around the globe, it often dips north-south as it follows the boundary between warm and cold air.

Air Masses

Air masses are macroscale phenomena, covering hundreds of thousands of square kilometers and extending upward for thousands of meters. They are relatively homogeneous volumes of air with regards to temperature and moisture, and they acquire the characteristics of the region over which they form and travel. The processes of radiation, convection, condensation, and evaporation condition the air in an air mass as it travels. Also, pollutants released into an air mass travel and disperse within the air mass. Air masses develop more commonly in some regions than in others. These areas of formation are known as source regions, and they determine the classification of the air mass. Air masses are classified as maritime or continental according to their origin over ocean or land, and as arctic, polar, or tropical depending principally on the latitude of origin. Table 3-1 summarizes air masses and their properties. Figure 3-11 shows typical trajectories of air masses into North America. The boundary between air masses with different characteristics is referred to as a **front**. A front is not a sharp wall but a zone of transition which is often several miles wide. Fronts are discussed later in this lesson.

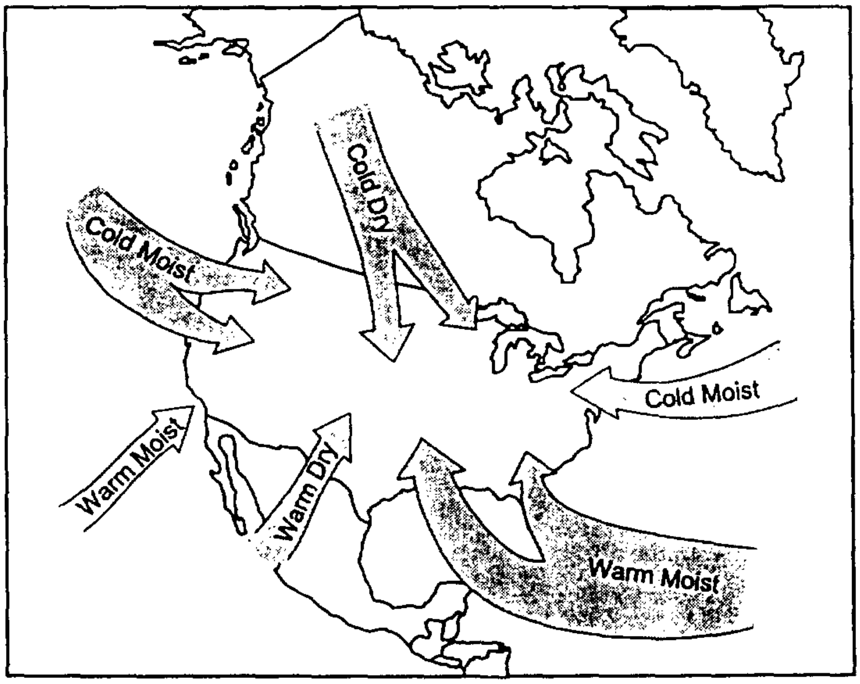

Figure 3-11. Trajectories of air masses into North America

Table 3-1. Classification of air masses

Name	Origin	Properties	Symbol
Arctic	Polar regions	Low temperatures, low specific but high summer relative humidity, the coldest of the winter air masses	A
Polar continental*	Subpolar continental areas	Low temperatures (increasing with southward movement), low humidity, remaining constant	cP
Polar maritime	Subpolar area and arctic region	Low temperatures, increasing with movement, higher humidity	mP
Tropical continental	Subtropical high-pressure land areas	High temperatures, low moisture content	cT
Tropical maritime	Southern borders of oceanic subtropical, high-pressure areas	Moderate high temperatures, high relative and specific humidity	mT

Note: The name of an air mass, such as Polar continental, can be reversed to continental Polar, but the symbol, cP, is the same for either name.

Temperature is a basic property of air masses. The temperature of an air mass depends on the region where it originates. Arctic air masses are the coldest and tropical air masses are the warmest.

Moisture is the second basic property in an air mass. Moisture plays such a significant role in weather and climate that it is commonly treated separately from the other constituents of air. In one or more of its forms, atmospheric moisture is a factor in humidity, cloudiness, precipitation, and visibility. Water vapor and clouds affect the transmission of radiation both to and from the earth's surface. Through the process of evaporation water vapor also conveys latent heat into the air, giving it a function in the heat exchange (as well as in the moisture exchange) between the earth and the atmosphere. Atmospheric water is gained by evaporation but lost by precipitation. Only a minute fraction of the earth's water is stored as clouds and vapor in the atmosphere at any one time. The net amount of water in the atmosphere at the end of any given period for a particular region is an algebraic summation of the amount stored from a previous period, the gain by evaporation, the gain or loss by horizontal transport, and the loss by precipitation. This relationship expresses the water balance of the atmosphere.

Fronts

Four frontal patterns—warm, cold, occluded, and stationary—can be formed by air of different temperatures. The cold front (Figure 3-12) is a transition zone between warm and cold air where the cold air is moving in over the area previously occupied by warm air. Cold fronts generally have slopes from 1:50 to 1:150, meaning that for every kilometer of vertical distance covered by the front, there will be 50 to 150 km of horizontal distance covered. The rise of warm air over an advancing cold front and the subsequent expansive cooling of this air lead to cloud cover and precipitation following the position of the surface front. (The surface front is the location where the advancing front touches the ground.)

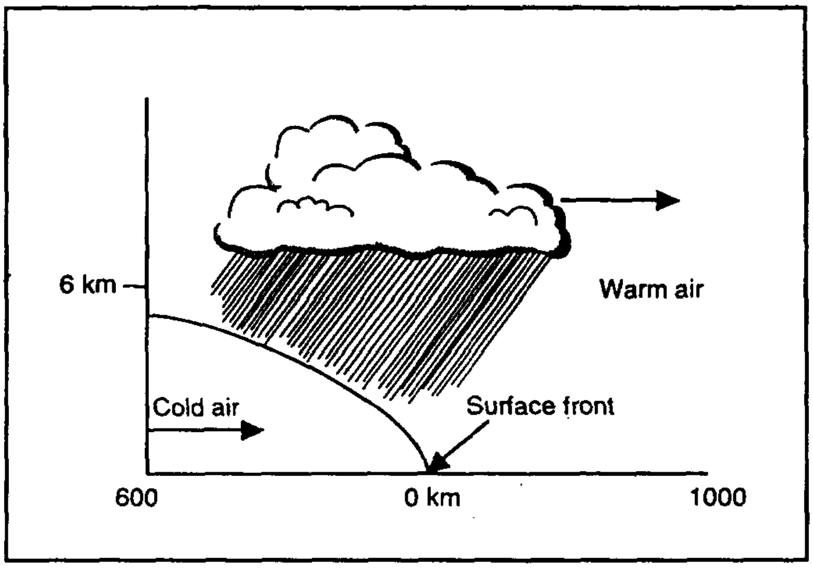

Figure 3-12. Advancing cold front

Warm fronts, on the other hand, separate advancing warm air from retreating cold air and have slopes on the order of 1:100 to 1:300 due to the effects of friction on the trailing edge of the front. Precipitation is commonly found in advance of a warm front, as can be seen in Figure 3-13.

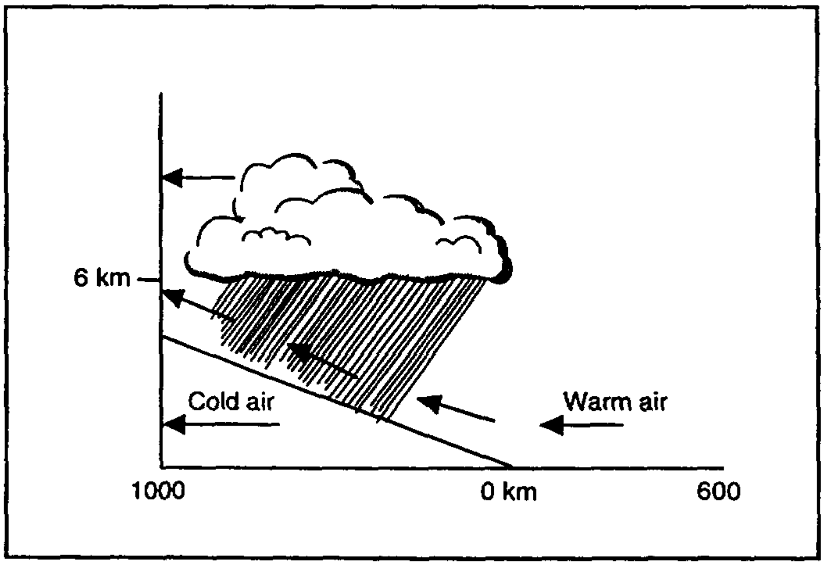

Figure 3-13. Advancing warm front

When cold and warm fronts merge (the cold front overtaking the warm front) **occluded** fronts form (Figure 3-14). Occluded fronts can be called cold front or warm front occlusions, as shown in Figure 3-15. But, in either case, a colder air mass takes over an air mass that is not as cold.

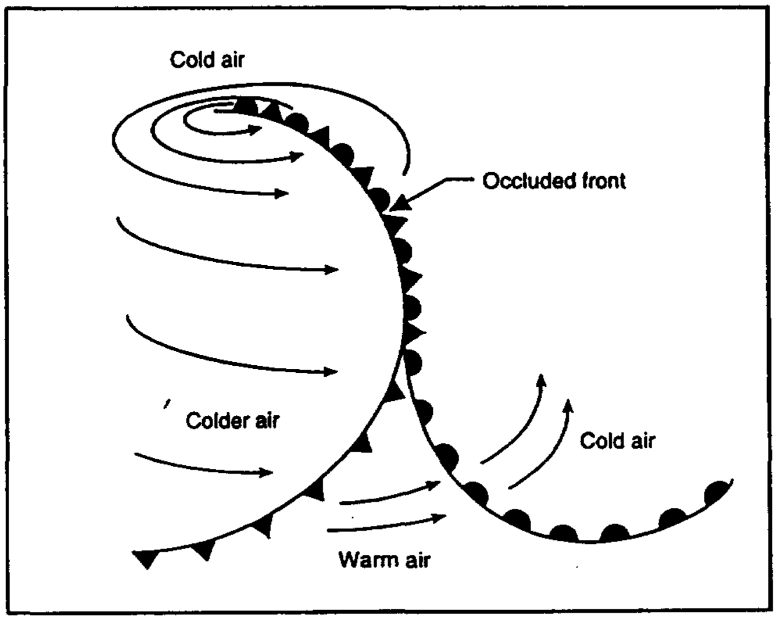

Figure 3-14. Occluded front

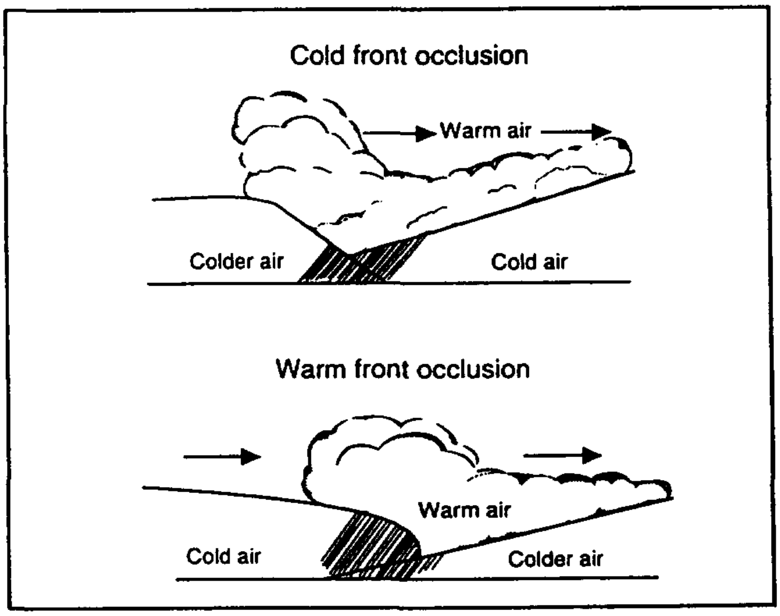

Figure 3-15. Cold and warm front occlusions

As either type of occluded front approaches, the clouds and precipitation resulting from the occluded front will be similar to those of a warm front (Figure 3-13). As the front passes, the clouds and precipitation will resemble those of a cold front (Figure 3-12). Therefore, it is often impossible to distinguish between the approach of a warm front and the approach of an occluded front. Regions with a predominance of occluded fronts have a great deal of low cloud cover, small amounts of precipitation, and small daily temperature changes.

The last type of front is the **stationary** front. As the name implies, the air masses around this front are not in motion. It will resemble the warm front in Figure 3-13 and will manifest similar weather conditions. Figure 3-16 shows how a stationary front is represented on a map. The abbreviations cP and mT stand for continental Polar and maritime Tropical air masses. A stationary front can cause bad weather conditions that persist for several days.

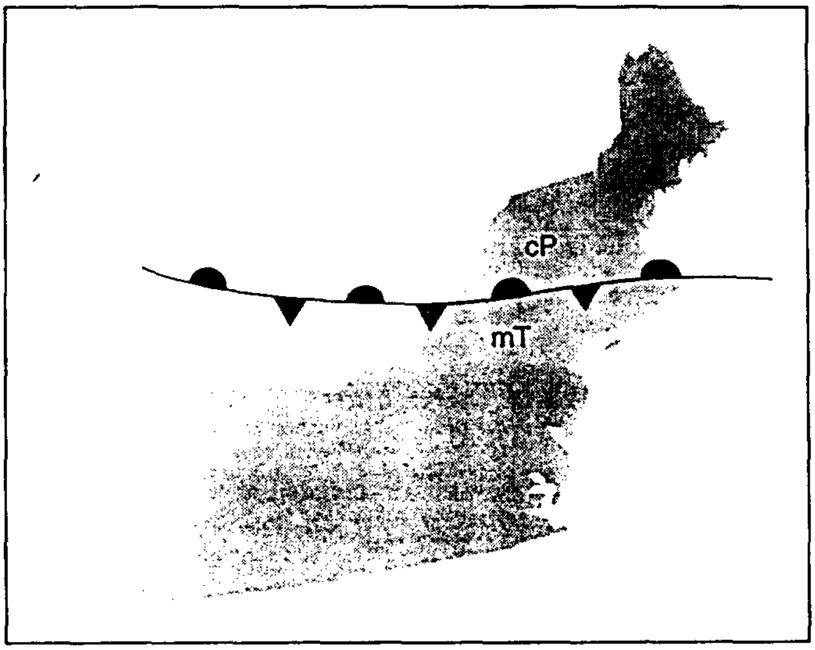

Figure 3-16. Stationary front

Migrating areas of high pressure (anticyclones) and low pressure (cyclones) and the fronts associated with the latter are responsible for the day-to-day changes in weather that occur over most of the mid-latitude regions of the earth. Mid-latitude low pressure systems form along frontal surfaces that separate air masses of different origin having different temperature and moisture characteristics. The formation of a low pressure system is accompanied by the formation of a wave on the front consisting of a warm front and a cold front, both moving around the low pressure system in a counterclockwise motion. This low pressure system is referred to as a cyclone. The life cycle of a typical cyclone is shown in Figure 3-17. As you recall, the triangles indicate cold fronts and the semicircles indicate warm fronts. The five stages depicted here are:

1. Beginning of cyclonic circulation
2. Warm sector well defined between fronts
3. Cold front overtaking warm front
4. Occlusion (merging of two fronts)
5. Dissipation

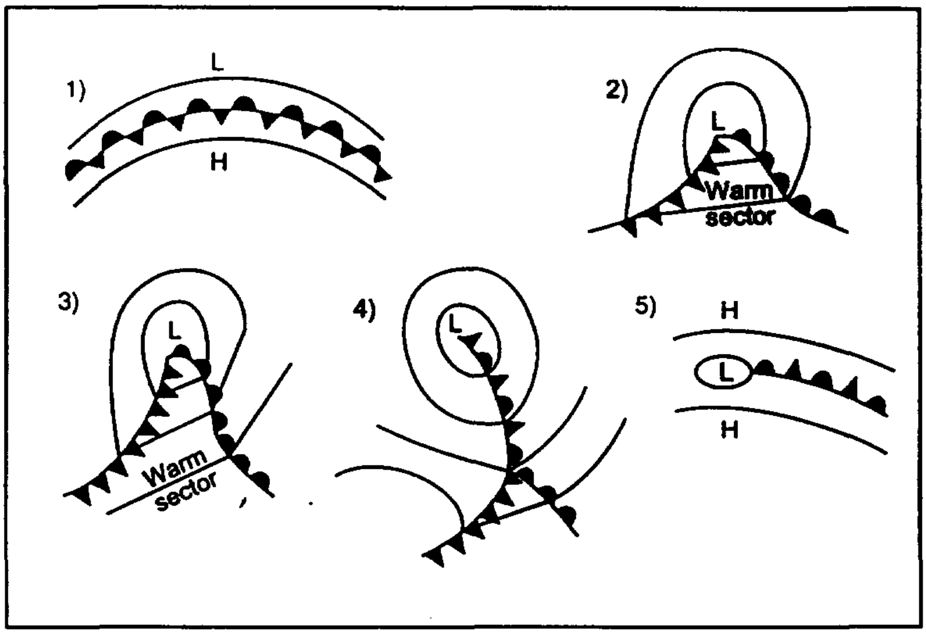

Figure 3-17. The life of a cyclone

Frontal Trapping

Frontal systems are accompanied by inversions. **Inversions** occur whenever warm air rises over cold air and "traps" the cold air beneath. Within these inversions there is relatively little air motion, and the air becomes relatively stagnant. This frontal trapping may occur with either warm fronts or cold fronts. Since a warm front is usually slower moving than a cold front, and since its frontal surface slopes more gradually, trapping will generally be more important with a warm front. In addition, the low level and surface wind speeds ahead of a warm front (within the trapped sector) will usually be lower than the wind speeds behind a cold front. Most warm frontal trapping will occur to the west through north from a given pollutant source, and cold frontal trapping will occur to the east through south of the source.

Topographical Influences

The physical characteristics of the earth's surface are referred to as **terrain features or topography**. Topographical features not only influence the way the earth and its surrounding air heat up, but they also affect the way air flows. Terrain features, as you would expect, predominantly affect air flow relatively close to the earth's surface. As shown in Figure 3-18, these features can be grouped into four categories: flat, mountain/valley, land/water, and urban.