Course Title: Climatology
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MJC-2Credits: 4
CLIMATOLOGY

Unit 11: FRONT and CYCLONES

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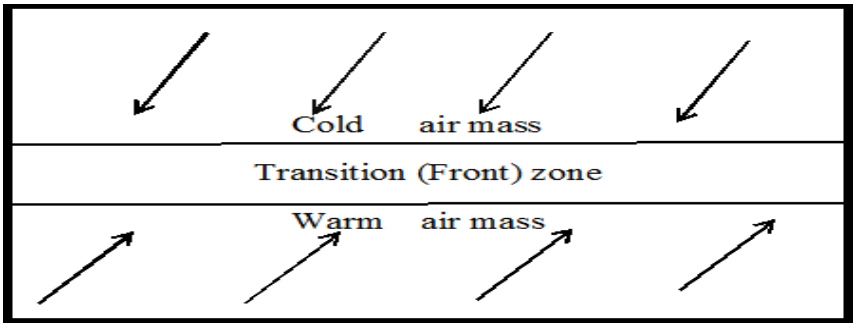
Introduction:

In previous unit i.e.-unit-10, you have learnt about air mass and their distribution in detail. Here, you are going to learn one of the special features of climatology associated with air mass i.e. Front and Cyclones. You all are acquainted with the term cyclone; but have you ever tried to understand its origin or formation? Cyclones are of one type or they are of different types? This and many more questions are generating in your mind. Therefore, in this chapter or unit you are going to acquaint with front and cyclone. These are the two basic and unique aspects of climatology but its weather system has tremendous impact over **cultural landscape**. So, as a student of climatology it is compulsory to know about front and cyclones. In detail you are going to learn about front, their genesis, and related weather phenomenon.

Defining Front, Types of Front, Frontogenesis and Frontolysis:

Front: In the last unit/chapter you have read that –A large mass of air present over an extensive geographical region with equal temperature and humidity (horizontally) and with equal normal lapse rate (vertically) is termed as an Air mass. Once formed, air mass becomes unstable (at their place of origin) and moved ahead from the region. During movement several types of changes occurs in air mass which depends on several geographical factors. During the movement, when two air masses of two physical properties comes in front of each other, they forms front. Fronts are the unique features of temperate region or you can say mid-latitudes region especially between 30^0 to 65^0North and South of equator. It means, they are uncommon in equatorial, tropical and in Polar Regions.

Fronts play an important role in understanding the climate and weather phenomenon of a region or place. It is because, front gives birth to different phases related to weather which is generally called cyclone and anticyclones. Therefore, sometimes fronts are termed as **Cradle of cyclones and anti-cyclones**. Norwegian scientists **Bjerknes and Slosberg** have introduced the concept of front and front surface in meteorology during World War I (They have considered the clash between two unlike air mass to be analogous to a confrontation between opposing armies along a battlefront) . Actually, **Front is a three dimensional (3D) transition zone formed between two converging air masses which have different physical properties.** The layer or surface which divides the two fronts is called **"Frontal Surface"**.



1: Initial stage of front formation

In other words- When two air masses of two different physical properties like- temperature, humidity, wind speed, lapse rate and density comes in front of each other through movement, they tries to intermingle. Due to difference in their physical properties (one of the two air mass is cold, dense, dry with high air pressure whereas , the other one is warm, lighter, moist with low air pressure), they don't intermingle hundred percent and create a special transition zone (between themselves). This special transition zone is known as '**Front'** in climatology. This front is not like a divisible line but like an invisible wall which has length, breadth and height. The front is neither parallel nor vertical to the earth surface rather it is leaning on certain angle. The slope or angle of front is based on the axial motion of the earth which increases towards pole.

Characteristics of Fronts:

Front is a three dimensional area characterised by the atmospheric turbulences due to its location between two different air masses. The physical difference of two air masses is called **thermal potential**. Here, in transition zone; **thermal energy converted into kinetic energy**. During this process, warm air mass tries to lift up, so air current started. As warm air lifted up, cold air mass tends to move here to fill the vacuum. Thus, horizontal movement of wind started. The uprising warm wind expands and starts cooling with **adiabatic lapse rate**. A flourishing cloud is formed and it rains heavily. Sometimes there is frost and snow falls. All these reasons cause instability in the atmosphere. Front is formed in both tropical and temperate zone. **The extension of front in tropical region is about 100 miles, thickness in some mile and height is up to 5000 feet.** In temperate zone, its extension is 1500-2000 miles, thickness is of some mile and height is up to 1000 feet. The speed of wind also varies with climatic zone. In tropical region the speed of wind is about 80 kms while it is 32- 48 kms per hour in temperate zones.

Adiabatic lapse rate:
The gradual change or decrease in the temperature of atmosphere with increasing height. Dry adiabatic lapse rate is a constant 9.8^0C/km while moist adiabatic lapse rate is 5^0C/km.

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Frontogenesis and Frontolysis:

The invasion and pushing of two air masses each other changes the shape of the front and it begins to appear like a wave. Temperate cyclone started with the development of front; because cold air mass enters into warm air mass region. This mechanism tends to starts circular movement. According to Climatologist, the genesis of circular movement of air/ wind in frontal zone is known as **'Frontogenesis'**. The process of frontogenesis takes place in an anticlockwise direction in northern hemisphere and clockwise direction in southern hemisphere. The clockwise and anti-clockwise direction depends on the Coriolis force and its effect formed due to the rotational movement of the earth. The circular movement of mid latitude cyclone are known as Temperate cyclone and Extra tropical Cyclones.

During the invasion and pushing of two air masses, once a time come when one occupies the dominant position .It means, one air mass wins the frontal competition and dominate over the other. Therefore, the 3D weakens and losing its significance. The end or dying process (dissipation) of the circular movement is called **'Frontolysis'**. Frontolysis is the stage when the condition of inversion of temperature generated. Simply, **Frontogenesis** is the war between to air mass and **Frontolysis** is the stage when one air mass wins against the other. In other words you can understand it as- Convergence of two different air masses is frontogenesis while overriding of one of the air mass by another is Frontolysis. **Bergeron has introduced the term frontogenesis and its development.** According to Trewartha – The areas where two air masses of two distinct natures converges is the areas of frontogenesis. Patterson has said- The line intersecting the frontal surface and earth surface is called front and the mechanism which forms front is called frontogenesis. The best development of front is in the North Atlantic region.

Favorable Conditions for Frontogenesis :

Front are developed over some defined regions. It means that some favorable conditions are necessary for the formation or genesis of front. They are –

a- Presence of two air masses with opposite temperatures

b- Prevailing direction of air masses

Presence of two air masses with opposite temperatures is necessary for the formation of front. In mid latitude region when warm and cold air masses try to meet, cold air mass pushes the warm air mass and formation of front occurs. Just opposite of this at equator, two trade winds comes from opposite direction but due to same temperature they are unable to form front. At 60^0 -65^0 north latitude front forms due to the meeting of Polar cold air mass and sub-tropical warm air mass.

Convergence of two different nature air masses is essential for the formation of front. Patterson has mentioned four types of wind movement system in which last situation gives favorable conditions for the genesis of front. As a student of climatology, you know that temperature and pressure differences are responsible for wind movement in different forms-

i: **Translatory circulation** - In this type of movement wind blow in one single direction. Isotherms are parallel and situated very far from each other. Therefore, front formation is not possible.

ii: **Rotatory circulation** - In this situation wind blow in a circulatory pattern .This circulatory pattern are of two types- a- Cyclonic b- Anti-cyclonic .

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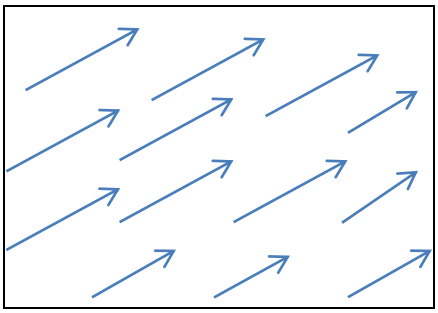
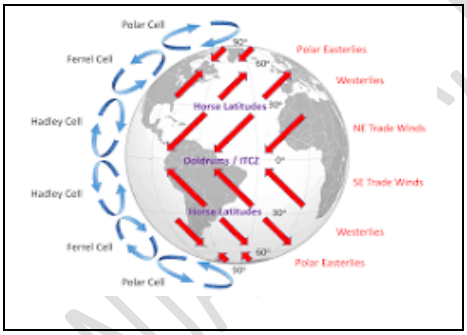
iii: **Convergent and Divergent Circulation** –Convergence occurred where low air pressure situation prevails. Hence, wind tries to move upward. This is not suitable condition for the formation of front as two air masses are there with one centre whereas two air masses are necessary along one line.

Divergence occurs where high air pressure prevails in the centre. In this condition, wind tends to settle down and spread in the surrounding region. This condition is favorable for Frontolysis.

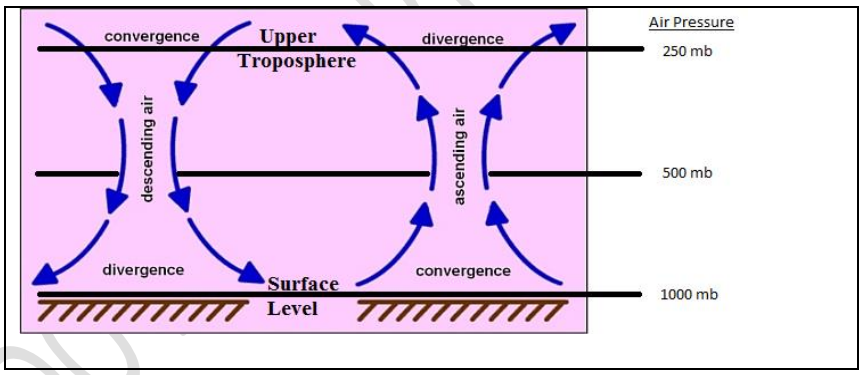
iv: **Deformatory Circulation** – In this type of air circulation, two air masses with two different temperature spread in horizontal direction along a line during meeting with each other. The line through which air spread outwards is called out blow axis line whereas the second axis is known as inner blow axis line. The inner flow axis line is most suitable for the formation of front. Such condition is found around a **'Col'**. Col is the meeting point of outer and inner flow of wind .



.2. a :Translatory circulation



2. b : Rotatory Circulation



2.C : Convergent and Divergent winds

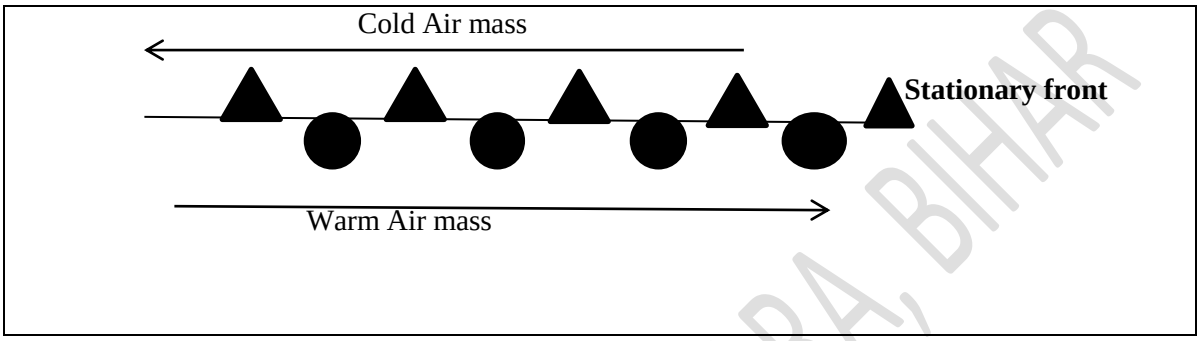
Nature of Front :

Front can be stable or unstable. There are no atmospheric disturbances in stable front. On the other hand, when front is unstable, cloud forms and it rains. The amount of rainfall depends on the temperature gradient and on humidity. In this view, such fronts are more active over coastal region where maritime air mass meets with continental air mass. Fronts are also active over mountainous region. Here, temperature gradients are active between mountainous peak and valley floor.

Types of Front:

According to thermodynamic properties, fronts are of four types.

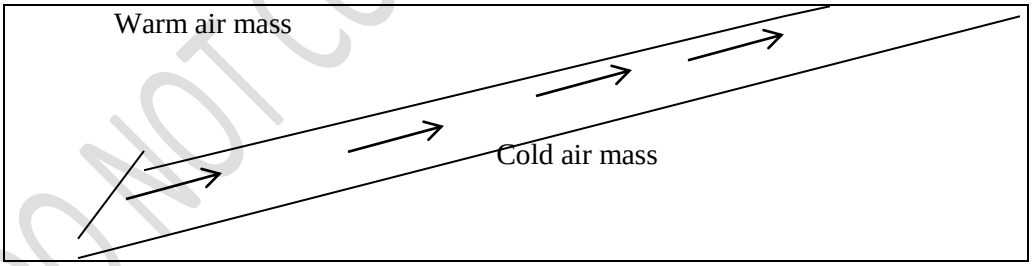
A- Stationary front- This is the first and last stage of a front. Two air masses of two different temperature and humidity comes near to each other; then they moves parallel in opposite direction .There is no displacement of air, therefore, no air current generates, no cloud formation and precipitation occurred. Such type of front is called **Stationary** front.



A: Section of Stationary front

Warm front- In this case, warm air mass moves forward and actively ride over cold air mass or try to ride over cold air mass. Here, the slope is found up to 1:80 to 1:200 or 1:100 to 1:400. Slowly rising warm air cools adiabatically. The weather becomes unstable leads to stratus cloud formation and at last precipitation occurs. Gentle to moderate precipitation continues for a long time i.e. for many hours. It rains on intervals for long hours on an extensive area. In warm front cirrus, cirro-stratus, stratus clouds are formed from top to bottom simultaneously.

Section of warm front



Situation of Warm front

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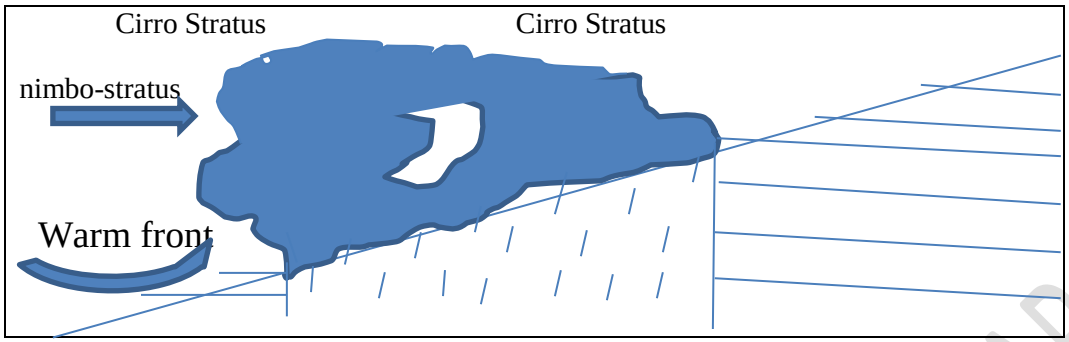


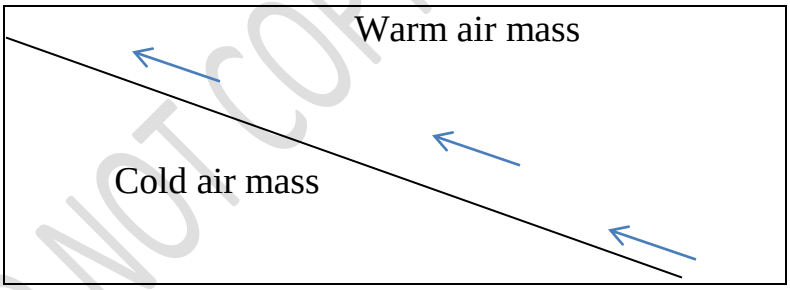
Weather condition in Warm front

11.4: Warm Front

When warm front ends, the eye of cyclone comes in the centre; called warm section. With this the weather condition suddenly changes. Air pressure becomes low. Precipitation stops and clear sky condition prevails.

Cold Front : Cold air mass is the condition where cold air mass invades into warm air mass region and pushes the warm air upward. The slope becomes 1:25 to 1:100. In cold front condition, warm air uprising very speedily. Therefore, condensation also becomes very fast and clouds form especially cumulo nimbus clouds are seen followed by heavy rain. After rainfall visibility improves and temperature goes down.

Section of Cold Front



Situation of Cold front

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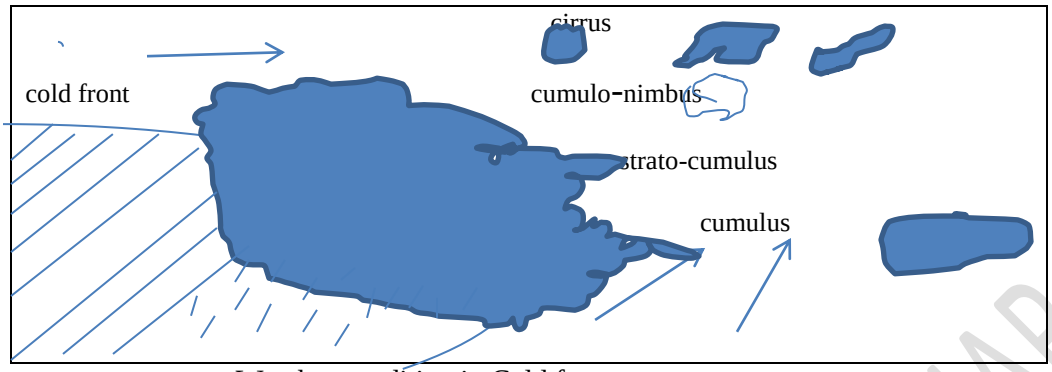


Weather condition in Cold front

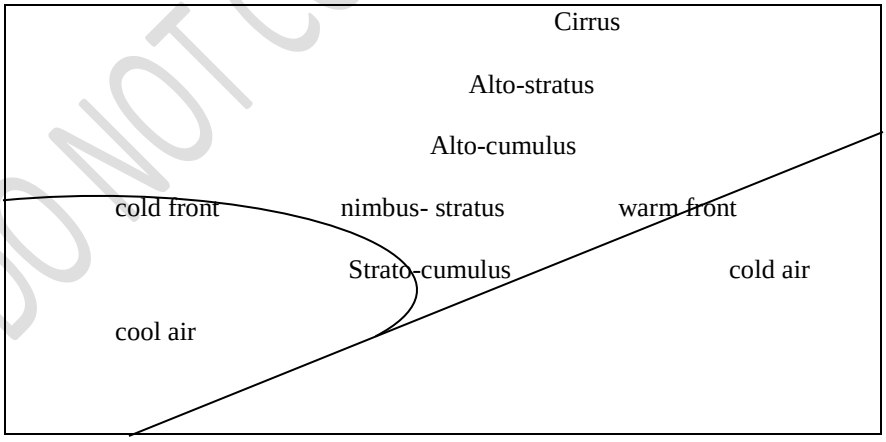
Cold front is also of two types-

a- In such type there is cold air invasion in lower surface. But its speed is very slow. Hence, cirrus clouds are formed at height with no precipitation. Inversion of temperature is the common character of such type of cold front.

b- Here, there is down streaming air is behind the front. But the air situated ahead is uprising very quickly which forms cyclonic condition. Here, heavy rain with fast moving air is the feature. Air pressure changes very rapidly.

Occluded Front : When cold air mass and warm air mass intermingle with each other and there is completely disconnection of warm air from the surface ; then this condition is called **Occluded front .**In this situation warm air completely over ride above the cold air and inversion of temperature can be seen .Occlusion of front are happen by two types depending upon the relative temperature of the air mass.

Warm Front Occlusion: In this situation, cold front moves faster than warm front and gives its impact at greater height. Here, cold front lifted up from the surface; known as Warm front occlusion. Such type of condition prevails over western part of India during winter season. Here, cold continental air meets with warm oceanic air.



Cold Front Occlusion: When moving cold air mass enters into the cold air mass areas situated beyond warm front, then it is called warm front occlusion. Warm front lifted up and creates warm front occlusion.

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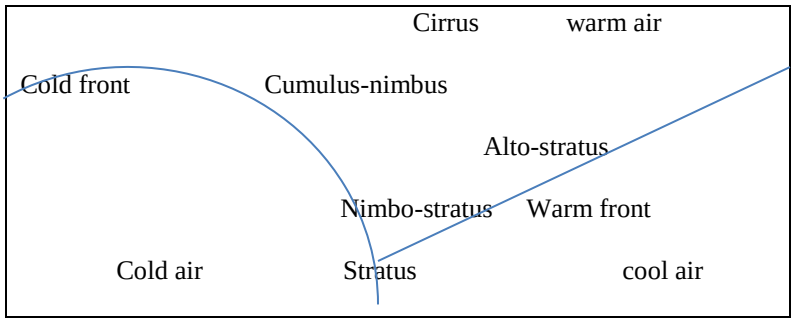
Such condition is can be seen in the eastern part of the continents. Here, occlusion process is very slow, so bad weather condition prevails for long time. Sky becomes clear after the end of the front.



Thus, a front originates and with the passage of time, warm air overrides the cold air. After the completion of such mechanism frontal surface doesn't touches the earth surface. Inversion of temperature occurs as cold air lies beneath the warm air. Then, Stability in atmosphere comes after front related activities are ceased. All such process is called Frontolysis. Thus you can say that frontogenesis and Frontolysis is a cyclic process.

Front Regions: There are two prominent regions on the earth where air convergence process occurs. Such regions created favorable conditions for the formation of front.

a- Equatorial low pressure zone/belt: Here, north -eastern and south- eastern trade winds meets to form front. These trade winds form clouds and heavy rains poured.

b- Sub tropical low pressure zone/ belt: In the hemisphere, Polar cold air and tropical warm and light air meets at 30^0 to 45^0 latitudes to form Polar front. During winter season it is more active over north Atlantic and north Pacific Oceans.

Other than this, front is also form near Arctic region where Polar Continental and Polar Oceanic air meets but there is no prominent differences in their temperature, hence low intense front is formed. Such type of fronts can be seen in the north of North America and Eurasia.

Cyclone:

In the above section of the chapter you have leant that when two different kinds of wind (warm and cold) converge, it creates front. In this process cold wind remains under the upper warm wind. Therefore, the upper warm wind gradually becomes cooler from the lower level. As condensation starts cloud forms and rainfall occurs. Tropical, temperate and monsoon region are famous for cyclonic rainfall. Some coastal regions are also famous for cyclone and cyclonic rainfall. Sometime cyclone becomes disastrous. A cyclone is a rotating low-pressure weather system and is usually formed over warm oceans such as the Bay of Bengal, Indian Ocean, etc. These tropical cyclones get their energy from the intense thunderstorms forming around the eye of the storm.

Due to differences in air pressure, the moving air condition becomes unstable. This instability creates circular flow of wind and after sometimes it intensifies and forms; cyclone or anti-cyclone. When

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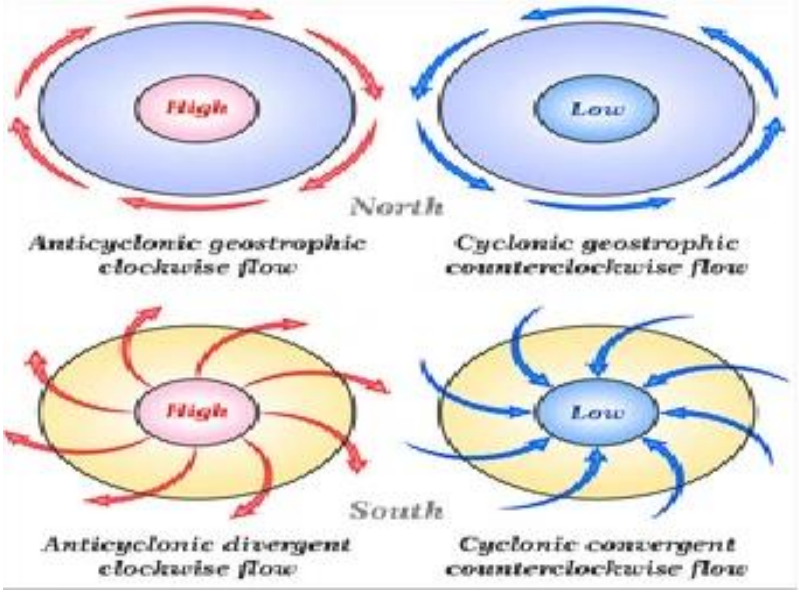
you are seeing it, it seems that the whole wind of the area is moving fast around an axis or drift like a whirlpool. This whirlpool is of two types-

a- Central low pressure area is surrounded by high pressure (Cyclone).

b- Central high pressure is surrounded by low pressure wind (Anti-cyclone).

a-Cyclone: If there is centrally low pressure area surrounded by high pressure wind, in this condition the surrounding cold winds try to reach at central low pressure area. This condition is known as **cyclone**. In northern hemisphere the movement of wind in such condition is anti-clockwise and clockwise in southern hemisphere. Here, the wind tries to reach at the centre but due to high temperature and low pressure they lifted up before reaching there. You will know to surprise that therefore, the central part is devoid of any disturbance or cloud, which is known as the **Eye of Cyclone**.

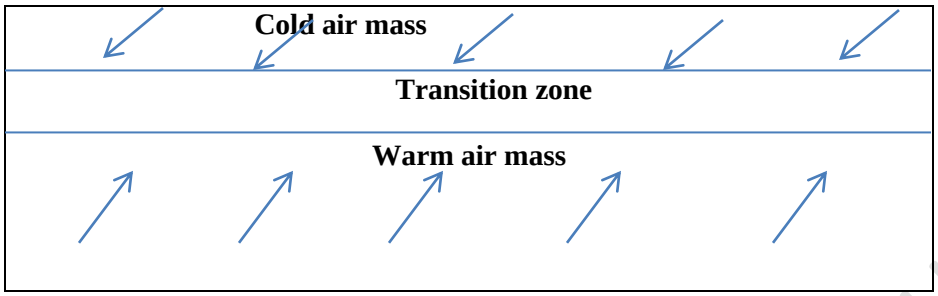
B-Anti-Cyclone: If there is central high pressure zone surrounded by low pressure areas then wind tries to move outwards from the central high pressure area. This condition is known as **anti-cyclone**. In northern hemisphere it moves clockwise direction while it takes anti-clockwise direction in southern hemisphere.



Types of Cyclones: According to genesis, cyclones are of two types- **temperate** cyclone and **tropical** cyclone. Both of these cyclones have different mechanism of their genesis and are also found at different places. The genesis of temperate cyclone is best explained by Polar front theory which you are going to learn ahead in this chapter.

.i -Temperate Cyclone: Temperate cyclone originates due to convergence of polar cold air and sub-tropical westerly warm air in sub polar low pressure belt i.e. 60^0 to 65^0 latitudes. Here, two air mass from two different direction comes and try to meet each other. The air masses are of two different natures so they can't intermingle very frequently. They mixed with each other very slowly. As a result, front develops in low pressure belt. Front is linear in nature and sometimes it is thousands of kilometers long,

5-75 km wide and 1.5 to 3 kms thick. Thus, front is a transition zone where mixed properties of two air masses are found.



Temperate cyclone starts with the development of front. Cold air tries to enter into the warm air area which gives birth to cyclic pattern of movement. The entire mechanism of the genesis of cyclic flow is called frontogenesis. And the end or dying process is called Frontolysis. Frontolysis is the stage when front comes to an end or temperate cyclone comes to an end and air masses/ wind again blow in two opposite directions. After re-mixing, develops the transition zone and initiates the second cyclone. Thus, temperate cyclone is a cyclic process. Temperate cyclone is best develops over north Atlantic region. Think over it. why it is not common in Pacific Ocean? Generally, the radius of temperate cyclone is 250 to 1000 kms whereas it is 750 kms for tropical cyclone.

In Pacific Ocean, low pressure belt has narrow part formed by Asia and North America. Due to lack of an extensive area small front develops here with negligible effect.

ii-Tropical Cyclones: Tropical cyclones originate between 6^0 to 15^0 latitudes and moves towards pole. Generally, they occur at the end of summer season. Their size is comparatively smaller than temperate cyclones. They have different names at different places. Convection activity is the main reason behind the genesis of such tropical cyclones. According to meteorologists, when temperature rises at sea; the concerning wind starts uprising due to become light in nature and creates atmospheric disturbances. Thermal influence play dominant role in the formation of tropical cyclones. After sometimes, this wind reaches to landmass where it meets with more intense warm air. At the coastal region both the warm air (one is comparatively cold and other one is warm) meets and creates a whirlpool like situation and becomes disastrous with their speed and rainfall. In India, every year Cyclones come before monsoon, during monsoon and after monsoon.

Comparison between tropical cyclone and temperate cyclone:

Now, you will understand the difference between tropical and temperate cyclones. How they differ from each other and in what manners? Come and understand it point wise.

1. Tropical cyclones are low latitude features while temperate cyclone is of high latitudes.
2. The period of tropical cyclone is short while it is long in temperate cyclone.

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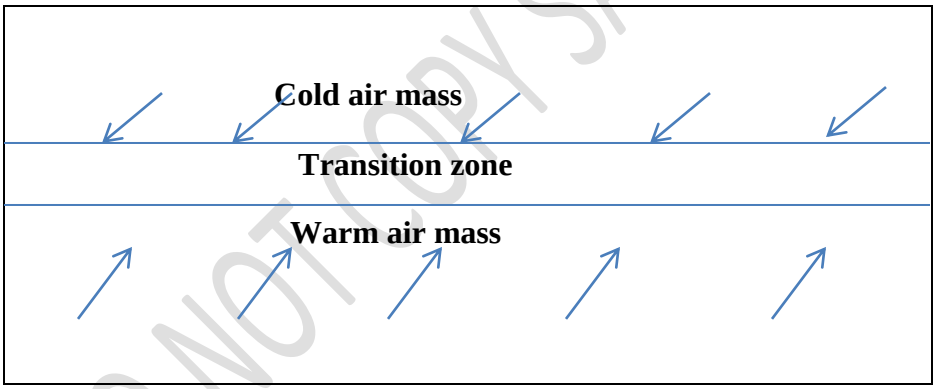
3. Tropical cyclone has 'eye' in its central part known as **Eye of cyclone** whereas in temperate cyclone **front** develops instead of eye.
4. Both the air masses are comparatively warm in nature in tropical cyclone while one is warm and another is cold air mass in temperate cyclone. Hence, both the air mass have a tendency to rise vertically very fast in tropical cyclone but in temperate cyclone there is one cold air mass which has tendency to flow/ blow along the surface.
5. Cumulo – nimbus clouds are formed followed by heavy rains in tropical cyclone while in temperate cyclone several levels of cloud are formed and bad weather prolongs for long time.
6. Most of the time tropical cyclone becomes disastrous whereas temperate cyclones are not so disastrous. In tropical cyclone , both the air are hot so they are very fast moving but in temperate cyclone both the air mass are comparatively less warm due to high latitude ; their movement is comparatively slow so they are less disastrous.

- **Formation of temperate cyclone:** Different theories have been put forward but **Polar front theory** is most accepted theory regarding origin or genesis of temperate cyclone. The Polar front theory has been postulated by Swedish meteorologist /scientist Bjerkins, Jacob and Fitzarald. According to these scientists, there are six phases for the genesis of temperate cyclone or you can say it as front. Every phase has changed weather conditions.

.a - First phase : This phase is also known as initial stage of temperate cyclone. Formation of transition zone is the prominent feature due to convergence to two different air masses coming from two different directions or latitudes. Stationary front develops. Warm and cold air masses remain stable on very extensive areas. Cold air mass comes from polar region whereas warm air mass comes from sub-tropical regions. You can find temperature, pressure; visibility and humidity etc. are in transition phase.



North of Iceland: Stationary front

.b - Second phase : In second phase, cold air mass tries to enter into warm air mass areas. It means, front has been pressurize to move towards low latitude. Stability of front now disturbed which creates two parts of the front- Cold front and Warm front. Bend can be seen at their meeting point. It means, cold front moves towards low latitudes or to the south it seems like bend towards south or low latitude. But warm front remains in their position. In other words- cold air mass now spread over comparatively more extensive areas and tendency of compression starts in warm air mass area .

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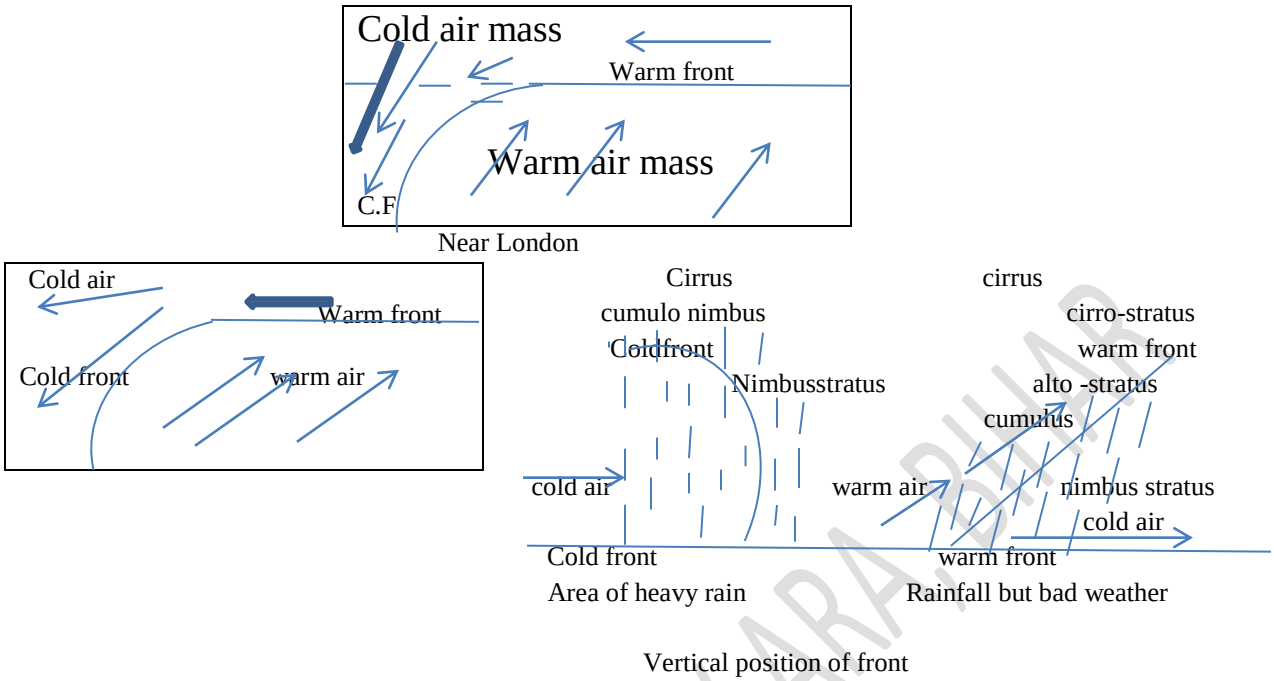
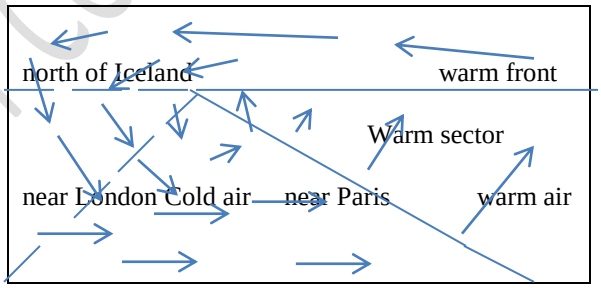


Drastic changes occurred in the areas of cold front and warm front. These changes are referred to the weather condition of temperate cyclone. In cold front region, warm air rises rapidly due to which the formation of clouds takes place after condensation followed by heavy rain. But in the warm front region, warm air gradually rises and forms layered clouds. Therefore, bad weather with drizzle condition prevails for longer time.

c – Third phase: In this phase, cold front again moves towards low latitudes and cold air covers more extensive areas. Hence, a clear cut property of cyclic movement can be seen. The area of warm air again compressed to a smaller area and develops a warm sector. The push factor creates a cyclone instead of a central low pressure area.



11.7. d : Fourth Phase: Warm sector converted into a linear sector and cold air covers all the areas .So cold air front again moves towards high latitudes. The features of cold air mass itself changes very much. Temperature and humidity increases as it moves towards south and it decreases as it moves northwards.

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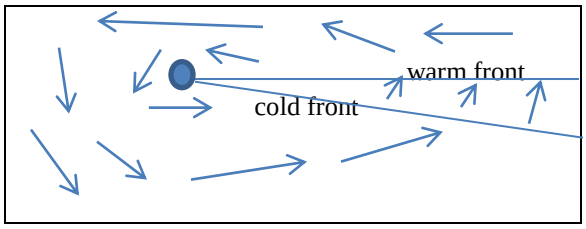

e : Fifth Phase : In this phase, warm and cold fronts meet with each other and creates occlusion of front. Thus, warm air completely disappeared. This occlusion is of two types you have already studied above. Fifth phase is the phase of dying wind in which there is no capacity of circular movement as warm sector already been comes to an end.

.f : Sixth Phase : Due to absence of front, planetary effect starts on the direction of wind. Wind becomes easterly and westerly and the first phase of temperate cyclone started again. Thus, there is an end of a temperate cyclone and there is a start of second or another temperate cyclone.

11.8- Depression: Indian Meteorological Department, New Delhi monitors any cyclone that develops within the North Indian Ocean between 45^0 east to 100^0 east. The official classification used in the North Indian Ocean is a lowest cyclone as **Depression** having wind speeds of 31-49 km/h. After that the tropical cyclone scale is used like this-

1- Depression=31-50 km/h (1924-1988)

2- Deep Depression=51-62 km/h

3- Cyclonic Storm= 63-88 km/h

4- Severe Cyclonic Storm= 89-117 km/h (introduced in 1988)

5- Very Severe Cyclonic Storm= 118-165 km/h (introduced in 1999)

6- Extremely Severe Cyclonic Storm= 166-220 km/h (introduced in 2015)

7- Super Cyclonic Storm= 221 and above km/h

Intensity Scale of Tropical Cyclone in South-west Indian Ocean is -

1- Lowest- Tropical Disturbance=<50km/h

2- Tropical Depression=51-62km/h

3- Moderate Tropical Storm= 63-88km/h

4- Severe Tropical Storm= 89-117km/h

5- Tropical Cyclone= 118-165km/h

6- Intense Tropical Cyclone= 166-212km/h

7- Very Intense Tropical Cyclone= >212km/h

Some severe cyclonic hits, India: It is estimated that, around 10,000 people are killed on average each year as a result of tropical storms at world level. On an average, 2 to 3 tropical cyclones make landfall in India each year, with about one being a severe tropical cyclone or greater. The strongest tropical cyclone India has ever recorded is the 1999 Odisha cyclone. Whereas, the

Bhola cyclone is one of the deadliest natural disasters ever recorded. The storm was formed over the Bay of Bengal in the month of November 1970 and made landfall on the coast of East Pakistan (Present Bangladesh) before continuing on to West Bengal. India has seen some severe cyclonic hit to its coastal states in recent past during 2020.

1. Cyclone Nisarga

Cyclone Nisarga is the second pre-monsoon cyclone that has emerged from the Arabian Sea and has expected to hit Goa, Maharashtra and Gujarat. Cyclone Nisarga has hit Alibag in Mumbai.

2. Cyclone Amphan

Cyclone Amphan was a powerful tropical cyclone which led to the destruction of lives and property in the states of Odisha and West Bengal. Cyclone Amphan was the first pre-monsoon super cyclone of this century and emerged from the Bay of Bengal.

3. Cyclone Kyarr

Cyclone Kyarr was the second strongest tropical cyclone since cyclone Gonu in 2007. Cyclone Kyarr developed in the Arabian Sea and moved towards the Gulf of Aden from the Indian coast. It hit the Western India, Oman, UAE, Socotra and Somalia.

4. Cyclone Maha

Cyclone Maha was an extremely severe cyclonic storm which became very intense while moving parallel to the Indian coast. The cyclone weakened when it approached Gujarat. Cyclone Maha made landfall near Gujarat as a depression which weakened afterwards.

5. Cyclone Vayu

Cyclone Vayu emerged from the Arabian Sea and was a very severe cyclonic storm which caused moderate damage to lives and property in the state of Gujarat. Cyclone Vayu was the strongest cyclone that hit the state since the 1998 Gujarat Cyclone. Along with India, cyclone Vayu also affected Maldives, Pakistan and Oman.

6. Cyclone Hikka

Cyclone Hikka emerged from the Arabian Sea and turned intense and hit Oman. In 2019, 4 cyclones emerged from the Arabian Sea-- Kyarr, Maha, Vayu and Hikka.

7. Cyclone Fani

Cyclone Fani was the strongest tropical storm that hit Odisha since the 1998 Odisha Cyclone. Cyclone Fani emerged from the Indian Ocean and caused huge destruction of lives and property in Odisha, West Bengal, Andhra Pradesh and East India. Outside India, it hit Bangladesh, Bhutan and Sri Lanka.

8. BOB 03

A depression formed in the Bay of Bengal and Indian Meteorological Department named in BOB 03. The very next day after the identification, the BOB 03 hit the north Odisha-West Bengal coastline and caused huge destruction of the lives and property.

9. Cyclone Bulbul

Cyclone Bulbul was a very severe cyclonic storm that hit the West Bengal in India. It caused huge rainfall, floods, etc. causing destruction to lives and property. Outside India it hit Bangladesh.

Extra-Tropical and Ex-Tropical Cyclones:

Extra-Tropical cyclones are sometimes called mid-latitude cyclones or wave cyclones as they are low-pressure systems which form outside the tropics and in the middle of the latitudes of 30^0 and 60^0. They are capable of producing mild showers, heavy gales, tornadoes, etc. **Ex-Tropical cyclones** or post-tropical cyclones are those which are formed when the characteristics of the cyclone are changed. The Bureau of Meteorology, Australia, calls post-tropical cyclone as an ex-tropical cyclone.

The Tropical Cyclone Warning Centre in Jakarta monitors cyclones between the longitudes of 90^0 East and 141^0 east from the Equator to 11^0 south and if cyclone develops in this region, it will be assigned a name by TCWC. However, the Australian Bureau of Meteorology monitors the cyclones between the longitudes of 90^0 East and 160^0 East below 10^0 South and if cyclone develops in this region, it will be named by BOM. As this cyclone originated in the region assigned to Indonesia, thus TCWC named this cyclone as 'Tropical Cyclone MANGGA'.

How Cyclone takes its name: The general term cyclone i.e. tropical cyclone has different name in different parts of the world. In Japan, Philippines and South China Sea (in western North Pacific) it is called **Typhoon**. Cyclone of Mexican coasts, Caribbean Sea, Central and eastern North Pacific and its surroundings is, known as **Hurricanes**. The cyclone develops over southern Indian Ocean, northern Australia and coast of Madagascar is known as **Willy-Willies**.

Cyclone is the name given to an area of low pressure surrounded by closed isobars which assume a more or less oval form. (P.LAKE) A typical hurricane produces the energy equivalent to 8,000 one megaton bombs. 90% of those who die from hurricanes die from drowning.

Since 1953, Atlantic tropical storms had been named from lists originated by the National Hurricane Center. They are now maintained and updated through a strict procedure by an international committee of the **World Meteorological Organization.** The six lists are used in rotation and re-cycled every six years, i.e., the 2016 list will be used again in 2022. The only time that there is a change in the list , if a storm is so deadly or costly that the future use of its name on a different storm would be inappropriate for reasons of sensitivity. If that occurs, then at an annual meeting by the WMO committee (called primarily to discuss many other issues) the offending name is stricken from the list and another name is selected to replace it. Several names have been retired since the lists were created. Here is more information the history of naming tropical cyclones and retired names.

If a storm forms in the off-season, it will take the next name in the list based on the current calendar date. For example, if a tropical cyclone formed on December 28th, it would take the name from the previous season's list of names. If a storm formed in February, it would be named from the subsequent season's list of names. In the event that more than twenty-one named tropical cyclones occur in the Atlantic basin in a season, additional storms will take names from the Greek alphabet.

Model Questions

1. What is front? Explain the different types of front in detail with suitable diagram.
2. What is front? Give a detail description of the formation of front and also describe the weather associated with it.
3. Differentiate between frontogenesis and Frontolysis. Discuss the weather conditions related with it.
4. Give detail information about temperate cyclone.
5. Differentiate between temperate and tropical cyclones.

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