Tropical Cyclone

Part II (1+1+1 System) Geography Hons.

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Topic: 4.1

A tropical cyclone is a system of the low pressure area surrounded by high pressure areas on all sides occurring in tropical zone bound by Tropic of Cancer in the north and Tropic of Capricorn in the south.

Chief Characteristics of Tropical Cyclones

1. Tropical cyclones are of numerous forms which vary considerably in shape, size and weather conditions.
2. There are wide variations in the size of the tropical cyclones. However, the average diameter of a tropical cyclone varies from 80 to 300 km. Some of the cyclones have diameter of only 50 km or even less than that.
3. The isobars in most tropical cyclones are generally circular, indicating that most of the tropical cyclones are circular in shape.
4. The isobars are closely spaced which indicates that the pressure gradient is very steep and winds blow at high speed.
5. Most of the tropical cyclones originate on the western margins of the oceans where warm ocean currents maintain sea surface temperature above 27°C.
6. They advance with varying velocities and their velocities depend upon a number of factors. Weak cyclones move at velocities varying from 30 to 35 km/hr. while hurricanes may attain velocity of 180 km/hr. or even more.
7. They are very vigorous and move with high speed over the oceans where there are no obstructions in their way.
8. They are more frequent in late summer and autumn in the Northern Hemisphere and spring in the Southern Hemisphere.

Classification of Tropical Cyclones

Tropical cyclones differ from one another with respect to their size, weather conditions and general characteristics and it is difficult to give a comprehensive classification of these cyclones. However, World Meteorological Organisation (W.M.O.) has given the following classification based on their place of origin, speed of winds, air pressure and clouds etc.

1. Tropical Depression is a system with low pressure enclosed within few isobars and it lacks a marked circulation or has winds below 17 m sec^{-1} (61 km/hr.).
2. Tropical Storm is a system with closed isobars and a wind circulation from 17 to 32 m sec^{-1} (115 km/hr.).
3. Tropical Cyclones are warm vortex circulation of tropical origin with a small diameter (some hundreds of kilometres) often of an approximately circular shape, minimum surface pressure (less than 900 mb) with sustained maximum winds of at least 33 m sec^{-1} (118 km/hr.) and torrential rains, sometimes accompanied by thunderstorm.

Conditions favourable for Tropical Cyclone formation

Although the exact cause of tropical cyclone formation is not yet fully known, various studies have confirmed that following conditions are essential for tropical cyclones to develop.

1. Warm water: Tropical cyclones form only over large sea surface of warm water with temperature at least 26°C, preferably over 27°C. High temperature leads to large scale evaporation which provides sufficient moisture to the air. When water is converted into vapour, a lot of heat is consumed which is known as latent heat. Thus moisture present in the air provides necessary latent heat. The amount of latent heat increases with the increase in moisture in the air. When condensation and precipitation occur in higher layers of the atmosphere, massive amount of latent heat is released and this latent heat provides energy to the storm. Ocean waters within the tropics are the warmest in late summer and early autumn and consequently most of the tropical cyclones are born in these seasons. South Atlantic and Eastern South Pacific oceans lack tropical cyclones because these areas are visited by cold ocean currents.

2. Depth of warm water: Sea water temperature of 27°C at the sea surface alone is not sufficient. High temperature of 27°C must prevail from the sea surface upto a depth of 60-70 metres. In the absence of such a condition, deep convection will bring cooler water at the surface which will be cut off the heat supply for cyclone formation. And if a cyclone is already formed, the absence of heat supply from the sea surface will lead the 4issipation of the cyclone.

3. Presence of pre-existing low-level disturbances: Trade winds converge near the equator to form inter- tropical convergence zone (ITZC) in which low-level disturbances in the form of easterly waves exist. These disturbances provide a proper platform for the development and growth of tropical cyclones.

4. Coriolis force: Coriolis force is the most essential prerequisite for movement of air in a cyclone. It is because of coriolis force that the winds blow towards the centre of a cyclone in anticlockwise direction in the northern hemisphere and in clockwise direction in the southern hemisphere. Since the magnitude of the coriolis force depends on latitude, it is zero at the equator and maximum as the poles. Thus no tropical cyclones are formed at the equator. It is only at 5°N and S latitudes that when the magnitude of coriolis force is sufficient enough to deflect the winds and lead to the development of a cyclone. It is because of coriolis force that maximum development of the tropical cyclones takes place around 15°N and S latitudes. About two-thirds of the tropical cyclones develop between 10° and 20°N and S latitudes.

5. High humidity: The air of the cyclone must have high level of humidity because it leads to formation of cumulonimbus clouds. Not much cloud is formed if the air coming in the cyclone is dry. For proper formation of a tropical cyclone the relative humidity of mid tropospheric air should be above 50-60 per cent. This is the reason that most of the tropical cyclones are formed over the ocean surfaces.

Life Cycle of Tropical Cyclones

The life cycle of an average cyclone is usually divided into four phases.

1. Formation phase: This is the first phase in which winds are variable with showers of rain over a large oceanic region. The atmospheric pressure starts falling over the entire area and winds start blowing in anticlockwise direction when viewed from above. The winds become stronger after sometime and the isobars are nearly circular. This is the stage of ‘unsettled weather’ as described by meteorological office.

2. Developing phase: There is further fall in the atmospheric pressure and increase in the amount of cloudiness and rainfall. There is inflowing of the moist air and the air rises above at the centre. Large amount of latent heat is released due to adiabatic cooling and there is further increase in rainfall. The pattern of air flow at higher altitudes varying from 10 to 12 km provides conditions for removal of air at these levels. This causes more inflow of moist air resulting in further increase in the amount of cloudiness and rainfall. The winds move around

the centre along a path which is more or less circular whose centre almost coincides with the centre of the cyclone.

3. Mature phase: According to the India Meteorological Department (IMD) the term 'mature phase' is used when the maximum wind speed exceeds 60 km/hr. The system is described as 'Severe Cyclone Storm' if the maximum wind speed is more than 90 km/hr. When the wind speed exceeds 120 km/hr., it is called 'Severe Cyclone Storm with a core of Hurricane Winds'. IMD calls a 'Super Cyclone' when the winds blow at speeds of more than 220 km/hr.

4. Dissipating phase: This phase begins as soon the cyclone leaves the sea area and enters land area. This is due to friction of the land area which results in decrease of wind speed. The air pressure at the centre begins to rise and reduced supply of water vapour reduces the energy of the cyclone. The entire system weakens and the cyclone losses its strength. The system continues to move over land for a few more days, giving abundant rainfall along its track and ultimately dies away.

Structure of Tropical Cyclones

A cyclone is a low pressure area surrounded by high pressure areas on all sides. The central low pressure area is known as the 'eye of the cyclone' around which winds blow in anticlockwise direction in the northern hemisphere and in clockwise direction in the southern hemisphere.

Structurally, a tropical cyclone can be divided into six distinct regions from 'eye' in the centre to the outermost limit.

1. The eye: The small central part of the tropical cyclone is known as its eye. It has the following characteristic features:

(i) It is an area of relatively calm winds and clear skies.

(ii) The boundary of the eye is determined by 'eye wall' which has basically three slopes. They are (a) circular (b) concentric and (c) elliptical.

(iii) The size of the 'eye' varies from 7 to 200 km in diameter for typhoons and the average value is 50 km.

(iv) The lowest pressure, the highest temperatures and the highest relative humilities are found within the 'eye'.

(v) The air at the outer edge of the 'eye' is dragged upward and outward by the surrounding air which accentuates the low pressure in the 'eye' and the air from above sinks into the eye. This is the main reason for clear sky and warm air in the 'eye'.

(vi) The 'eye' contracts while the cyclone intensifies.

(vii) The 'eye' is often elliptical and becomes more circular with intensity.

(viii) The 'eye' in a cyclone normally develops when the pressure falls to 980 mb. If the 'eye' develops at an early stage (985 mb), the cyclone develops rapidly and the 'eye' is usually small.

2. Eye wall: Around the 'eye' is a wall of cumulonimbus clouds surrounding it from all sides and is known as the 'eye wall'. This is more or less a circular ring about 10-20 km wide marked by intense thunderstorms involving explosive cumulonimbus clouds with violent vertical motion. Some of the strongest winds and highest intensities of rainfall occur in the eye wall.

3. Spiral bands: Also known as rain bands or feeder bands, these are spiral shaped bands because of which the cyclone appears like a galaxy when from the space. They may be hundreds of kilometres long but their width is restricted to a few kilometres. The distance between two bands varies from 50 to 80 km and this distance

decreases from the edge towards the ‘eye’. These bands are characterized by thunderstorms and heavy rainfall which is always in excess of the surrounding areas.

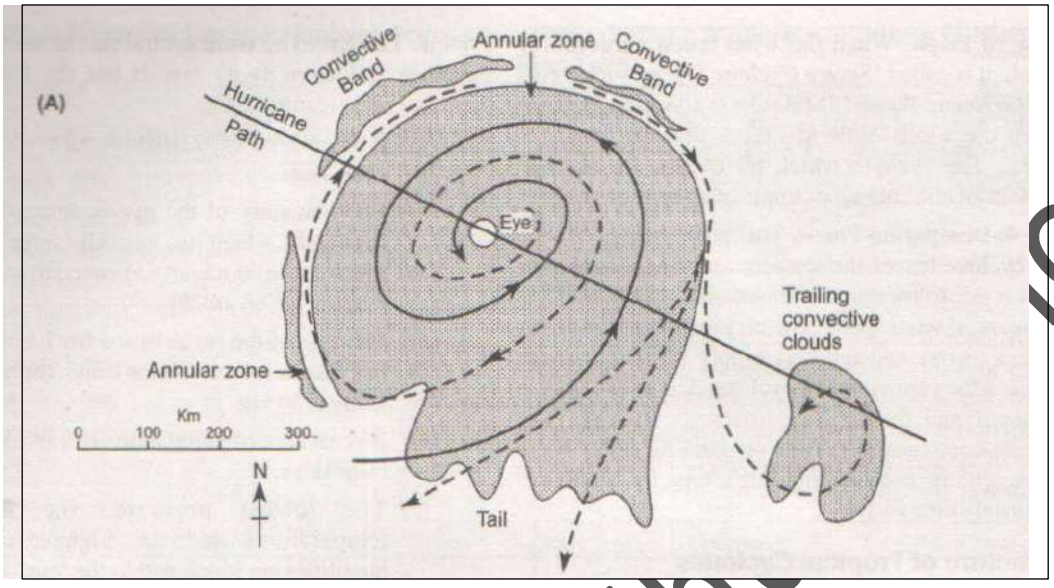

Fig: Appearance of tropical cyclone in plan

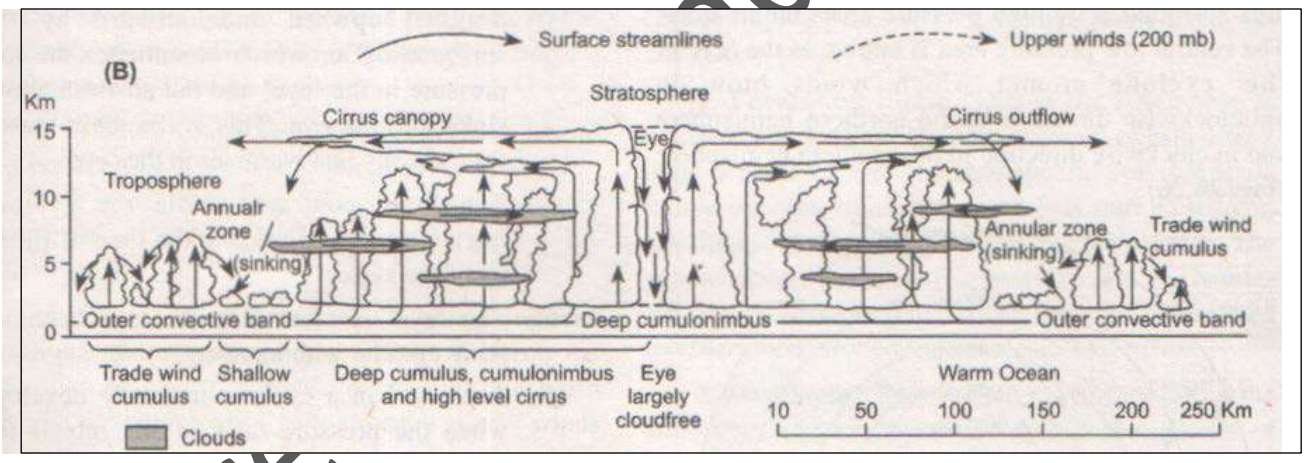

Fig: Structure of tropical cyclone along profile

4. The annular zone: Next to the spiral bands is the annular zone which is characterized by suppressed cloudiness, high temperature and low humidity. This happens due to subsidence of air from above at the outer limits of the cyclone.

5. The outer convective band: It occurs at the edge of the main cloudiness and surrounds the annular zone. It consists of an outer fringe of deep convective cloud. This convective cloud comes into being by instability which is due to convergence of subsiding outflow with the main surface inflow.

6. Trade wind cumulus: This is the outermost fringe of the cyclone which is away from the main cloud mass. Obviously this is the region of limited cloud cover and limited depth of convection within the trade winds. Beyond this region, the tropical cyclone ceases to exist and normal atmospheric conditions prevail.

World Distribution of Tropical Cyclones

As their name indicates, the tropical cyclones originate, grow and travel within the tropics bounded by the Tropic of Cancer in the north and Tropic of Capricorn in the south. About 65 per cent of the world's tropical cyclones appear between latitudes 10° and 20°, whereas only 13 per cent of such cyclones occur in high latitudes. They have never been found north of 30°N and south of 22°S. In the belts of 3-10° latitude in both the hemispheres the latitudinal frequency of cyclone occurrence is about 22 per cent. At 2-3° latitudes only single occasions have been observed. No cyclone develops at the equator due to absence of coriolis force.