GS FOUNDATION
BATCH FOR CSE 2024

Geography - 04

(DN Airmass, Front, Cyclone New)

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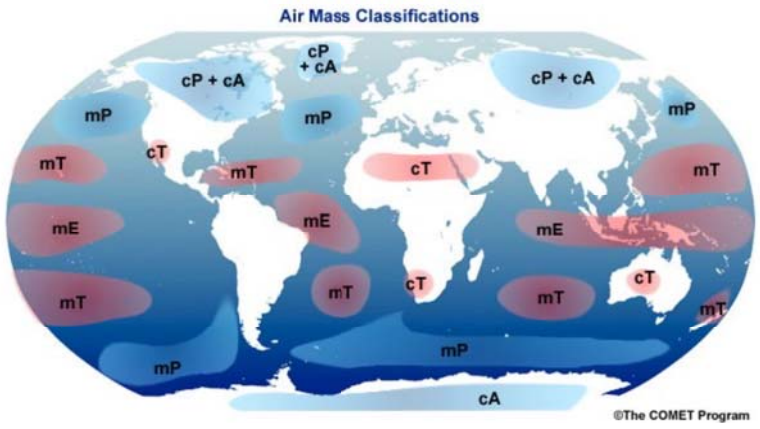
Air Mass, Cyclone

- Dimple Nankani

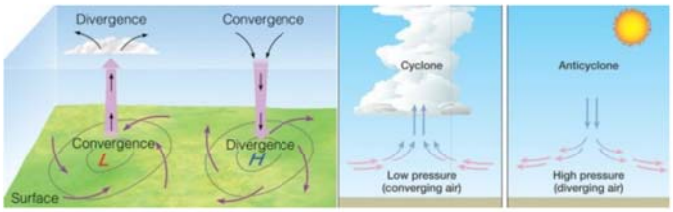
Air Mass

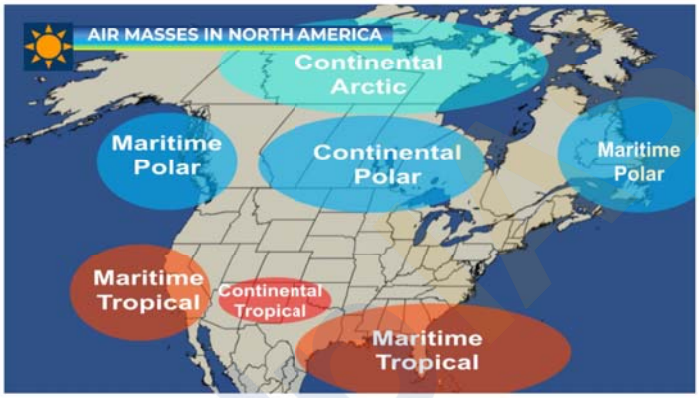
- These are massive bodies of air covering thousands of sq km (horizontally across the Earth's surface) and for entire height of troposphere.
- Airmass have nearly same temperature and moisture levels horizontally.
- Nature and properties of airmasses are acquired from the surface over which airmass develops.



Air Mass Formation: Properties of Source Regions

- Air masses form over source regions that give them their uniform temperature and humidity. **They form on relatively flat surface and extensive surface**
- **Airmass develop in region of High Pressure Conditions and atmospheric stability.** These condition prevent these large volumes from moving. So, while they stay stationary over a region, they acquire the conditions of that region, either temperature or humidity: **Siberian High Pressure condition in winters, Canadian High Pressure Conditions in Winters.**





Types of Air Masses

Based on places of the formation: There can be 4 types of air masses:

- **Antarctica:** These air masses form in the Antarctica region and are very cold.
- **Arctic:** These air masses form in the Arctic region and are very cold.
- **Tropical:** These air masses form in low lying latitudes and are warm up to a moderate level.
- **Polar:** These air masses form in the high-latitude region and are cold.

Based on nature of surface: There can be 2 types of air masses:

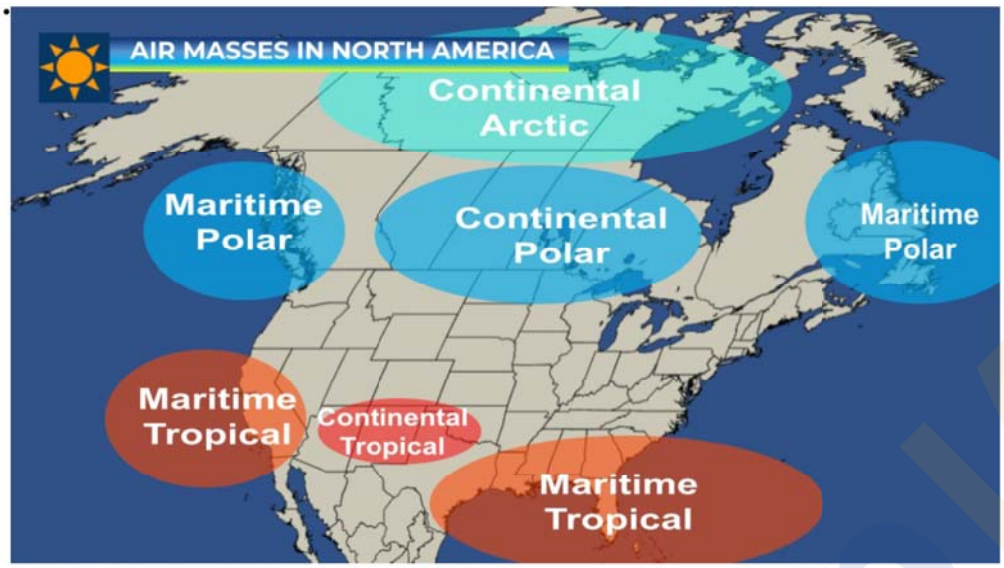
- **Maritime:** Maritime ones form over the water bodies and are filled with moisture.
- **Continental:** Whereas, the Continental ones form over the land and are arid.
- **Eg:** An air mass formed over Siberia is a continental polar air mass that is cold and dry. However, one that is formed over the Indian Ocean is a tropical air mass that is humid and warm.

Accordingly, following types of airmasses are recognised:

1.Maritime tropical (mT);
2.Continental tropical (cT);
3.Maritime polar (mP);
4.Continental polar (cP);
5.Continental arctic (cA).
6.Continental Antartica (CAA)

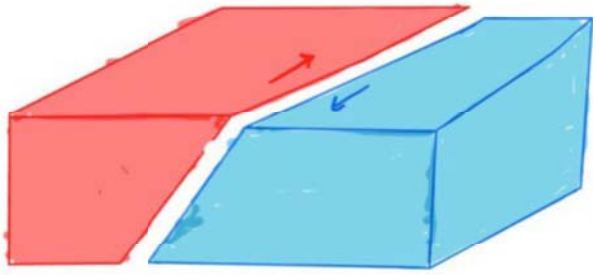
Tropical air masses are warm
polar air masses are cold.

Two most imp airmasses are: cP, mT



Fronts

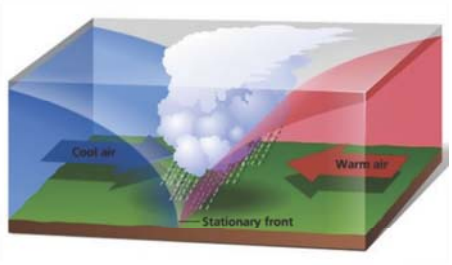
- It is an inclined zone along which two opposing air masses (having contrasting characteristics in terms of air temperature, humidity, density) converge together.
- The frontal zone is inclined at a low angle to the Earth's surface.
- Along a front, one airmass will be relatively warmer than the other airmass. Warmer Airmass will try to rise along the front and cooler airmass will drag beneath



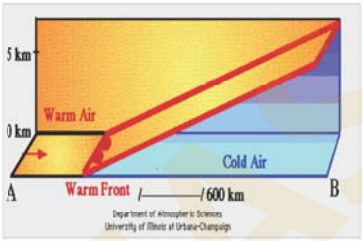
Types of Fronts

Based on the nature of convergence, relative acceleration of air masses, and stages of front formation, four types are identified:

1. **Stationary Front**: 2 airmass standing in front of Each Other



2. **Warm Front:** Warm airmass is active and moves into region of cold airmass

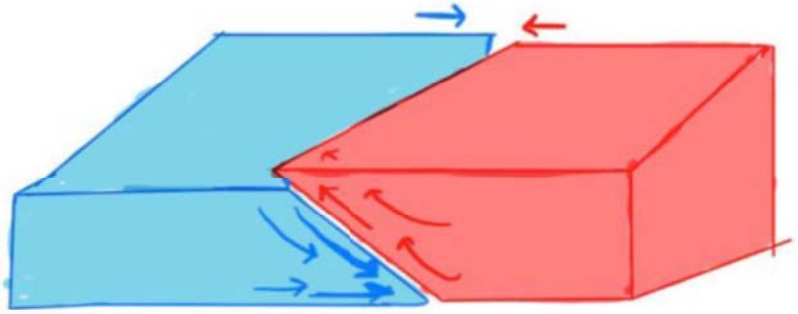


3. **Cold Front**: Cold airmass is active and moves into region of warm airmass

4. **Occluded Front**: Warm airmass is completely tossed above cold airmass

Some Important Points

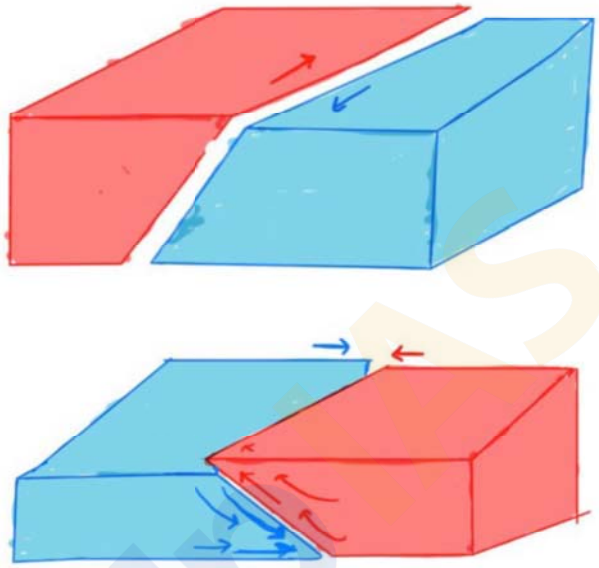
- Warm airmass rises above and cold airmass is pushing from below always whether in warm or cold front



- Cold Front is relatively more steep and warm front is relatively more gentle
- Cold Airmass moves fast as compared to warm Airmass

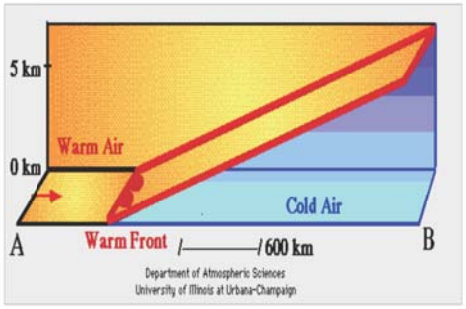
Stationary Front

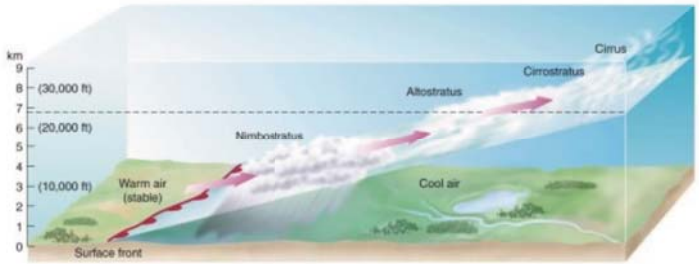
- In this type two air masses having contrasting physical properties rest against each other without showing any major movement.
- Weather generally remains stable but sometimes it might rain.



Warm Front

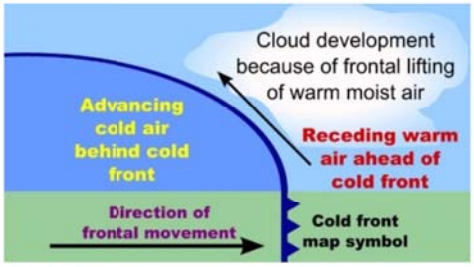
- When a warm air mass collides against the cold air mass, it rises above the cold air mass (cold air mass is relatively heavier and denser)
- The warm front is a gently sloping frontal surface along which warm and light air becomes active and aggressive and rises slowly over cold and dense air. Due to this condensation takes place gradually.
- It leads to nimbostratus, altostratus and cirrostratus cloud formation. These clouds produce moderate to gentle precipitation over a relatively large area for several hours

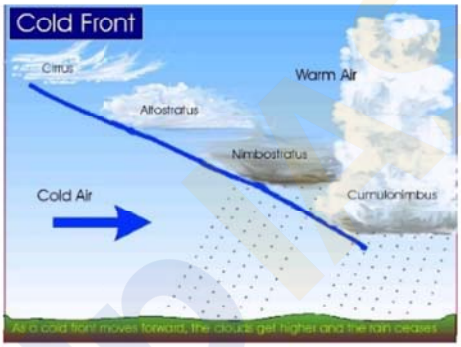




Cold Front

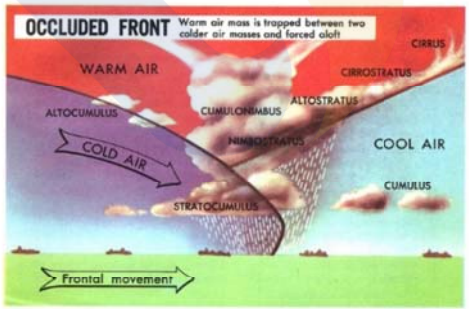
- This is formed when cold air mass initiates the movement and hits the warm air mass and makes it rise.
- It is a steep frontal surface and so condensation takes place rapidly.
- Cirrus, Alto stratus, Nimbostratus and Cumulonimbus clouds are formed and heavy rainfall with lightning and thundering takes place.

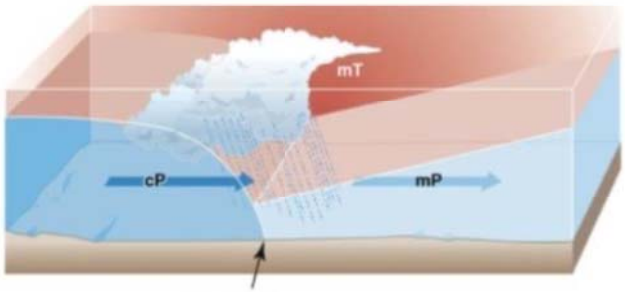


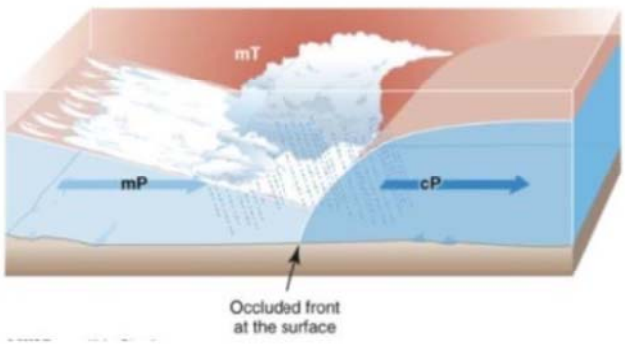


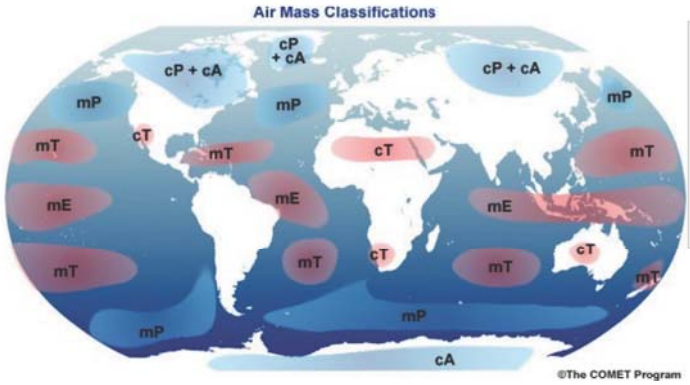
Occluded Front

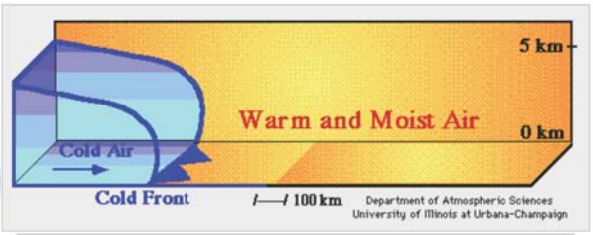
- When warm air mass is completely raised over the cold air mass it is called an occluded front.
- Weather along this sector is complex—a mixture of cold front type and warm front type weather. These are common in western Europe.

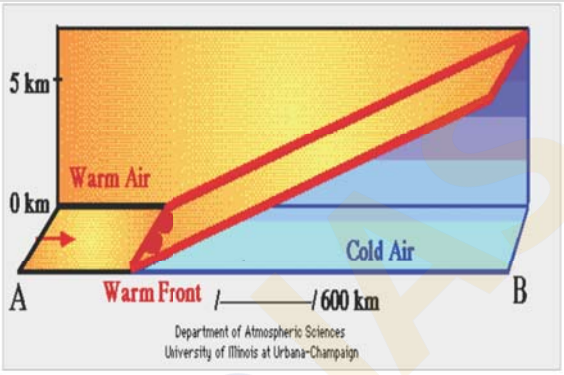


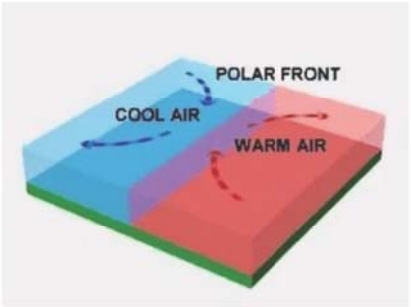






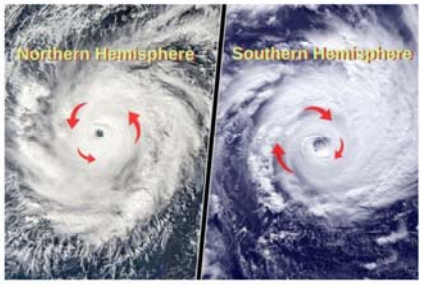






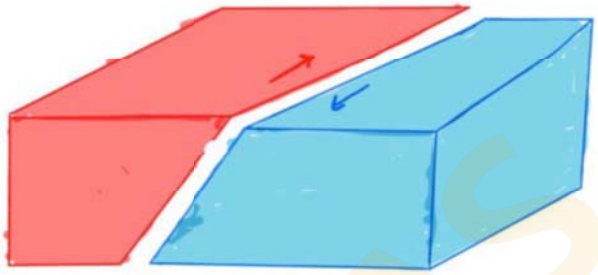
Cyclone

- Are Low pressure System
- Are Rotating System
- Localised low pressure centre with winds converging from all sides.
- Moves Anticlockwise in NH and Clockwise in SH
- At the equator, the Coriolis force is zero so low pressure gets filled instead of getting intensified. That is the reason why tropical cyclones are not formed near the equator.
- Genesis of Low Pressure can be
  - Thermal Origin: Heating and Rising Air. This is seen in tropical latitude: TROPICAL CYCLONE
  - Dynamic Origin: Related to Upper Tropospheric Conditions (Rossby Wave) or due to movement of air mass: TEMPERATE CYCLONE



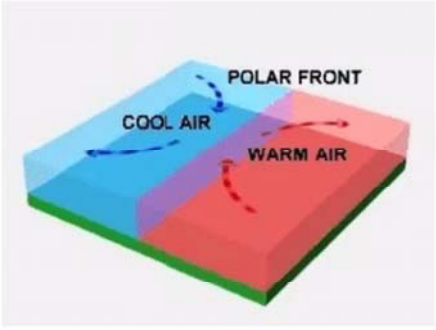
Temperate Cyclone (Extra-Tropical Cyclones)

- Extra-Tropical Cyclones are storm systems emerging in the mid and high latitudes (60 degree – 65 degree), away from the tropics.
- Very extensive ~500km.
- Generates around the dynamically induced low pressure i.e due to the movement of the Upper Tropspheric Wind and movement of front.
- In the beginning, the front is stationary.



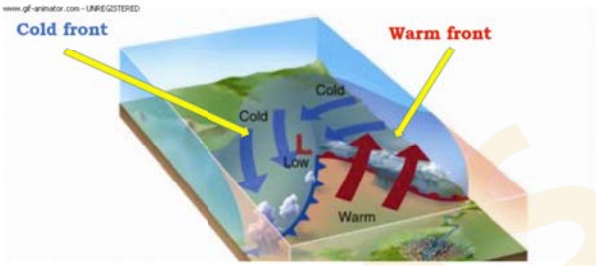
Formation of Temperate Cyclone (Extra-Tropical Cyclones)

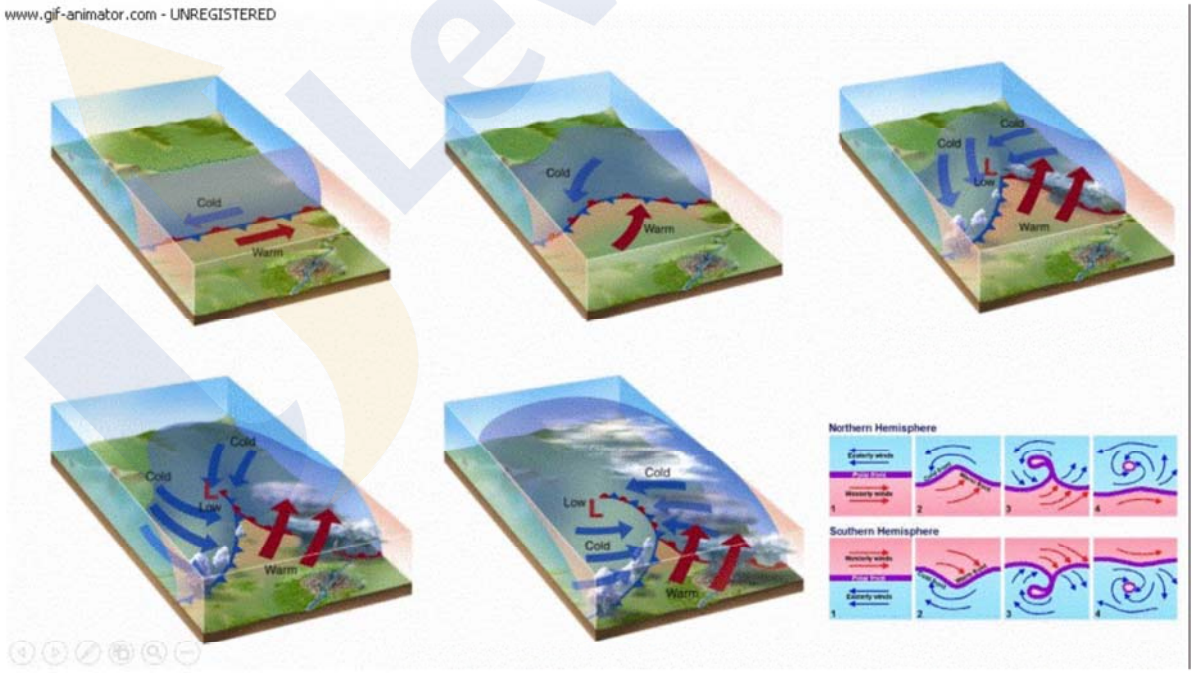
- Then a low pressure develops
- In the Northern hemisphere, cold air blows from the north of the front and warm air blows from the south.
- When the pressure falls along the front, the cold air move towards the south, and the warm air moves northwards setting in motion an anticlockwise cyclonic circulation.
- The cyclonic circulation results in a well-built extratropical cyclone, with a cold front and a warm front.



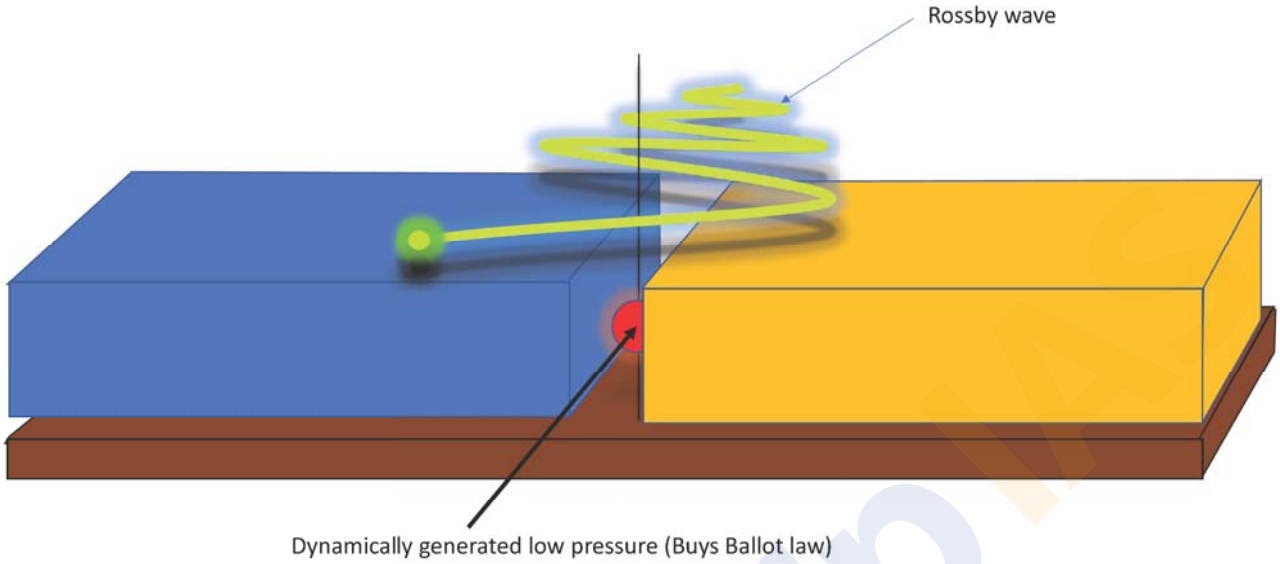
Formation of Temperate Cyclone (Extra-Tropical Cyclones)

- There are pockets of warm air compressed between the forward and the rear cold air.
- The cold front moves faster than the warm front eventually surpassing the warm front.
- The warm air is entirely lifted and the front is occluded and the cyclone dissipates.

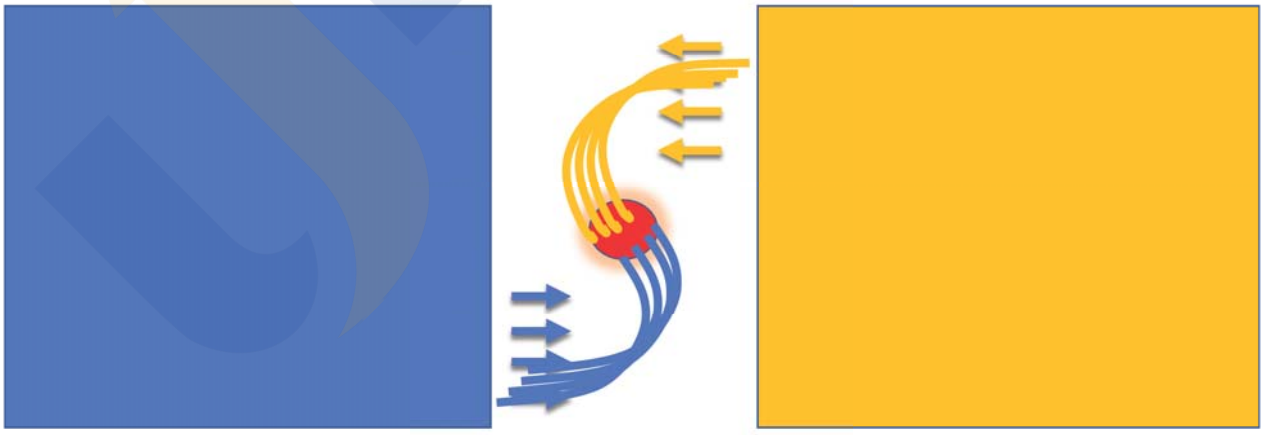




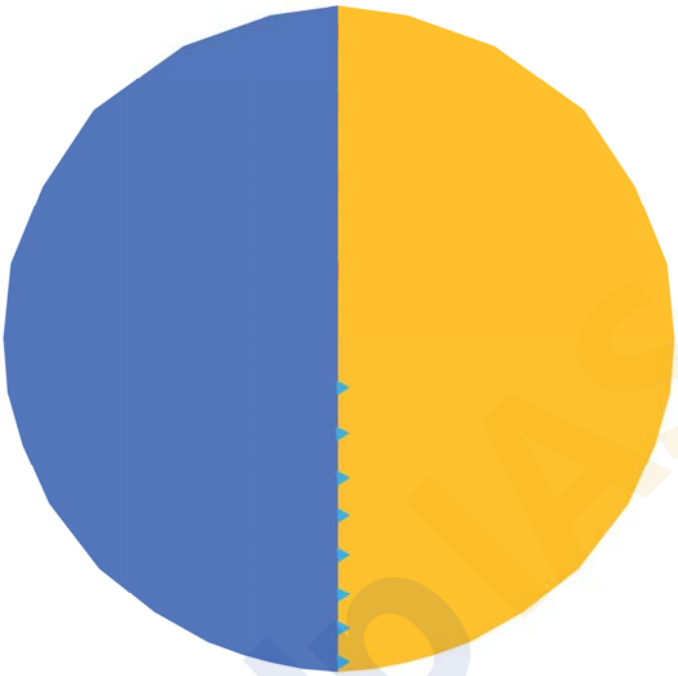
Frontogenesis and creation of Low pressure

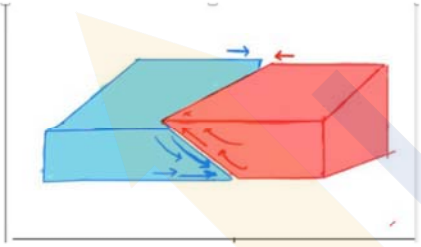


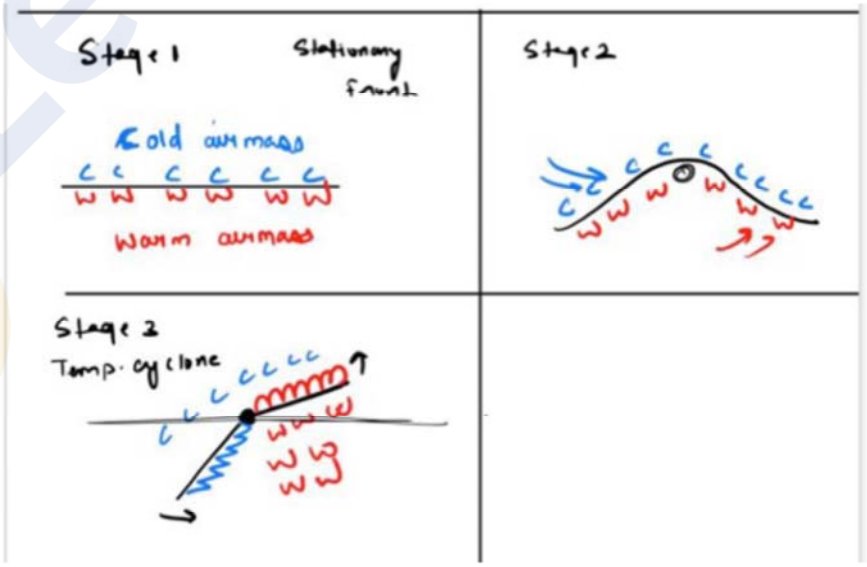
Front starts to move



Cold front catching up warm front







Characteristics of temperate cyclone

1. Temperate cyclone are massive system over thousands of square kilometre with their radius exceeding 200 to 300 km

2. They are more intense in the winters because of the stronger air mass contrast

3. Compared to tropical cyclone which are much smaller and stronger system, temperate cyclone are not as violent.

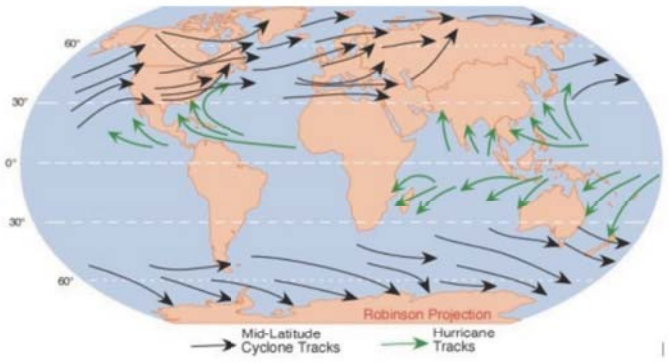
4. Wind velocity is within 50 km/hour and sometime above 80 km/hour

Characteristics of temperate cyclone

5. Temperate cyclone move from West to east due to the influence of the westerlies

6. Temperate cyclone can form on land and also on waters but they are relatively more developed on the land unlike tropical cyclone that always form on the warm waters and never on land

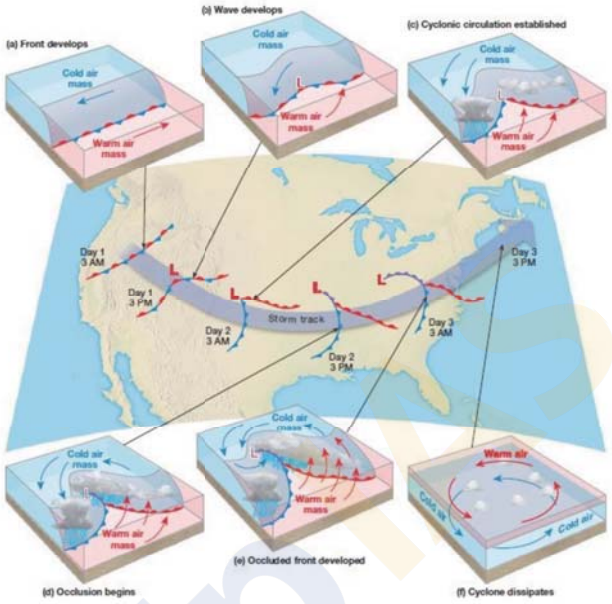
7. In high mid latitudes following are the preferred location for low pressure development like Aleutian low pressure region, Icelandic low pressure region, Mediterranean Sea low pressure system.



REVISION

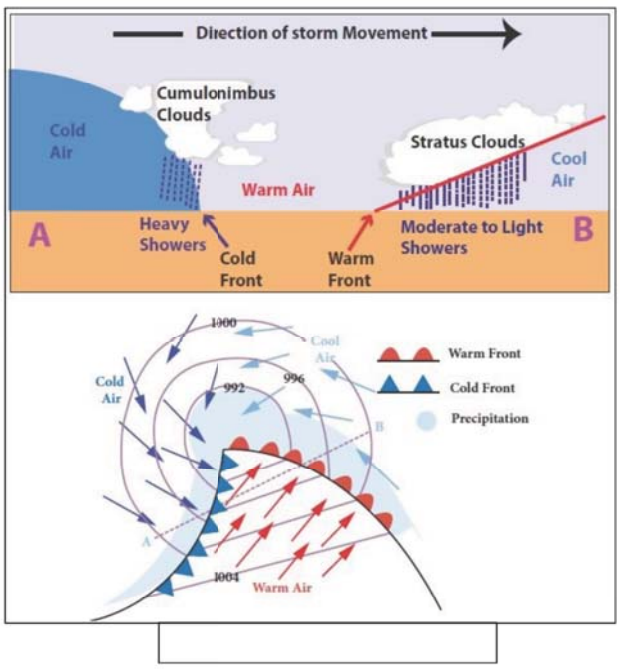
Life cycle of temperate cyclone

- **Stage 1** – low pressure develops between the two fronts
- **Stage 2** – low pressure intensifies, the fronts starts rotating
- **Stage 3 –** As the cold air mass is denser it keep tossing the warm air up as the cold front advances.
- **Stage 4** – now cold front catches the warm front and completely occludes it above the ground
- **Stage 5** – the low pressure dissipates gradually.



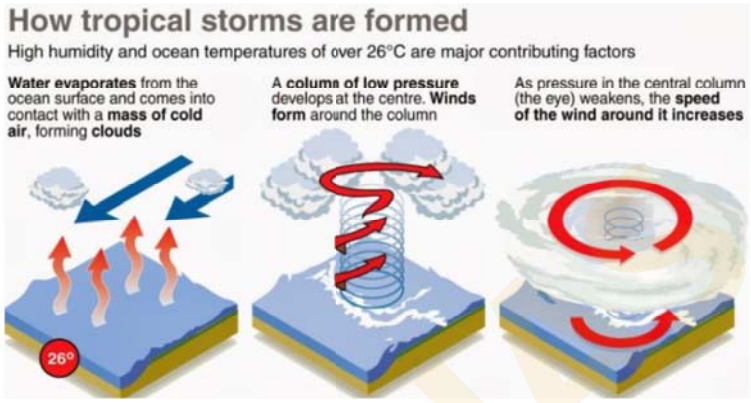
Structure of temperate cyclone

These cyclones are nothing but a rotating cold and warm fronts around a dynamically induced low pressure.
All the weather phenomena are those which are associated with the cold and warm fronts.



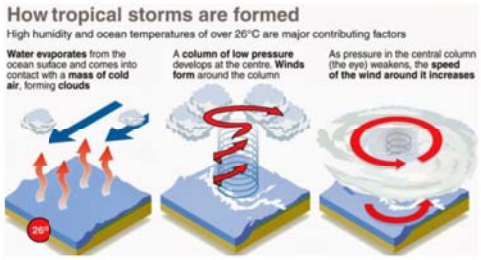
Tropical Cyclone

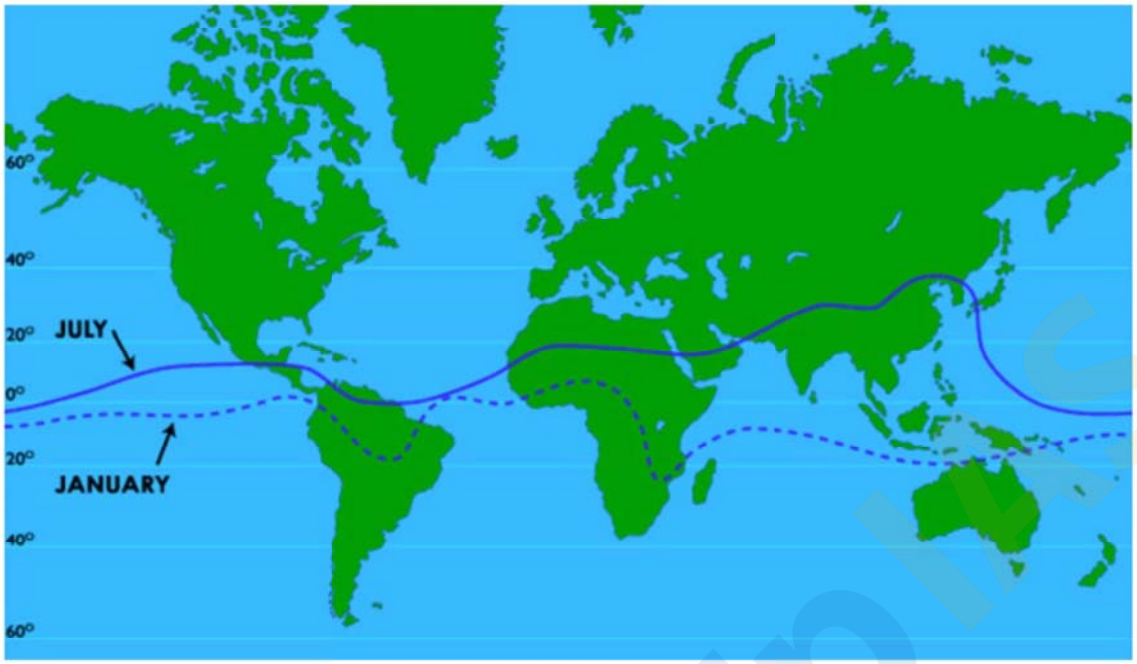
- Tropical cyclones are violent low pressure system that originate over oceans in tropical areas and move over to the coastal areas bringing about large scale destruction caused by violent winds, very heavy rainfall
- Move Anticlockwise in NH
- Move Clockwise in SH



Favourable Conditions for the Formation of Tropical Cyclone

- A large area of water surface with a temperature above 27° C.
- The Coriolis force is strong enough to form a cyclonic vortex.
- A weak low-pressure area or low-level cyclonic circulation already exists on ocean surface
- There should be a divergence around 9 km to 15 km which sucks the air from ocean surface above and thus the upward movement of air is accelerated and low pressure centre at the surface is further intensified.
- Variations in the vertical wind speed are minor. This is referred to condition of **Low Wind Sheer**
- Tropical cyclones develop around inter-tropical convergence zone





Annual movement of the intertropical convergence zone (ITCZ). *Source:*

Inter tropical convergence zone

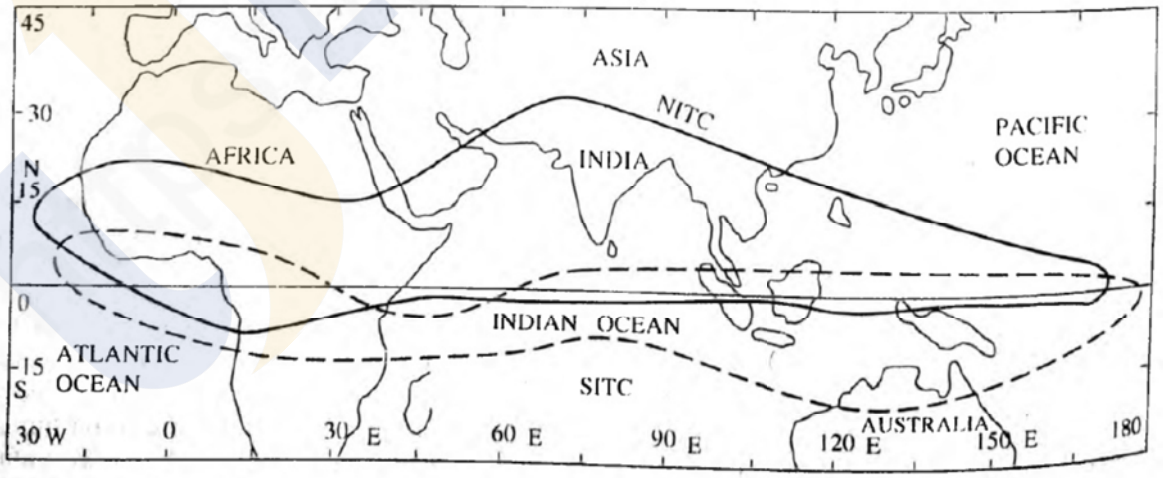
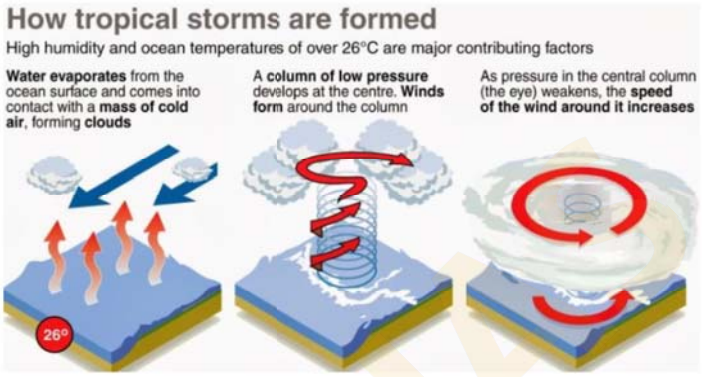


Fig. 6.5 : Intertropical convergence (NITC and SITC).

Origin of Tropical Cyclone

- Tropical cyclones arise over tropical oceans in late summers and have a thermal origin (August to mid-November).
- Because of the Coriolis effect, the powerful local convectional currents take on a whirling motion at these regions.
- These cyclones form and move under the influence of trade wind towards the land

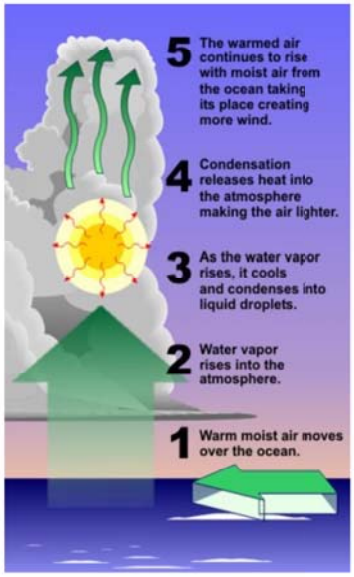


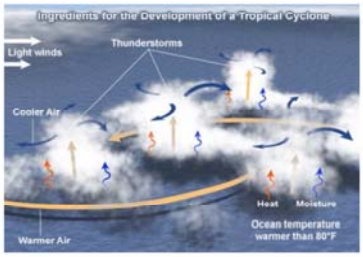
Developmental Stages of Tropical Cyclone

Tropical cyclone development can be classified into 3 stages

1. Formation and Initial Development Stage

- Transport of water vapor and heat from the warm ocean to overlying air, largely through evaporation from the sea surface, leads to the creation of a cyclonic storm.
- Condensation of rising air above the ocean surface stimulates the creation of huge vertical cumulus clouds.
- Condensation releases heat and keeps entire air column warm

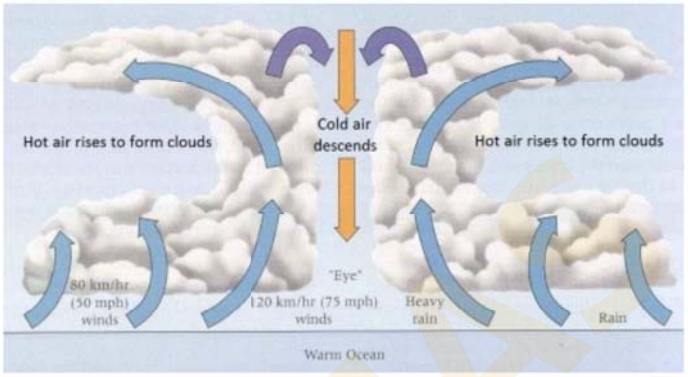




Developmental Stages of Tropical Cyclone

2.Mature Stage

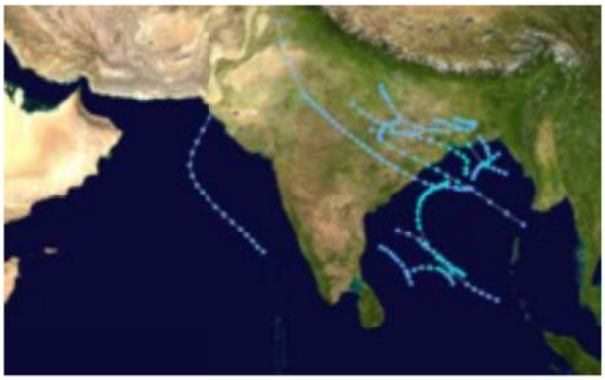
- Rising air intensify as a tropical storm and spread horizontally at tropopause level.
- When air spreads out, some portion of air migrates downward and subsides in eye.
- When subsidence is induced, the air warms up due to compression, resulting in a warm **'Eye'** (low-pressure center). Sinking in the eye does not reach the ocean surface, but only reaches a depth of 1-3 kilometer.



Developmental Stages of Tropical Cyclone

3. End of cyclone

- As soon as the source of warm moist air is abruptly cut off, a tropical cyclone begins to weaken.
- On reaching the land the moisture supply is cut off and the storm dissipates.
- The place where a tropical cyclone crosses the coast is called the landfall of the cyclone.



Structure of Tropical Cyclone: Eye, Eye Wall, Spiral Bands

1.Eye:

- The "eye" is a roughly circular area at the center of a severe tropical cyclone with comparatively mild winds.
- There is little to no precipitation in the eye.
- The eye is the area with the lowest surface pressure and the warmest temperatures.

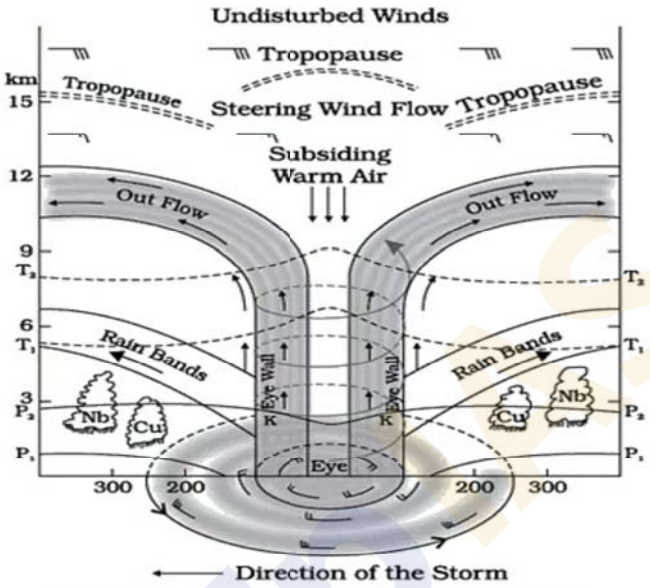


Fig: Vertical section of the tropical cyclone

Structure of Tropical Cyclone: Eye, Eye Wall, Spiral Bands

2.Eyewall:

- The "eyewall" a roughly circular ring that surrounds the eye with strong spiralling ascent of air
- It is the area of the tropical cyclone with the strongest surface winds.
- The wind reaches maximum velocity in this region, reaching as high as 250 km per hour.
- Torrential rain occurs here.

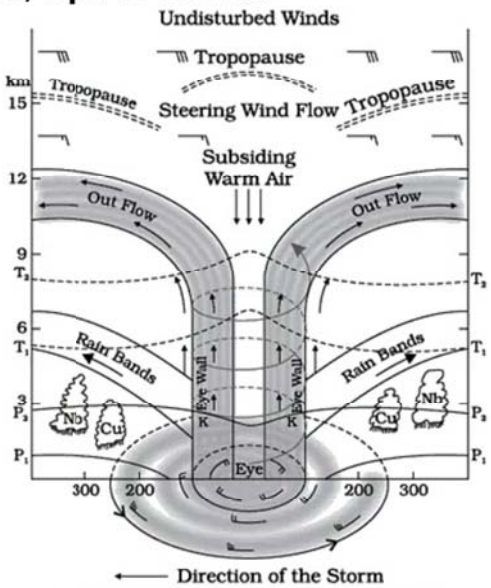


Fig: Vertical section of the tropical cyclone

Structure of Tropical Cyclone: Eye, Eye Wall and

3. Spiral Bands:

- From the eye wall rain bands may radiate and trains of cumulus and cumulonimbus clouds may drift into the outer region.
- Spiral bands are so named because they appear to spiral along the cyclone

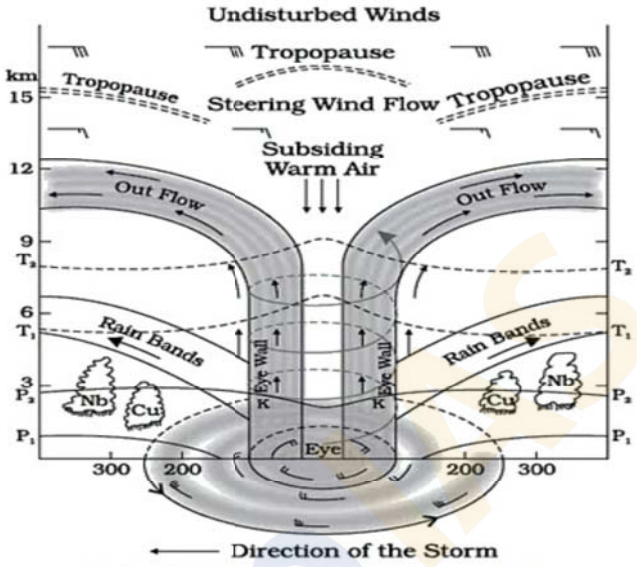
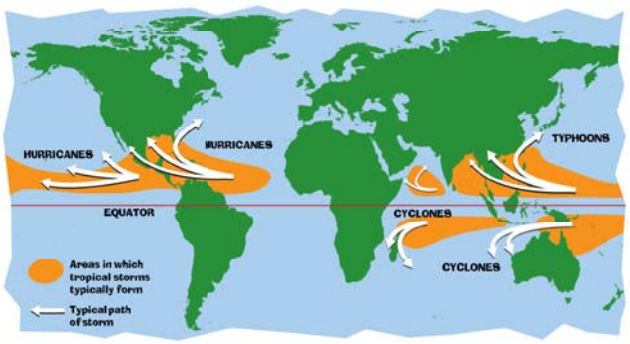


Fig: Vertical section of the tropical cyclone

Favourite Breeding Grounds and Local Name

Favourite Breeding Ground:

- South-east Caribbean region (called **hurricanes**).
- Philippines islands, eastern China (called **typhoons**).
- Bay of Bengal and Arabian Sea (called **cyclones**).
- Around the south-east African coast and Madagascar-Mauritius islands.
- North-west Australia.



Local Names of Tropical Cyclone: In different areas, cyclc are referred to by different names.

1. Hurricanes – In the Atlantic and Eastern Pacific.
2. Typhoons – In Southeast Asia
3. Cyclone – In the Indian Ocean and Western Pacific around Australia

2020

Consider the following statements:

1. Jet streams occur in the Northern Hemisphere **only**.
2. Only some cyclones develop an eye.
3. The temperature inside the eye of a cyclone is nearly 10 C lesser than that of the surroundings.

Which of the statements given above is/are correct:

(a) 1 only (b) 2 and 3 only

(c) 2 only (d) 1 and 3 only

TROPICAL CYCLONE	TEMPERATE CYCLONE
Tropical cyclones, move from east to west.	These cyclones move from west to east
A tropical cyclone has an effect on a comparatively smaller area than a Temperate cyclone.	Temperate cyclone affect a much larger area
The velocity of wind in a tropical cyclone is much higher and it is more damaging.	The velocity of air is comparatively lower
Tropical Cyclone forms only on seas with temperature more than 26-27degree C and dissipate on reaching the land.	Temperate cyclones can be formed on both land and sea
A tropical cyclone doesn't last for more than 7 days	Temperate cyclone can last for a duration of 15 to 20 days

2015

In the South Atlantic and South-Eastern Pacific regions in tropical latitudes, cyclone does not originate. What is the reason?

(a) Sea surface temperatures are low
(b) Inter-Tropical Convergence Zone seldom occurs
(c) Coriolis force is too weak
(d) Absence of land in those regions

2020

Consider the following statements:
1. Jet streams occur in the Northern Hemisphere only.
2. Only some cyclones develop an eye.
3. The temperature inside the eye of a cyclone is nearly 10 C lesser than that of the surroundings.

Which of the statements given above is/are correct:
(a) 1 only
(b) 2 and 3 only
(c) 2 only
(d) 1 and 3 only

2013

On the planet earth, most of the freshwater exists as ice caps and glaciers. Out of the remaining freshwater, the largest proportion

(a) is found in atmosphere as moisture and clouds
(b) is found in freshwater lakes and rivers
(c) exists as groundwater
(d) exists as soil moisture

2021

With reference to the water on the planet Earth, consider the following statements:

1. The amount of water in the rivers and lakes is more than the amount of groundwater.
2. The amount of water in polar ice caps and glaciers is more than the amount of groundwater.

Which of the statements given above is/are correct?
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Mains Questions

- Q) Briefly mention the alignment of major mountain ranges of the world and explain their impact on local weather conditions, with examples. 2021
- Q) How do the melting of the Arctic ice and glaciers of the Antarctic differently affect the weather patterns and human activities on the Earth? Explain. 2021
- Q) How does the cryosphere affect global climate? 2017
- Q) Discuss the concept of air mass and explain its role in macro-climatic changes. 2016
- Q) Tropical cyclones are largely confined to the South China Sea, Bay of Bengal, and the Gulf of Mexico. Why? 2014