CYCLONES, ANTICYCLONES, AIR-MASSES AND FRONTS

The term "cyclone" was derived from the Greek word "Kyklos", which signifies amongst other things, the coil of a snake. The expression is very realistic since the rain-bands in the cyclone as revealed 100 years later by radar indeed resemble the coils of a snake in rage.

> "*A region of low atmospheric pressure cell, involving the convergence of air, which flows into and spirally rises at the center.*" ("*Physical Geo.*" by H.J. de Blij)

The Isobars around a cyclone are generally circular in shape, with their values decreasing toward the center. In the northern hemisphere, winds flow counter-clockwise around a cyclone (see fig. 7.1), while in the southern hemisphere, winds flow clockwise around a cyclone. Cyclones can be classified into two groups *i.e.*,

(*i*) Tropical Cyclone (*ii*) Temperate Cyclone

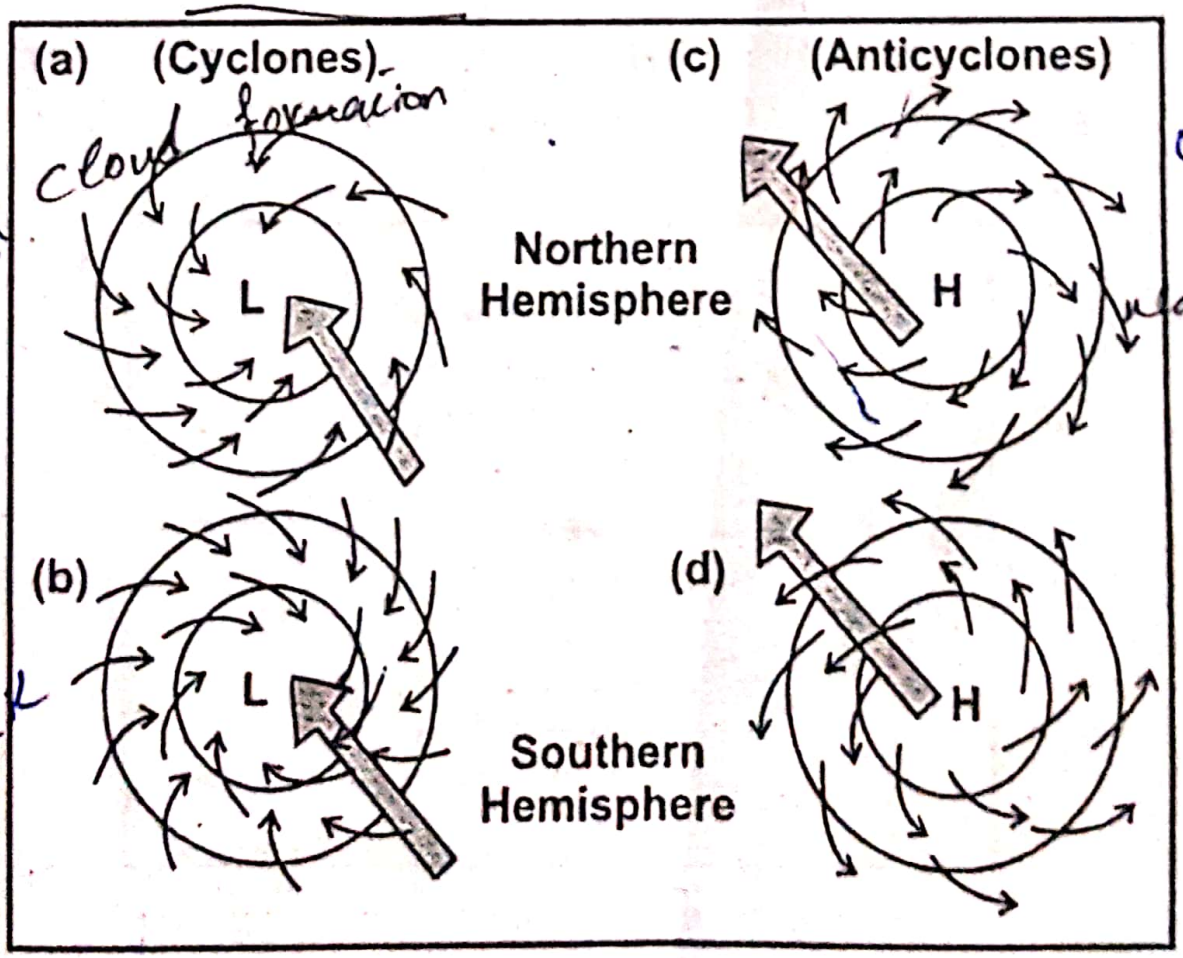


Fig. 7.1: *Surface winds within cyclones and anticyclones.*

1. Tropical Cyclone:

The tropical cyclone originate mostly within the Tropics. They a the most powerful and destructive type of cyclonic system. Tropic cyclone is known as the *hurricane* in the Atlantic Ocean, *typhoon* i Pacific and Indian Ocean, while "Willy Willies" in Australia.

1.1 Origin:

This type of cyclone develops over oceans in 8° to 15° N and S latitudes, but not closer to the equator. They develop due to the local convectional currents. The conditions most suited to their origin and development are:

1. Quiet air
2. Highly saturated atmosphere
3. Great heat

These conditions are found in the doldrums, especially over the sea. The atmosphere of the western margins of such ocean surfaces possess the greatest capability for absorbing water vapour.

1.2 Shape and Size:

The tropical cyclone is usually short in size, but its diameter varies in length. At origin, they are only 80 km (50 mi) in diameter. But well-developed cyclones have their diameter ranging from 300 to 1500 km (185 to 925 mi), or more.

They are generally circular in form, but resemble more an ellipse than a circle (see fig. 7.2). The two lengths of the ellipse have a ratio of 2:3.

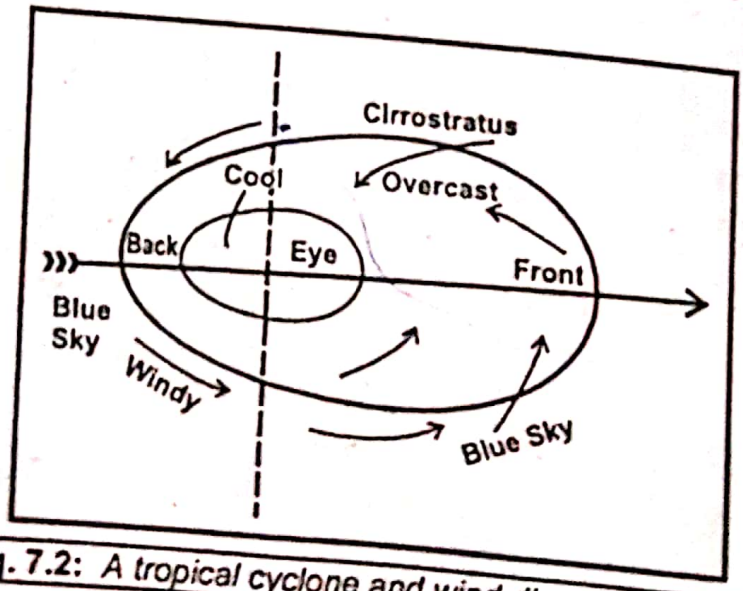


Fig. 7.2: *A tropical cyclone and wind direction within it.*

1.3 Velocity and Speed:

The pressure at the centre often falls below 25 inches and the velocity with which they travel varies from storm to storm and day to day.

It may be zero in some cases, while in others it may be as much as 800 mph. Generally their speed is 10 to 15 miles an hour.

At the center the wind force is very light, but as we proceed from the centre, wind force goes on increasing till the velocity becomes even 50 to 60 meters per second.

1.4 Tracks, Movement and Areas:

Tropical cyclone moves along the curved path (see fig. 7.3). In the northern hemisphere they travel first to the west and then turn to the north-west. At latitude 20° or 25° they turn towards the north and pass into north-east direction. The chief areas of activity for the tropical cyclones are as under:

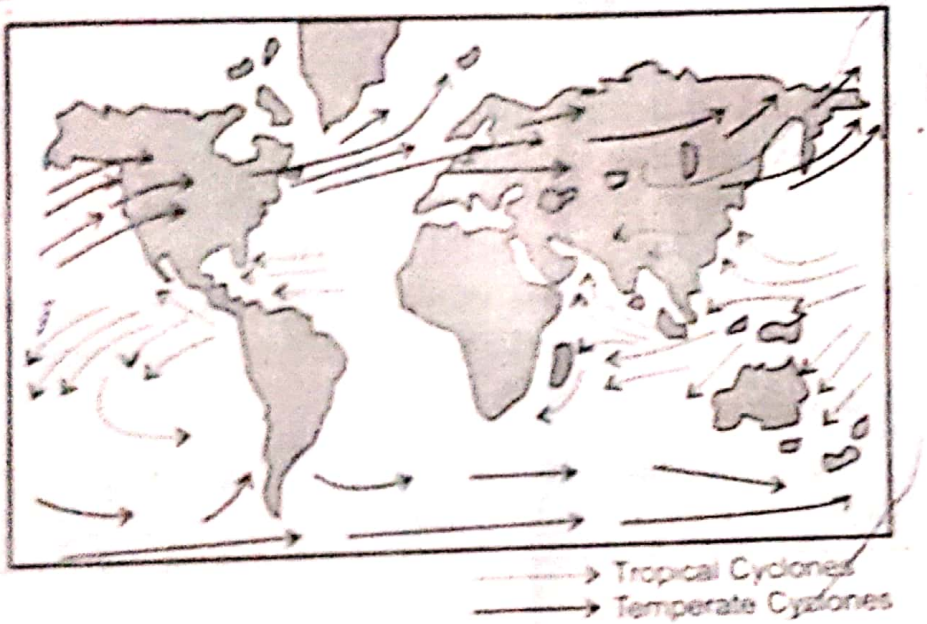


Fig. 7.3: *Main tracks and areas of tropical and temperate cyclones*

(i) West Indies and the coasts of Florida, where they known as Hurricanes.

(ii) Philippines, the coasts of China and Japan, these are known as Typhoons.

(iii) Bay of Bengal and Arabian Sea, where these are known as Cyclones.

(iv) North-east and north-western coasts of Australia, where they known as Willy Willies.

(v) Madagaskar and coastal regions of East Africa.

1.5 Structure:

The tropical cyclones have their Isobars almost circular in pattern. The lowest Isobars (950 mb or lower) always in the middle. The centre is known as the eye of the cyclone. Round this eye is the barometric slope and pressure gradients are quite steep.

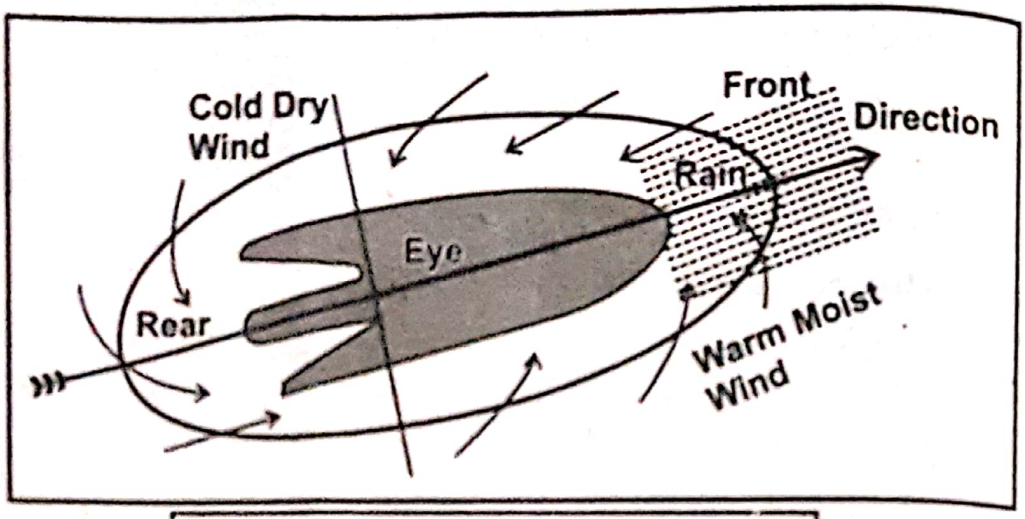


Fig. 7.4: *The structure of a tropical cyclone.*

The eye of the cyclone is characterized by a small patch of blue sky. Here the air is descending and due to compression it gets warmed up. Hence the sky is clear and there is an extent of calm and dry weather. Round the eye there is a strong upward movement of air, and this cause the cirrus clouds to spread over the sky. This central area is surrounded by heavy clouds and torrential rainfall, with violent thunderstorms. The rainfall is more in the front of the cyclone than in the rear.

1.6 Weather:

The following are the chief characteristics of the weather associated with the passage of a tropical cyclone: (see fig. 7.5)

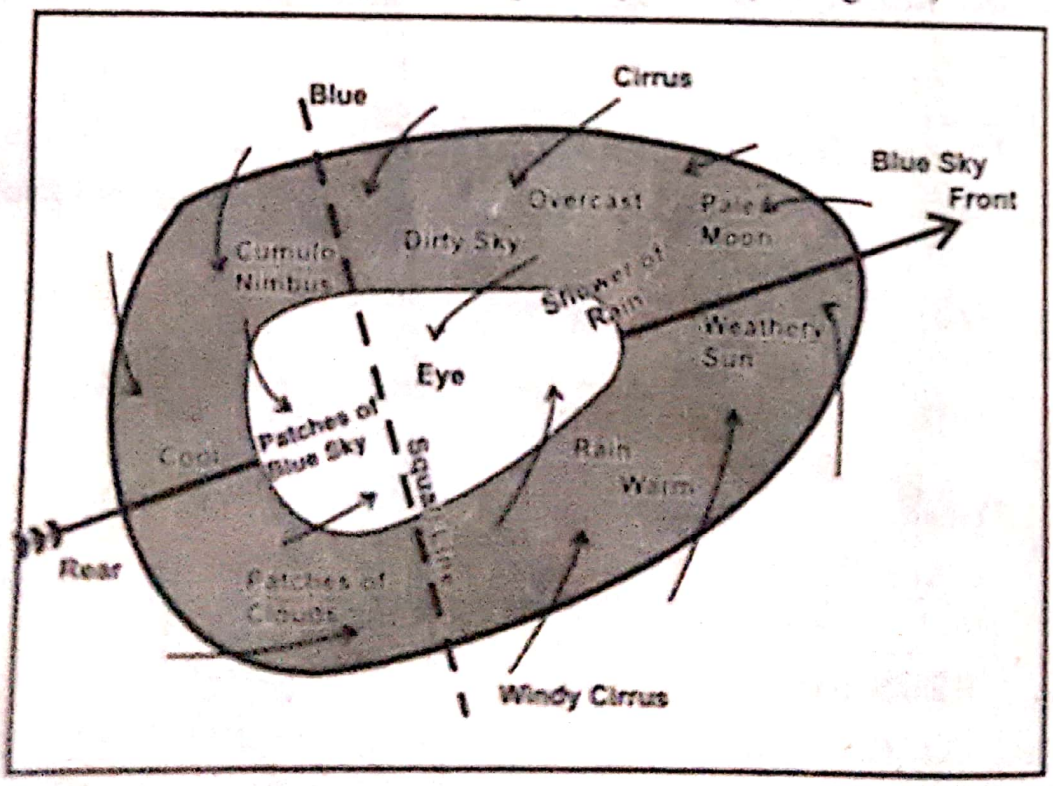


Fig. 7.5: *Weather within a tropical cyclone.*

(*i*) The approach of the cyclone is heralded by cirrus clouds.

(*ii*) This is followed by gradually darkening clouds, till dark nimbus come and hide the sun (sky) completely.

(*iii*) Then there is a heavy downpour of rain, which passes away as the tail is reached.

(*iv*) The tail of the cyclone brings sleet (mixture of rain and hail), after that the weather once more is clear.

(*v*) Then the tail of the cyclone actually approaches, with thunder and lightning combined, with an oppressive calm weather.

2. Temperate Cyclone:

Temperate or extra-tropical cyclones are most dominant over the North Atlantic Ocean, especially during the winter season. They are much larger in diameter than that of Tropical cyclones, but possess weaker pressure gradients.

2.1 Origin:

About the origin of temperate cyclone two theories are given: *i.e.*,

(*i*) Dynamic Theory (*ii*) Polar Front Theory

(*i*) Dynamic Theory:

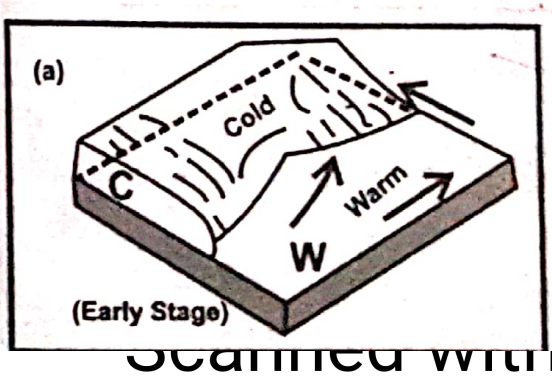
According to dynamic theory, temperate cyclones are developed due to the crowding of different currents of air against high-pressure belt. The cyclone originates at the height of 7,500 ft., just below the region of cirrus clouds. When the currents of cold air meet the warm rising air, an eddy is formed, which begins to descend. Hence the cyclone is cone-shaped, with the narrow edge upwards.

(*ii*) Polar Front Theory:

Polar Front Theory states that the depressions are formed, due to the meeting of warm sector consisting of light warm equatorial air with the heavy and colder polar air. This theory was presented by a Norwegian meteorologist Jakob Bjerknes, he briefed it as under: (see fig. 7.6).

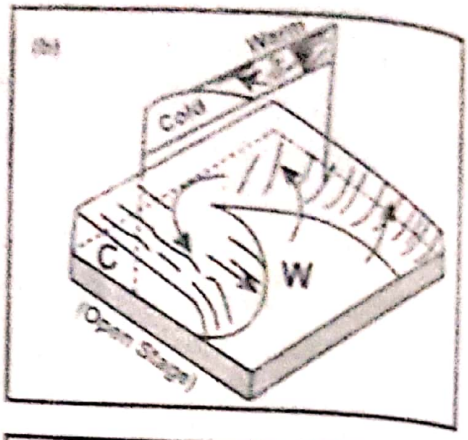
(*a*) Stage I:

At the first stage warm and cold air moving in opposite direction, with a light depression (see fig. 7.6, a).



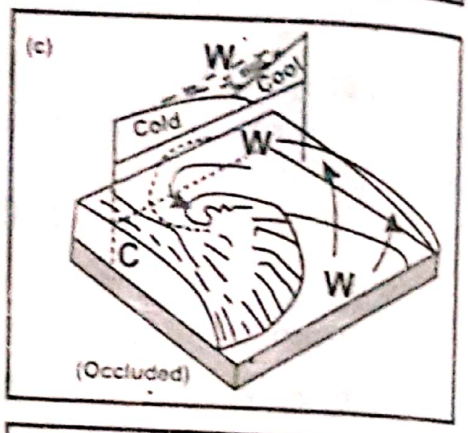
(b) **Stage II:**

At this stage cold air is now actively pushing southwards along a cold front. The warm air is actively moving northwards (fig. 7.6, b).



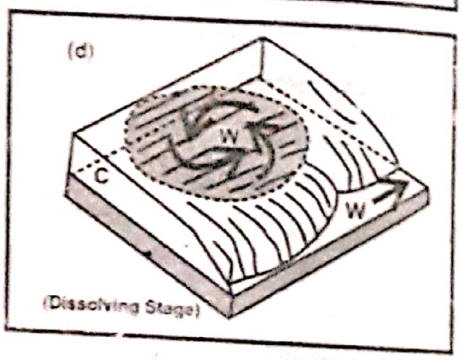
(c) **Stage III:**

At the third stage the cold front has overtaken the warm front, reducing the zone of warm air to a narrow sector, and producing an occluded front (see fig. 7.6, c).



(d) **Stage IV:**

At the fourth and final stage the warm air is forced off the ground, isolating it from the main warm air region (see fig. 7.6, d).



(e) **Stage V:**

Now as an end product a cyclone is originated and is ready to move forward to the eastern direction (see fig. 7.6, e).

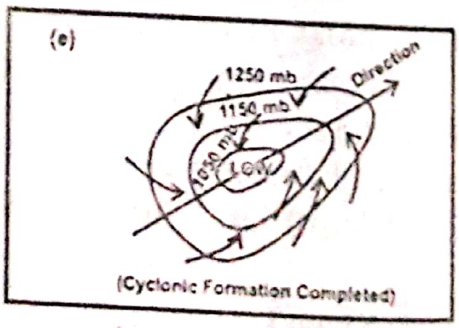


Fig. 7.6: (a) to (e)

2.2 Shape & Size:

A cyclone of normal size is usually three to four hundred miles across and has a height of five to seven miles. They are generally V-shaped looking. The area covered by these is often as much as millions of sq. km (mi). In North America, their size is 2,500 km (1540 mi).

2.3 Velocity and Speed:

Within the cyclone, the force of wind is different in different portions. Winds are the strongest in the southern and eastern sections, where their direction is identical with that of the cyclone. All the winds up to an altitude of 5 to 6 km (3 to 5 mi), move almost parallel to the isobars. The wind velocity increases with the approach of cyclone, but decreases after it has passed. The velocity of temperate cyclone is not fixed. It depends upon the season, location and varies with individual cyclones.

Temperate cyclones are fastest in winter months, and slowest during the summer season. They are faster in N. America than in Europe.

2.4 Tracks, Movement and Areas:

Normally these cyclones travel with the prevailing Westerlies and their usual direction is from west to east. But in northern hemisphere they dip to the south over the continents, while they are deflected towards the north over the oceans (see fig. 7.7).

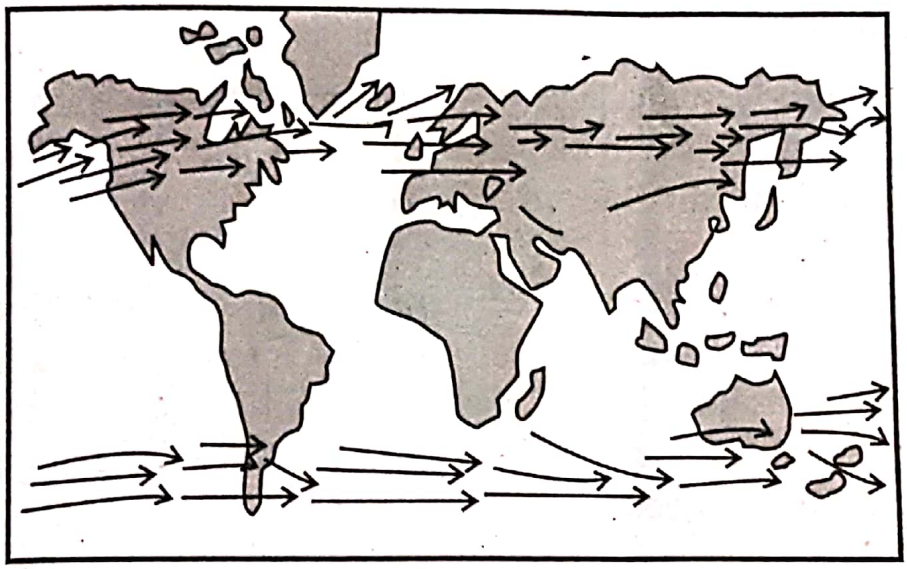


Fig. 7.7: *The chief/major tracks of temperate cyclones.*

Temperate cyclone commonly form in succession to travel in a chain the North Atlantic and North Pacific Ocean. In the southern hemisphere, their tracks are more nearly along a single lane following the parallels of latitude. This simplicity of pattern is the result of uniform ocean surface throughout mid-latitudes. Only the southern tip of South America breaks the monotonous oceanic expanse.

2.5 Structure:

The temperate cyclone is quite unsymmetrical in outline. It has the shape of an upturned "V". At the centre of this depression exists the low-pressure area, while the north-west lies cold sector, and to the north-east is the warm sector. In the cold sector, cold winds prevail and

the line towards which the cold air seems to be moving is known as cold front. This is the ultimate limit or boundary of the cold air. In the north-east sector prevail the warm winds, and the line towards which they blow is known as the warm front (see fig. 7.8 + 7.14, a).

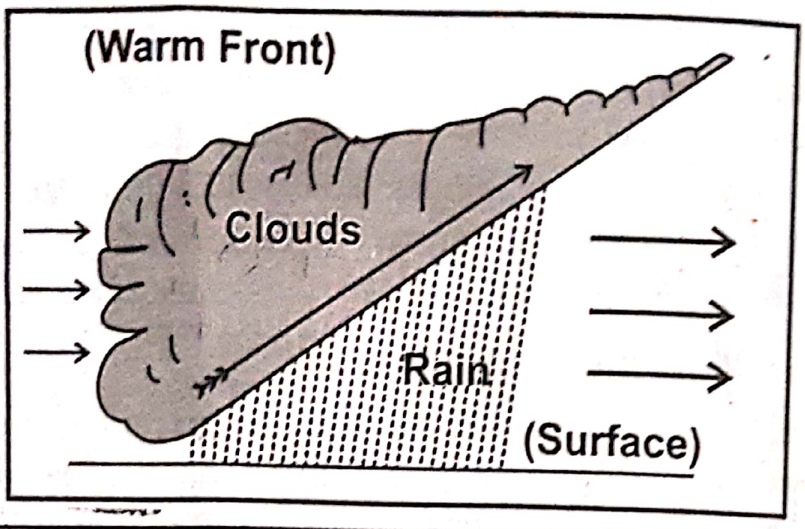


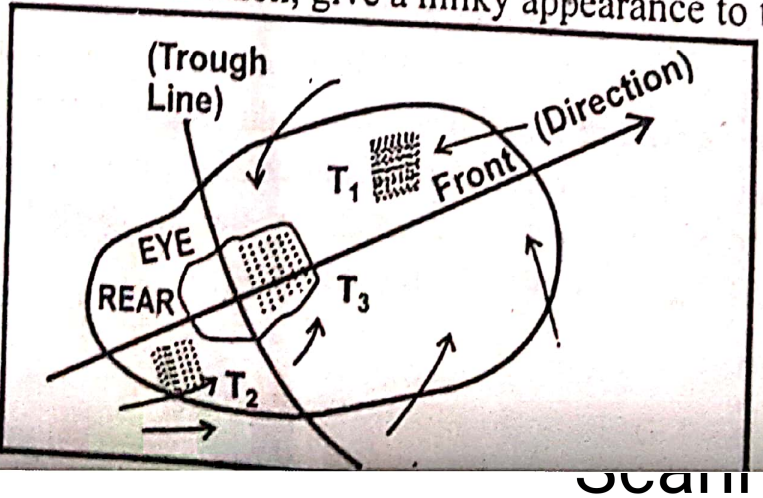
Fig. 7.8: *The upward movement of warm air at a warm front.*

2.6 Weather:

In the north-western or cold sector, the cold air pushes the warm air front beneath and although clouds are formed, the extent of clouds and rainfall is very limited. Due to the cold winds the temperature is continually declining.

In the north-eastern areas, or warm sector, the warm air which is full of water vapour continually meets the cold air and overruns the later. As it rises high, dense nimbus clouds are formed and are followed by a heavy downpour of rain, or snowfall (see fig. 7.9). The approach of temperate cyclone is heralded by:

(*i*) The wisps and plumes of cirrus clouds spread over the sky and thin white veil, which spreading upward from the western horizon, give a milky appearance to the blue sky.



(*ii*) The long streaks of thin white clouds run parallel to one another and spread like radii from some point in the horizon.

(*iii*) Fall of mercury in the barometer.

(*iv*) Shifting in the direction of wind.

(*v*) Formation of hale round the sun or moon.

As soon as the cyclone approaches, there is drizzle, which turns into a heavy downpour. The force and velocity of winds also increases. On the approach of warm front, the fall of mercury in the barometer stops and the rainfall ceases. The sky becomes clear and fine weather is ushered. This shows that the center of the cyclone is reached and the weather will remain clear, till the warm sector has passed. Immediately after this, the temperature begins to fall, the sky becomes clouded and it begins to rain. This indicates the approach of the cold front. The rain brings hailstones and is accompanied with lightning and thunder. But soon the rain stops and the sky begins to clear.

2.7 Distinguishing Features Between Tropical Cyclone & Temperate Cyclone:

The following are some salient features regarding to distinguish tropical cyclone from temperate cyclone:

1. Tropical cyclone has no anticyclone companion.
2. The Isobars of tropical cyclone are more symmetrical and more nearly circular.
3. In tropical cyclone rains are inclined to be more torrential.
4. In tropical cyclone temperature distribution from the center to any direction is similar.
5. They are more numerous in warm seasons, rather than in winter.
6. They have calm and rainless center called "eye of the cyclone".
7. Tropical cyclones move from east to west with the prevailing trade winds (Easterlies).
8. Their source of energy is latent heat of condensation.

3. Anticyclone:

An Anticyclone is the area of high pressure, or the reverse of cyclone. The winds are blowing spirally outwards from a high pressure center (cell). ~~The Isobars are oval-shaped of circular in arrangements. So, we can define an anticyclone as:~~

"An atmospheric high-pressure cell, involving the divergence of air, which subsides at and flows spirally out of the center, is called an anticyclone." ("*Physical Geo.*" by H.J. de Blij)

The values of Isobars are increasing toward the center (see fig. 7.10, b). In the northern hemisphere, winds flow clockwise around an anticyclone; in the southern hemisphere, winds flow counter-clockwise (see fig. 7.1, d) around an anticyclone.

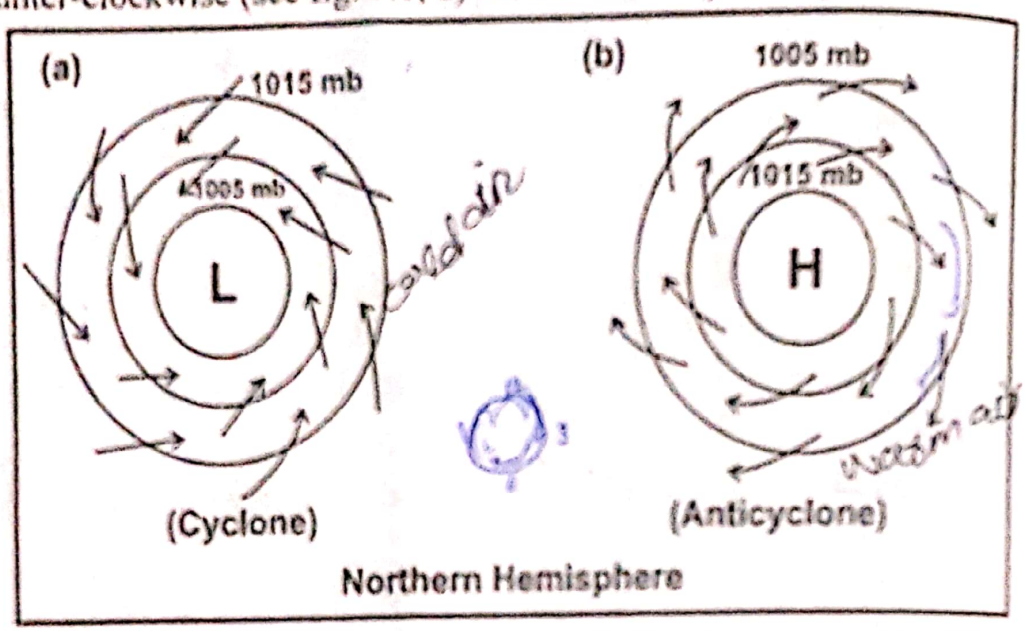


Fig. 7.10: *Air circulation pattern within a cyclone and anticyclone in the Northern Hemisphere*

3.1 Characteristics of an Anticyclone:

The general characteristics of an anticyclone and its structure are as under:

(*i*) An anticyclone lies between two cyclones, and has no specific direction.

(*ii*) Sometimes it may forwards or retreat or it is in a fixed position for considerable time.

(*iii*) The winds are high and slow. They never grow violent, and at the center there is calm with variable winds.

(*iv*) Often cold and heat waves accompany the anticyclone.

(*v*) The Isobars are far apart more especially towards the center, and the variations of temperature are also noticeable.

(*vi*) With an anticyclone, there are local rains.

(*vii*) Due to the generally light winds, local influence and local winds like the land and sea breezes become noticeable.

(*iiiv*) It is extensive and its velocity ranges from 30 to 50 km (20 to 30 mi) per hour.

3.2 Types of Anticyclone:

The following are some important types of anticyclone:

(*i*) **Cold Anticyclone:**

It originates on those landmasses, which are subject to very great cold. Due to cold a high pressure area develops. Siberia, Central Asia and Antarctica are good examples of source areas for cold anticyclone. They are formed at the back of the cyclone, due to the cold polar air blowing southwards.

(*ii*) **Warm Anticyclone:**

Develops near the subtropical highs (STHs), because the air descending from higher levels in the stratosphere (the lowest layer of atmosphere), gets heated and dry, and due to compression, increases the pressure. In the western sector of the anticyclone fog is formed, by contact with cold earth.

(*iii*) **Mechanical Anticyclone:**

Because of earth's centrifugal force the Westerlies tend to climb up the bulge over the equator, and Easterlies get over to the poles due to less gravitational force. As a result the belt near 30° – 35° N,S, is subjected to mechanical squeeze, and the result is high pressure center. This is more prominent over the oceans. These anticyclones are of a migratory character.

(*iv*) **Radiational Anticyclone:**

In Antarctica and Greenland, there is always a high pressure because of:

1. higher latitude 2. free radiation

Thus these areas become the centers of anticyclones, which are permanent.

(*v*) **Thermal Anticyclone:**

These are of semi-permanent nature and the result of low temperature, producing high pressure in ocean areas. The temperature of surface water is reduced by cold currents, producing high pressure of the anticyclones.

3.3 Weather in an Anticyclone:

The weather generally associated with an anticyclone is fine and dry, but in its middle, the weather experienced largely depends upon the season. While the weather conditions on the margins depend upon the source from which the wind comes.