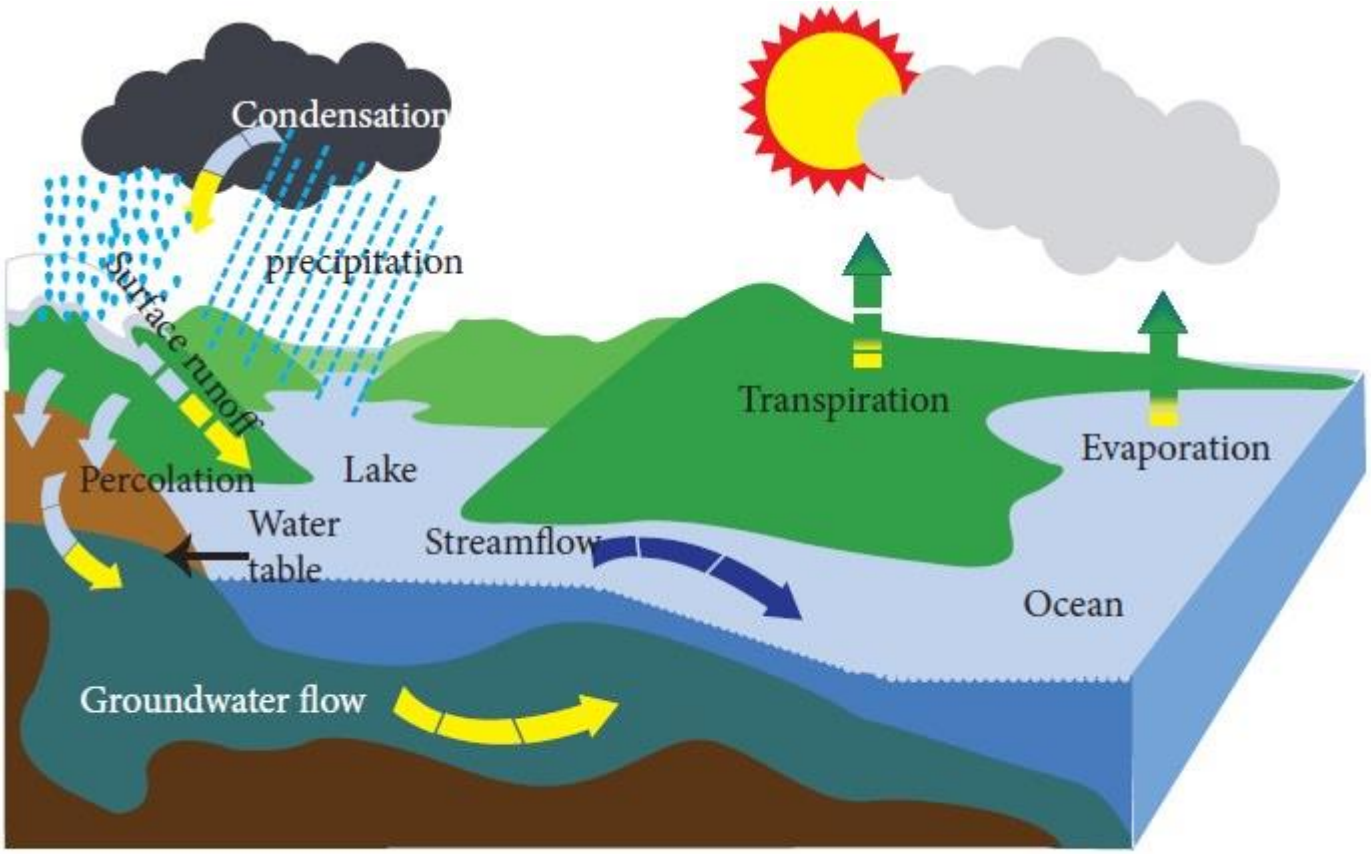


Figure 6.24 Hydrological cycle

Evaporation is the process by which water in liquid state changes into vapour state using heat energy from Sun. Evaporation is maximum when the temperature is high, on the large expanse of water and when dry winds blow over water surface.

Condensation is the process by which water vapour cools to form water droplet by loosing temperature. The condensation occurs when dew point is reached in the atmosphere.

Precipitation is the process by which all forms of water particles fall from the atmosphere and reach the ground.

The rain drop that falls may get evaporated before it reaches the ground in an extremely arid region.

Student Activity

The cup filled with ice cubes has tiny water droplets on its outer surface (Figure 6.21). Identify why.

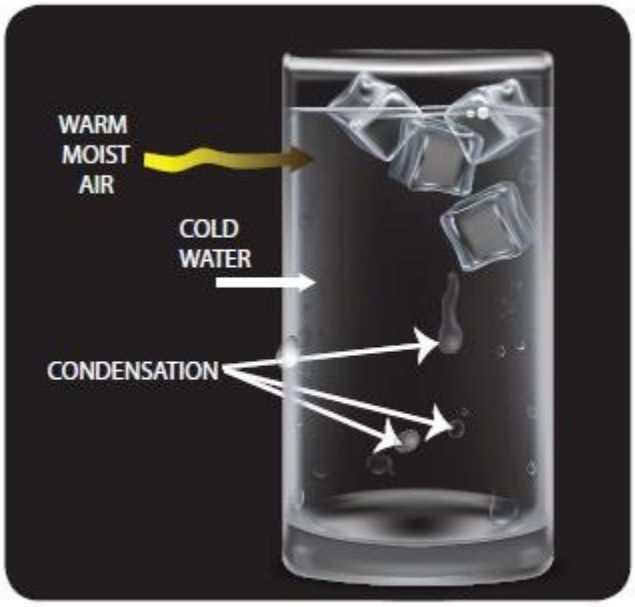


Figure 6.21 Process of Condensation

The moisture in the atmosphere is based on the following processes:

Evaporation – Water changes from liquid state to gaseous (vapour) state.

Transpiration – Water state changes from liquid in to (gas) vapour state due to the activity of plants.

Evapotranspiration – This denotes that the total amount of (liquid) water state changed in to (gas) vapour state due to evaporation and the activity of plants transpiration.

Isonephs – The imaginary line connecting the places having equal amount of cloudiness.