* Goal 2.5 Weather and Meteorology

Meteorology

*Lesson 4

The Causes of Weather

Where does the weather in our country come from?

*Think About It...

Which air masses determine the weather in our country?

*Focus Question...

* **Weather or Climate?**
  * The current state of the atmosphere
    * Weather
  * Short term variation in atmospheric conditions
    * Weather
  * It's cloudy with a chance of meatballs!
    * Weather

*Weather or Climate?

*Weather or Climate?

* The long term variation in weather
  * Climate
* Average weather for a specific location
  * Climate
* Winston-Salem is humid, subtropical with 4 seasons.
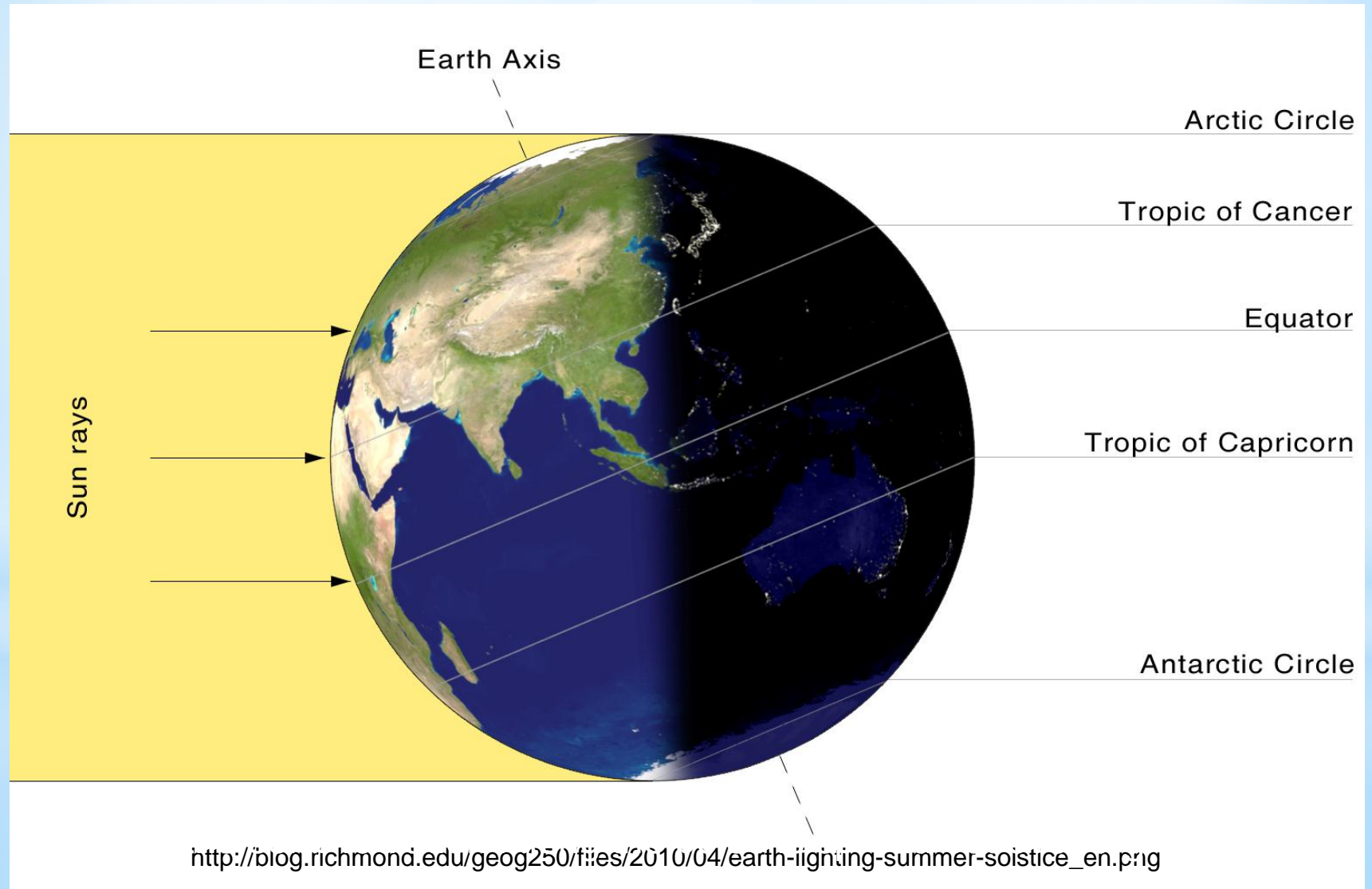 * Climate

*Weather or Climate?

2. What two things are always in motion to distribute heat energy on and around the Earth?
   - ✓ **ocean currents**
   - ✓ **global wind systems**

3. What explains why the poles are never very warm?
   - ✓ The Sun's rays do not hit the Earth as directly at the poles as at the tropics so the same amount of solar radiation is spread over a larger area.
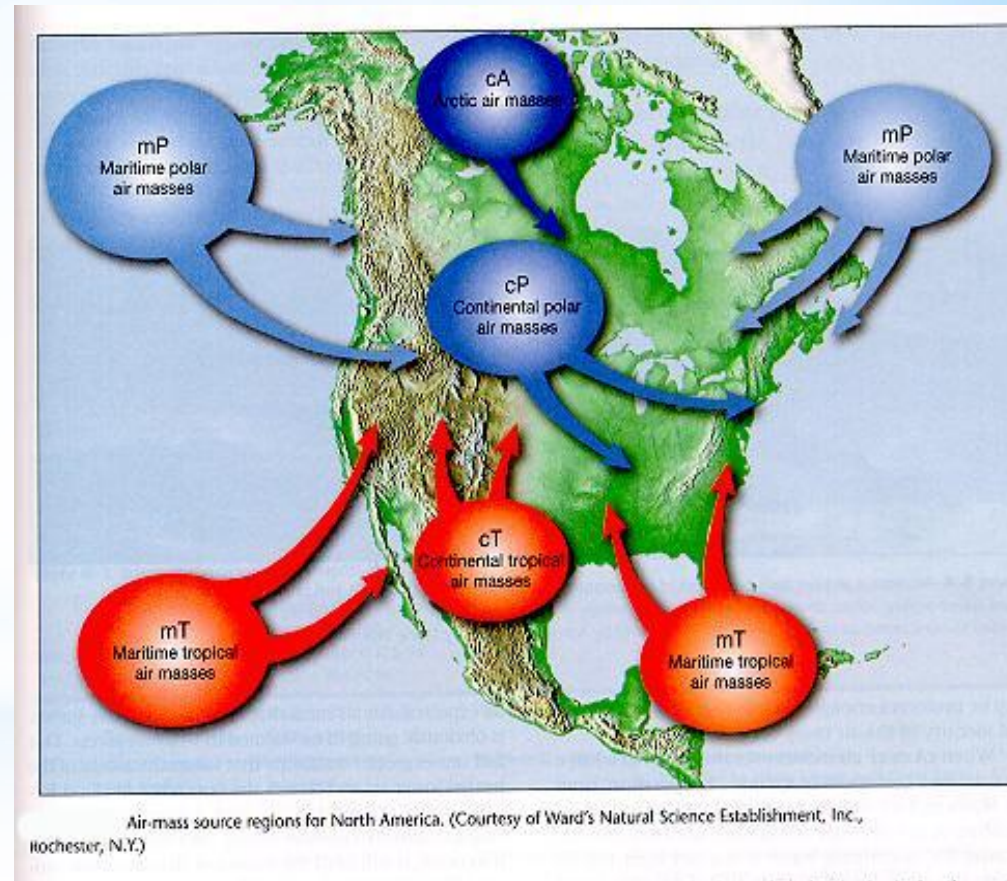
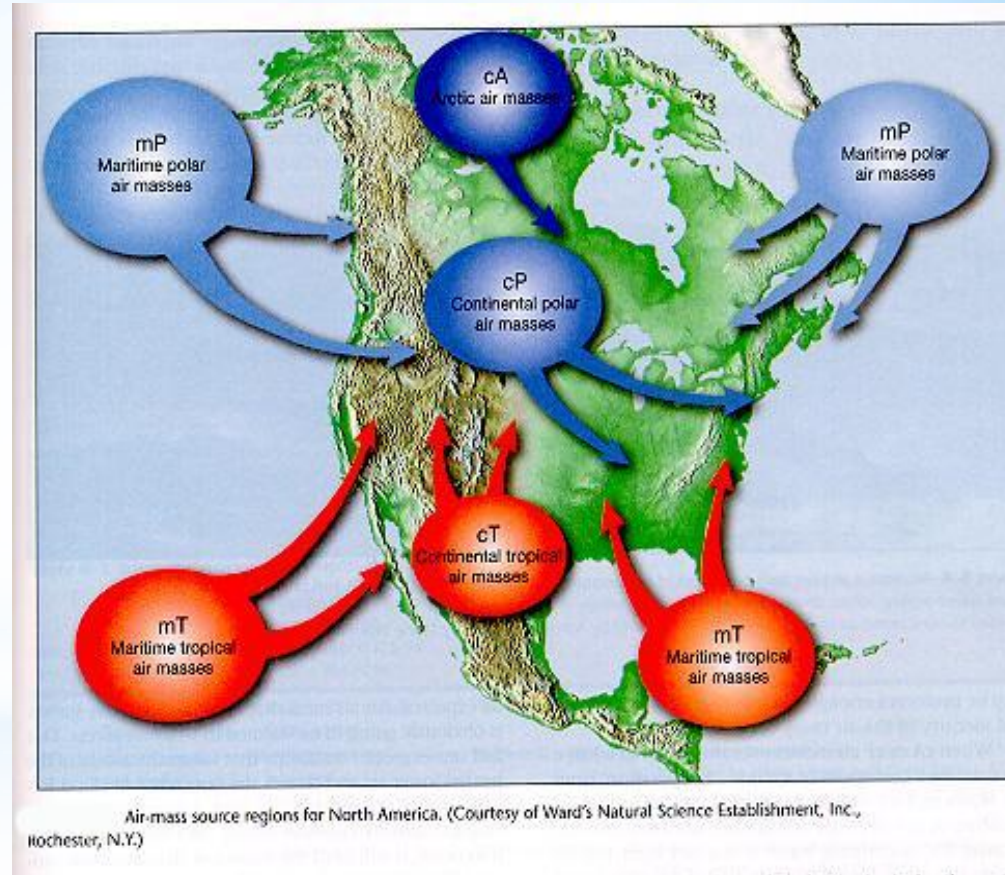*Energy in the Atmosphere...

Earth Axis

Arctic Circle

Tropic of Cancer

Equator

Tropic of Capricorn

Antarctic Circle

Sun rays

http://blog.richmond.edu/geog250/files/2010/04/earth-lighting-summer-solstice_en.png

*Continental Tropical

  *Abbreviation - cT

  *Origin - land

  *Origin - tropical

  *Moisture Content - dry

  *Temperature - warm

Air-mass source regions for North America. (Courtesy of Ward's Natural Science Establishment, Inc., Rochester, N.Y.)
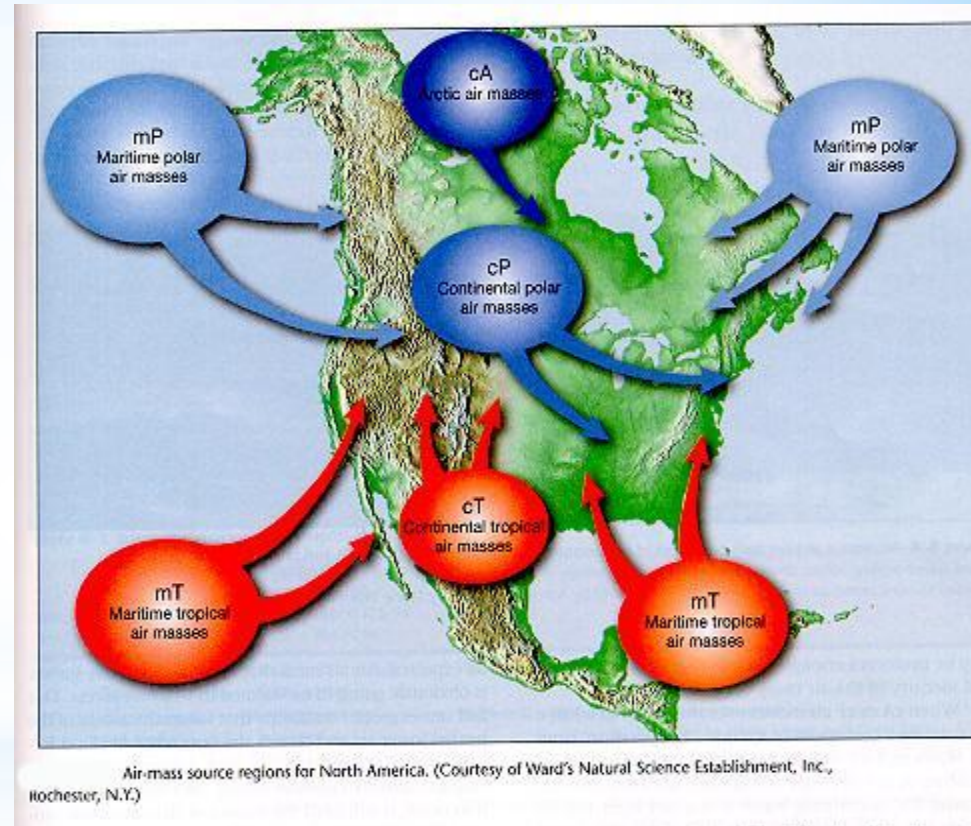
*Air Masses...

*Maritime Tropical
* Abbreviation - mT
* Origin – ocean/water
* Origin - tropical
* Moisture Content - humid
* Temperature - warm

Air-mass source regions for North America. (Courtesy of Ward's Natural Science Establishment, Inc., Rochester, N.Y.)
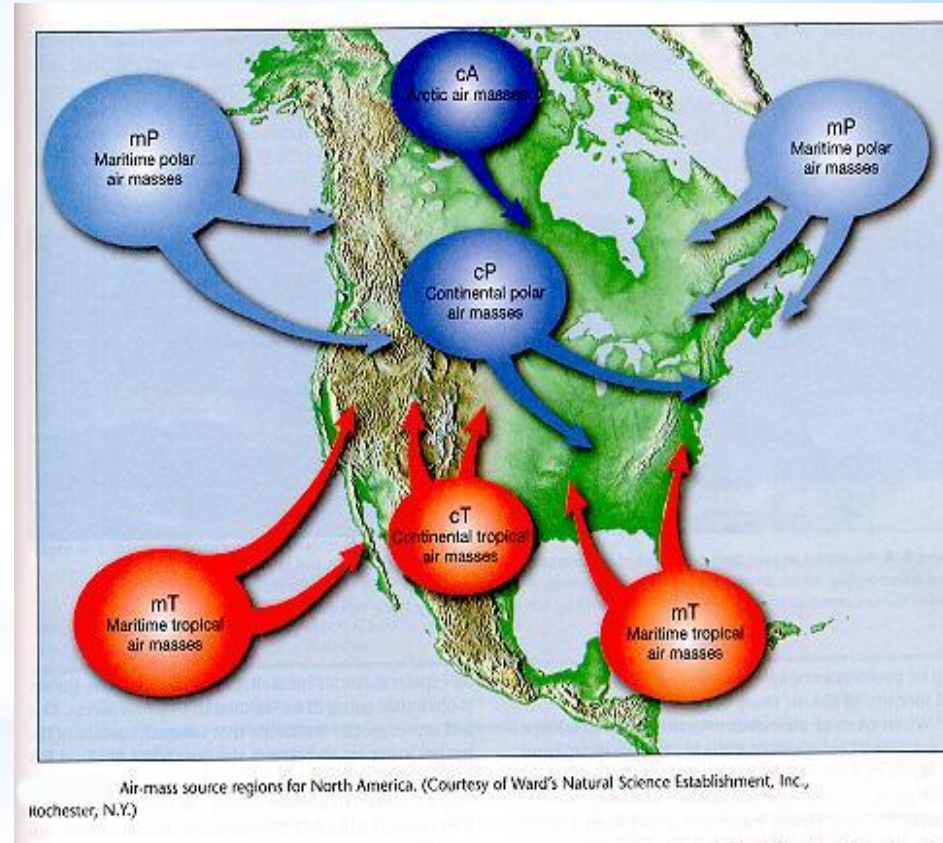
*Air Masses...

Continental Polar

* Abbreviation - cP
* Origin - land
* Origin – high latitudes
* Moisture Content - dry
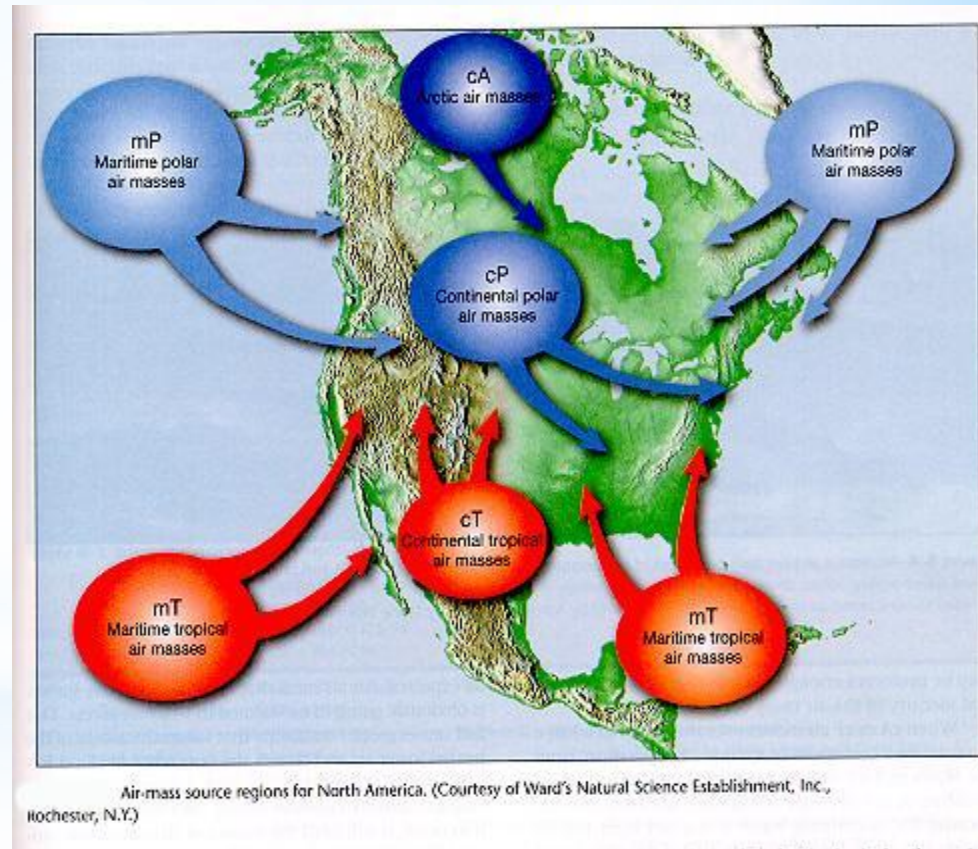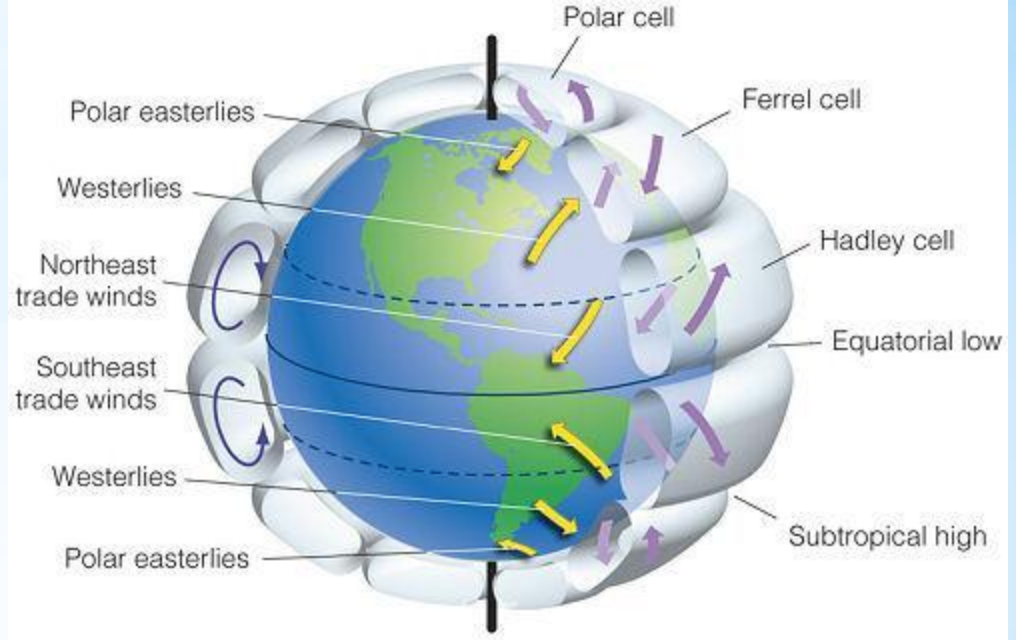* Temperature – cool or cold

Air-mass source regions for North America. (Courtesy of Ward's Natural Science Establishment, Inc., Rochester, N.Y.)

*Air Masses...

*Maritime Polar

- *Abbreviation - mP
- *Origin – ocean/water
- *Origin – high latitudes
- *Moisture Content - humid
- *Temperature – cool or cold

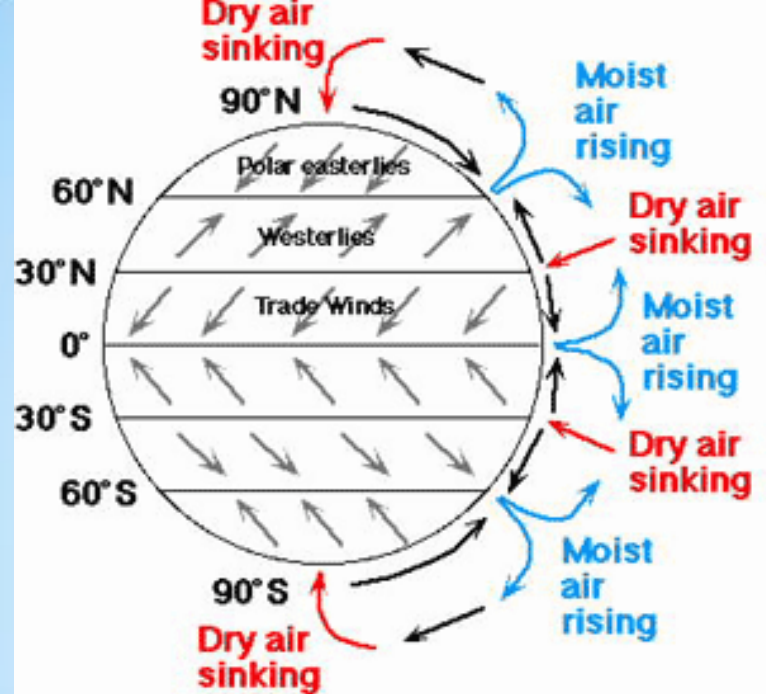Air-mass source regions for North America. (Courtesy of Ward's Natural Science Establishment, Inc., Rochester, N.Y.)

*Air Masses...

*Arctic (Continental)

* Abbreviation - A
* Origin – land
* Origin - Arctic
* Moisture Content – dry
* Temperature – very cold

Air-mass source regions for North America. (Courtesy of Ward's Natural Science Establishment, Inc., Rochester, N.Y.)

# Air Masses That Affect Our Weather…

*Global Wind Systems

* Global Wind Systems...

*Polar Easterlies
- *Comes from the east
- *Located between 60 degrees latitude and the pole in both hemispheres
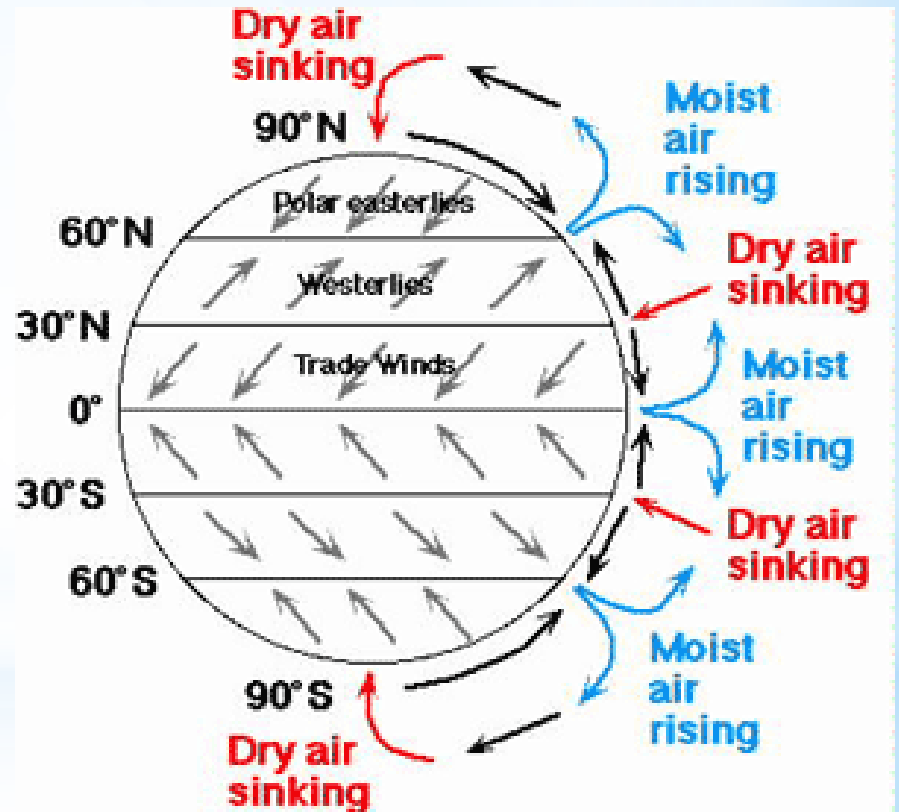
*Global Wind Systems...
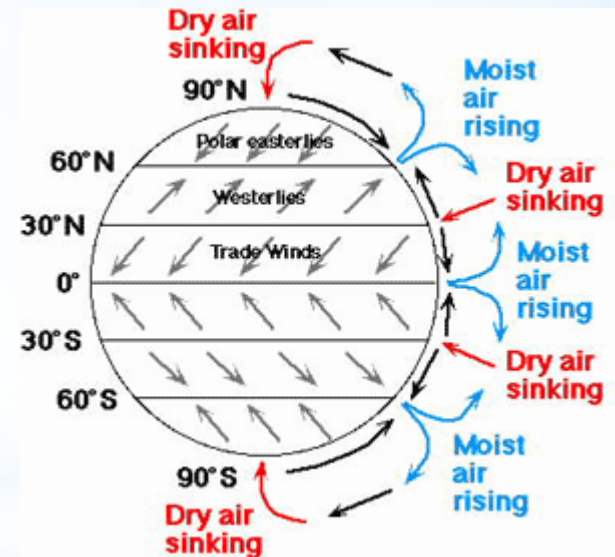
*Prevailing Westerlies
  *Comes from the west
  *Located between 30 and 60 degrees latitude in both hemispheres
  *This is the wind system that directs fronts across our country.
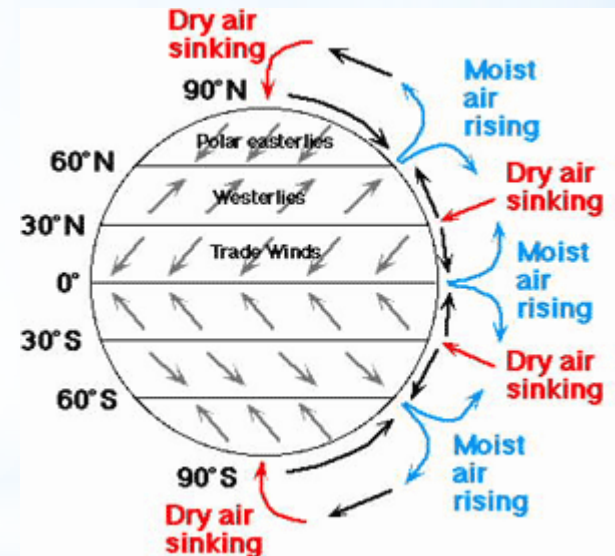
*Global Wind Systems...

*Trade Winds
  * Comes from the east
  * Located between the equator and 30 degrees latitude in both hemispheres

3. What is the **intertropical convergence zone (ITCZ)**?

- ✓ The area near the equator where the trade winds converge from 2 different directions.

- ✓ Air is forced up and creates an area of low pressure. (Remember – warm air rising!)

- ✓ The ITCZ provides the moisture for many of the world's tropical rain forests.

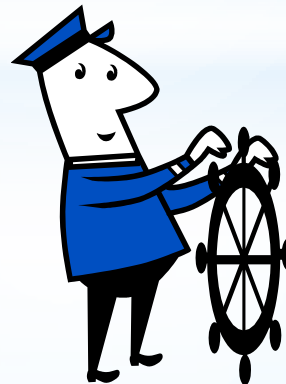- ✓ Picture on next slide…

*The Intertropical Convergence Zone
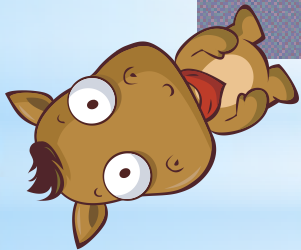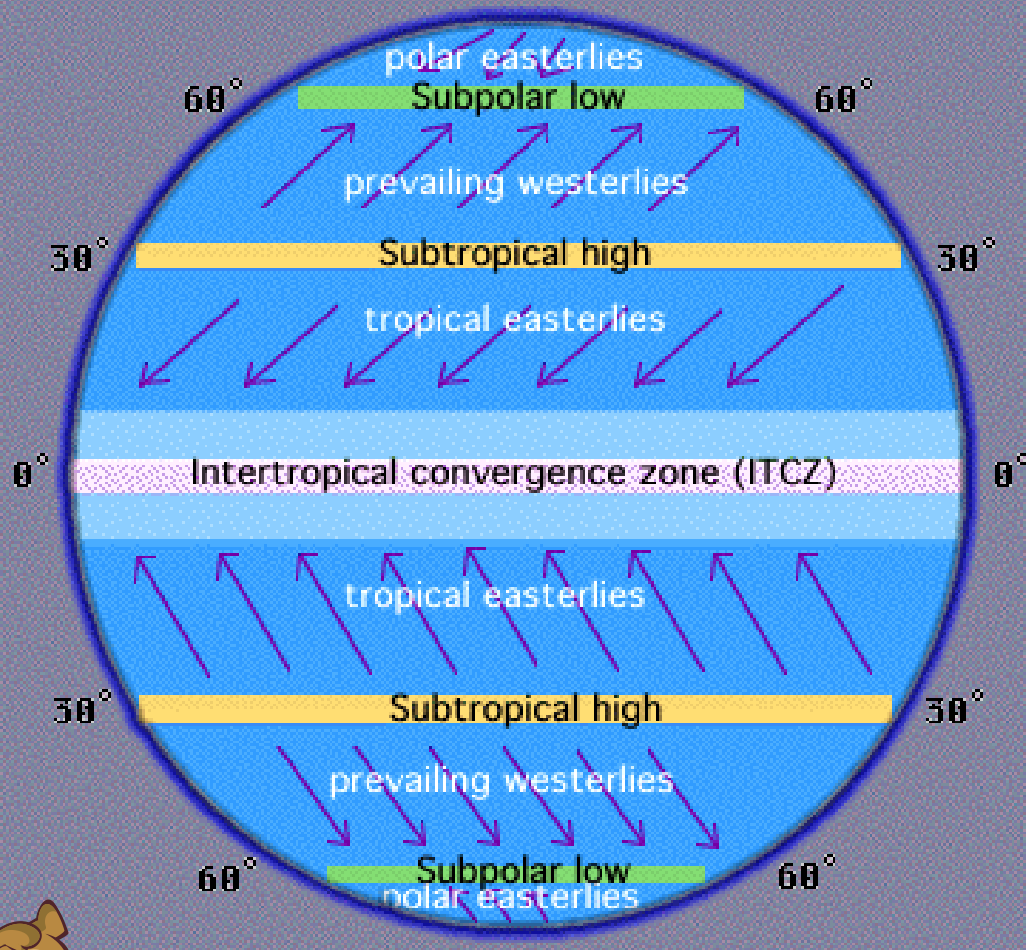
The Intertropical Convergence Zone

4. What are the doldrums?

✓ Another name for the ITCZ!

✓ Sailing ships would often get stranded in this area because of the light (or no!) winds.

✓ The phrase, "I'm stuck in the doldrums," came from this phenomenon.
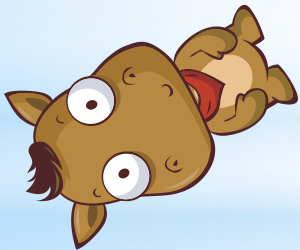
*The Doldrums...

Looking for wind!

5. Why were the horse latitudes so named?

- ✓ Around the 30 degrees latitude, sinking air creates a belt of high pressure which causes weak winds.

- ✓ Sailors stranded here were said to throw their horses overboard when they couldn't feed them!
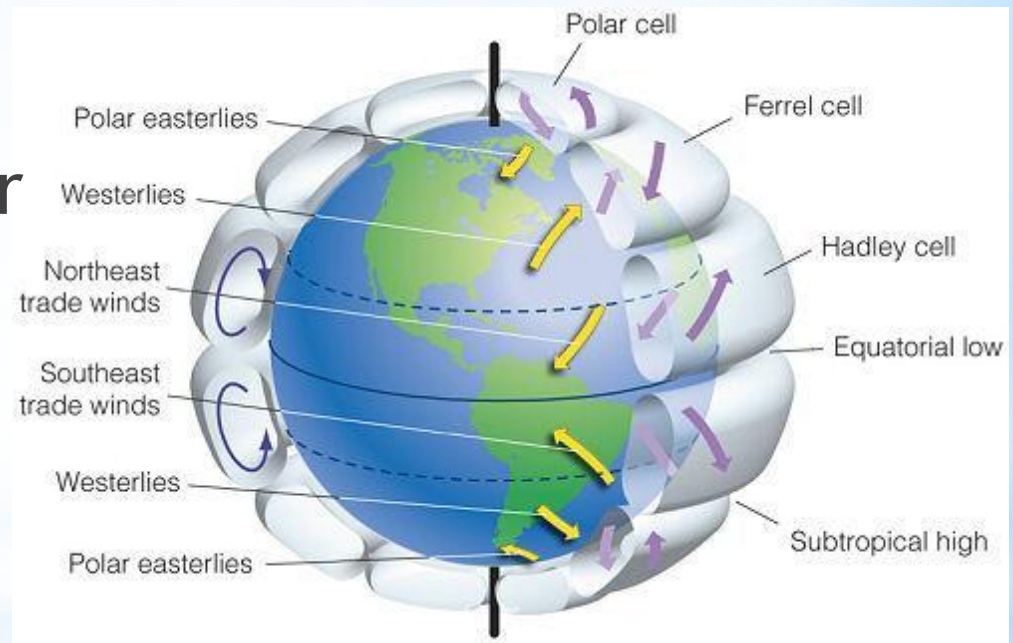
*Horse Latitudes...

*Weather Systems in the USA

6. Which global wind system is responsible for much of the movement of weather across the USA and Canada?
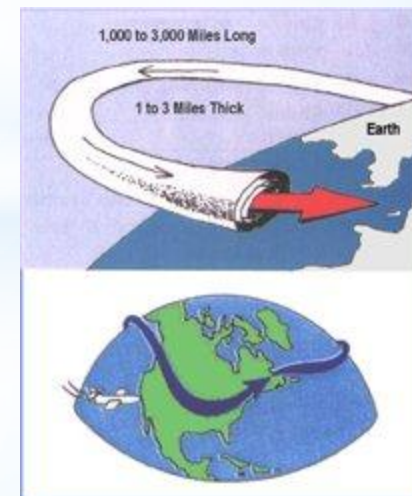
✓ The prevailing westerlies

*Jet Streams...

*Definition of Jet Stream...

- *Narrow bands of fast, high altitude westerly winds (which resemble jets of water)

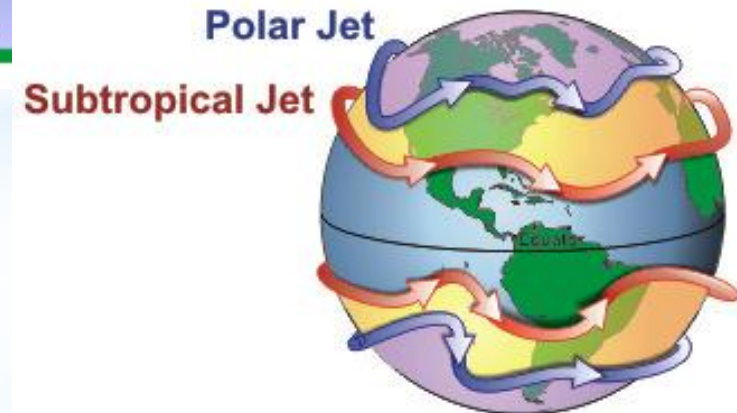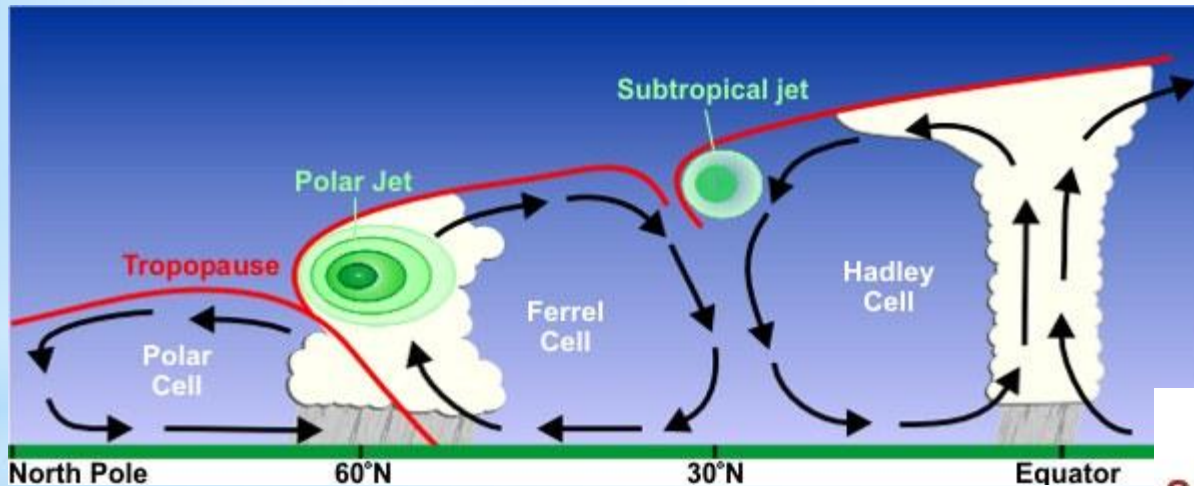- *Jet streams follow the boundaries between hot and cold air and are strongest in the winter.
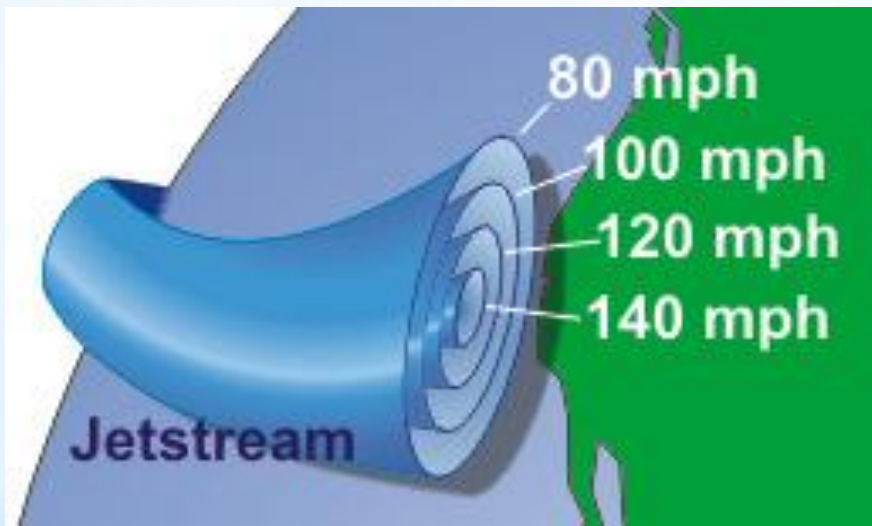
* A Jet Stream As It Appears on a Weather Map...

* Jet Streams...

* Location by Wind Systems...

A. **Polar jet stream** (separates polar easterlies from prevailing westerlies)

B. **Subtropical jet stream** (where the trade winds meet the prevailing westerlies)

*Top Speeds – normally between 80 – 140 mph, but up to 275 mph!

*Elevations – between 4-8 miles

* Jet Streams

2. Why are jet streams so named?
   - ✓ Because they resemble jets of water
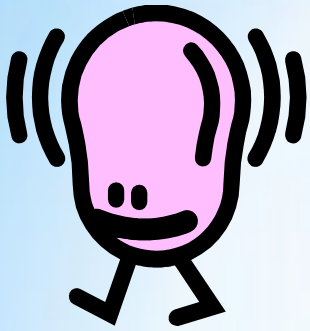3. Which direction do jet streams come from?
   - ✓ The west

* Jet Streams

*Lesson 5

The Causes of Weather

What is a "front" the front of?!
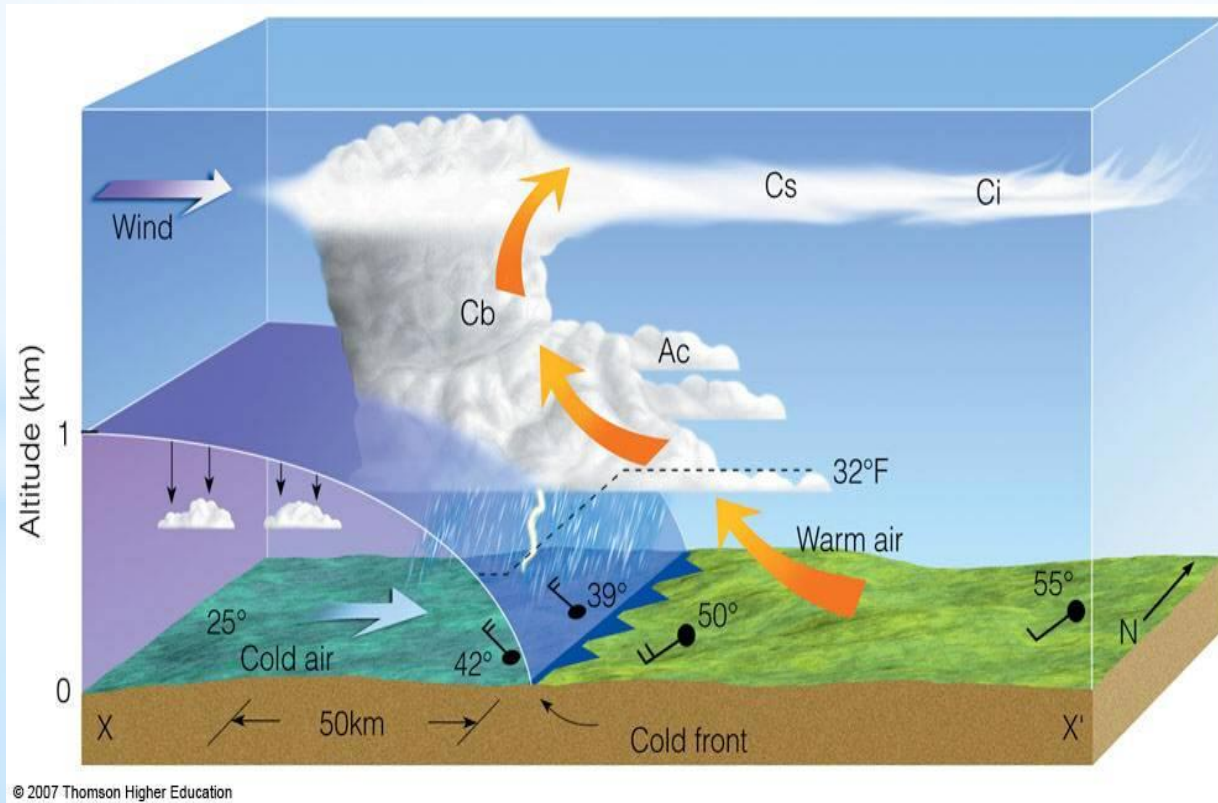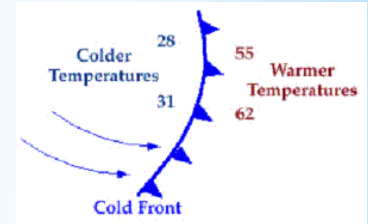
*Think About It...

*Focus Question...

What causes the four types of fronts and what weather does each bring?

*Cold Front...

* **Definition** – Cold, dense air displaces warm air and forces it up a steep front

* **Symbol** – blue icicles!

* **Weather** – clouds, showers, and thunder storms

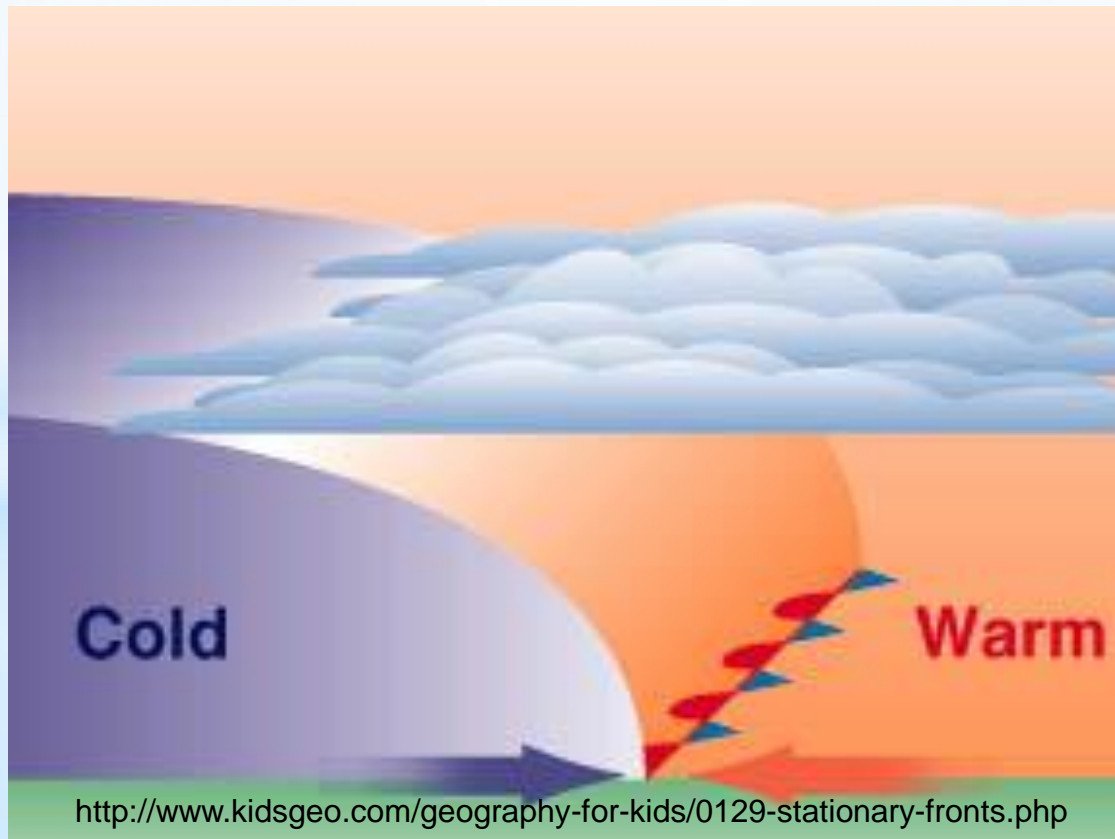# *Warm Front...

* **Definition** – Advancing warm air displaces cold air and moves up slowly

* **Symbol** – red lava rocks!

* **Weather** – extensive cloudiness and precipitation
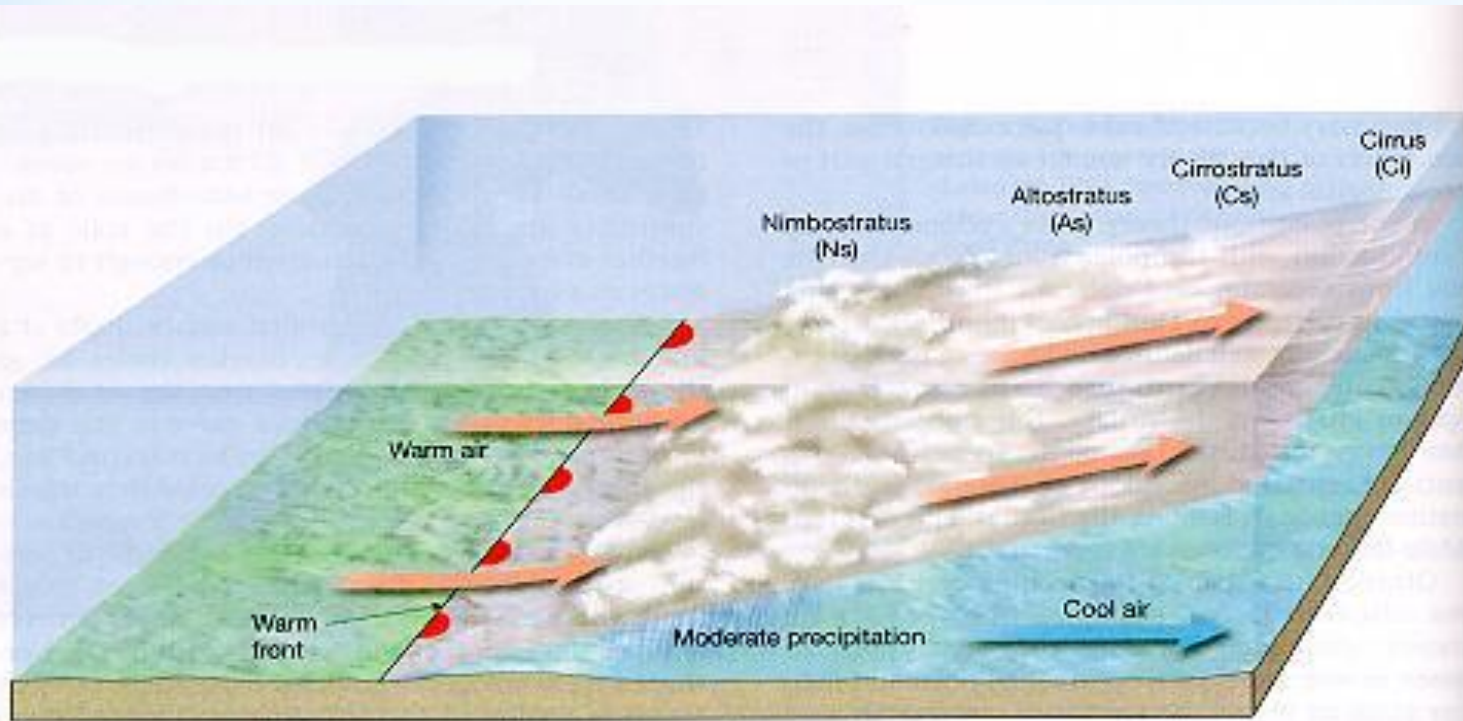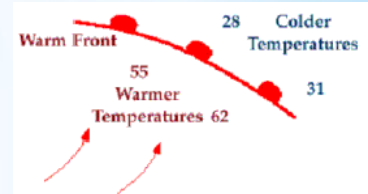
Warm front produced as warm air glides up over a cold air mass.

*Stationary (Stalled) Front...

* **Definition** – Two air masses meet and neither advances

* **Symbol** – blue icicles alternate with red lava rocks

* **Weather** – some clouds and precipitation

Cold   Warm

http://www.kidsgeo.com/geography-for-kids/0129-stationary-fronts.php

*Occluded Front...

* **Definition** – A cold air mass moves so rapidly that it overtakes a warm front and wedges the warm air up.

* **Symbol** – purple alternating rocks/icicles

* **Weather** – precipitation on both sides of the front
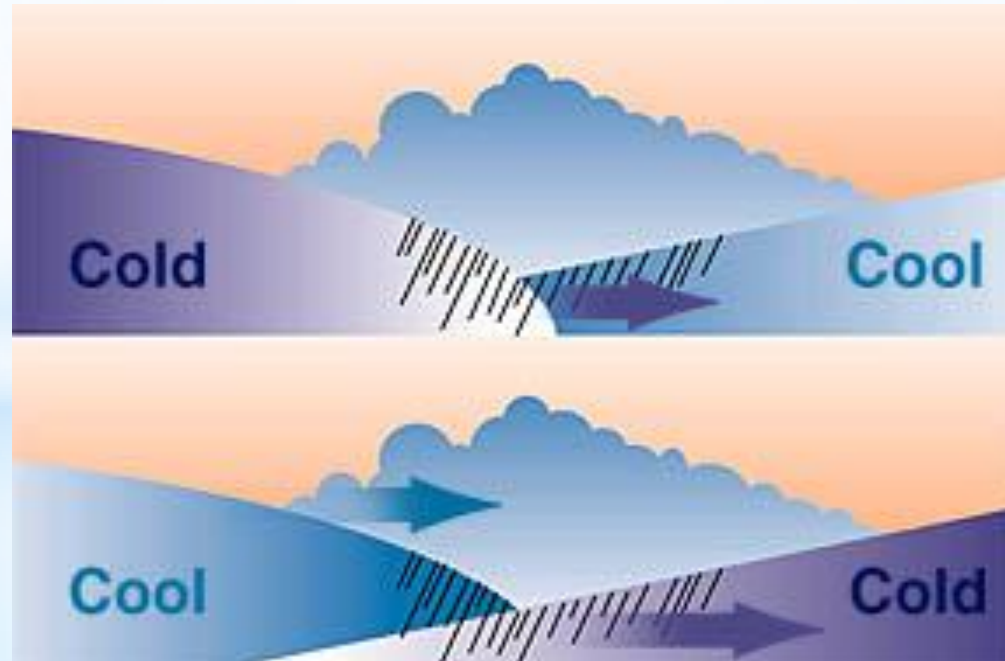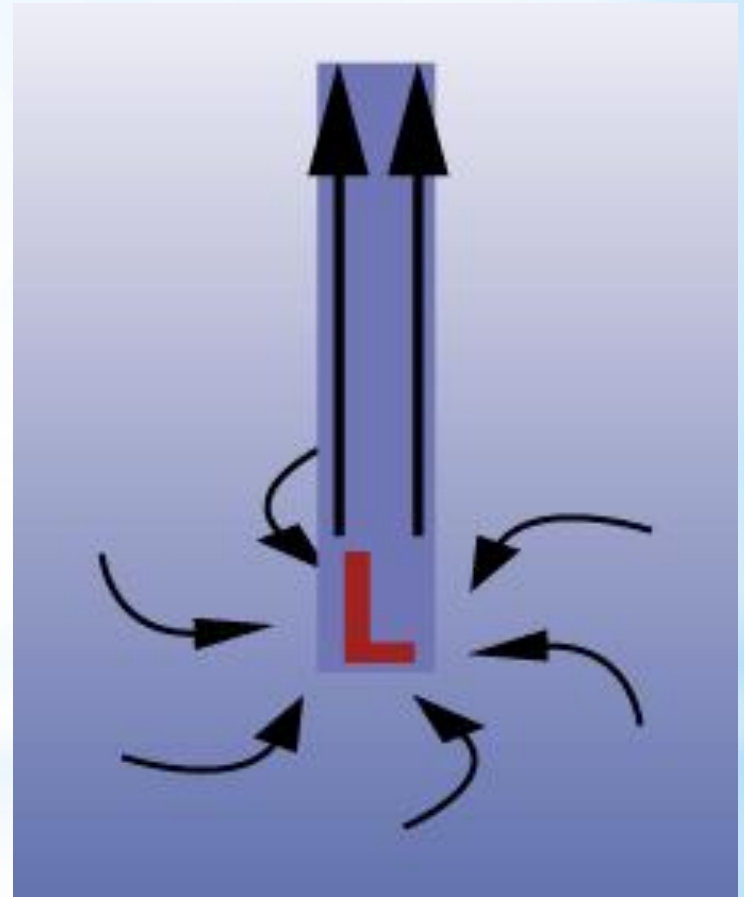
*Pressure Systems – High Pressure

a. Cold air sinking

b. Fair weather

c. Rotates clockwise

d. Represented as a blue 'H'

Good 'H'air Day!

http://www.windows2universe.org/earth/Atmosphere/high_pressure.html
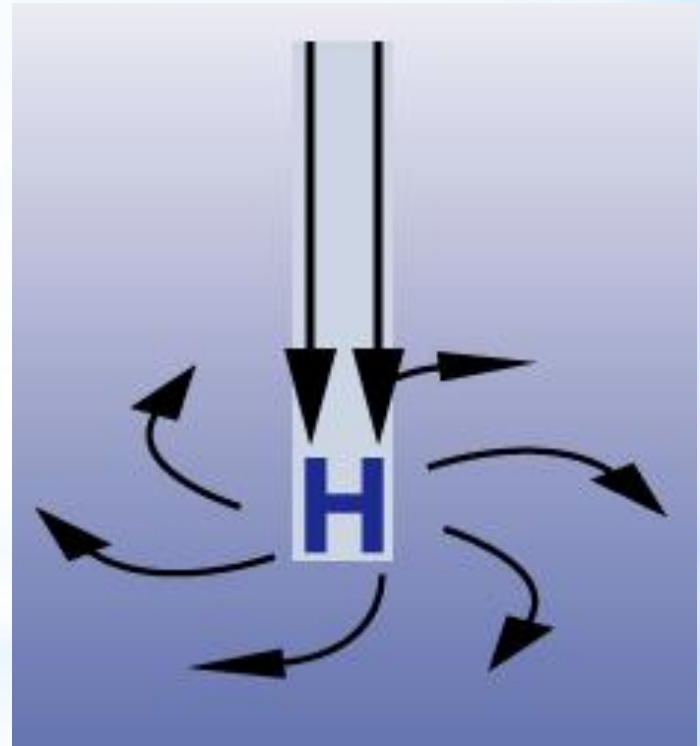
*Pressure Systems – Low Pressure

a. Warm air rising

b. Clouds and precipitation

c. Rotates counter-clockwise

d. Represented as a red 'L'

   'L'ousy Weather Day!
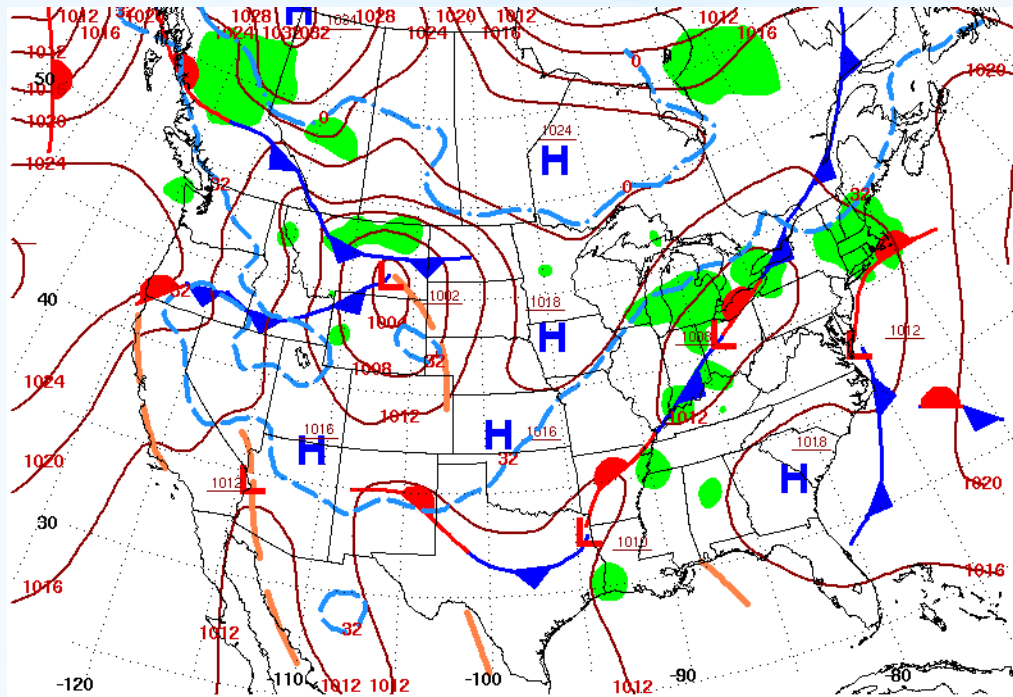
*Lesson 6

Gathering Weather Data

*Saturday's (12/8/12) Weather... 1:00pm

* Cloud Cover: **BKN**
* **Clouds – Ci, Cs, As, St**
* Temperature – 62 degrees
* Pressure: **30.02 in**
* Humidity: **91%**
* Amount of Precipitation – light rain
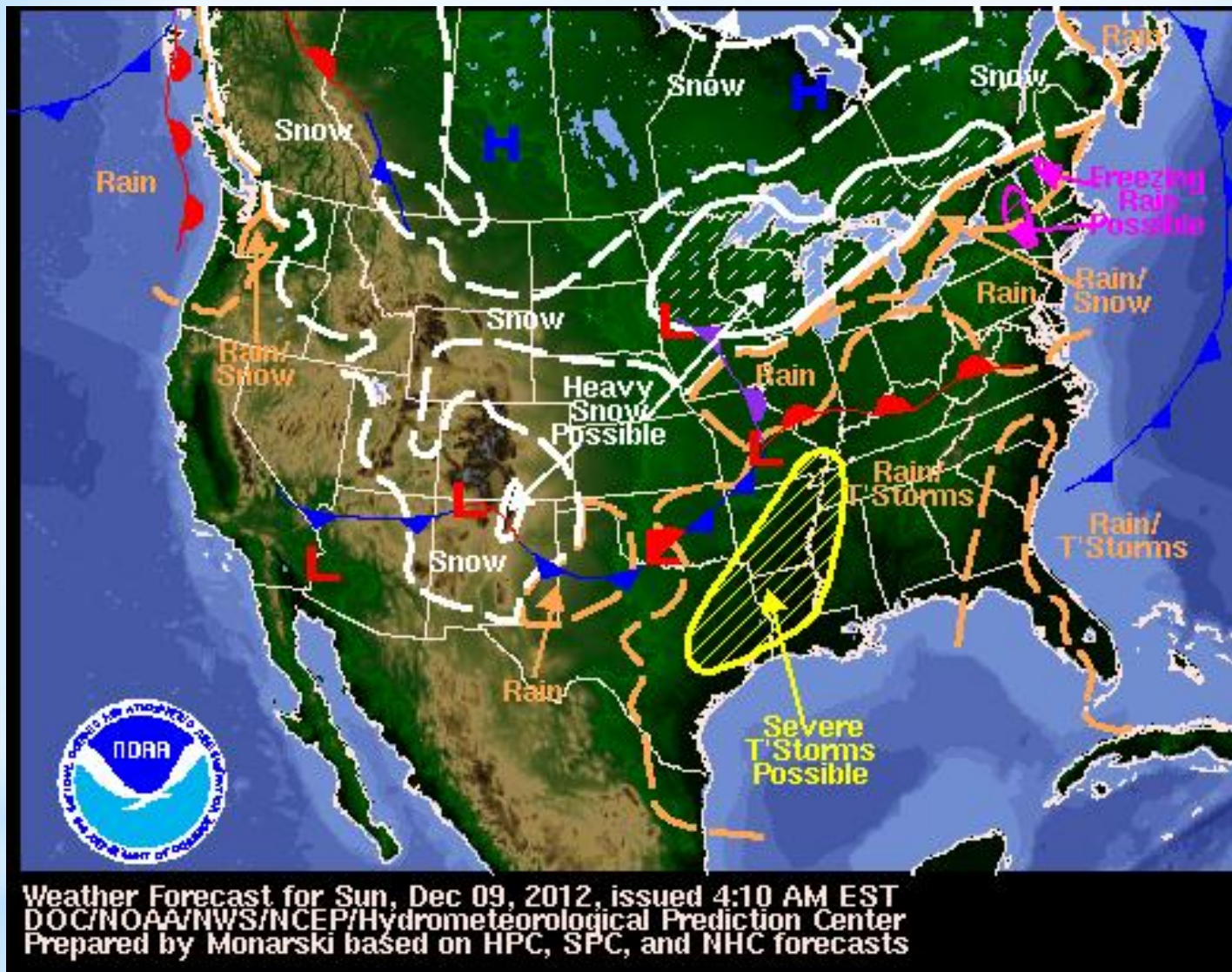* Fronts/Press Systems – next slide

Surface Weather Map at 7:00 A.M. E.S.T.

*Saturday's Fronts/ Pressure Systems

Sunday's (12/9/12) Weather... 3:30pm

* Cloud Cover: **OVC**

* **Clouds – Ns, Fc**

* Temperature – 64 degrees

* Pressure: **30.08 in**

* Humidity: **90%**

* Amount of Precipitation – rain

* Fronts/Press Systems – next slide

Weather Forecast for Sun, Dec 09, 2012, issued 4:10 AM EST
DOC/NOAA/NWS/NCEP/Hydrometeorological Prediction Center
Prepared by Monarski based on HPC, SPC, and NHC forecasts

*Sunday's Weather…

■ Fox 8 Local Forecast –

* http://myfox8.com/weather/

*Weather Channel National Forecast –
http://www.weather.com/forecast

*Weather Broadcast...

We get our weather from radio/TV/computers. Where do weather-persons get their weather?
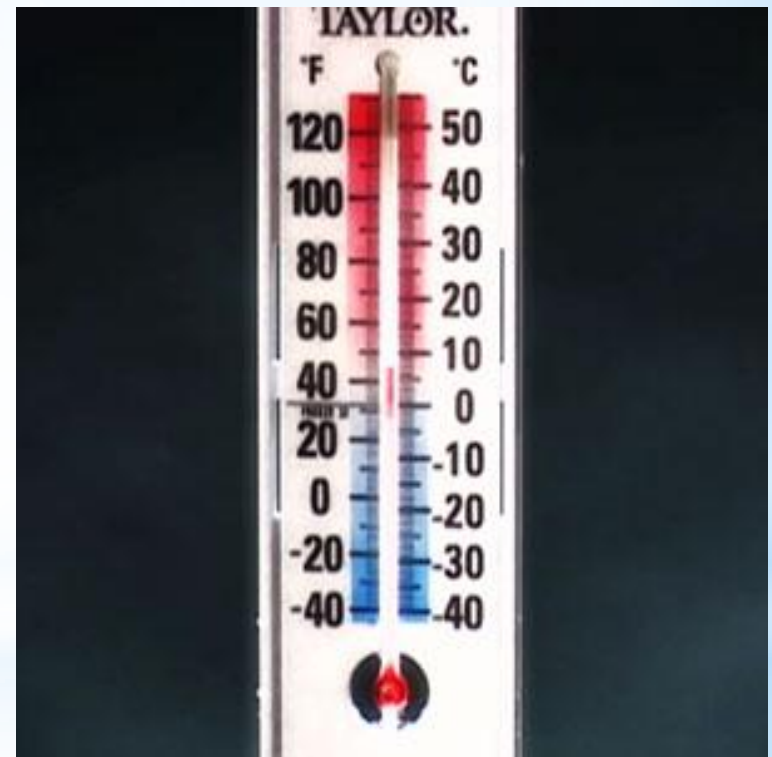
*Think About It...

*Focus Question...

How do meteorologists gather data about the weather?

*Surface Data Instruments

*Thermometer

* Measures temperature

* Thermometers contain liquids that expand when heated.
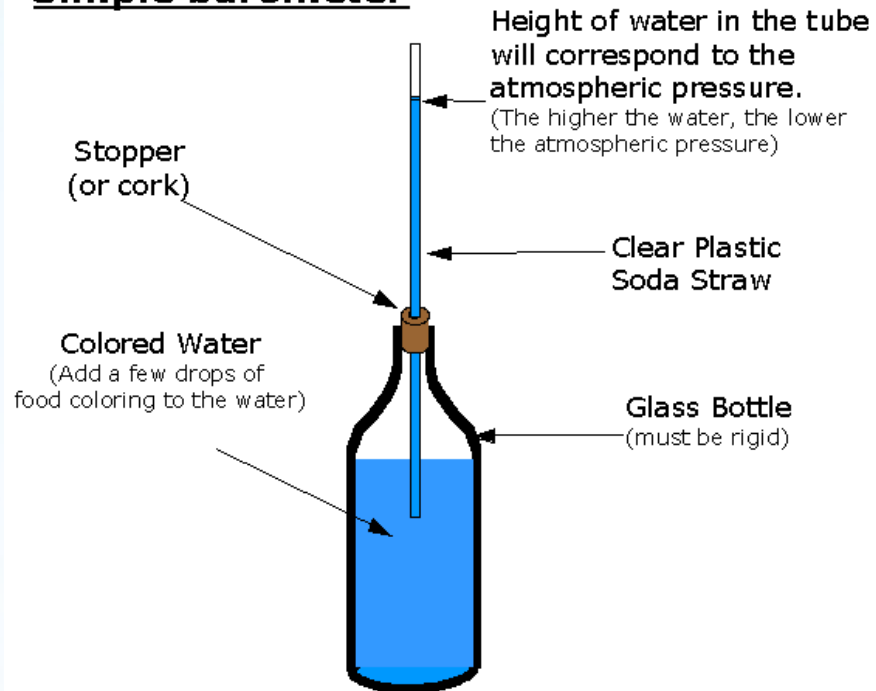
*Degrees Celsius or Fahrenheit

Surface Data Instruments

*Barometer

* Measures air pressure

* A barometer may contain mercury or a vacuum inside a metal chamber that contracts or expands with changes in air pressure.

*Millibars or inches of mercury

http://robertwhite.com/marineimages/precision_barometer.jpg

Simple barometer

Height of water in the tube will correspond to the atmospheric pressure.
(The higher the water, the lower the atmospheric pressure)

Stopper (or cork)

Clear Plastic Soda Straw

Colored Water
(Add a few drops of food coloring to the water)

Glass Bottle
(must be rigid)

http://www.home-weather-stations-guide.com/images/simple_barometer.gif

*Surface Data Instruments

*Anemometer
  * Measures wind speed
  * Has cupped arms that rotate as the wind blows.
  *... mph or km/h

http://www.smg.gov.mo/www/dm/equip/ws.jpg

*Surface Data Instruments

*Hygrometer
  * Measures relative humidity
  * Uses wet- and dry-bulb thermometers and determines how fast the water evaporates from the wet bulb.
  *Percentage of water air is holding compared to how much it can hold.

https://www.avogadro-lab-supply.com/item_images/Wet%20Dry3.jpg
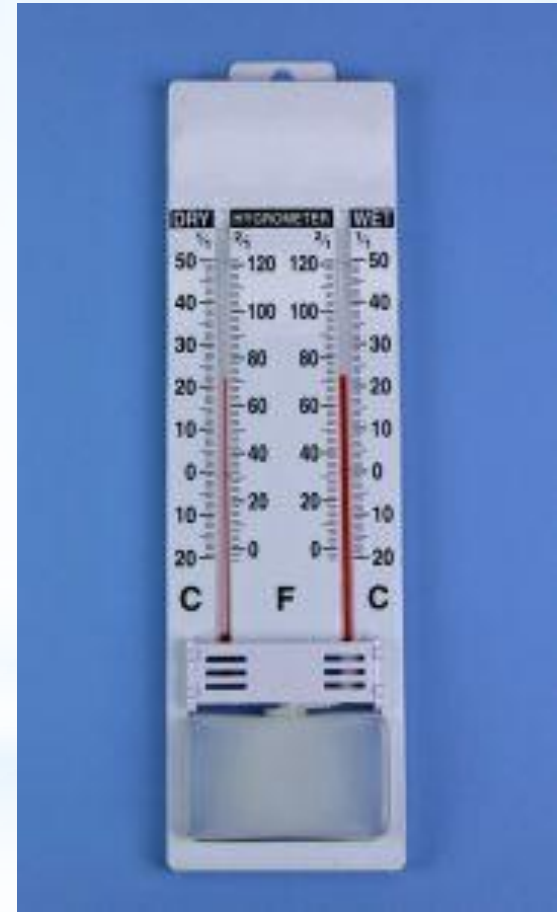
*Surface Data Instruments

*Ceilometer
  * Measures the height of cloud layers and estimates cloud cover
  * meters above ground level

Cloud base →

0   5000 ft

Indicator

Laser ceilometer

© 2007 Thomson Higher Education
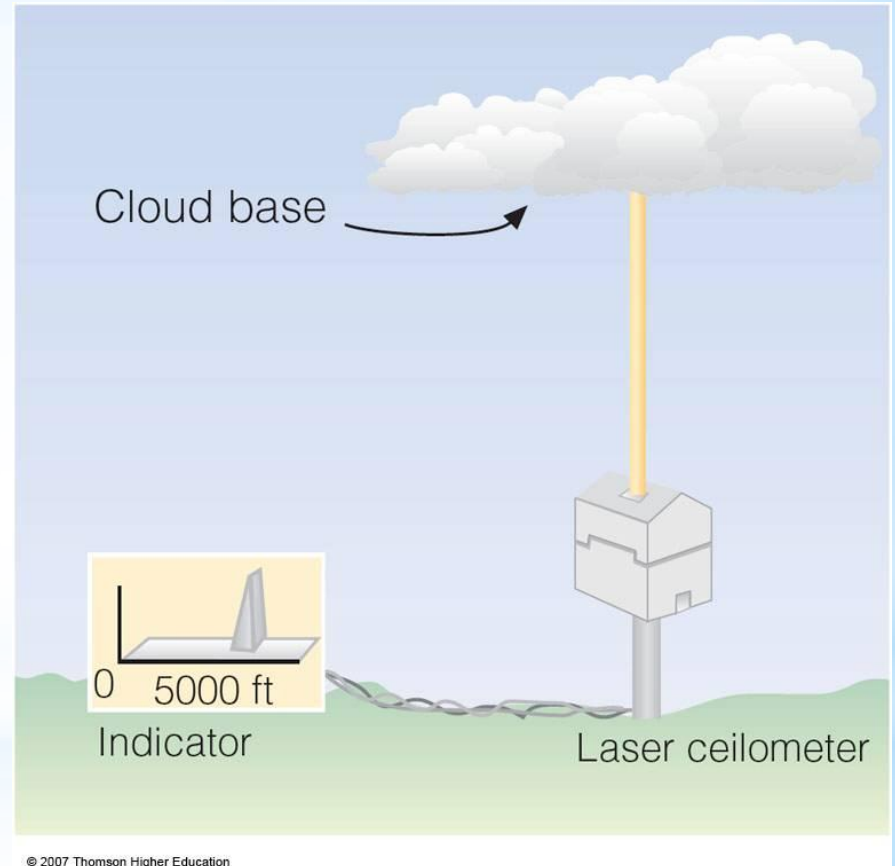
*Upper Level Data

1. To make accurate forecasts, meteorologist gather data up to **30,000 m**.

2. A radiosonde is a balloon-borne package of weather sensors.

   a. Radiosondes take measurement on **temperature**, **air pressure** and **humidity.**

   b. They can track how fast and in what direction the radiosonde is moving to determine wind speed/direction.

*The Radiosonde...

* http://www.erh.noaa.gov/gyx/weather_balloons.htm

* "The Integrated Global Radiosonde Archive (IGRA) consists of radiosonde and pilot balloon observations at over 1500 globally distributed stations (Figure 1). Observations are available for standard, surface, tropopause and significant levels. Variables include:

    * Pressure
    * Temperature
    * Geopotential Height
    * Dewpoint Depression
    * Wind Direction
    * Wind Speed

* The period of record varies from station to station, with many extending from 1970 to present (Figure 2). Station records are updated daily and are available online at no charge. "

http://www.ncdc.noaa.gov/oa/climate/igra/index.php

*Weather Radar and Satellites

1. Radar pinpoints where **rain** is falling at any given moment

   a. radio detecting and ranging

   b. A radar system works by bouncing **radio** waves off large **rain** drops.

   http://radar.weather.gov/

The COMET Program
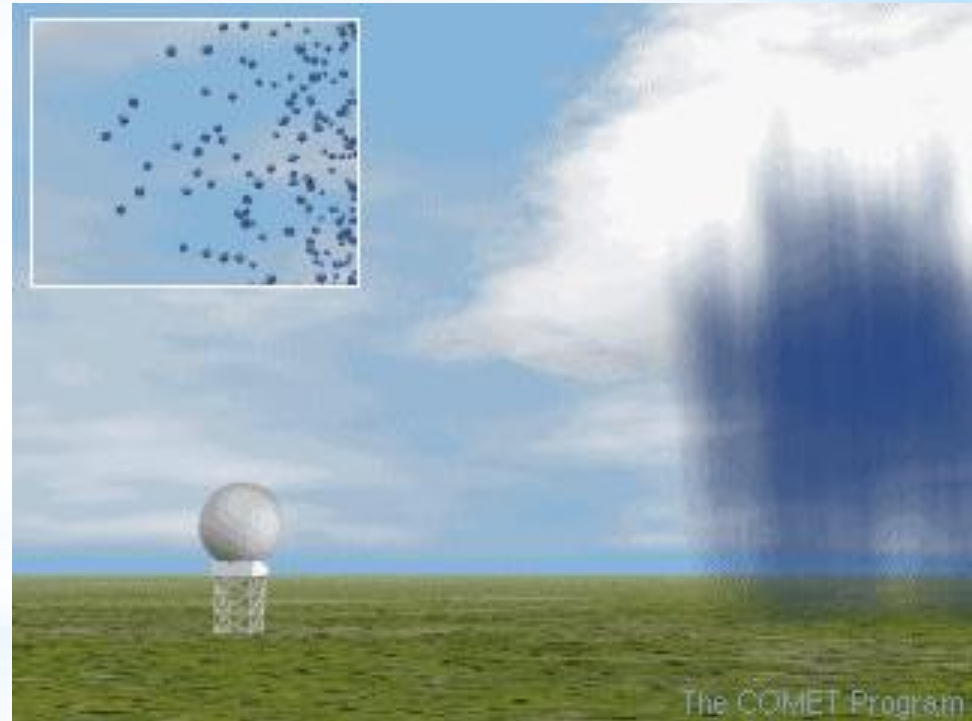
1c. ... is the change in wave frequency that occurs in energy, such as sound or light, as that energy moves toward or away from an observer.

http://science.discovery.com/videos/time-doppler-effect.html

Meteorologists use Doppler Radar to plot the speed at which raindrops move toward or away from a radar station. This allows them to detect severe weather events!

*The Doppler Effect...

National Doppler Radar Sites
Select radar location and click.
Requires Java/Javascript

*Doppler Radar

http://www.erh.noaa.gov/gyx/radar.htm

http://www.spc.noaa.gov/faq/tornado/doppler.htm
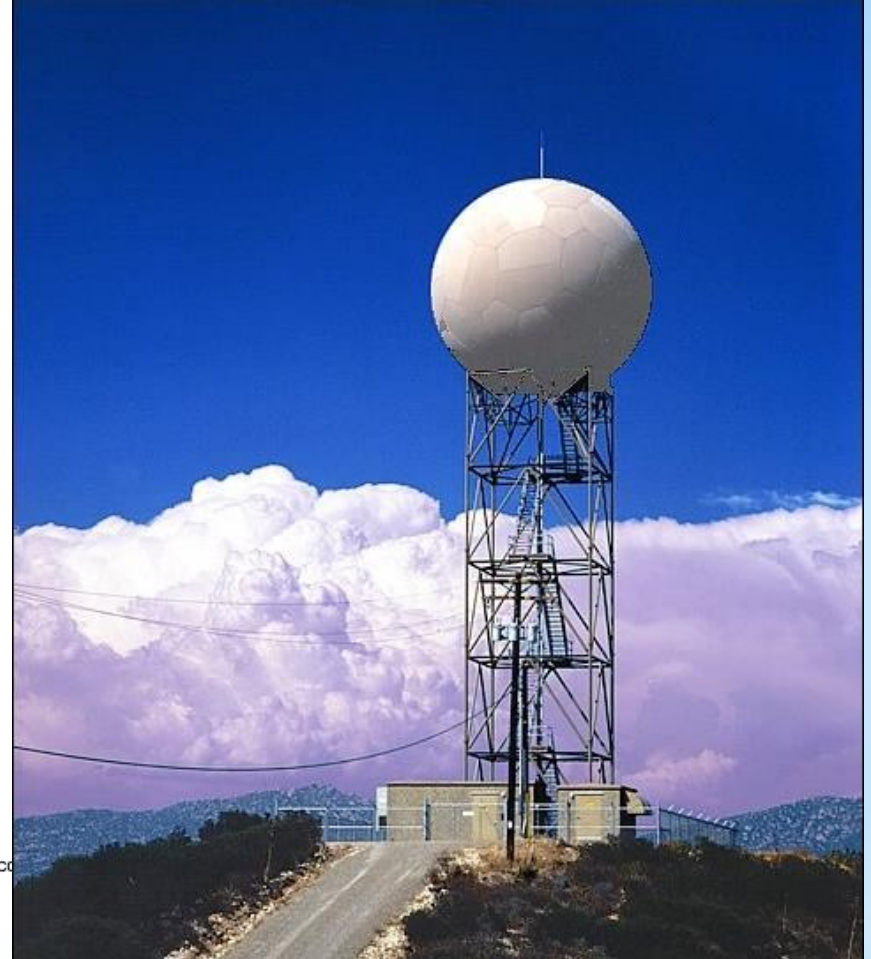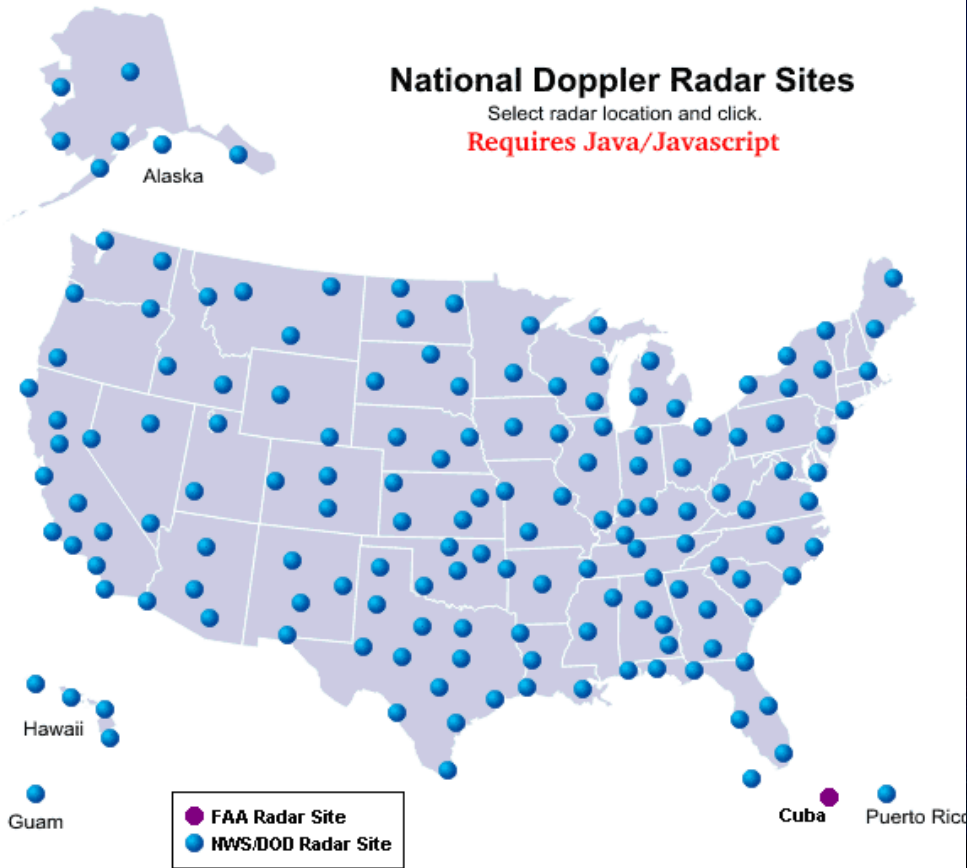
*Weather Satellites...

2. a. Weather radar tracks rain.

b. Weather satellites track clouds.
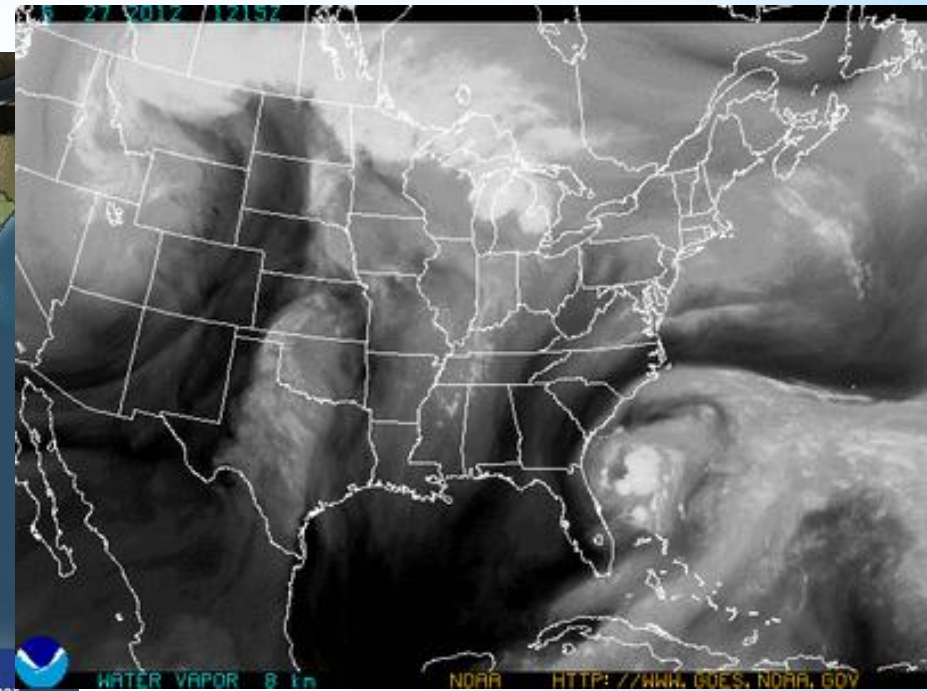
1. What is a station model?

✓ A record of weather data for a particular site at a particular time

2. What is the advantage of using a station model?

✓ A large amount of data can be shown in a small space
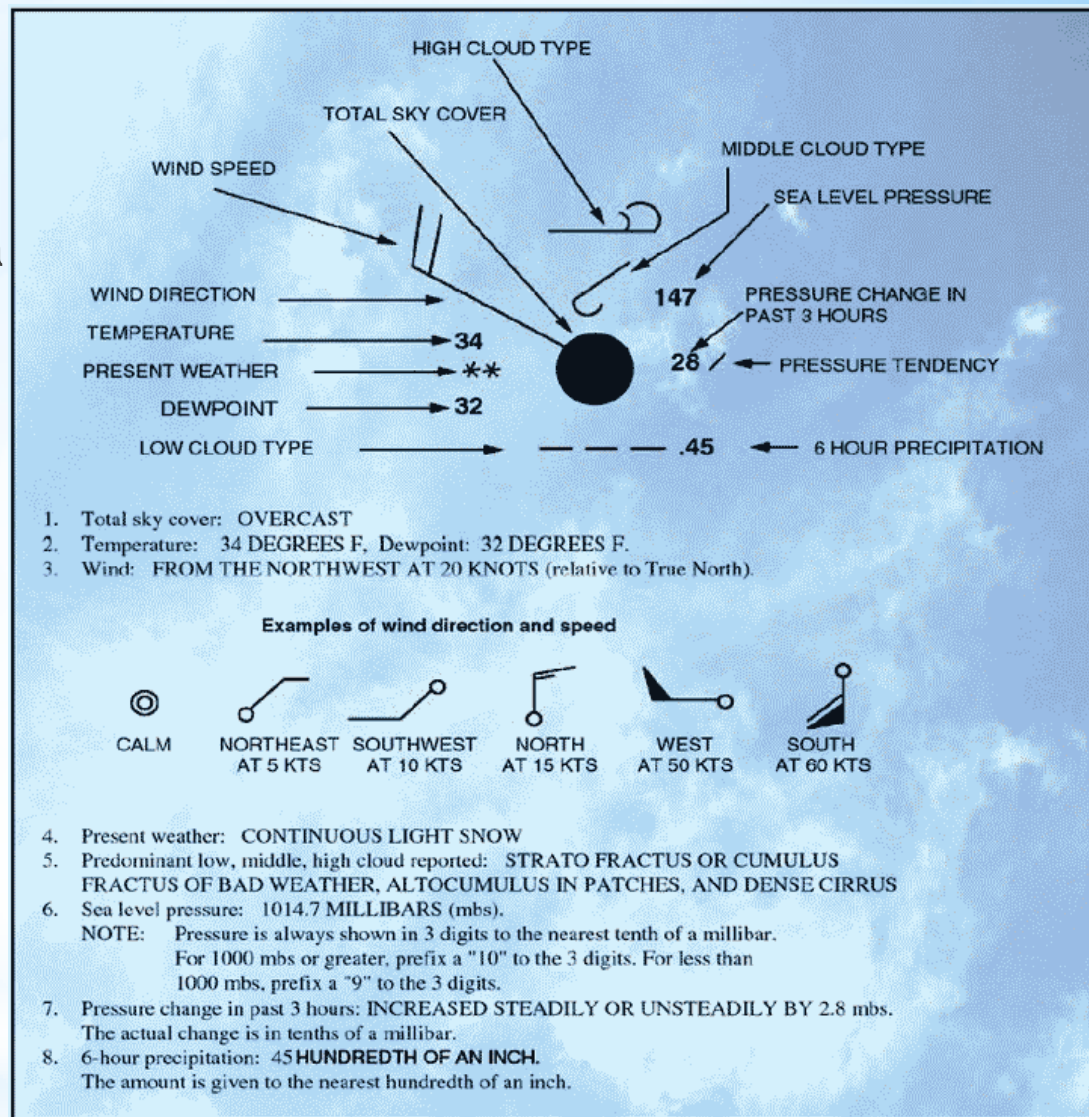
*Station Models...
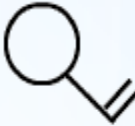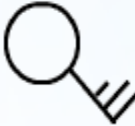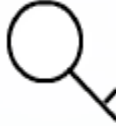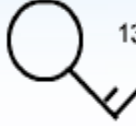
# *Station Model Symbols...

Cloud/Sky Cover

Total Sky Cover

- ◯ No clouds
- ◐ Less than one-tenth or one-tenth
- Two-tenths or three-tenths
- Four-tenths
- Five-tenths
- Six-tenths
- Seven-tenths or eight-tenths
- Nine-tenths
- ● Completely overcast
- ⊗ Sky obscured

Wind Speed

◯ Calm

1 - 2 knots

3 - 7 knots

8 - 12 knots

13 -17 knots

18 -22 knots

23 -27 knots

28 - 32 knots

33 -37 knots

38 -42 knots

43 -47 knots

48 + knots

Key

= 5 knots

= 10 knots

= 50 knots

*Station Model...

http://visual.merriam-webster.com/images/earth/meteorology/station-model.jpg
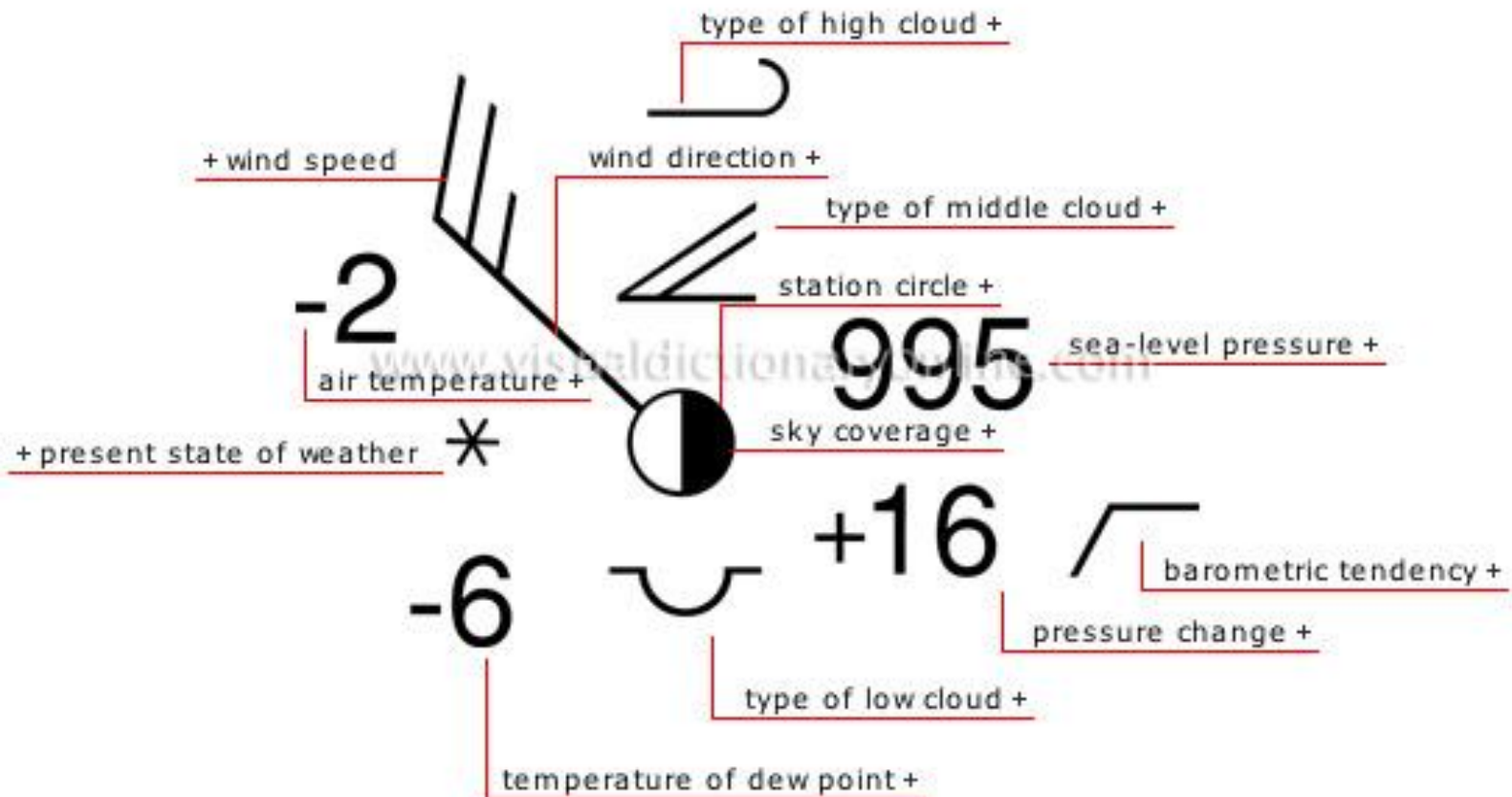
*Station Models...

1. high clouds... scattered cirrus
2. middle clouds... thin altostratus in bands
3. low clouds... fractocumulus of bad weather
4. precipitation... rain
5. temperature... 20 degrees Celsius
6. dew point... 19 degrees Celsius
7. barometric pressure... 918.8
8. wind speed... 3-7 knots
9. wind direction...southeast (SE)
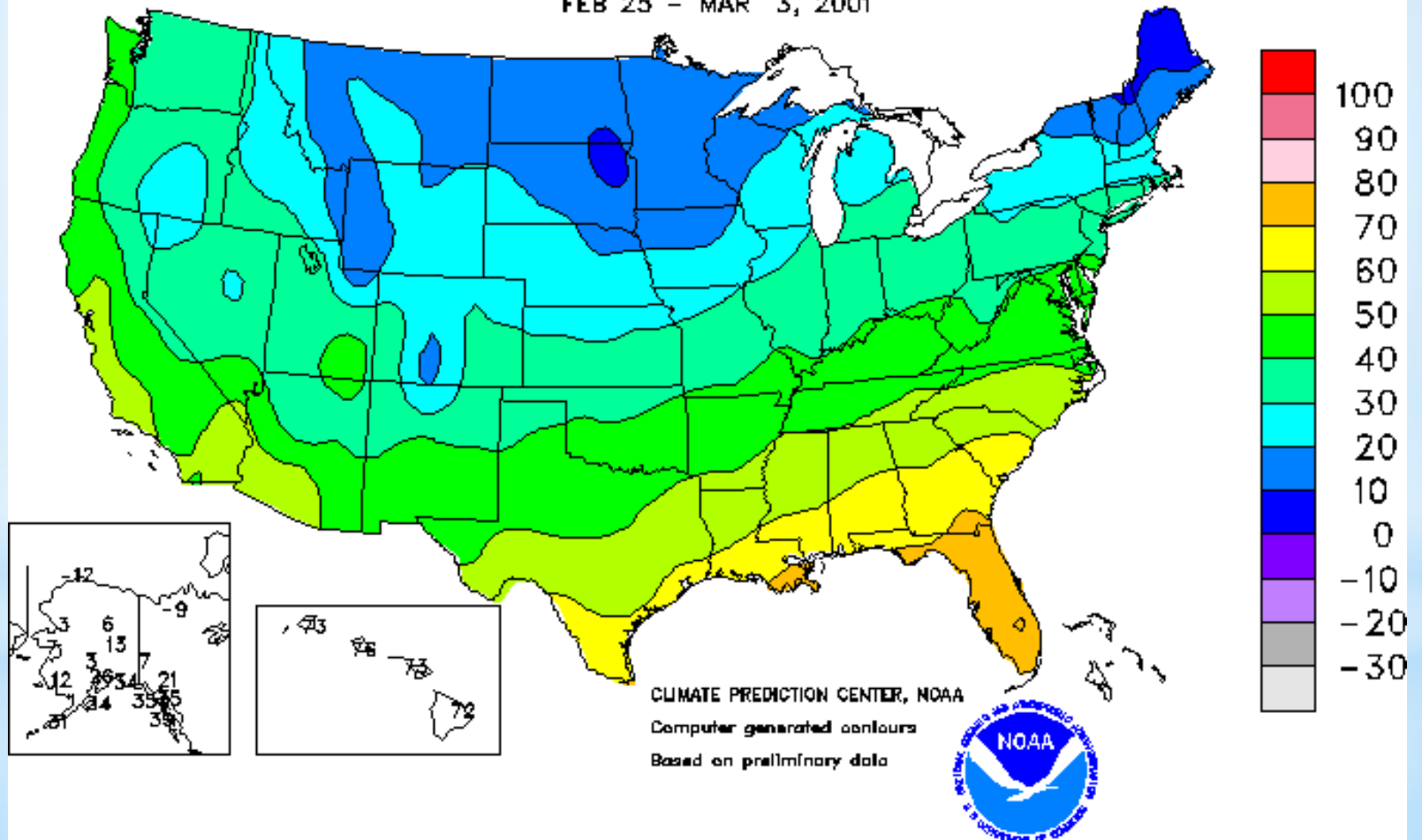
*Isobars
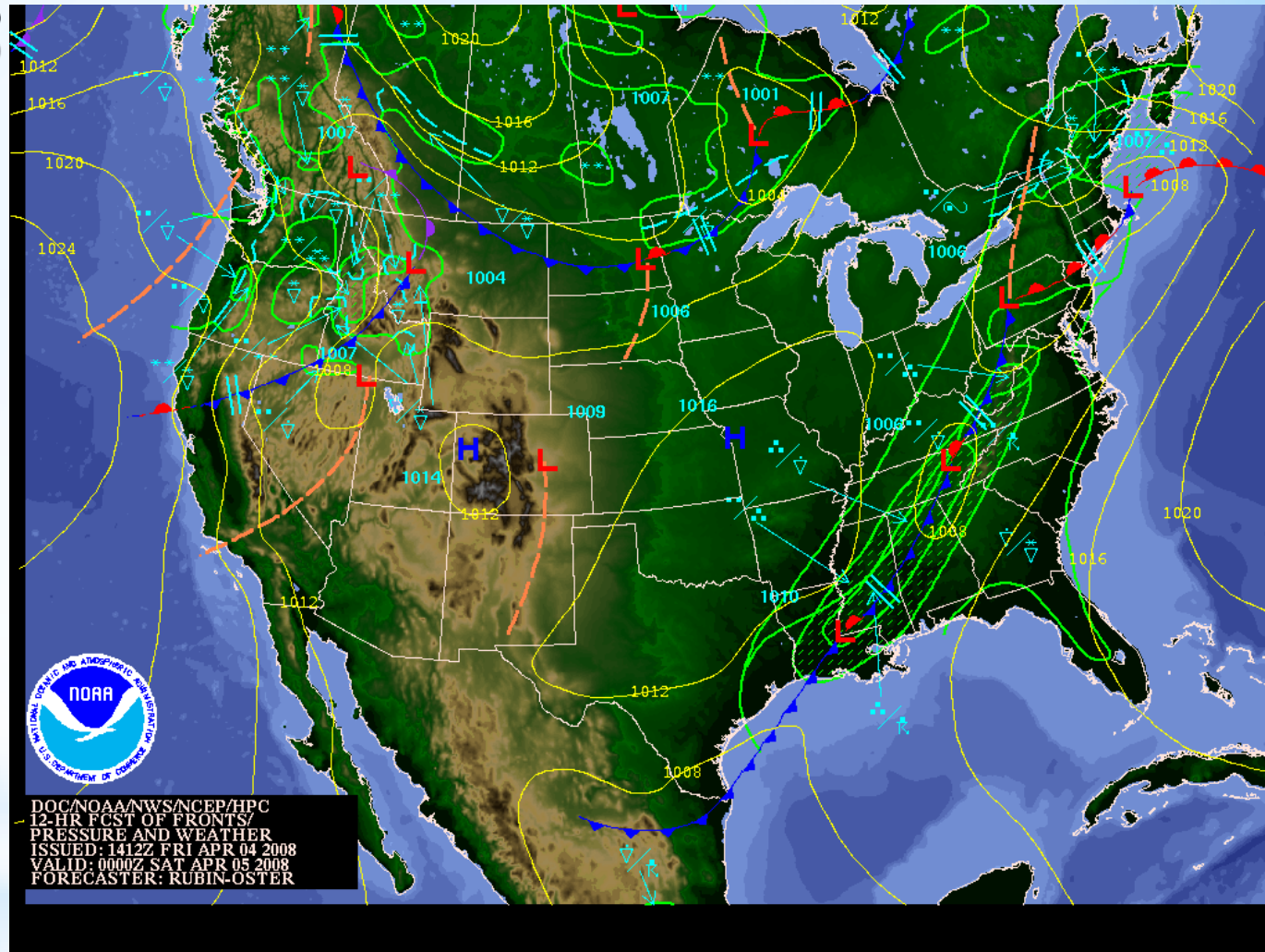
Isobars that are closer together indicate stronger winds.

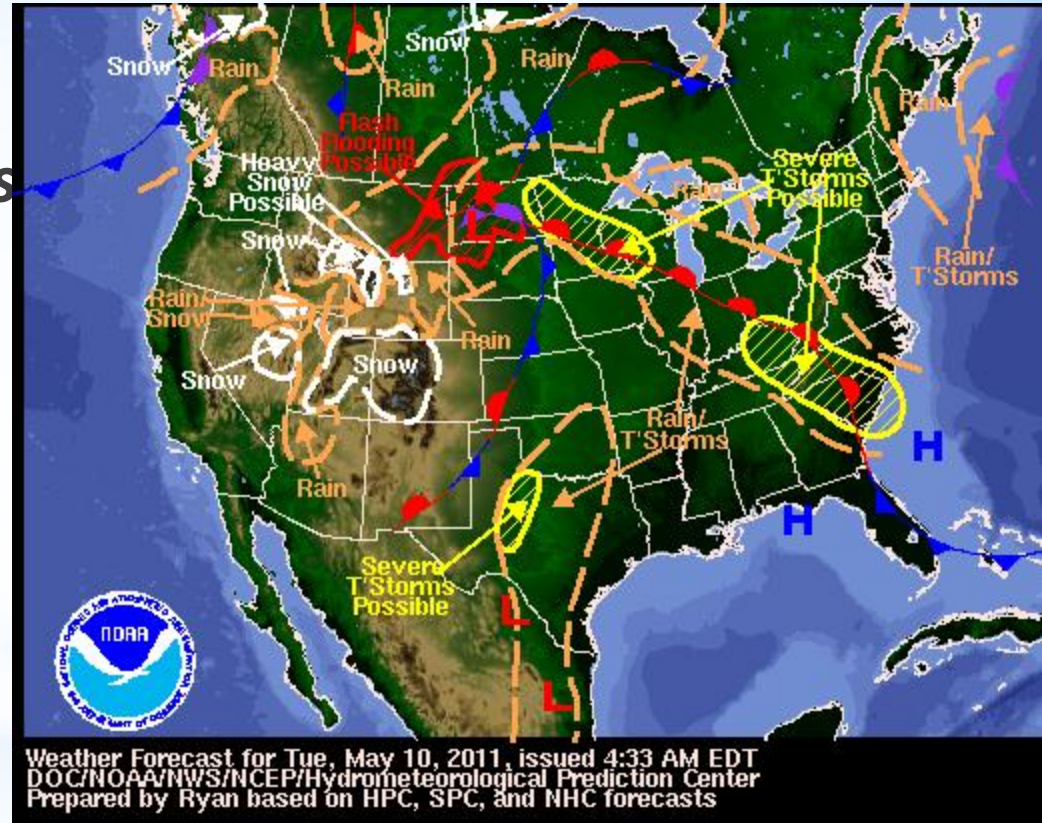**Where are winds the strongest?**

Average Temperature (°F)
FEB 25 – MAR 3, 2001

http://www.learner.org/jnorth/images/graphics/u-z/weather_isotherm030201.gif

*Weather Forecasting...

There are two major types of weather forecasts...

11. A **digital forecast** relies on numerical data. ***This is the main method used in modern forecasting***.

12. An **analog forecast** involves comparing current weather patterns to patterns that took place in the past.

13. All forecasts are more reliable in the **short term** and less reliable in the **long term**.

Weather Forecast for Tue, May 10, 2011, issued 4:33 AM EDT
DOC/NOAA/NWS/NCEP/Hydrometeorological Prediction Center
Prepared by Ryan based on HPC, SPC, and NHC forecasts

a. lowest pressure?

C

b. wind at Station B?

there is none

c. highest wind speed?

D

d. highest pressure?

D

*Practice!

e. Front south of Station A?

warm

f.   most cloud cover?

C

g. really lousy hair day?

C (low pressure!)

h.   temperature change at Station C?

it will be colder

*Practice!