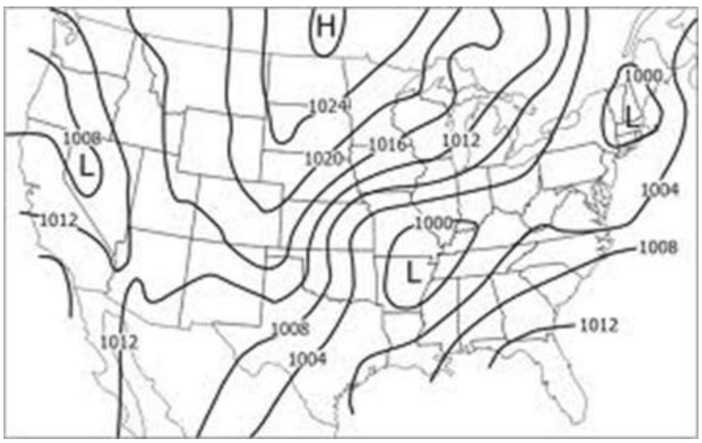
<u>Topic 8: Weather Notes, Continued—Workbook Chapter 8</u>

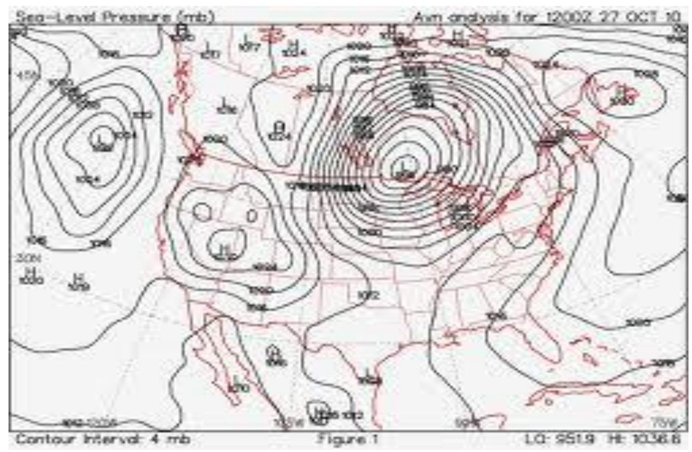
<u>Wind</u> is caused by differences in air pressure created by changes in temperature and water vapor content.

<u>Wind blows from high pressure areas to low pressure areas.</u>

<u>Wind speed</u> depends upon the rate of change (gradient) from high pressure to low pressure. If pressure doesn't change much over a large area, the gradient is low and the wind speed will be low. If the pressure changes greatly over a small area, the gradient is steep or high and the wind speed is fast.

<u>Isobars</u> on weather maps indicate the pressure gradient. If isobars are close together, the gradient is high and wind speed is fast. If isobars are far apart, the gradient is low and wind speed is low:



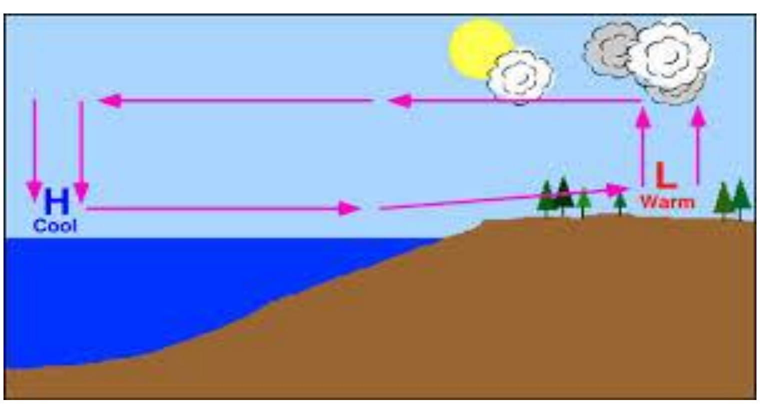


<u>Land/Sea Breezes</u>

During the day in coastal areas:

- Land heats up faster than water, causing the air above the land to be warmer, less dense, lower in pressure. It rises.
- Cooler, more dense air over the water has higher pressure. This air rushes in to replace the air that's rising over the land

The result: a **sea breeze** or **onshore** wind

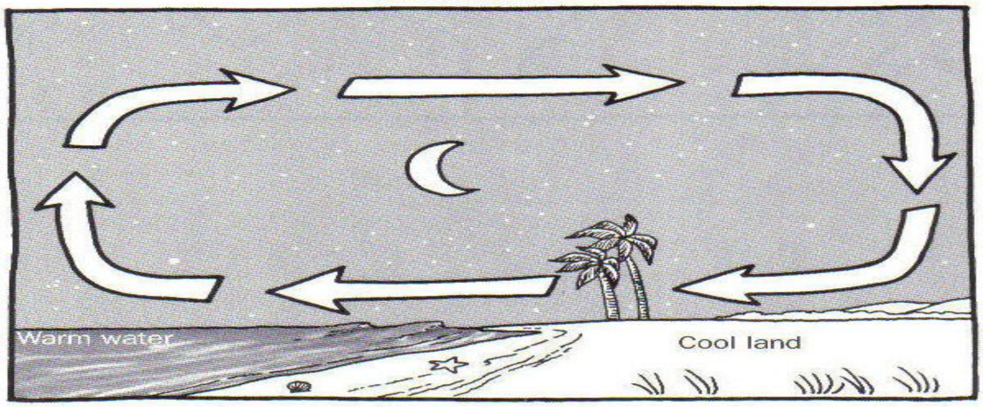


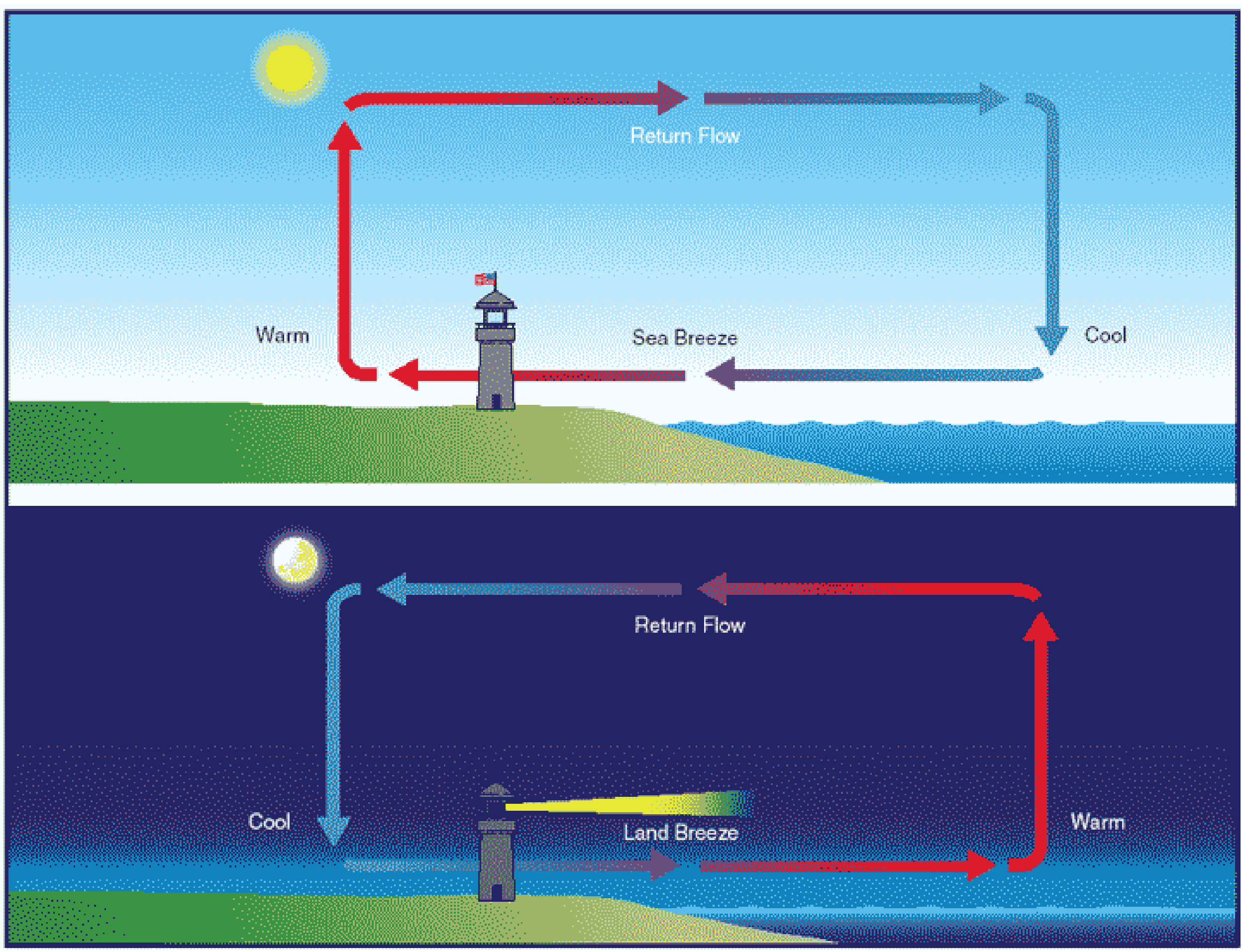
During the night in coastal areas:

- Land cools off faster than water. The air above the land is cooler, more dense, higher pressure at night than the air above the water.
- Warmer, less dense, low pressure air above the water rises.
- Cooler, more dense air above the land rushes in to replace the air rising above the water.

The result: **land breeze** or **offshore** wind

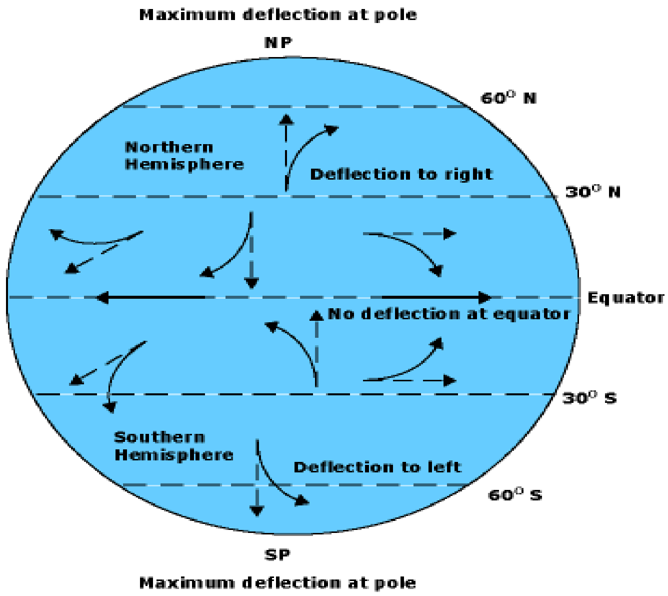
LAND BREEZE





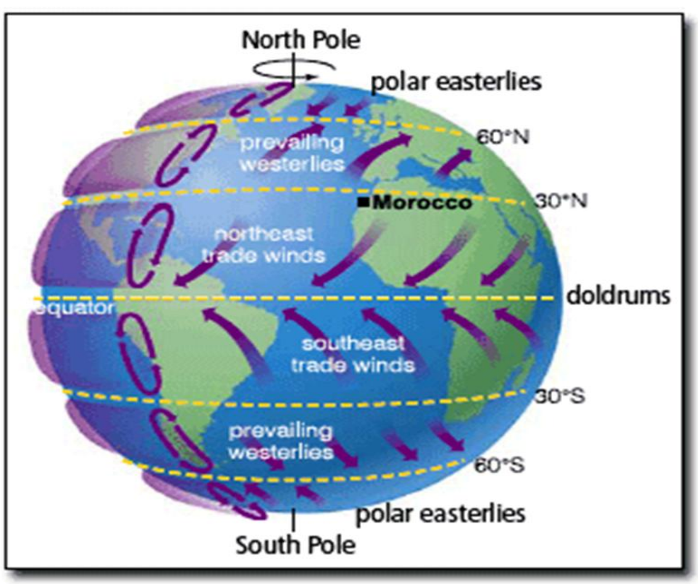
Coriolis Effect on wind direction:

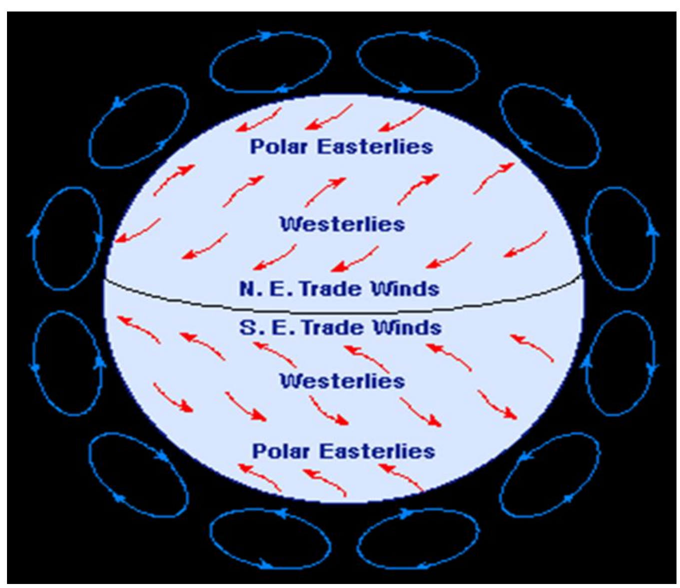
Earth's rotation causes winds to be deflected to the right
in the Northern Hemisphere, to the left in the Southern Hemisphere:



<u>Air Currents and Convection Cells</u>

Uneven distribution of heat energy on Earth causes differences in air pressure, creating convection cells as cooler, more dense, high pressure air falls and warmer, less dense low pressure air rises. This results in global air currents shown in the ESRT on page 14.

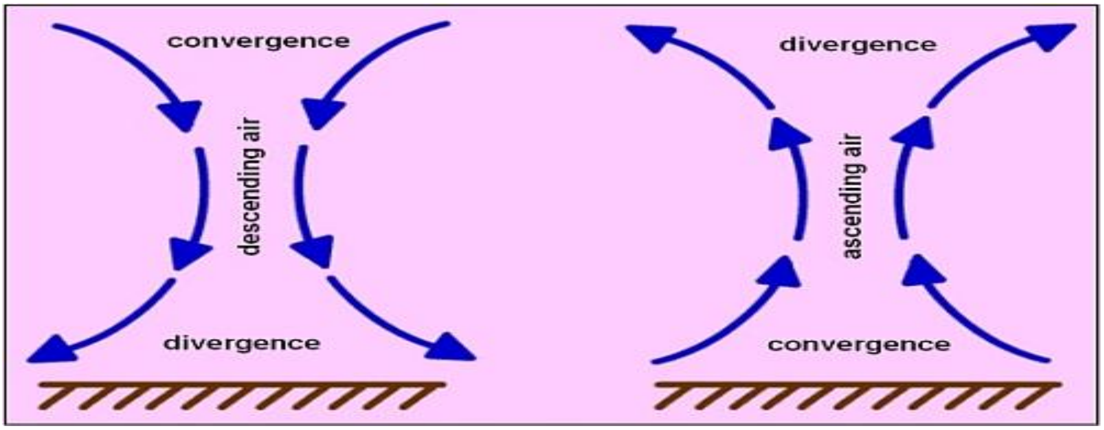




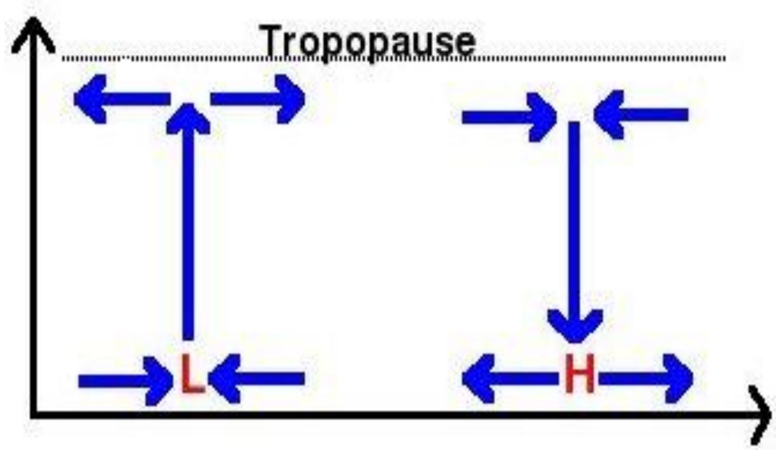
<u>The Coriolis effect also influences the direction of global winds or air currents.</u>

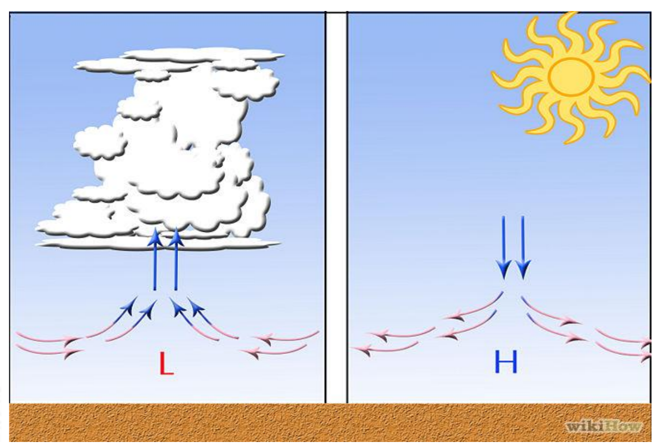
Regions where the air in these convection cells comes together to form vertical currents are regions of **convergence** (**low pressure areas**).

Regions where air spreads out from the vertical currents are regions of **divergence** (**high pressure areas**).



On the surface of the Earth, winds blow horizontally away from areas of divergence (high pressure regions) to areas of convergence (low pressure regions).



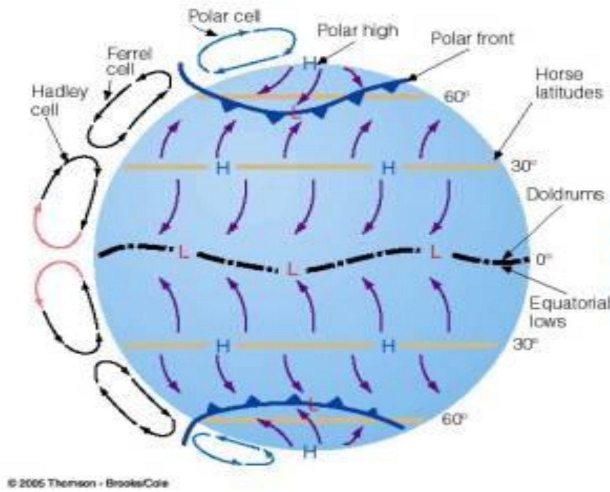


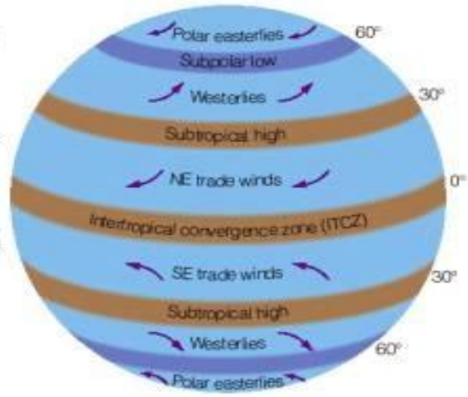
Planetary Winds/Prevailing Winds

Planetary winds are the prevailing winds that generally develop due to the movement of air from high to low pressure areas and the deflection of that movement by the Coriolis effect.

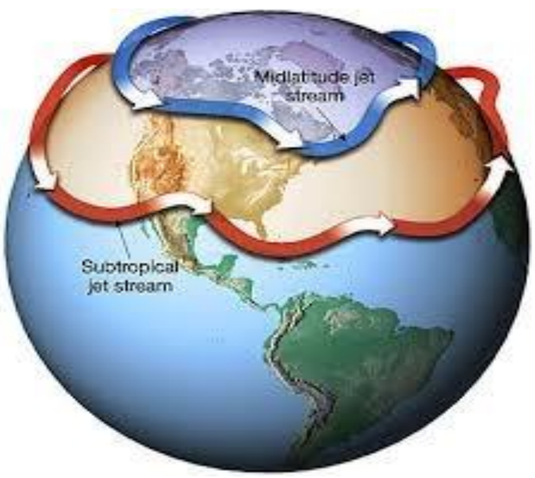
Planetary/prevailing winds in the United States move generally from a southwest to a northeast direction ("prevailing southwesterlies")

This causes weather patterns in the U.S. to move from the southwest to the northeast.

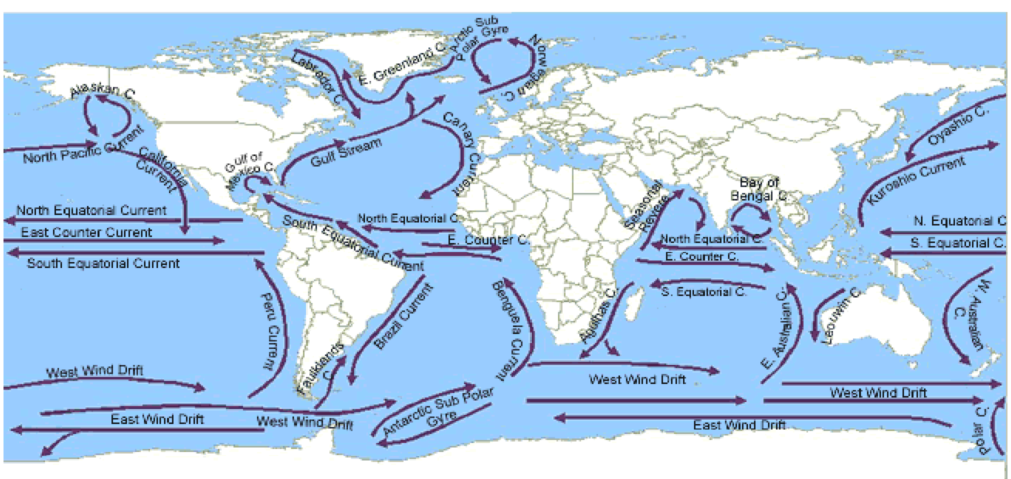




Jet Streams are easterly-moving bands of fast winds (up to 200 mph) at the top of the troposphere. Jet streams affect weather patterns in the mid-latitude regions of the northern and southern hemispheres.



Ocean currents are formed when wind blows over the surface of the water, transferring its energy. Planetary/prevailing winds and pressure belts thus affect ocean currents. Ocean currents spin clockwise in the northern hemisphere and counterclockwise in the southern hemisphere due to the Coriolis effect.



Ocean currents map is found on page 4 in the ESRT.

Atmospheric moisture

The oceans are the main source for water vapor in the atmosphere. Water vapor enters the air by evaporation, transpiration and sublimation.

Evapotranspiration = evaporation + transpiration.

The rate of evaporation depends upon:
- Insolation: more insolation, more energy for evaporation
- Surface area: more area exposed, the greater the evaporation rate
- Air saturation: the drier the air, the faster the rate of evaporation
- Wind speed: wind moves air away from a surface, replacing it with drier air. The greater the wind speed, the faster the evaporation rate.

A dynamic equilibrium: rate of evaporation = rate of condensation

Precipitation

Precipitation is falling liquid or solid water from clouds (rain, drizzle, snow, sleet, freezing rain, hail).

It forms when ice crystals or water droplets in the clouds become too large to be suspended in the air and fall due to gravity. Deposition (the opposite of sublimation) forms ice crystals; condensation forms water droplets. Condensation on Earth's surface = dew; deposition = frost.

A **cloud** is a collection of liquid water drops and/or ice crystals suspended in the atmosphere and dense enough to be visible. **Haze** is when the density of water droplets is low; **fog** is a cloud that forms just above Earth's surface.

The altitude where dew point and air temperature are the same is where clouds will form.

FACTORS NEEDED FOR CLOUD FORMATION: 1. saturated air
2. condensation surface (aerosols, dust) 3. cooling temperatures

Air Masses

An **air mass** is a large body of air that shows the same temperature and humidity throughout at a given altitude. Within an air mass, all points at the same altitude have nearly the same temperature and humidity.

Air masses can cover nearly an entire continent or ocean. An air mass takes its characteristics from the Earth surface over which it forms, which is called its **source region**.

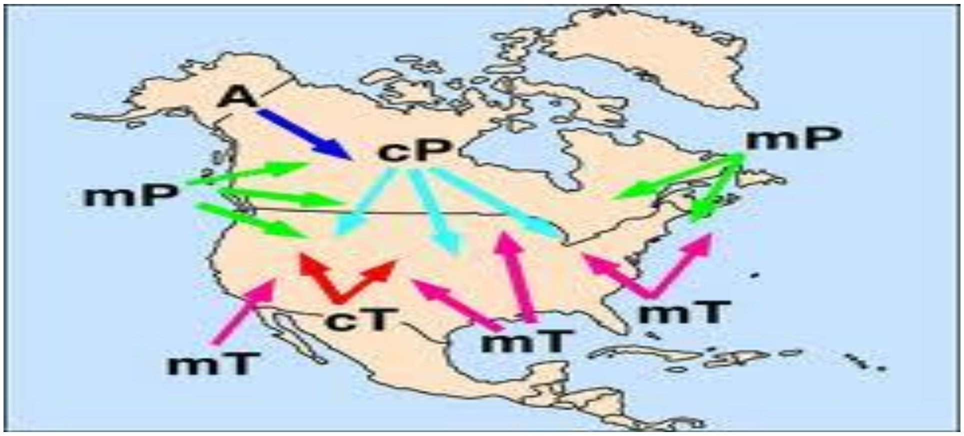
Air masses over land = dry; over the ocean = moist
Air masses at high latitudes = cold; low latitudes = warm

Naming an air mass:

c= continental (over land);	**T**= tropical (low latitudes)
m= maritime (over ocean)	**P**= polar (high latitudes)

4 major air masses affect weather in the continental United States:

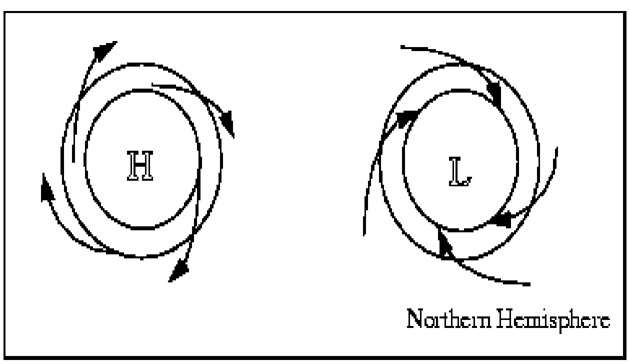
cP = continental polar—dry and cool (over Canada)
mT = maritime tropical—moist and warm (ex: over southern Atlantic)
cT = continental tropical—dry and warm (over southwest US)
mP = maritime polar—moist and cool (over northern Atlantic)

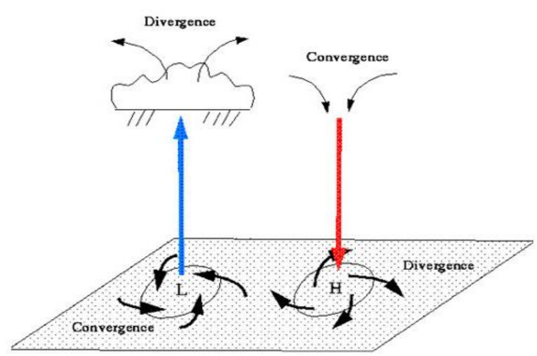


<u>Air masses do not mix with each other.</u> (warm air rises, cold air sinks).

<u>The boundary between different air masses is called a ***front.***</u>

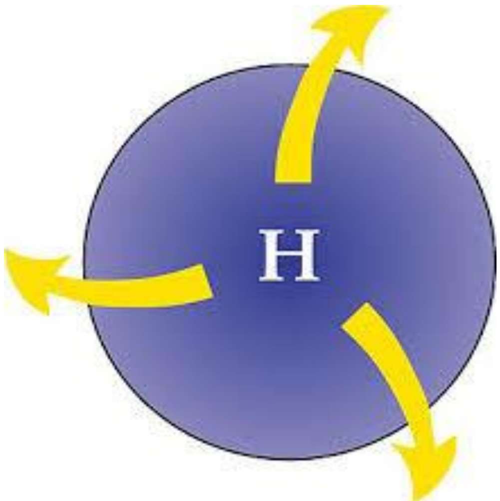
Air masses are classified by their pressure and wind circulation.
Low pressure systems (lows) are called **cyclones.** The lowest air pressure is found in the center of the system. Winds blow **counterclockwise toward the center** of a low:

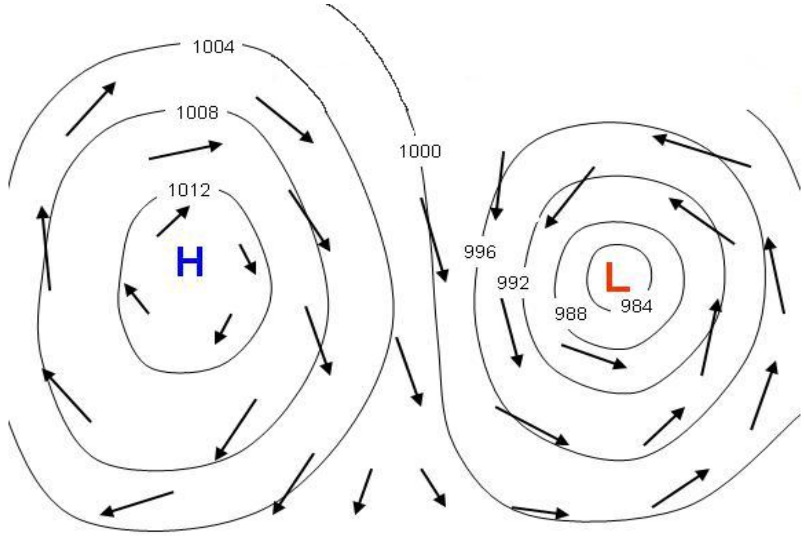




High pressure systems (highs) are called **anticyclones**. The highest pressure is found at the center of the system.

Winds blow **clockwise and away from the center** of a high:



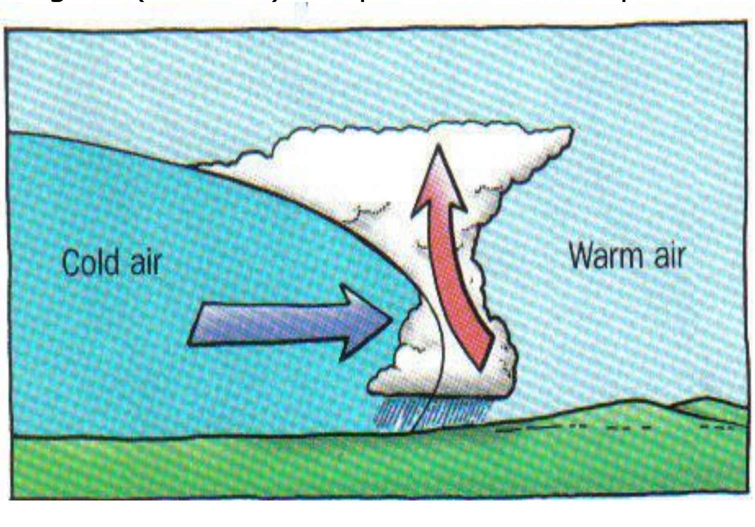


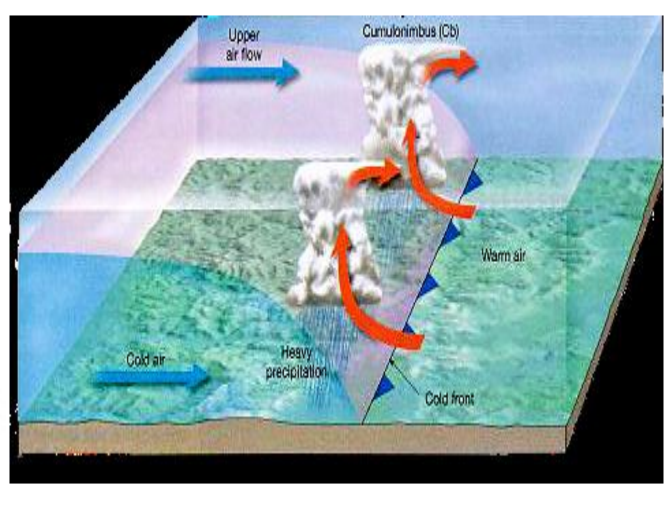
__Fronts–__ *the interface or boundary between 2 different air masses*

Fronts are **named for the air mass that is moving**.

Cold Front:
--cold air mass advances into an area occupied by a warm air mass
--warm air rises as cold, more dense air moves in under it
--puffy, cumulus clouds form as the warm moist air rises, expands, cools
--**precipitation is brief, heavy, over scattered areas along the front**
--**after front passes, winds change direction, pressure rises, temperatures drop and skies are clear**

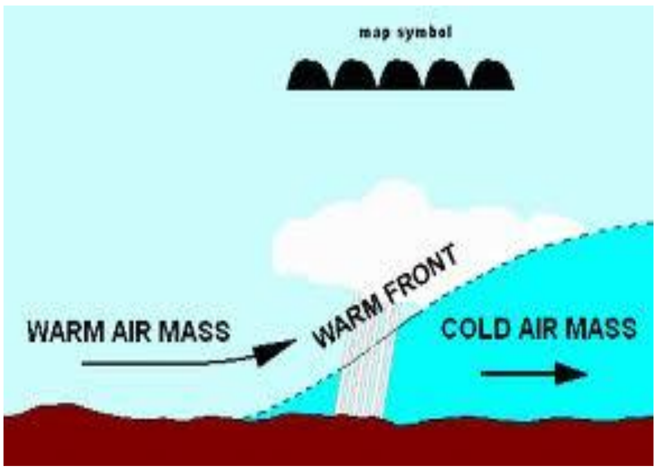
As the cold front passes through an area:
--low pressure is replaced by high pressure
--moist air (high humidity) is replaced by dry air (low humidity)
--higher (warmer) temperatures are replaced by lower(cooler) temperatures

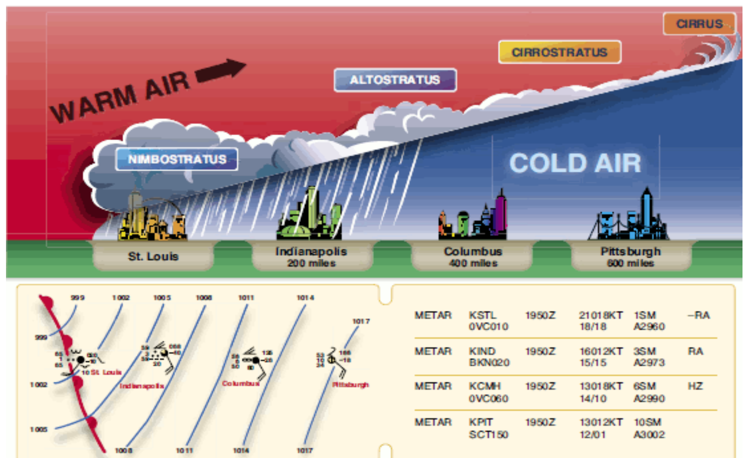


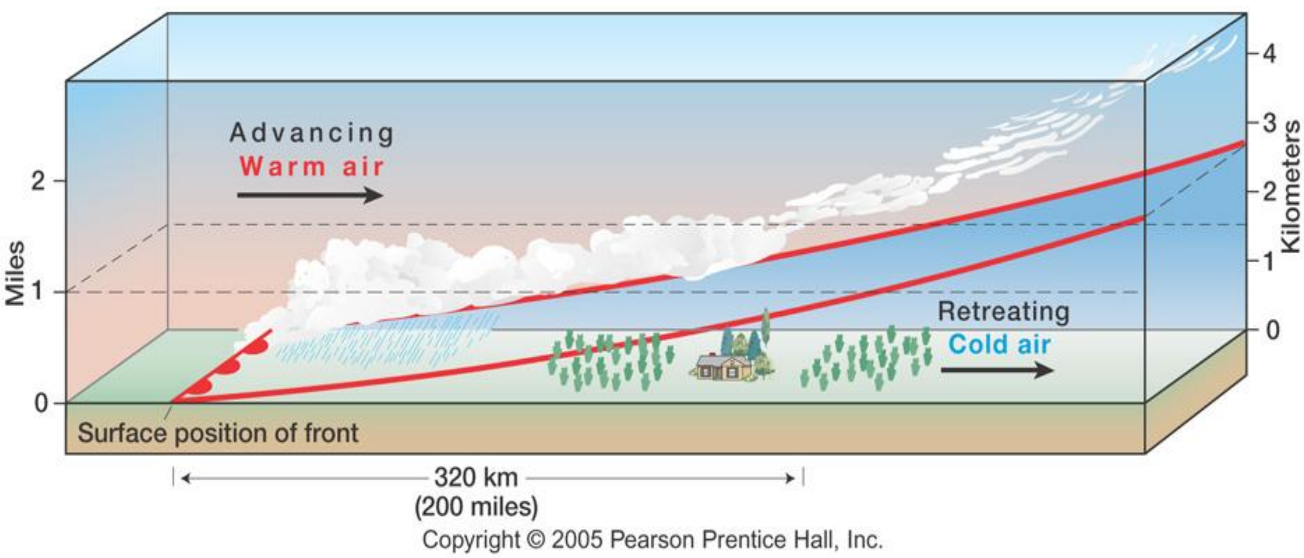


Warm Front:
--warm air mass advances on a cooler air mass, riding up and over it, slowly pushing it out of the way
--high thin clouds (cirrus) appear; clouds become thicker and lower as front moves in (stratus)
--precipitation occurs <u>ahead</u> of the frontal surface, for long periods of time over a widespread area

As the warm front passes through an area:
--high pressure is replaced by low pressure
--dry air (low humidity) is replaced by moist air (high humidity)
--lower (cooler) temperatures are replaced by higher (warmer) temperatures

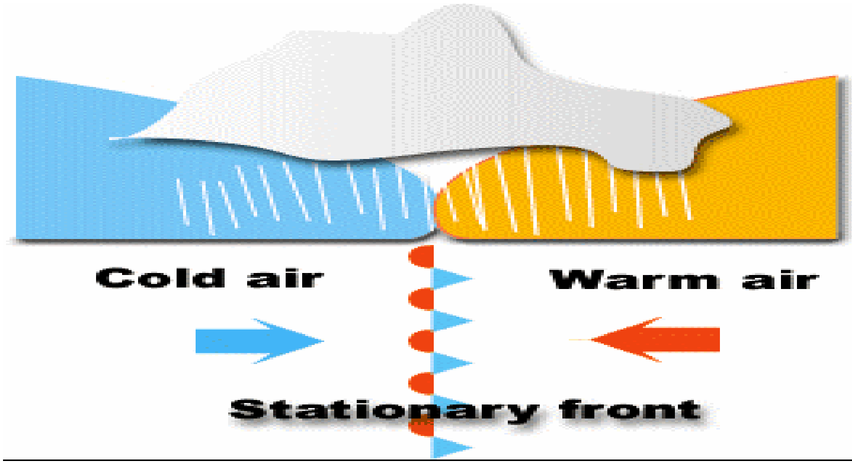




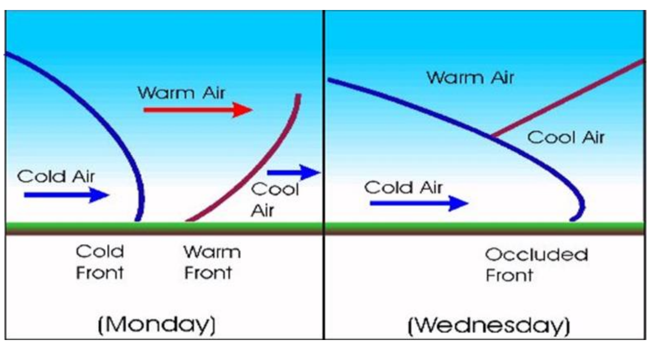


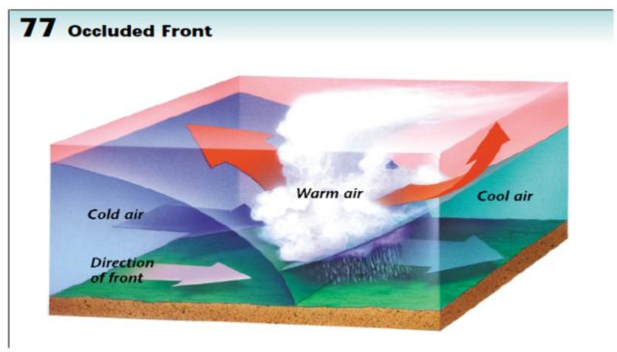
<u>In general, cold fronts move more quickly than warm fronts, and bring more severe weather patterns. Slow-moving warm fronts often take days to pass, bringing showers that last a long time.</u>

Stationary Front:
--formed when 2 adjacent air masses with different characteristics remain in place for a considerable length of time. **Weather is similar to a warm front.**

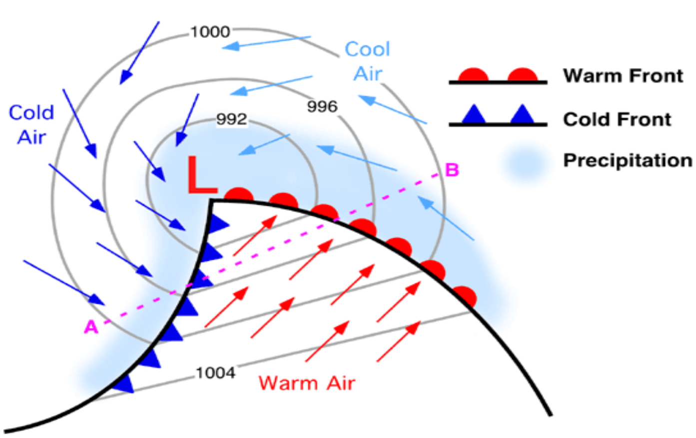


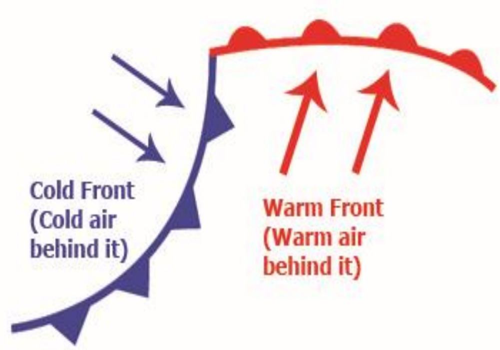
Occluded Front:
--begins as a stationary front. As the cold air mass begins to move, it overtakes the warm air mass, trapping it against a cooler air mass. This causes the warm air mass to lift entirely off the ground. Weather is similar to a cold front.
<u>Occluded fronts form "mid-latitude lows" that result in heavy precipitation</u>.





<u>Northern Hemisphere Mid-latitude Cyclone</u>





Weather Tracks:

Weather in the United States follows a southwest to northeast track due to prevailing southwest winds.

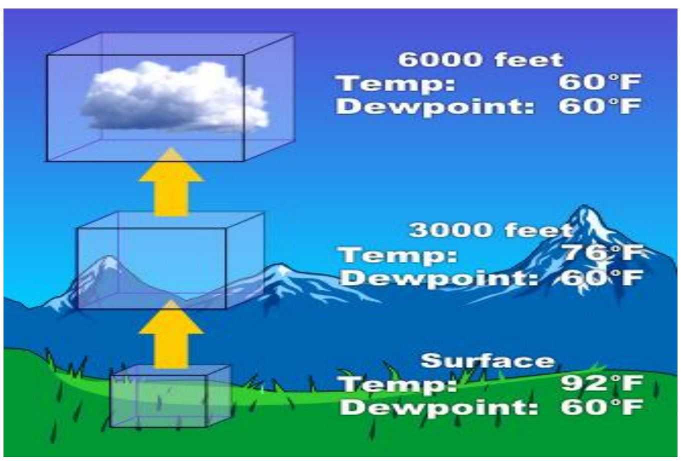
Adiabatic Temperature Changes

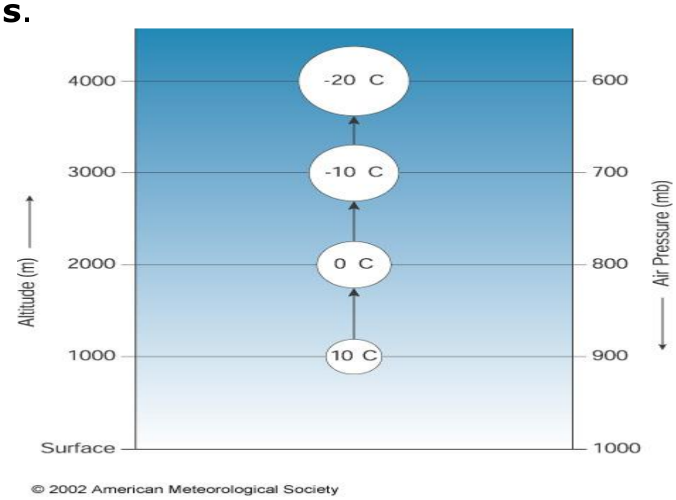
Temperature changes that occur as a result of the expansion or compression of a gas are called adiabatic temperature changes.

During these temperature changes, no heat energy is added or removed; rather, *changes in kinetic energy* cause the temperature of the gas to change.

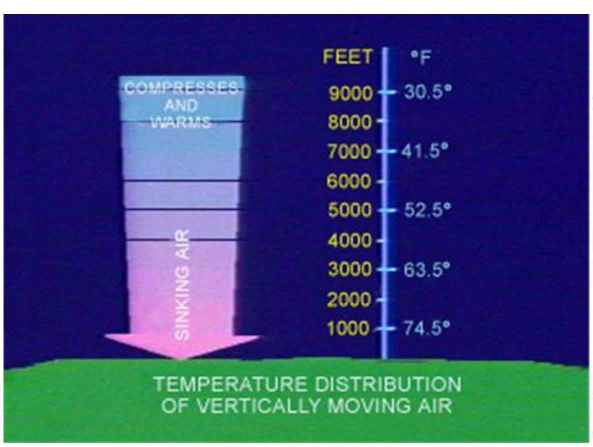
As an air mass rises in the atmosphere:
--it moves to an area of lower air pressure (pressure decreases as altitude increases)
--lower pressure causes the air mass to expand and push aside the surrounding air, causing the air molecules to lose kinetic energy
--lower kinetic energy = lower temperature

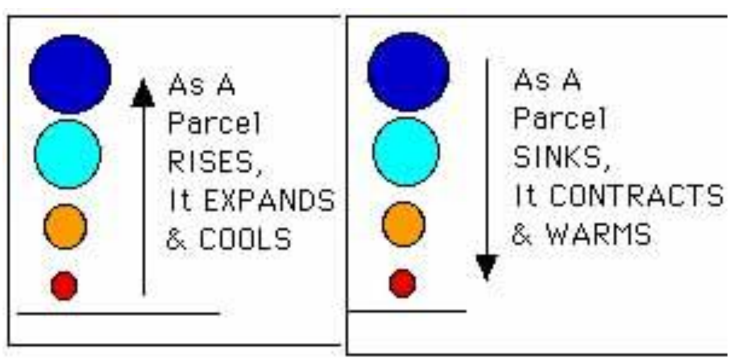
The air mass then **rises, expands, and cools**.

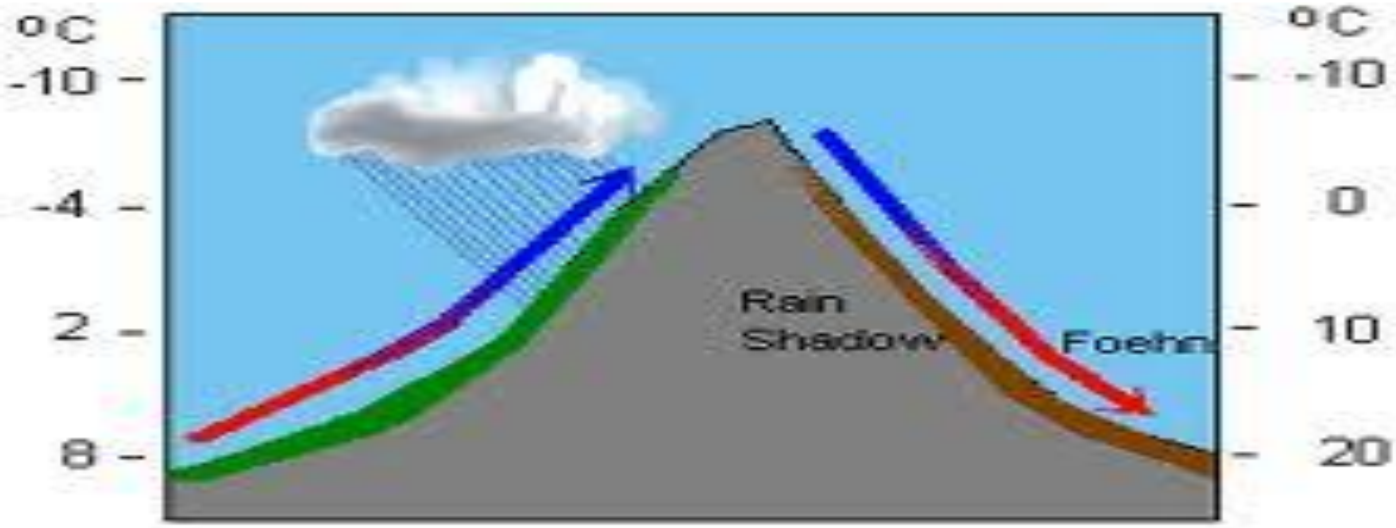


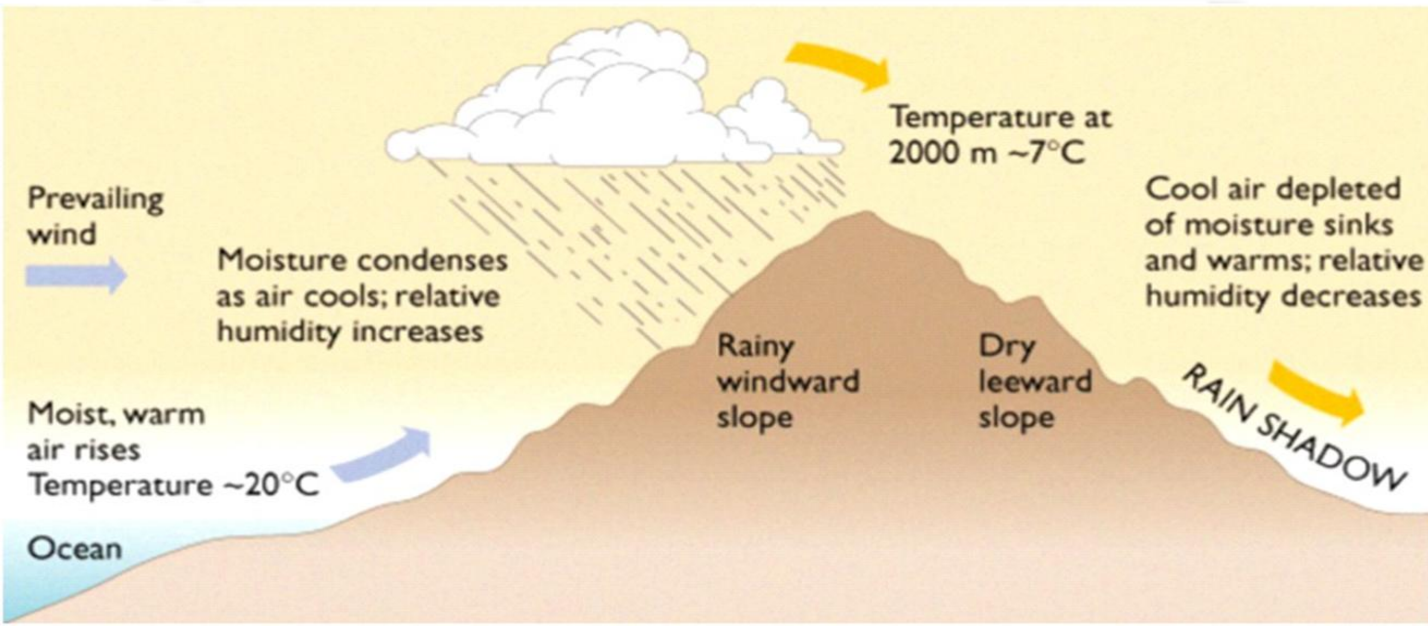


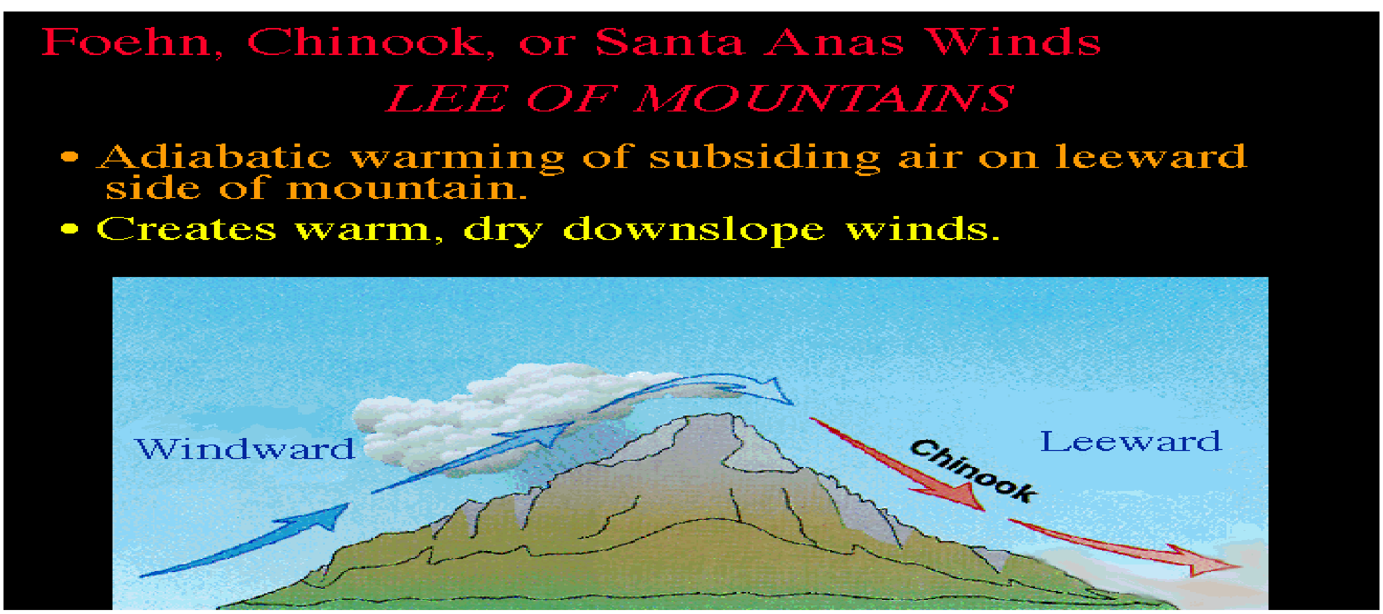
As an air mass falls or sinks, it moves into an area of higher air pressure. This causes the air mass to compress, increasing kinetic energy and thus warming the air mass. (The air molecules are closer together due to the increased pressure, which causes more collisions and leads to higher kinetic energy).






°C
-10
-4
2
8
°C
-10
0
10
20
Rain
Shadow
Foehn


Temperature at
2000 m ~7°C
Prevailing
wind
Cool air depleted
of moisture sinks
and warms; relative
humidity decreases
Moisture condenses
as air cools; relative
humidity increases
Rainy
windward
slope
Dry
leeward
slope
Moist, warm
air rises
Temperature ~20°C
RAIN SHADOW
Ocean


Foehn, Chinook, or Santa Anas Winds
LEE OF MOUNTAINS
• Adiabatic warming of subsiding air on leeward side of mountain.
• Creates warm, dry downslope winds.
Windward
Chinook
Leeward