Date:

Geography (Hons)-Paper-CT5-3rd Semester

Fronts: warm and cold; frontogenesis and frontolysis.

Questions

1. Define front.
2. Distinguish between warm front and cold front.
3. Discuss the weather sequence of passing warm and cold fronts.
4. Discuss the sequence of clouds and weather condition associated with a warm front.
5. Discuss the sequence of clouds and weather condition associated with a cold front.
6. Distinguish between frontogenesis and frontolysis.
7. What are the favourable conditions for frontogenesis and frontolysis
8. Define front.
9. What is ground front?
10. Name the different types of front with diagram.
11. What is warm front?
12. Name the sequence of clouds for the approaching warm front?
13. Draw a vertical cross section of a warm front.
14. Name the sequence of clouds for the approaching cold front.
15. Draw a vertical cross section of a cold front.
16. Why is the term 'line of discontinuity' applied to the frontal zone?
17. Discuss the salient features of a front.
18. Why is the slope of a warm front small?
19. Why are the changes of temperature and wind direction slower in warm front than that of a cold front?
20. Why do warm front usually yield moderate to gentle precipitation over a larger area and longer time than cold front?
21. Mention the weather associated with the passage of warm front.
22. Find out the relationship between slope of front and wind velocity

Fronts:

A front is an interface or transition zone between two air masses of different physical characteristics such as temperature, humidity, pressure, density, etc. These two air masses come into contact due to the converging movements in the general atmospheric circulation. These fronts are sloping boundaries. There is an abrupt discontinuous change in the weather elements previously encountered. This is why the term 'line of discontinuity' is applied to this transition zone. Here 10° to 20° C temperature may change over a distance of 3 kilometres.

The concept of front or frontal surfaces was introduced in meteorology by the Norwegian school of meteorologists in about 1918. The three distinguished Norwegian meteorologists whose intensive investigations laid the foundation of this concept are—

i. V. Bjerknes
ii. J. Bjerknes and
iii. H. Solberg

The term 'front' was borrowed by analogy from the military front during World War-I.

The frontal surface may be defined as the three-dimensional transition zone between contrasting air masses.

The *frontal zones of discontinuity* are 15 to 200 kilometres wide and are relatively narrow. The line formed by the intersection of the frontal surface with the ground is referred to as the *groundfront* or simply the *front*.

Classification of Fronts:

As a result of the observations of atmospheric conditions at the surface and aloft, the following types of fronts are identified:

i. Warm Front
ii. Cold Front
iii. Occluded Front and
iv. Stationary Front

Frontal Symbols used in Weather Maps

Warm Front:

A Warm Front is defined as gently sloping frontal surface in which there is active movement of warm air over cold air. As the surface position of a warm front moves, the warm air occupies territory formerly covered by cooler air. Because of friction, advance of the surface position of the front is slowed down so that the front has a small slope. The average slope of a warm front is from 1: 100 to 1: 200. As the warm air gradually ascends the gently sloping surface of the wedge of cold air lying ahead, it cools adiabatically. This cooling leads to cloudy condensation and precipitation. Unlike the cold front, the changes in temperature and wind direction are gradual.

The **sequence of clouds** precedes a warm front follows a particular weather condition. The appearance of *cirrus* clouds heralds the approach of a warm front. These high-altitude clouds form some 1000 kilometresor more ahead of the surface front indicating the ascent of overrunning warm air over the retreating wedge of cold air. The *cirrostratus*clouds that form ahead of the front produce halos around sun and moon. In case there is instability in the overrunning warm air, *mackerel sky* is produced by *cirrocumulus*clouds. As the front closer to the observer, the clouds become lower and thicker. About 300 kilometresin advance of the surface position of the front thicker *stratus* and *nimbostratus* clouds appear and precipitation starts falling from them. Thus, as the warm front approaches, the clouds show a sequence of —

i. *Cirrus,*
ii. *cirrostratus,*
iii. *altostratus,*
iv. *stratus and*
v. *nimbostratus and*
vi. *finally nimbus*

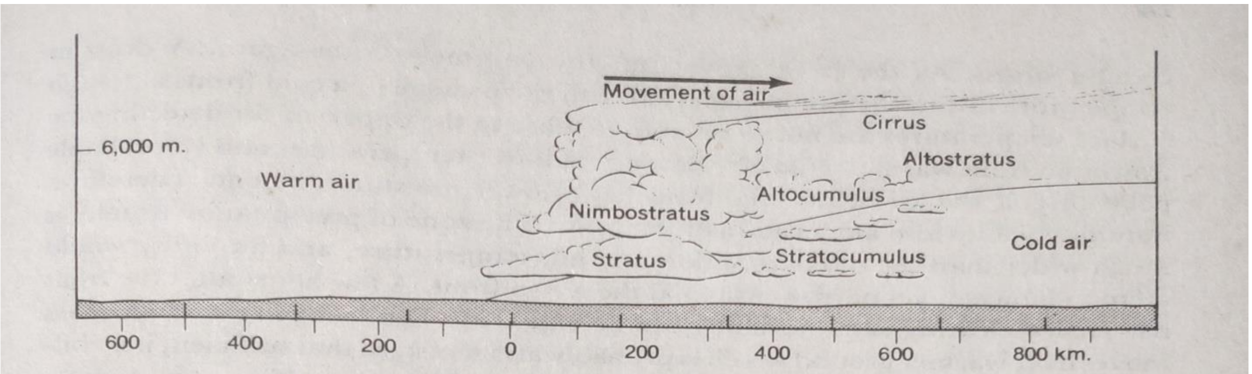

Figure 5.11 Vertical cross section of a warm front. (NOAA)

The thick cloud sheet overlying the surface position of the front gives steady precipitation extending over a long distance ahead of the front. Warm fronts usually yield moderate to gentle precipitation over a relatively larger area for several hours. **This is in conformity with the gentle slope of the front.**Convection activity is generally absent along a warm front. But there are occasions when cumulonimbus clouds and associated thunder storms are produced along the warm fronts. But this is exception rather than the rule.

Sometimes the rains falling through the cold air mass below evaporate. This causes the air below the cloud base to become saturated and *stratus*clouds form. These clouds make atmospheric visibility poor causing much hardship to pilots of small aeroplanes. During the winter, an

inversion of temperature is produced along the warm front which is situated near the surface. The inversion layer may produce during the cold season freezing rain or sleet in the very cold air ahead of a warm front.
The passage of warm front is marked by a rise in temperature and pressure. The specific humidity rises, and there is usually a change in the weather. The weather in warm sector, of course, depends on physical properties of the air mass and the season.

Cold Front:

A cold Front is defined as a front along which cold air is invading the warm-air zone. Since the colder air mass is denser, it remains at the ground and forcibly uplifts the warmer and lighter air mass. In fact, *when pressure distribution is such as to force the cold air to advance and the warm air to retreat, the zone of transition is called a cold front*. The vertical structure of warm air that is forced upward by an advancing wedge of cold air determines the type of weather produced along the cold front.

The effect of friction retards the air motion near the ground, while the free air aloft has a higher velocity. This causes the cold front to become much steeper than the warm front. The steepness of the front is closely related to its velocity. Thus higher velocity results in the steeper slope, while lower velocity makes the slope of the front rather gentle. The slope of a cold front varies from 1: 50 to 1: 100. In other words, the wedge of cold air has a slope of 1km of rise for 50 or 100 km of distance. When a cold front moves rapidly, warm air can be forced to rise ahead of the front. Depending on the instability of the overrunning warm air, convective clouds or even thunderstorm may occur along the leading edge of the cold front. This type of front slopes backward instead of forward, so there is no warning far in advance of an approaching cold frontand no preceding cloudiness until the front is near. The cold front in general is associated with a narrow band of cloudiness and precipitation. The cold front passes more rapidly. The sky becomes clear soon after the passage of the front. However, the weather produced along the cold front is more violent.

When the cold front moves over a rough terrain, the lower air is retarded by the effect of friction at the ground. This causes the air aloft to run ahead of the surface air and a bulge or squall head is formed. The lapse rate steepens and the convective overturning takes place resulting in heavy showers in the line ahead of the surface position of the front. In meteorology this is called the

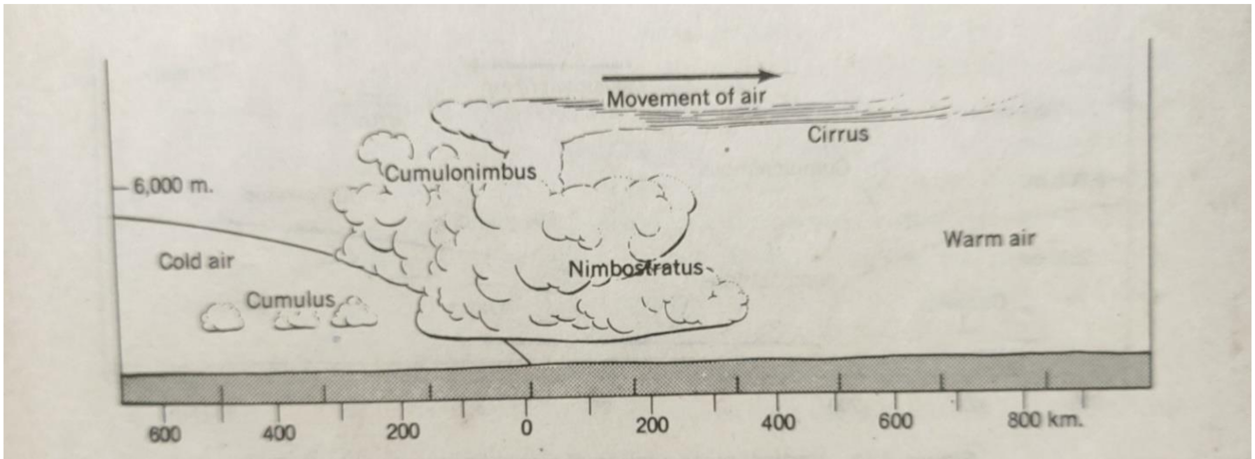

Figure 5.12 Vertical cross section of a cold front. (NOAA)

squall line. However, precipitation depends on the moisture and temperature conditions of the warm air lying above.

With the approach of cold front there is some increase of wind in the warm sector. *Cirrus* and *cirrostratus* clouds appear in the sky. These cloud types are quickly followed by lower and denser *altocumulus* and *altostratus* clouds. At the actual front, the clouds are of *nimbostratus* and *cumulonimbus* type which produce heavy showers. In certain cases precipitation falls ahead of the front, while on occasions it is behind the same. However, there are departures from this typical condition depending on the physical characteristics of both the air masses.

If the cold air moves over a warm water surface, the lower layers absorb heat and moisture which results in heavy rain or snowfall. Such a precipitation occurs in the cold air. This phenomenon is characteristic of late fall and early winter when there is considerable difference between the temperatures of air and water. On occasions, secondary cold fronts develop some distance behind the rapidly moving cold front.

With the passage of the cold front, the sky becomes rapidly clear and the weather improves. There is a sudden drop in temperature. A wind shift from south to west or northwest generally accompanies the frontal passage. There is a marked decrease in specific and relative humidity.

The weather after a cold front has passed is dominated by subsiding and relatively cold air mass. In winter, the passage of cold front is followed by a cold wave which further reduces the surface temperature.

Frontogenesis and Frontolysis:

It was **Tor Bergeron** who for the first time used the term '*frontogenesis'* for the creation of new fronts. Later on, the term was extended to include the process of regeneration of the old and decaying fronts. Thus, frontogenesis, a Latin derived word, means 'creation of altogether new fronts' or 'the regeneration of decaying fronts already in existence.' *Frontolysis*, on the contrary, means the destruction or dying of a front. It would not be out of place to mention that fronts do not come into existence all of a sudden, rather they appear only after the processes of frontogenesis have been in operation for quite some time. In the same way, the act of weakening or vanishing of the existing fronts is not accomplished suddenly. The processes of frontolysis must continue for time in order to destroy an existing front.

Frontogenesis is likely to occur when the wind blow in such a way that the isotherms become packed along the leading edge of the intruding air mass. Convergence of the wind toward a point or contraction toward a line augments the process of frontogenesis.

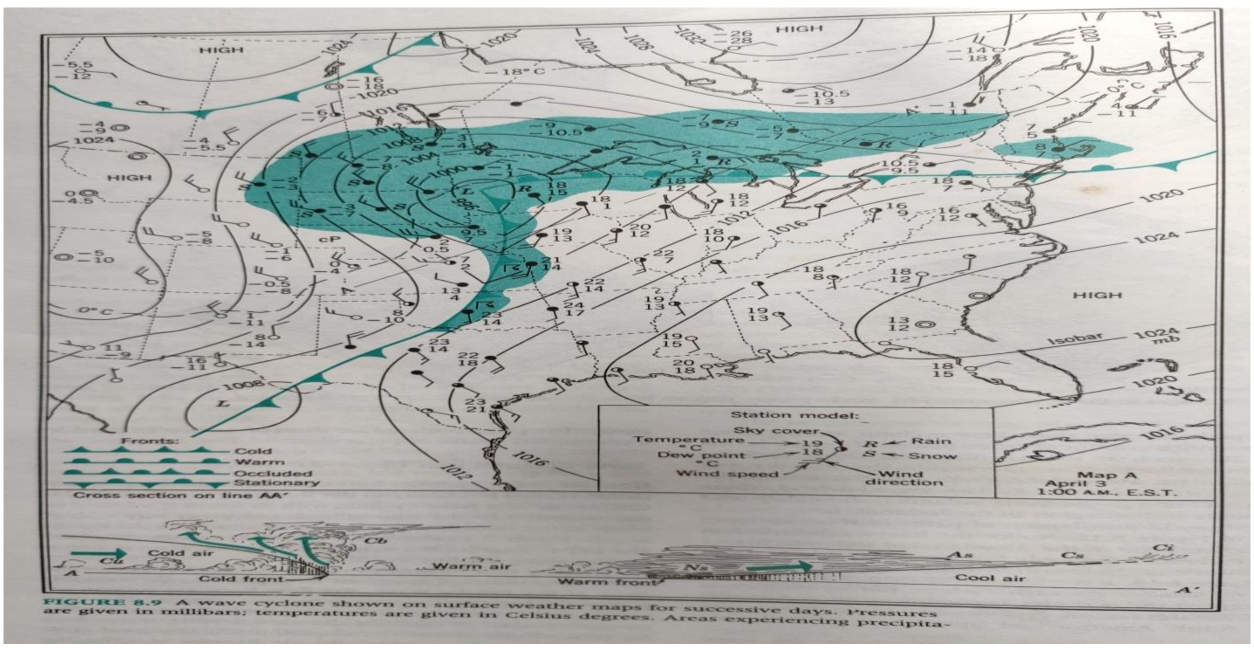

FIGURE 8.9 A wave cyclone shown on surface weather maps for successive days. Pressures are given in millibars; temperatures are given in Celsius degrees. Areas experiencing precipita-

On the contrary, divergence of the wind from a point, or dilation from a line is helpful to the process of frontolysis. Frontolysis, therefore, is likely to occur when fronts move into regions of divergent air flow. That is why on crossing the subtropical high-pressure regions, the fronts generally disappear.

To summarise, when contrasting air masses have convergent movement, the frontogenesis occurs. The temperature contrast in the converging air masses is another most important prerequisite for the process of frontogenesis to occur. The fronts come into existence only when the above two conditions are fulfilled simultaneously. In other words, the convergence of air masses with different temperatures and densities is conducive of frontogenesis. On the contrary, when the air masses move away from each other or when the temperature contrast between the adjacent air masses diminishes due to one reason or the other the fronts dissipate or start decaying. According to Byers, either of the above two conditions may lead to frontolysis.

The regions of cyclonic wind-shift or cyclonic wind shear witness the creation of new fronts. Most of the fronts are associated with troughs of low pressure. Contrarily, the areasof anticyclonic wind shear do not allow the formation of fronts. Even the pre-existing fronts degenerate in such areas.