

Funding provided by NOAA  
Sectoral Applications Research Project

# PRESSURE SYSTEMS, AIR MASSES & FRONTS

Basic Climatology  
Oklahoma Climatological Survey

# PRESSURE SYSTEMS

# Pressure makes the wind blow

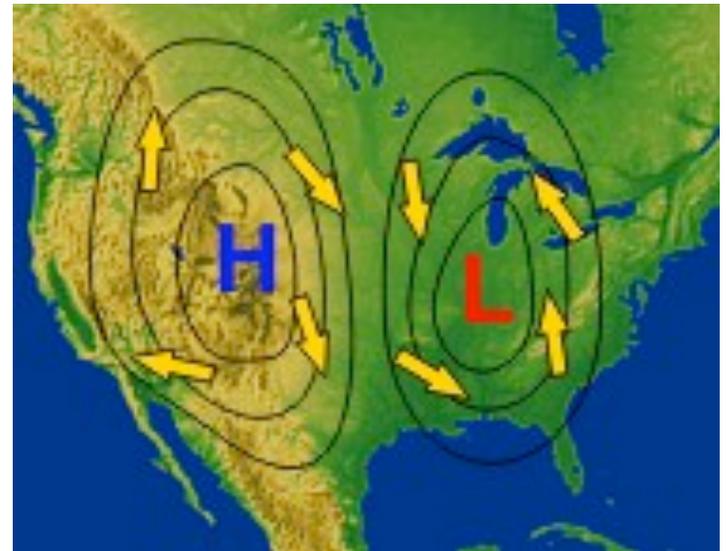
- Wind is simply air molecules in motion
  - ▣ We “see” wind through the force of these molecules on objects, such as leaves
- Air moves from areas of high pressure to low pressure
  - ▣ Recall *density* – molecules are packed more tightly together when pressure is high, so they want to spread out a bit



Source: NOAA National Weather Service Jetstream

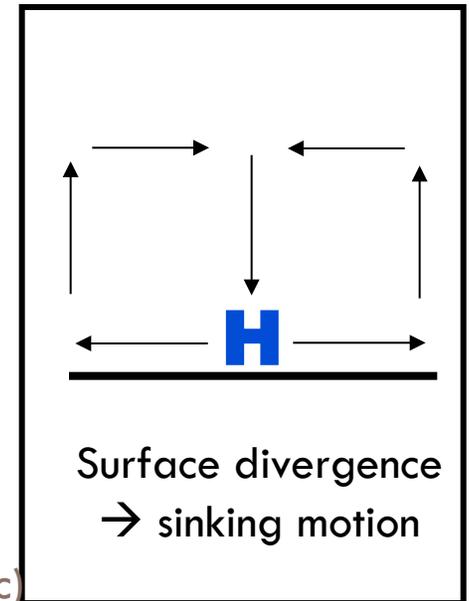
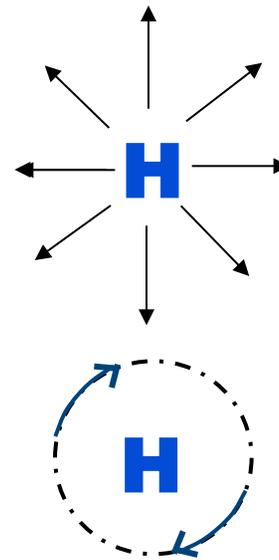
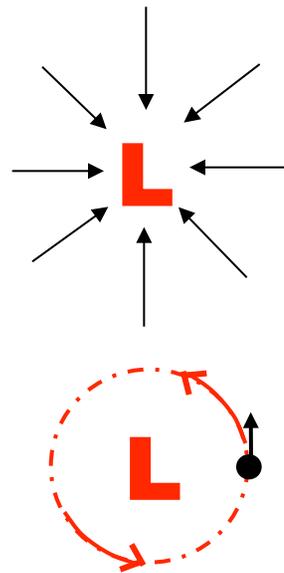
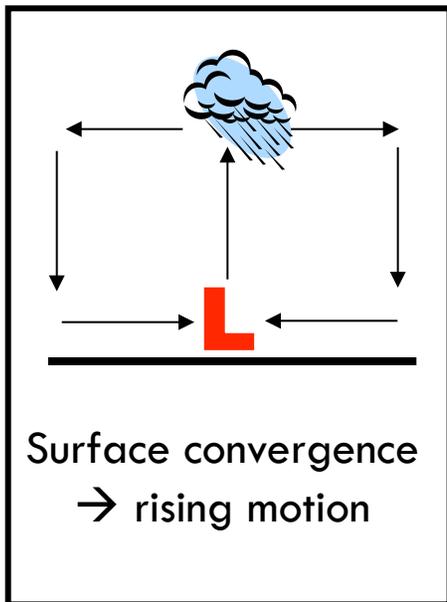
# Pressure makes the wind blow

- But remember all that stuff about the Earth's rotation?
  - ▣ The *Coriolis force* turns air parcels to the right (in the northern hemisphere)
  - ▣ This causes air to 'spin' around the pressure centers
- The air would end up going around in circles around the pressure centers except for friction
  - ▣ Friction slows wind speeds, lessening the effects of the Coriolis force
- Air moving away from high pressure creates divergence at the surface, drawing air downward from aloft
- Air moving toward low pressure creates convergence at the surface, forcing air upward near the low's center



Source: NOAA National Weather Service Jetstream

# Low vs. High Pressure (N. Hemis.)

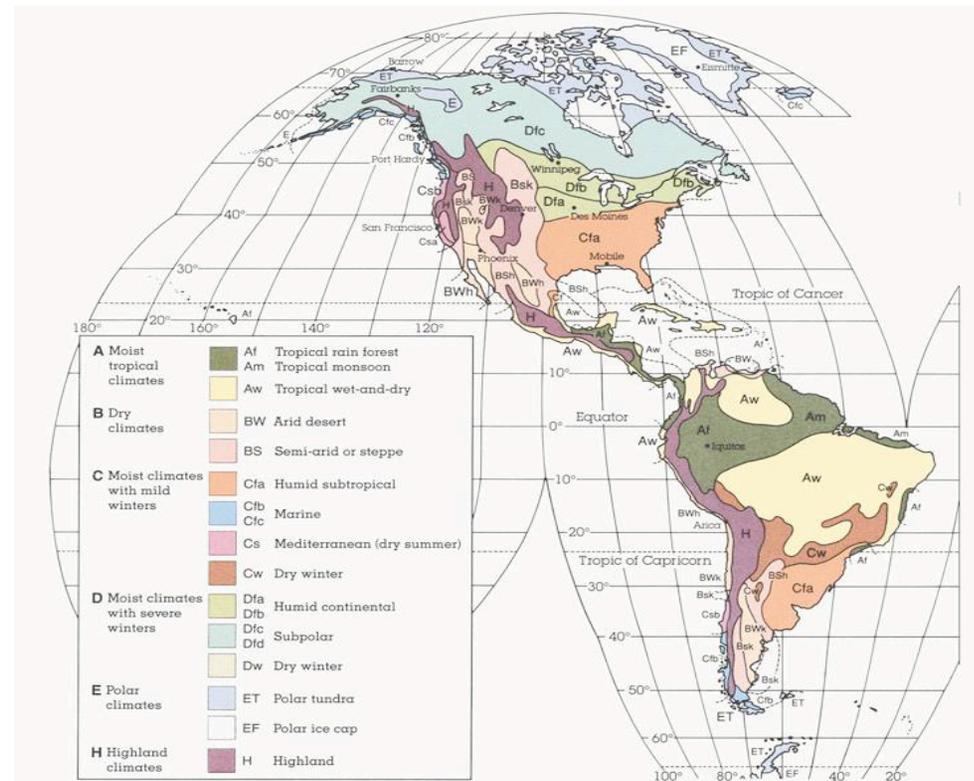


In the Northern Hemisphere, if you stand with your back to the wind, then the lower pressure will be to your left.

# AIR MASSES

# Remember This?

- Air in motion brings with it characteristics of its source region
- These characteristics are called an air mass
- Boundaries between air masses are called fronts

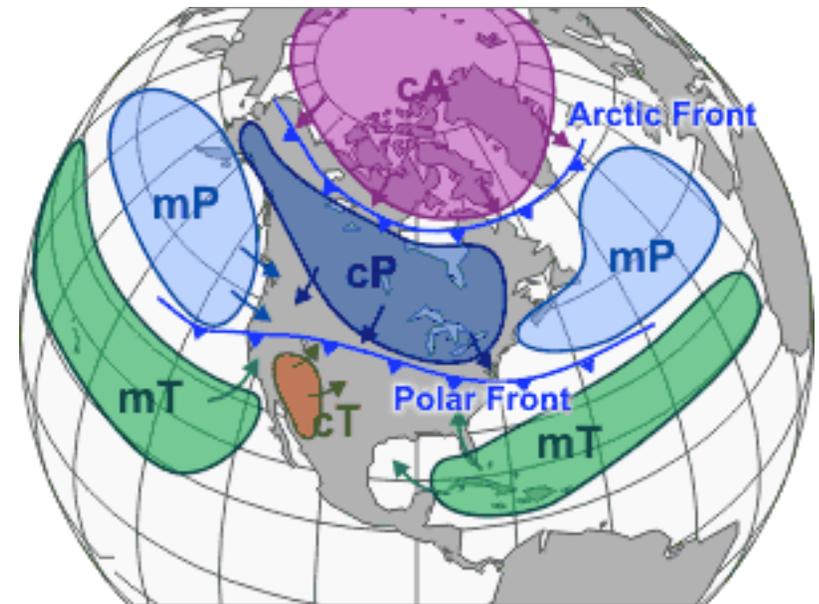


# Types of Air Masses

- Air masses are distinguished by one of four source characteristics:
  1. **Polar** (sometimes called Arctic)
  2. **Tropical**
  3. **Continental** (land regions)
  4. **Maritime** (water regions)
- As air masses move, they become modified such that they show characteristics of two source regions
  - cP = continental Polar
  - mT = maritime Tropical

# Air Masses of North America

- (1) **cP** and **cA** Continental Polar and Continental Arctic  
Cold (very cold in winter) and dry, stable conditions
- (2) **mP** Maritime Polar  
Cool, moist and somewhat unstable. Forms in polar regions, then moves over oceans.
- (3) **mT** Maritime Tropical  
Very warm and moist. Forms over the eastern Pacific and the Caribbean sea and Gulf of Mexico.
- (4) **cT** Continental Tropical  
Hot, dry and unstable conditions. Forms over northern Mexico and the southwestern U.S. during the summer.

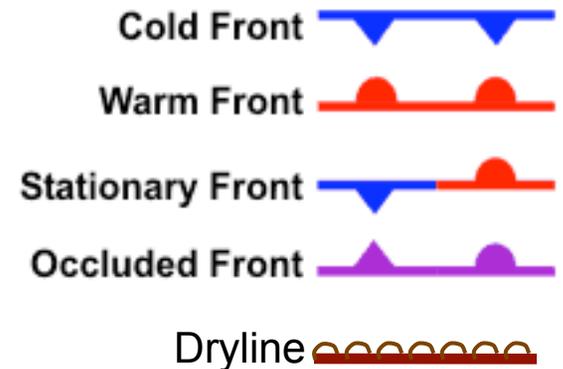


Source: NOAA National Weather Service Jetstream

# FRONTS

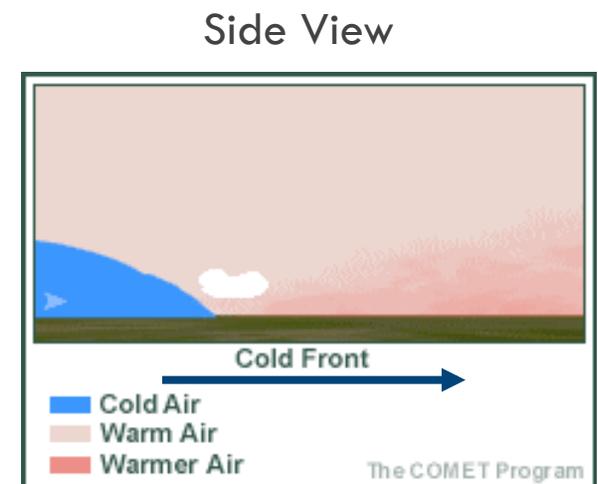
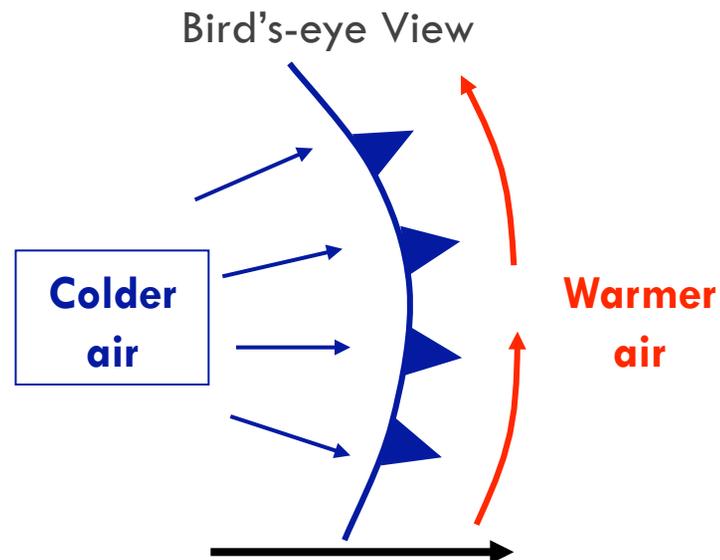
# Fronts

- *Fronts* are the boundaries between air masses
- Fronts are defined by the characteristics of the air mass it is replacing:
  - Cold front: colder air is replacing relatively warmer air
  - Warm front: warmer air is replacing relatively colder air
  - Stationary front: neither air mass is moving
  - Occluded front: a cold air mass (cold front) has overtaken a warmer air mass (warm front), lifting the warm layer aloft
  - Dryline: like a front, but a sharp contrast in moisture (humidity) more so than temperature
- Fronts are three-dimensional
  - Their slope determines the types of clouds that form along the boundaries



# Cold Front

- ☀ A cold front is a boundary where a cold air mass is replacing a warm air mass.
- ☀ Blue triangles point in the direction of movement.
- ☀ Air on the warm side is lifted rapidly over cold air → air rises and cools → condensation begins and clouds form, heavy showers may fall
- ☀ *Cumulus clouds* are associated with cold fronts.
- ☀ A cold front moves faster than a warm front.

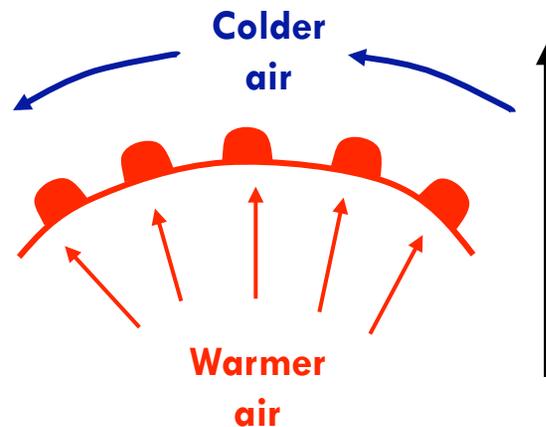


# Warm Front

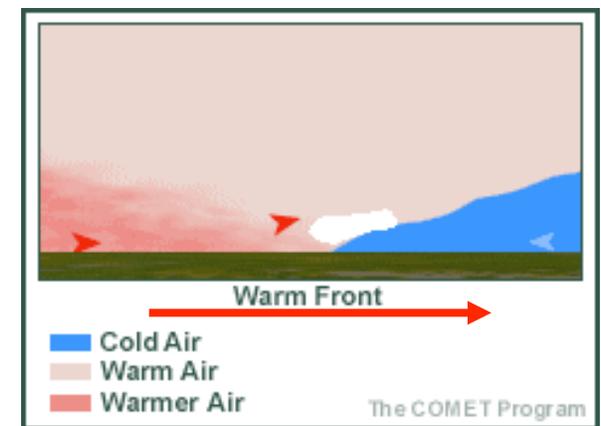
- ☀ A warm front is a boundary between an advancing warm air mass and a retreating cold air mass.
- ☀ Red half circles point in the direction of motion.
- ☀ Warm air rises over cold air at a slant, which leads to gradual lift.
- ☀ *Stratus, altostratus, and cirrus* are associated with warm fronts.



Bird's-eye View



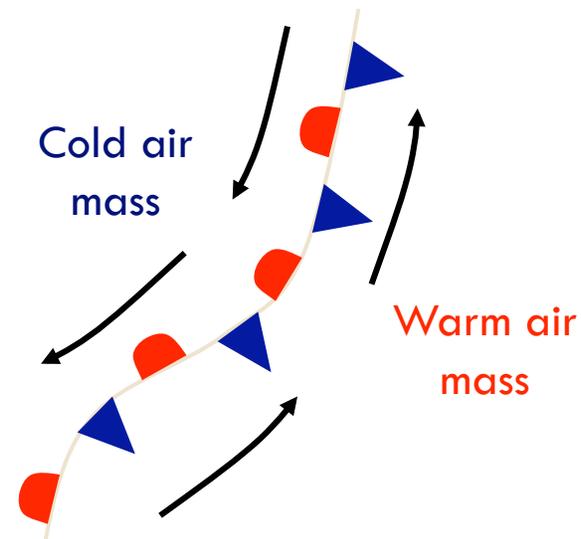
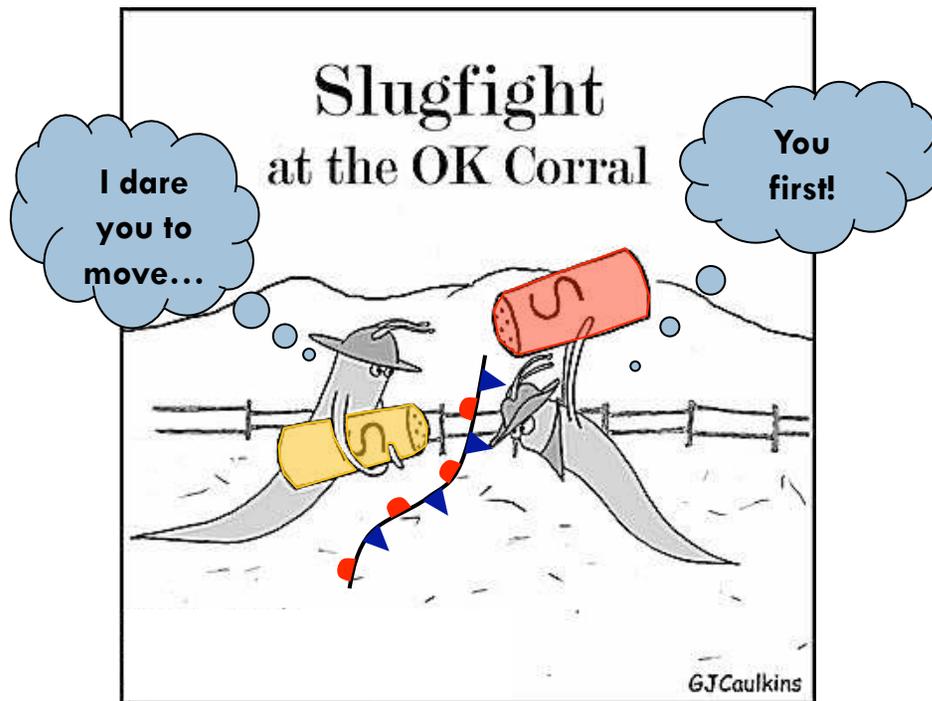
Side View





# Stationary Front

- ☀ A stationary front experiences very little to no movement.
- ☀ Two air masses are at a “stand-off,” waiting for one to make a move.
- ☀ The wind blows parallel to the front, but in opposite directions.



# Identifying Fronts

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☀ Now we know the front types...but how do we find them?

☀ Radar

☀ Weather map

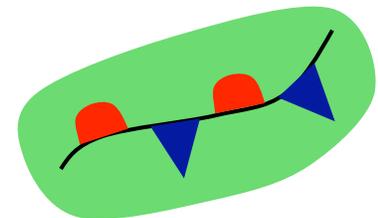
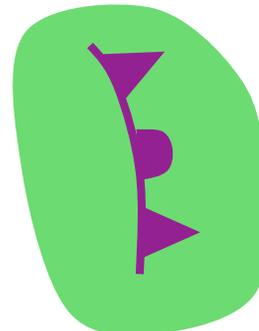
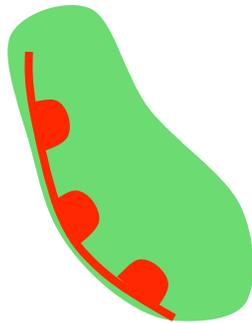
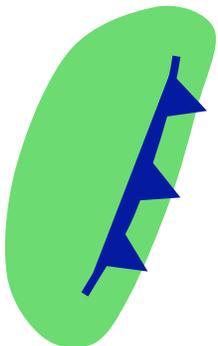
☀ Fronts on Radar

☀ **Cold front**—Precipitation is mostly behind the front, but there is some before and along the front. There is a convective band (high echo values) with a stratiform band (low echo values).

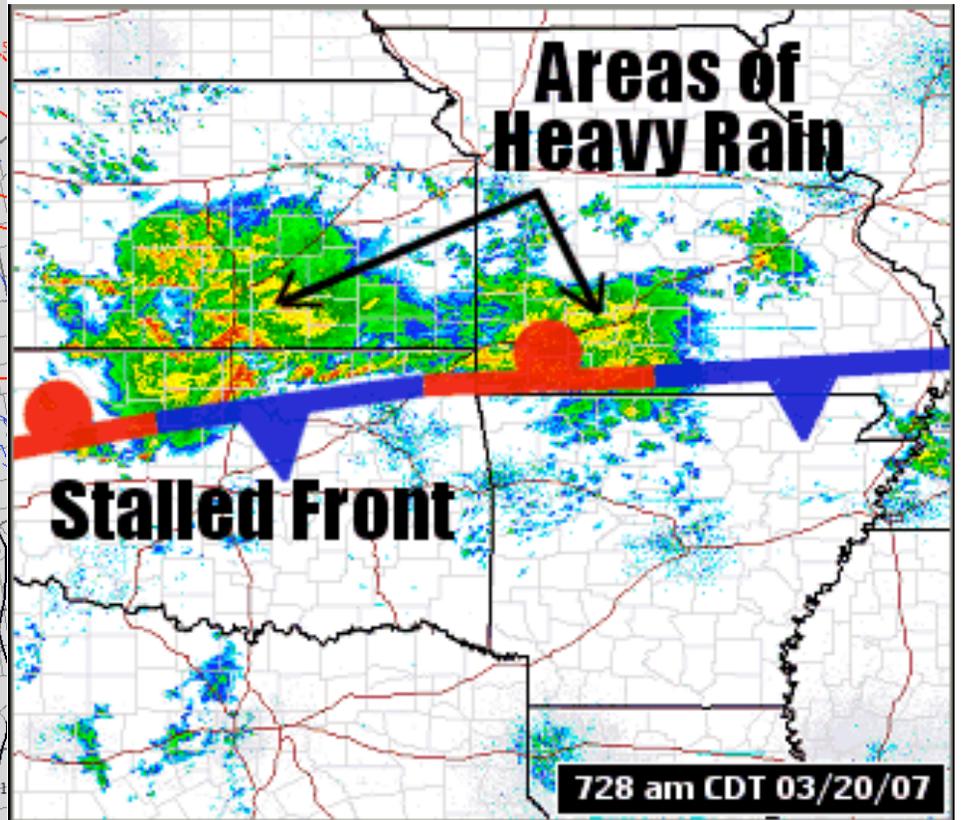
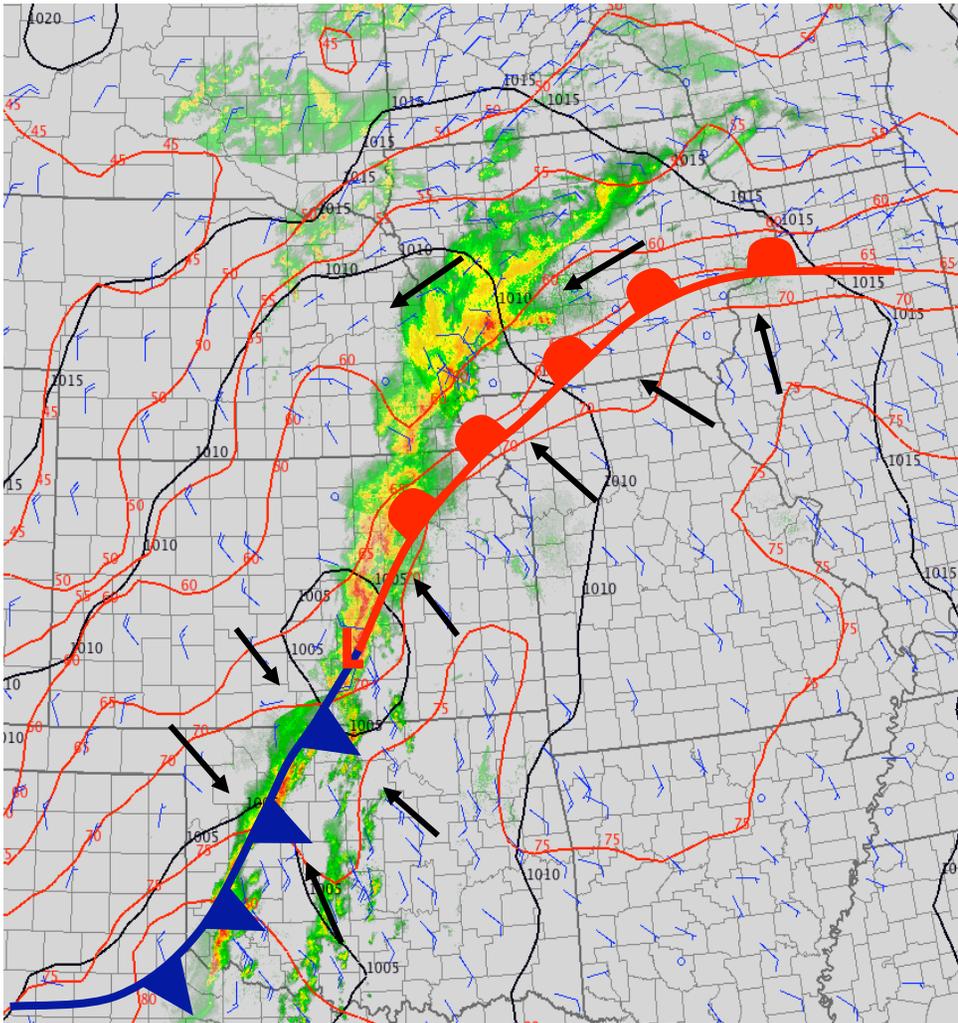
☀ **Warm front**—Precipitation is mainly before the front, with some along the front. The precipitation is mainly stratiform (low echo values).

☀ **Occluded front**—Precipitation falls before, behind, and along the front.

☀ **Stationary front**—There is no precipitation if both air masses are dry; if there is enough moisture, precipitation can fall over the same area for a while, which can lead to flooding!

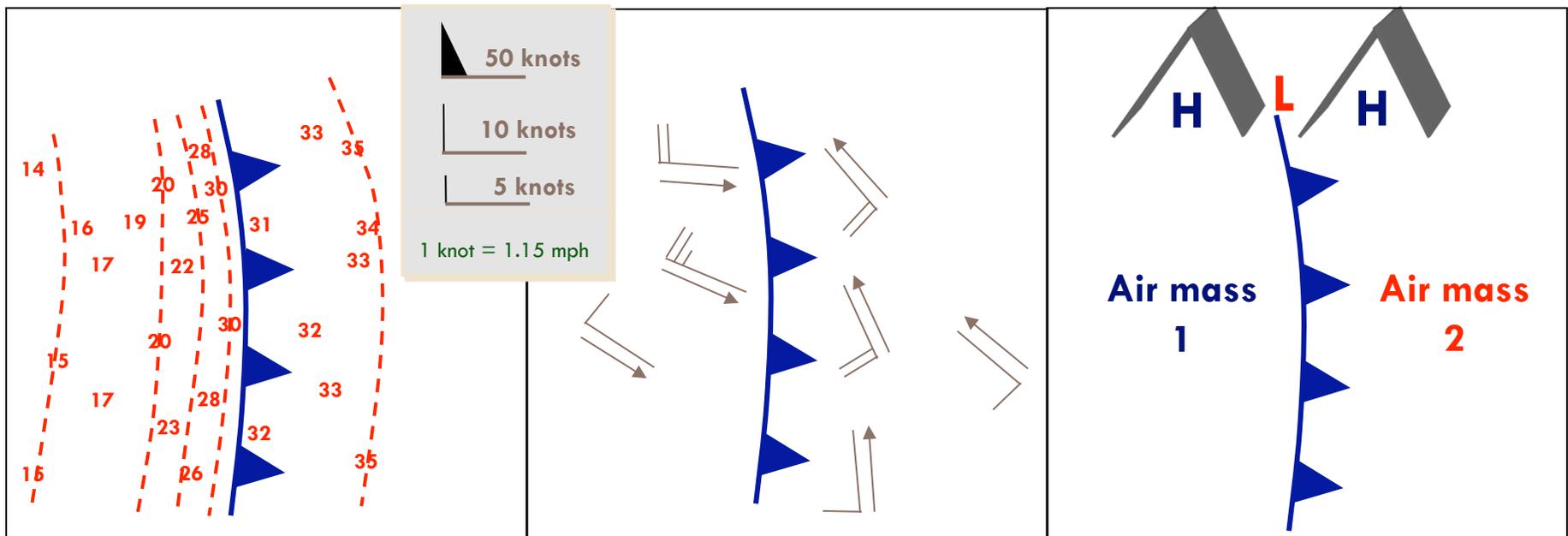


# Identifying Fronts on Radar



# Identifying Fronts on Weather Map

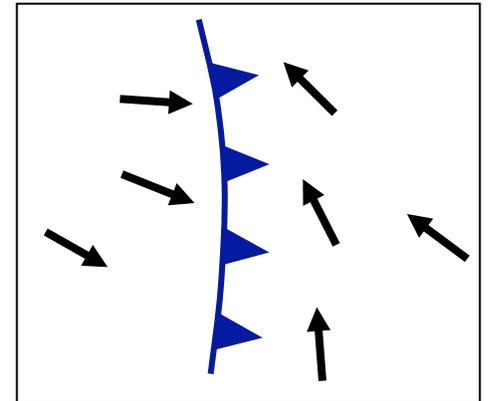
- ☀ Sharp temperature changes over relatively short distance
- ☀ Changes in moisture content (dew point changes)
- ☀ Wind direction shifts
- ☀ Pressure and pressure changes
- ☀ Clouds and precipitation patterns (seen in radar/satellite)



# Identifying Fronts on Weather Map

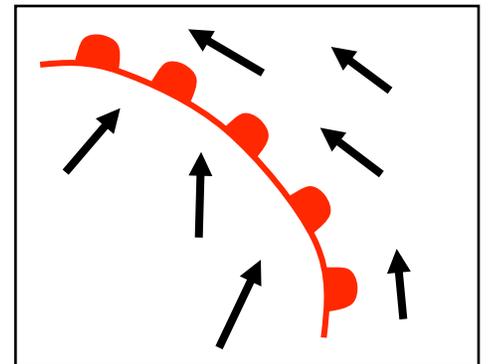
## ☀ Cold front

- ☀ Cooler temperatures with frontal passage
- ☀ Lower dewpoint temp. with frontal passage
- ☀ Winds: S/SW before front, W/NW after front



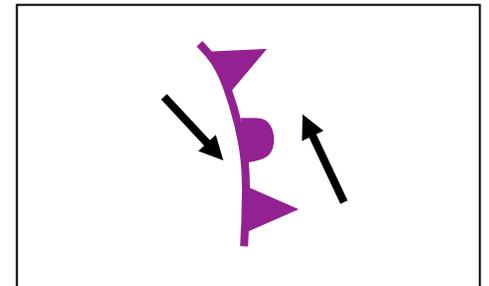
## ☀ Warm front

- ☀ Warmer temperatures with frontal passage
- ☀ Higher dewpoint temp. with frontal passage
- ☀ Winds: S/SE before front, S/SW after front



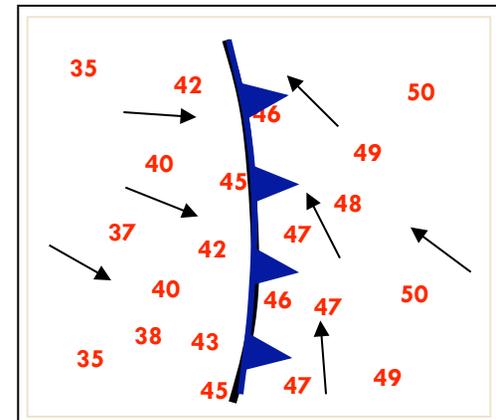
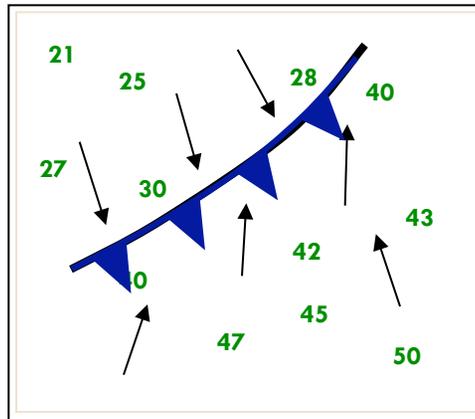
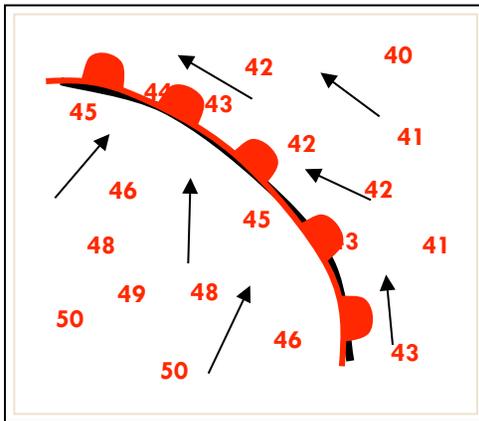
## ☀ Occluded front

- ☀ Often cooler temperatures with frontal passage
- ☀ Slightly lower dewpoint temp. with frontal passage
- ☀ Winds: E/SE/S before front, W/NW after front



# Identify the Fronts

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# Dryline

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- ☀️ Smaller scale than other fronts
- ☀️ Mainly seen in the Plains states, especially in W Texas, OK and KS (spring/early summer)
- ☀️ Narrow zone where there is a sharp change in moisture (dewpoint temperature)
- ☀️ Black or brown scalloped line
- ☀️ Separates warm, dry air and warm, moist air
- ☀️ Severe thunderstorms (e.g., supercells) can form along the dryline.

