STRICTLY BASED ON **NDA/NA EXAMINATION** CURRICULUM

World Geography

PARAMOUNT DEFENCE ACADEMY

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Topics Covered

1. **Earth and it's system**
2. **Latitudes and Longitudes**
3. **Solar System**
4. **Moon Systems**
5. **Continental Drift Theory**
6. **Rocks**
7. **Climate**
8. **Earthquakes and Volcanoes**
9. **Ocean Currents**
10. **Tides**
11. **Pressure Belts & Winds**
12. **Earth Atmosphere**
13. **Clouds**
14. **Grasslands of the World**

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Earth and its Systems

Area: Total surface area 509,700,000 sq. km; Land area about 148,400,000 km (about 29 percent of the total area) Water area about 361,300,000 sq. km (about 71 percent of the total surface area).

Motions; (i) Rotation (spinning motion on polar axis), once every 23 hours 56 minutes and 4.09 seconds.

- **Ocean Depths**: Deepest area— **Mariana Trench in Pacific Ocean** southwest of Guam (11,033 meters below sea surface). The average depth of oceans 3,730 meters.
- **Chemical Makeup of the Earth's Crust** (percent by weight): oxygen 46.6. silicon 27.7, aluminum 8.1, iron 5.0, calcium 3.6, sodium 2.8, potassium 2.6, magnesium 2.0 and other elements 1.6.

Rotation of Earth

- Earth rotates along its axis from **west to east**.
- It takes approximately 24 hours to complete on rotation.
- **Days and nights** occur due to rotation of the earth.
- The circle that divides the day from night on the globe is called the **circle of illumination.**
- Earth rotates on a **tilted axis**. Earth's rotational axis makes an angle of **23.5°** with the normal i.e. it makes an angle of **66.5°** with the orbital plane. Orbital plane is the plane of earth's orbit around the Sun.
- Rotation (spinning motion on polar axis), once every 23 hours 56 minutes and 4.09 seconds.
- Revolution (around the sun), once every **365 days, 6 hours, 9 minutes and 9.54 seconds.**
- Geo and Magnetic South and North
- Why temperature falls with increasing latitude (as we move from equator towards poles)?

Revolution

- The second motion of the earth around the sun in its orbit is called revolution. **It takes 365¼ days (one year) to revolve around the sun.**
    - **Six hours saved every year are added to make one day (24 hours) over a span of four years.**

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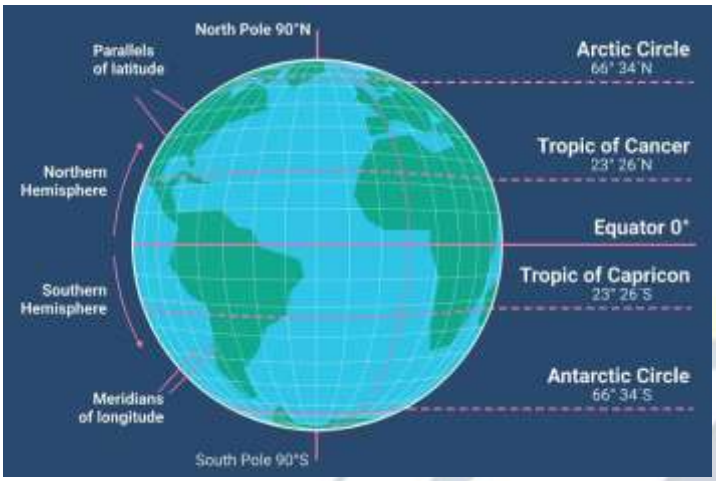
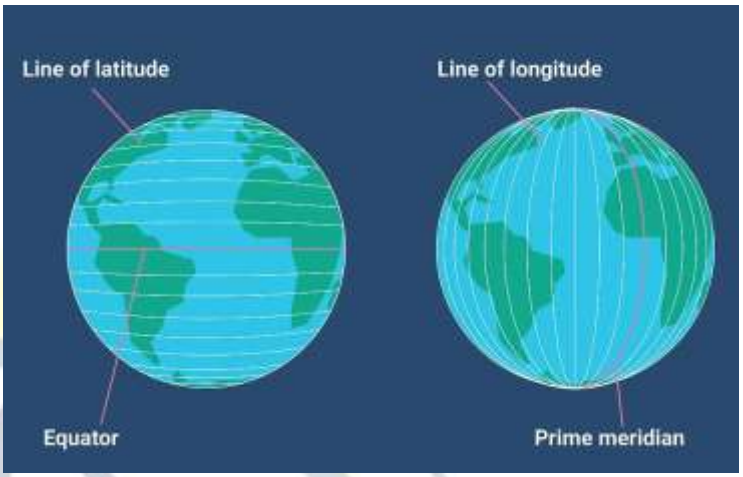
Latitudes and Longitudes

- **Latitudes and Longitudes are imaginary lines used to determine the location of a place on earth.**
- The location of a place on the earth can be mentioned in terms of latitudes and longitudes.





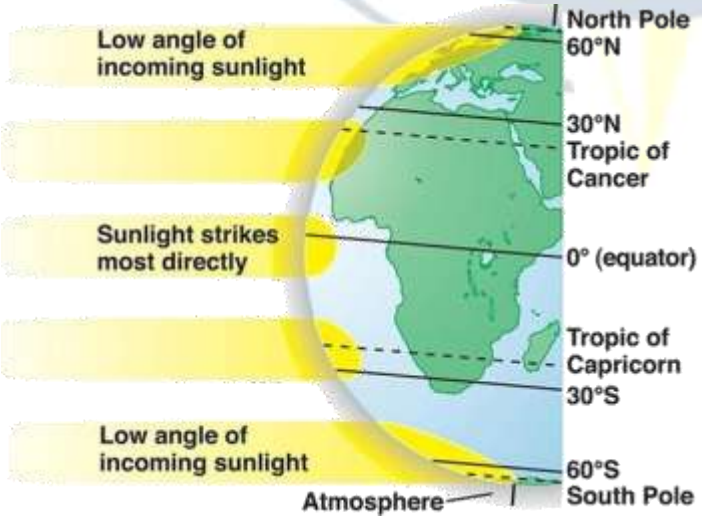
- As the earth is slightly flattened at the poles, **the linear distance of a degree of latitude at the pole is a little longer than that at the equator.**

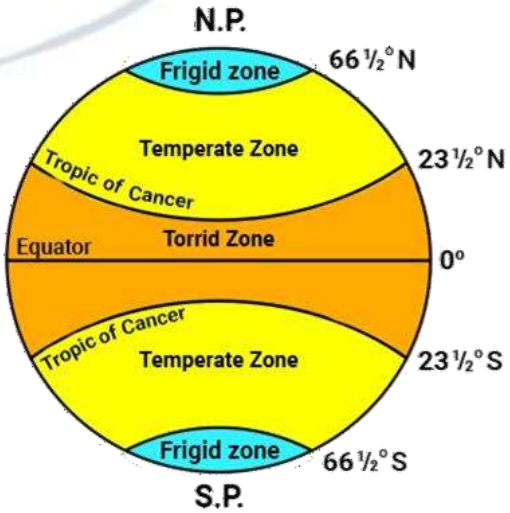
For example, at the equator (0°) it is 68.704 miles, at 45° it is 69.054 miles and at the poles it is 69.407 miles. The average is taken as 69 miles (111km).

- **Tropic of Cancer (23½° N) in the northern hemisphere.**
- **Tropic of Capricorn (23½° S) in the southern hemisphere.**
- **Arctic circle at 66½° north of the equator.**
- **Antarctic circle at 66½° south of the equator.**

Equator

- Equator is an **imaginary line running on the globe that divides it into two equal parts.**
- Northern half of the earth is known as the Northern Hemisphere and Southern half is known as the Southern Hemisphere.





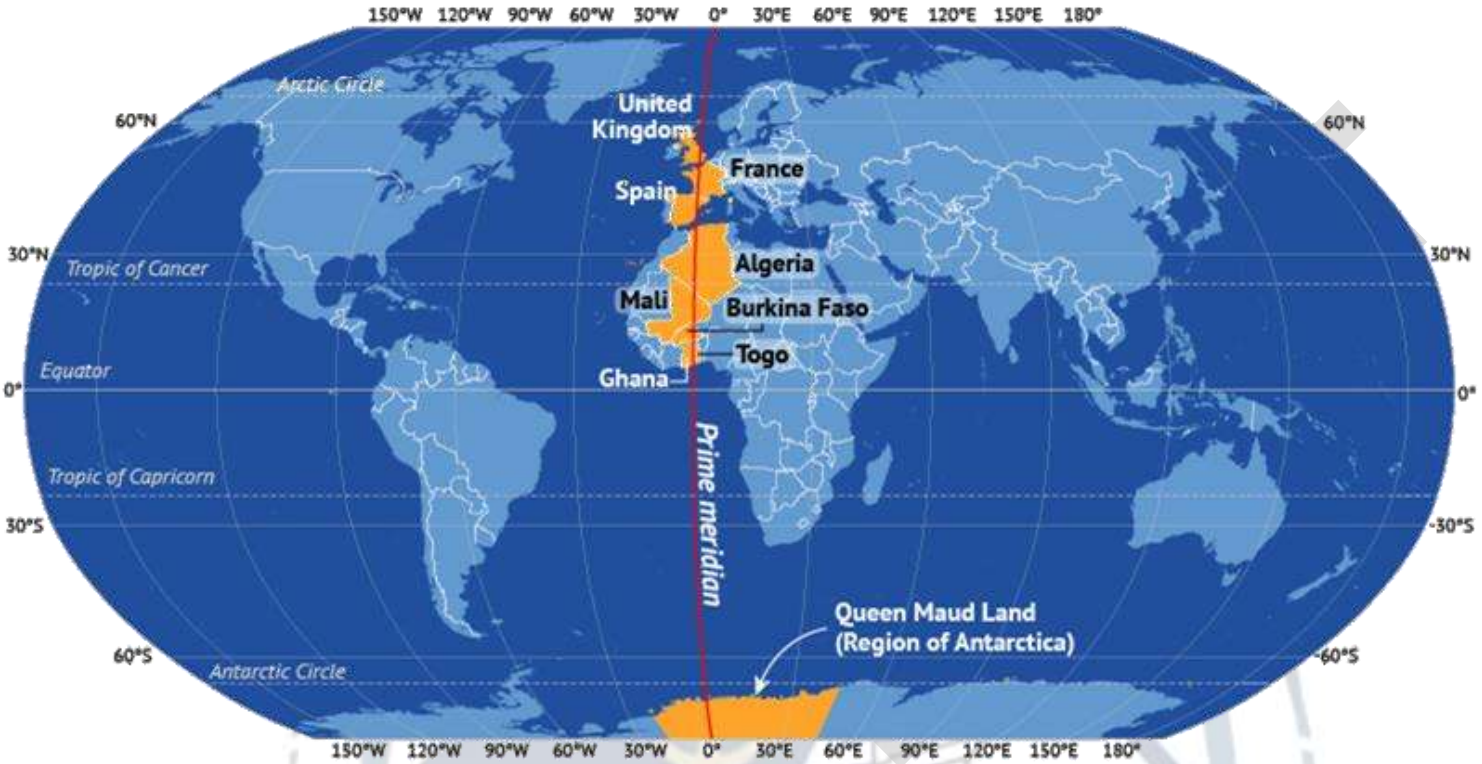
Heat zones of the earth

- The mid-day sun is exactly overhead at least once a year on all latitudes in between the Tropic of Cancer and the Tropic of Capricorn. This area, therefore, receives the maximum heat and is called the torrid zone.
- Torrid Zone is the tropical region. The temperature remains high. The Torrid Zone forms the hottest region of the world with two annual seasons namely a dry and a wet season. This zone includes most of Africa, southern Mexico, Central America and northern South America.
- Equatorial and Hot Tropical Zone. Heat Budget
- **The mid-day sun never shines overhead on any latitude beyond the Tropic of Cancer and the Tropic of Capricorn**. The angle of the sun's rays goes on decreasing towards the poles. As such, the areas bounded by the Tropic of Cancer and the Arctic circle in the northern hemisphere, and the Tropic of Capricorn and the Antarctic circle in the southern hemisphere, have moderate temperatures. These are, therefore, called temperate zones.
- Climate is mild, generally ranging from warm to cool. The four annual seasons, Spring, Summer, Autumn and Winter occur in these areas. **The North Temperate Zone includes Great Britain, Europe, northern Asia, North America and northern Mexico. The South Temperate Zone includes southern Australia, New Zealand, southern South America and South Africa.**
- **Areas lying between the Arctic circle and the north pole in the northern hemisphere and the Antarctic circle and the south pole in the southern hemisphere, are very cold**. It is because here the sun does not raise much above the horizon. Therefore, its rays are always slanting. These are, therefore, called frigid zones.
- **Coldest temp is in Antarctica area because it is land with thick ice sheets**

Longitude

- Longitude is an **angular distance, measured in degrees along the equator east or west of the Prime (or First) Meridian.**
- On the globe longitude is shown as a series of semi-circles that run from pole to pole passing through the equator.
- Unlike the equator which is centrally placed between the poles, any meridian could have been taken to begin the numbering of longitude.
- zero meridian the one which passes through the Royal Astronomical Observatory at Greenwich, near London.
- This is the Prime Meridian (0°) from which all other meridians radiate eastwards and westwards up to 180°.
- As the parallels of latitude become shorter poleward, so the meridians of longitude, which converge at the poles, enclose a narrower space.
- They have one very important function, **they determine local time in relation to G.M.T. or Greenwich Mean Time, which is sometimes referred to as World Time.**

- Ground dist. at given lat. = Cos(angle)*111
- Lat and log make 90 everywhere



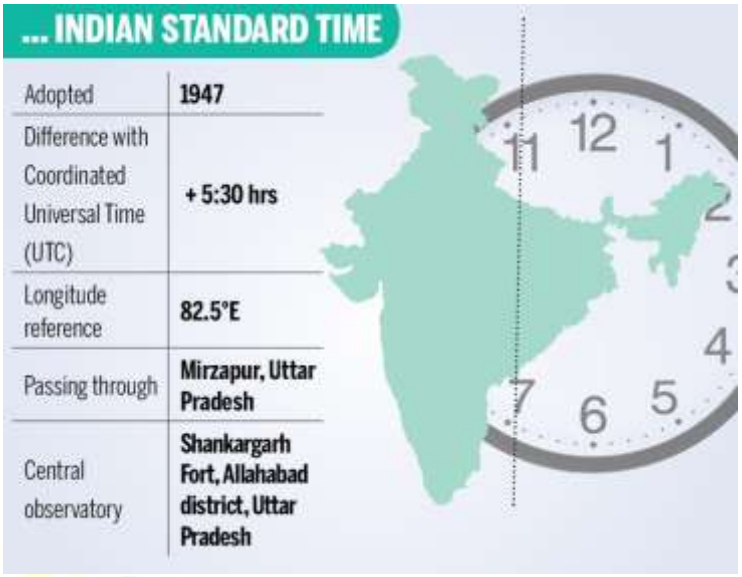
Longitude and Time

- **Since the earth makes one complete revolution of 360° in one day or 24 hours, it passes through 15° in one hour or 1° in 4 minutes.**
- The earth rotates from west to east, so every 15° we go eastwards, local time is advanced by 1 hour. Conversely, if we go westwards, local time is retarded by 1 hour.
- We may thus conclude that places east of Greenwich see the sun earlier and gain time, whereas places west of Greenwich see the sun later and lose time.
- **If we know G.M.T., to find local time, we merely have to add or subtract the difference in the number of hours from the given longitude.**

Standard Time and Time Zones

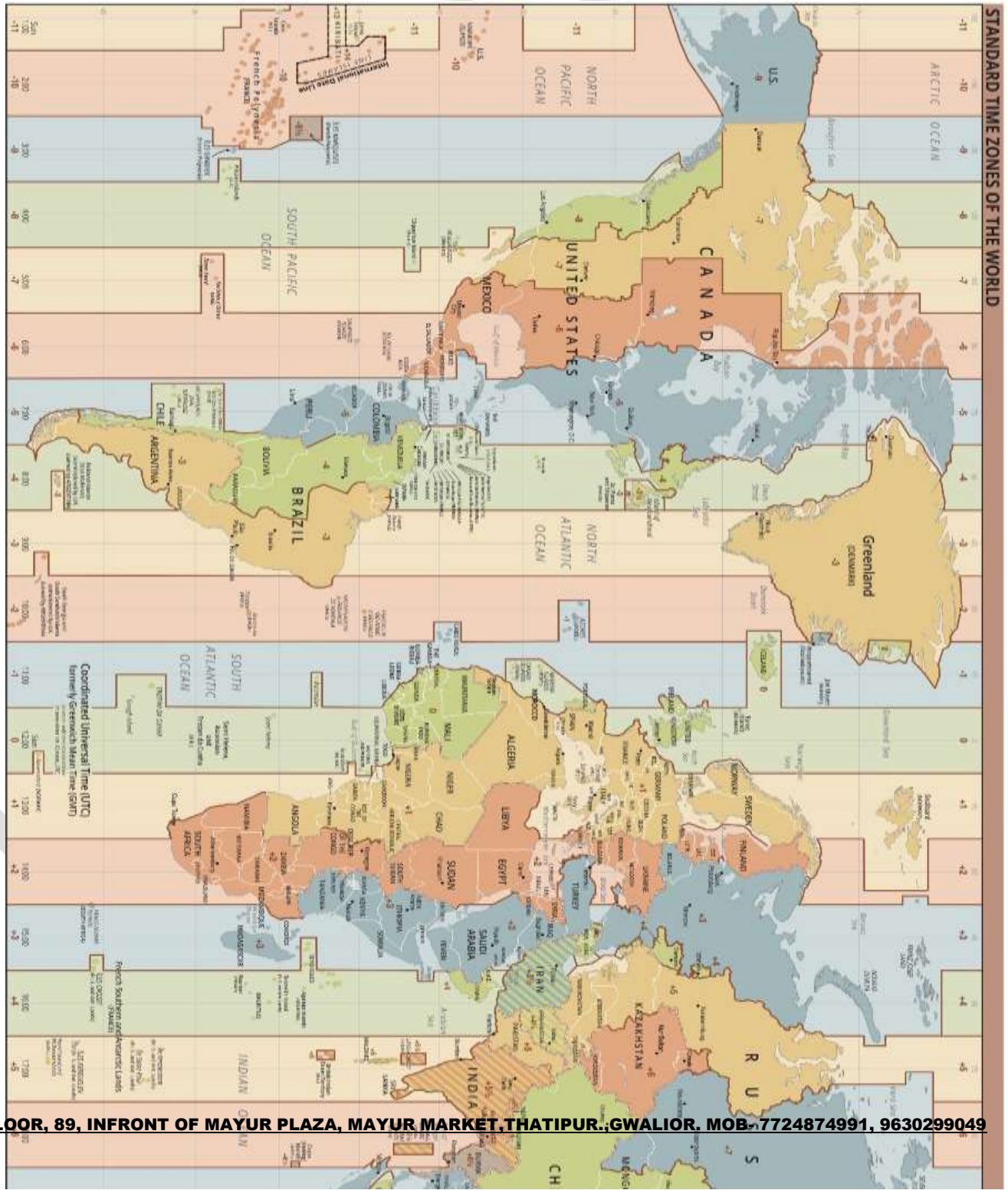
- **If each town were to keep the time of its own meridian, there would be much difference in local time between one town and the other.**
- Travelers going from one end of the country to the other would have to keep changing their watches if they wanted to keep their appointments. This is impractical and very inconvenient.
- To avoid all these difficulties, a system of standard time is observed by all countries.
- **Most countries adopt their standard time from the central meridian of their countries.**
- **In larger countries such as Canada, U.S.A., China, and U.S.S.R, it would be inconvenient to have single time zone. So, these countries have multiple time zones.**
- Both Canada and U.S.A. have five time zones—the Atlantic, Eastern, Central, Mountain and Pacific Time Zones.
- The difference between the local time of the Atlantic and Pacific coasts is nearly five hours.
- US.S. R had eleven time zones before its disintegration. Russia now has nine time zones.
- **A traveler going eastwards gains time from Greenwich until he reaches the meridian 180°E, when he will be 12 hours ahead of G.M.T.**
- **Similarly, in going westwards, he loses 12 hours when he reaches 180°W.** There is thus a total difference of 24 hours or a whole day between the two sides of the 180° meridian.
- This is the International Date Line where the date changes by exactly one day when it is crossed. A traveler crossing the date line from east to west loses a day (because of the loss in time he has made); and while crossing the dateline from west to east he gains a day (because of the gain in time he encountered).

- The International Date Line in the mid-Pacific curves from the normal 180° meridian at the Bering Strait, Fiji, Tonga and other islands to prevent confusion of day and date in some of the island groups that are cut through by the meridian.



Indian Standard Time

- The Indian Government has **accepted the meridian of 82.5° east for the standard time which is 5 hours 30 mins, ahead of Greenwich Mean Time.**

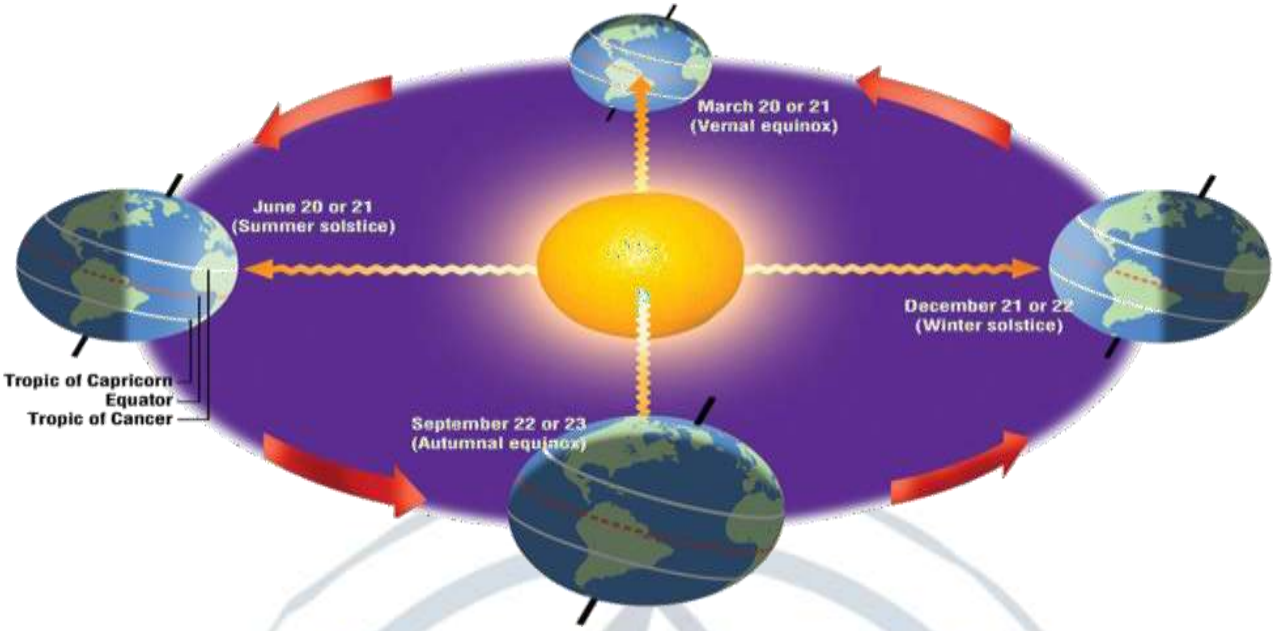


Solstice

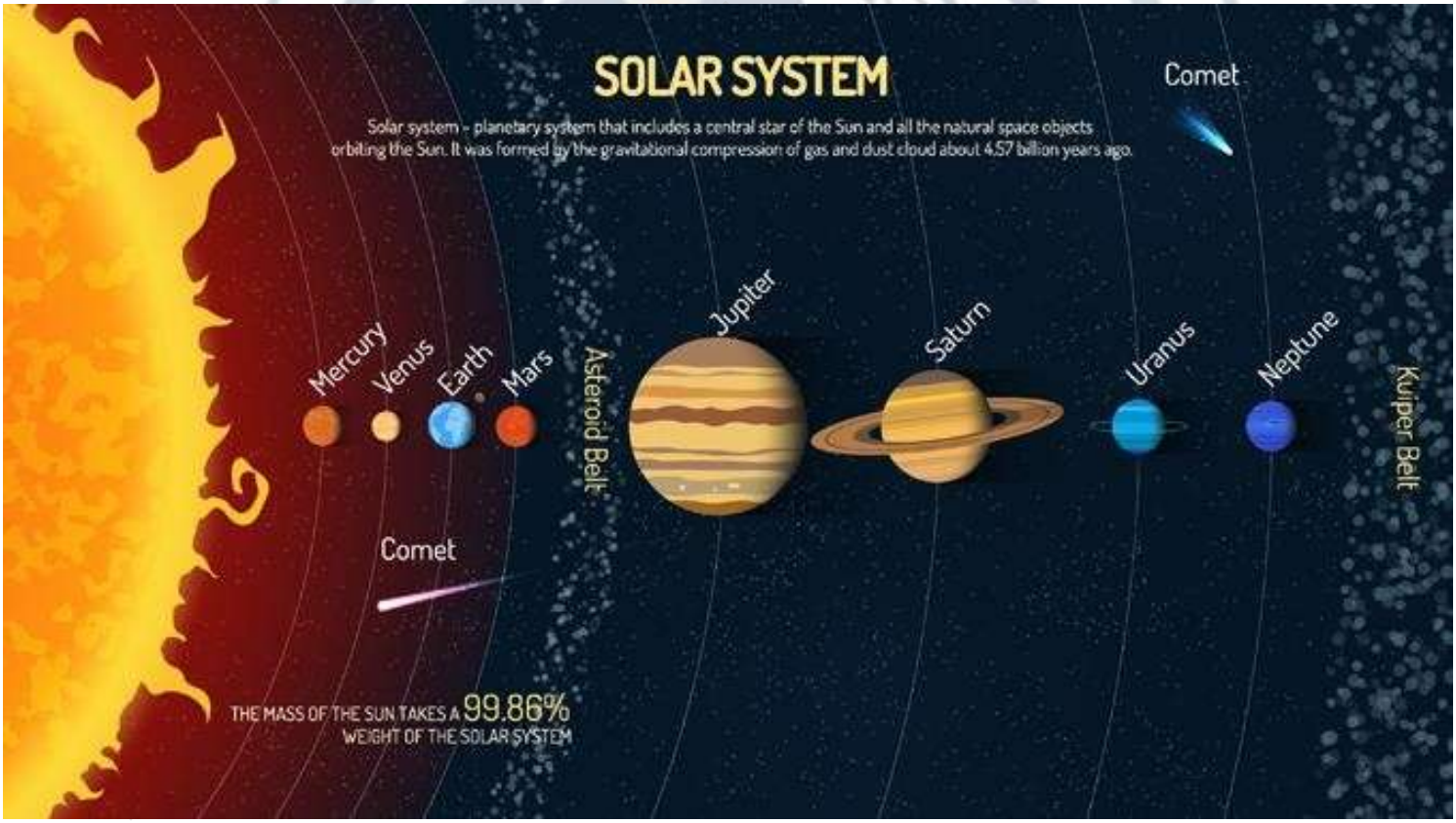
- **On 21st June, the northern hemisphere is tilted towards the sun**. The rays of the sun fall directly on the Tropic of Cancer. As a result, these areas receive more heat.
- **The areas near the poles receive less heat as the rays of the sun are slanting.**
- The north pole is inclined towards the sun and the places beyond the Arctic Circle experience continuous daylight for about six months.
- Since a **large portion of the northern hemisphere is getting light from the sun, it is summer in the regions north of the equator**. The longest day and the shortest night at these places occur on 21st June.
- **At this time in the southern hemisphere all these conditions are reversed**. It is winter season there. The nights are longer than the days. This position of the earth is called the summer solstice.
- On 22nd December, **the Tropic of Capricorn receives direct rays of the sun as the south pole tilts towards it. As the sun's rays fall vertically at the Tropic of Capricorn (23½° s), a larger portion of the southern hemisphere gets light. Therefore, it is summer in the southern hemisphere with longer days and shorter nights**. The reverse happens in the northern hemisphere. This position of the earth is called the winter solstice.

Equinox

- **On 21st March and September 23rd, direct rays of the sun fall on the equator**. At this position, neither of the poles is tilted towards
- the sun; so, the whole earth experiences equal days and equal nights. This is called an equinox.
- On 23rd September, it is autumn season [season after summer and before the beginning of winter] in the northern hemisphere and spring
- Season [season after winter and before the beginning of summer] in the southern hemisphere. The opposite is the case on 21st March, when it is spring in the northern hemisphere and autumn in the southern hemisphere.
- Thus, you find that there are days and nights and changes in the seasons because of the rotation and revolution of the earth respectively.
- Rotation === Days and Nights.
- Revolution === Seasons.
- Why regions beyond the Arctic circle receive sunlight all day long in summer?



Solar System



Constellations

- Different groups of stars form various patterns and they are called constellations. **Saptarshi is an example of constellations.**
- The solar system is made up of the Sun, eight planets, satellites and other celestial bodies.
- **99.8% mass is Sun, 0.2 planets, satellites**
- Movement around the axis- West to east except Venus and Uranus

Asteroids

- Asteroids are **numerous tiny bodies which also move around the Sun apart from the stars, planets and satellites.**
- They are found between the orbits of Mars and Jupiter.
- Vesta- largest Asteroid, Rygu

Meteoroids

- Meteoroids are **small pieces of rocks which move around the sun. Made of Ni, Fe. Lonar lake**
- Dwarf Planets- Orbit around Sun, Distance more tha Neptune. Now 5- Ceres, Haumea, Eris, Pluto, Make Neptune

Inner planets

- Less mass
- Less Satellites
- Denser
- Revolve rapidly around Sun
- Rotate Slow around axis, to maintain its movement around Sun.
- Circular orbit.

Outer planets

- Less dense
- More Satellite
- Revolve Slow
- Rotate fast
- Orbits are elliptical
- Perihelion (Near) & Aphelion (Far)

Mercury

- **Fast revolution (88earth days)**
- Not hottest (less mass)
- H, He in atm

- No Satellite
- Marnier 10- first Spacecraft to visit Mercury
- Bepi Columbus- Sent by EU and Japan

Venus

- **Hottest, Driest**
- Atm- Co2(90%), CO, N
- Rotate east to west
- No Satellite
- **2nd brightest element in Solar Sys**
- Only planet whose rotation period is more than revolution

Mars

- Red Plan by of Iron Oxide
- Inclined axis
- Polar sheets made up of co2
- 2 Satellite- Phobos, Dlimos
- Olympus Moon- Highest mountain Solar sys

Jupiter

- *Mass- 320 times earth, H, He in atm*
- Rings, Most Volume
- **Ganymede- Biggest Satellite.**

Saturn

- **2nd Biggest, H, He**
- Titan, Casine- Satellites

Uranus

- **East to west, Roll around the sun (90)**
- 3rd largest, Coldest Planet

Neptune

- H, He, NH4, Acetylene
- **Methane presence appears blue**
- Satellite- Triton- Coldest body on earth

Kuiper Belt Objects

- Region beyond Solar sys extending the orbit of Neptune

- **Massive and large than Asteroid belt**
- *Dwarf Planets in this region*
- Oort Region, Kirkwood gap

Comets

- **Asteroid like obj covered with Ice, Ammonia- Frozen rocky body**
- Definite orbits (we see only when sun come in b/w)
- Tail like str- halleys (once in 70 years) 2061

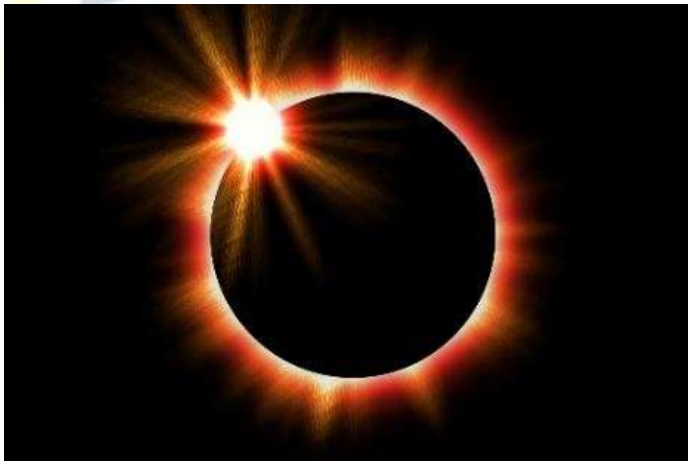
Moon System

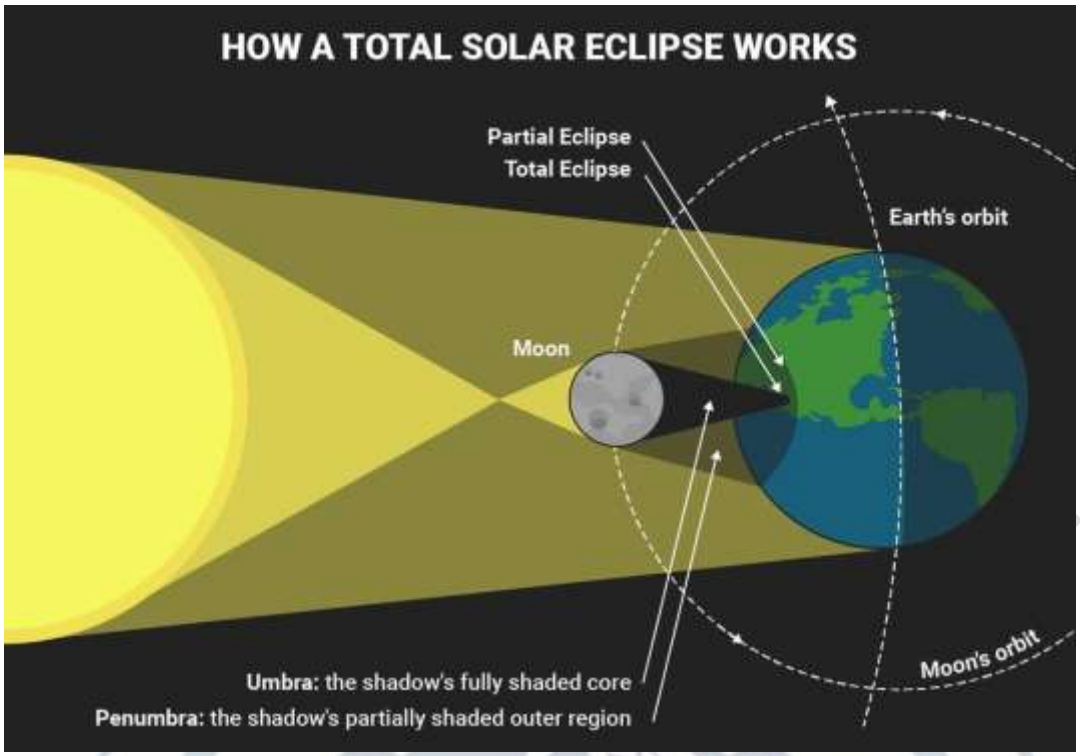
Moon

- **No atmosphere**
- **Full of rocks and mountain**
- Neil Armstrong- 1969- Apollo II Mission
- Temp- 265- 170-degree Fah
- One Lunar day on earth – Interval b/w appearance of moon- 24hr 53 Min
- **Amount of time moon take to revolve around earth is same as it takes to rotate around its axis.**
- **It changes its shape every day. This is because, the heavenly body has no light of its own; it can only reflect light from the sun. Only the side of the moon which faces the sun can reflect this light and can appear bright; the other side appears dark. As this celestial bod revolves around the earth, we can see different amounts of the region illuminated by the sun. Thus, it appears to change its shape.**
- **When this heavenly body is behind the earth and sun, we can see the entire illuminated portion – this is a full-moon (Paurnami).** When it is between the sun and earth, we can only see the dark portion and a new moon (Amavasya) occurs. Between these two extremes we see intermediate phases such as a half moon and crescent.
- This Planetoid takes almost 27 days to revolve around the earth. But between two full moons there are
- 29.5 days. This is because the earth also travels a distance through space during that time around the sun. It has to cover an extra distance (which takes 2 more days) if it has to be exactly behind the earth and sun again. (Sideral, Synodic)
- The celestial body only shows us only one side of itself. One side of it called dark side or far side never faces the earth. This is because the moon takes the same amount of time to rotate about its axis as it does to revolve around the earth. This known as Tidal Locking.

Solar Eclipse

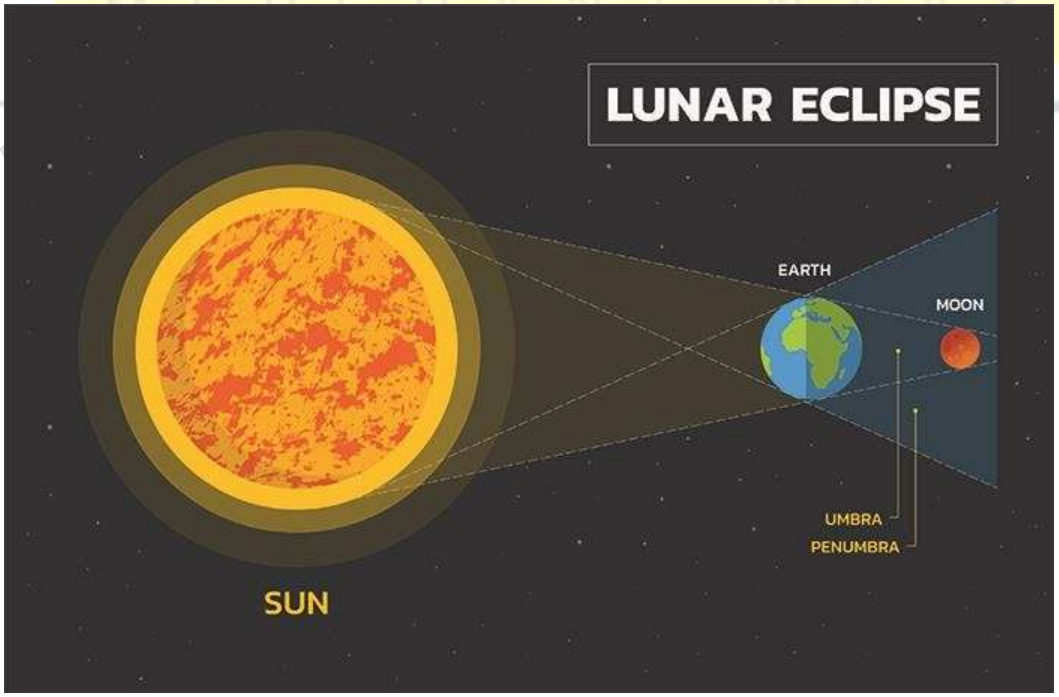
- **occurs when the moon comes in between the sun and the earth.**
- As a result, the **moon blocks the light of the sun from reaching the earth's surface and casts a shadow on it.**
- This occurs on a new moon phase. We can observe up to 5 solar eclipses per year.





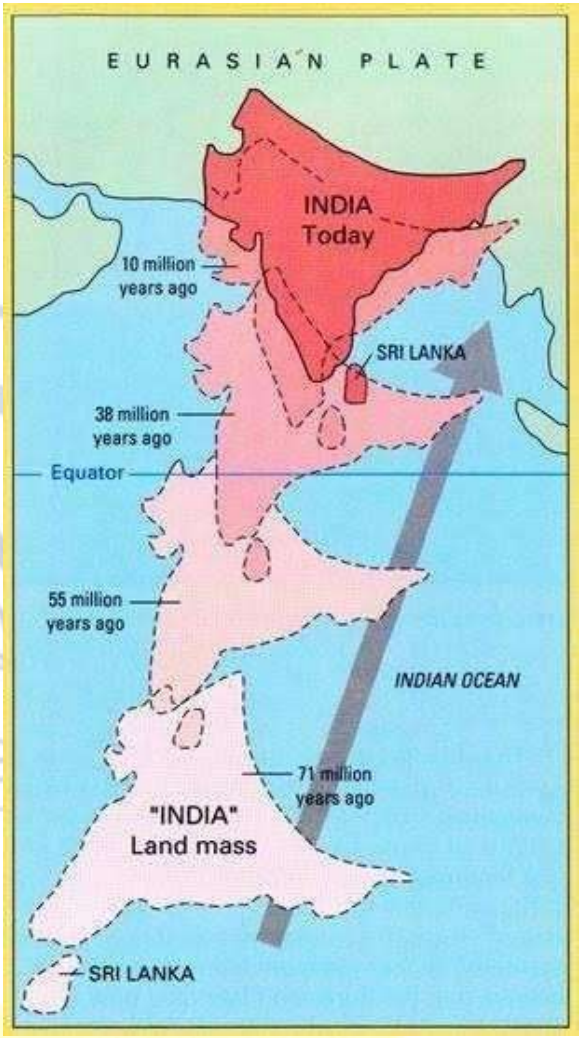
Lunar Eclipse

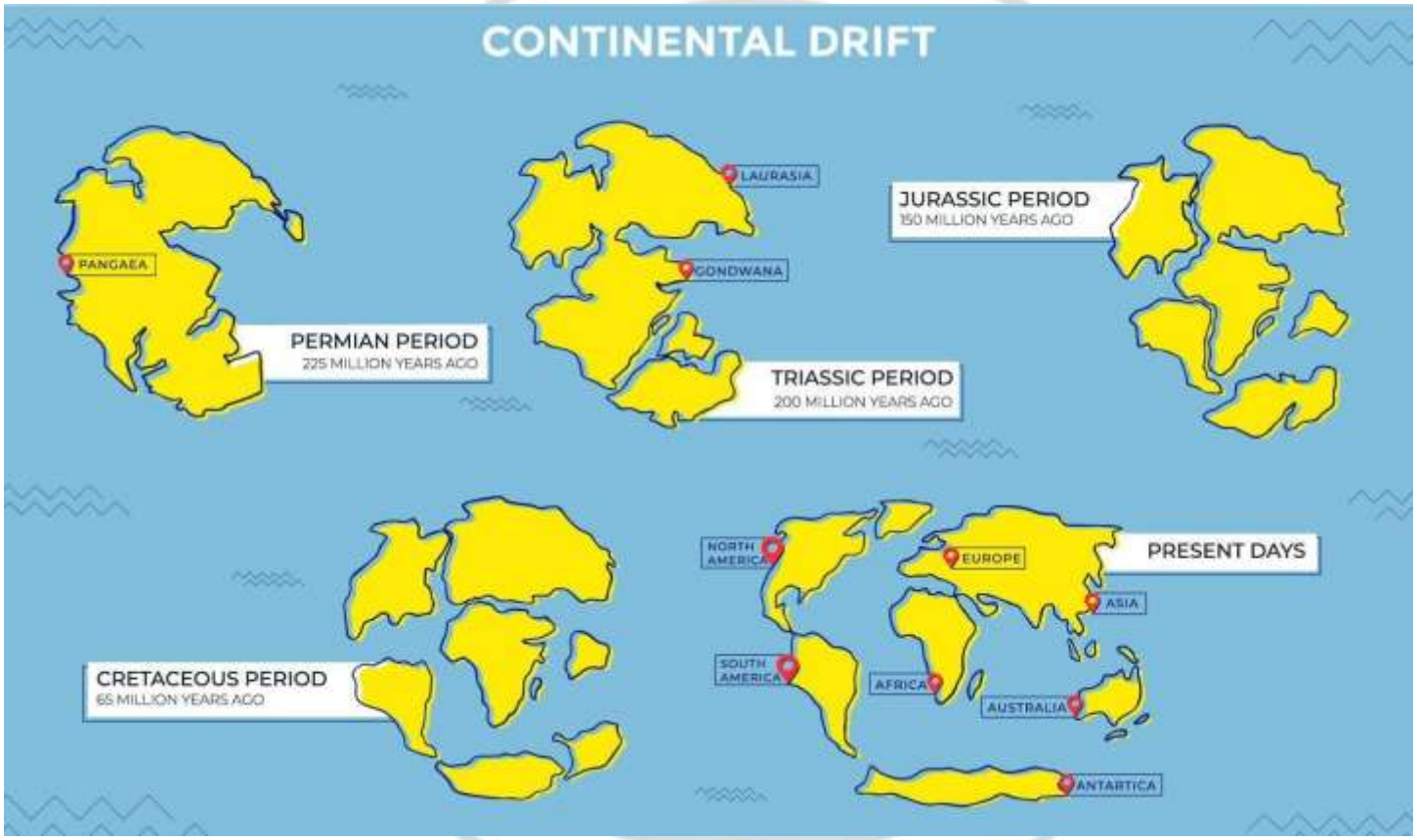
- known as the **eclipse of the moon,**
- it occurs **when the earth comes in between the sun and the moon**.
- As a result, the **earth blocks the light of the sun from reaching the moon's surface and casts its shadow on the moon.**
- It occurs on a full moon day. We can observe up to 3 lunar eclipses per year.



Theory of Continental Drift

- **Alfred Wegener** suggested continental Drift Theory in the 1920's.
- According to Continental Drift Theory there existed one big landmass which he called Pangaea which was covered by one big ocean called Panthalassa.
- A sea called **Tethys** divided the Pangaea into two huge landmasses: Laurentia (Laurasia) to the north and Gondwanaland to the south of Tethys.
- Drift started around 200 million years ago (Mesozoic Era, Triassic Period, Late Triassic Epoch), and the continents began to break up and drift away from one another.
- According to Wegener, the drift was in two directions:
    - equator wards due to the interaction of forces of gravity, pole-fleeing force (due to centrifugal force caused by earth's rotation) and buoyancy (ship floats in water due to buoyant force offered by water), and
    - westwards due to tidal currents because of the earth's motion (earth rotates from west to east, so tidal currents act from east to west, according to Wegener).




CONTINENTAL DRIFT
PANGAEA
PERMIAN PERIOD
225 MILLION YEARS AGO
LAURASIA
GONDWANA
TRIASSIC PERIOD
200 MILLION YEARS AGO
JURASSIC PERIOD
150 MILLION YEARS AGO
CRETACEOUS PERIOD
65 MILLION YEARS AGO
NORTH AMERICA
EUROPE
ASIA
PRESENT DAYS
SOUTH AMERICA
AFRICA
AUSTRALIA
ANTARTICA

Rocks

It is collection of minerals

Core- No rock

Mantle- Only in upper

Part Crust Upper

Dominant elements

Oxy- 46.6%

Silicon – 27.7 %

Aluminum - 8.1%

Classification of Rocks:

- Igneous Rocks Solidified from **magma and lava**
- Sedimentary Rocks The result of the deposition of fragments of rocks by exogenous processes
- Metamorphic Rocks Formed out of existing rocks undergoing recrystallization

Igneous Rocks

- **Formed out of magma and lava and are known as primary rocks.**
- If molten material is cooled slowly at great depths, mineral grains may be very large.
- Sudden cooling (at the surface) results in small and smooth grains.
- **Granite, gabbro, pegmatite, basalt, etc. are some of the examples of igneous rocks.**
- There are two types of igneous rocks: intrusive rocks (Granite) and extrusive rocks (Basalt-Deccan Traps).
- Granite- Quartz, Potash, Mica
- Upper mantle – gabbro
- Crust- Granite

Plutonic Rocks or intrusive rocks

- Sometimes, the molten matter is not able to reach the surface and instead cools down very slowly at great depths.
- Slow cooling allows big-sized crystals (large grains) to be formed.
- E.g.- Granite

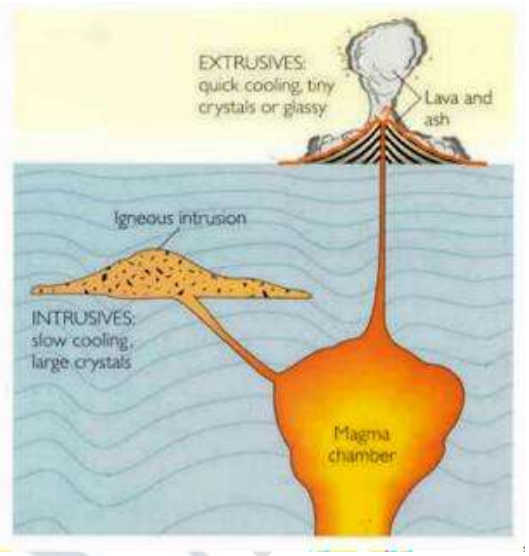
Lava or Volcanic Rocks or Extrusive rocks

- These are formed by **rapid cooling of the lava thrown out during volcanic eruptions.**
- Rapid cooling prevents crystallization, as a result such rocks are fine-grained.
- E.g.-Basalt (most common on earth surface- ocean crust). The Deccan traps in the

peninsular region is of basaltic origin.

- Gabbro Basalt

- Basic rocks contain a greater proportion of basic oxides, e.g. of iron, aluminum or magnesium, and are thus denser and darker in color.



Acidic rocks

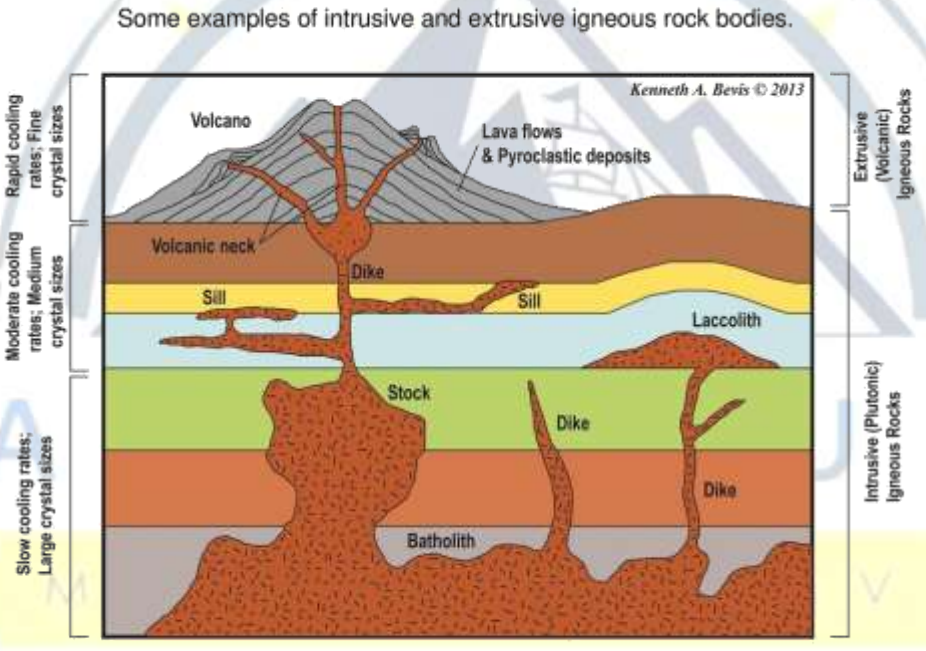
- High content of silica up to 80 per cent

- Granite, quartz, feldspar etc.

Basic rocks

- Poor in silica; magnesia content (40 per cent)

- Basalt, gabbro, dolerite etc.



Sedimentary Rocks

- **Sedimentary or detrital rocks.**

- **Formed as a result of denudation (weathering and erosion).**

- These deposits through compaction turn into rocks. This process is called lithification.

- Cover 75 per cent of the earth's crust

- They are layered or stratified of varying thickness. Example: sandstone, shale etc.

- Loess == Wind deposited sediments.

Depending upon the mode of formation, they are classified into

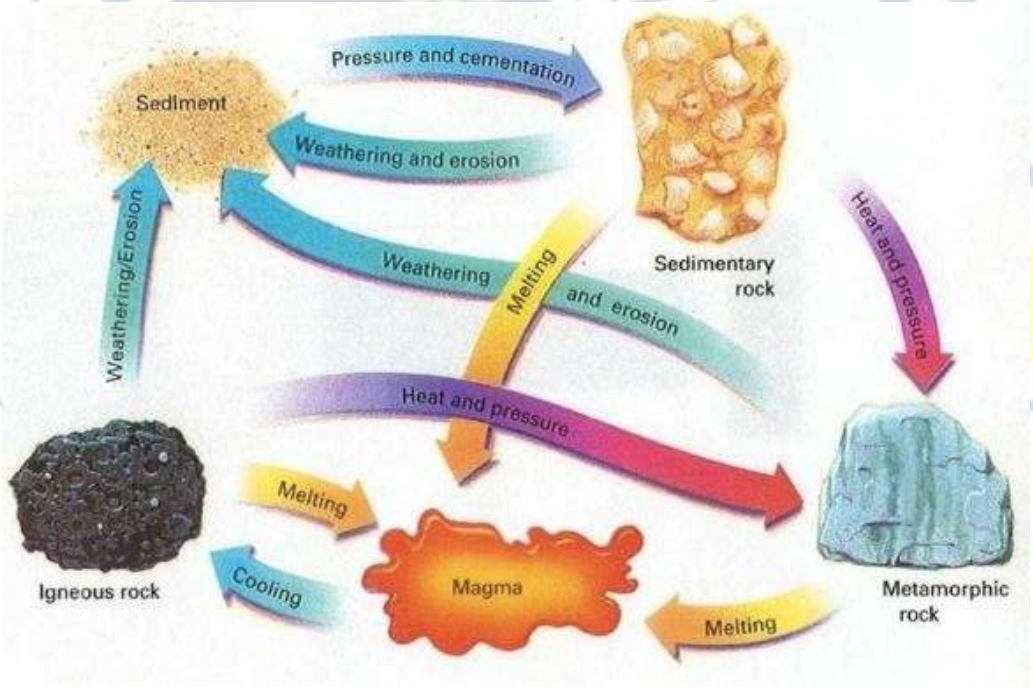
- **mechanically formed** — sandstone, conglomerate, limestone, shale, loess etc.

- **organically formed** — geyserite, chalk, limestone, coal etc.

- **chemically formed** — chert, limestone, halite, potash etc.

Mechanically Formed Sedimentary Rocks

- Formed by **mechanical agents like running water, wind, ocean currents, etc.**
- These rocks consist of a number of layers or strata
- These rocks are **characterized by marks left behind by water currents and waves etc.**
- These rocks have fossils of plants and animals.
- These rocks are generally porous and allow water to percolate through them.
- **Different varieties of sandstone are spread over Madhya Pradesh, eastern Rajasthan, parts of Himalayas, Andhra Pradesh, Bihar and Orissa.**
- The great Vindhyan highland in central India consists of sandstones, shales, limestones.
- Coal deposits occur in river basins of the Damodar, Mahanadi, Godavari in the Gondwana sedimentary deposits.
- Sedimentary rocks are not as rich in minerals of economic value as the igneous rocks.
- But important minerals such as hematite iron ore, phosphates, building stones, coals, petroleum and material used in cement industry are found.



Metamorphic Rocks

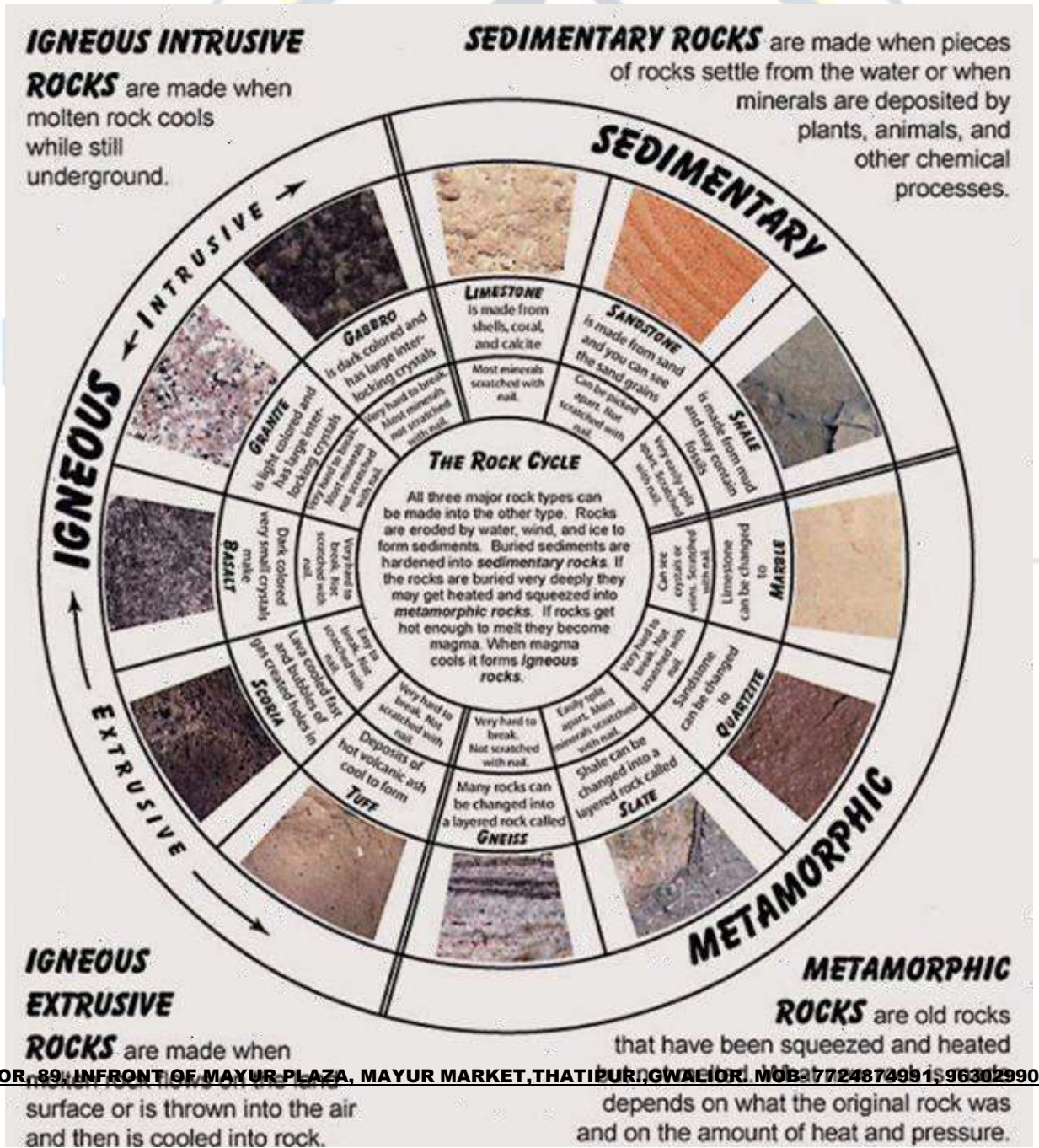
- The word metamorphic means '**change of form**'.
- Form under the action of pressure, volume and temperature (PVT) changes.
- **Metamorphism occurs when rocks are forced down to lower levels by tectonic processes or when molten magma rising through the crust comes in contact with the crustal rocks.**

- Metamorphism is a process by which already consolidated rocks undergo recrystallization and reorganization of materials within original rocks.

In the process of metamorphism in some rocks grains or minerals get arranged in layers or lines. Such an arrangement is called foliation or lineation.

Causes of Metamorphism

- Orogenic (Mountain Building) Movements
- Thermal Metamorphism
- Dynamic Metamorphism
- Igneous or Sedimentary rock
- Influence
- Metamorphosed rock
- Granite Pressure Gneiss Clay, Shale Pressure Schist Sandstone Heat Quartzite Clay, Shale Heat Slate ==> Phyllite Coal Heat Anthracite ==> Graphite Limestone Heat Marble



Rock cycle

- Rock cycle is a continuous process through which old rocks are transformed into new ones.

Igneous or Sedimentary rock	Influence	Metamorphosed rock
Granite	Pressure	Gneiss
Clay, Shale	Pressure	Schist
Sandstone	Heat	Quartzite
Clay, Shale	Heat	Slate ==> Phyllite
Coal	Heat	Anthracite ==> Graphite
Limestone	Heat	Marble

Climate

- Climate holds an important place in our own life. Our life and various economic activities (agriculture, industries, commerce, etc.) are affected by climate.
- Climate has also an important place in physical geography.
- **Climate is a measure of the average pattern of variation in temperature, humidity, atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods of time**
- **The difference between weather and climate is that weather consists of the short-term (minutes to months) changes in the atmosphere while climate is the average of weather over time and space**. In most places, weather can change from minute-to-minute, hour-to-hour, day to-day, and season-to-season. Climate, however, is the average of weather over time and space.

Factors affecting climate: -

Latitude

- Due to the earth's inclination, the mid-day sun is almost overhead within the tropics but the sun's rays reach the earth at an angle outside the tropics. Thus, temperature diminishes from equatorial regions to the poles.

Altitude:

- **Earth's atmosphere is mainly heated through conduction from the surface, so places near the surface are warmer than those higher up**
- Thus, temperature decreases with increasing height above sea level. This rate of decrease in temperature with altitude (lapse rate) is never constant, varying from place to place and from season to season. However, for all practical purposes, it may be reckoned that a fall of 6.5°C occurs with an ascent of 1000 meters or 1o C per 165 meters

Continentality (Distance from sea):

- Land surfaces have higher specific heat capacity of heat as compared to water bodies i.e. **it takes less energy to raise the temperature of a given volume of land by 1 degree C as compared to same volume of water body**. This accounts for temperature extremes in the continental interiors as compared to maritime areas

Oceans Currents:

- Marine areas are influenced by the warm or cold ocean currents. **Ocean currents like the Gulf Stream or the North Atlantic Drift warm the coastal districts of Western Europe keeping their ports ice-free. Ports located in the same latitude but washed by cold currents, such as the cold Labrador Current off north-east Canada, are frozen for several months**

Local winds:

- If winds are warm i.e., they have been blown from a hot area, they will raise temperatures. If winds have been blown from cold areas, they will lower temperatures. Local winds like F marked changes in temperature. **Local winds like Fohn, Chinook, Sirocco and Mistral also produce marked changes in temperature**.

Natural Vegetation and Soil:

- Natural vegetation affects the temperature of the region significantly. Often areas with dense forest cover like areas in thick foliage of Amazon jungles receive less insolation and are, often, cooler than the areas in open space. **dry soils like sands are very sensitive to temperature changes, whereas wet soils, like clay, retain much moisture and warm up or cool down more slowly.**

El Nino & El Nana

- El Nino and La Nina are opposite phases of what is known as the El Niño-Southern Oscillation (ENSO) cycle. The ENSO cycle is a scientific term that describes the fluctuations in temperature between the ocean and atmosphere in the **east- central**

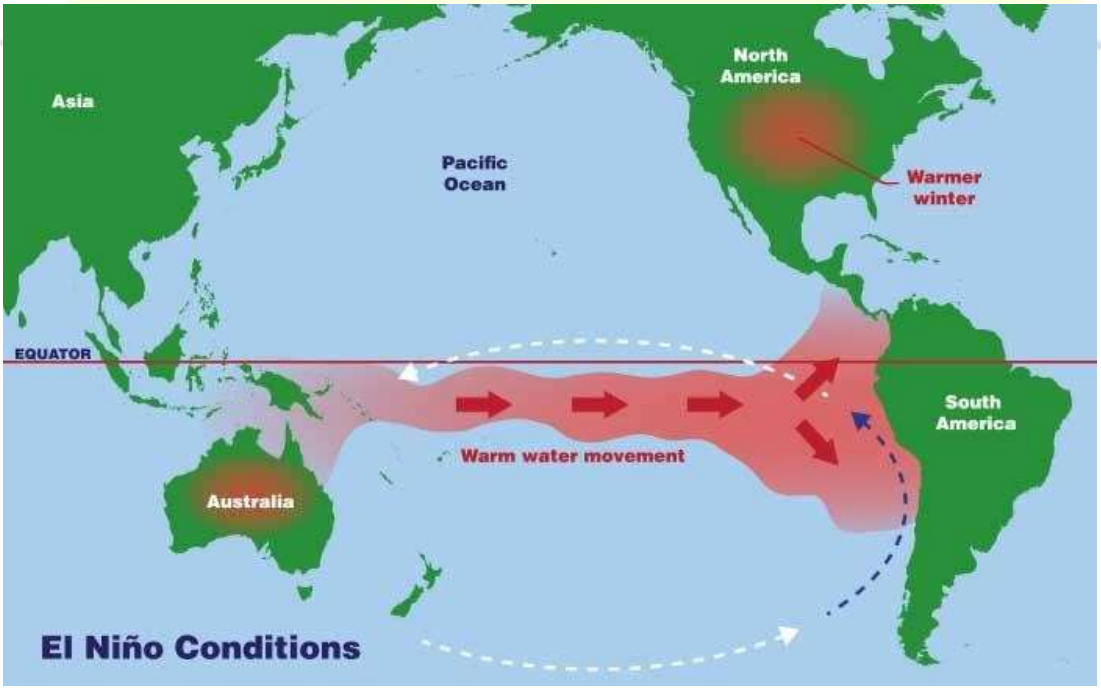
- **Equatorial Pacific**. (The area between South America and Australia near the equator

- La Nina is sometimes referred to as the cold phase of ENSO and El Nino as the warm phase of ENSO. These deviations from normal surface temperatures and have large-scale impacts not only on ocean processes, but also on global **weather and climate**, including India

NORMAL CONDITION

- In a normal year, surface low pressure develops in the region of northern Australia and Indonesia and a high-pressure system over the coast of Peru. **As a result, the trade winds over the Pacific Ocean move strongly from east to west.**

- The easterly flow of the trade winds carries warm surface waters westward, bringing convective storms (thunderstorms) to Indonesia and coastal Australia. Along the coast of Peru, cold bottom cold nutrient rich water wells up to the surface to replace the warm water that is pulled to the west.

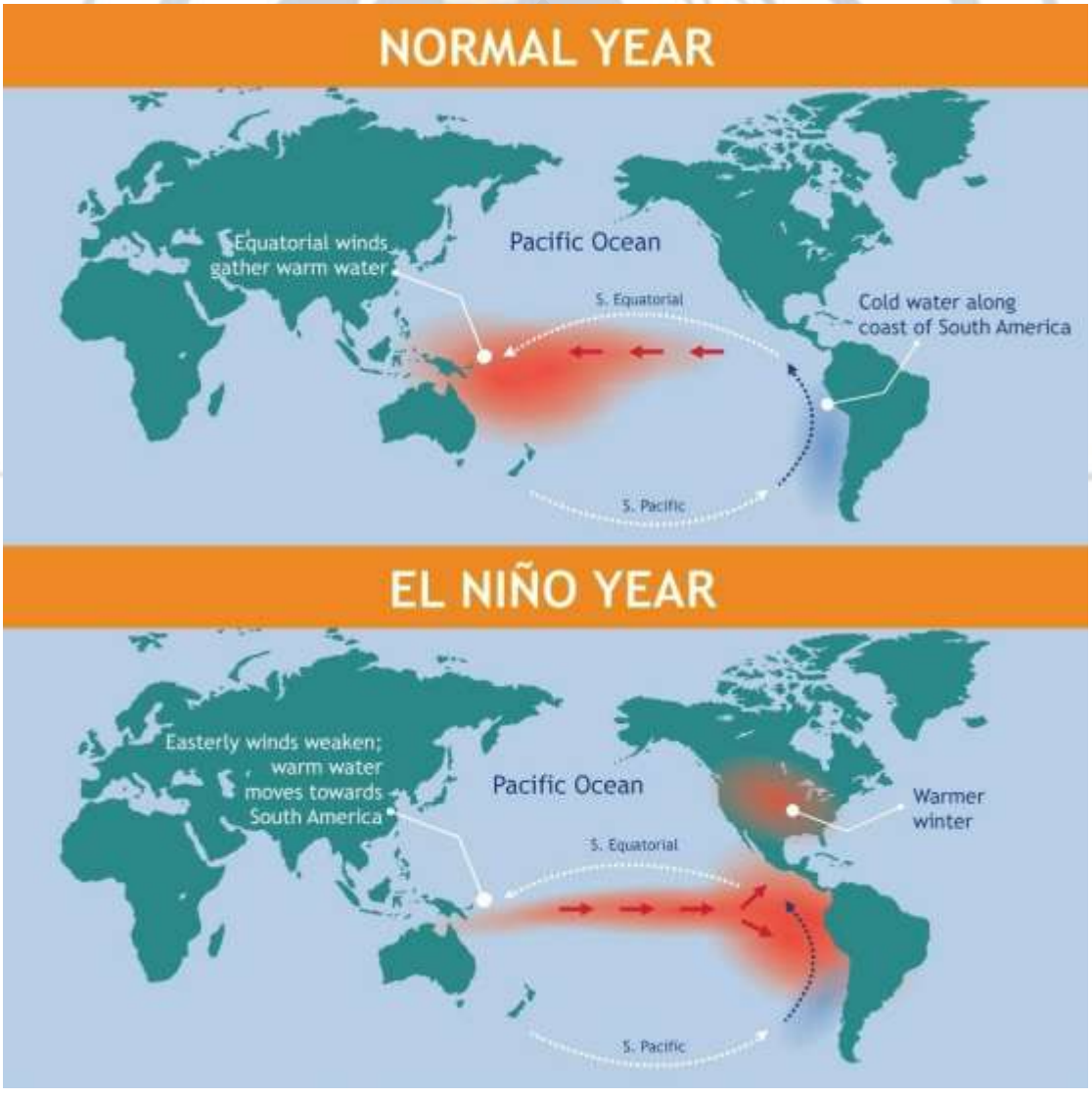


Walker circulation (Occurs during Normal Years)

- The Walker circulation (walker cell) is caused by the pressure gradient force that results from a **high-pressure system over the eastern Pacific Ocean, and a low-pressure system over Indonesia**

During El Nino year

- In an El Niño year, air pressure drops over large areas of the central Pacific and along the coast of South America.
- The normal low-pressure system is replaced by a weak high in the western Pacific (the southern oscillation). This change in pressure pattern causes the **trade winds to be reduced == Weak Walker Cell. Sometimes Walker Cell might even get reversed.**
- This reduction allows **the equatorial counter current (current along doldrums) to accumulate warm ocean water along the coastlines of Peru and Ecuador.**
- This accumulation of warm water causes the thermocline to drop in the eastern part of Pacific Ocean which **cuts off the upwelling of cold deep ocean water along the coast of Peru.**
- Climatically, the development of an El Niño **brings drought to the western Pacific, rains to the equatorial coast of South America, and convective storms and hurricanes to the central Pacific.**



Effects of El Nino

- The warmer waters had a **devasting effect on marine life existing off the coast of Peru and Ecuador.**
- Fish catches off the coast of South America were lower than in the normal year (Because there is no upwelling).
- **Severe droughts occur in Australia, Indonesia, India and southern Africa.**
- Heavy rains in California, Ecuador, and the Gulf of Mexico.
- **El Nino and Indian monsoon are inversely related.**

Normal Condition

- Eastern Pacific == Coast of Peru and Ecuador == Cold Ocean Water == Good for Fishing.
- Western Pacific == Indonesia and Australia == Warm Ocean Water == Plenty of rains.
- El Nino Condition
- Eastern Pacific == Coast of Peru and Ecuador == Warm Ocean Water == Fishing industry takes a hit.
- Western Pacific == Indonesia and Australia == Cold Ocean Water == Drought.

Classification of Climate

Table 12.2 : Climatic Types According to Koeppen

Group	*Type*	*Letter Code*	*Characteristics*
A-Tropical Humid Climate	Tropical wet	Af	No dry season
	Tropical monsoon	Am	Monsoonal, short dry season
	Tropical wet and dry	Aw	Winter dry season
B-Dry Climate	Subtropical steppe	BSh	Low-latitude semi arid or dry
	Subtropical desert	BWh	Low-latitude arid or dry
	Mid-latitude steppe	BSk	Mid-latitude semi arid or dry
	Mid-latitude desert	BWk	Mid-latitude arid or dry
C-Warm temperate (Mid-latitude) Climates	Humid subtropical	Cfa	No dry season, warm summer
	Mediterranean	Cs	Dry hot summer
	Marine west coast	Cfb	No dry season, warm and cool summer
D-Cold Snow-forest Climates	Humid continental	Df	No dry season, severe winter
	Subarctic	Dw	Winter dry and very severe
E-Cold Climates	Tundra	ET	No true summer
	Polar ice cap	EF	Perennial ice
H-Highland	Highland	H	Highland with snow cover

Group A: Tropical Humid Climates

- Tropical humid climates exist between Tropic of Cancer and Tropic of Capricorn.
- Inter-Tropical Convergence Zone makes the climate hot and humid.
- The annual range of temperature in this region is very low whereas the annual
- The tropical group is divided into three types. They are:
    - Af – Tropical wet climate
    - Am – Tropical monsoon climate
    - Aw – Tropical wet and dry climate

Tropical Wet Climate (Af)/Tropical rainforest/Equatorial/Selva

- Tropical wet climate is
- The chief areas that lie in this climate are:
    - Amazon Basin in South America
    - Western Equatorial Africa
    - The islands of East Indies
- A substantial amount of rainfall occurs in every month of the year.
- These regions race
- The temperature is uniformly high.
- The annual range of temperature is negligible
-

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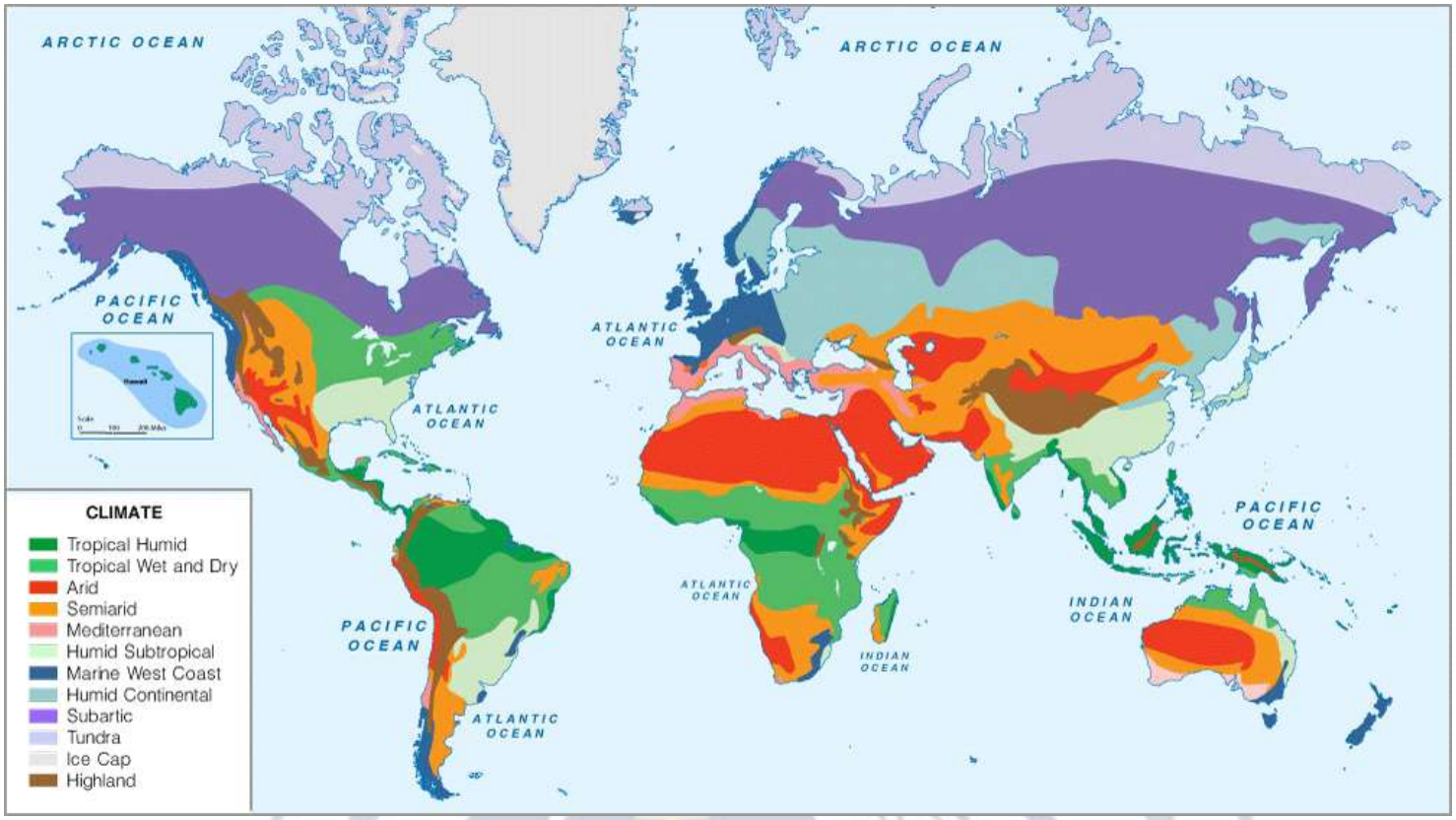


- The maximum temperature during daytime is about 30°C whereas the minimum temperature is about 20°C. Avg is 27
- The region is bestowed with Tropical evergreen forests and large biodiversity sub-continent

Tropical Monsoon Climate (Am)

- Tropical monsoon climate (Am) is found over:
  - The Indian sub
  - North Eastern part of South America
  - Northern Australia
- These regions receive heavy rainfall in summer b/c **reversal of winds (land to sea and sea to land)**
- **Alternating period of Rainfall and draught.**
- Winter in this area seems to be dry.

- In winters central Asia have High pressure, north east trade winds blow over south east Asia but Himalayas prevent them from entering into India

Tropical Wet and Dry Climate (Aw)/Savanna/Sudan

- Tropical grassland of North Australia, Guiana Highlands, campo's of Brazil
- It is a transitional Zone which gets convection rainfall in during summer whereas remains dry during rest of year.
- Temperature is High (23), Rainfall (160cm)
- The diurnal ranges of temperature are extreme in the dry season.
- The wet season is shorter in this region.
- The dry season is longer with the drought being more severe.
- Savanna is tropical grassland with deciduous
- Tropical wet and dry climate is found in north and south of Tropical Wet Climate (Af) type climate regions (between wet & dry)

Group-B Climates/Dry Climates/Desert Climate

- These arid and semiarid climates cover about a quarter of the land surface of the Earth. (Arid = Desert, Semi-Arid = Steppe)
- predominantly seen in the 15-30 degrees latitude in northern and southern hemisphere
- These regions have intense solar radiation and clear skies.
- Sahara, Arabia, Thar
- Annual Temperature is 38 on west coast Atacama, Namibia.
- These regions experience
    - Low precipitation
    - Great variability in precipitation from year to year
    - Low relative humidity
    - High evaporation rates
- The maximum temperature in this region in summer is very high.
- The annual and diurnal ranges
- The inconsistency in the rainfall distresses the life in the steppe much more than in the desert, more frequently causing famine.
- Steppe- b/c of interior position

Koeppel's Group C Climates

- Warm temperate (mid latitude) climates stretch from 30°– 50° of latitude mainly on the western and eastern margins of continents.
- These climates usually have warm summers with mild winters.
- They are classified into four types:
    - Humid subtropical – C_{wa}
    - Mediterranean Climate – C_s
    - Marine west coast climate – C_{fb}

- **Humid Subtropical Climate/China Type (Cwa)**
- **Eastern Coasts of continents between 25-40 latitude.**
- **South eastern US, Uruguay, Argentina, South Brazil, Eastern China, South Japan and east coast of Australia**

- The Humid Subtropical Climate is similar to Tropical Wet and Dry Climate (Aw) climate excluding that the temperature in winter is mild, summers are hot and humid
- Hurricanes and typhoons are experienced in late summers.
- **Mediterranean climate** is found around Mediterranean Sea, along the west coast of continents in subtropical latitudes between 30° – 45° latitudes
- The climate is predominantly found in the
  - Central Chile
  - Central California
  - Along the coast in South Eastern
  - South Western Australia
- These areas come under the influence of westerly wind (low pressure) in winter and sub-tropical high in summer.
- Therefore, the climate is characterized by **hot, dry summer and mild, rainy winter**

Koeppel's Group D Climates

- **Taiga Climate Coniferous forest found- b/c evaporation is less. Polar winds**
- In a major portion of the middle and high latitudes lie a group of climates classified within the Koeppen scheme as C and D.
- The average temperature is above 10 °C in their warmest months.
- The average temperature in the coldest month is below −3 °C.
- This climatic condition is generally found in the interiors of continents and on their upper

east coasts, typically north of 40°N.

- Group D climates are very rare in the Southern Hemisphere, due to the smaller land masses in the middle latitudes and the almost complete absence of land at 40–60° south.
- It exists only in some highland locations.
- old snow forest climate is found in the large continental area in the northern hemisphere between 40°-70° North latitudes.
- The regions lying in this climate are:
    - Europe
    - Asia
    - North America

Cyclones & Anticyclones

Air Masses

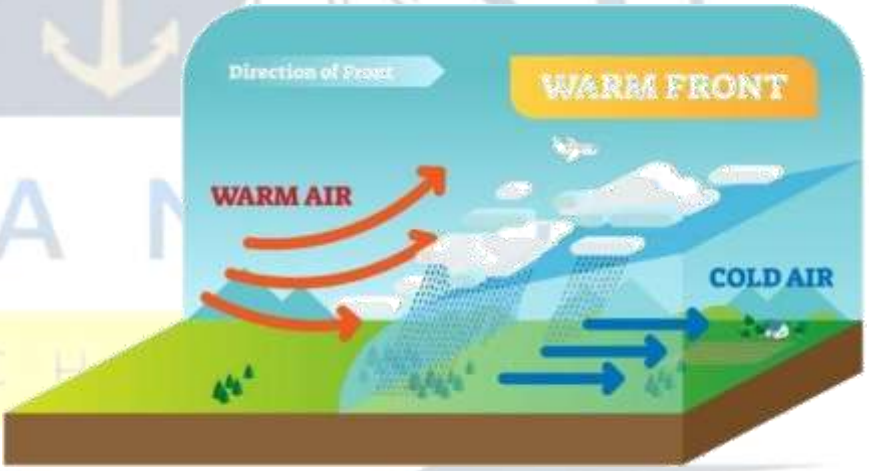
- Over a homogeneous area, when air remains for a sufficiently long time, it acquires the characteristics of that area.
- Homogeneous area can be vast plains or oceans where only little horizontal variation occurs in temp. & moisture.
- **Homogeneous regions over which air masses form are called source regions**

Fronts

- **When two different type of air masses meet, the boundary zone b/w them is called a front**
- Process of its formation is known as frontogenesis

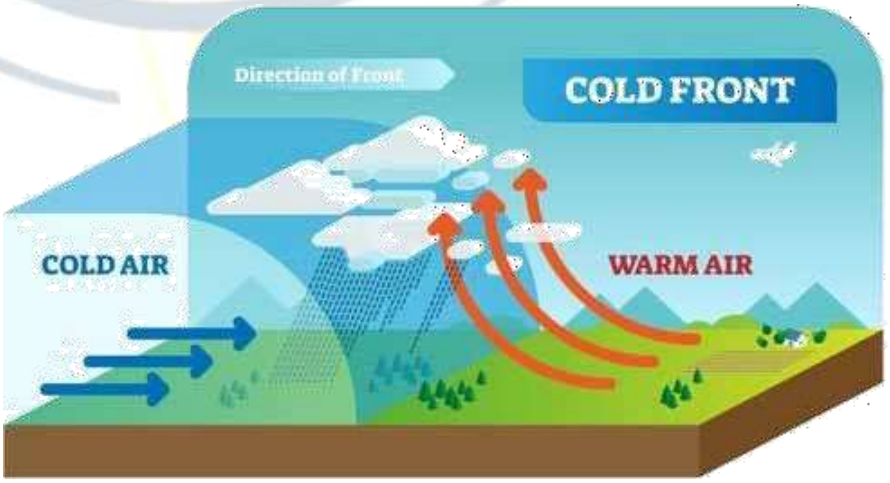
Warm Front

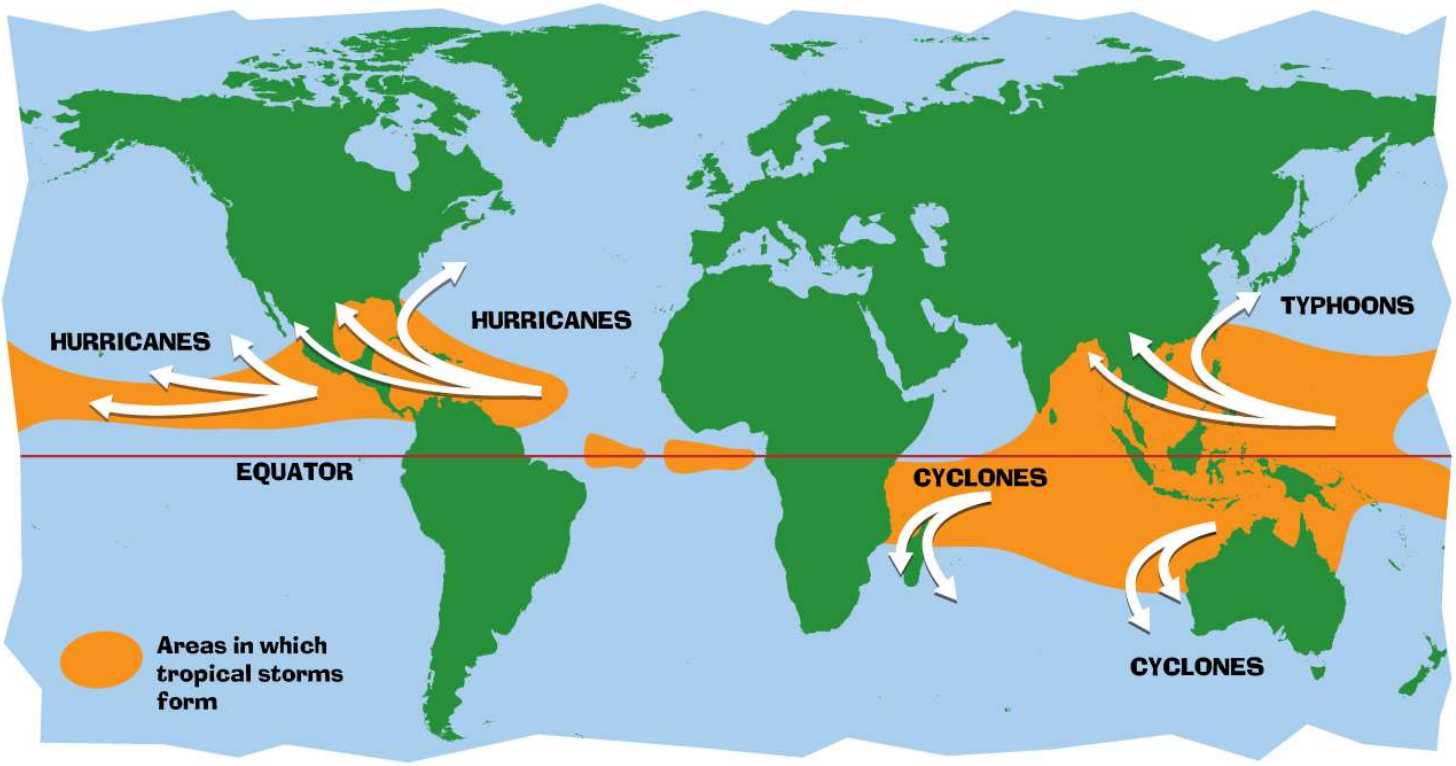
- **When a warmer & lighter air mass moves against a colder & denser air mass**
- the former rises over the latter one & warm front is formed



Cold Front

- **When a colder air mass forces its way under a warmer air mass & pushes the latter upward, cold front is formed**



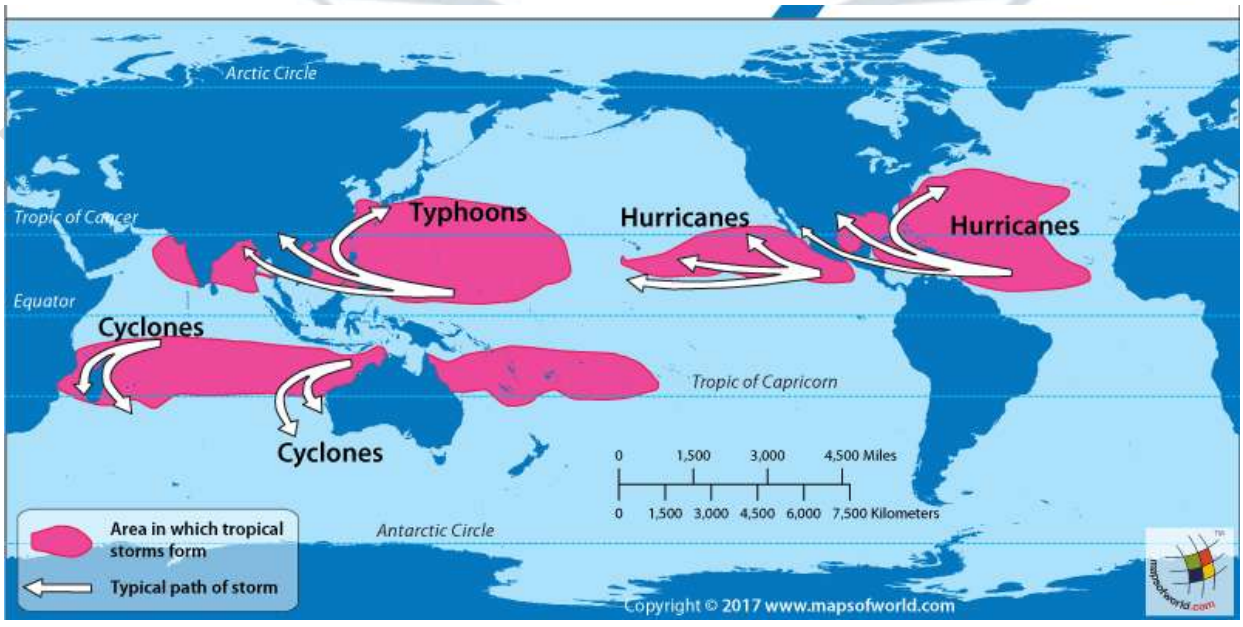


- **Tropical cyclones are violent storms that originate over oceans in tropical areas and move over to the coastal areas** bringing about large-scale destruction due to violent winds (squalls), very heavy rainfall (torrential rainfall) and **storm surge**.

- They are irregular wind movements involving **closed circulation** of air around a low-pressure center. This closed air circulation (whirling motion) is a result of **rapid upward movement of hot air** which is subjected to Coriolis force. The low pressure at the center is responsible for the wind speeds.

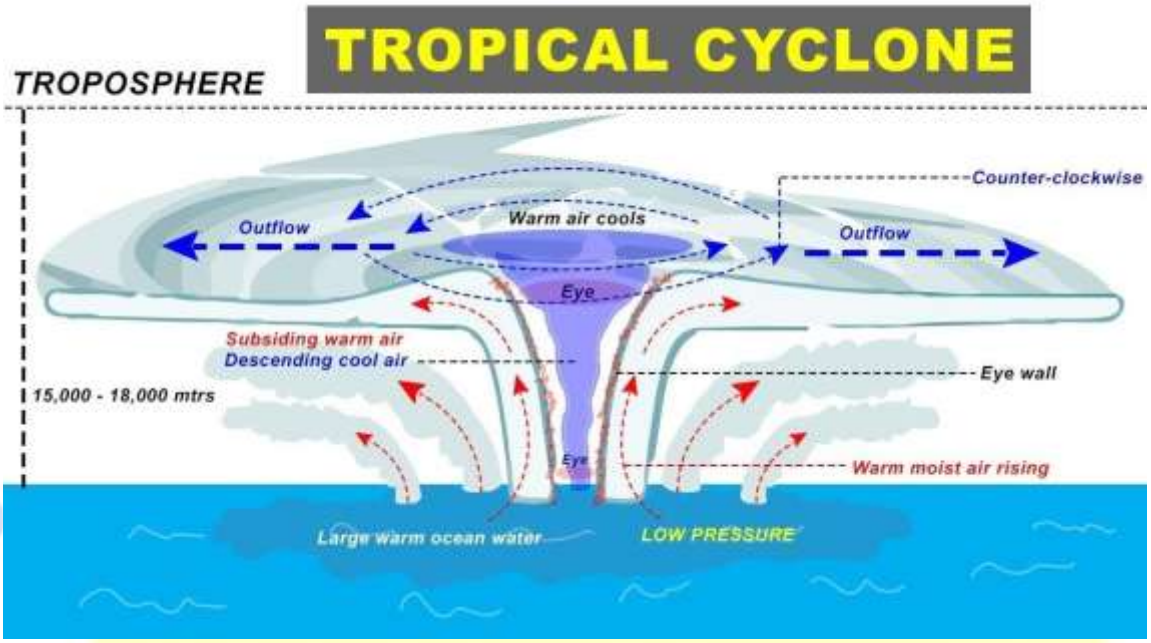
Conditions Favorable for Tropical Cyclone Formation

- Large sea surface with temperature higher than 27° C
- Presence of the Coriolis force enough to create a cyclonic vortex
- Small variations in the vertical wind speed
- A pre-existing weak low-pressure area or low-level-cyclonic circulation



Why cyclones occur mostly in late summers?

- At this time, there are **two advantages—the air is overheated and the sun is exactly over the equator.**
- The Coriolis force is zero at the equator (no cyclones at equator because of zero Coriolis Force) but it increases with latitude. Coriolis force at 5° latitude is significant enough to create a storm [cyclonic vortex].
- **About 65 per cent of cyclonic activity occurs between 10° and 20° latitude.**
- because of the rising warm humid air, a true cyclonic vortex may develop very rapidly. However, only a few of these disturbances develop into cyclones.
- the convergence of trade winds air masses of different temperatures and the resulting instability are the prerequisites for the origin and growth of violent tropical storms.



- Energy that intensifies the storm comes from the condensation process in towering cumulonimbus clouds, surrounding center of the storm.
- Hence, with **constant supply of moisture from the sea, storm is further strengthened**
- On reaching land, moisture supply is cut off & the storm dissipates
- **Place where tropical cyclone crosses the land is called landfall of the cyclone**
- Central low pressure is known as eye of the cyclone → Calm with subsiding air having lowest pressure & highest temp.

Origin and Development of Tropical Cyclones

- **The tropical cyclones have a thermal origin, and they develop over tropical seas during late summers (August to mid-November).**
- At these locations, the strong local convectional currents acquire a whirling motion because of the Coriolis force.

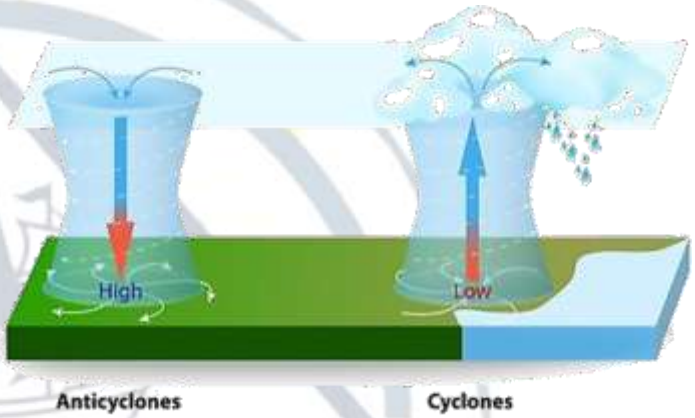
- After developing, these cyclones advance till they find a weak spot in the trade wind belt.

How Anticyclones work

- **Anticyclones are areas of high pressure. The sinking air spreads out when it reaches the ground, producing a divergence at the surface. Aloft, air rushes in to fill the void, creating a convergence aloft.**

- Anticyclones produce a stable atmosphere. Anticyclones, or highs, are also referred to as blocking highs because they tend to force areas of low pressure to travel around them

Cyclones	Anti cyclones
It is a low pressure system with surroundings of high pressure.	It is a high pressure system with surroundings of low pressure.
It blows anti clockwise in the Northern Hemisphere.	It blows clockwise in the Northern Hemisphere.
It blows clockwise in the Southern Hemisphere.	It blows anti clockwise in the Southern Hemisphere.
It is associated with cloudy skies, heavy rainfall with stormy winds.	It is associated with clear skies, mild winds and dry conditions.
It can cause great damage to lives and property if precautions are not taken.	The weather is settled and pleasant.



Naming of cyclones

Within the North Indian Ocean between 45°E – 100°E, tropical cyclones are named by the India Meteorological Department (IMD/RSMC New Delhi) when they are judged to have intensified into a cyclonic storm with 3-minute sustained wind speeds of at least 34 kn (39 mph; 63 km/h).

Earthquakes and Volcanos

Earthquakes

- An earthquake is the shaking or trembling of the earth's surface, caused by the sudden movement of a part of the earth's crust. They result from the sudden release of energy in the Earth's crust that creates seismic waves or earthquake waves.

Terms associated with earthquakes

Focus

- The place of origin of an earthquake inside the earth.

Epicenter

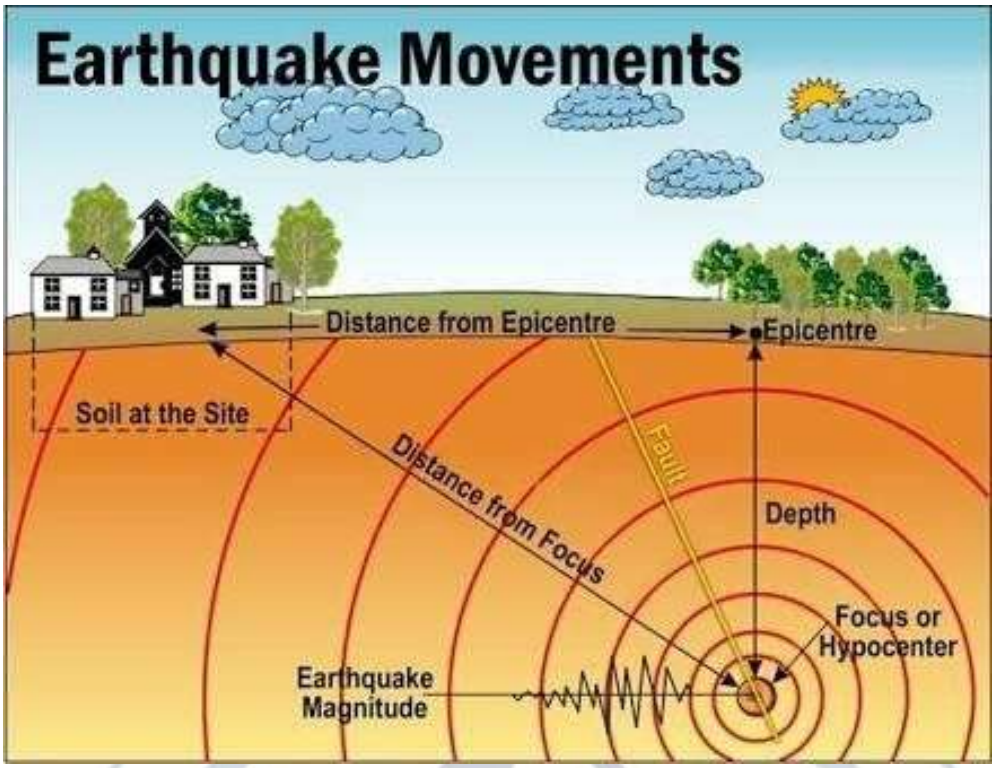
- Point on the earth's surface vertically above the focus. Maximum damage is caused at the epicenter.

Causes of Earthquakes

- Most earthquakes are causally related to **compressional or tensional stresses built up at the margins of the huge moving lithospheric plates.**
- The immediate cause of most shallow earthquakes is the **sudden release of stress along a fault, or fracture in the earth's crust.**
- **Sudden slipping of rock formations along faults and fractures in the earth's crust** happen due to constant change in volume and density of rocks due to intense temperature and pressure in the earth's interior.
- **Volcanic activity** also can cause an earthquake but the earthquakes of volcanic origin are generally less severe and more limited in extent than those caused by fracturing of the earth's crust.
- Earthquakes occur most often along **geologic faults, narrow zones where rock masses move in relation to one another**. The major fault lines of the world are located at the fringes of the huge tectonic plates that make up Earth's crust.
- **Plate tectonics**: Slipping of land along the fault line along, convergent, divergent and transform boundaries cause earthquakes. Example: San Andreas Fault is a transform fault where Pacific plate and North American plate move horizontally relative to each other causing earthquakes along the fault lines.
- **Earthquakes in the reservoir region, mining sites etc. are human induced.**

Seismic Waves or Earthquake Waves

- The slipping of land generates seismic waves and these waves travel in all directions.
- Earthquake is any sudden shaking of the ground caused by the passage of seismic waves through Earth's rocks.
- Seismic waves are produced when some form of energy stored in Earth's crust is suddenly released, usually when masses of rock straining against one another suddenly fracture and "slip.



Types of Seismic Waves

Earthquake waves are basically of two types — body waves and surface waves.

- Body waves are **generated due to the release of energy at the focus and move in all directions travelling through the body of the earth. Hence, the name body waves.**
- The body waves **interact with the surface rocks and generate new set of waves called surface waves. These waves move along the surface.**

There are two types of body waves. They are called P and S-waves.

- Primary waves or P waves (longitudinal)(fastest)
- Secondary waves or S waves (transverse) (least destructive)
- Surface waves or L waves (transverse)(slowest) (most destructive)

Primary Waves (P waves)

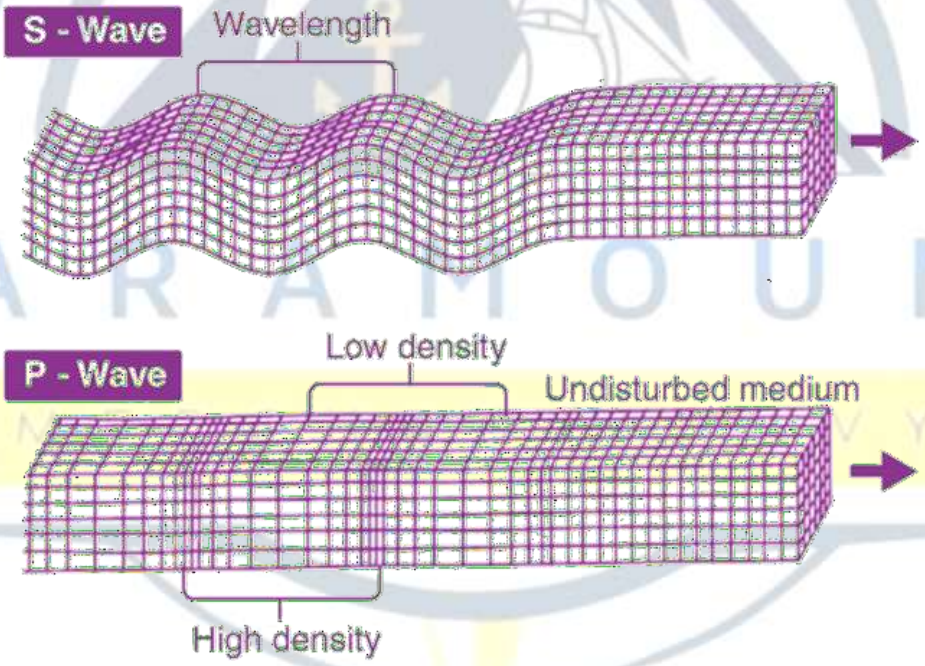
- Also called as the longitudinal or compressional waves.
- Analogous to sound waves.
- Particles of the medium vibrate along the direction of propagation of the wave.
- P-waves move faster and are the first to arrive at the surface.
- These waves are of high frequency.
- They can travel in all mediums.
- Velocity of P waves in Solids > Liquids > Gases

Secondary Waves (S waves)

- Also called as transverse or distortional waves.
- Analogous to water ripples or light waves.
- S-waves arrive at the surface with some time lag.
- A secondary wave cannot pass through liquids or gases.
- These waves are of high frequency waves.

Surface Waves (L waves)

- Also called as long period waves.
- They are low frequency, long wavelength, and transverse vibration.
- Generally, affect the surface of the Earth only and die out at smaller depth.
- Develop in the immediate neighborhood of the epicenter.
- They cause displacement of rocks, and hence, the collapse of structures occurs.
- These waves are the most destructive.



- Earth's major earthquakes occur mainly in belts coinciding with the margins of tectonic plates.
- The most important earthquake belt is the **Circum-Pacific Belt, which affects many populated coastal regions around the Pacific Ocean**—for example, those of New Zealand, New Guinea, Japan, the Aleutian Islands, Alaska, and the western coasts of North and South America.
- The seismic activity is by no means uniform throughout the belt, and there are a number of branches at various points. Because at many places the Circum-Pacific Belt is associated with volcanic activity, it has been popularly dubbed the "Pacific Ring of Fire." The Pacific Ring of Fire accounts for about 68 per cent of all earthquakes.

- **A second belt, known as the Alpine Belt (Himalayas and Alps).** The energy released in earthquakes from this belt is about 15 percent of the world total. The mid-world mountain belt (Alpine Belt) extends parallel to the equator from Mexico across the Atlantic Ocean, the Mediterranean Sea from Alpine-Caucasus ranges to the Caspian, Himalayan mountains and the adjoining land

Volcanism

A volcano is a vent in the earth's crust from which molten rock material (magma), explosive bursts of gases and volcanic ashes erupt.

Causes of Volcanism

- The chemical reactions of radioactive substances deep within the interior of the earth generate tremendous amount of heat. Some heat is already present in the form of residual heat (heat captured at the center during earth's formation) is already present at the earth's interior.

- There is a huge temperature difference between the inner layers and the outer layers of the earth due to differential amount of radioactivity. This temperature difference gives rise to convectional currents in the outer core as well as the mantle.

Geysers and Hot Springs

- **Almost all the world's geysers are confined to three major areas: Iceland, New Zealand and Yellowstone Park of U.S.A.**

- Iceland has thousands of hot springs. Some of them have been harnessed to heat houses, swimming pools and for other domestic purposes.

- Hot springs and geysers have become tourist attractions e.g. in Japan and Hawaii.

- Water that percolated into the pours rock is subjected to intense heat by the underlying hard rock which is in contact with hot magma in the mantle or the lower part of crust.

- Under the influence of intense heat, the water in the capillaries and narrow roots in the porous rock undergoes intense expansion and gets converted to steam resulting in high pressure.

- **Circum-Pacific region, popularly termed the 'Pacific Ring of Fire', has the greatest concentration of active volcanoes.** Volcanic belt and earthquake belt closely overlap along the 'Pacific Ring of Fire'.

- 'Pacific Ring of Fire' is estimated to include two-thirds of the world's volcanoes.

Volcanos in India

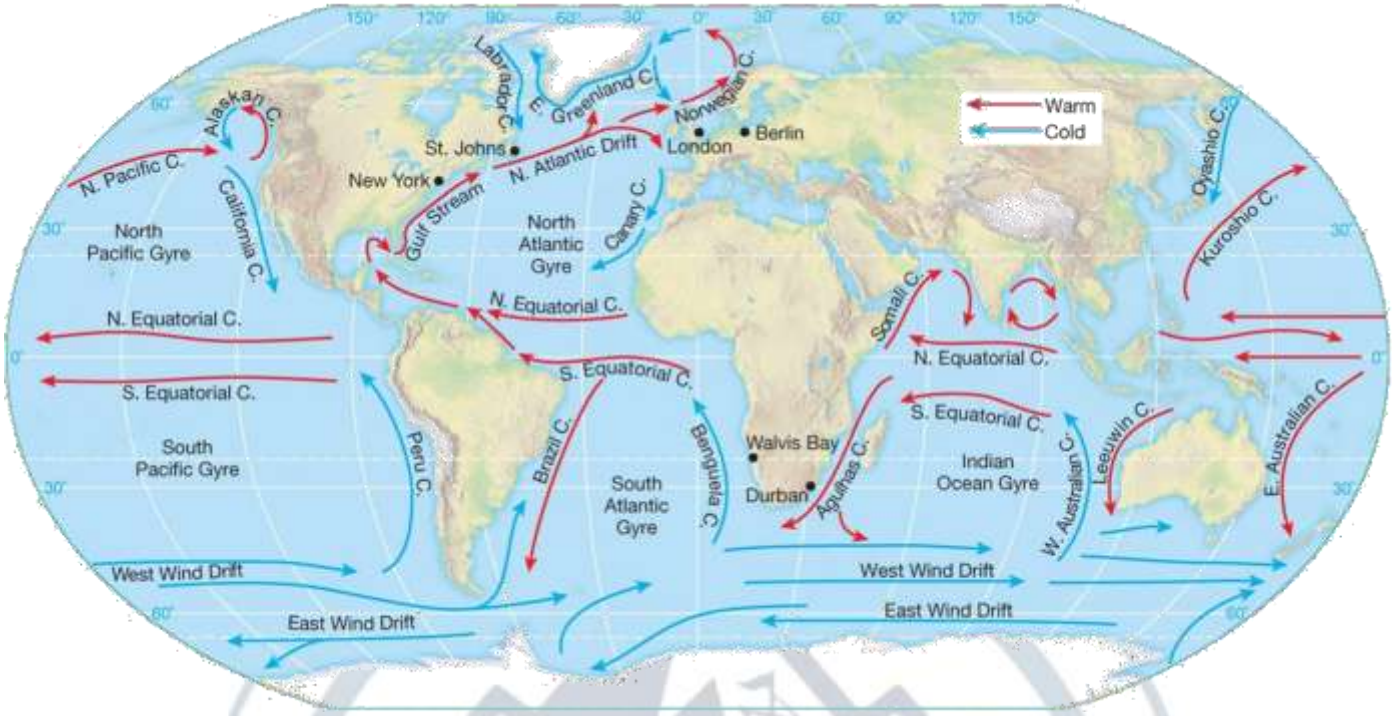
- There are no volcanoes in the Himalayan region or in the Indian peninsula.

- **Barren Island, lying 135 km north-east of Port Blair became active again in 1991 and 1995.** After its activity in the nineteenth century, it passed through a mild solfataric stage as evidenced by the sublimations of Sulphur on the walls of the crater.

- The other volcanic island in Indian territory is **Narcondam, about 150 km north-east of Barren Island;** it is probably extinct. Its crater wall has been completely destroyed.

PARAMOUNT DEFENCE ACADEMY

Ocean Currents through Maps



- The movements that occur in oceans are categorized as: **waves, tides and currents.**
- Waves are formed due to **friction** between wind and surface water layer. The stronger the wind, the bigger the wave. They die out quickly on reaching the shore or shallow waters.
- The movements of water in oceans can be categorized into currents, waves, and tides. Among these, ocean currents are the large masses of surface water that circulate in regular patterns around the oceans.

Ocean Current

- **Depending upon their temperature, ocean currents can be classified into warm currents and cold currents.**
- Warm currents flow from equatorial regions towards the polar regions and hence have a higher surface temperature. [from lower latitudes to higher latitudes].
- Cold currents flow from polar regions towards the equator and have a lower surface temperature [from higher latitudes to lower latitudes].

Factors responsible for Ocean Currents

The following are the factors responsible for ocean currents:

- **The Planetary winds,**
- **Temperatures,**
- **Salinity,**
- **The earth s rotation,**
- **Obstruction from land**
- **The Planetary winds**

The Planetary winds

- **The general distribution of winds in the lower atmosphere is called as Planetary winds**. The Earth's atmosphere is divided into permanent pressure belts - The Equatorial low-pressure belt, The Sub-tropical high-pressure belt, Sub-polar low-pressure belt and Polar high-pressure belts. The planetary winds are permanent winds that blow from one pressure belt to the other. Accordingly, they have been divided into - Tradewinds, Westerlies and Polar Easterlies.

- **Wind blowing on the surface of the ocean pushes the water to move. Friction between the wind and the water surface affects the movement of the water body in its course.**

- Winds are responsible for both magnitude and direction [Coriolis force also affects direction] of the ocean currents.

Temperature

- **The differential heating of the Sun at the equator and the poles causes a difference in the temperature of ocean water**. At the equator, since the temperature is higher the ocean water gets heated up and expands. This makes the warm water lighter and hence rises while at the poles, cold water is denser and sinks. Warm water from the equator slowly moves along the surface towards the poles, while the cold water from the poles slowly creeps along the bottom of the sea towards the equator.

- Hence, the difference in heating and surface temperatures play a key role in movements of ocean water.

Salinity

- **The density of water also depends on its salinity and the salinity of water varies from place to place. Waters of low salinity flow on the surface of waters of high salinity while waters of high salinity flow at the bottom.**

- **The earth's rotation and Coriolis force**

- The earth's rotation deflects moving objects to the right and ocean currents are no exception. Under the action of Coriolis force, the movement of ocean currents in the northern hemisphere is in the clockwise and in the southern hemisphere it is in the anti-clockwise direction. Hence it can be said that ocean currents obey Ferrell's law.

Currents in the Pacific Ocean

- North Equatorial Current (Warm)
- South Equatorial Current (Warm)
- Counter Equatorial Current (Warm)
- Kuroshio System (Warm)
- Oyashio Current (Cold)
- California Current (Cold)
- Peruvian or Humboldt Current (Cold)
- East Australia Current (Warm)
- North Pacific Drift (Warm)

Currents in the Atlantic Ocean

- North Equatorial Current (warm)
- South Equatorial Current (warm)
- Equatorial Counter Current
- Gulf Stream (warm)
- Florida Current (Warm)
- Canaries Current (Cold)
- Labrador Current (Cold)
- Brazilian Current (Warm)
- Falkland Current (Cold)
- South Atlantic Drift (Cold)

Currents in the Indian Ocean

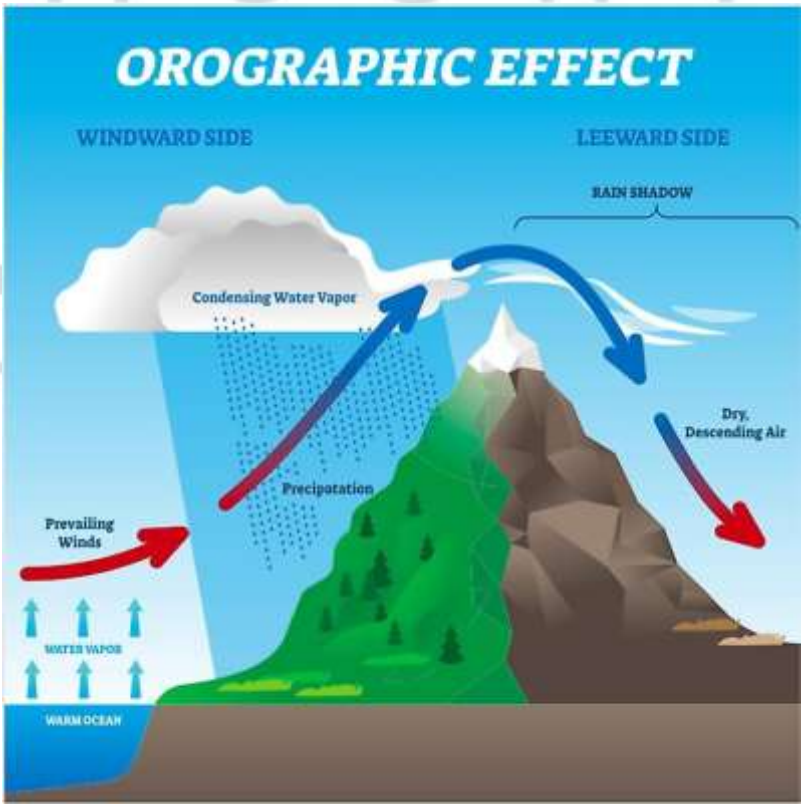
- The North East Monsoon Drift
- The South West Monsoon Drift
- North Equatorial Current (Warm)
- South Equatorial Current (Warm)
- Somali Current (Cold)
- Mozambique Current (Warm)
- Madagascar Current (Warm)
- Agulhas Current (Warm)
- West Australian Current (Cold)

Impact of Ocean Currents

- Local Climate
- Warm and Cold currents affect the local climate of a region.

Rains and Desert Formation

- Warm ocean currents bring rains to the coastal regions and also the interiors while cold currents do not.
- Warm currents flow along the east coast of continents in tropical and sub-tropical latitudes resulting in warm and rainy climates while cold currents flow along the west coast of continents.
- Cold currents are one of the reasons why deserts are located the western margins of continents in the sub-tropical belts
- Fishing grounds the mixing of warm and cold currents help to replenish the oxygen and favor the growth of planktons which is the regions are rich in microscopic marine plants and animals.
- These are crucial for the survival of marine ecosystems.



Tides

- **The periodical rise and fall of the water level in oceans and sea, once or twice a day, due to the gravitational pull of the sun and the, is called a tide**. The study of tides is very complex, spatially and temporally, as it has great variations in frequency, magnitude and height. The Ocean's Tide

- There are three major forces causing an occurrence of tides they are
    - Moon s gravitational pull
    - Sun s gravitational pull.
    - Centrifugal force which acts opposite to gravitational pull of the earth.

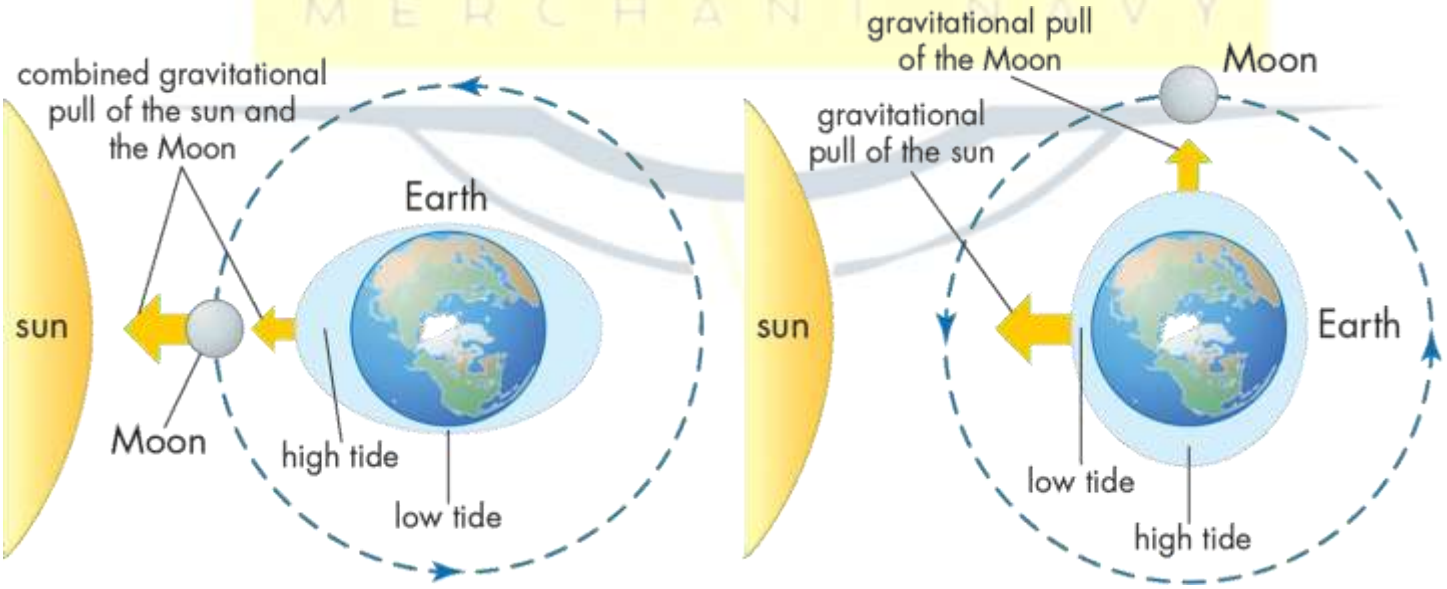
- **Tides occur due to an imbalance between the various forces acting on the ocean water at a point in time.** In general, the tide- generating force is the difference between these two forces; i.e. the gravitational attraction due to the mass of the moon and the centrifugal force due to rotation of the earth.

MECHANISM

- When the two forces are not in balance, it gives rise to the tide-generating force. The side of the Earth which is closest to the moon has the strongest gravitational attraction towards the moon while water on the other side of the Earth experiences a weaker gravitational force.

- **The moons gravitational force has a greater effect than the sun's gravitational force due to the relative distance of moon and sun respectively**. The tide-generating force is proportional to the product of the mass of the two bodies but also inversely proportional to the square of the distance between them.

- **The tide-generating force due to the Sun is 0.46 that of the moon.**



TYPES OF TIDES

Based on frequency

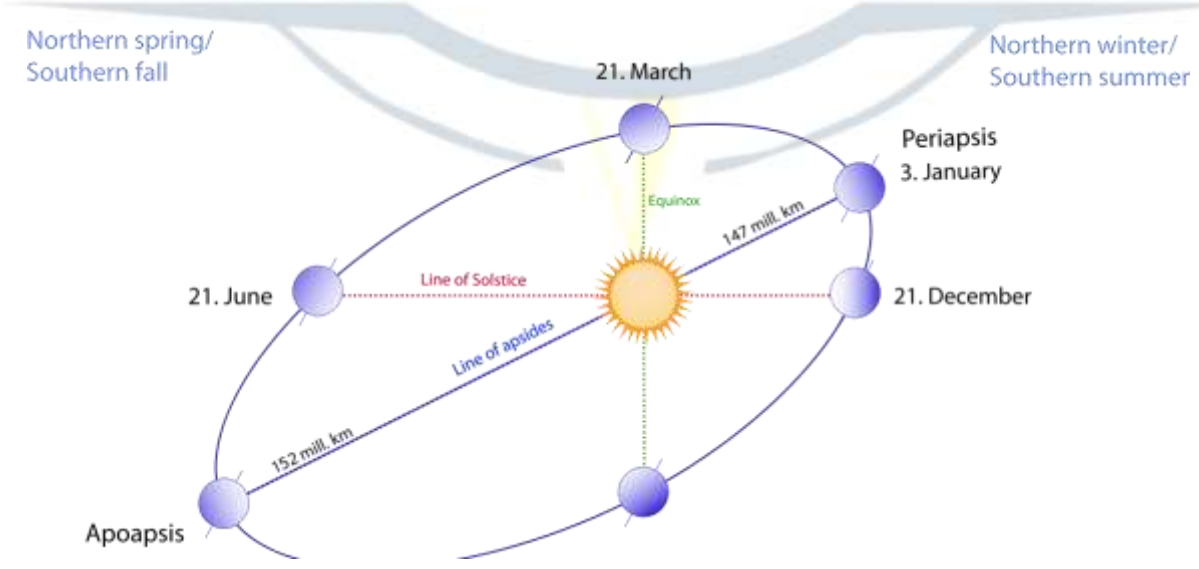
- **Semi-diurnal Tide**: This is the most common tidal pattern, featuring two high tides and two low tides each day.
- **Diurnal Tides**: Only one high tide and one low tide each day. The successive high and low tides are approximate of the same height.
- **Mixed Tide:** Tides having variations in heights are known as mixed tides. They generally occur along the west coast of North America and also in the Pacific Ocean.

Based on sun, moon and earth s positions

- **Spring Tides**: When the position of the sun, the moon, and the earth are aligned in such a way that it forms a straight line, the height of the tide will be higher than normal. These are called as spring tides. It occurs twice in a month-one on the full moon and the other on the new moon.
- **Neap Tides:** After seven days of spring tides the sun and the moon form a 90-degree angle between each other. The resultant force of gravitation gives rise to a tide of very low magnitude which is termed as the neap tide. It also occurs twice in a month.

Based on magnitude

- **Perigee**: When the moon s orbit is closest to the earth, it is called as perigee. During this period, unusual heights of high and low tide occur.
- **Apogee**: When the moon s orbit is farthest from the earth, it is called as apogee. Tidal ranges will be much less than average height during this period.
- **Perihelion:** It is the position where the earth is closest to the sun (around January 3rd). Unusually high and low tides occur at this time.
- **Aphelion:** It is the position where the earth is farthest from the sun (around July 4th). Tidal ranges will be much less than the average height during this period.



Pressure Belts & Winds

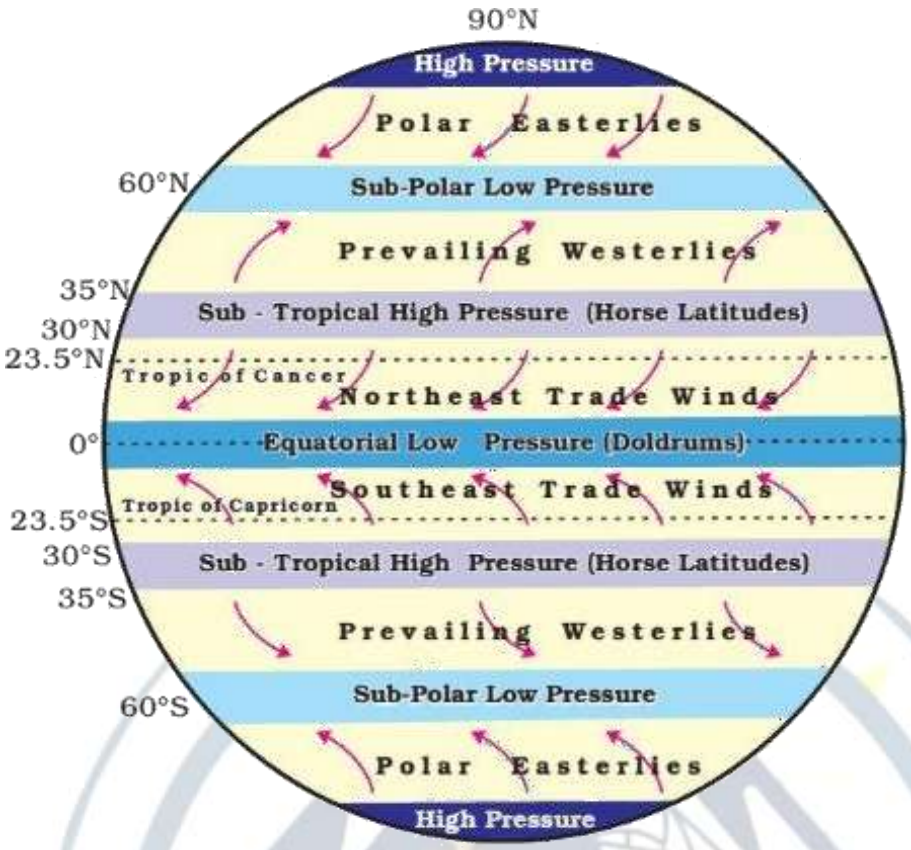
Pressure Systems

- **Air expands when heated and gets compressed when cooled**. This results in variations in the atmospheric pressure.
- The differences in atmospheric pressure causes the movement of air from high pressure to low pressure, setting the air in motion
- **Atmospheric pressure is the weight of the column of air at any given place and time**. It is measured by means of an instrument called barometer.
- **Isobars are lines connecting places having equal pressure**. In order to eliminate the effect of altitude on pressure, it is measured at any station after being reduced to sea level for purposes of comparison.
- The spacing of isobars expresses the rate and direction of pressure changes and is referred to as pressure gradient.
- **There are distinctly identifiable zones of homogeneous horizontal pressure regimes or 'pressure belts**. On the earth's surface, there are in all seven pressure belts.

The seven pressure belts are:

- equatorial low,
- the sub-tropical highs,
- the sub-polar lows, and
- the polar highs.
- Equatorial Low-Pressure Belts
- **Lies between 10°N and 10°S latitudes.**
- Width may vary between 5°N and 5°S and 20°N and 20°S.
- High temp, Air expands, earth rotation centrifugal
- Isobars wide spread
- This belt happens to be the **zone of convergence of trade winds** from two hemispheres from sub-tropical high-pressure belts.

This belt is also called the Doldrums, because of the extremely calm air movements.



Major Pressure Belts and Wind System

Subtropical High-Pressure Belts

- **Temp is high, pressure should be low but expelled air from equator**
- 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 Equator as Trade winds

Circum-Polar Low-Pressure Belts

- **These belts located between 60° and 70° in each hemisphere are known as Circum-Polar Low-Pressure Belts.**
- Polar winds get more area
- Due to 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 Circumpolar Low-Pressure Belt. This region is marked by violent storms in winter.

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.**
- Area is also very small
- These areas of Polar high pressure are known as the Polar Highs.

- Outward divergent flow
- These regions are characterized by **permanent Ice Caps.**
- Belts are not continuous but vary as per the land mass
- Cont. in Southern hemisphere
- B/c of high- and low-pressure system, atmosphere of troposphere is circulated and the system of winds is developed.

Classification of Winds

- Permanent winds or Primary winds or Prevailing winds or Planetary Winds
- The trade winds, westerlies and easterlies.
- Secondary or Periodic Winds
- Seasonal winds: These winds change their direction in different seasons. For example, monsoons in India.
- Periodic winds: Land and sea breeze, mountain and valley breeze.
- Local winds
- These blow only during a particular period of the day or year in a small area.
- Winds like Loo, Mistral, Foehn, Bora.
- Coriolis Force- b/c of earth rotation deflecting force, Max at poles, zero at equator
- In N.H- make the wind to deflect towards right
- In S.H- make the wind to deflect towards left

Primary Winds or Prevailing Winds or Permanent Winds or Planetary Winds

- These are the **planetary winds** which blow extensively over continents and oceans.
- The two most well- understood and significant winds for climate and human activities are trade winds and westerly winds.

Trade Winds/Easterlies

- **The trade winds are those blowing from the sub-tropical high-pressure areas towards the equatorial low-pressure belt.**
- **Therefore, these are confined to a region between 30°N and 30°S throughout the earth's surface.**
- The trade winds from two hemispheres meet at the equator, and due to convergence, they rise and cause heavy rainfall.

Westerlies

- The westerlies are the winds **blowing from the sub-tropical high-pressure belts towards the sub polar low-pressure belts.**
- They blow from southwest to north-east in the northern hemisphere and north-west to south-east in the southern hemisphere.
- The westerlies are best developed between 40° and 65°S latitudes. These latitudes are often called Roaring Forties, Furious Fifties, and Shrieking Sixties – dreaded terms for sailors.

Polar easterlies

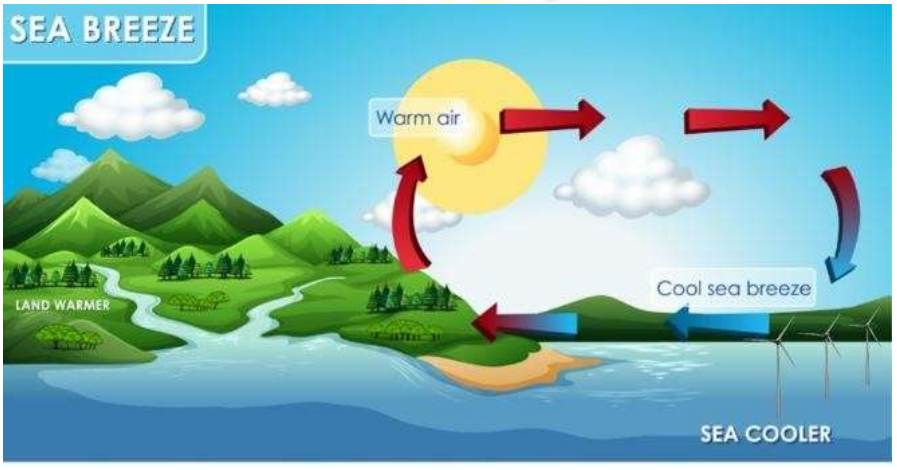
- **The Polar easterlies are dry, cold prevailing winds blowing from north-east to south-west direction in Northern Hemisphere and south-east to north-west in Southern Hemisphere.**
- They blow from the polar high-pressure areas of the sub-polar lows.

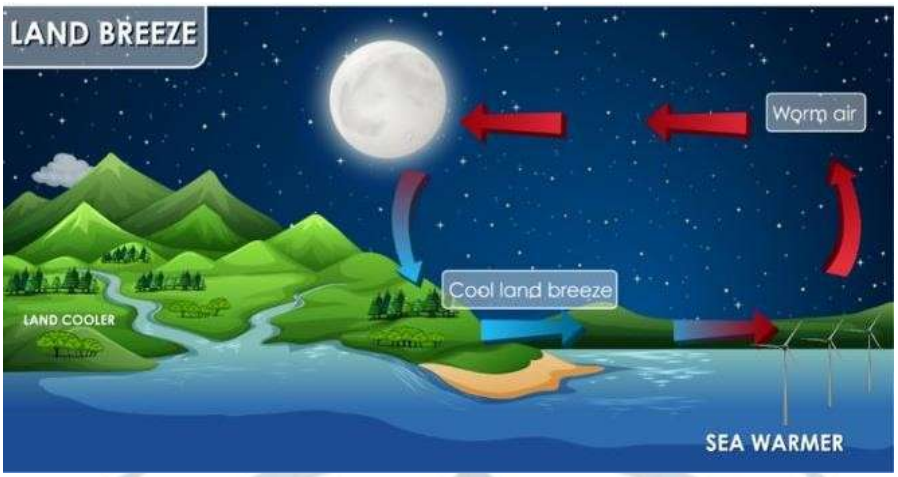
Secondary Winds or Periodic Winds

- **These winds change their direction with change in season.**
- Monsoons are the best example of large-scale modification of the planetary wind system.
- Other examples of periodic winds include land and sea breeze, mountain and valley breeze, cyclones and anticyclones, and air masses.
- **Monsoons were traditionally explained as land and sea breezes on a large scale. Thus, they were considered a convectional circulation on a giant scale.**
- The monsoon winds flow over India, Pakistan, Bangladesh, Myanmar (Burma), Sri Lanka, the Arabian Sea, Bay of Bengal, southeastern Asia, northern Australia, China

Land Breeze and Sea Breeze

- **The land and sea absorb and transfer heat differently. During the day the land heats up faster and becomes warmer than the sea. Therefore, over the land the air rises giving rise to a low-pressure area, whereas the sea is relatively cool and the pressure over sea is relatively high. Thus, pressure gradient from sea to land is created and the wind blows from the sea to the land as the sea breeze. In the night the reversal of condition takes place**





Tertiary Winds or Local Winds

- Local differences of temperature and pressure produce local winds.
- Such winds are local in extent and are confined to the lowest levels of the troposphere. Some examples of local winds are discussed below.

Hot Local Winds:

- **Loo**: Loo are hot and dry winds, which blow very strongly over the northern plains of India and Pakistan in the months of May and June. Their direction is from west to east and they are usually experienced in the afternoons. Their temperature varies between 45 degree C to 50-degree C.
- **Foehn**: Foehn is strong, dusty, dry and warm local wind which develops the Leeward side of the Alps mountain ranges. It affects the Switzerland most. The temperatures of the winds vary from 15 degree to 20 degree Celsius which helps in melting snow. Thus making pasture land ready for animal grazing and help the grapes to ripe early.
- **Chinook: Chinook is the name of hot and dry wind which moves down the eastern slopes of the Rockies in U.S.A**. and Canada. The literal meaning of Chinook is 'snow eater' as they help in melting the snow earlier. They keep the grasslands clear of snow

Cold Local Winds:

- The local cold winds originate in the snow-capped mountains during winter and move down the slopes towards the valleys. They are known by different names in different areas.
- Mistral: Mistrals are the most common local cold winds. They originate on the Alps and move over France towards the Mediterranean Sea through the Rhone valley. They are very cold, dry and high velocity winds. They bring down temperature below freezing point in areas of their influence

Some Popular Local Winds of the World:

- **Sirocco: This is a warm, dry and dusty wind which blows in northerly direction from the Sahara Desert and after crossing over the Mediterranean Sea reaches Italy, Spain, etc**., where it is also known as Blood Rain because of its reddish sand brought along with it from Sahara Desert. There are different local names for Sirocco in Africa e.g. 'Khamish' in Egypt, 'Giblin' in Libya and 'Chilly 'in Tunisia, in Spain and Canary and Madeira island, it is known as 'Leveche' and 'Leste' respectively.

- **Black Roller**: These are the warm and dry dusty winds, blowing in the great plains of North America.

- **Yoma**: This is the warm and dry wind like 'Santa Ana', blowing in Japan. Temporal: This is the monsoon wind blowing in the Central America.

- **Simoom**: This is the warm and dry wind blowing in the Arabian Desert. It causes storms and obstructs visibility.

- **Samoon:** This is the wind blowing in Kurdistan region of Iran and Iraq and has the characters similar to Foehn

- **Karaburan**: These are the dust Laden fast blowing winds in the Tarim Basin in the central Asia.

- **Harmattan:** This is the warm and dry wind blowing in from north-east and east to west in the Sahara Desert. The weather becomes suddenly dry and pleasant in the western coast of Africa, at the arrival of Harmattan. Therefore, it is called 'Doctor' in the New Guinea.

- **Brick Fielder**: This is the warm and dry wind blowing in the Victoria province of Australia.

- **Norwester**: This is the warm and dry wind blowing in northern New Zealand.

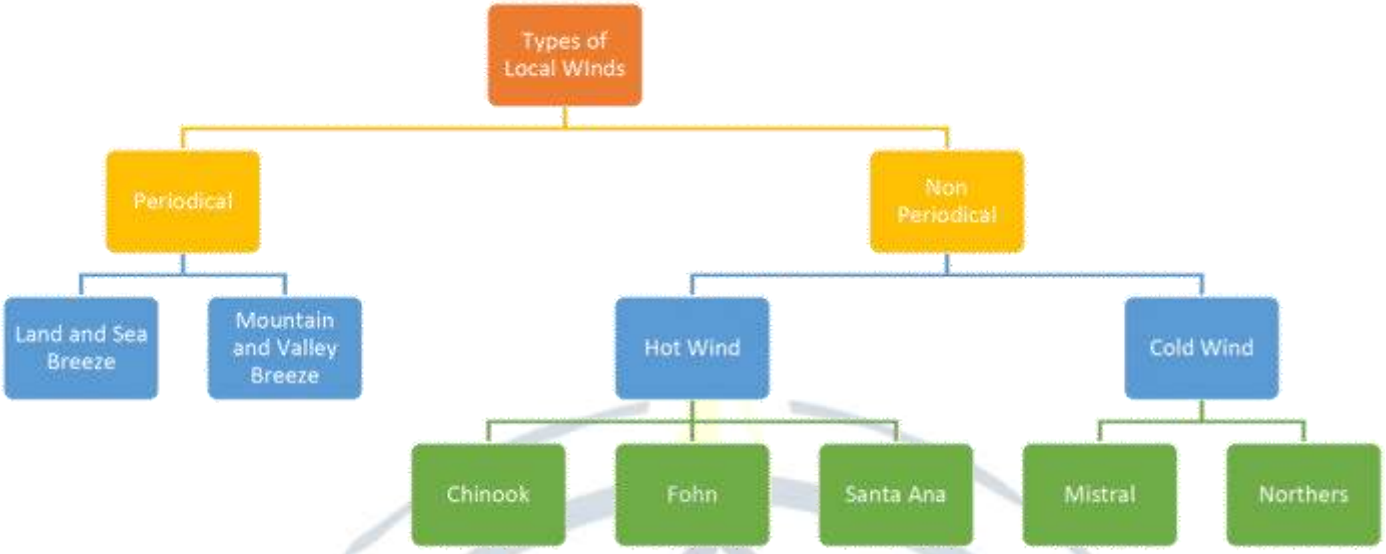
- **Santa Ana:** This is the warm and dry wind blowing in California (USA).

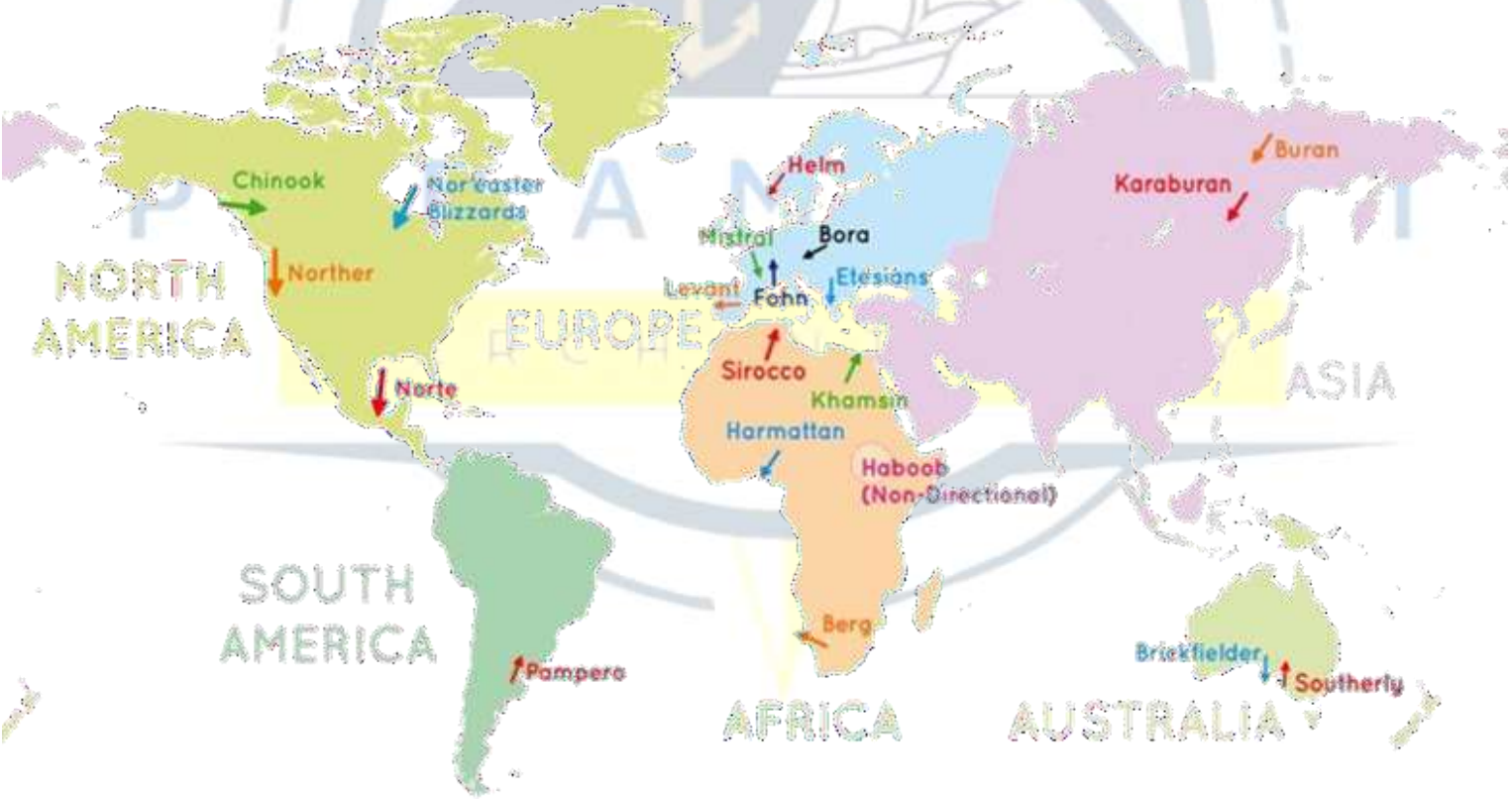
- **Zonda**: This is a warm wind blowing in Argentina and Uruguay, from the Andes to the plains. This is also called 'cool Foehn'.

- **Blizzard**: It is a violent stormy cold polar wind laden with dry snow and is prevalent in north and south Polar Regions. These winds affect Canada and USA.

- **Pampero:** These are the cold polar winds blowing very fast in the pampa's region of South America.

Cold wind	Warm winds
❑ Pampero	❑ Foehn or Fohn
❑ Gregale	❑ Chinook
❑ Bora	❑ Zonda
❑ Tramontane	❑ Loo
❑ Mistral	❑ Sirocco


Types of Local Winds
Periodical
Non Periodical
Land and Sea Breeze
Mountain and Valley Breeze
Hot Wind
Cold Wind
Chinook
Fohn
Santa Ana
Mistral
Northers


Chinook
Nor'easter Blizzards
Norther
Norte
NORTH AMERICA
SOUTH AMERICA
Pampero
EUROPE
Helm
Mistral
Bora
Levant
Fohn
Etesians
Sirocco
Khamsin
Harmattan
Haboob (Non-Directional)
Berg
AFRICA
Buran
Karaburan
ASIA
Brickfielder
Southerly
AUSTRALIA

Earth Atmosphere

Structure of the atmosphere

Troposphere

- lowermost layer of the atmosphere.
- Height-18 km on the equator and 8 km on the poles.
- Thickness is greatest at the equator.
- contains dust particles and water vapor.
- air never remains static in this layer. Therefore, this layer is called 'changing sphere' or troposphere.
- The environmental temperature decreases with increasing height of the atmosphere. It decreases at the rate of 1 degree Celsius for every 165 m of height. This is called **Normal Lapse Rate.**
- The zone separating troposphere from the stratosphere is known as tropopause.

Stratosphere

- is found just above the troposphere at height- 50 km.
- The temperature remains same in the lower part of this layer up to the height of 20 km & increases after that with height
- the temperature increases slowly with the increase in the height.
- Used for flying of aircraft.
- The upper limit of the stratosphere is known as stratopause.
- contains a layer of ozone gas.
- The relative thickness of the ozone layer is measured in Dobson Units.
- The air here is very dry, and it is about a thousand times thinner here than it is at sea level. Because of that, this is where jet aircraft and weather balloons fly.
- It contains a high concentration of ozone (O_3) in relation to other parts of the atmosphere.

Mesosphere

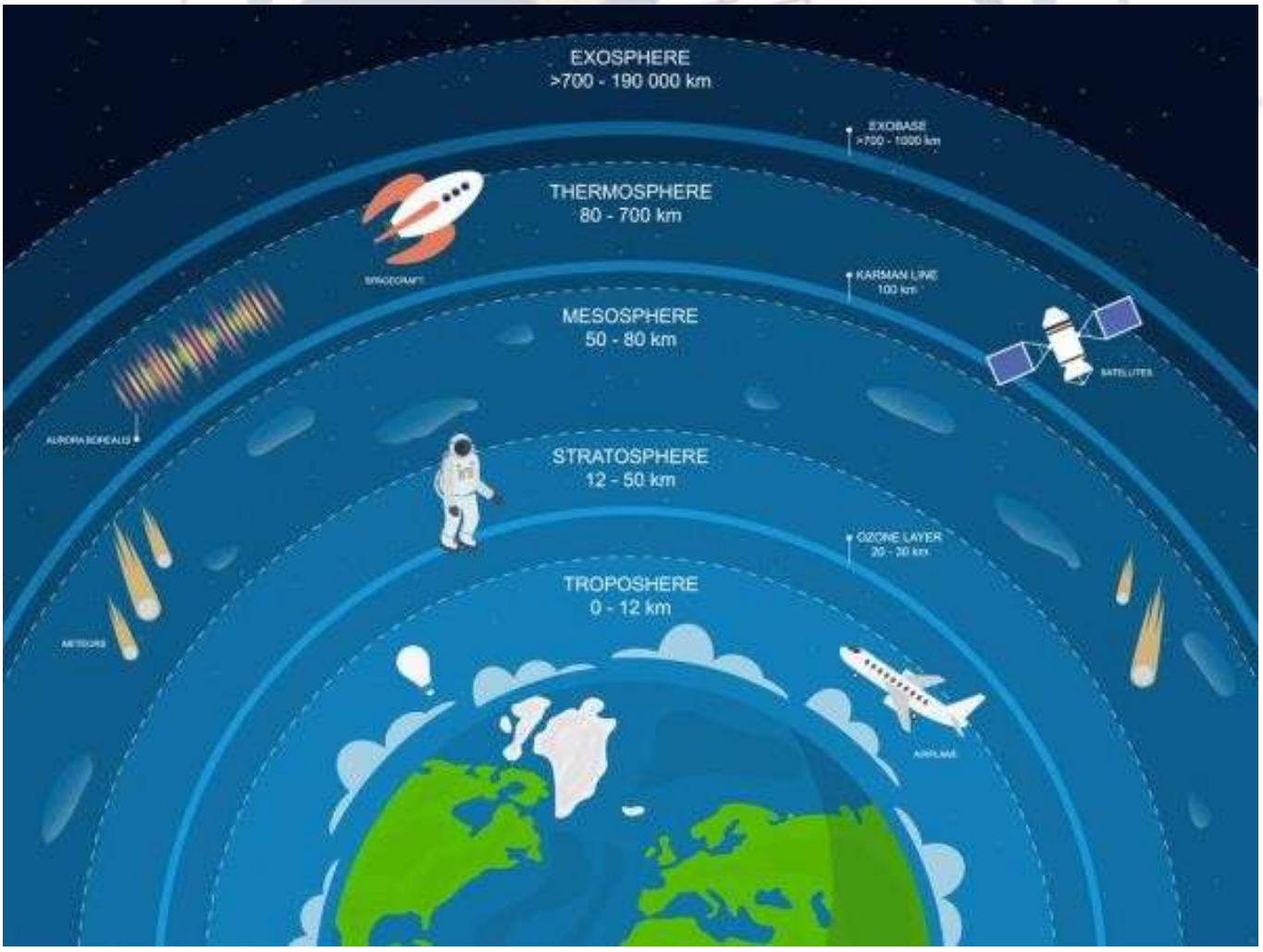
- third layer of the atmosphere at the height -80 km.
- the temperature starts decreasing with increasing altitude and reaches up to – 100 degree Celsius (coldest layer) at the height of 80 km. (Normal Lapse rate)
- Meteors or falling stars occur in this layer.
- No Ozone
- The upper limit of the mesosphere is known as mesopause.
- **Meso + Starto + Tropo = Homosphere**

Thermosphere

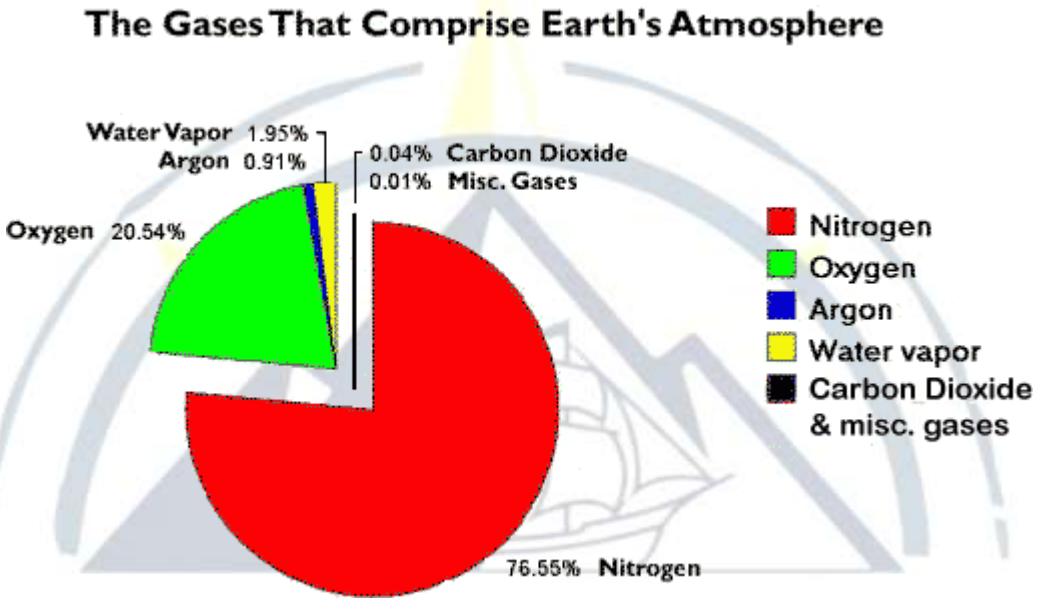
- located **between 80 and 400 km**.
- contains electrically charged particles known as ions, hence called ionosphere.
- Charge Particles from Solar winds, cosmic rays
- Radio waves transmitted from the earth are reflected back to the earth by this
- radio broadcasting has become possible.
- The temperature here starts increasing with heights.
- The gases in the thermosphere, as well as in the troposphere, stratosphere, and mesosphere, consist of atomic oxygen, molecular oxygen, atomic nitrogen, molecular nitrogen, helium, and hydrogen.

Exosphere

- uppermost layer of the atmosphere.
- Gases are very sparse in this sphere due to the lack of gravitational force.
- the density of air is very less here.
- Meteor start burning here
- The exosphere is also made up of the earth's lightest gases, which are mostly hydrogen, helium, carbon dioxide, and atomic oxygen



Composition of the atmosphere



CARBON DIOXIDE

- Carbon dioxide is meteorologically a very important gas.
- is transparent to the incoming solar radiation (insolation) but opaque to the outgoing terrestrial radiation.
- It absorbs a part of terrestrial radiation and reflects back some part of it towards the earth's surface.
- Carbon dioxide is largely responsible for the greenhouse effect.

OZONE GAS

- important component of the atmosphere found between 10 and 50 km above the earth's surface.
- It acts as a filter and absorbs the ultra-violet rays radiating from the sun.
- The amount of ozone gas in the atmosphere is very little
- is limited to the ozone layer found in the stratosphere.

Water Vapor

- Gases form of water present in the atmosphere is called water vapor.
- The amount of water vapor decreases with altitude. It also decreases from the equator (or from the low latitudes) towards the poles (or towards the high latitudes).
- Its maximum amount in the atmosphere could be up to 4% which is found in the warm and wet regions.
- Water vapor reaches in the atmosphere through evaporation and transpiration. Evaporation takes place in the oceans, seas, rivers, ponds and lakes while transpiration takes place from the plants, trees and living beings.
- Water vapor absorbs part of the incoming solar radiation (insolation) from the sun and preserves the earth's radiated heat. It thus acts like a blanket allowing the earth neither to become too cold nor too hot.

Dust Particles

- Dust particles are generally found in the lower layers of the atmosphere.
- These particles are found in the form of sand, smoke-soot, oceanic salt, ash, pollen, etc.
- These dust particles help in the condensation of water vapor. During the condensation, water vapor gets condensed in the form of droplets around these dust particles and thus clouds are formed

Clouds

Cloud is a mass of minute water droplets or tiny crystals of ice formed by the condensation of the water vapors in free air at considerable elevations. As the clouds are formed at some height over the surface of the earth, they take various shapes. According to their height, expanse, density and transparency or opaqueness clouds are grouped under four 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 color.

Cumulus

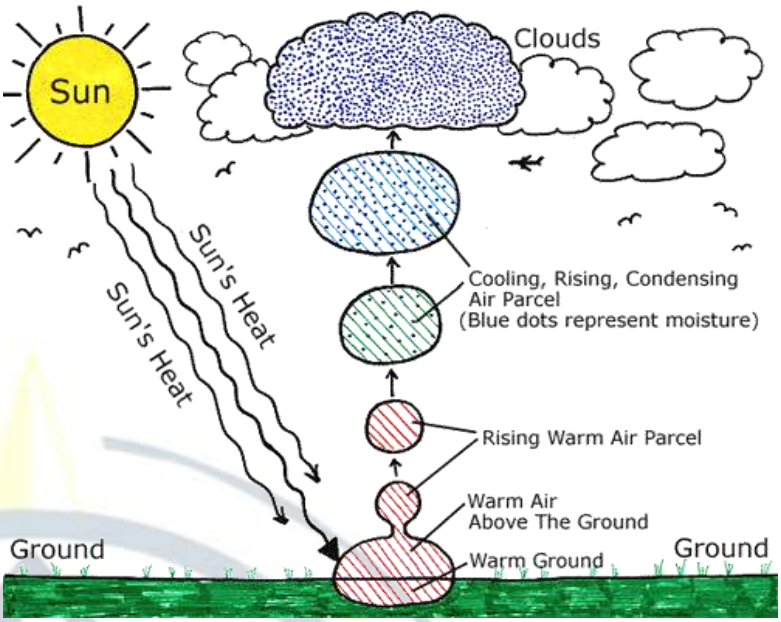
Cumulus clouds look like cotton wool. They are generally formed at a height of 4,000 - 7,000 m. They exist in patches and can be seen scattered here and there. They have a flat base.

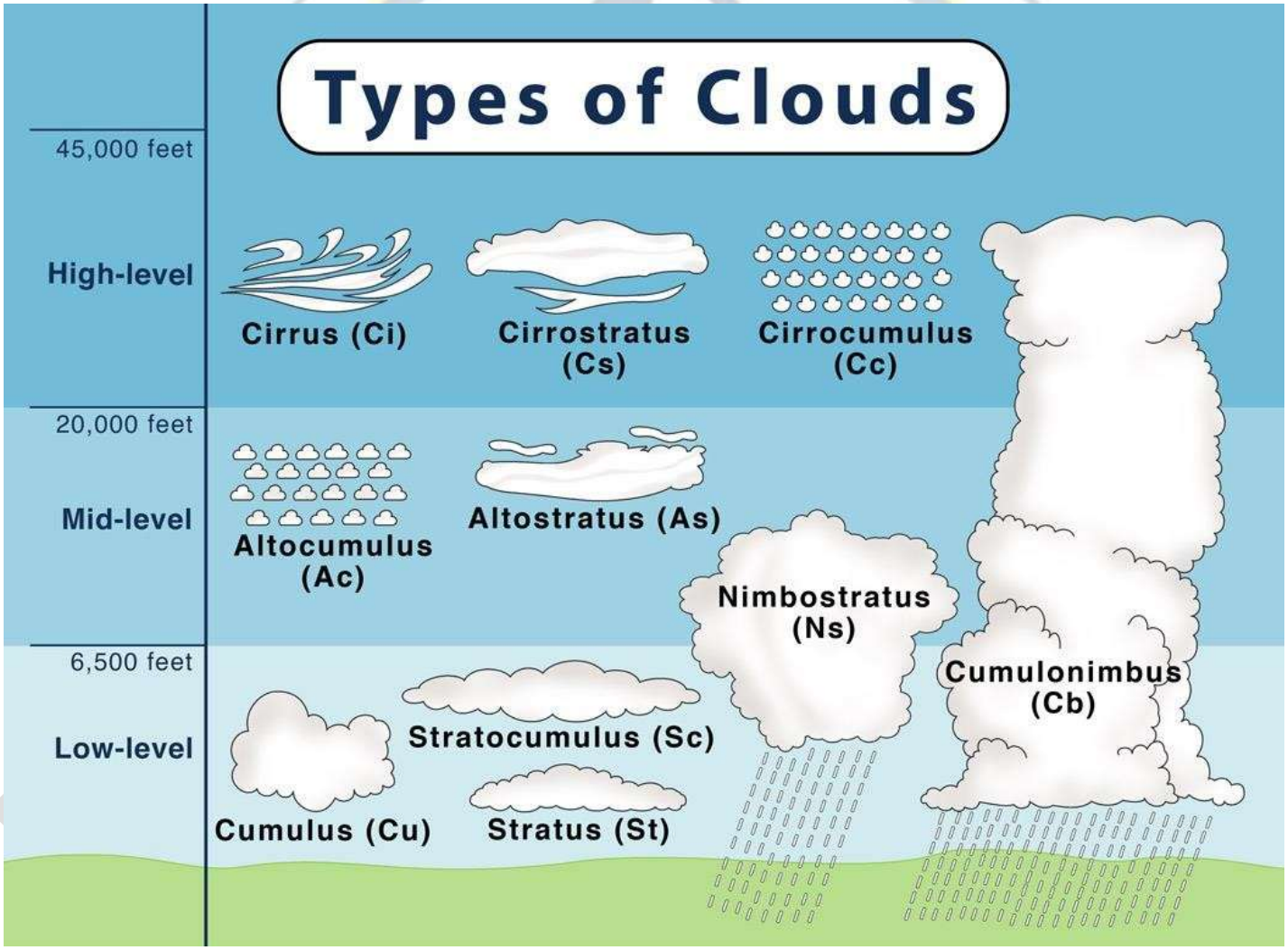
Stratus

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.

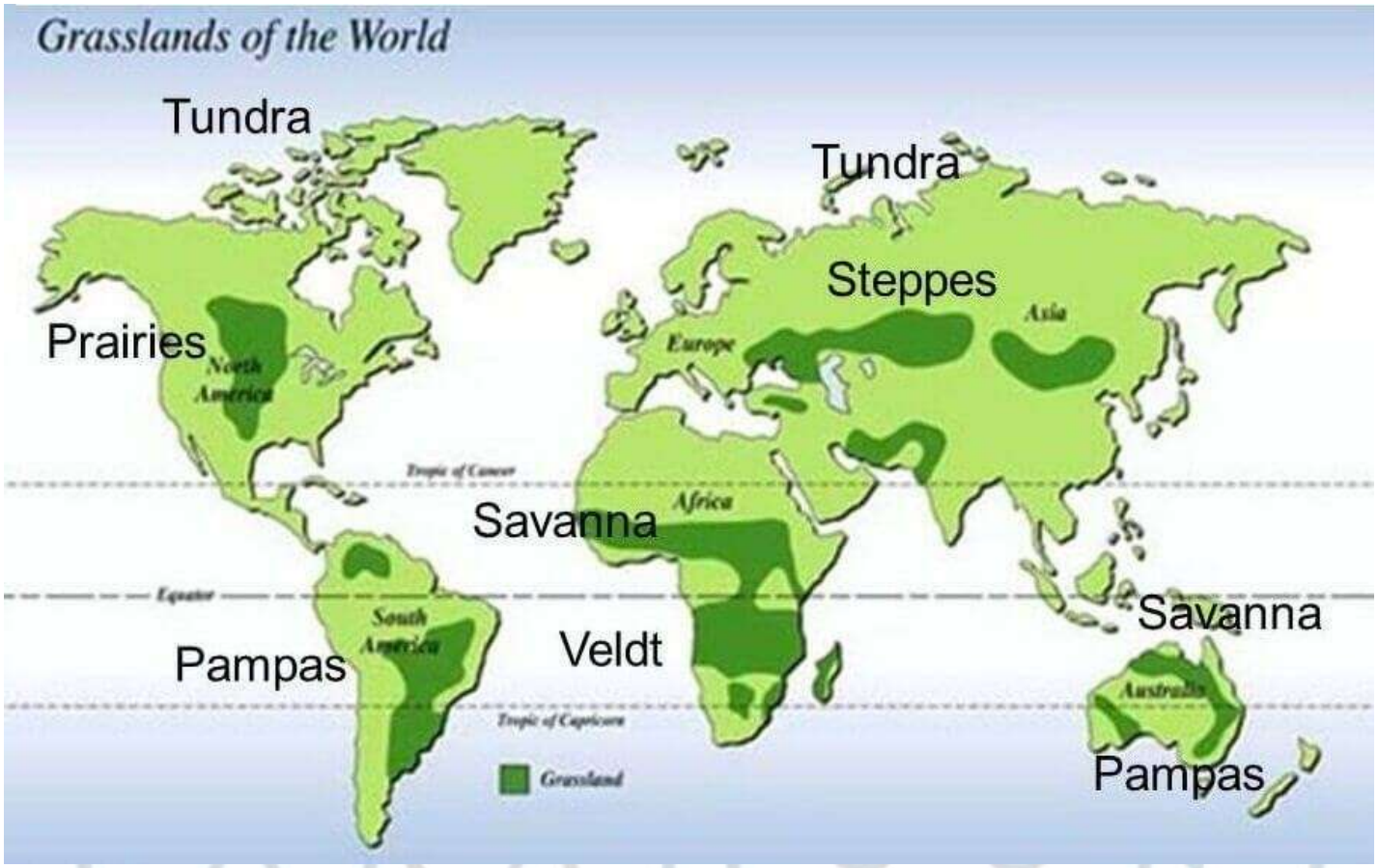
Nimbus

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 vapors.





Grasslands of the World



Grasslands	Region
Steppe	Europe and North Asia
Pustaz	Hungary
Prairies	USA
Pampas	Argentina
Veld	South Africa
Downs	Australia
Canterbury	New Zealand
Savannah	Africa and Australia
Taiga	Europe and Asia