Lesson - 14

Air masses, Front, Cyclone and Anticyclone

Air Masses

An extension and dense part of atmosphere in which physical properties specially temperature and humidity are relatively uniform horizontally, are called Air masses. Generally, the air masses are extended upto thousands of kms and consist of many layers. Each layer of the air mass has uniform properties. When the atmospheric conditions of an extensive area remains stable for a longer period of time, the air above it attains the temperature and moisture conditions of the ground surface, this leads to the formation of an air mass. After the formation of air mass, it seldom remains stationary over the source region. It moves ahead and affects the regions where it prevails. During this, its properties undergo changes but due to its extensive size these changes are very slow.

Source Regions of its origin

The regions where the air masses originate are called source regions. An ideal source region of an air mass should have the following essential conditions:-

(i) There should be an extensive and homogeneous surface of the earth so that it may have uniform temperature and moisture conditions. The source region may be entirely a landmass or an entirely an Oceanic surface.

(ii) The speed of the wind should be slow and should have divergence, so that The air of other region may not enter.

(iii) The atmospheric conditions should remain constant for considerable longer period of time, the air mass may possess the characteristics of the ground surface.

There are 6 ideal source regions of air masses on earth:-

(i) Polar Oceanic regions (Northern parts of Atlantic and Pacific Ocean-during winter season)

(ii) Sub-polar Continental regions (Snow covered Eurasia and North America - during winter season)

(iii) Monsoon region (South- east Asia)

(iv) Tropical Oceanic Regions (anticyclone regions- summer and winter)

(v) Tropical Continental regions (North Africa, Asia and Mississippi Valley region of USA)

(vi) Equatorial Region (throughout the year)

Classification of Air Masses

The air masses are classified on two basis:-

(i) Nature of the surface of source region

(ii) Transformation of air masses

These are two types of air masses based on the nature of the source region- Tropical and

Polar. As the source of origin of air masses maybe land mass or ocean, each is divided into two subtypes- Maritime tropical air mass, continental tropical airmass, Maritime polar air mass, Continental polar air mass. As more moisture content is present in Maritime air masses, it causes more rainfall, contrary to this Continental air masses are dry and causes lesser rainfall.

As the masses move further away from the source region, they are transformed according to the region through which they are pass. This transformation is of two types Thermo-dynamic and Mechanical. As the air

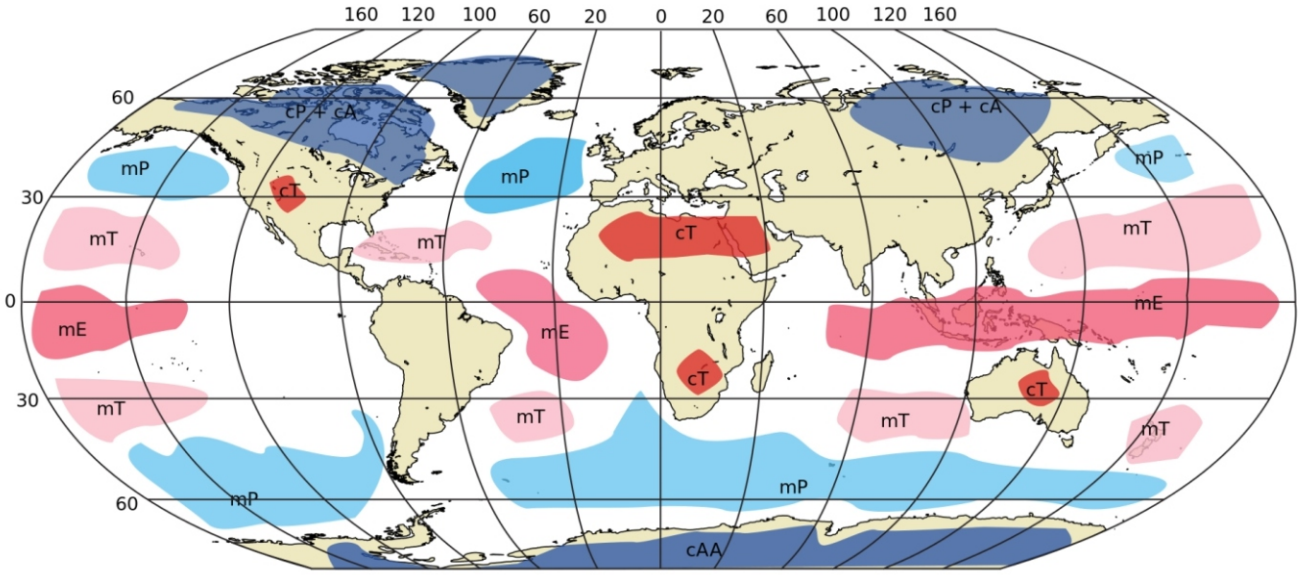
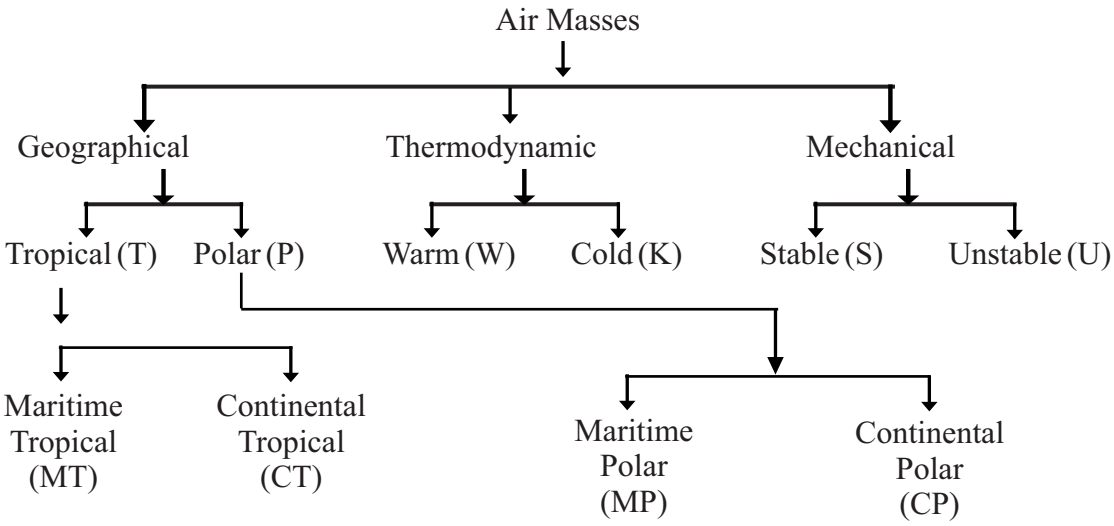


Fig. 14.1 : Air masses of the world

Table 14.1 : Classification of Air Masses



masses passe through a surface, the temperature differences occur, which causes increase or decrease in temperature of the lower layers of the moving air mass, this is called Thermodynamic Modification. The modifications of the air masses which are not affected by the warmth or coldness of the surface area are called Mechanical Modifications . For example-Modifications occuring by Cyclones and Anticyclones and Vertical movement of air. When the air mass is moving, it is called Unstable- U and when it's not moving, it is called Stable- S.

Front

The term 'Front' was used first of all during the World War. When two air masses of different nature (warm and cold) connect, they try constantly to maintain their temperature and moisture conditions. An inclined boundary is formed during this process which is called front. When two air masses of different character come in contact with each other , they do not merge, but try to maintain their differences for long period of time. According to Blair "The surface or line, along which air masses remain seperated, is called front.

Fronts are important in climatology as they give birth to many specific atmospheric conditions like cyclones and anticyclones. This is the reason why fronts are also called "Cradles of cyclones and anticyclones."

Origin of Front

The following conditions are necessary for the origin of front:-

(i) Air Masses having different properties means warm and Cold Air Masses
(ii) Variation in humidity
(iii) Atmospheric Circulation

Types of Fronts

Petterson has divided Fronts in four different types, which develop in the mid-latitudinal cyclones.

(1) Warm Front

Front in which the warm air becomes active and rises slowly over cold and dense air is called warm front.

(2) Cold Front

The Cold front is formed when the cold and dense air uplifts the hot and lighter air .

(3) Stationary Front

The front in which the two contrasting air masses converge in such a manner that they are parallel to each other and there is no movement of air, it is called Stationary Front.

(4) Occluded Front

This type of front is formed when a cold air mass overtakes the warm front and lifts the

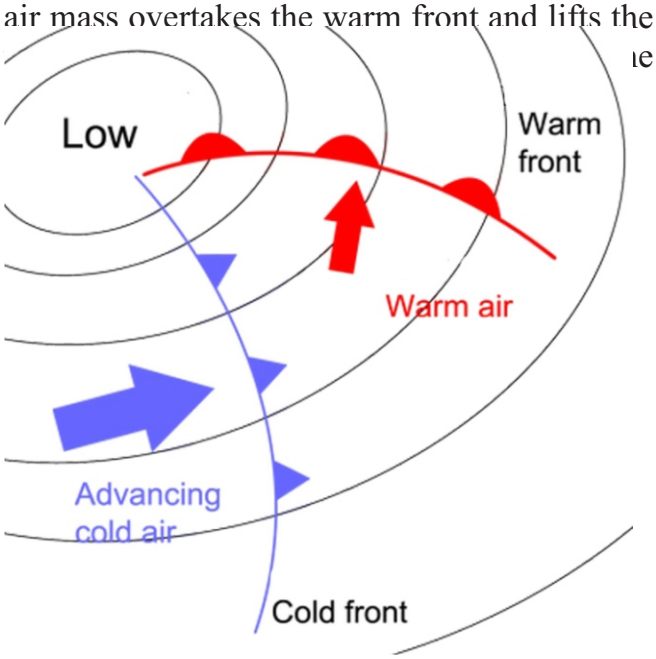


Fig.14.2 : Front and Cyclone

Cyclone

Cyclone is generally the centre of low pressure, in which the air pressure increases outwards, due to this the winds blow towards the centre. According to Ferrel's law ,these winds will move anticlockwise in the Northern hemisphere and clockwise in the southern hemisphere fully. It means that the winds will

turn towards right in the northern hemisphere and towards left in the southern hemisphere. According to Twewartha, 'Cyclones are those centres of low pressure which are surrounded by circular and adjoining isobars. The shape of the cyclones are mostly circular , elliptical or 'V' shaped.

Major characteristics of cyclones

(i) Cyclones are areas of low pressure, in which the pressure increases outwards from the centre.
(ii) The winds move towards the centre.
(iii) The shape of the cyclones is mostly circular, elliptical or 'V' alphabet shape.
(iv) Cyclones affect the weather conditions, which causes decrease in pressure, formation of halo around Sun and Moon, and heavy rainfall etc.
(v) The winds blows anticlockwise in Northern hemisphere and clockwise in the southern hemisphere.

Types of cyclones

1. Temperate cyclone
2. Tropical cyclone

(1) Temperate Cyclone

The weather conditions are not uniform in mid-latitudes. Mostly the weather keeps on changing here, resulting in the origin of cyclone in mid latitudes, having low pressure in it's centre and is surrounded by high pressure. They are of circular, elliptical or v-shaped, which are called lows or depressions or trough. They are formed due to the convergence of warm and cold air. They are mostly found in the regions extended between 35° to 65° latitude in both the hemispheres, where they blow from west to east under the influence of Westerlies. The sequential movement of these cyclones are similar to up and down movement of the whirls in a flowing stream. The cyclones cause formation of clouds in the atmosphere which causes rainfall or snowfall when the conditions are appropriate. These cyclones cause changes in the air pressure and temperature. The velocity of these cyclones is comparatively higher during winters than summers.

Origin of temperate cyclones

The temprate cyclones are produced mainly by polar fronts but out of temprate zone they can devlope the origin of temperate cyclones is mostly at polar regions anywhere. Their origin and development is mostly during the winter season. The major centres of these cyclones where they originate are North Pacific Ocean to West of Alluetian low pressure region and western coastal margins of North Atlantic Ocean to Iceland low pressure region, the area of cyclones further extends to China, Phillipines, Siberia. The origin of these cyclones in the southern hemisphere during winter and summer seasons, is in the similar pattern. In this hemisphere the cyclones are very frequent near 60° South latitude.

Types of temperate cyclones

These cyclones are divided into three different categories:-

(i) Thermal Cyclone
(ii) Dynamic Cyclone
(iii) Secondary cyclones

The weather conditions tends to change before the arrival of cyclone. When the sky is covered with thin white layer of clouds and there is sudden decrease in pressure in barometer, there is change in the direction of winds, the sun and the moon are encircled by halo, circulation of winds almost stops, it indicates the arrival of a cyclone.

(2) Tropical Cyclones

Tropical cyclones are formed between the Tropic of Cancer and Tropic of Capricorn on both sides of the equator. There are numerous forms of tropical cyclones. The cyclones become more vigorous and cause havoc in the

affected area. No uniformity is found in these cyclones as that of temperate cyclones.

The major characteristics of the cyclones are as follows-

(i) The centre of the cyclone is characterized by low pressure and the isobars are circular.
(ii) The velocity of these cyclones varies, somewhere their speed is 32 km per hr and somewhere it is 200 kilometre per hour.
(iii) There size also varies. Mostly their diameter is between 80 to 300 kms.
(iv) These cyclones are permanent in nature. They can cause heavy rainfall for many days at the same place.
(v) The cyclones are more devastating.
(vi) The speed of these cyclones is more on oceans but it reduces as they reach land mass.

Origin

The cyclones are originated between 8° to 15° north latitudes over oceans. They are more common during summer season. Their birth place of origin and development are mostly oceanic areas. They usually fade away as they reache the land mass. The cyclones are called hurricane near Western Islands, China and Philippines, in Japan they are called Typhoon and Cyclone in Indian Ocean. The major centres of the origin of these cyclones are North Atlantic Ocean, Gulf of Mexico, Western Island group, South China Sea and most of the regions of Pacific Ocean.

The tropical cyclones are categorised into the following parts:-

(1) Tropical depressions, (2) Tropical Storms (3) Hurricane or Typhoons (4) Tornado

Hurricane is the name given to tropical cyclones of USA.

Typhoon is similar to Hurricane which is frequently found in eastern coastal regions of China.

Tornado is comparatively smaller in size but most vigorous and devastating tropical cyclone which is frequent in the Mississippi Valley of USA and some regions of Australia.

Theories about the origin of cyclone

There are three major theories about the origin of cyclones:-

(1) Local Thermal Theory
(2) Dynamic Theory(Lambert and Shaw)
(3) Polar Front Theory(Berknes 1918)

Anticyclone

The anticyclone wind system, which are surrounded by circular isobars having high pressure at the centre and lowest at the outer margins. The winds blow from the centre towards the outer margins. Anticyclones are totally opposite to cyclones in nature, characteristics, wind system and weather conditions. They are much larger in size comparatively more than the cyclones. The winds blow gently and the sky remains clear. The term anticyclone was first used by Galton in 1861. Anticyclones of permanent nature are mostly found between 30° latitude in both the hemispheres over in the oceans. They usually fade away in the higher layers of the atmosphere.

There is high pressure area at the centre

Characteristics:-

(i) Anticyclones are high pressure areas, and the pressure decreases outwards from the centre.
(ii) The winds blow clockwise in the Northern hemisphere and anticlockwise in the southern hemisphere.
(iii) Anticyclones are comparatively larger in size than cyclones and circular in shape.
(iv) With the arrival of anticyclones the weather becomes pleasant; the sky becomes clear and winds blow gently.
(v) They are more frequent in temperate

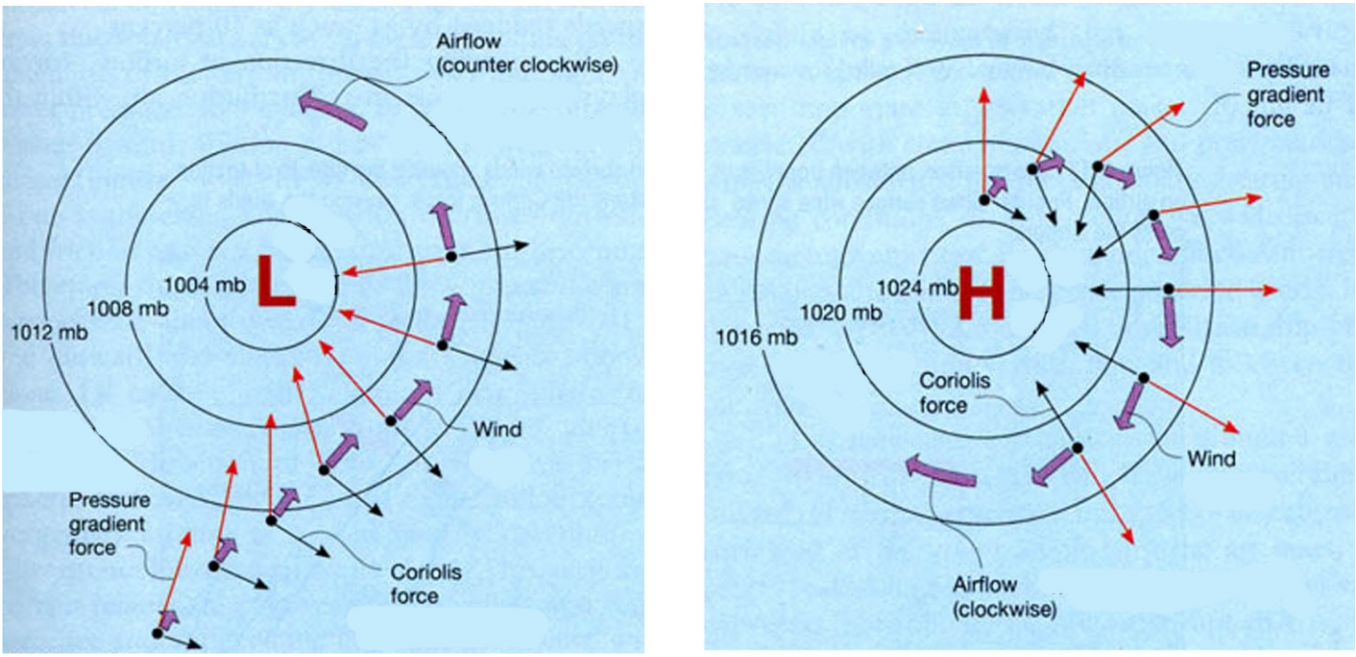


Fig. 14.3 : Cyclone and Anticyclone in Northern hemisphere

high pressure areas.

Types of Anticyclones

The famous meteorologists, Hanzilk in 1909 categorised anticyclones into two different categories:-

(1) Cold anticyclone

(2) Warm anticyclone

On the basis of new discovery of meteorologist

(3) Blocking anticyclone was also categorized .

So now there are three types of anticyclones.

(1) Cold Anticyclone

These cyclones basically originate in the polar regions specially in Arctics, from where they advance in easterly and south easterly direction. (Fig. 14.3)

They are comparatively smaller than tropical anticyclones but they move rapidly than the latter. There thickness is also lesser and the height is not more than 3000 m. These are of two types:-

(i) Temporary Anticyclones usually fade away as they move forward. There are very few anticyclones that reach the tropical regions.

(ii) Semi Permanent Anticyclones these anticyclones are more active and travel longer distances.

The origin of cold cyclones are mostly thermally induced. These Anticyclones are developed because of high pressure developed due to decrease of temprature by radiation and receiving less insolation during winter season in the Arctic regions. Basically cold anticyclones follow two important tracks:-

(1) North of Canada and (2) North of Siberia

(2) Warm anticyclone

These anticyclones originate in the belt of temprate high pressure areas. The winds diverge in this belt. They are larger in size but are less active. However they are more active in south east USA and West European countries. In this type of anticyclone, the wind blows gently and sky remains cloudless and mostly clear .

(3) Blocking Anticyclone

This type of cyclones have been categorised on the basis of new discoveries made by meteorologists. They are developed

due to obstruction in the air movement in the upper layers of troposphere. They have similar characteristics of wind system, air pressure and weather conditions of warm anticyclones. They are smaller in size and mostly move slowly. They originate in North-West Europe and Western region s of Atlantic Ocean and Pacific Ocean.

Jet stream

The fast moving air in the upper layers of troposphere, near the boundary of troposphere is called jet stream. These are narrow belt of, spiral and high speed wind currents. They continuously encircle the earth. They are 40 to 160 km wide and 2 to 3 km thick.

Their speed is more than 120 kilometres per hour. Their speed is more during winter season. The circulation pattern changes according to the season. Their circulation shifts towards the poles during summer season and towards the equator during winter season. The discovery of these winds was made during Second World War. Since then they were extensively studied. However there is no unanimous approach of meteorologist regarding the origin and other aspects of Jet stream but still the information collected is utilised to facilitate the aircrafts. Jet streams are divided into two parts:-

(i) Subtropical Jet Stream
(ii) Mid Latitudinal or Polar Front Jet Stream

(i) Subtropical Jet Stream

The location of this Jet stream is found between 30° to 35° latitudes in both the hemispheres. They prevail throughout the year. They are believed to be formed due to rotation of the earth. The rotation of the earth creates maximum velocity in the atmosphere near the equator. This results, in rising of air currents above the equatorial region, that extends in north and south and blows in high velocity. These air currents, under the impact of Coriolis force diverge towards right in Northern hemisphere and towards left in Southern hemisphere. These air currents take the form of subtropical jet stream at 30° latitude.

Mid Latitudinal or Polar Front Jet Stream.

These Jet streams are formed due to the variation in temprature and keep deep reaction with polar front. They are located between 40° to 60° latitudes in both the hemispheres. Their location tends to change more frequently than subtropical jet stream. They shift towards Polar Regions during summers and towards equator during winters.

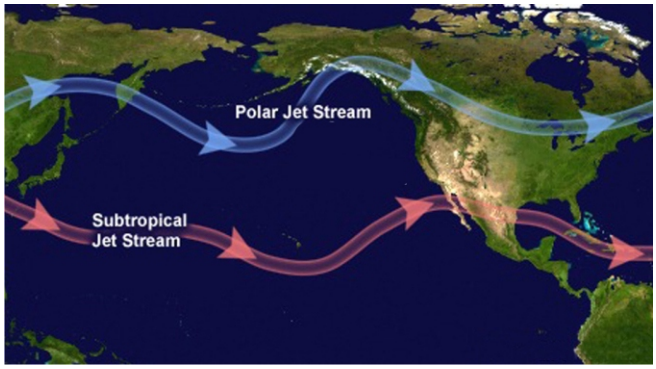


Fig. 14.4 : Direction of Jet Stream

Although the jet streams are not yet fully understood but they still create a huge impact on weather conditions. Many atmospheric conditions are affected and made vigorous by Jet streams like cyclones and anticyclones, monsoon winds, high velocity winds and many other atmospheric conditions.

Important points

1. The high velocity winds blowing in the upper layers of troposphere in mid-latitudes is called jet stream.
2. The line along which two different air masses converge is called Front. There are two types of front, warm front and cold front.
3. Cyclones are low pressure centres surrounded by high pressure from all

sides. The winds in cyclone, blow in anticlockwise direction in the Northern hemisphere and clockwise in the southern hemisphere. They cause rainfall with thunderstorm.

4. In an anticyclone pressure conditions and direction of winds is totally opposite to cyclone. The weather remains dry and clear.

Exercise
Multiple choice questions

1. Which of the following is called Cradle of cyclones and anticyclones?
   (A) Fronts
   (B) Air Masses
   (C) Disturbances
   (D) Hurricane

2. The direction of winds in the Northern hemisphere in cyclones is:-
   (A) Anticlockwise
   (B) Vertical
   (C) Clockwise
   (D) Diagonal

3. A Hurricane is a:-
   (A) Temperate cyclone
   (B) Tropical cyclone
   (C) Anticyclone
   (D) Front

4. Who propounded the dynamic concept of origin of cyclones?
   (A) Bjerknes
   (B) Lampert and Shaw
   (C) Wegner
   (D) Davis

5. Which of the following is not a type of front?
   (A) Warm Front
   (B) Cold Front
   (C) Stationary Front
   (D) Non- stationary Front

Very short type questions

6. Classify air masses on the basis of its place of aaaorigin.
7. What is a Warm Front?
8. What is a Stationary Front?
9. Where do the tropical cyclone origin?
10. What is a Cyclone?

Short type questions

11. What is a front? What are its different types?
12. What are the necessary conditions for the formation of Fronts?
13. Differentiate between cyclone and anticyclone.
14. What is a Hurricane?
15. What are the major theories about the origin of cyclones?

Essay type questions

16. What are Fronts? What are the conditions necessary for the formation of fronts and describe it's major types.
17. What is a Cyclone? Describe the origin of Temperate cyclones and their different types.
18. What are cyclones and anticyclones? Describe their characteristics and different types.

Answer key

1.A. 2.A. 3.B. 4.B. 5.D