Mid-latitude Cyclone and Anti-Cyclone

Part II (1+1+1 System) Geography Hons.
Paper: IV
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Mid-latitude Cyclone

Cyclones originating in the temperate zones extending from 350 to 65° latitudes are known as mid-latitude cyclones. They are also called or temperate or extra tropical cyclones or wave cyclones.

Origin of Temperate Cyclones

Various theories have been advanced regarding the origin of temperate cyclones but no theory has found universal acceptance and scholars still express divergent opinions in this respect.

The most accepted and popular theory is that advanced by V. Bjerknes and J. Bjerknes of Norway. A brief description of this theory is given below:

Polar Front theory of origin of mid-latitude cyclones: Also known as 'frontal theory' or 'wave theory' or 'Bergen theory', the polar front theory of origin of temperate cyclones was propounded by Vilhelm Bjerknes and his son Jakob Bjerknes, the two famous meteorologists of Norway in 1918. According to this theory the mid-latitude cyclones come into being due to collision of two air masses of contrasting characteristics of temperature and humidity. Air masses of low temperature and humidity meet the air masses of high temperature and humidity in the temperate zone. They meet each other at about 60° latitude. Here they do not merge with each other readily; rather they form a front known as Polar Front. Fig. 1 shows six different stages of origin and growth of a temperate cyclone.

A. Incipient Stage: This is also called the initial stage. In this stage, the cold air mass from the north and warm air mass from the south have just come close to each other. The front formed between the two air masses is represented by a straight line. There is no movement towards the front in either of the air masses and the front is static. There can be a few altostratus clouds and some light rainfall may be expected.

B. Juvenile Stage: This is the beginning of cyclone circulation. A swell has developed in the warm air mass due to movement of the warm air. This air has entered the cold air and the front has become wavy. The area and amount of rainfall increase. At this stage, the front is clearly divided into warm and cold sectors. The warm-front is in front of cold air mass and cold-front is shown in front of warm air mass. The warm air ascends the wedge of cold air. In the warm front the cold air pushes the warm air from beneath so that the warm air is pushed up. As a result, rainfall is caused at both the fronts and clouds can be seen both ways.

C. Early Maturity: This stage approaches 36 to 60 hours after the first stage has been initiated. Warm sector has become well defined between the cold and warm fronts. The cold front moves faster than the warm front and the warm front begins to get smaller.

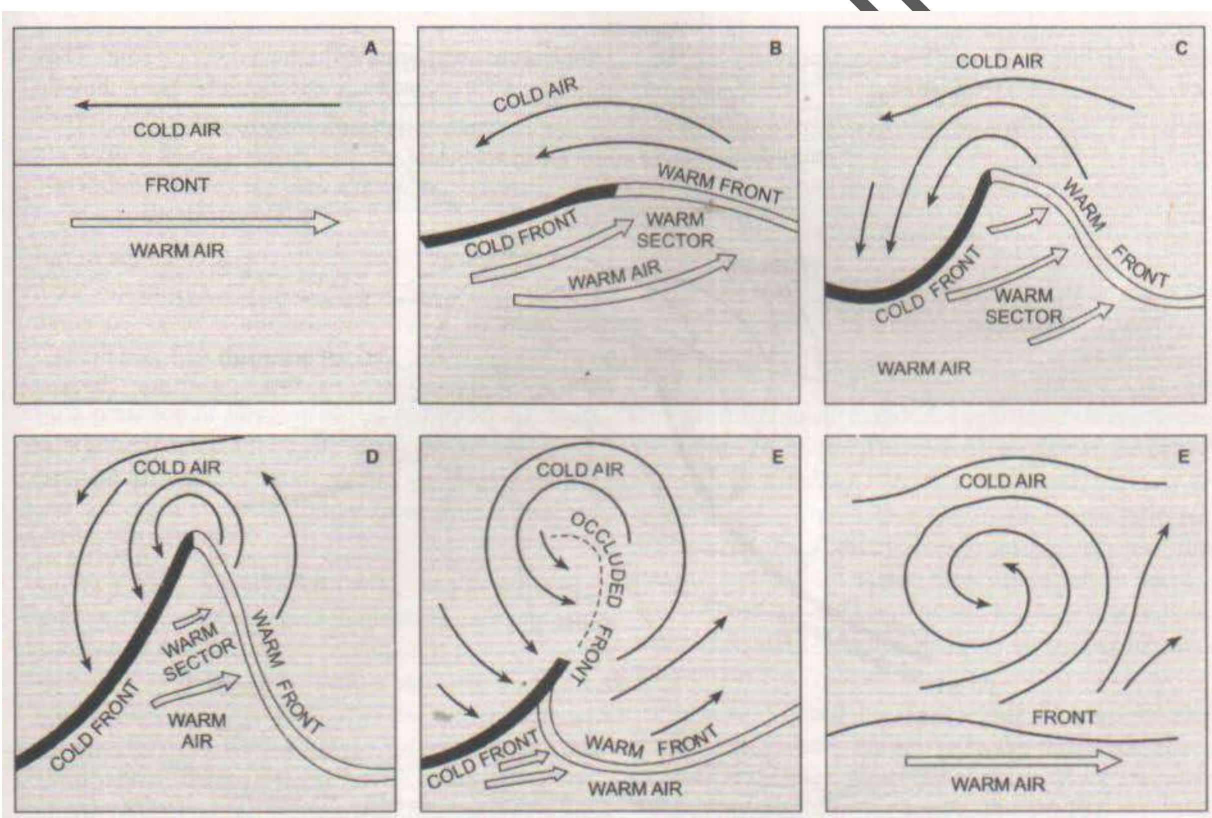
Nimbo stratus, stratus, altostratus, cirrostratus and high altitude cirrus clouds are produced at the warm front. The order of the clouds mentioned above is because of the ascent of warm and humid air. Warm air ascends at the cold front due to the push of the cold air. As a result cumulonimbus clouds are born here. It has been noted that cyclones move at a speed of 50 to 80 km per hour in winter and 25 to 30 km per hour in the summer season.

D. Full Maturity: In this stage the cold front is overtaking the warm front and the cold front has shortened the warm front by moving faster than latter. The warm sector is now much smaller. It resembles the third stage. The cyclone gets shorter.

E. Old Stage or Occluded Stage: In this stage the cold front has caught up with the warm front. The cold air from the west has moved faster and has become one with the cold air from the east at the surface of the earth. The warm air loses contact with the earth as it rises en mass. The meeting of cold and warm fronts is called occlusion and the front is known as occluded front.

In the above example, if the cold air coming from the west is colder than the cold air from the east, the occluded front is called cold occluded front but if it is less cold, the front is known as warm occluded front.

F. End Stage: This is also called the stage of dissipation. The cyclone has come to an end. Only a few revolving air currents can be seen as the remnants of the cyclone. The mutual positions of cold and warm air masses are now similar to those in the first diagram.



A. Initial stage B. Beginning of a cyclonic circulation C. Worm sector well defined between warm and cold front

D. Cold Front overtaking warm front E. Occlusion F. Dissipation

Fig. 1: Stages in the development and occlusion of a mid-latitude cyclone along the polar front

Shape and size: A temperate cyclone assumes various shapes such as circular, semi-circular, elongated or V-shaped during the course of its growth and development. Most temperate cyclones are elliptical shaped on full growth. The ratio of its minor and major axis is 1: 2. The average radius of a temperate cyclone varies from 400 km to 800 km; but several cyclones extend over several thousand kilometers. In some extreme cases the diameter of a temperate cyclone may vary from 150 km to 3000 km. Some of the temperate cyclones may cover an area of a million sq. km. The height of an average temperate cyclone is 10 to 12 km.

Wind velocity: Isobars in a temperate cyclone are widely spaced and the average pressure difference between the centre and the periphery is about 10 to 20 mb. Therefore, the wind velocity is not much as is generally expected in a cyclone. The average wind velocity in winter is 40 to 60 km per hour which is reduced to 15-20 km per hour in summer.

Direction of movement: Generally the temperate cyclones move from west to east under the influence of westerly winds. Their average speed of easterly movement is 32 km per hour in summers and 49 km per hour in winters. These cyclones follow slightly curved paths in the northern hemisphere due to the presence of large stretches of land masses. In the southern hemisphere, however, there is almost complete absence of land masses in the temperate zone and these cyclones follow more or less straight west-east direction.

Weather associated with a temperate cyclone: The isobars in a temperate cyclone are distant apart and the pressure gradient is low. There is absence of strong winds. Before the arrival .of the cyclone, there are cirrostratus clouds. Sun looks more pale and there is Lunar Halo (circle around the moon). The arrival of the cyclone is indicated by rise in temperature and fall in atmospheric pressure. Wind direction becomes variable. Light rainfall continues for about 24 hours. The rain stops at the arrival of warm front. Pressure becomes stable and cloud cover becomes thin. The temperature starts falling after the warm front has crossed. This is an indication of the arrival of cold front. Again there are clouds in the sky and it starts raining. Sometimes it is associated with hail and lighting. The sky becomes clear after the cold front crosses.

Areas visited by temperate cyclones: The temperate cyclones are active in the temperate zone, especially between 40 to 60 latitudes. They are most frequent in the following areas.

1. North Atlantic Ocean: Here the temperate cyclones originate by meeting of cold air masses from Greenland and Iceland with the warm air masses from lower latitudes. They affect large areas of Great Britain, Norway, Sweden and other parts of Europe.

2. Mediterranean Sea: Here temperate cyclones are formed due to the convergence of cold and dry air masses from the central Europe with the westerly during the winter season. They originate in the Mediterranean Sea and after crossing the Middle East countries reach Pakistan and North West India. The light winter rainfall caused by these cyclones in Punjab, Haryana, and western parts of Uttar Pradesh is extremely useful to rabi crops, especially wheat.

3. North Pacific Region: Temperate cyclones of this region originate near the Aleutian Islands and cause rainfall in vast areas of U.S.A. and Canada after crossing the Rockies.

4. China Sea: Temperate cyclones of this region originate near the Japan Sea and cause rainfall in North China after crossing the China Sea.

Anticyclone

As the word ‘anticyclone’ implies the air circulation having opposite conditions and characteristics of a cyclone is called anticyclone. The term ‘anticyclone’ to indicate divergent air circulation in all directions from high pressure center, was first introduced by F. Galton in the year 1861.

Surrounded by almost circular isobars anticyclone is such a wind system which has highest pressure at the center and pressure decreases outward in such a way that it becomes lowest at the outer margin and the winds blow from the center outward in clockwise direction in the northern hemisphere and anticlockwise direction in the southern hemisphere. (Fig.1)

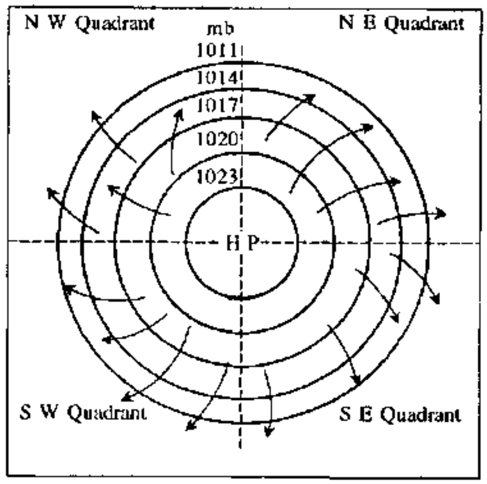


Fig. 1: Air pressure and wind system in an anticyclone.

Thus, anticyclones are high pressure systems and are more common in the subtropical high pressure regions but are practically absent in the equatorial regions. They are generally associated with rainless fair weather. This is why anticyclones are called weather less phenomena.

General Characteristics

The anticyclones are characterized by the following properties:

1. They are usually circular in shape but some times they also assume ‘V’ shape. There is maximum air pressure at the centre and it decreases outward. The difference of pressure between the centre and periphery of anticyclone ranges between 10-20 mb and sometimes it becomes 35 mb.

2. They are much larger in size and area than temperate cyclones as their diameter is 75 percent larger than that of the latter.

3. Though anticyclones follow cyclones but their track is highly variable and unpredictable. They move very sluggishly and some times they become stationary over a particular place for few days. The average velocity of anticyclones is 30- 50km per hour.

4. Because of high pressure at the centre winds blow outward clockwise in the northern hemisphere and anticlockwise in the southern hemisphere.

5. Winds descend from above at the centre and thus weather becomes clear and rainless because the descending winds cause atmospheric stability.

6. Temperature in anticyclones depends on weather, nature of air mass and humidity in the air. They record high temperature during summer season due to development of warm air masses whereas they carry low temperature during winter season due to polar cold air masses.

Wind System

Wind system is not fully developed in anticyclones because of weak pressure gradient. On an average, wind circulation is of divergent system wherein winds spread in all directions from high pressure centre to low pressure periphery. There is westerly wind in the front portion of an eastward advancing cold anticyclone while the rear portion is characterized by easterly winds (Fig. 1). The winds are very much sluggish in the rear portion in comparison to the winds in the front portion. The centre is characterized by light breeze. Wind system is seldom developed fully in warm anticyclones.

Shape and Size

Anticyclones are generally of circular, near circular or wedge shape but are very large in size. Sometimes, they become so large in size that their diameters become 9,000 km. There is little difference between the length and width of anticyclones. Temperate anticyclones are so extensive that a single anticyclone covers nearly half of the USA.

Temperature

Anticyclones are originated due to the descent of either polar cold air mass or warm tropical air mass. It is, thus, obvious that cold anticyclones are associated with extremely low temperature and they cause cold waves during winter season but when they come in summer season, weather becomes pleasant. On the other hand, warm anticyclones bring heat waves during summer season in the tropical regions.

Weather Conditions

Generally, anticyclones are rainless and sky is free of clouds because of the fact that descending air in the centre of anticyclone is warmed up at dry adiabatic rate due to subsidence. This causes rise in temperature which reduces normal lapse rate of temperature, with the result the stability of air increases resulting into marked increase in the aridity of air. This is why anticyclones are indicative of dry weather. This does not mean that anticyclones are always rainless. While passing over oceans some times they pick up moisture and yield light rains or drizzles with moderate clouds. The arrival of anticyclones is heralded by clearing of clouds, if already present in the sky, clear weather and decrease in wind velocity. The weather of Canada, USA, and north Eurasia is mostly affected by anticyclones.

Types

Normally, anticyclones are divided into (i) cold anticyclones, (ii) warm anticyclones, and (iii) blocking anticyclone

1. Cold anticyclones: After originating in the arctic regions cold anticyclones advance in easterly and south-easterly directions. Though they are smaller than warm anticyclones in size but move more rapidly than the latter. They are of very low thickness. Very few cold anticyclones are higher than 3,000 m. Cold anticyclones are divided into two subtypes e.g. (i) temporary anticyclones, which die out in the transit while moving forward, only a few reach tropical regions, and

(ii) semi permanent anticyclones, which cover longer distances and are more active. Cold anticyclones are thermally induced because they do not develop due to descent of air from above. They are originated due to development of high pressure because of very low insolation during winter season in the arctic regions.

Cold anticyclones follow two tracks. (i) Anticyclones after originating in the north of Canada move in easterly and south-easterly direction and affect the weather conditions of Canada and USA. (ii) Anticyclones originating in the north of Siberia move towards China, Japan and Alaska. Anticyclones affecting north-west Europe originate with temperate cyclones (in their rear portion). While entering tropical region cold anticyclones die out due to increase in temperature.

2. Warm anticyclones originate in the belt of subtropical high pressure where winds diverge in opposite directions. Thus, warm anticyclones are originated due to descent of air from above and consequent divergence at the surface. They thus are dynamically induced. They are large in size but are very sluggish in movement. Some times, they become stationary over a place for several days and weeks. They are associated with light wind, cloudless sky and clear weather. Warm anticyclones mostly influence the weather of S.E. USA and Western Europe.

3. Blocking anticyclones develop due to obstruction in the air circulation in the upper troposphere. This is why they are called blocking anticyclones. They develop over North West Europe and adjoining Atlantic Ocean and the western part of the North Pacific Ocean between 140°-170° W longitudes. They are similar to warm anticyclones as regards wind system, air pressure and weather but are small in size and move very slowly.