EDEN IAS - GEOGRAPHY CLASS NOTES

EDEN IAS MISSION PRELIMS 2021

GEOGRAPHY CLASS - 6

ATMOSPHERIC PRESSURE

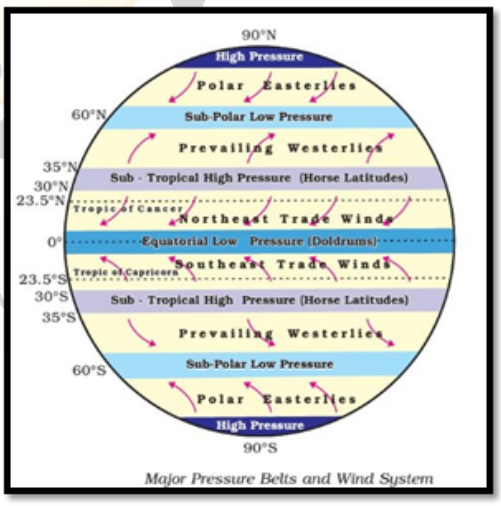
- The weight of a column of air contained in a unit area from the mean sea level to the top of the atmosphere is called the atmospheric pressure. The atmospheric pressure is expressed in units of milibar. At sea level the average atmospheric pressure is 1,013.2 milibar.
- Due to gravity the air at the surface is denser and hence has higher pressure.
- Air pressure is defined as total weight of a mass of column of air per unit area at sea level. Air pressure is Maximum at the sea level.
- Pressure exerted by air at a particular point is determined by temperature and density. There is inverse relation between temperature and pressure.
- Air pressure is measured as a force per unit area. The unit of air pressure is milibar or mb measured by a barometer.
- The distribution of atmospheric pressure is shown on a map by isobars.
- An isobar is an imaginary line drawn through points of equal atmospheric pressure at the sea level. The spacing of isobars expresses the rate and direction of pressure change and is called pressure gradients.
- The pressure decreases with height. At any elevation it varies from place to place and its variation is the primary cause of air motion, i.e. wind which moves from high pressure areas to low pressure areas.

MAJOR PRESSURE BELTS

There are 4 major pressure belts as mentioned below

1. Equatorial low pressure belt
2. Subtropical high pressure belt
3. Sub polar low pressure belt
4. Polar high pressure belt

- **Equatorial low pressure belt:** At the equator heated air rises creating a low-pressure area at the surface. This is called the equatorial low pressure. It is also known as doldrums.
- **Subtropical high pressure belt:** Reaching the troposphere the warm air bends towards the pole and descends at 30- 35° latitude or the tropics creating a belt of sub-tropical high pressure. Subtropical high pressure zone is also known as horse latitude. Sub-tropical highs are the source of air moving along the surface towards the poles.
- **Sub-polar low pressure belt :** At 60-65° latitudes surface air streams coming from polar high pressure and sub-tropical high pressure converge and move up. This upward movement of air creates a low pressure system at the surface which is the Sub-polar low pressure.
- **Polar high pressure belt:** At the poles, the low temperature makes air contract and creates a zone of high pressure. This thermally created high pressure system is called polar high pressure. This dense cold air flows equator-wards away from the area of high pressure.



Major Pressure Belts and Wind System

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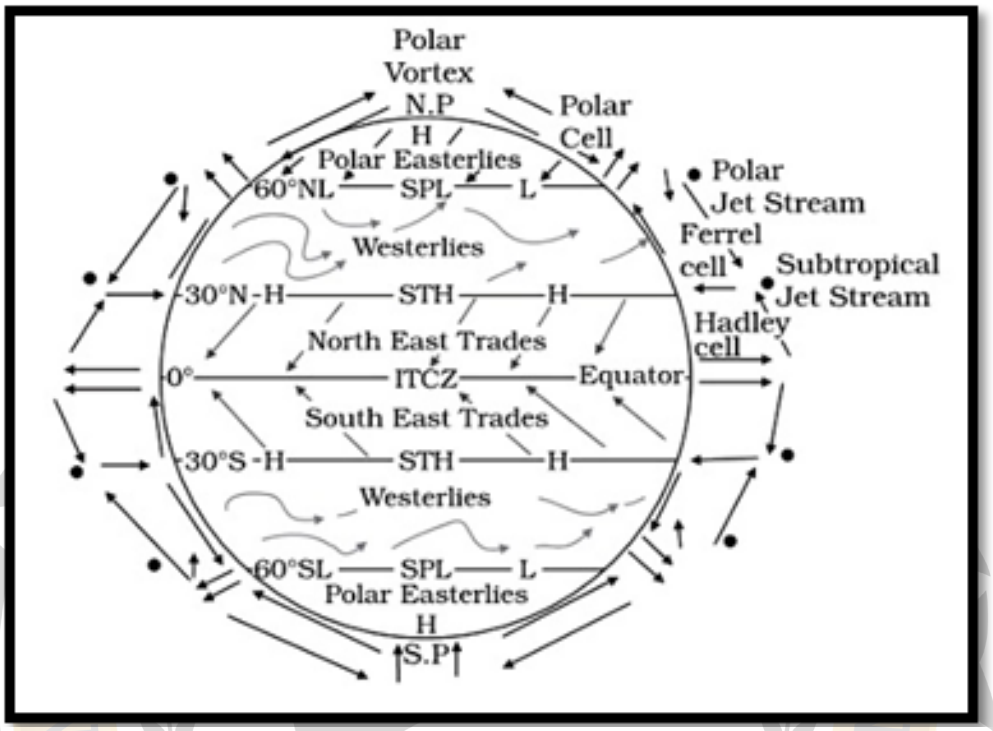
WINDS AND ATMOSPHERIC MOTION

- Wind is air in motion which can be in any direction. Wind is caused by spatial differences in atmospheric pressure and flows from areas of high pressure to those of low pressure. These differences are caused by uneven absorption of solar radiation at earth's surface.
- Wind speed is at its greatest during daytime when the greatest spatial extremes in atmospheric temperature and pressure exist. Wind speed can be measured using the Beaufort wind scale.
- Wind direction is measured as the direction from where a wind comes from. Direction is measured by a wind vane.



The horizontal movement of air (Wind) is controlled by following forces:

- The horizontal winds near the earth surface respond to the combined effect of three forces – the pressure gradient force, the frictional force and the Coriolis force. In addition, the gravitational force acts downward.

I. Pressure Gradient force-

- The differences in atmospheric pressure produce a force. The rate of change of pressure with respect to distance is the pressure gradient.
- The pressure gradient is strong where the isobars are close to each other and is weak where the isobars are apart.
- This is the main driving force of global winds. This creates a wind from high-pressure, surplus areas to move towards the low-pressure, deficit areas.

II. Coriolis force-

- The rotation of the earth about its axis affects the direction of the wind. This force is called the Coriolis force after the French physicist who described it in 1844.
- It deflects the wind to the right direction in the northern hemisphere and to the left in the southern hemisphere.
- The deflection is more when the wind velocity is high. The Coriolis force is directly proportional to the angle of latitude.
- It is maximum at the poles and is absent at the equator.
- The Coriolis force acts perpendicular to the pressure gradient force.
- The pressure gradient force is perpendicular to an isobar.
- The higher the pressure gradient force, the more is the velocity of the wind and the larger is the deflection in the direction of wind

III. Geostropic wind-

- In mid-latitudes, the Pressure Gradient and Coriolis force are balanced. Therefore, air moves parallel to the isobars rather than from regions of high pressure to low pressure.
- When isobars are straight and when there is no friction, the pressure gradient force is balanced by the Coriolis force and the resultant wind blows parallel to the isobar. This wind is known as the Geostropic wind

IV. Centripetal force- Air moving towards a low-pressure area in a defected path accelerates towards the centre of low pressure.

V. Frictional forces- Frictional drag from the Earth's surface decreases wind speed and modifies its direction, crossing isobars as it moves from high-pressure regions to low-pressure regions areas.

GENERAL ATMOSPHERIC CIRCULATION

- The pattern of the movement of the planetary winds is called the general circulation of the atmosphere. The general circulation of the atmosphere also sets in motion the ocean water circulation which influences the earth's climate.
- In other words the uneven distribution of insolation energy is the main factor that causes atmospheric circulation.
- Heat is transferred within the atmosphere and oceans, recognizable as wind patterns, ocean currents and pressure belts from low latitudes to high latitudes, redistributing heat from surplus areas to deficit areas.
- The wind circulation around a low is called cyclonic circulation. Around a high it is called anti cyclonic circulation.

Table : Pattern of Wind Direction in Cyclones and Anticyclones

Pressure System	*Pressure Condition at the Centre*	*Pattern of Wind Direction*	
		Northern Hemisphere	*Southern Hemisphere*
Cyclone	Low	Anticlockwise	Clockwise
Anticyclone	High	Clockwise	Anticlockwise

Factors affecting the pattern of planetary winds are:

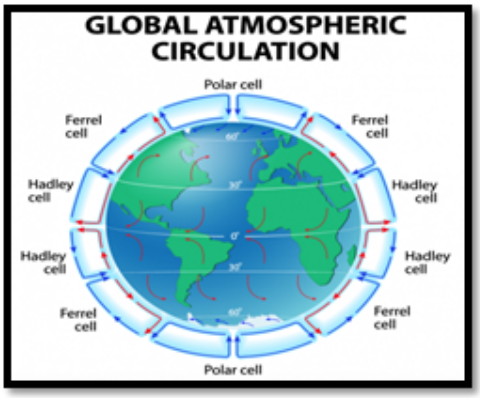
(i) Latitudinal variation of atmospheric heating;
(ii) Emergence of pressure belts;
(iii) The migration of belts following apparent path of the sun;
(iv) The distribution of continents and oceans;
(v) The rotation of earth.

What is Global Atmospheric Circulation?

- The Earth is surrounded by a thin layer of air called the atmosphere. The air in the atmosphere moves in response to differences in temperature at the equator (warm) and the poles (cold). This movement of air is called global atmospheric circulation.

Impact of global atmospheric circulation

- Temperatures at the equator are high because incoming solar radiation is more intense as the sun's energy is more concentrated. Due to high temperatures at the equator, the air rises up into the atmosphere. This creates low pressure (as the air is rising it puts less pressure on the Earth's surface). As the air rises it becomes colder, causing condensation (forming clouds) that leads to rainfall. This is why tropical rainforests are found along the equator.



- When the air reaches the top of the atmosphere it needs somewhere to go. Some of the air travels north and some south of the equator. The air cools and then sinks at around 30° north and south of the equator. As the air is sinking this creates high pressure. As moisture in the sinking air fell at the equator it is dry so few clouds form here. This is why deserts are found along 30° north and south of the equator.
- Global atmospheric circulation creates winds across the planet as air moves from areas of high pressure to areas of low pressure. It also leads to areas of high rainfall, like the tropical rainforests, and areas of dry air, like deserts.
- In addition to heat from the equator moving towards the poles through atmospheric circulation, ocean currents also transfer heat. Oceans transfer approximately 20 per cent of the total heat from the tropics to the poles. Each ocean has a circular pattern of surface currents called a gyre. They are produced as assess of water move from one climate zone to another. They are also created by surface winds generated by global atmospheric circulation.

Upper air circulation- Tri-cellular model

- Circulation of winds from the surface upwards and vice-versa are called cells. These are generally of following 3 types:
  1. Hadley cell
  2. Ferrel cell
  3. Polar cell

Hadley Cell

- This is a cell of atmospheric motion. The warm air rises at the equator, creating areas of low pressure. Upon reaching the Tropopause, heat is lost and the air moves pole-wards.
- The air sinks in the sub-tropics as it is colder and denser.
- The sinking air causes areas of high pressure on the surface. The air then returns towards the tropics to replace the rising air. This forms a cell which is known as Hadley cell.

Ferrel cell

- In the middle latitudes the circulation is that of sinking cold air that comes from the poles and the rising warm air that blows from the subtropical high. At the surface these winds are called westerlies and the cell is known as the Ferrel cell.
- The Tri-cellular model of 1856 is inaccurate due to the recognition of seasonal shifts of the sun's position, energy transfers in mid-latitudes and most importantly the effect of Jet streams and Rossby waves, which disrupt north-south air movements in Ferrell cells.

Polar cell

- At polar latitudes the cold dense air subsides near the poles and blows towards middle latitudes as the polar easterlies. This cell is called the polar cell.
- In the Polar Regions, cold dense air sinks and spreads towards the lower latitudes. Here, it warms and rises spreading out towards the Tropopause; moving pole-wards again to replace the sinking air.

Thus, the movement of air between the equator and 30° north and south is known as the Hadley Cell. Air rises again at around 60° north and south and descends again around 90° north and south forming the Ferrel and Polar Cell

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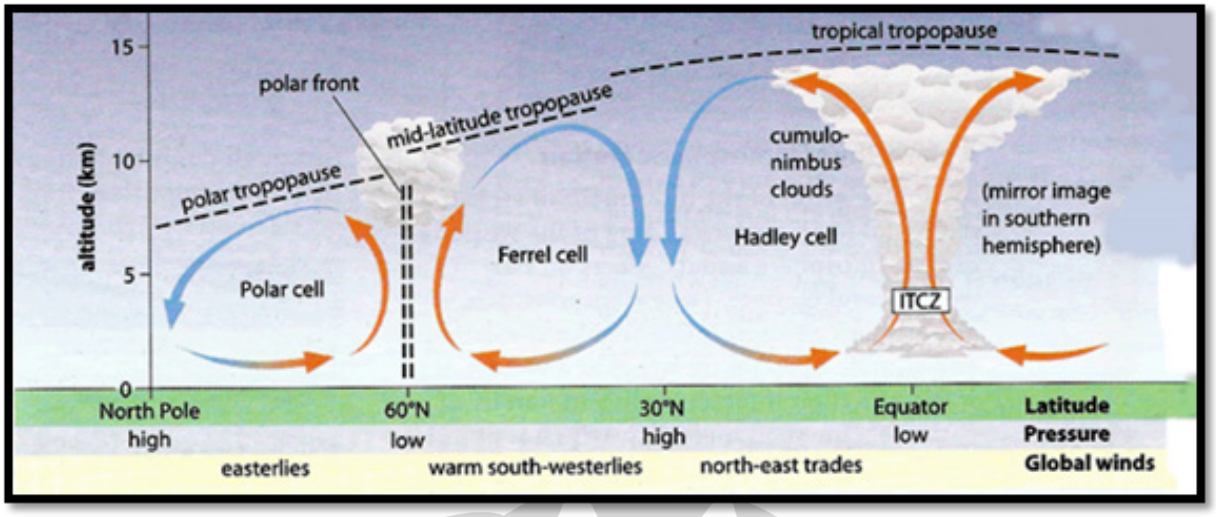


Mid-latitudes air circulations

Upper-air, westerly winds are called the Rossby Waves. Varying on season, there can be 2-5 waves. They are influenced by relief barriers, land and sea differences and can last for up to 6 weeks. These waves, in conjunction with jet streams, directly cause surface depressions and anticyclones. The wave form depends on:

- Thermal differences between polar and tropical regions
- The rotation of the earth
- Major relief barriers i.e. Rocky Mountains

Jet streams

- These are very high-speed narrow bands of wind, found where the temperature and pressure gradients are greatest in the upper atmosphere.

The Polar Front Jet Stream

- This separates the polar and tropical air in waves of troughs and ridges; it is situated between 35 to 55 degrees.
- The ridges take warm air up anticlockwise, creating areas of unstable, low surface pressure.
- The Troughs bring cold air descending clockwise to the surface creating dry, stable conditions with high surface pressures.

The Sub-Tropical Jet Stream

- With lower wind speeds and less pronounced waves, this stream is located at 25 – 30 degrees of latitude.

The Easterly Equatorial Jet Stream

- This jet stream is linked to the Indian monsoon and therefore is seasonal.

TYPES OF WINDS

Winds can occur on a large scale. On the bases of their area of influence they are divided into two types:

(1) Planetary winds:

- Trade winds
- Westerlies
- Polar winds

(2) Periodic winds:

- Seasonal winds
- Local winds

- Land and sea breezes

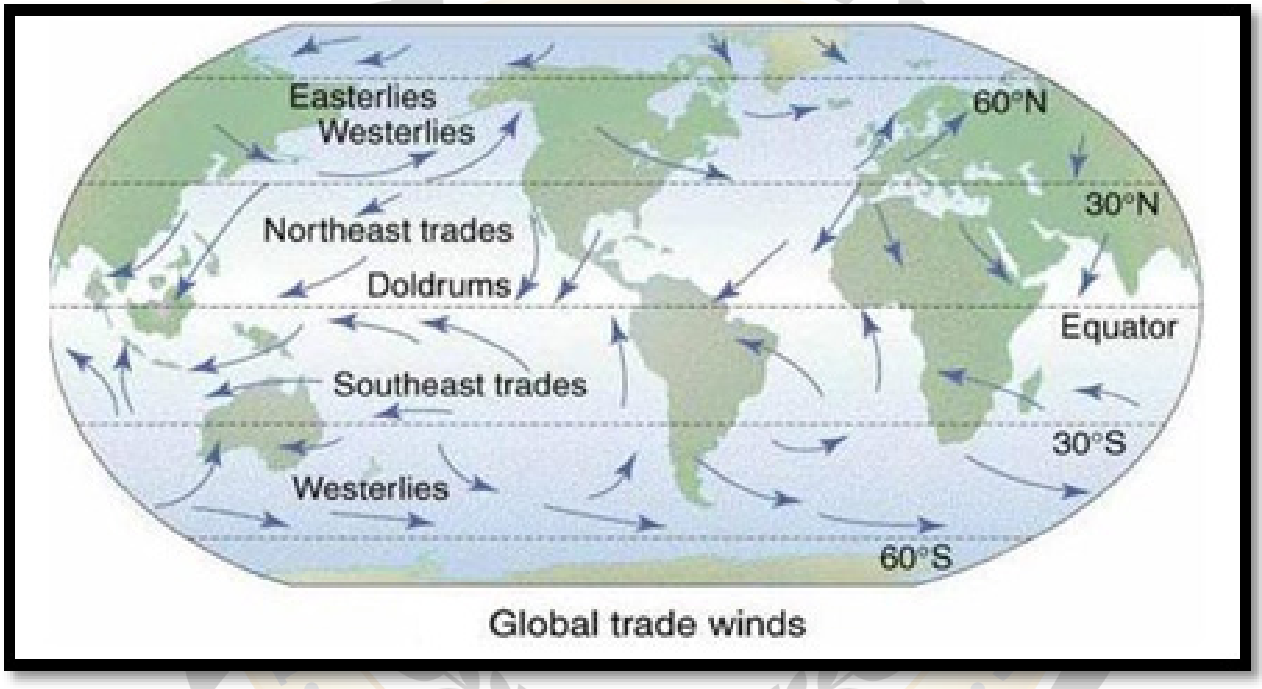
1. Planetary 0Winds

- They are a major part of general global circulation of air. They occur due to temperature and pressure variance existing throughout the world. They are of following types:

(i) Trade winds
(ii) Westerlies
(iii) Polar winds

(i) Trade Winds

- The winds which Blows from the subtropical highs or horse latitudes (between 30°N and 30°S) towards the equatorial low pressure zones are referred as trade winds.
- In the northern hemisphere, the trade wind blowing from the northeast and is known as the Northeast trade wind.
- In the southern hemisphere, the wind blowing from the southeast and are called the southeast trade wind.



Global trade winds

(ii) Westerlies Winds

- Prevailing wind in the middle latitudes between 35° and 65° latitude, blowing from high pressure area in the horse latitudes towards the poles are called as Westerlies wind.
- The winds are predominantly from the southwest in the northern hemisphere and from the northwest in the southern hemisphere and bring extra-tropical cyclones with them.
- In southern hemisphere they are stronger and more constant in direction than those of the northern hemisphere because of the vast expanse of water.
- They are best developed between 40° and 65° south latitudes. These latitudes are hence often called Roaring forties, furious fifties and shrieking sixties.

(iii) Polar Wind

- Winds blowing in the arctic and the Antarctic latitudes are polar winds.
- They blow from polar high pressure towards sub-polar low pressure belt.
- In the northern hemisphere, they blow from north-east, and are called the north-east polar winds.
- In the southern hemisphere, they blow from south-east and are called south-east polar winds.
- As these winds blow from ice-capped landmass, they are very cold.

2. Periodic Winds

Land and sea breezes local and monsoon winds are periodic winds. They are of the following types:

(i) Seasonal Winds (Monsoon Winds)

- Monsoons are regional wind systems that predictably change direction with the passing of the seasons.
- Monsoons occur over distances of thousands of kilometers, and their two dominant patterns of wind flow act over an annual time scale.
- From Indian context the monsoons are the seasonal reversal of wind patterns.

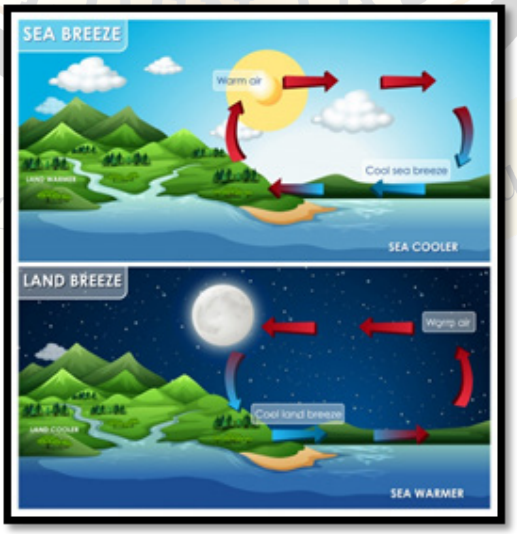
(ii) Local winds:

- Winds flow in comparatively small area and have special characteristics.
- They are generated by purely because of local factors (local temperature differences) and their zone of influence is quite limited. They play an important role in the weather of a particular locality.

Local wind	Nature of wind	Place of location
Chinook (Snow eaters)	Hot, dry wind	The Rockies mountains
Foehn	Hot, dry wind	The Alps
Khamsin	Hot, dry wind	Egypt
Sirocco	Hot, moist wind	Sahara to the Mediterranean Sea
Harmattan (Guinea Doctor)	Hot, dry wind	West Africa
Bora	Cold, dry wind	Blows from Hungary to North Italy
Mistral	Cold wind	The Alps and France
Blizzard	Cold wind	Tundra region
Levanter	Cold wind	Spain
Norwester	Hot wind	New Zealand
Santa Ana	Hot wind	South California

(iii) Land and Sea Breezes:

- Sometimes local conditions may set air in continuous motion. Even in calm days in summer, heated air rising from land surface may cause strong breezes to move in from over the cooler sea. Such movement of air from sea to the land is known as sea breeze.
- By night, land cools more rapidly than the sea, cool air may move seawards as land breeze, usually a gentle flow.
- In some countries, if hot deserts border the seas, strong winds may develop. Sea breeze will be felt miles inland.



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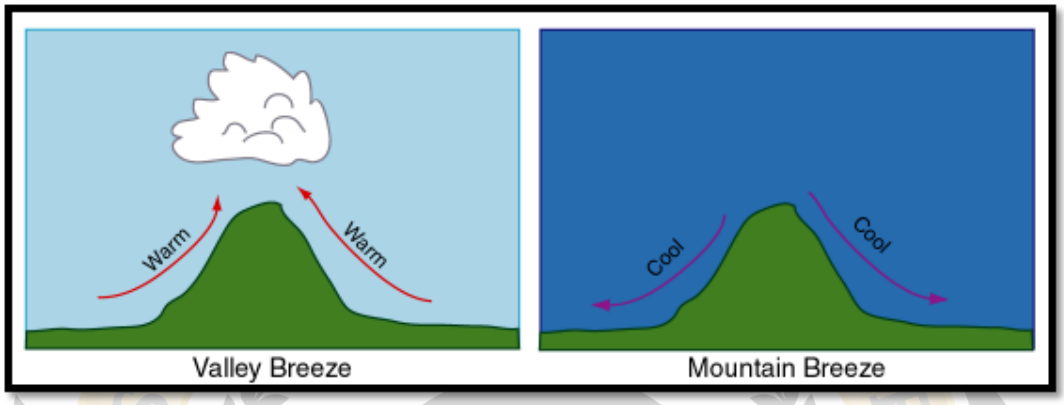
(iv) Mountain and valley breezes:

- In mountainous regions, during the day the slopes get heated up and air moves upslope and to fill the resulting gap the air from the valley blows up the valley. This wind is known as the valley breeze.
- During the night the slopes get cooled and the dense air descends into the valley as the mountain wind.
- The cool air, of the high plateaus and ice fields draining into the valley is called katabatic wind.
- Another type of warm wind occurs on the leeward side of the mountain ranges. The moisture in these winds, while crossing the mountain ranges condenses and precipitate.
- When it descends down the leeward side of the slope the dry air gets warmed up by adiabatic process. This dry air may melt the snow in a short time.



CLOUDS

- Cloud is a mass of minute water droplets or tiny crystals of ice formed by the condensation of the water vapor in free air at considerable elevations. They are mass of very fine water droplets, ice particles or mixture suspended in the atmosphere.
- Clouds are formed by the adiabatic cooling of air when it is below its dew point. Cooling process is created by upward movement of light and warm moist air which reduces pressure, expands and reaches its dew point. There is further cooling below dew point causing condensation.

Basic types of clouds

According to their height, expanse, density and transparency or opaqueness, all the clouds are grouped under four basic types: (i) Cirrus; (ii) Cumulus; (iii) Stratus; (iv) Nimbus.

- Cirrus: Cirrus clouds are formed at high altitudes (8,000 - 12,000m). They are thin and detached clouds having a feathery appearance. They are always white in colour.
- Cumulus: Cumulus clouds look like cotton wool. They are generally formed at a height of 4,000 - 7,000 m. They exist in patches and can be seen scattered here and there. They have a flat base.
- Stratus: As their name implies, these are layered clouds covering large portions of the sky. These clouds are generally formed either due to loss of heat or the mixing of air masses with different temperatures.
- Nimbus: Nimbus clouds are black or dark gray. They form at middle levels or very near to the surface of the earth. These are extremely dense and opaque to the rays of the sun. Sometimes, the clouds are so low that they seem to touch the ground. Nimbus clouds are shapeless masses of thick vapor.

Classification of Clouds

- Usually clouds are classified in terms of their vertical arrangement in the atmosphere of high, middle and low clouds.

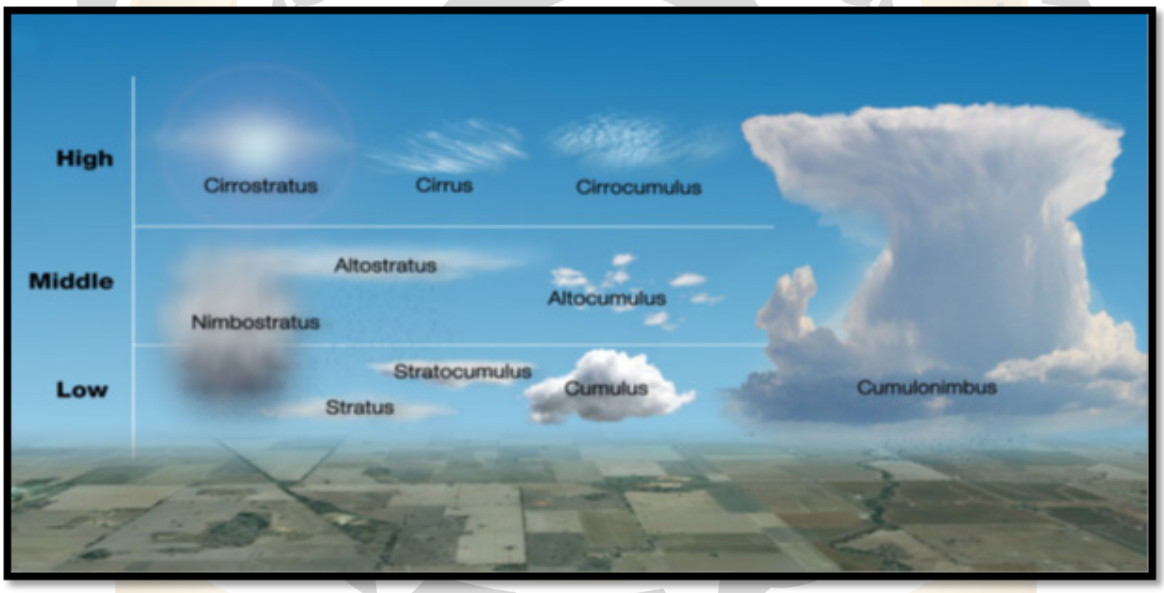
- A combination of the four basic types of clouds can give rise to the following types of clouds: high clouds – cirrus, cirrostratus, cirrocumulus; middle clouds – altostratus and altocumulus; low clouds – stratocumulus and nimbostratus and clouds with extensive vertical development – cumulus and cumulonimbus.

1. **High clouds: 6000 to 12000 meters above sea level.**
- Cirrus: Wispy, fibrous-looking cloud which indicate fair weather.
- Cirrocumulus: A thin cloud, often globular and rippled.
- Cirrostratus: Thin white sheet type which gives the sun and moon their haloes.

2. **Medium clouds: 2000 to 6000 meter above sea level.**
- Altocumulus: Globular, bumpy looking clouds with a flat base covering entire sky
- Altostratus: Greyish, watery looking and wool pack cloud.

3. **Low clouds: below 2000 meters above sea level.**
- Stratocumulus: Low rolling, bumpy clouds.
- Nimbostratus: Fog-like low cloud causes dull weather with drizzle. It is also associated with lightning thunder and hailstorm.
- Stratus: These clouds are low, grey and layered, almost fog-like in appearance, bring dull weather and often accompanied by drizzle air or snowfall.

4. **Clouds of great Vertical extent: 1500 to 9000 m.**
- Cumulus: A round-topped and flat based cloud, which form a whitish grey globular mass. It sometimes becomes thunder cloud.
- Cumulonimbus: Cumulus cloud which reaches up to 9000 meters, often indicates convectional rain, lightning and thunder storm.



PRECIPITATION

The process of continuous condensation in free air helps the condensed particles to grow in size. When the resistance of the air fails to hold them against the force of gravity, they fall on to the earth's surface. So after the condensation of water vapor, the release of moisture is known as precipitation. This may take place in liquid or solid form.

Various forms of precipitation

- **Rainfall:** The precipitation in the form of water is called rainfall.
- **Snow fall:** when the temperature is lower than the 0 degree C, precipitation takes place in the form of fine flakes of snow and is called snowfall. Moisture is released in the form of hexagonal crystals. These crystals form flakes of snow. Besides rain and snow, other forms of precipitation are sleet and hail, though the latter are limited in occurrence and

are sporadic in both time and space.

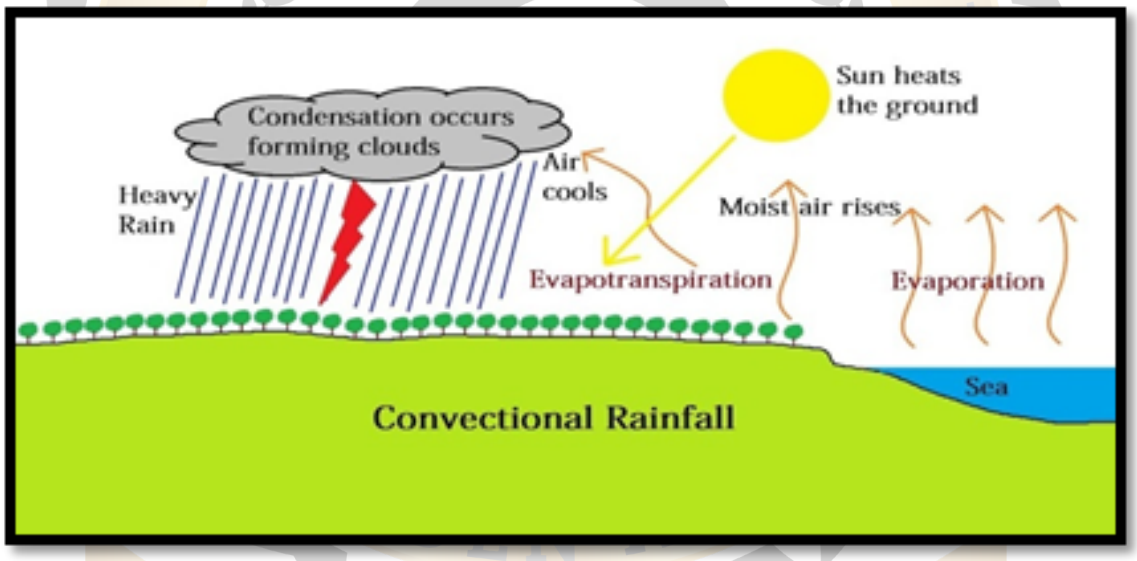
- **Sleet:** Sleet is frozen raindrops and refrozen melted snow-water. When a layer of air with the temperature above freezing point overlies a subfreezing layer near the ground, precipitation takes place in the form of sleet. Raindrops, which leave the warmer air, encounter the colder air below. As a result, they solidify and reach the ground as small pellets of ice not bigger than the raindrops from which they are formed.
- **Hailstones:** Sometimes, drops of rain after being released by the clouds become solidified into small rounded solid pieces of ice and which reach the surface of the earth are called hailstones. These are formed by the rainwater passing through the colder layers. Hailstones have several concentric layers of ice one over the other.

Types of Rainfall

On the basis of origin, rainfall may be classified into three main types – the convectional, Orographic or relief and the cyclonic or frontal.

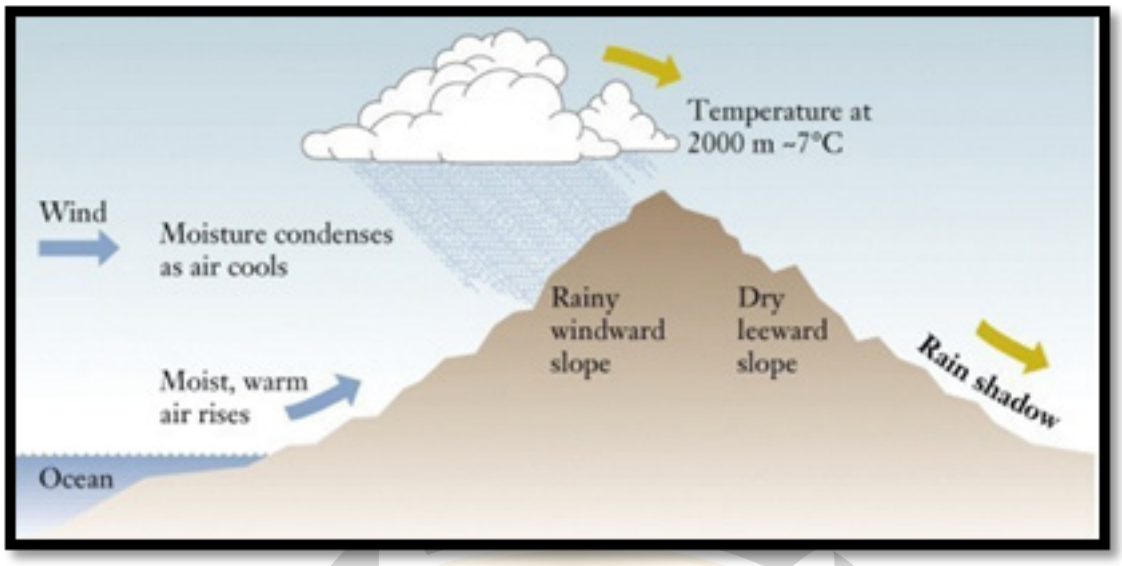
Convectional Rainfall

- The air on being heated becomes light and rises up in convection currents. As it rises, it expands and loses heat and consequently, condensation takes place and cumulous clouds are formed. With thunder and lightning, heavy rainfall takes place but this does not last long. Such rainfall is known as convectional rainfall.
- Such rain is common in the summer or in the hotter part of the day. It is very common in the equatorial regions and interior parts of the continents, particularly in the northern hemisphere.
- Ex: In India, this type of rainfall can be seen in plains especially in northern India during summer months.



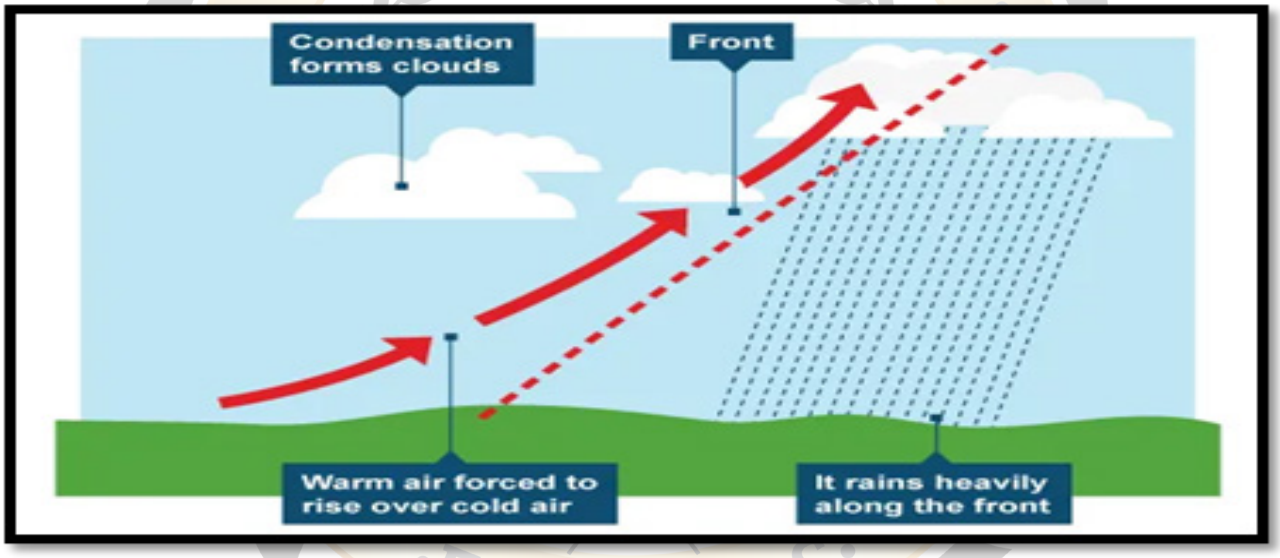
Orographic Rainfall

- When the saturated air mass comes across a mountain, it is forced to ascend and as it rises, it expands; the temperature falls, and the moisture is condensed in to clouds then leading to rainfall.
- The chief characteristic of this sort of rain is that the windward slopes receive greater rainfall.
- After giving rain on the windward side, when these winds reach the other slope, they descend, and their temperature rises. Then their capacity to take in moisture increases and hence, these leeward slopes remain rainless and dry.
- The area situated on the leeward side, which gets less rainfall is known as the rain-shadow area. It is also known as the relief rain.
- Ex: The Western Ghats are the perfect example of Orographic rainfall in India. This can also be found in Meghalaya hills and foothills of Himalayas.



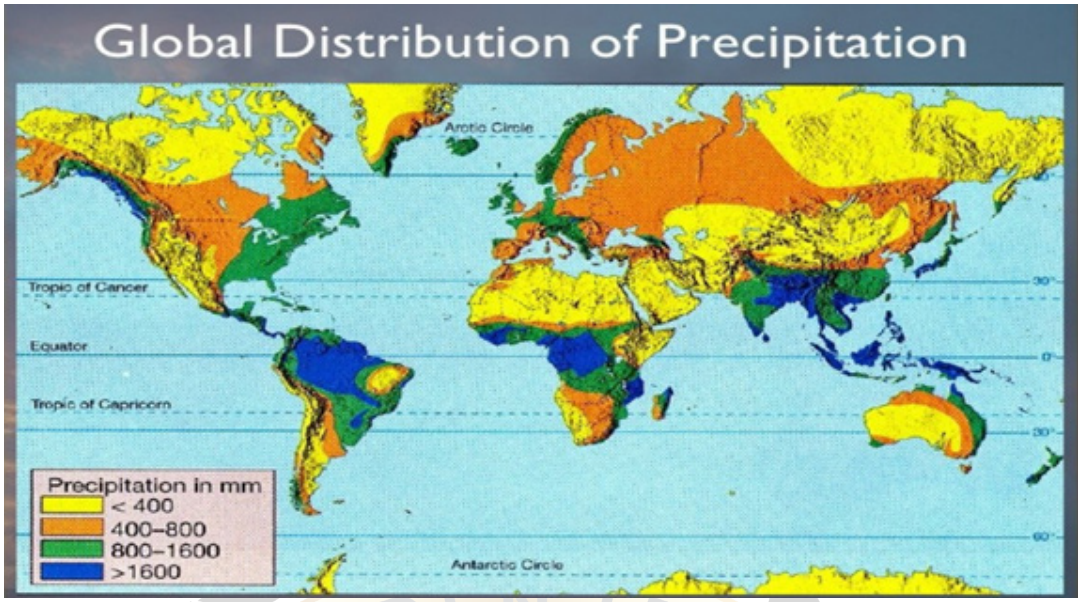
Cyclonic/ Frontal Rainfall

- Frontal rainfall occurs due to the upward movement of the air caused by the convergence of different air masses with different temperatures.
- The warm air rises over the cold air and cyclonic rain occurs. The cold air pushes up the warm air and sky gets clear again.
- Ex: Coastal India, especially Bay of Bengal states receive frontal rainfall.



Global Distribution of Rainfall

- As we proceed from the equator towards the poles, rainfall goes on decreasing steadily.
- The coastal areas of the world receive greater amounts of rainfall than the interior of the continents.
- The rainfall is more over the oceans than on the landmasses of the world because of being great sources of water.
- Between the latitudes 350 and 400 N and S of the equator, the rain is heavier on the eastern coasts and goes on decreasing towards the west.
- But, between 45 degrees and 65degrees N and S of equator, due to the westerlies, the rainfall is first received on the western margins of the continents and it goes on decreasing towards the east.
- Wherever mountains run parallel to the coast, the rain is greater on the coastal plain, on the windward side and it decreases towards the leeward side.



Classification Regions Based on Precipitation/Rainfall:

1. **Regions of Heavy Precipitation: Rainfall more than 150 cm per year are:**
- **Equatorial regions:** Amazon and Congo Basins, Malaysia, Indonesia and New Guinea.
- **Tropical Monsoon regions:** Parts of India, Southeast Asia and South China.
- **Mid-latitude West Margin regions:** Coastal regions of British Columbia, North-west Europe, South Chile and South Island of New Zealand.

2. **Moderate rainfall (100 to 150 cm per year)**
- Eastern margins of continents in the trade-wind belt.
- E.g. Eastern margin of China, U.S.A., Brazil, South Africa and Australia.

3. **Regions of very low rainfall (less than 25 cm.)**
- **Tropical deserts –** Western margins of continents in the trade wind belt, Californian desert (USA), Atacama (South America), Kalahari (Southern Africa), Sahara, Arabian Desert and West Australian desert.
- **Mid-latitude desert –** Interiors of large continents like Asia and North America.
- **Polar Regions –** Arctic and Antarctic.