

AIR MASSES & FRONTS

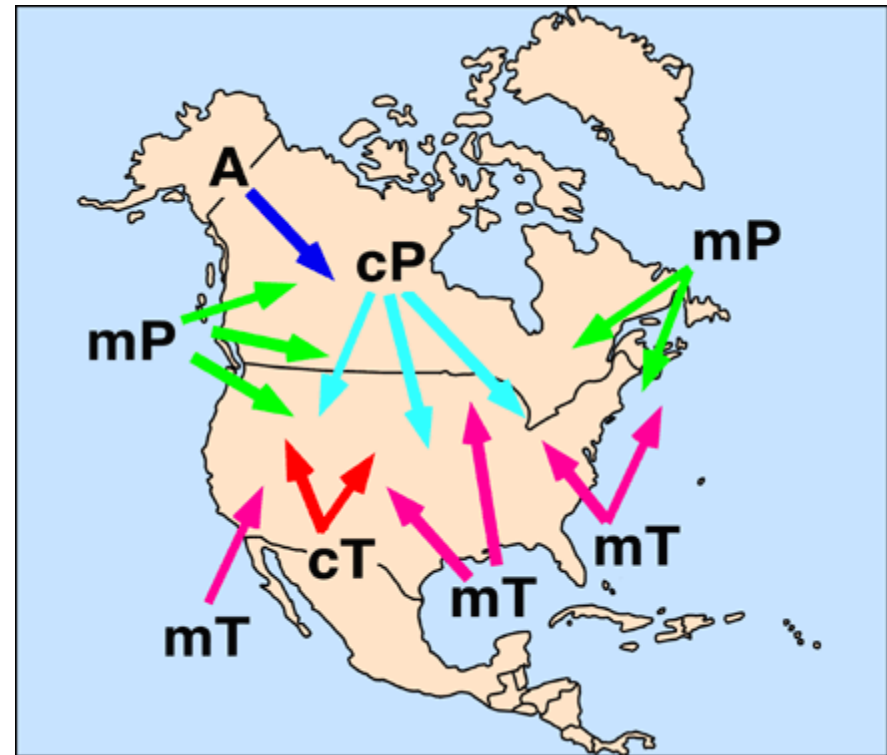
AIR MASSES

Air Masses

- An air mass is defined as a large body of air with very similar characteristics.
- Generally speaking, air masses are generally defined by temperature and dewpoints (moisture parameters.)
- Air masses are named based on the source region of the air mass itself

Types of Air Masses

- Continental Polar, “cold and dry”
 - Originates closer to the Poles over land-locked regions.
- Continental Tropical, “warm and dry”
 - Originates closer to the Tropics over land-locked regions.
- Maritime Polar, “cold and damp”
 - Originates closer to the Poles over water.
- Maritime Tropical, “warm and humid”
 - Originates closer to the Tropics over water.
- Arctic, “very cold”
 - Originates in the very cold land-locked areas



Analyzing Air Masses

- An air mass is most easily identified by comparing it to other air masses.
- Air masses can be modified with time, most notably by days of sunshine or lack thereof.
- Fronts are the dividing line between air masses so understanding air masses, means understanding where fronts are located.

FRONTS

Fronts

4 different types:

1. Cold front
2. Warm front
3. Stationary
4. Occluded



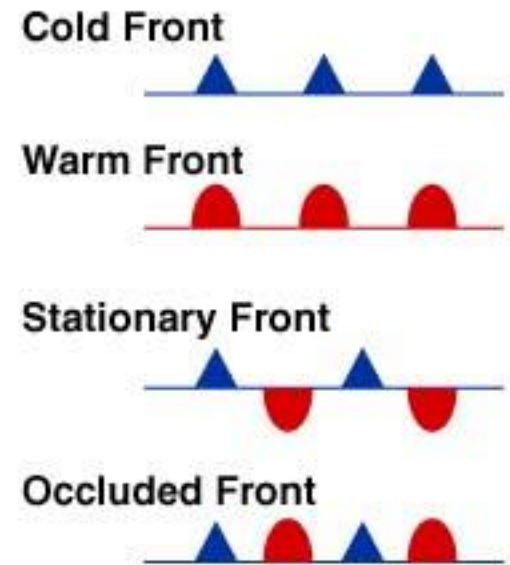
Fronts are the boundaries between two air masses.

Fronts are the basic building blocks of weather systems.

Fronts occur where two large air masses collide at the earth's surface.

Each air mass has a different temperature associated with it.

Fronts are caused by winds moving one air mass away from its birthplace.



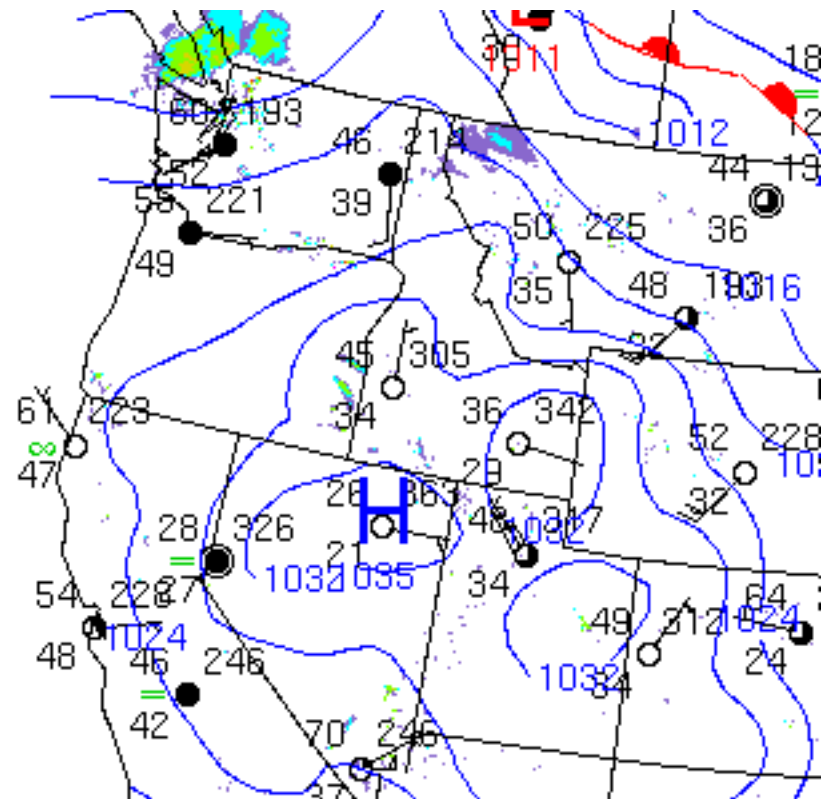
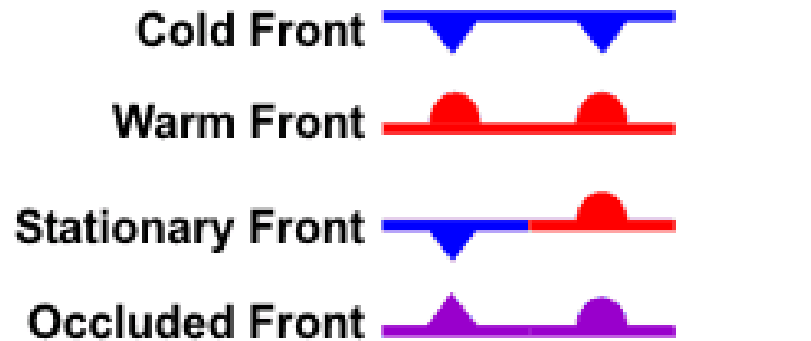
Air Masses and Fronts

Fronts are classified as to which type of air mass (cold or warm) is replacing the other.

A **cold front** separates the leading edge of a cold air mass displacing a warmer air mass.

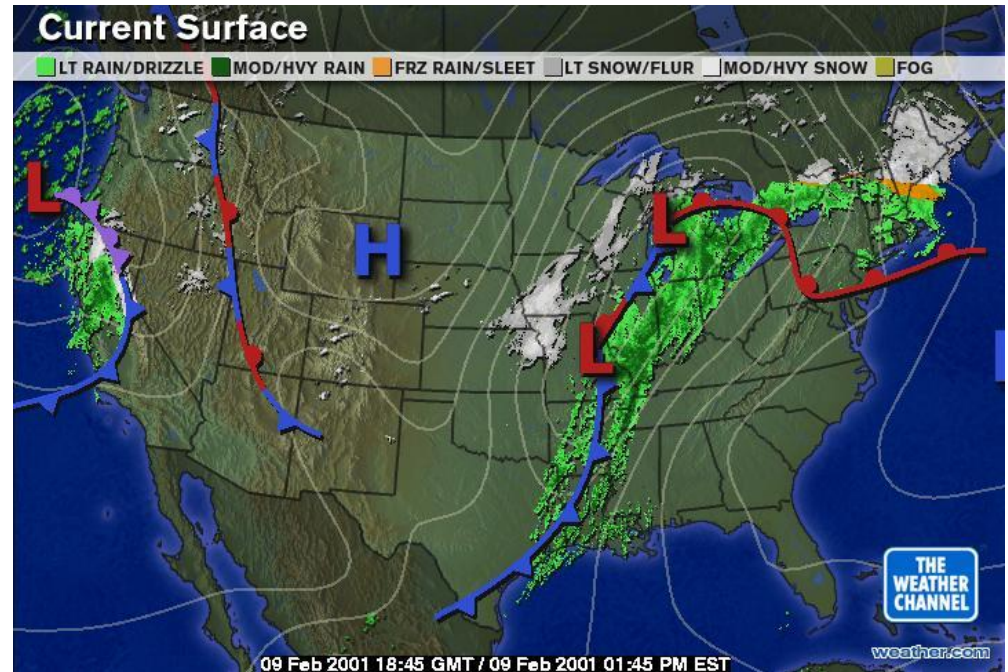
A **warm front** is the leading edge of a warmer air mass replacing a colder air mass.

If the front is essentially not moving (i.e. the air masses are not moving) it is called a **stationary front**.



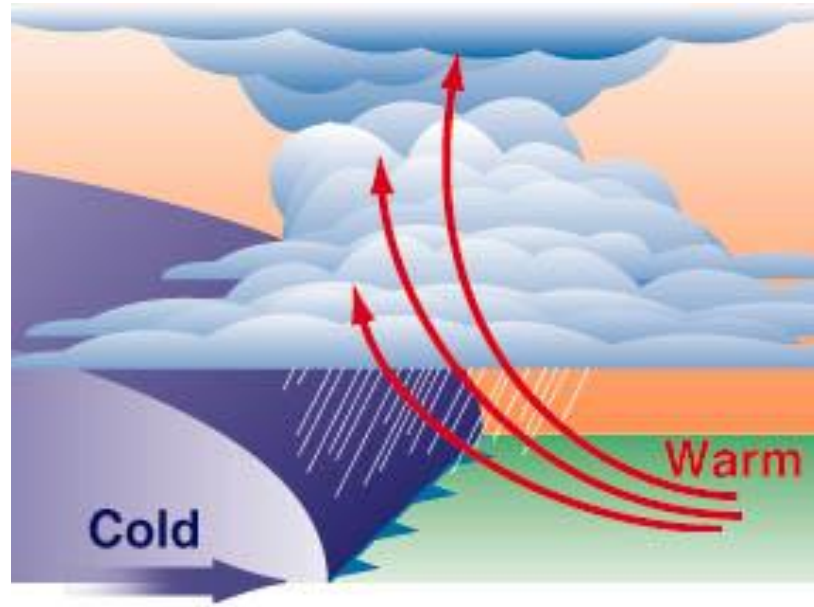
Types of Fronts

- Cold
 - Noted by cold air advancing and displacing warmer air that exists.
- Warm
 - Noted by cold air retreating from an area.
- Stationary
 - While differing air masses exist along a boundary, little movement is analyzed of the air masses.
- Occluded
 - A complicated process where the surface low becomes completely surrounded by cooler/cold air. Occlusion processes can be a “cool type” or “cold type” (more later.)



Fronts

1. Cold front



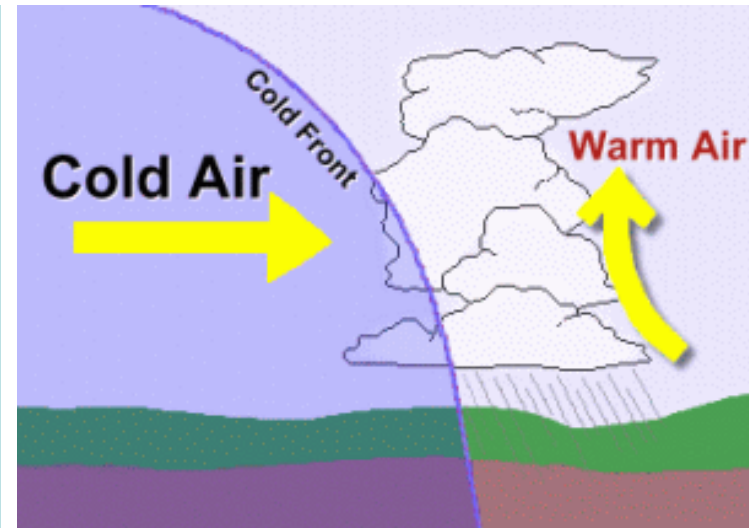
Cold fronts occur when heavy cold air displaces lighter warm air, pushing it upward.

Cumulus clouds form and usually grow into snow storms.

Temperatures drop anywhere from 5° to 15°.

Winds become gusty and erratic.

Rain, snow, sleet, and hail can occur with a cold front.

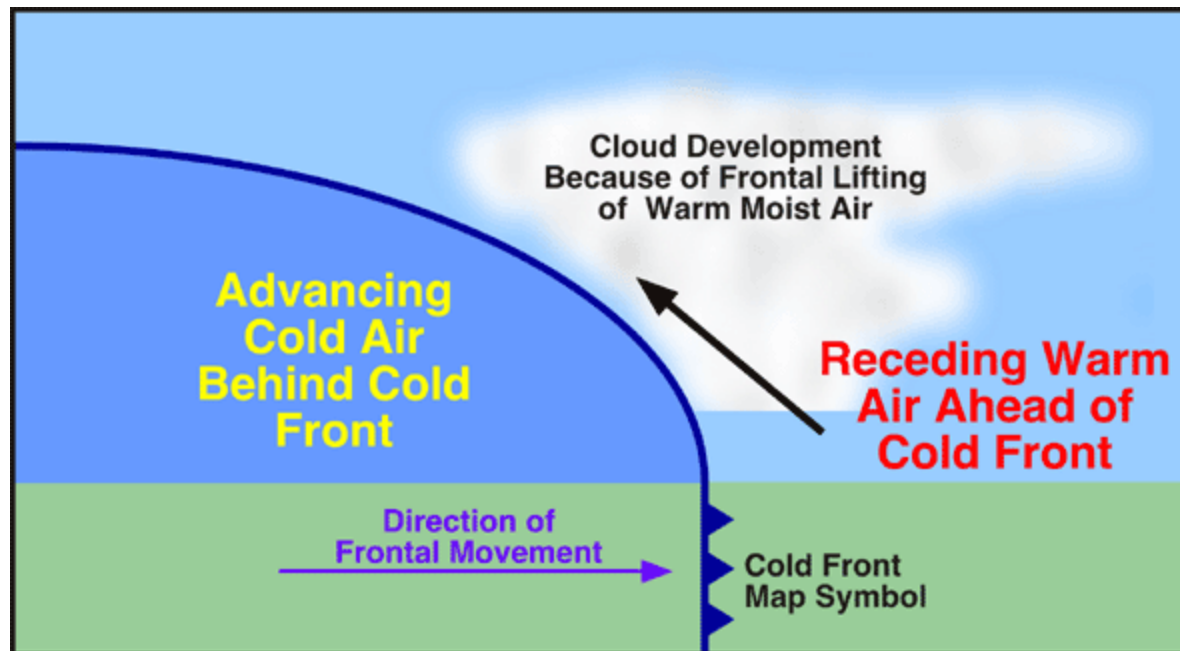


Cold Front



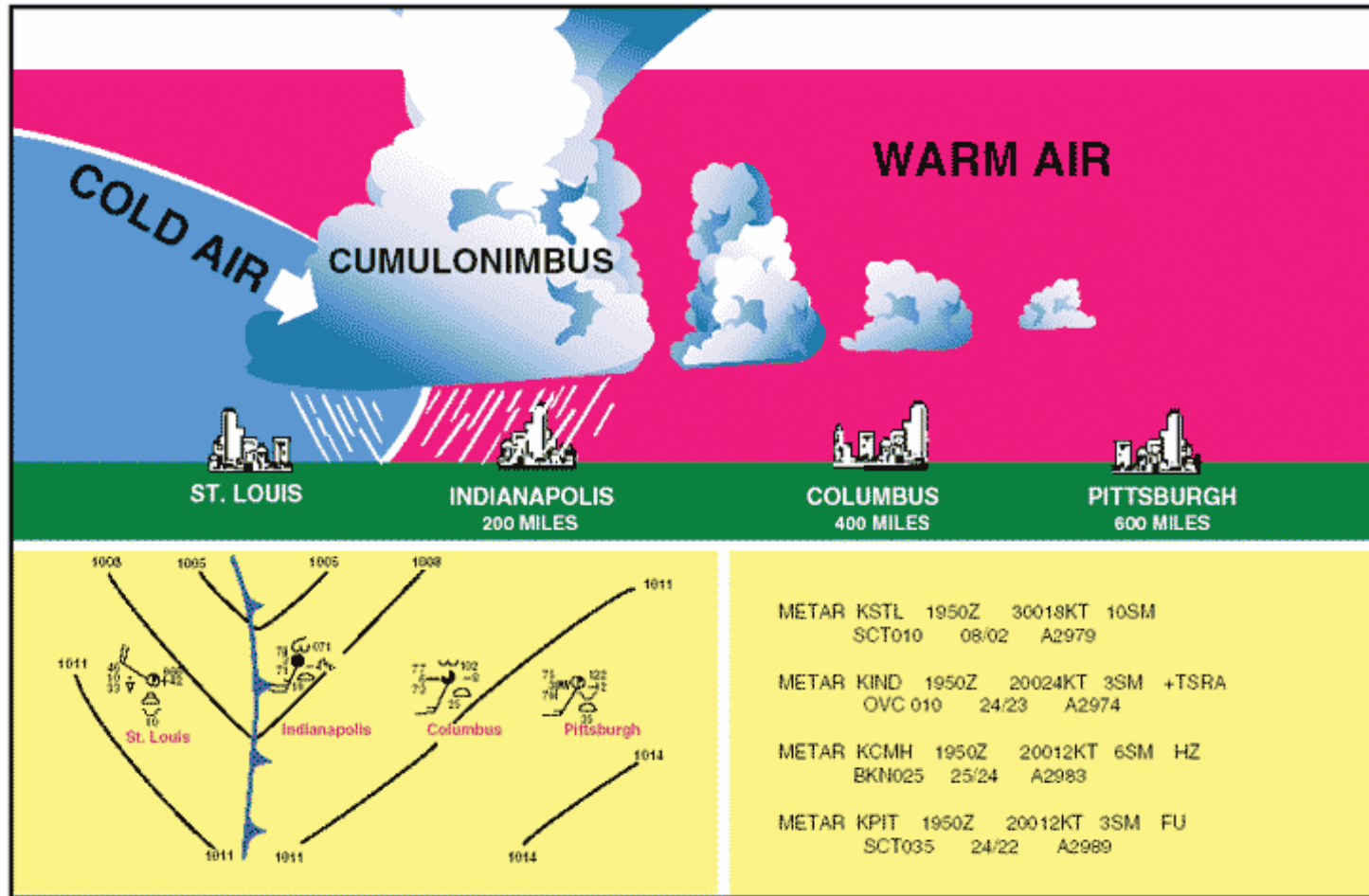
- Marked on a map with a blue line and blue triangles pointing towards the warm air.
- Associated with cumulus & cumulonimbus clouds ahead of the front in the warm air, producing showers and thunderstorms.

Cold Front

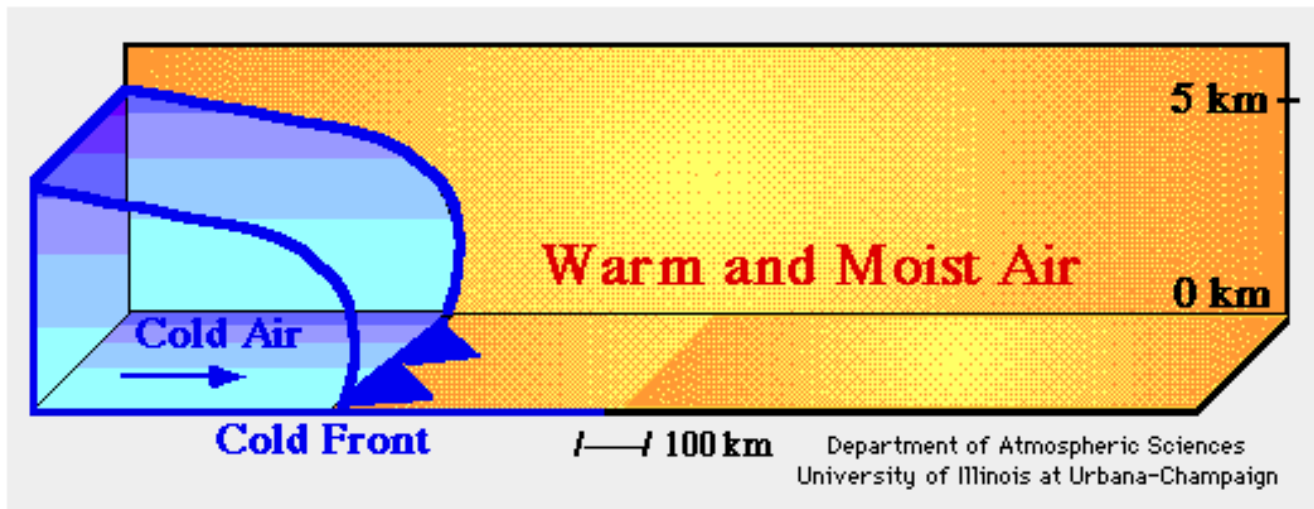


<http://www.physicalgeography.net/fundamentals/7r.html>

Cold Front

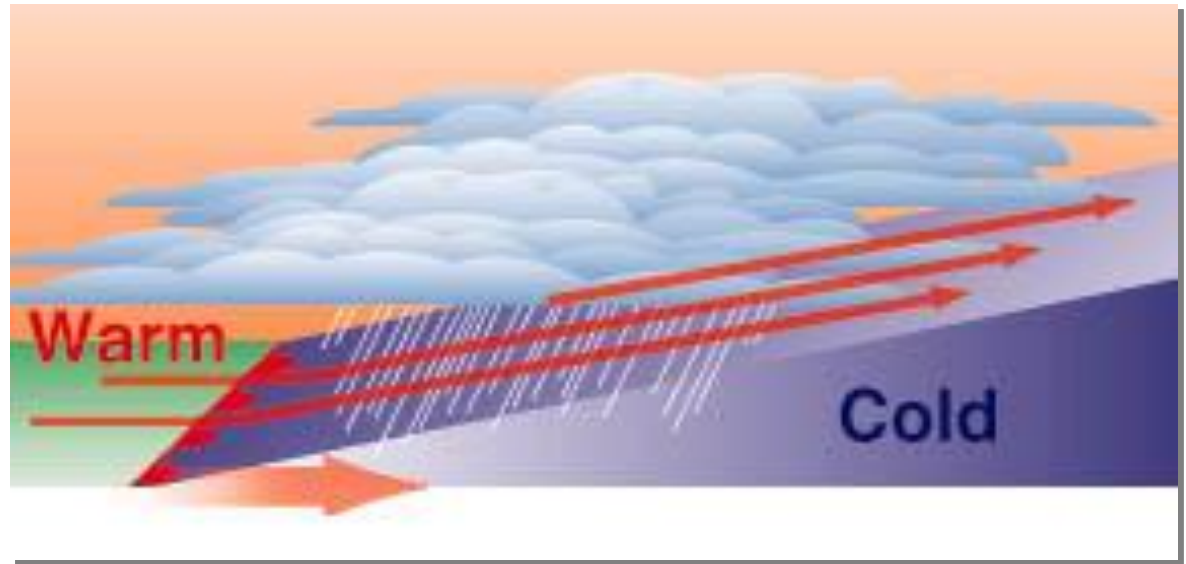


Cold Front



Fronts

2. Warm front

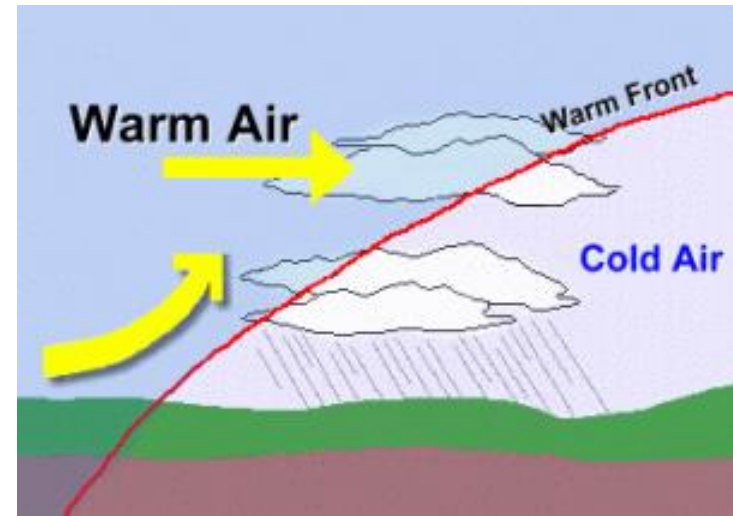


Warm fronts occur when warm air replaces cold air by sliding over it.

Altostratus clouds form and may be associated with rain, snow, or sleet.

Temperatures may warm slightly.

Winds are usually gentle with this kind of front.

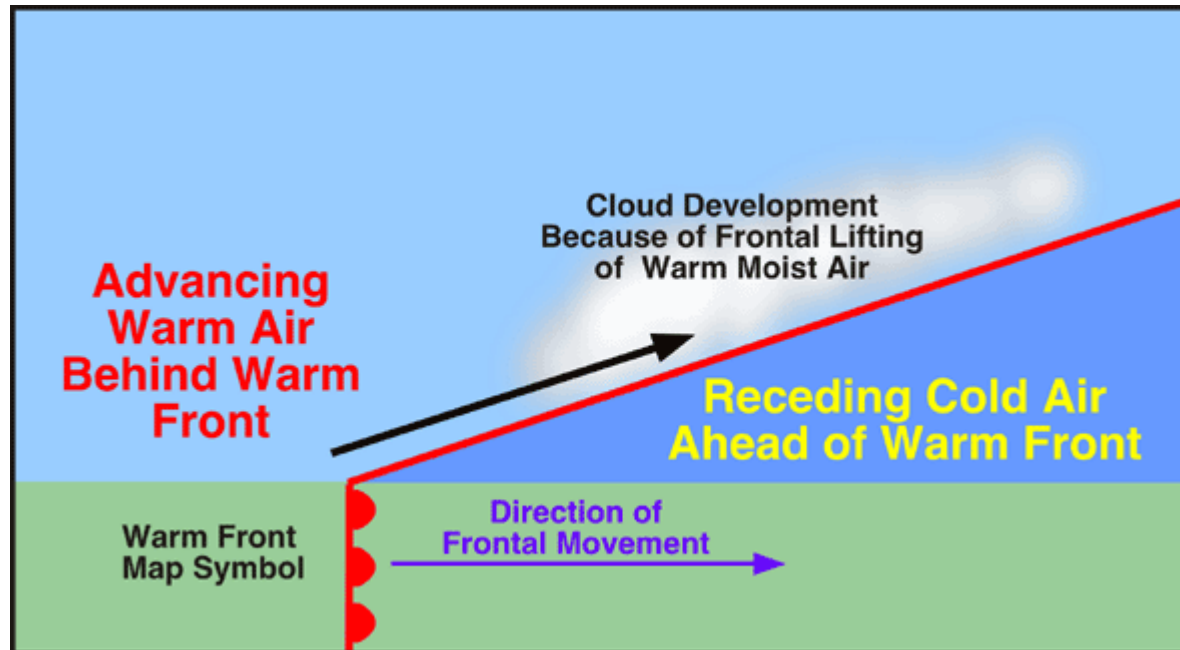


Warm Front

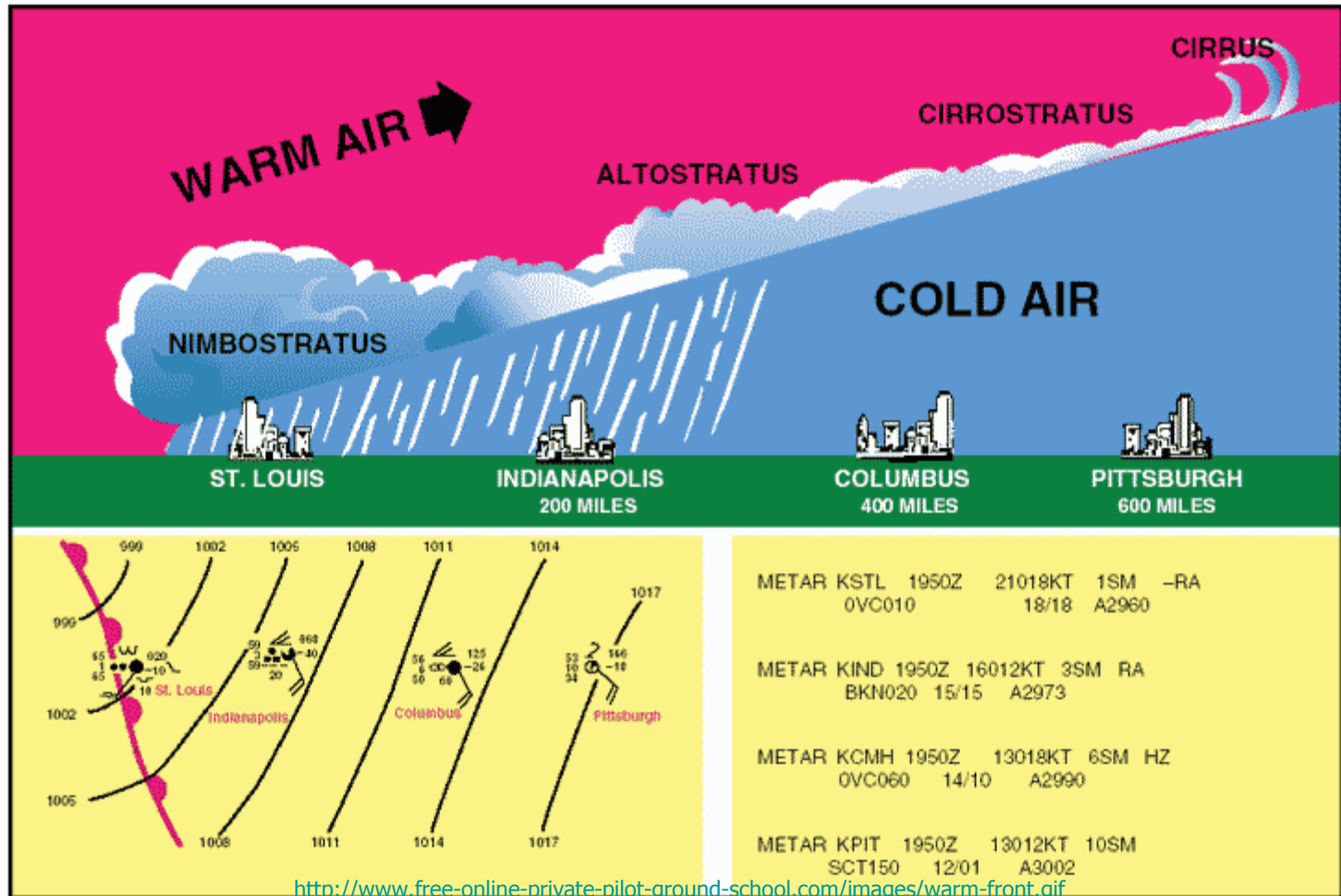


- Marked on a map by a red line with red semi-circles pointed towards the cool air (in the direction the warm air is retreating to.)
- Generally associated with stratus type clouds, overcast skies, fog, and general rain or snow.

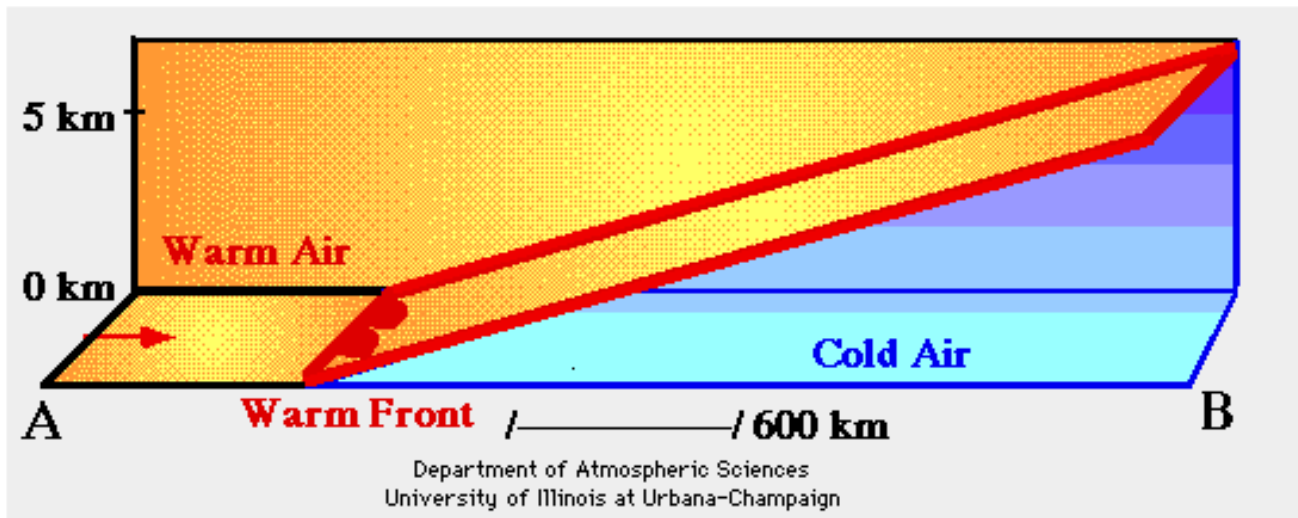
Warm Front



Warm Front

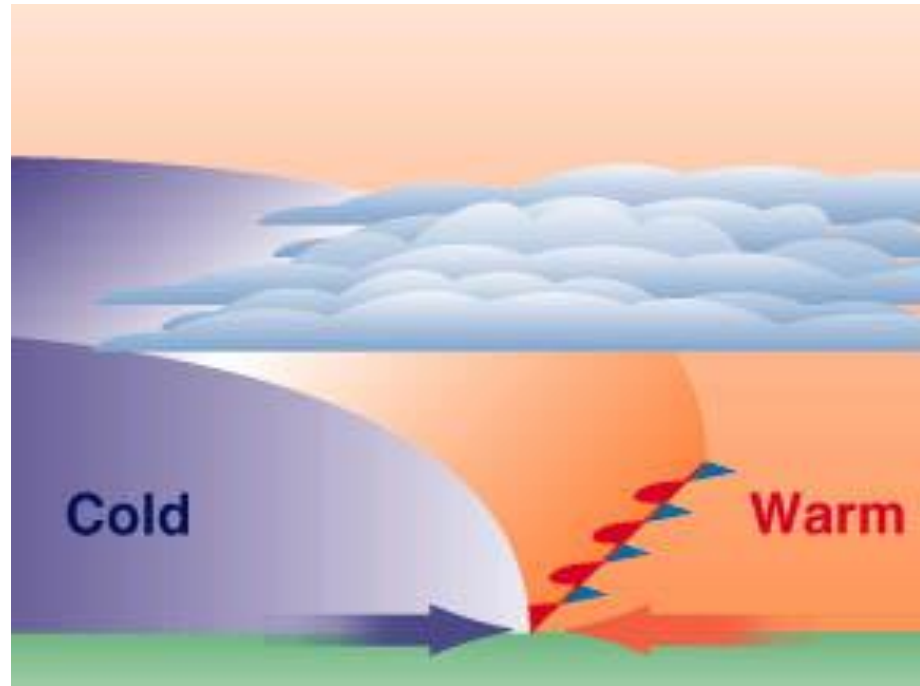


Warm Front



Fronts

3. Stationary



Stationary fronts occur when neither warm nor cold air advances.

The two air masses reach a stalemate.

These type of conditions can last for days, producing nothing but Altocumulus clouds.

Temperatures remain stagnant and winds are gentle to nil.

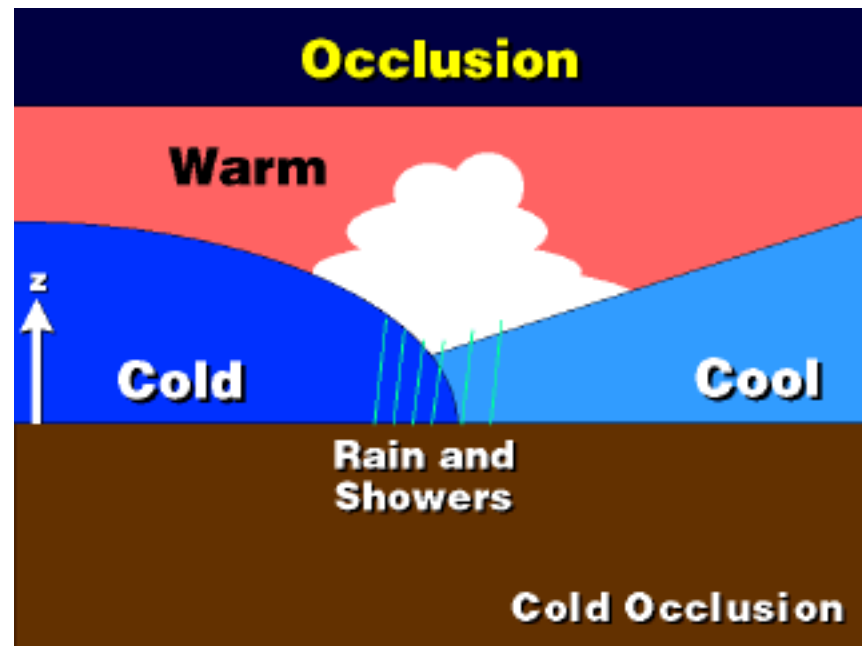
Stationary Front



- Marked by alternating blue lines & blue triangles (pointed in the direction of the warmer air) and red lines & red semi-circles (pointed in the direction of the cooler air)
- Usually noted as **quasi**-stationary as it is rarely ever completely stationary. It tends to meander a bit.

Fronts

4. Occluded



Cold occlusion: When a cold air mass follows a warm air mass, the cold air mass, which moves faster, eventually catches up the warm front.

This then lifts the warm air (behind the warm front) off the ground, creating an occluded front, where the two fronts are joined.

Usually associated with rain or snow and cumulus clouds.

Temperature fluctuations are small and winds are gentle.

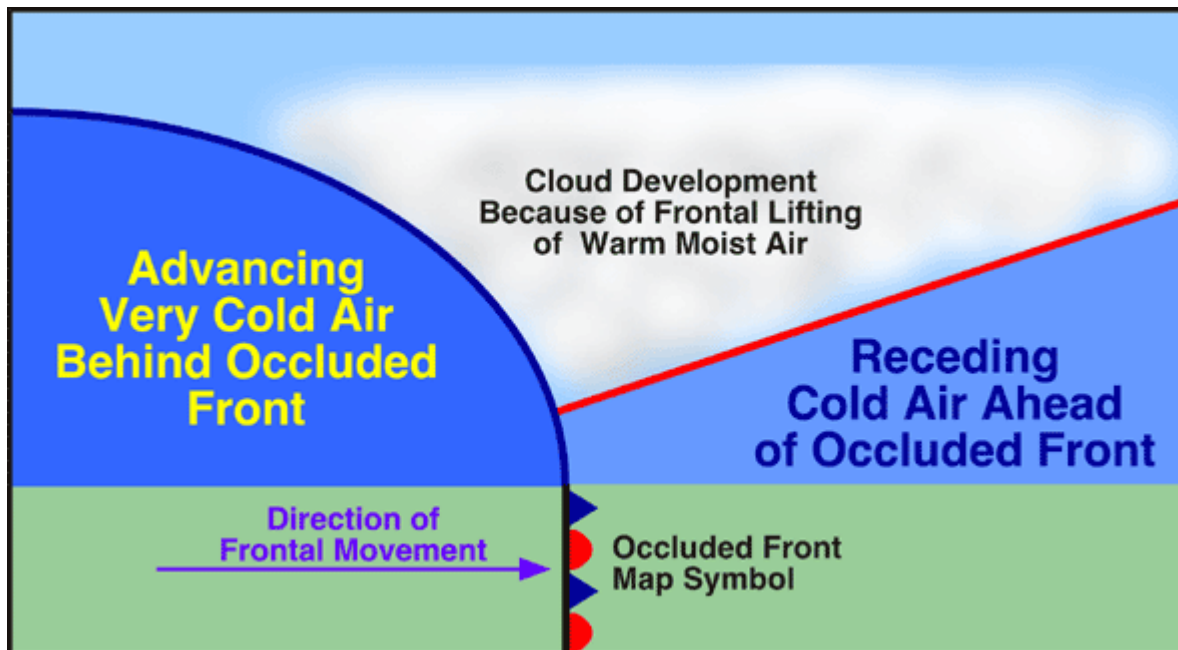
May indicate the end of a storm cycle

Occluded Front

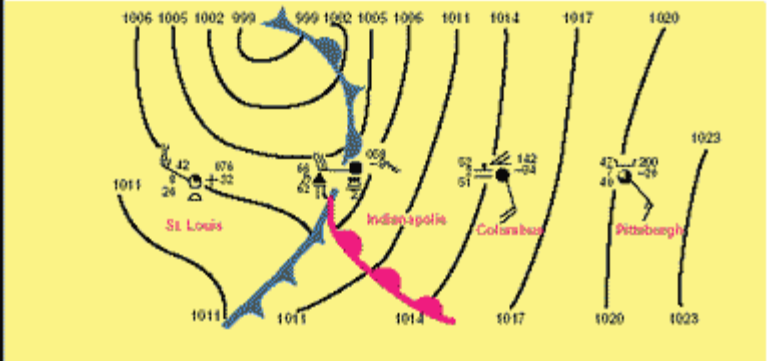
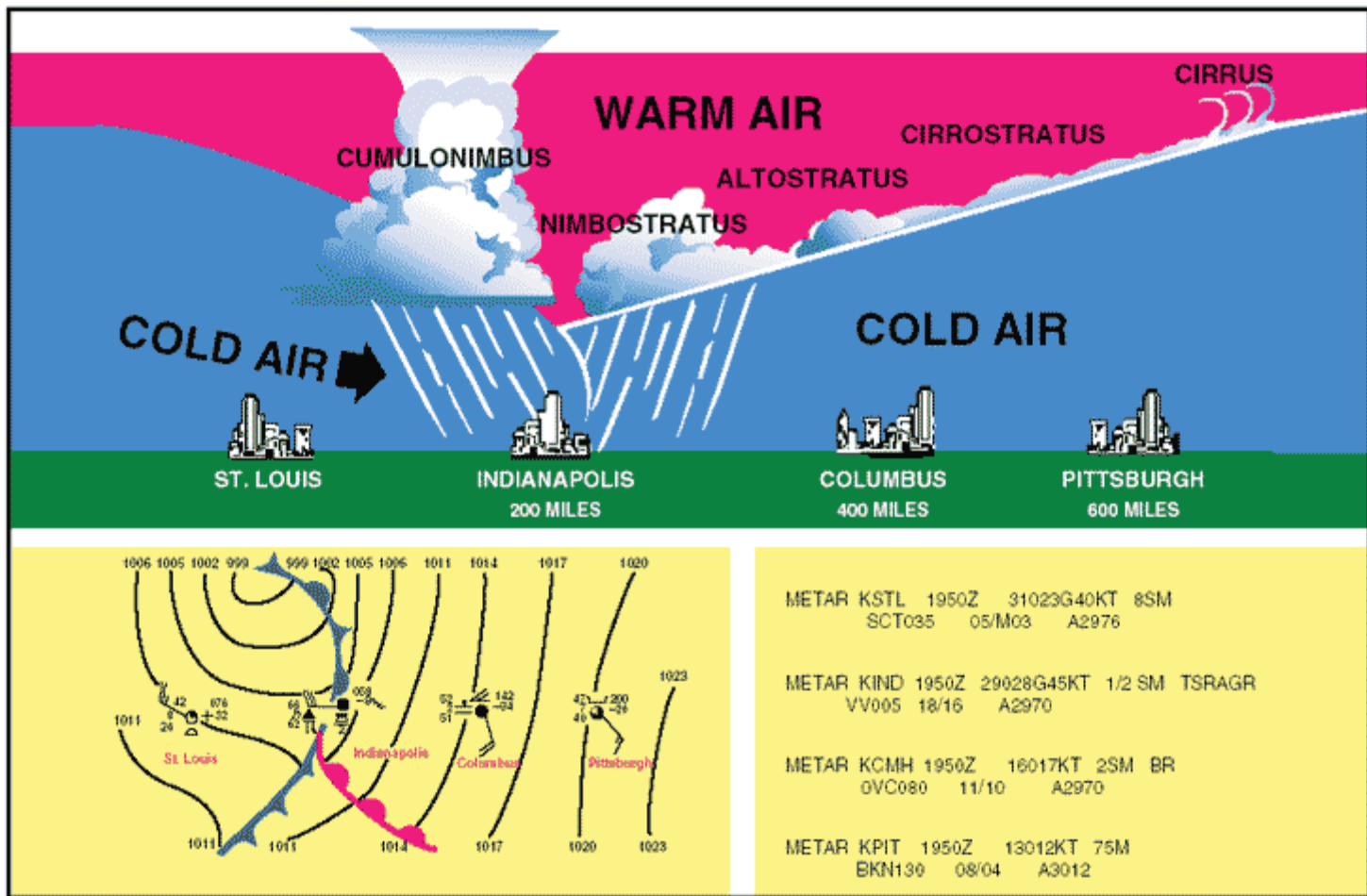


- Marked by a purple line with alternating purple triangles and purple semi-circles, all pointing in the direction of the frontal movement.
- There are two general types of occlusions, cool-type and cold-type. Examples to follow.

Occluded Front



Occluded Front



METAR KSTL 1950Z 31023G40KT 8SM
SCT035 05/M03 A2976

METAR KIND 1950Z 29028G45KT 1/2 SM TSRAGR
VV005 18/16 A2970

METAR KCMH 1950Z 16017KT 2SM BR
OVC080 11/10 A2970

METAR KPIT 1950Z 13012KT 75M
BKN130 08/04 A3012

CYCLONES

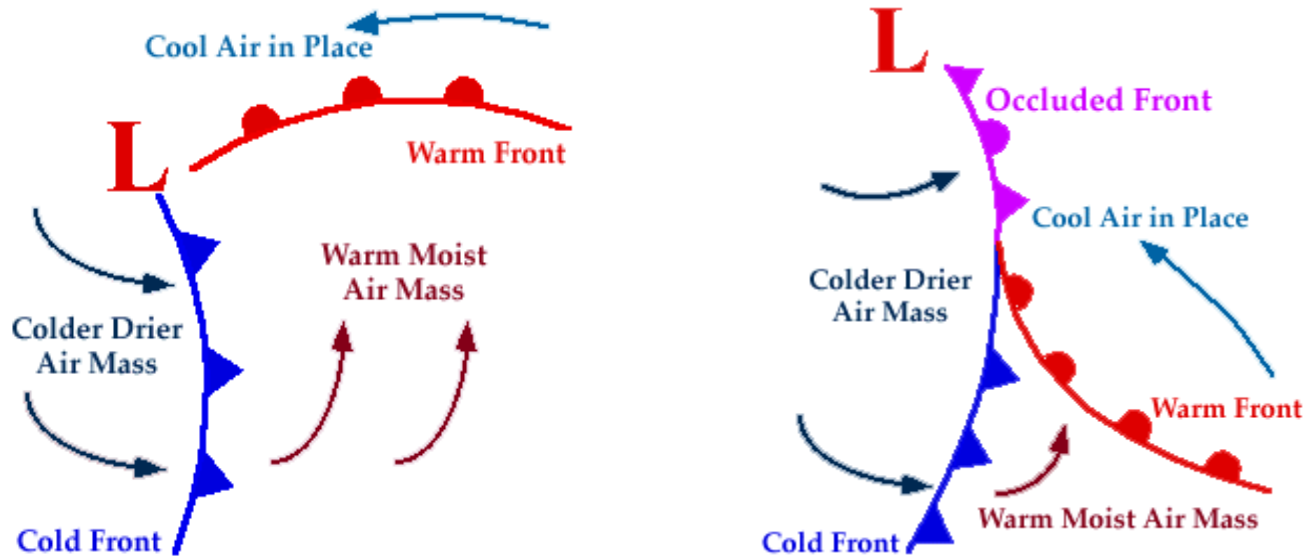
Cyclones: Putting it all together

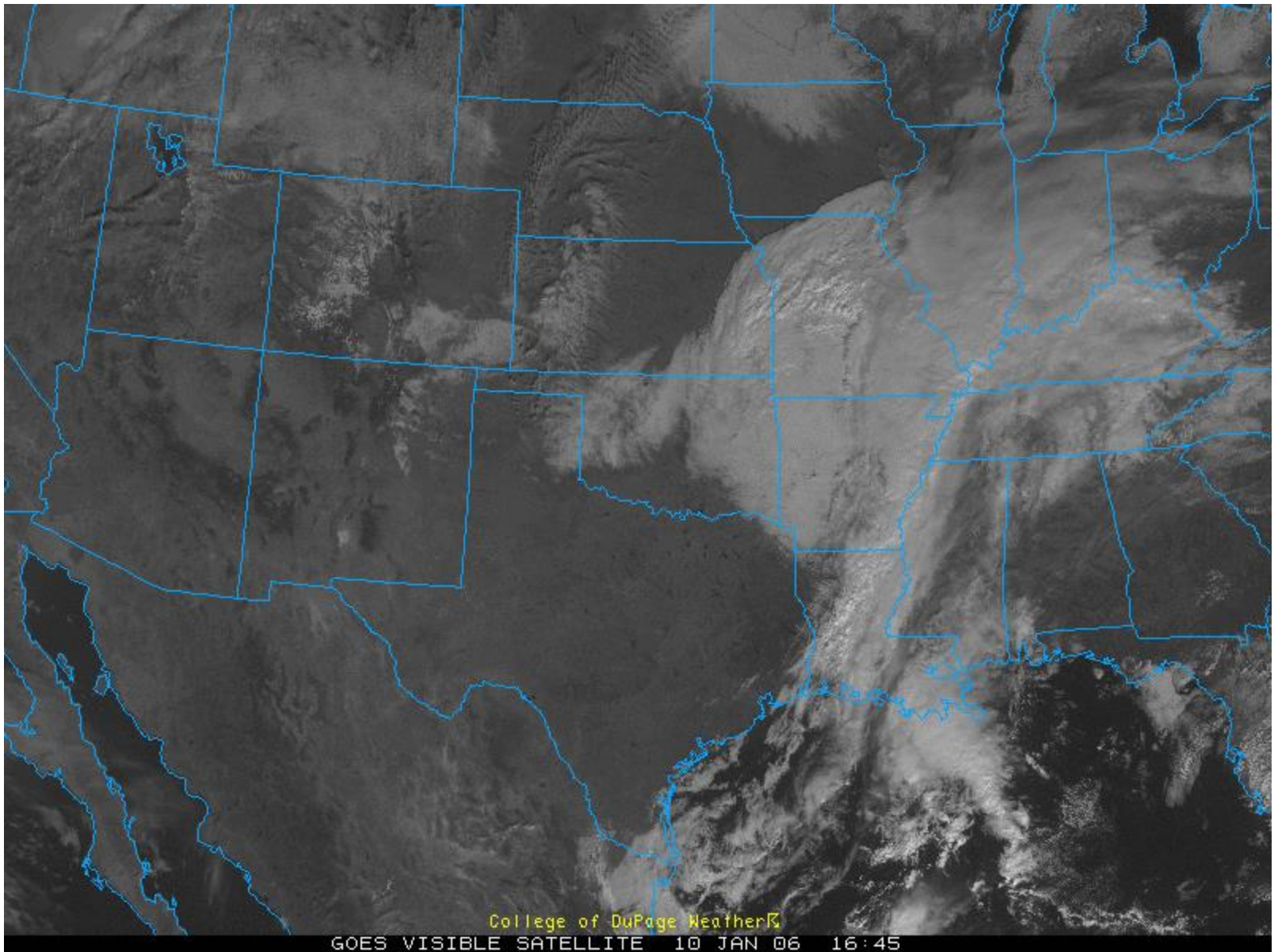
- There are two types of cyclones, tropical/warm core and extratropical/cold core.
- Extratropical cyclones are characterized by having differing air masses frontal movements where tropical cyclones do not.
- We will concern ourselves with extratropical cyclones in this presentation.

Cyclones: Putting it all together

- Students must begin to understand the four dimensional view of a cyclone
 - North-South
 - East-West
 - Up-Down
 - Time

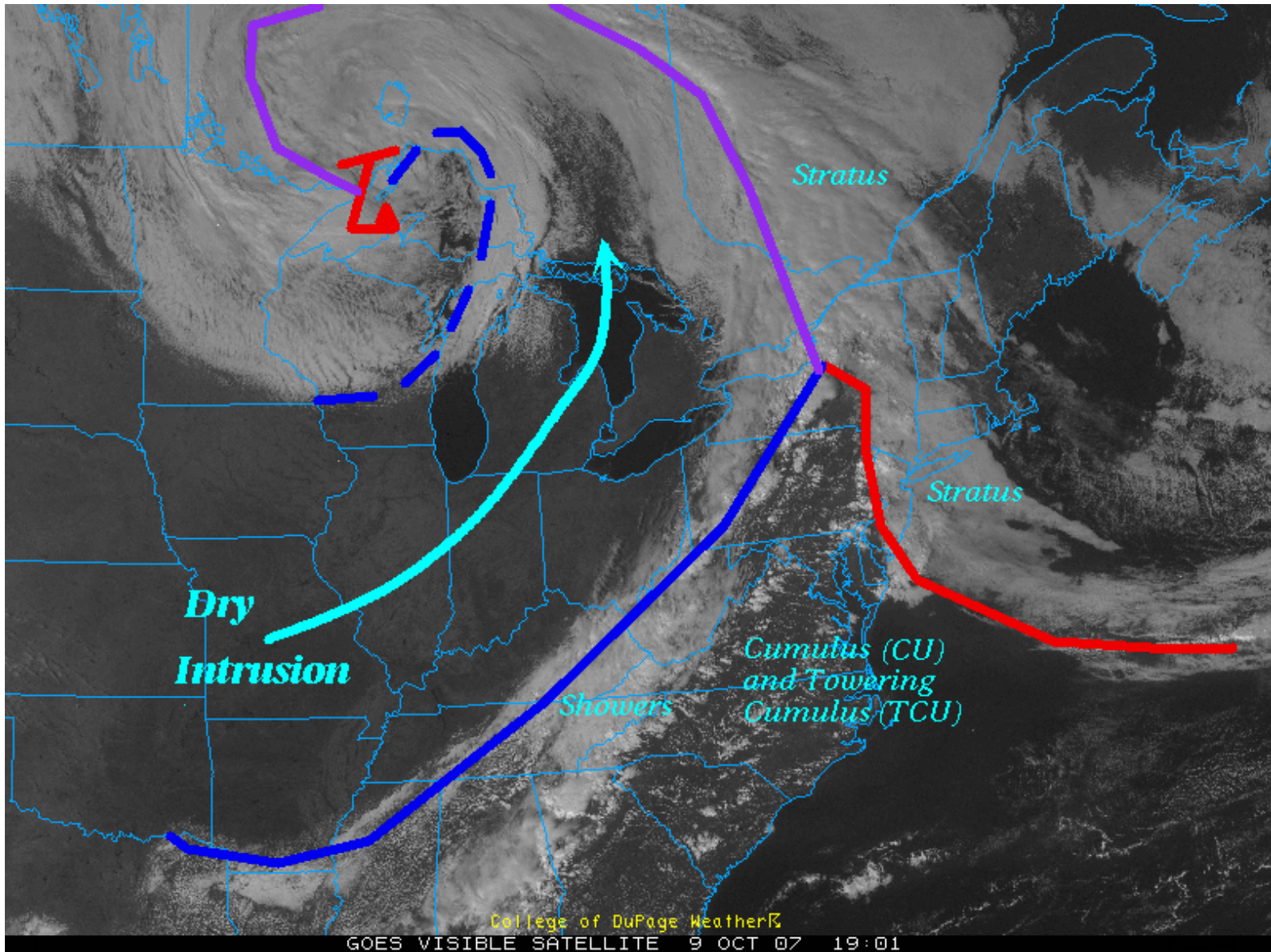
The cyclone





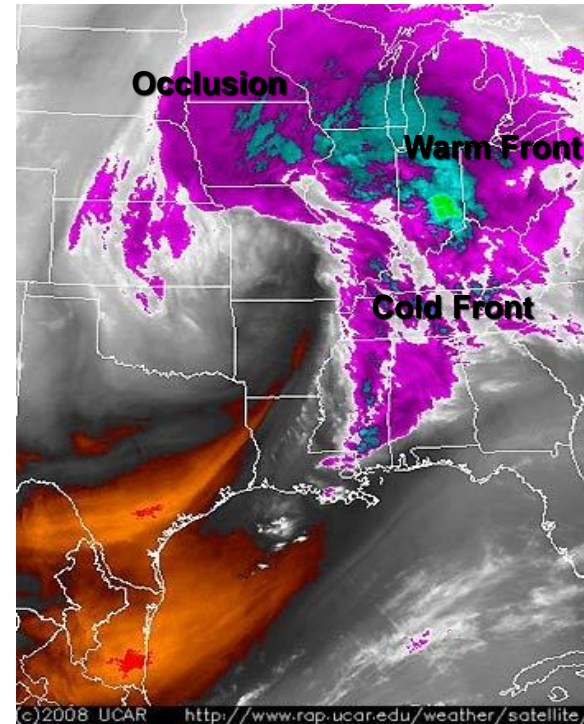
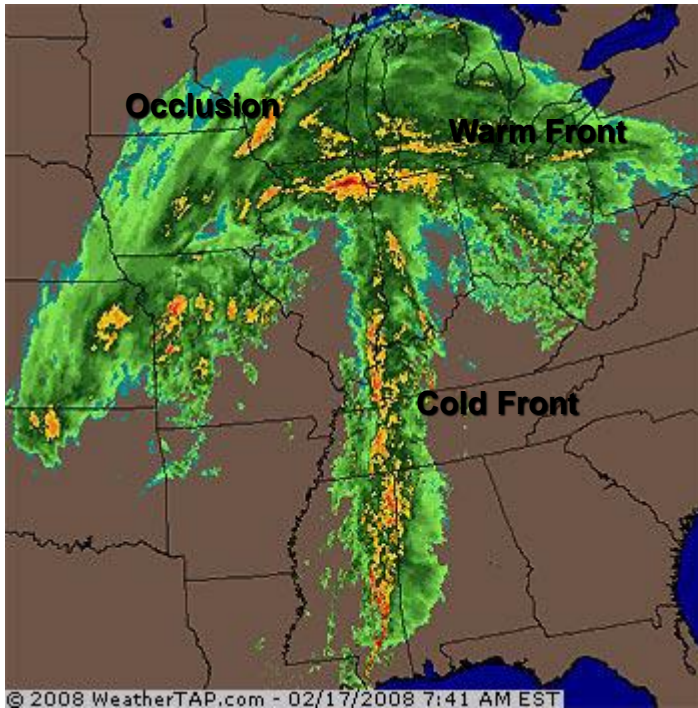
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Cyclone



Cyclone

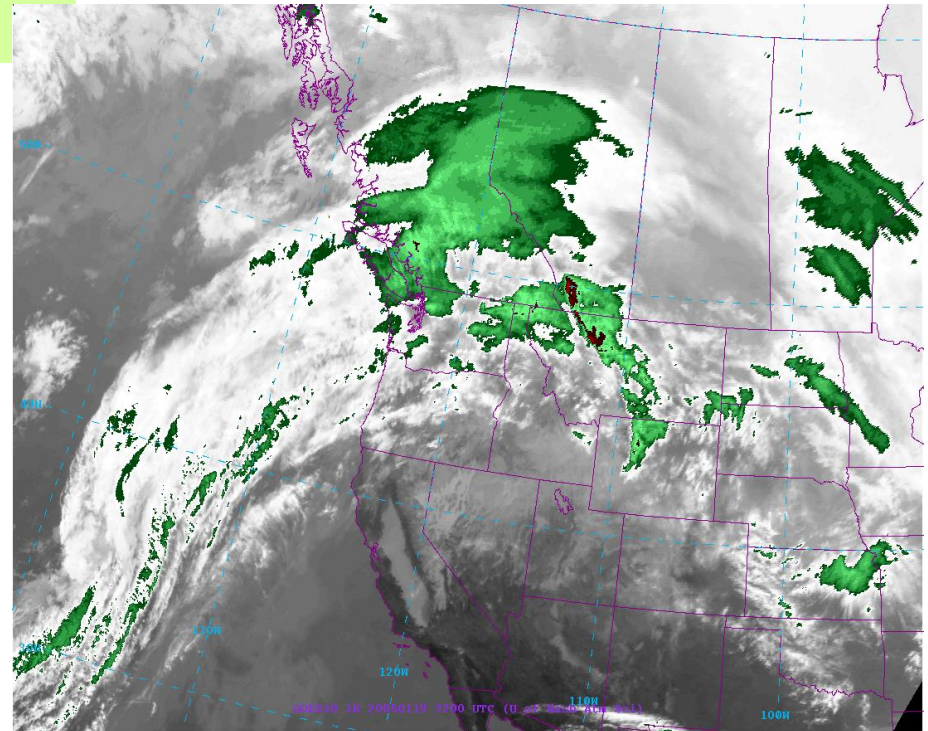
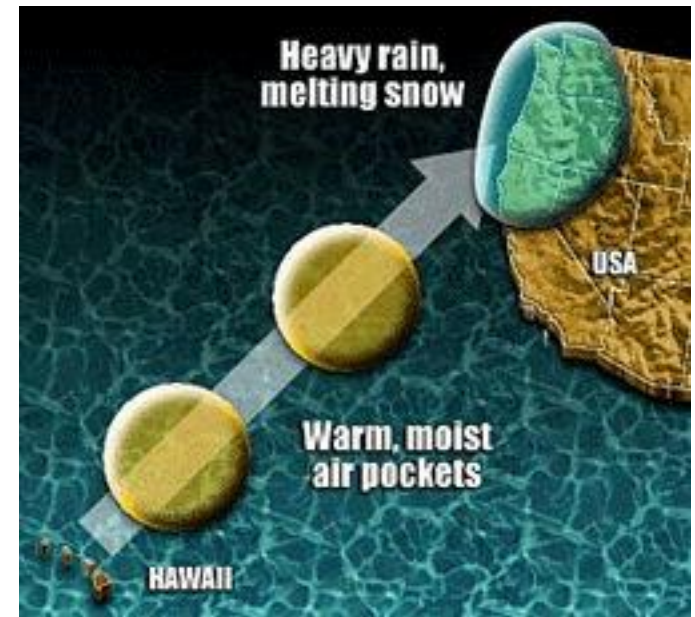
- Radar & Satellite view of a cyclone



Storm Tracks

Pineapple Express

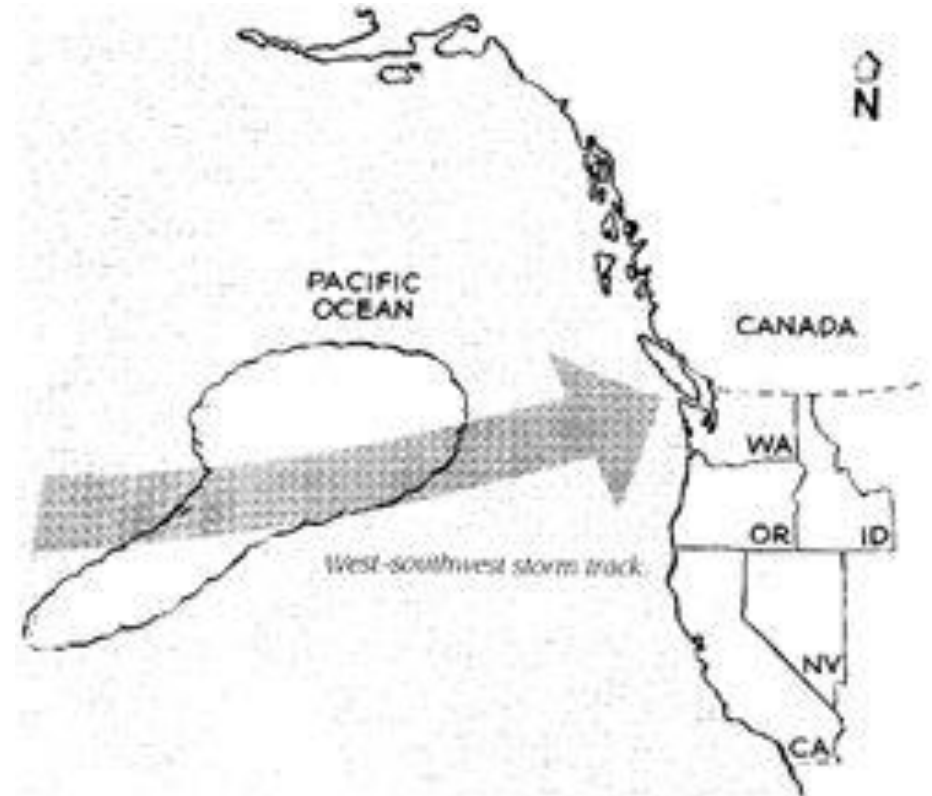
- SW Storm Track
- Pineapple express
- These storms can leave over 7" of water
- High snow accumulation at the highest of elevations in the mountains
- High elevation freezing levels



Storm Tracks

West-SW Storm Track

- Temperature and humidity is lower than for the “pineapple express
- A common storm track
- A break between storms, sometimes a few hours, sometimes a full day.
- Cooler air moves in after each disturbance,
- Freezing level is 3000' to 5000', when these systems move through.



Storm Tracks

West-NW Storm Track

Precipitation is short-lived, producing fairly rapid cooling

These systems drop light (low SWE) snow in the mountains

Freezing level is 1500' to no more than 3000' or so in winter.



Storm Tracks

Northerly Storm Track

Cold air travels from the north, passes just long enough over the ocean to pick up moisture (but not long enough to warm the air and produce rain).

Winds slide along, rather than across the ranges, so more snow may fall in the flatlands than in the mountains.

Freezing level is at ground level.



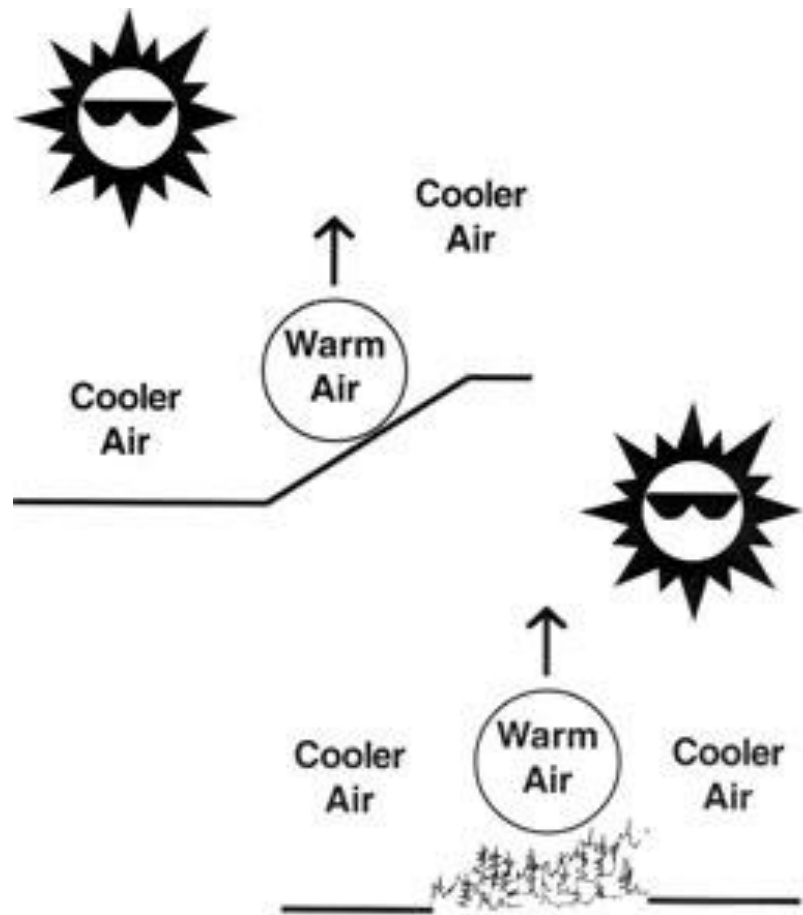
**AIR MASS
LIFTING
MECHANISMS**

Types of Lifting Mechanisms

1. Convective Uplifting
2. Convergent Uplifting
3. Orographic Uplifting
4. Frontal Uplifting

Lifting Mechanisms

Convection and convective lifting

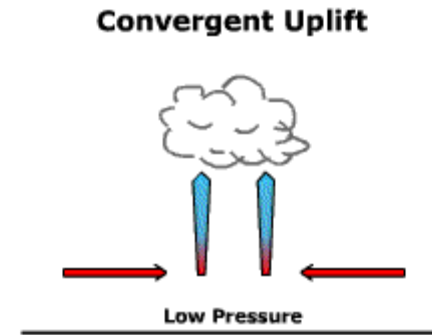


Air is heated by the Earth's surface. The air is heated unequally, areas of warmer air are formed amidst cooler air.

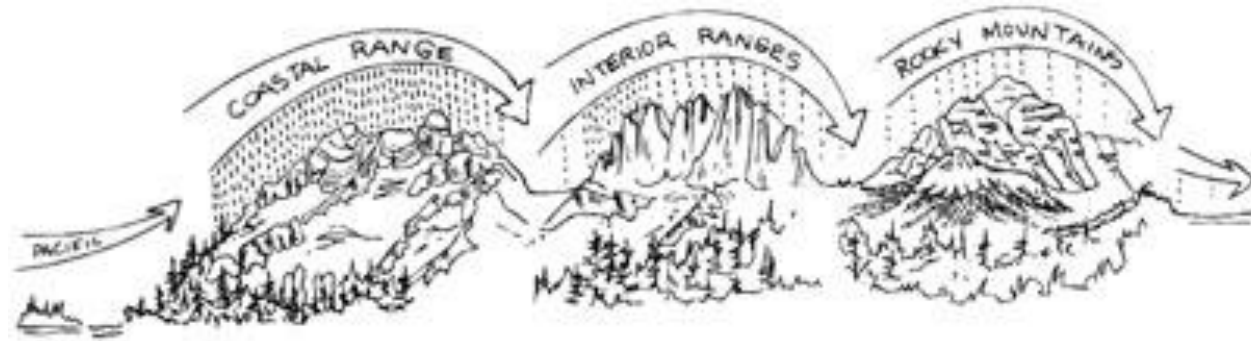
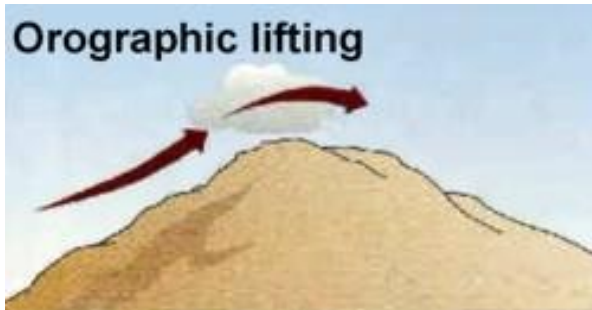
Since warm air is lighter, it will tend to rise and this may lead to the formation of localized clouds and showers.

Convergent Uplift

Convergent uplift occurs when air enters a center of low pressure. As air converges into the center of a cyclone it is forced to rise off the surface. As the air rises it expands, cools, and water vapor condenses. Convergent and convective uplift are the two most important uplift mechanisms for condensation in the tropics. Under the intense sun, surface heating causes the moist tropical air to rise. Convergence of the trade winds in the Intertropical convergence zone creates copious rainfall in the wet tropics as well.



Lifting Mechanisms



Orographic lifting

Orographic lift takes place when a moving mass of air runs up against a mountain range and is forced upwards.

This is the most powerful lifting mechanism and accounts for the majority of precipitation in the PacNW.

Moist ocean air is lifted orographically and can cause precipitation without any associated storms or frontals systems.

The warm and cold fronts that bring heavy snowfalls to the Cascades Mountains often dissipate by the time they reach eastern Washington; little moisture remains and lesser amounts of snow fall at Mission Ridge

Orographic Uplift

Orographic uplift is the forced ascent of air when it collides with a mountain. As air strikes the windward side, it is uplifted and cooled. Windward slopes of mountains tend to be the rainy sides while the leeward side is dry. Dry climates like steppes and desert are often found in the "rain shadow" of tall mountain systems that are oriented perpendicular to the flow of air. A rainshadow in the lee of the tradewinds as they cross the mountainous northwest portion of the Big Island of Hawaii (Figure 7.10). Cloud formation and green vegetation identifies the windward, while the reddish brown indicates the dry leeward side.

Orographic Uplift





Rainshadow on the Big Island of Hawaii.
(Source NASA EOS)

FRONTAL UPLIFT

Frontal uplift occurs when greatly contrasting air masses meet along a weather front. For instance, when warm air collides with cool air along a warm front, the warm air is forced to rise up and over the cool air. As the air gently rises over the cool air, horizontally developed stratus-type clouds form. If cold air collides with warm air along a cold front, the more dense cold air can force the warmer air ahead to rise rapidly creating vertically developed cumulus-type clouds.

