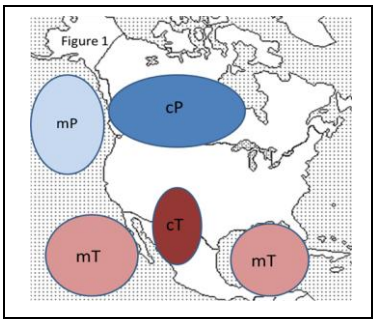
# Air Masses and Fronts Worksheet




Formation of Air Masses

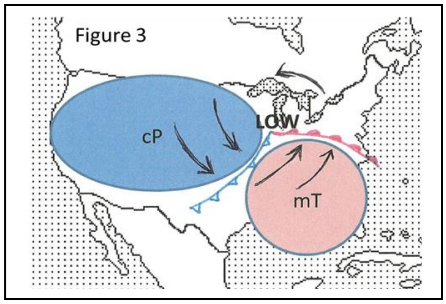
An air mass will form when air sits over an area for a long period of time. The air mass will take on the same characteristics as the surface beneath. Therefore an air mass sitting over tropical waters will become warm and moist. This type of air mass is called Maritime Tropical (mT). An air mass developing over a cold land area is called Continental Polar (cP) and is cold and dry. A Maritime Polar (mP) air mass becomes cold and moist because it forms over cold water and a Continental Tropical air mass is warm and dry, forming over warm land. Figure 1 shows where these air masses might develop. The actual temperature and moisture content of these air masses can always vary according to the season and the length of time spent over and area, but they always have these characteristics relative to other air masses.

**Match the air masses to their characteristic** (each letter is used twice)**:**

| Air Mass |
|---|
| A. Maritime Tropical (mT) |
| B. Continental Tropical (cT) |
| C. Continental Polar (cP) |
| D. Maritime Polar |

| Letter | Characteristic |
|---|---|
| | Dry and warm |
| | Moist and cold |
| | Moist and warm |
| | Dry and cold |
| | Forms over warm land |
| | Forms over warm water |
| | Forms over cold water |
| | Forms over cold land |

**The Cold Front:**




Differences in air pressure will cause air masses to move. When a cold air mass moves into an area of warmer air, the denser cold air will force the warmer air to rise at the frontal boundary. This situation is called a cold front as seen in Figure 2. In the cold front towering cumulus and cumulonimbus clouds will form. The density difference between the two air masses and the moisture in the warm air will determine how severe the weather in the front will be. Cold air is denser than warm air and dry air is denser than moist air. This means that cold dry air is denser than warm moist air. Because the density is different between the air masses, there is very little mixing of the air. Both air masses are moving in relatively the same direction. Usually, the warm air in advance of the front has southwest winds and the cold air moving in is blowing from the northwest. It is common to experience a change in direction from southwest to northwest after a cold front moves through. The cold air mass is moving faster and at a slightly different angle than then warm air. As the cold air moves, friction against the ground slows the air near the surface. This causes upper winds to tumble downward at the front boundary. The warm air is being lifted rapidly in advance of the front. This creates vertical shear winds which are dangerous for airplanes especially as they land or take off.

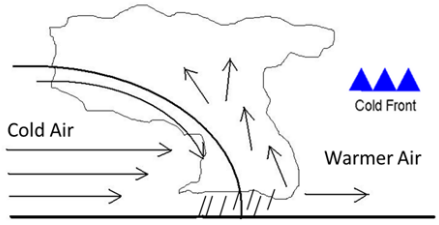



Figure 2 COLD FRONT

Vertical shear winds occur when there is a quick change in vertical direction. At a cold front air is rising in the warm air and sinking in the cold air. Airplanes cannot adjust for the

rapid change in air flow. Technology using Doppler radar is now able to detect this situation and make take-offs and landings much safer. The rapid rise in the warm air causes cloud formation. The moister the warm air, the more cloud development takes place. Weather along a cold front is generally stormy and sometimes severe. Tornadoes are associated with cold fronts. The United States has more tornadoes than any other country in the world. The U.S. has 4 times as many tornadoes than all of Europe. Most of these tornadoes form in the plains where there are no landforms that can disturb air flow. In the spring the Continental Polar air masses are extremely dry and cold. As these air masses are brought down into the U.S. they form cold fronts which drive into the warm moist air from the Gulf of Mexico. This creates cold fronts that are very severe and can produce damaging storms and tornadoes. During the winter, since the air is cooler in the Midwest, there is not as much moisture in the air and cold fronts are not as severe. In summary, cold fronts produce narrow bands of clouds along the front that can produce stormy to severe weather.

**What you learned about cold fronts:**

- What causes air masses movement?

_____

- What causes the warm air ahead of a cold front to rise?

_____

- What kind of clouds usually form in a cold front?

_____

- What wind direction change usually occurs as a cold front moves through an area?

_____

- Where do vertical shear winds form?

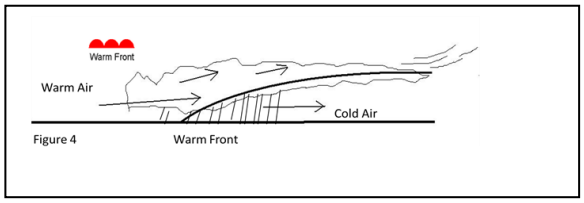
_____

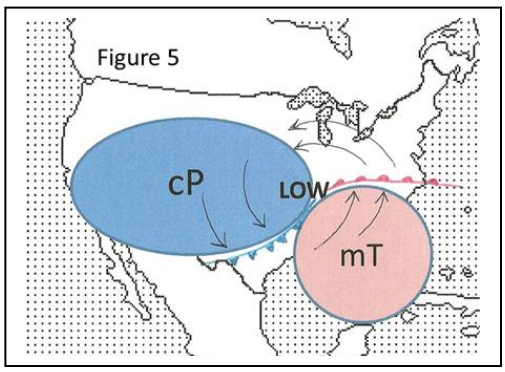
- What kind of weather is usually expected in a cold front?

_____

**The Warm Front:**

When a warm air mass moves into an area of cooler air, a warm front will form as shown in Figure 4. The warm air is less dense than the cooler air and cannot push the cooler out of the way. As a result, the angle of the frontal boundary is not as severe as a cold front and the warm air climbs slowly over the cooler air.




This produces layered clouds like stratus and nimbostratus clouds. Far in advance of the front cirrostratus and cirrus clouds form. Warm fronts form clouds that cover a large area and create rain or snow events that could last for days. When we are experiencing warm front produced weather the warm air is aloft and we are in the cooler air. The moist warm air from the Gulf provides the moisture for the clouds and precipitation. Here in Indiana heavy snow and ice storms are produced by warm fronts. The weather produced wraps around to the northern

section of the low pressure system as seen in Figure 5. Our heaviest snow and most severe ice storms occur when the winds are out of the east and northeast as moist air from the Gulf is lifted and pulled around the Low. In the winter warm fronts can produce blizzard conditions and in the spring they can produce prolonged rain events that can cause flooding. In summary, warm fronts produce overcast skies and steady precipitation that may last for long periods.

**What you learned about warm fronts:**

- What cloud types are typically associated with a warm front?

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- Which air mass provides the moisture that produces the clouds and precipitation?

_____

- What severe events could warm fronts produce?

_____

- What kind of weather is usually expected in a warm front?

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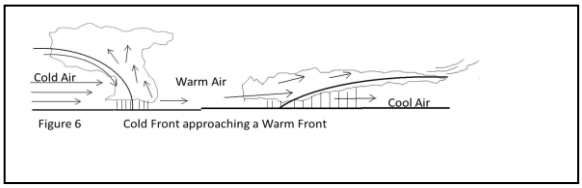


Figure 6 Cold Front approaching a Warm Front

**Other types of fronts:**
There are only two types of fronts, cold fronts and warm fronts. Occluded and stationary fronts are variations of cold and warm fronts. Cold fronts usually advance faster than warm fronts, so it is possible for a cold front to catch up to a warm front. In Figure 6 a cold front is advancing toward a warm front. When the cold front overtakes the warm front, the warm air is lifted between the two cooler air masses. There are several different types of occluded fronts depending on the density of the two cooler air masses. In Figure 7 the approaching cold air is denser than the warm air and the cooler air so the coldest air mass will lift the cooler air as well. Occluded fronts form near the center of low pressure systems as seen in Figure 8. The weather in an occluded front depends on your location within the front. As the front passes you would expect stratus and nimbostratus clouds followed by towering cumulus and cumulonimbus clouds. The last type of front is also a variation of a cold front or a warm front. A stationary front is simply a cold or warm front that comes to a standstill. The warmer air involved continues to rise over the cooler air, but the position of the front on the ground moves very little. In a stationary front, normally the cold air flattens out and the resulting front resembles a warm front with stratus and nimbostratus clouds. As seen in Figure 8, stationary fronts form away from the influence of the primary Low and are influenced by other factors in the atmosphere.

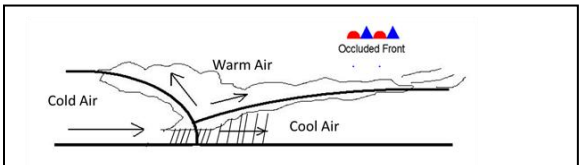
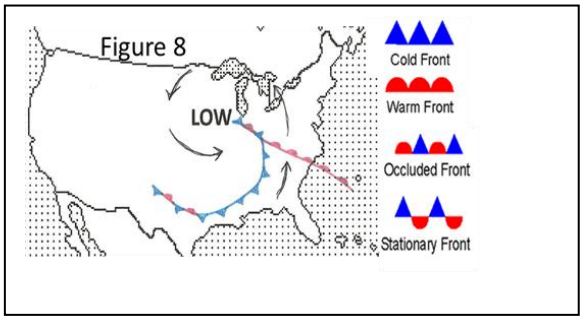


Figure 7 Occluded Front




**What you learned about other fronts:**

- How does an occluded front form?

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- Within the Low, where do occluded fronts form?

_____

- How do stationary fronts form?

_____

- Within the Low, where do stationary fronts form?

_____