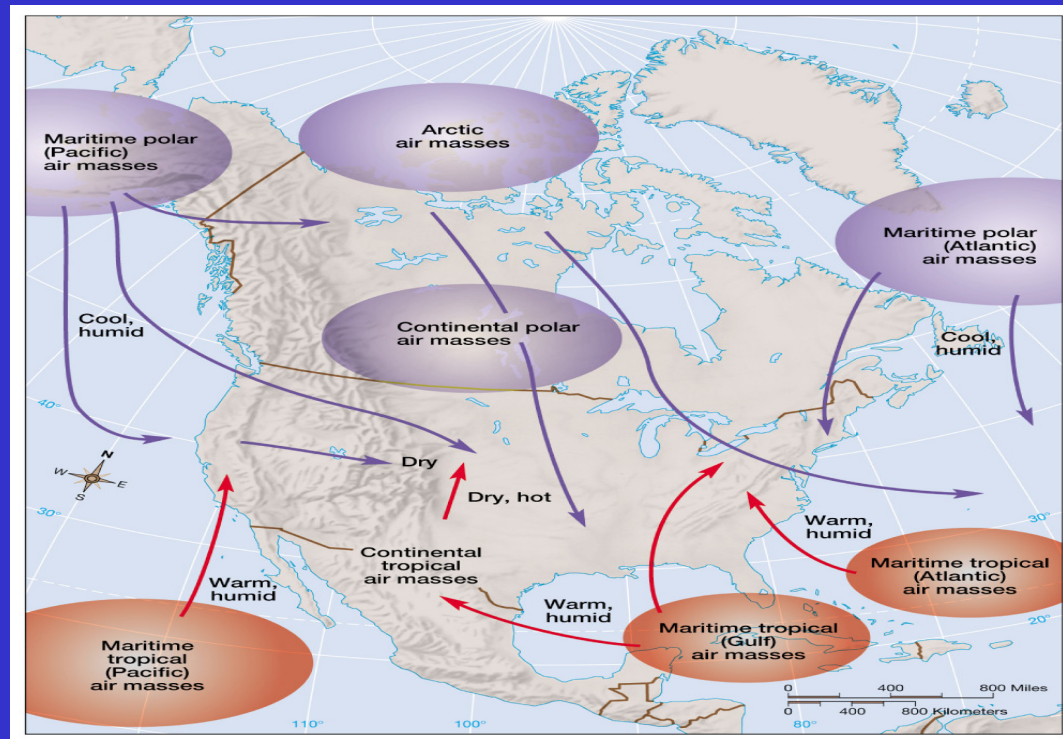


# *Chapter 9: Air Masses and Fronts*



- ☐ What Characterize Air Masses?
- ☐ What Define Fronts?

## □ Air masses

Contain uniform temperature and humidity characteristics.

## □ Fronts

Boundaries between unlike air masses.



# Air Masses

- ❑ Air masses have fairly uniform temperature and moisture content in horizontal direction (but not uniform in vertical).
- ❑ Air masses are characterized by their temperature and humidity properties.
- ❑ The properties of air masses are determined by the the underlying surface properties where they originate.
- ❑ Once formed, air masses migrate within the general circulation.
- ❑ Upon movement, air masses displace residual air over locations thus changing temperature and humidity characteristics.
- ❑ Further, the air masses themselves moderate from surface



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# Source Regions

- ❑ The areas of the globe where air masses form are called source regions.
- ❑ A source region must have certain temperature and humidity properties that can remain fixed for a substantial length of time to affect air masses above it.
- ❑ Air mass source regions occur only in the high or low latitudes; middle latitudes are too variable.

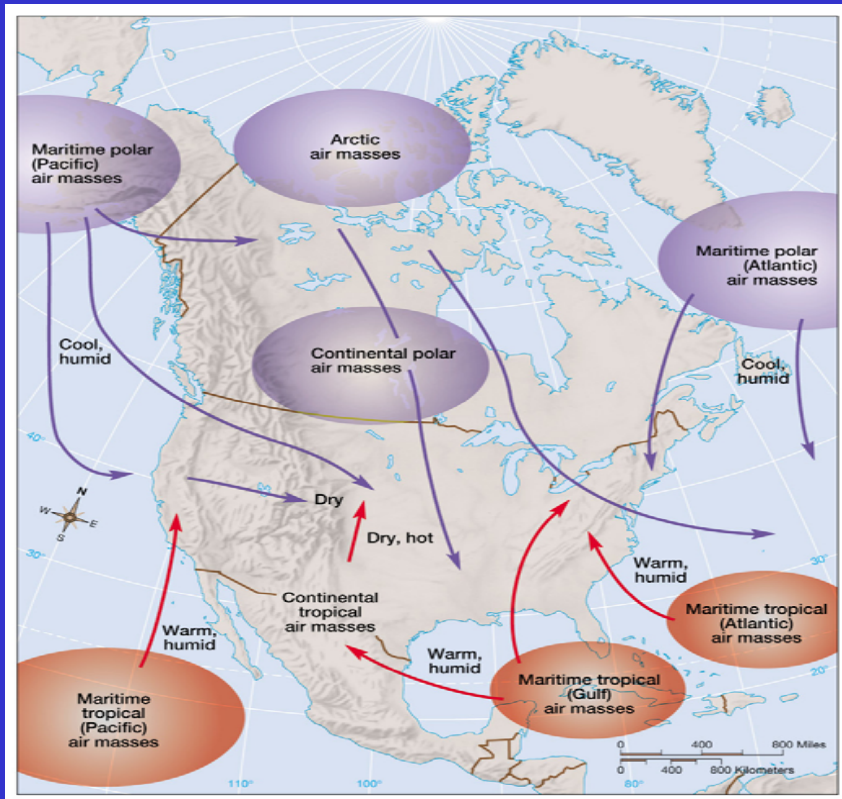


# Classification of Air Masses

- ❑ Air masses are classified according to the temperature and moisture characteristics of their source regions.
- ❑ Bases on moisture content: continental (dry) and maritime (moist)
- ❑ Based on temperature: tropical (warm), polar (cold), arctic (extremely cold).
- ❑ Naming convention for air masses: A small letter (*c*, *m*) indicates the moist content followed by a capital letter (*T*, *P*, *A*) to represent temperature.



# Five Types of Air Masses



- ❑ Theoretically, there should be 6 types of air masses (2 moisture types x 3 temperature types).
- ❑ But mA-type (maritime Arctic) does not exist.
- ❑ cA: continental Arctic  
cP: continental Polar  
cT: continental Tropical  
mP: maritime Polar  
mT: maritime Tropical



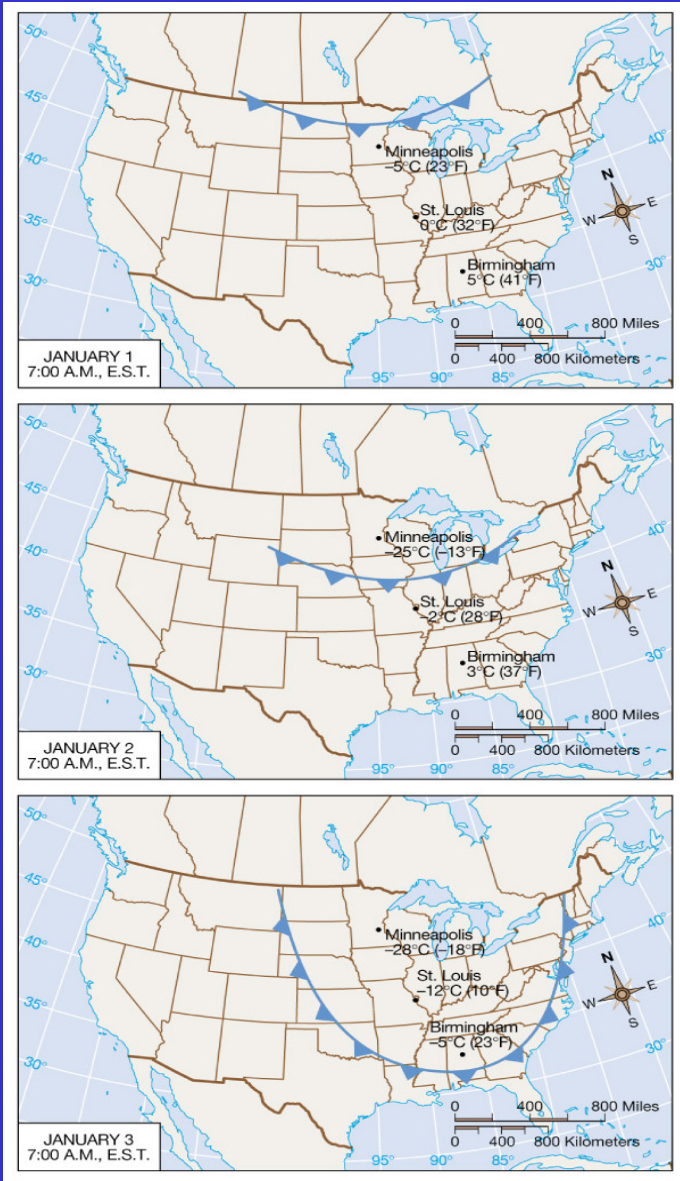
# Continental Polar (cP) Air Mass

- ❑ Continental Polar air masses form over large, high-latitude land masses, such as northern Canada or Siberia.
- ❑ cP air masses are cold and extremely dry.
- ❑ Wintertime cooling over these land areas cause the atmosphere to become very stable (even inversion).
- ❑ The combination of dry and stable conditions ensure that few if any clouds form over a cP source region.
- ❑ Summer cP air masses are similar to winter cP, but much less extreme and remain at higher latitudes.





# Modification of cP Air Masses

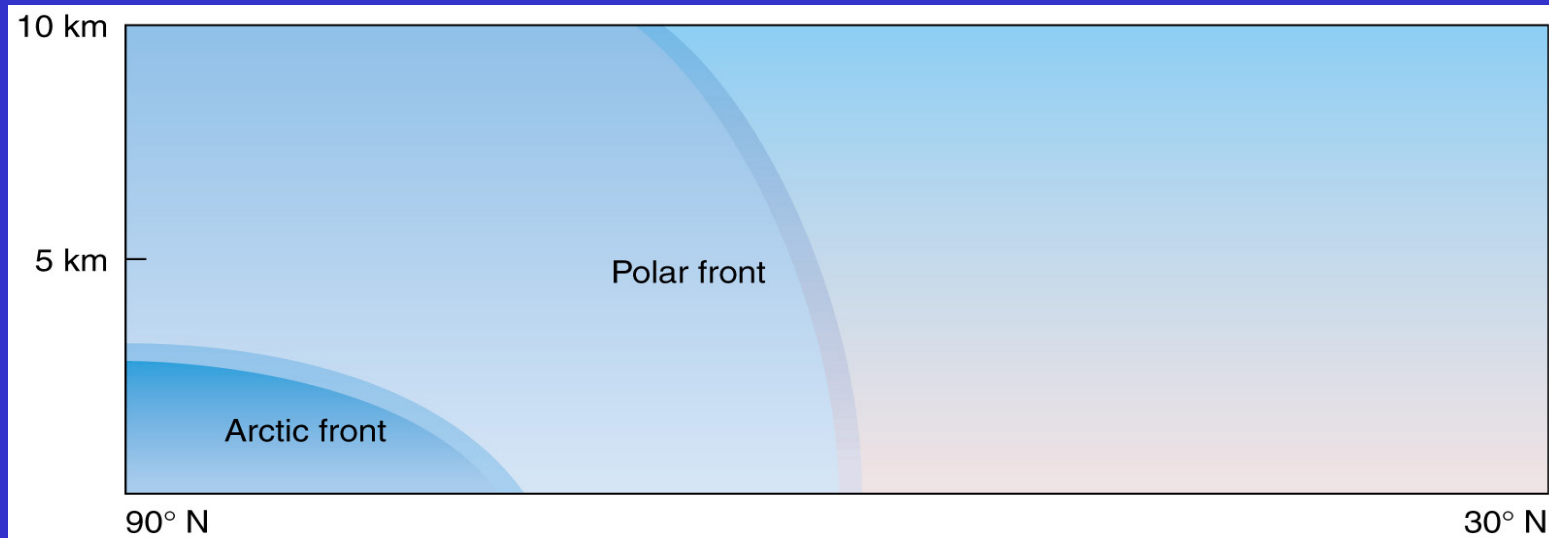


- ❑ Migrations of cP air induce colder, drier conditions over affected areas.
- ❑ As cP air migrates toward lower latitudes, it warms from beneath.
- ❑ As it warms, moisture capacity increases while stability decreases.





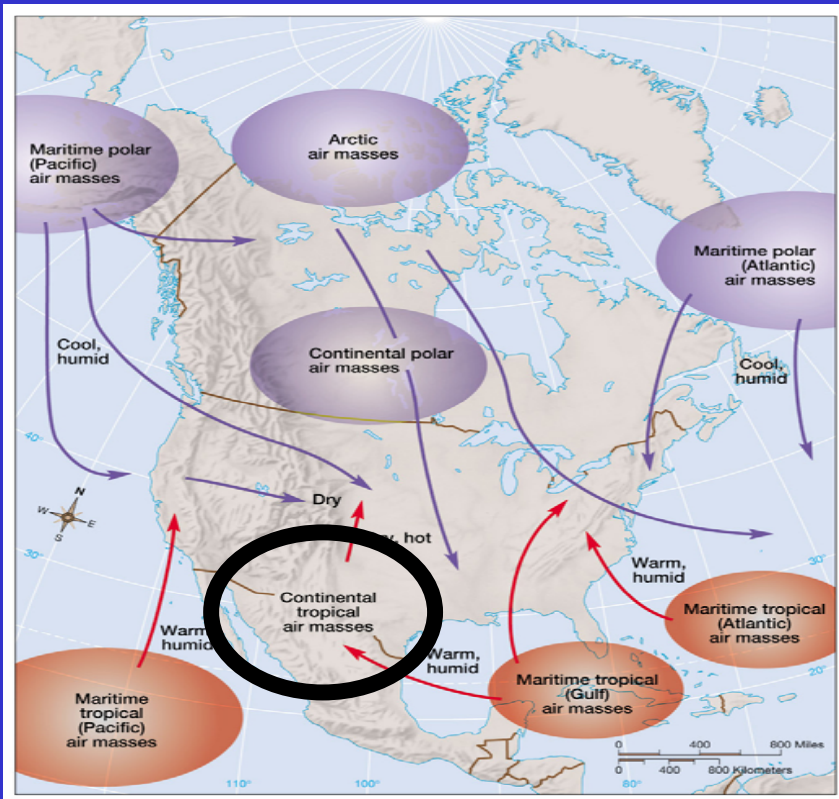
# Continental Arctic (cA) Air Masses



- ❑ *Continental Arctic (cA)* air represents extremely cold and dry conditions as, due to its temperature, it contains very little water vapor.
- ❑ The boundary between cA and cP air is the shallow (~1-2 km) arctic front.
- ❑ cA air masses can extend as far southward as the Canadian-United State.



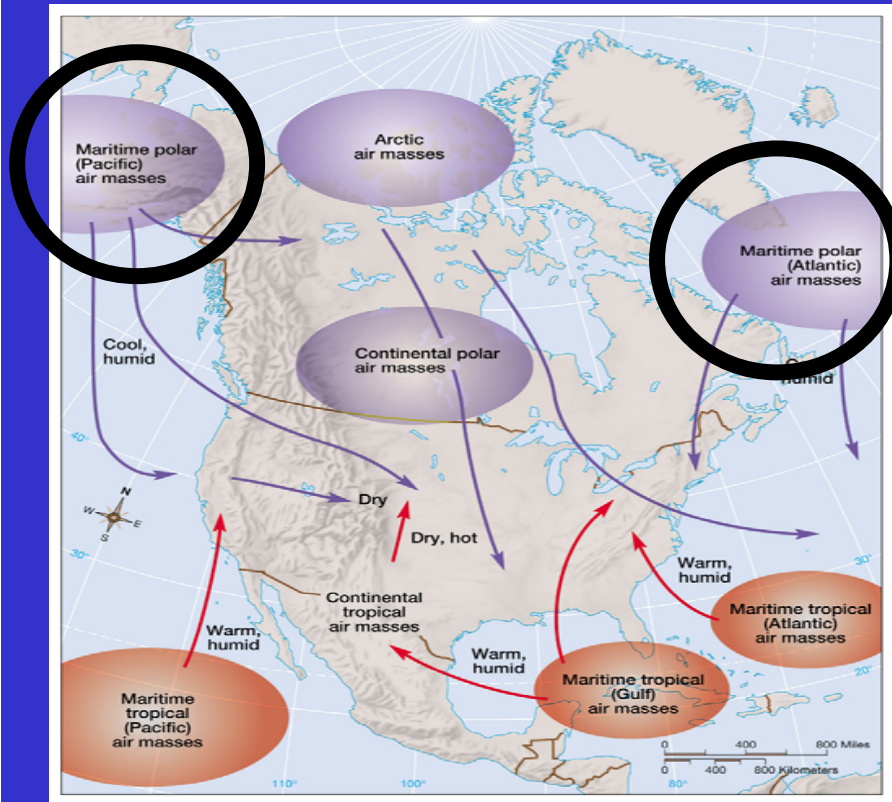
# Continental Tropical (cT) Air Masses



- ❑ Mainly a summertime phenomenon exclusive to the desert southwest of the U.S. and northern Mexico.
- ❑ Characteristically hot and very dry.
- ❑ Very unstable, yet clear conditions predominate due to a lack of water vapor.
- ❑ Thunderstorms may occur when moisture advection occurs or when air is forced orographically.



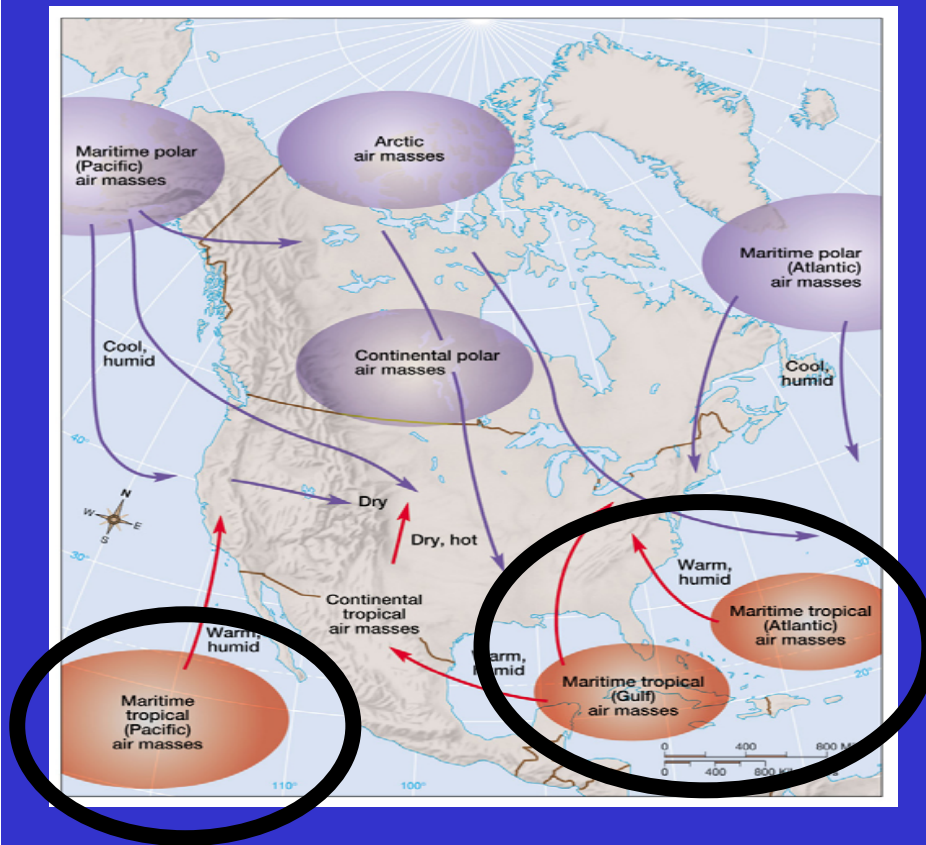
# Maritime Polar (mP) Air Masses



- ❑ Maritime polar air masses form over upper latitude oceanic regions and are cool and moist.
- ❑ mP air masses form over high-latitude ocean as cP air masses move out from the interior of continents. (I.e., cP → mP).
- ❑ Oceans add heat and moisture into the dry and cold cP air masses.
- ❑ Along the west coast of the U.S., mP air affects regions during winter and may be present before mid-latitude cyclones advect over the continent.
- ❑ Along the east coast, mP air typically affects regions after cyclone passage as the mP air wraps around the area of low pressure



# Maritime Tropical (mT) Air Masses

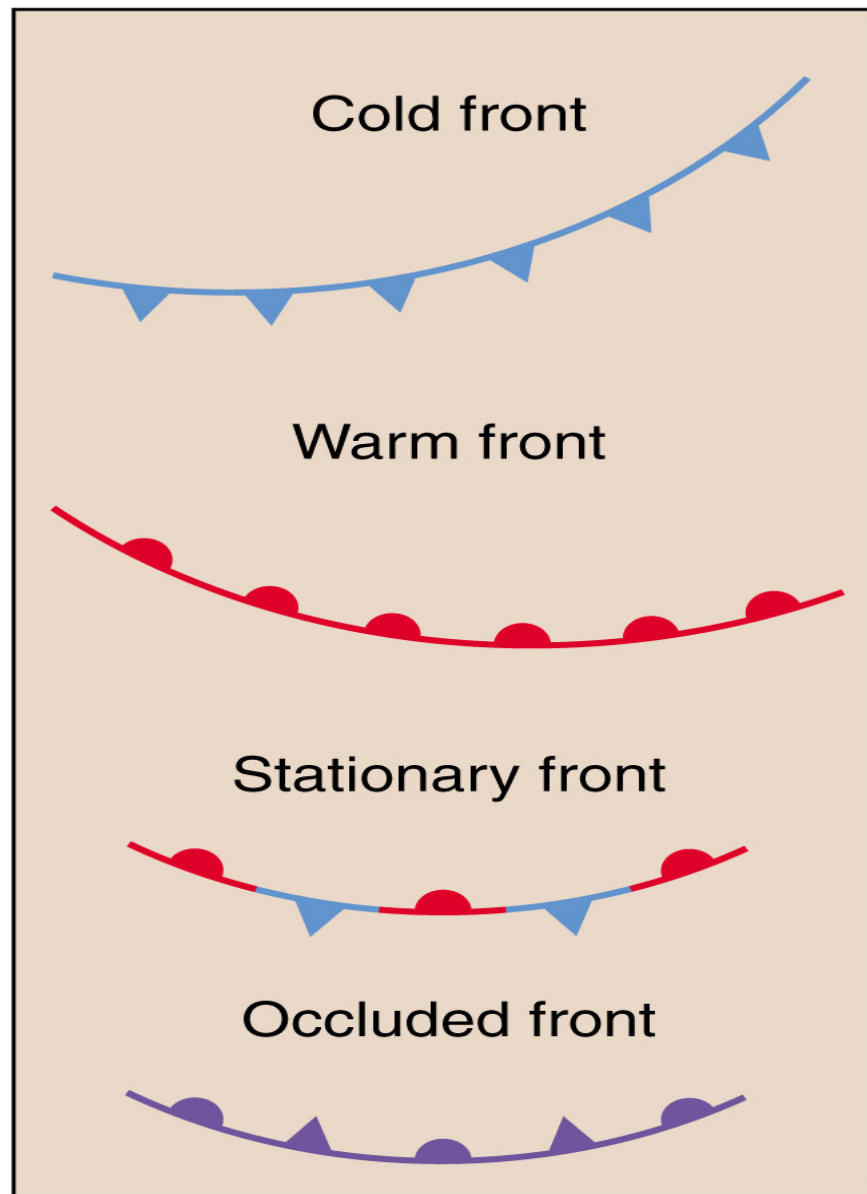


□ Advection of mT air also promotes the so-called Arizona monsoon.

- Form over low latitude oceans and as such are very warm, humid, and unstable.
- mT air masses from Atlantic and Gulf of Mexico is the primary source region for the eastern U.S.
- As air advects over the warm continent in summer the high humidity and high heat occasionally combine to dangerous levels.
- mT air masses have an enormous influence on the southwestern U.S, particularly in summer.



# Fronts

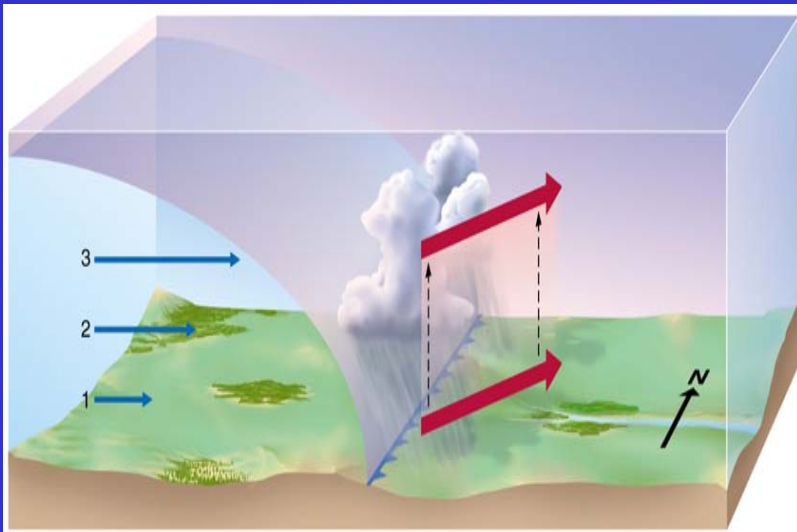
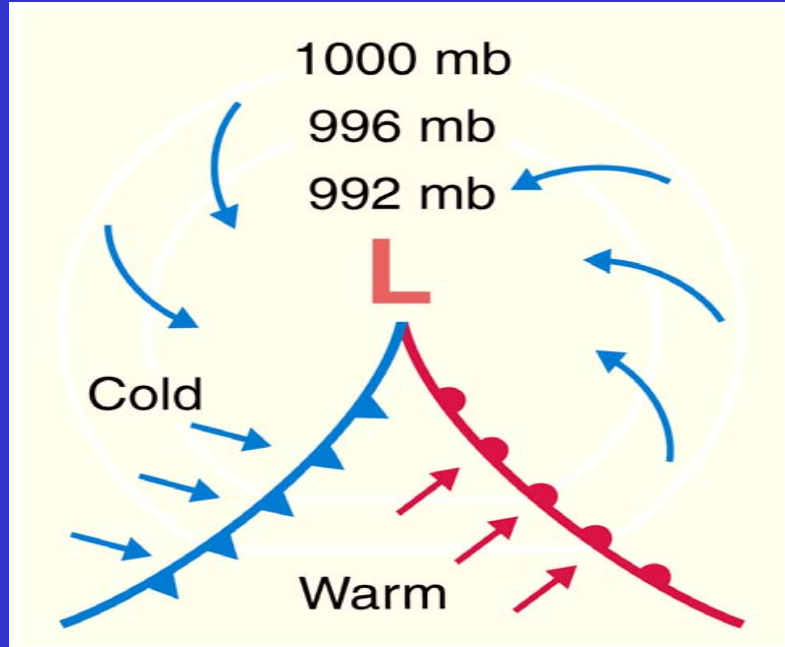


- ❑ Fronts separate air masses and bring about changes in temperature and humidity as one air mass is replaced by another.
- ❑ There are four general types of fronts associated with mid-latitude cyclones with the name reflective of the advancing air mass.





# Cold Fronts

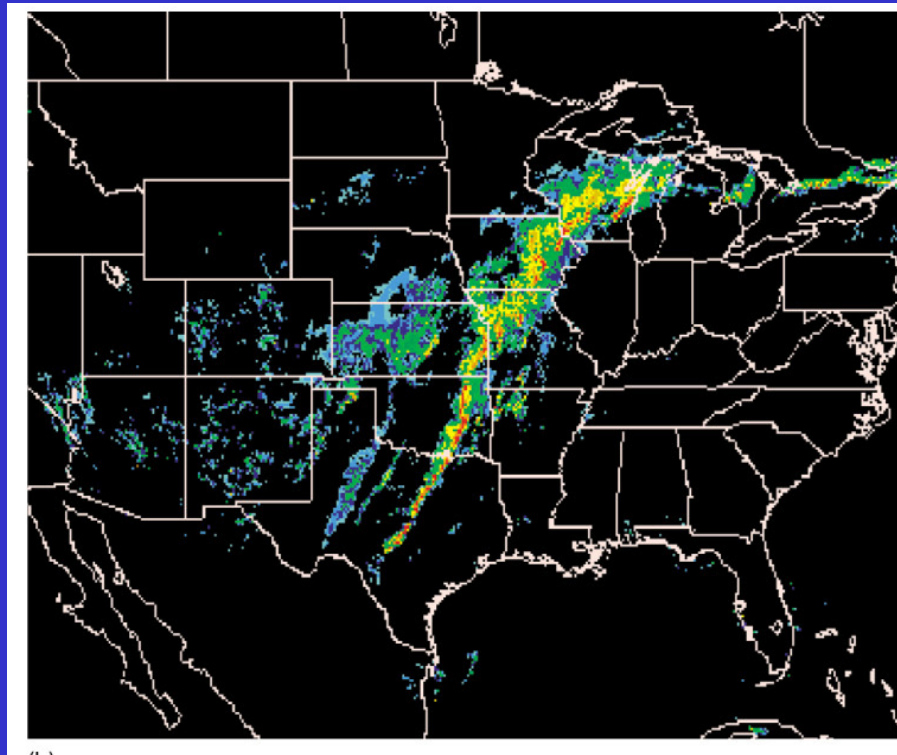


- ☐ Cold fronts form when cold air displaces warm air.
- ☐ Indicative of heavy precipitation events, rainfall or snow, combined with rapid temperature drops.
- ☐ Steep front slope, typically 1:100.
- ☐ Moving faster, up to 50 km/hr (30 mph).
- ☐ Northwesterly winds behind a cold front, and southwesterly in ahead of the front.

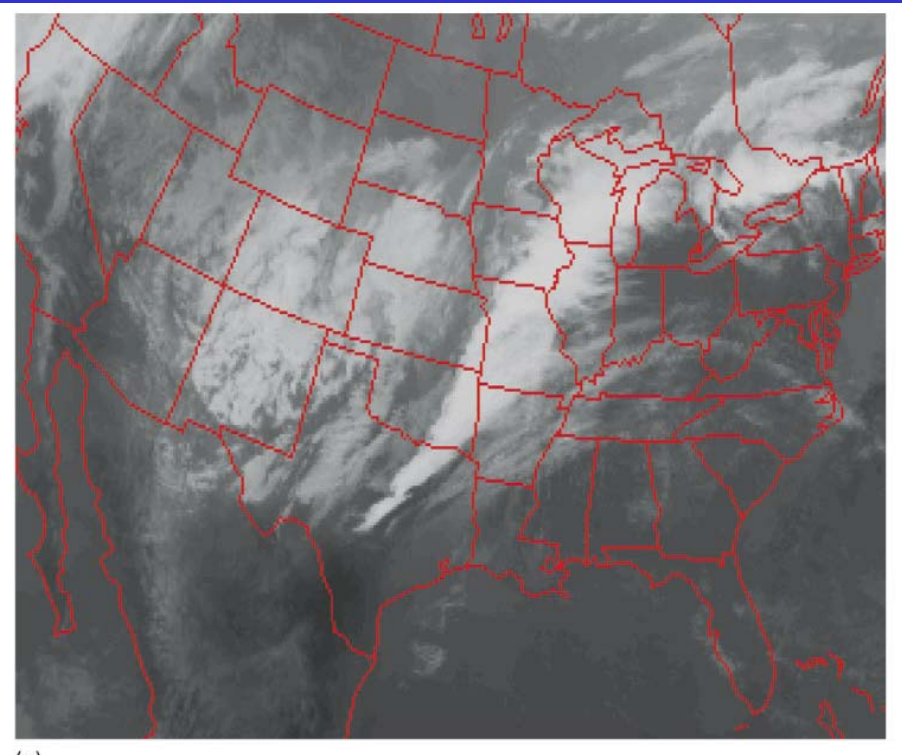


# Radar/Satellite Views of Cold Fronts

Radar Picture

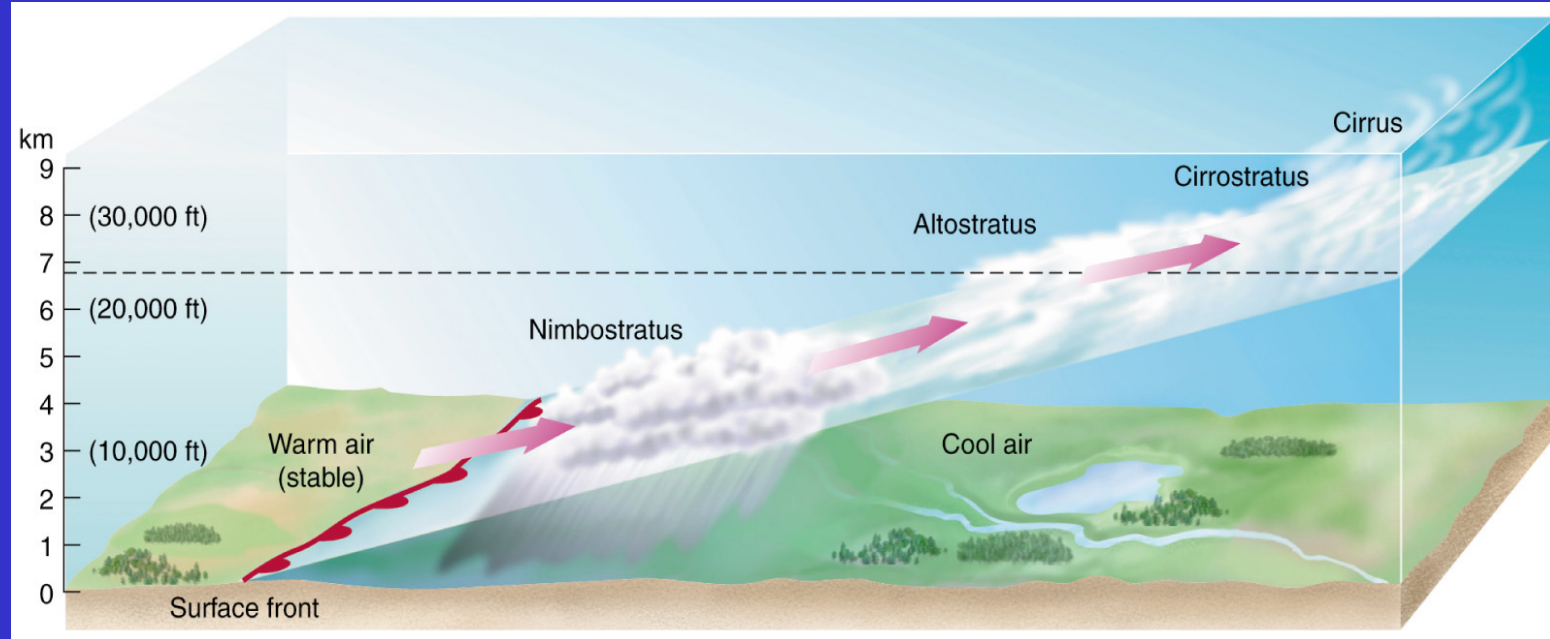


Satellite Picture





# Warm Fronts

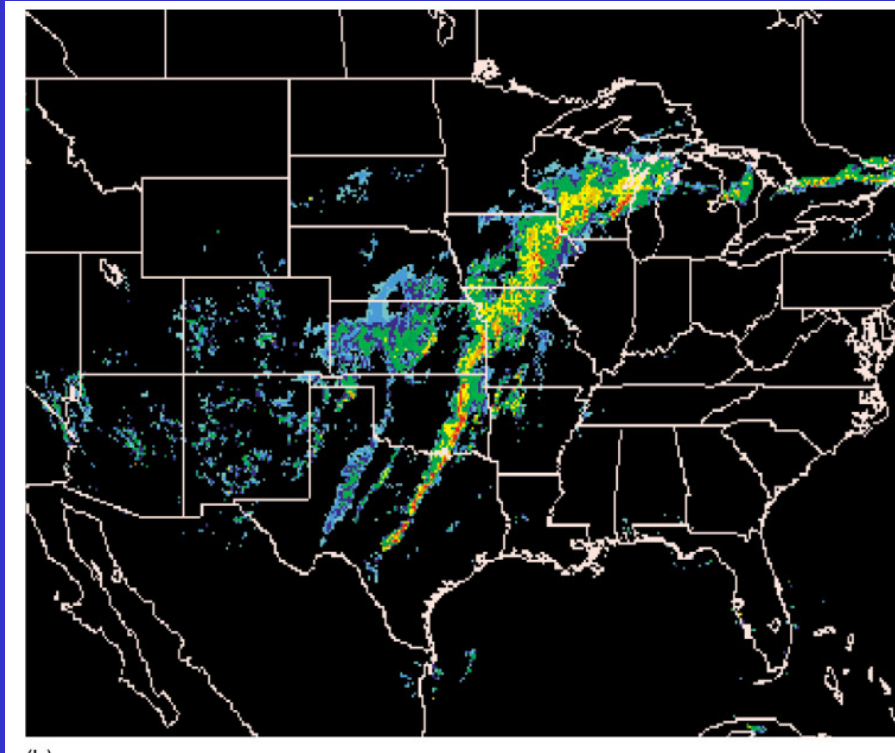


- ❑ Created when warm air displaces colder air.
- ❑ Shallow horizontal stratus clouds and light precipitation.
- ❑ Frontal fogs, sleet, freezing rain may occur as falling raindrops evaporate in the colder air near the surface.
- ❑ Half the slope of cold fronts, typically (1:200).
- ❑ Moving slower, about 20 km/hr (12 mph).

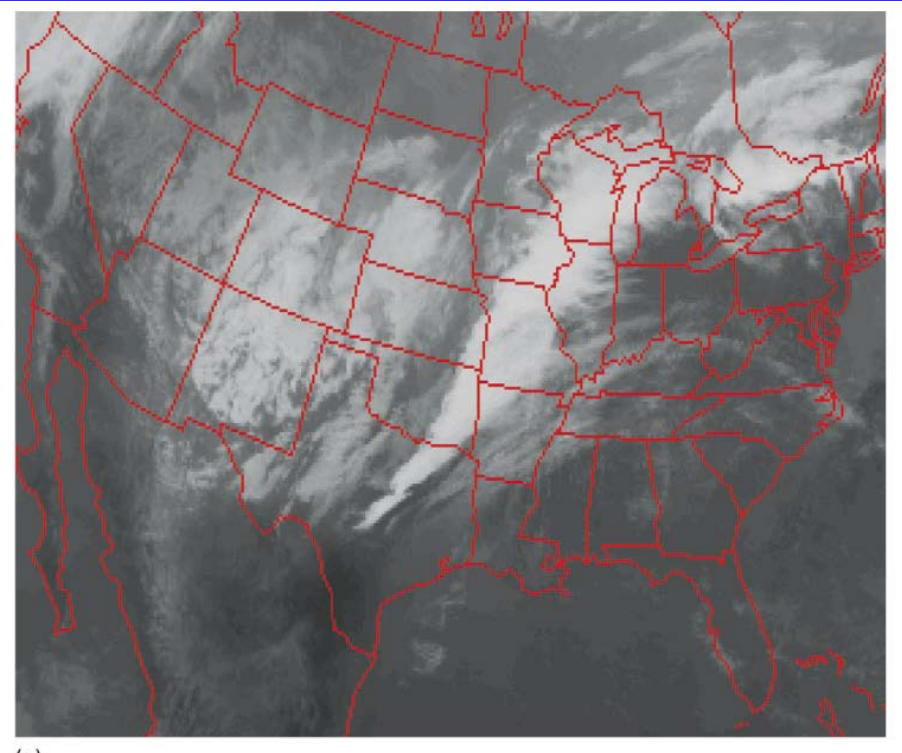


# Radar/Satellite Views of Warm Fronts

Radar Picture



Satellite Picture

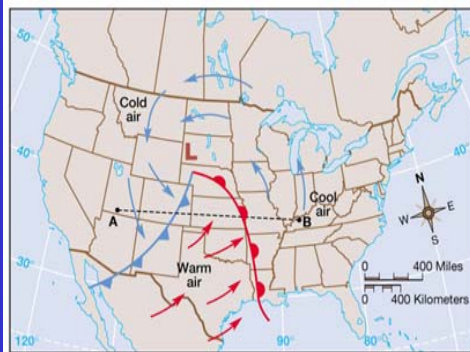


# Stationary Fronts

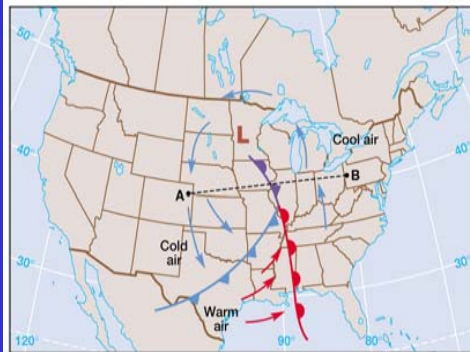
- ❑ When two unlike air masses remain side by side, with neither encroaching upon the other, a stationary front exists.
- ❑ Fronts may slowly migrate and warmer air is displaced above colder.
- ❑ Fronts sloping over the cold air.



# Occluded Fronts



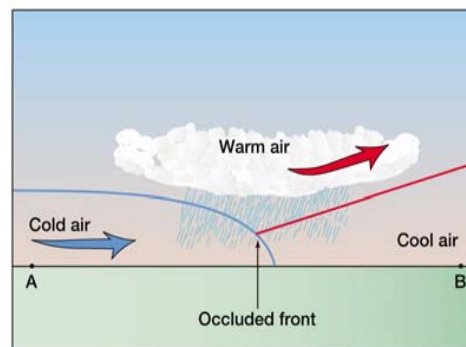
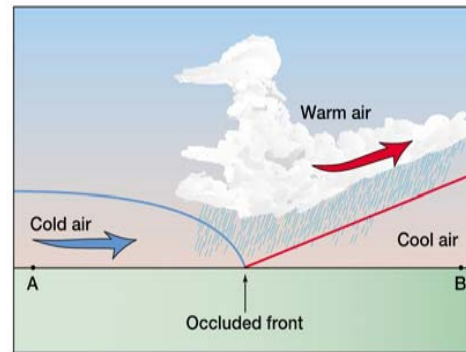
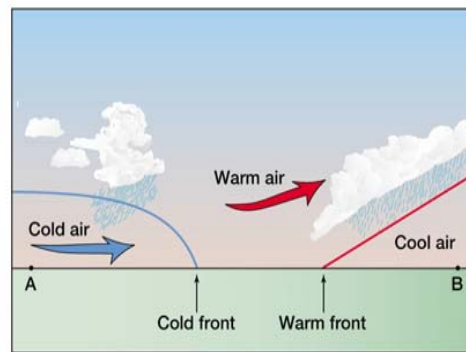
(a) Mature wave cyclone



(b) Partially occluded wave cyclone



(c) Occluded wave cyclone

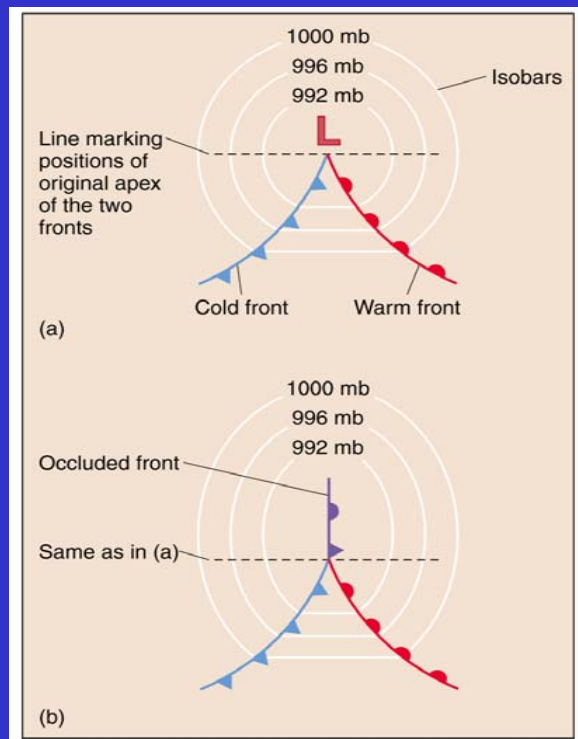


- ❑ Occlusion: the warm air is cut off from the surface by the meeting of two fronts.
- ❑ Usually, a fast-moving cold front catches a slow-moving warm front.
- ❑ A *cold-type occlusion*: eastern half of the continent where a cold front associated with cP air meets a warm front with mP air ahead.
- ❑ A *warm-type occlusion*: western edges of continents where the cold front, associated with mP air, invades an area in which colder cP air is entrenched.

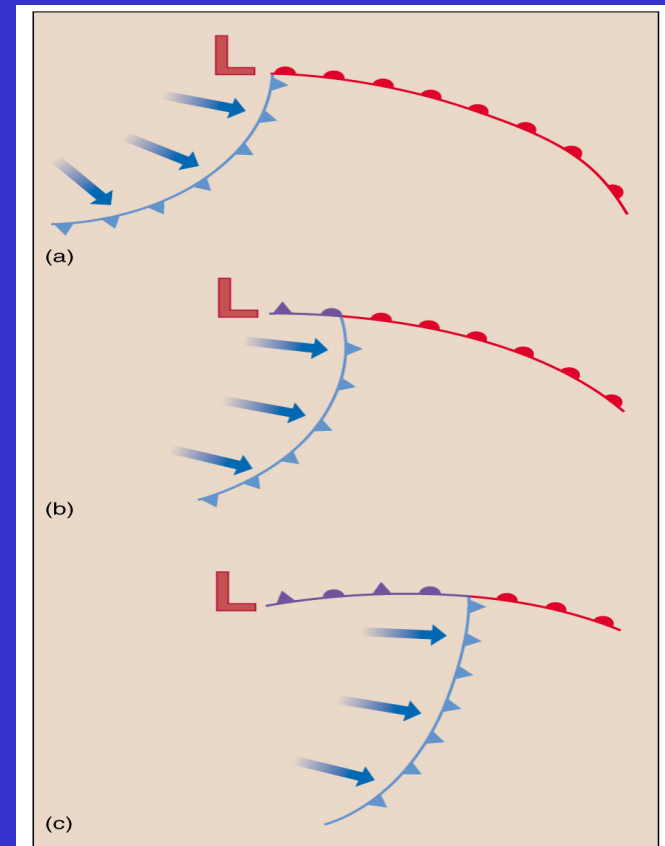




# Two Other Ways to Produce Occluded Fronts

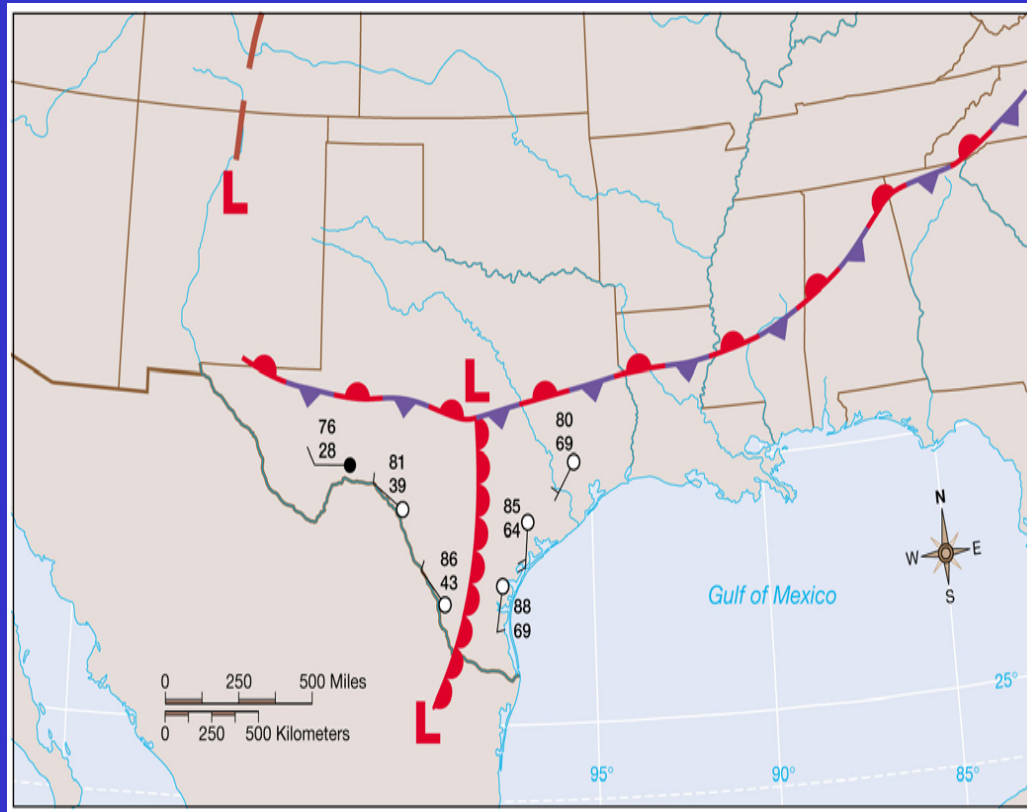


Some occlusions form when the surface low elongates and moves away from the junction of the cold and warm fronts



Some occlusions occur when the intersection of the cold and warm fronts slides along the warm front

# Drylines



- Because humidity is an important determinant of air density, air masses with similar temperatures but strong humidity gradients will act as fronts.
- Boundaries between dry and moister air are called *drylines*.
- They frequently occur throughout the Great Plains and are an important contributor to storm development.

