Topic 7 Weather

The study of the atmosphere is called _____.

I. Weather:

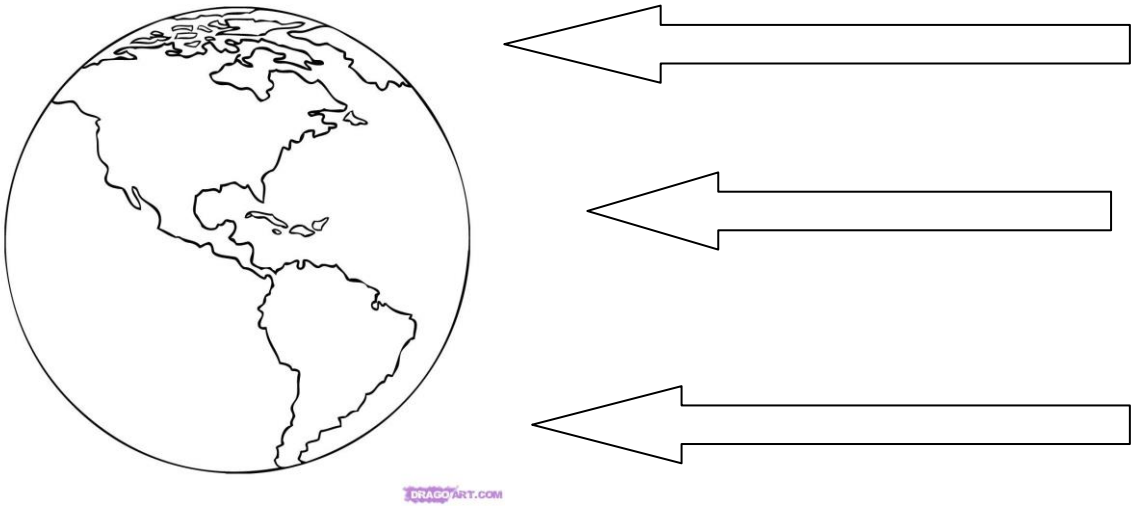
_____

_____

a. Most weather occurs in the _____ which is the bottom layer of the atmosphere

b. Causes of the weather:

_____



c. Variables of the atmosphere and the instruments that measure them:

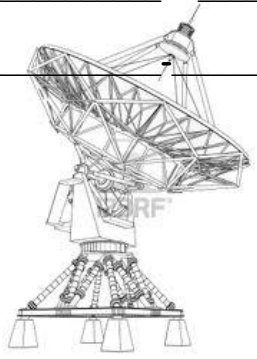
1. _____ --- _____

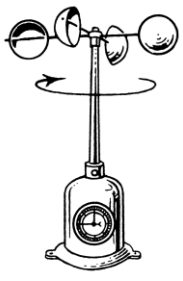
2. _____ -- _____

3. _____-- _____

4. _____ -- _____

5. _____ -

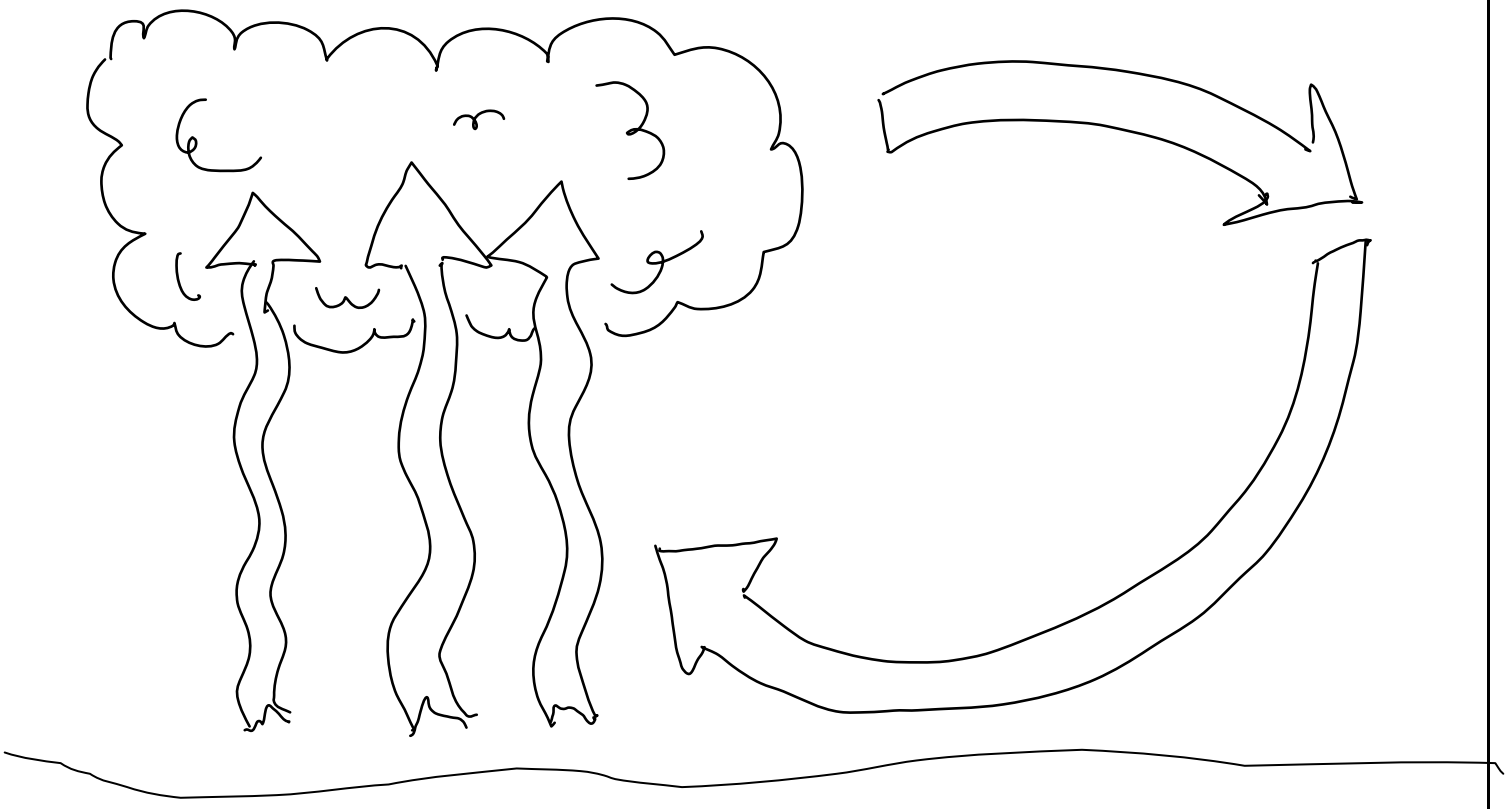




II. Heating of the Atmosphere

a. The atmosphere is heated in several different ways

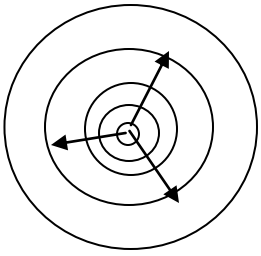
Name	Description or definition
1	
2	
3	
4	
5	



Process of formation of Clouds and Condensation of water

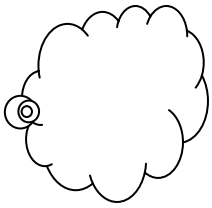
Winds converge

Air rises



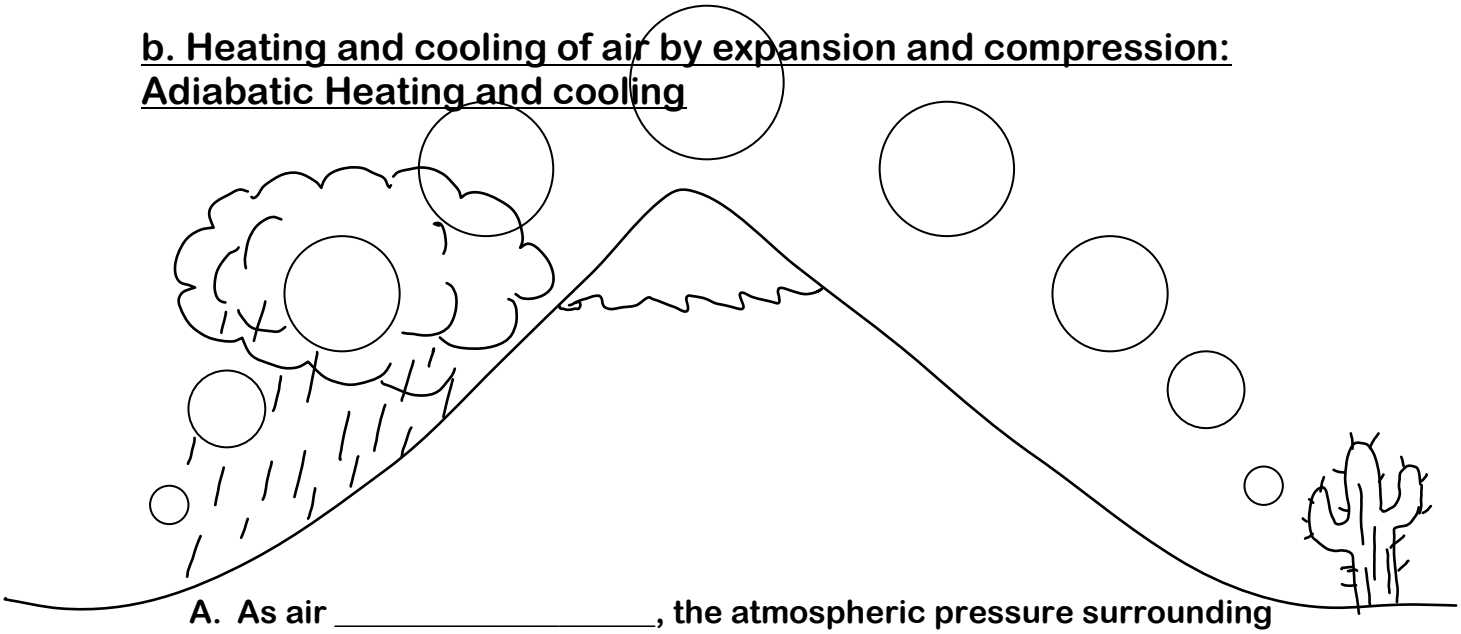
Air Expands

Temperature cools and meets Dew point



Condensation Occurs (Gas into a liquid) Sticks to dust particles

b. Heating and cooling of air by expansion and compression: Adiabatic Heating and cooling



A. As air _____, the atmospheric pressure surrounding the parcel of air decreases.

B. Therefore, the parcel of air _____ in volume and rises.

C. As it expands, it becomes _____.

D. When the temperature of this parcel of air falls to its _____ ____

E. the water vapor the air _____ and a _____ appears in the sky

This is the ***windward side*** of a mountain. Their climates tend to be more humid with high rain amounts.

A. As a parcel of air _____

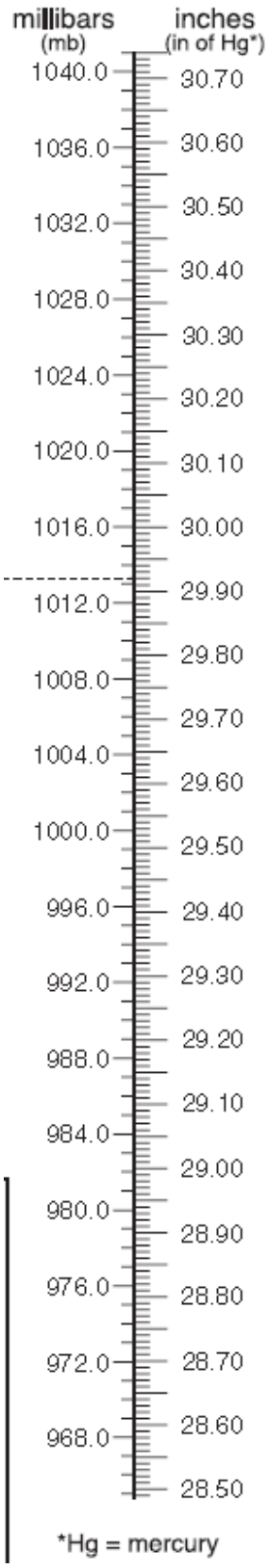
B. The pressure _____,

C. The volume is _____.

D. Due to this pressure of the atmosphere above it, the temperature of the air masses _____.

E. This is the ***lee ward*** side of a mountain this side tends to be warmer and much drier.

III. Air Pressure

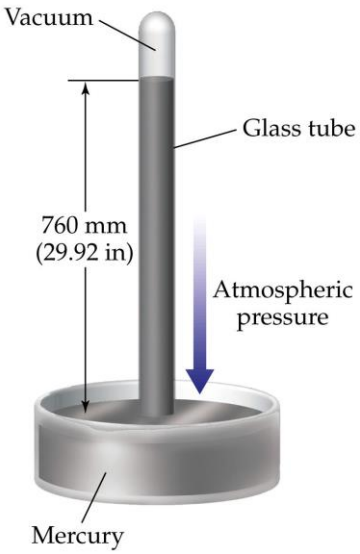


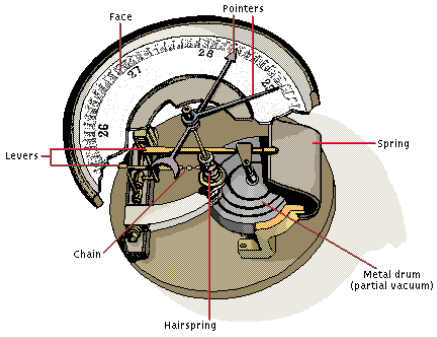
a. Measurement of and changes in Air Pressure

_____ is an instrument that measures pressure

There are two types of barometers

Aneroid and mercury



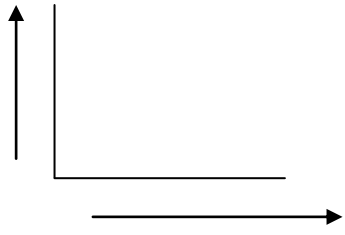


There is two scales to-measure pressure

Millibars	Inches
1013.2mb	
	30.20 in
1031.0 mb	
1010.9 mb	
	30.50 in
	29.85 in
	30.65 in

b. How can pressure of the air Change?

1. **<u>Temperature</u>:**



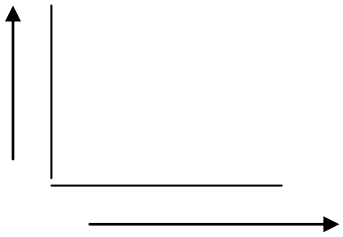
If the temperature of a parcel of air increases, the Density _____.

Therefore, the pressure will _____

2. **<u>water vapor</u>:**

Increases in water vapor would _____ air pressure.

3. **<u>Altitude</u>:**



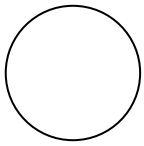
An increase in altitude would _____ air pressure

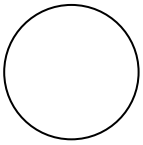
c. High and Low Pressure Cells

Side View of a High and Low pressure Cells

Above (birds eye) View of Pressure Cells

anticyclone (High Pressure) **Cyclones (low pressure)**



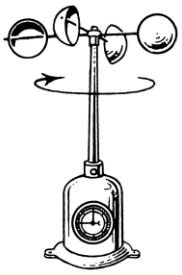


- **Because of the Coriolis effect the winds spin or curve in or out of a pressure cell**

In a High pressure the winds go _____, turning _____.

In a low pressure the winds go _____, turning _____.

Of course the winds turn the opposite in the Southern Hemisphere.



IV. Wind

a. Measurement made with an Anemometer

- **Highest recorded wind velocity**
  - **Mount Washington, New Hampshire**

- **Wind velocity on Mount Washington averages 32 mph year-round.**
- **Hurricane force winds (> 121 km/h, 75 mph) are observed from the summit of the mountain on average of 110 days per year.**
- **From November to April, hurricane force winds occur on average of 2 out of every 3 days. Winds of 161 km/h (100 mph) or greater occur about every 3rd day from November through March.**
- **In January, the windiest month, the winds reach or exceed hurricane force on 3 out of every 4 days.**
- **On January 2nd, 1969, the winds averaged 161 km/h (100 mph) for 24 hours, with a peak gust of 241 km/h (150 mph). In winter, conditions of this type are fairly common on Mount Washington.**
- **Mount Washington holds the world's record wind speed ever recorded from a surface weather station. In April 1934, observers measured a 371 km/h (231 mph) wind gust before the anemometer was destroyed.**

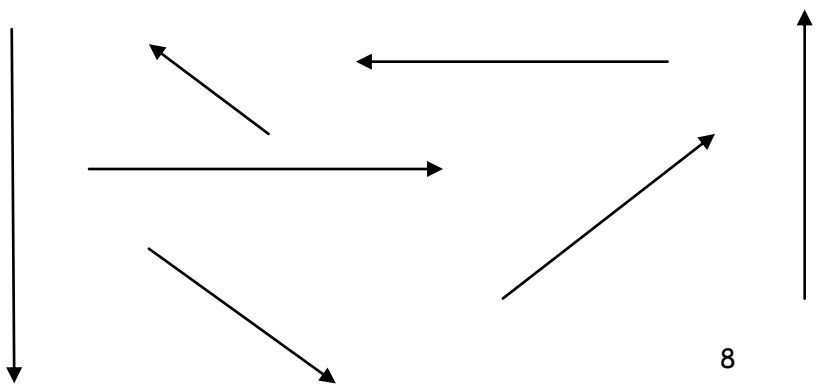
b. Winds are caused by differences in air pressure

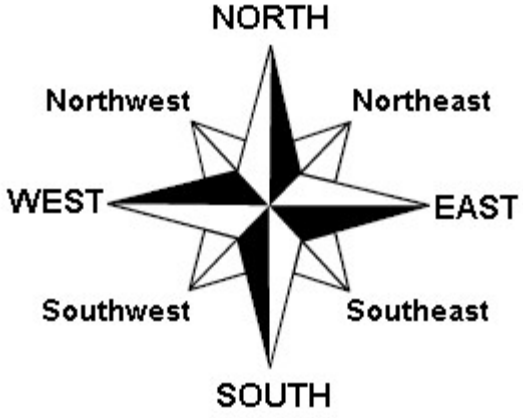
- ✓ **Winds always move from _____ _____ to _____ _____**

- ✓ **The difference in air pressure is called the Pressure Gradient.**
- ✓ **The steeper (more difference between the high and the low) the gradient the _____ wind velocity.**

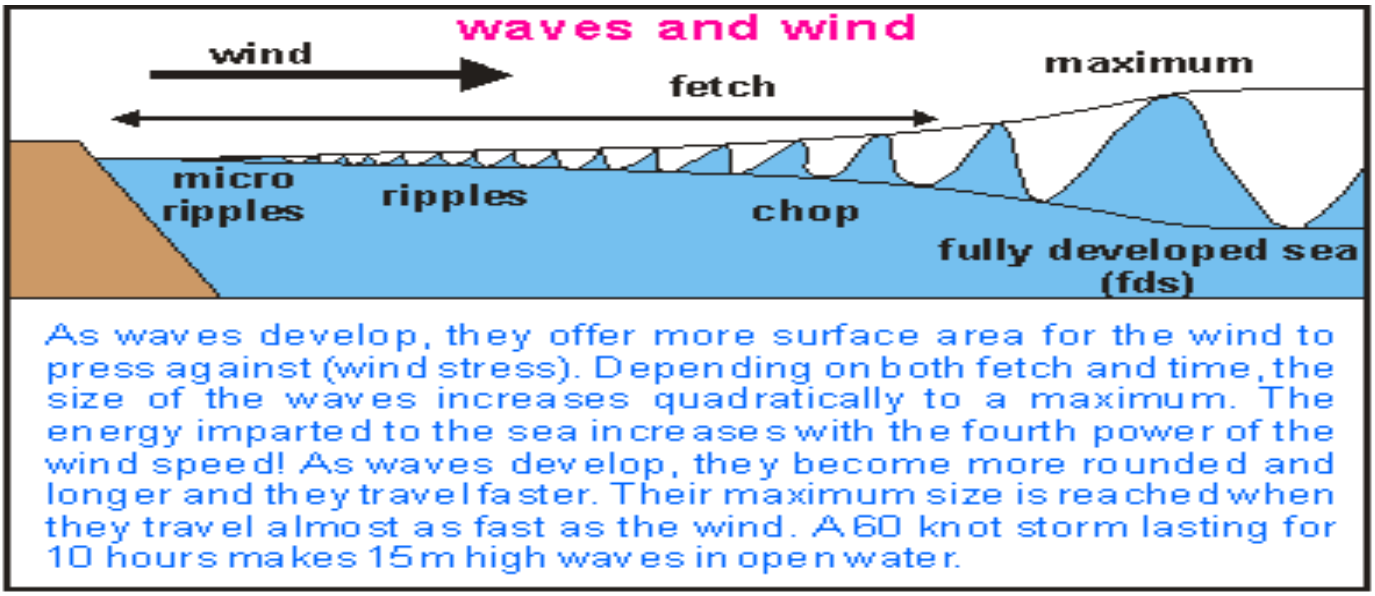
c. Wind Direction

Winds are named from the direction they are come _____ not where they are going to.





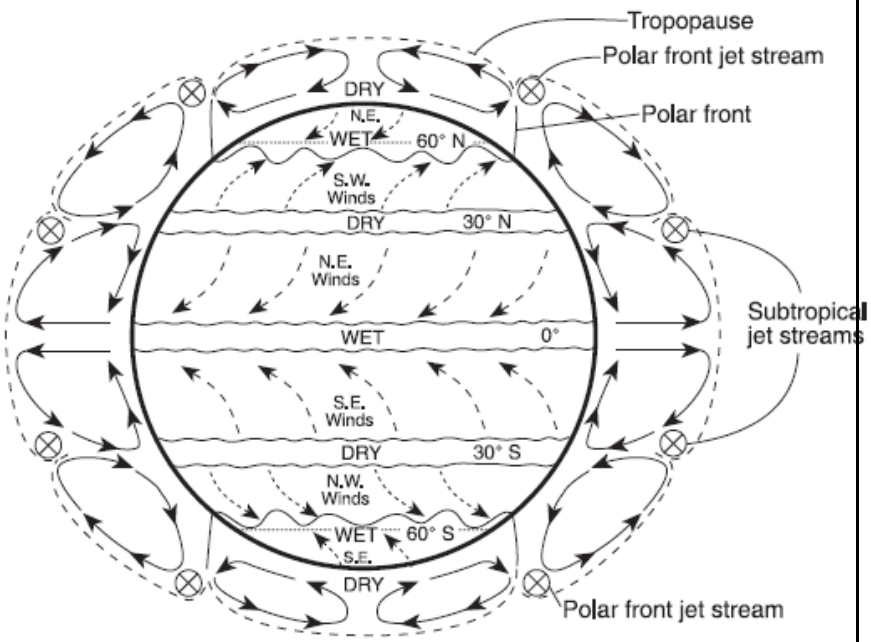
d. Winds cause waves



As waves develop, they offer more surface area for the wind to press against (wind stress). Depending on both fetch and time, the size of the waves increases quadratically to a maximum. The energy imparted to the sea increases with the fourth power of the wind speed! As waves develop, they become more rounded and longer and they travel faster. Their maximum size is reached when they travel almost as fast as the wind. A 60 knot storm lasting for 10 hours makes 15m high waves in open water.

e. Convection Cells:

Because of unequal heating convection cells develop and transfer energy around the Earth.

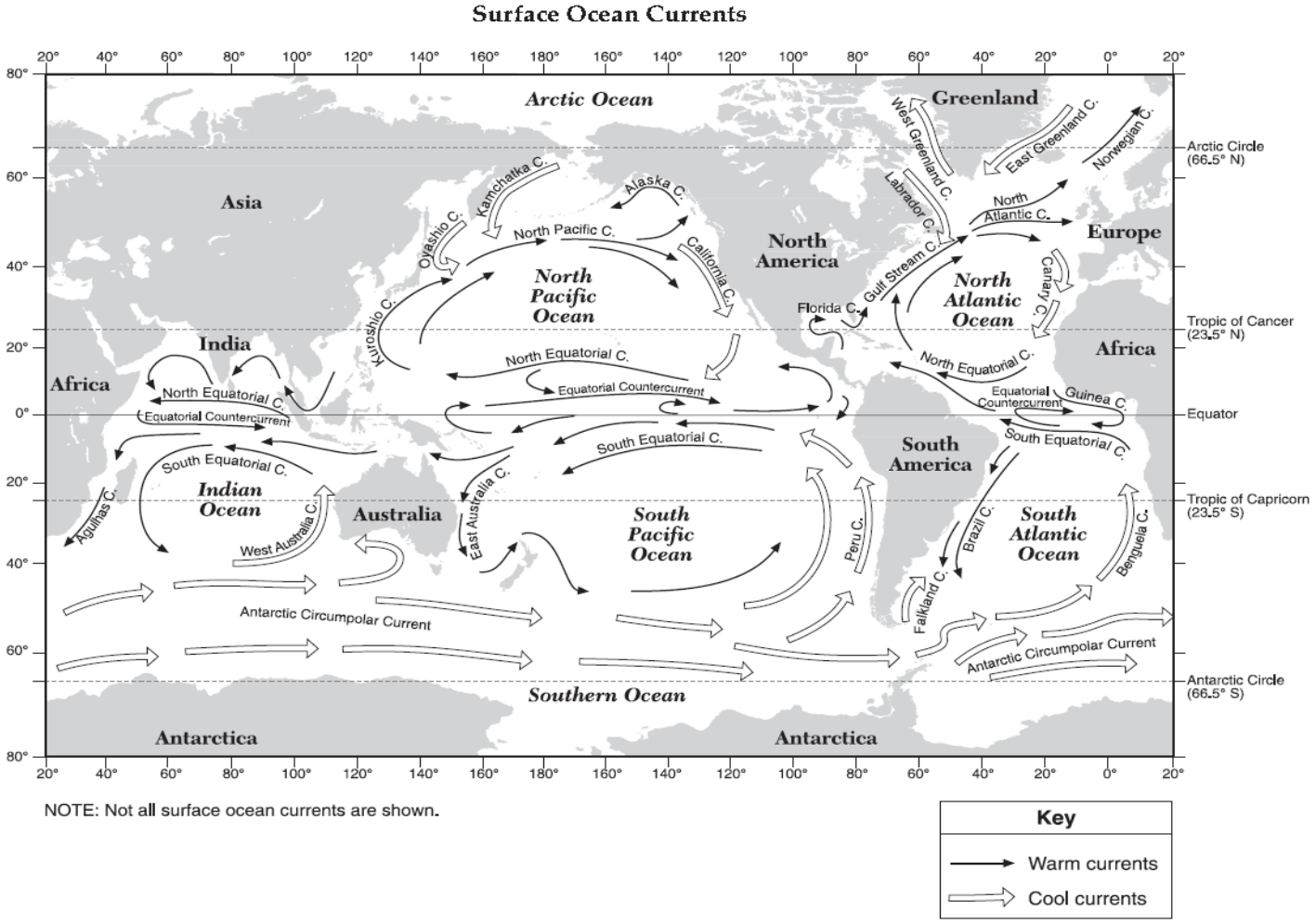


Planetary Wind belts and pressures belts develop.

Seasonal shifting of the wind and pressure belts are caused by the direct rays of insolation hitting

Different parts of the earth as it revolves around the Sun.

<u>Formation of surface ocean currents</u>:
Surface ocean currents are caused by wind blowing over the oceans and transferring energy to the water



1. What type of current is the gulf stream	
2. What type of current is the Labrador current	
3. What current is at 20^0 south and 140 ^{0} west?	
4. How many currents are listed in the Indian Ocean?	
5. What current circles the entire earth?	

V. Atmosphere Moisture

a. Energy of Evaporation and transpiration of water

Define evaporation:

_____

_____

Define Transpiration:

_____

_____

b. Process of Evaporation

c. Factors affecting Evaporation

- Amount of energy available
- surface area of the water
- degree of saturation of the air
- wind speed

d. Humidity temperature and dew point

Humidity:

_____

_____

Relative Humidity:

_____

_____

Dew Point:

_____

_____

e. Measuring relative Humidity

Sling Psychrometer

Instructions:

1. **Locate the dry bulb (normal air temp) reading on the left and side of the relative humidity chart in the ref tables**

2. **Subtract the wet-bulb reading from the dry bulb**

3. **Locate the difference between the wet bulb and dry bulb reading across the top of the chart**

4. **Follow the horizontal row for the dry bulb reading to the right until it meets the vertical number this number is the relative humidity.**

Determining Dew Point:

1. **Locate the dry bulb (normal air temp) reading on the left-hand side of the chart**

2. **Subtract the wet bulb reading from the dry bulb reading**

3. **Locate the difference between the wet bulb and dry bulb readings across the top to the chart**

4. **Follow the horizontal row for the dry bulb reading to the right until it meets the vertical column running down from the difference between the wet bulb and dry bulb readings this number is the dew point temperature**

Dry bulb	Wet bulb	Difference	Humidity	Dew point

Directions: Use page 12 in your reference table to fill in the blanks on the table.

Dry bulb Temperature	Wet bulb temperature	Difference between wet and dry bulb	Relative Humidity	Dew Point
-1	-2			
6			35	
28				17
18		5		
20	20			
		6	60	
		2		11
	12	5		
20		12		
16			54	
12			2	----------
		1		-21

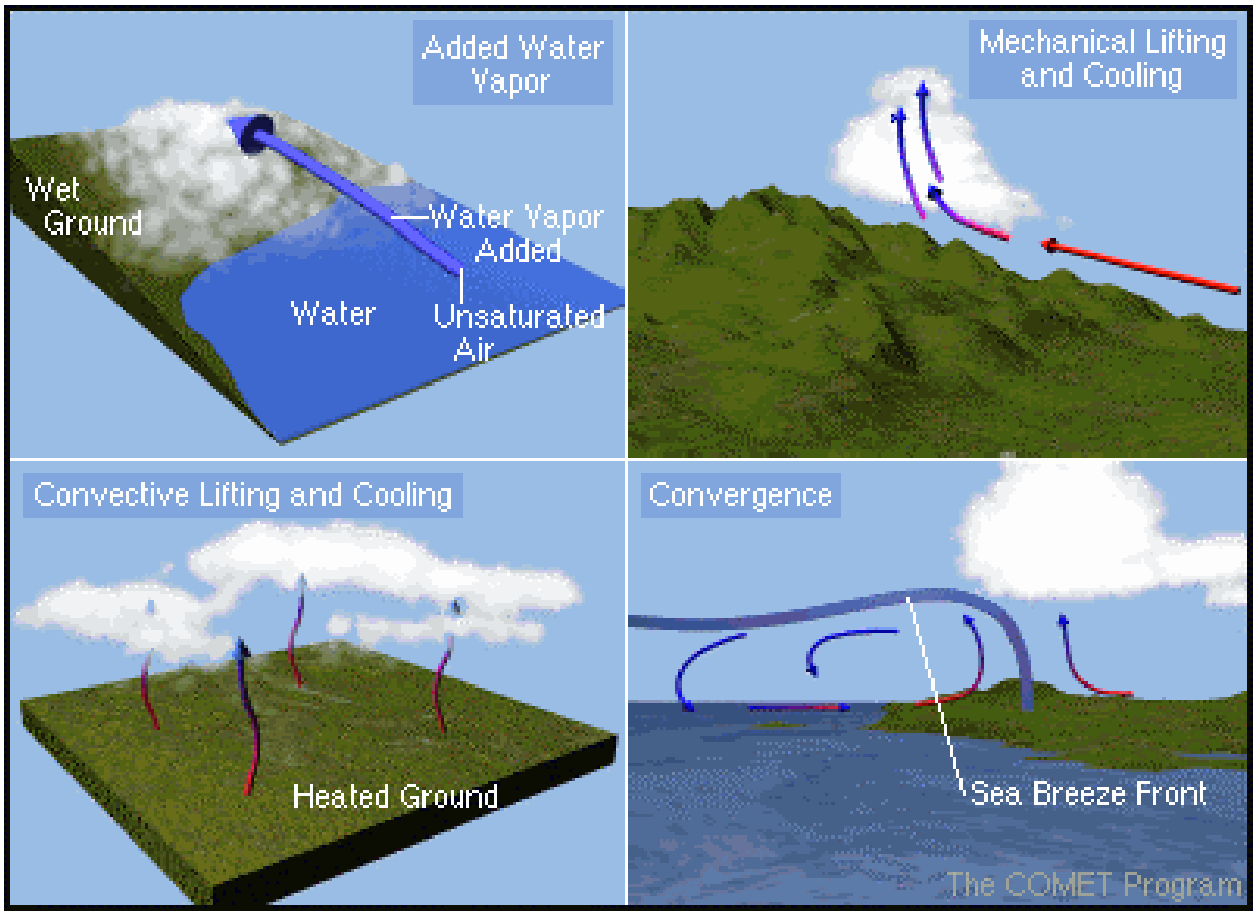
VI. Precipitation and Cloud formation:

Name the types of precipitation:

Differ in how the originate

There are certain conditions that must be net in order for it to precipitate. What do we need in order to receive any type of precipitation?

1. _____
2. _____
3. _____
4. _____



Cloud formation:

There are different ways to make clouds:
There are different types of clouds:

Name: **Cumulus**

Altitude: **< 2 km**

Composition: **Water**

Temperature: **5° to 15° C**

Name: **Cirrus**

Altitude: < **6 km.**

Composition: **Ice Crystals**

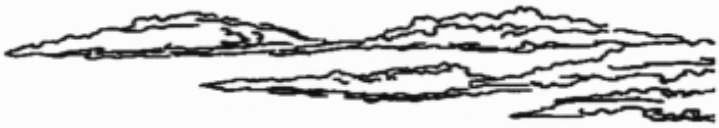
Temperature: **-50° to -60° C**

Name: **Stratus**

Altitude: < **2 km.**

Composition: **Water**

Temperature: **5° to 15° C**



Name: **Cumulonimbus**

Altitude: **12 km**

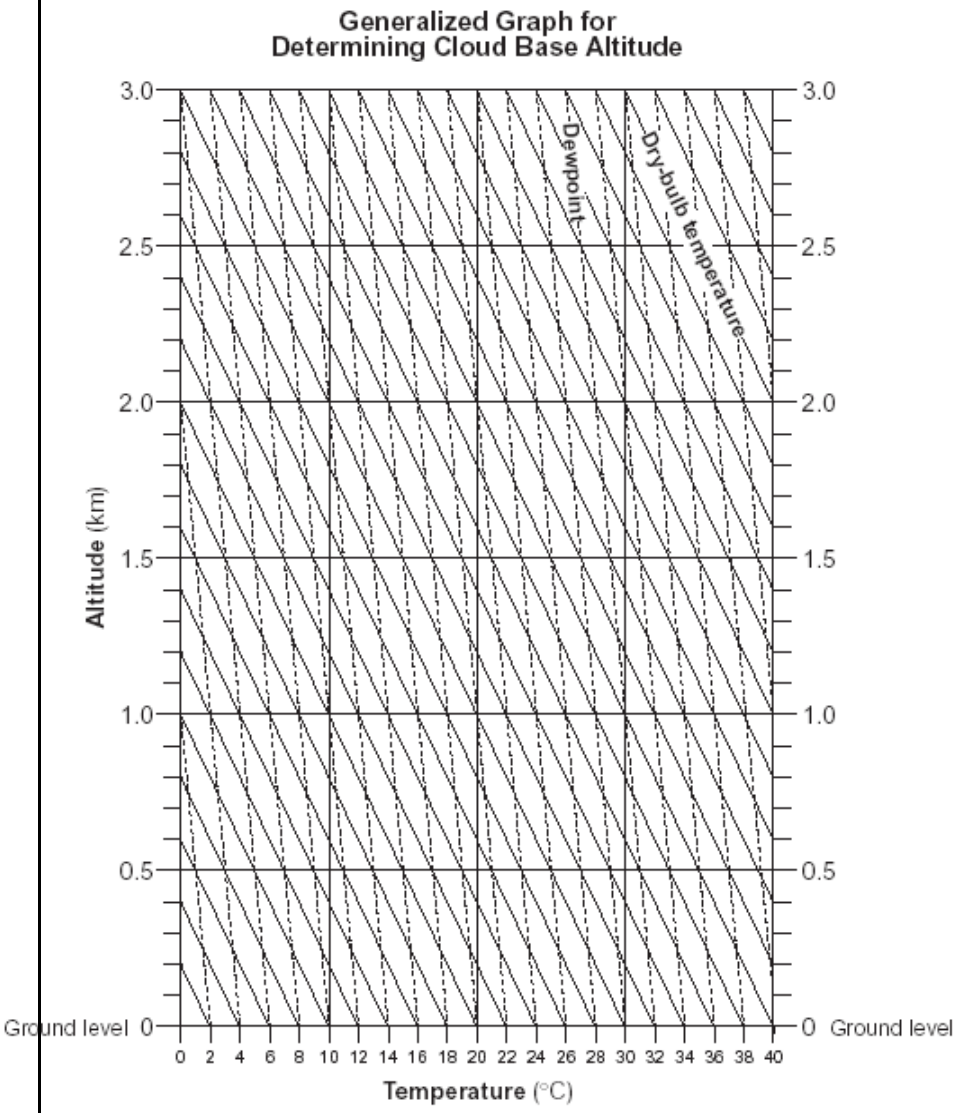
Composition: **Water and Ice**

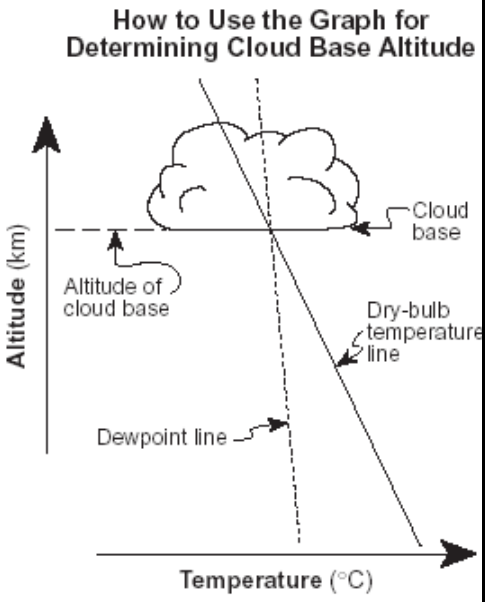
Temperature: **-50° to -60° C**

Cloud Base Altitude Chart

Every day one of the variables that weather centers report is the ceiling or altitude of the bottom of the clouds. This is particularly of interest to pilots and the military. It is actually very simple to calculate. On the chart below you will follow the dew point line and the dry bulb temperature line (Regular air temperature) until they intersect. Once you have that point, you read on a horizontal line to the side, which should tell you the altitude of the clouds.

Using the chart below, follow this example. Lets say the dry bulb temperature is 20^{0}C (the solid line) and the dew point temperature is 8^{0}C (the dashed lines). Follow each line up; both are on a slant, dry bulb more than the dew point. Once you reach where they both meet now move your finger either to left or to the right to read the altitude. It should be 1.5 km.





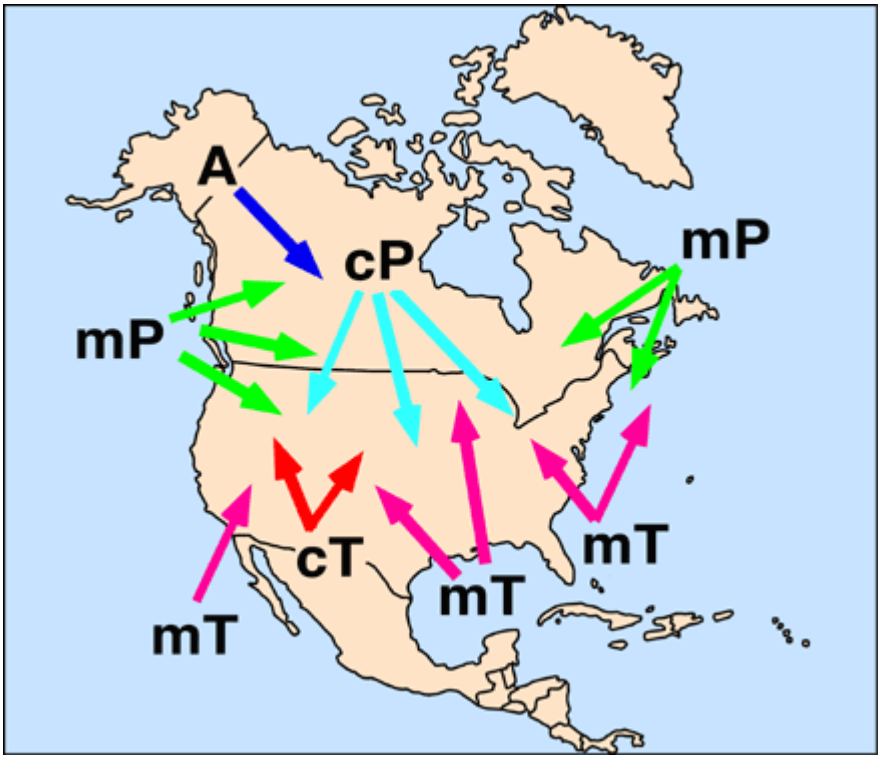
Using the diagram on the previous page calculate the Cloud Base for the following

	Dry bulb temperature	Dew Point	Cloud Base
1	40^0C	36^0C	
2	36^0C	28^0C	
3	30^0C	14^0C	
4	40^0C	16^0C	
5	30^0C	24^0C	
6	36^0C	18^0C	
7	30^0C	12^0C	
8	10^0C	10^0C	

For the last set of numbers you notice that dry bulb temperature and the dew point are the same for each. If this forms at ground level what is this called?_____

Is it possible for clouds to be at the same altitude two different days with different dry bulb and dew point readings? _____

VII. Air Masses and Fronts



Define Air Masses:

_____

_____

Characteristics of air masses:

_____

_____

_____

_____

_____

_____

Location of some the most popular Air masses in this Hemisphere:

Which two masses effect out weather in New York the most?

1. _____ 2. _____

VIII Fronts :

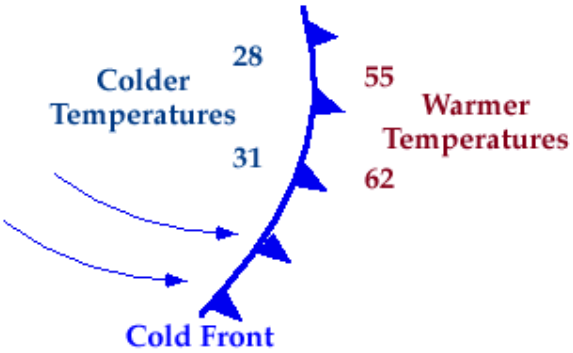
Define: The boundaries between air masses.

A front is defined as the transition zone between two air masses of different density. Fronts extend not only in the horizontal direction, but in the vertical as well. Therefore, when referring to the frontal surface (or frontal zone), we referring to both the horizontal and vertical components of the front.

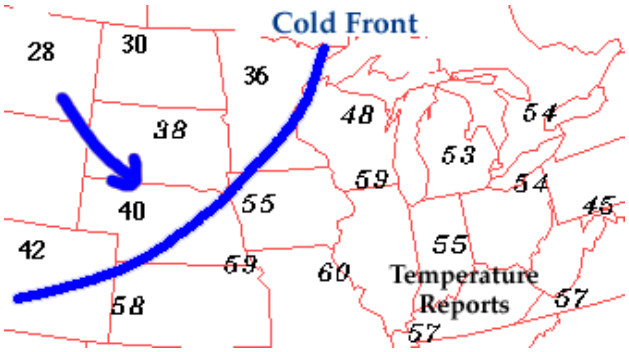
a. Cold Front

Transition zone from warm air to cold air

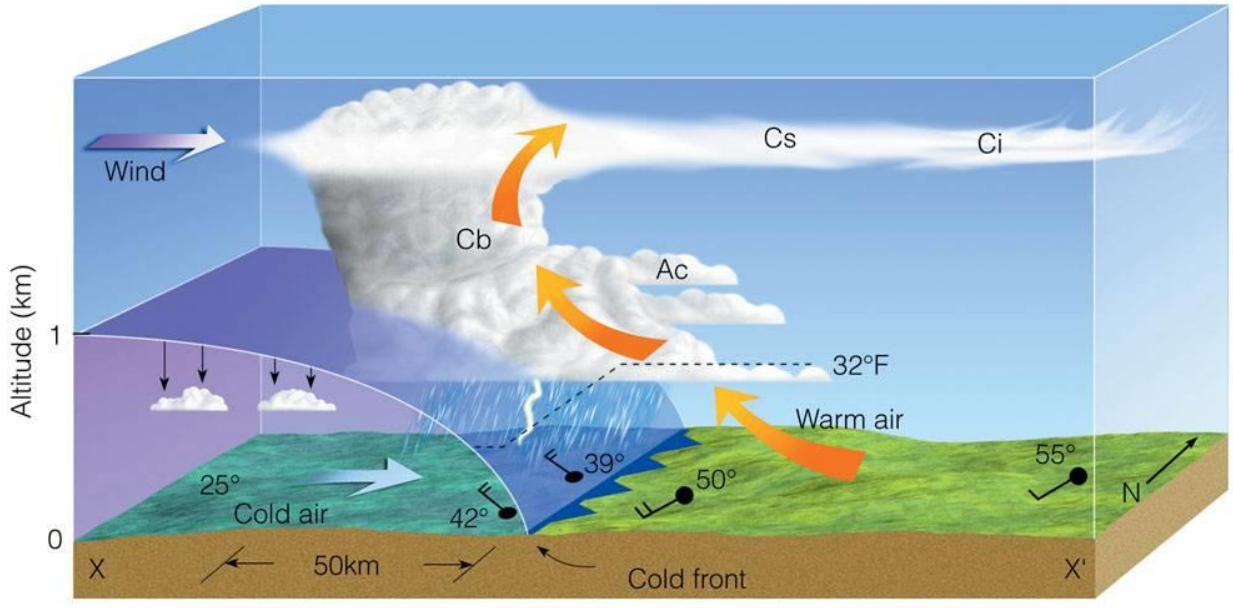
A cold front is defined as the transition zone where a cold air mass is replacing a warmer air mass. Cold fronts generally move from northwest to southeast. The air behind a cold front is noticeably colder and drier than the air ahead of it. When a cold front passes through, temperatures can drop more than 15 degrees within the first hour.



Symbolically, a cold front is represented by a solid line with triangles along the front pointing towards the warmer air and in the direction of movement. On colored weather maps, a cold front is drawn with a solid blue line.



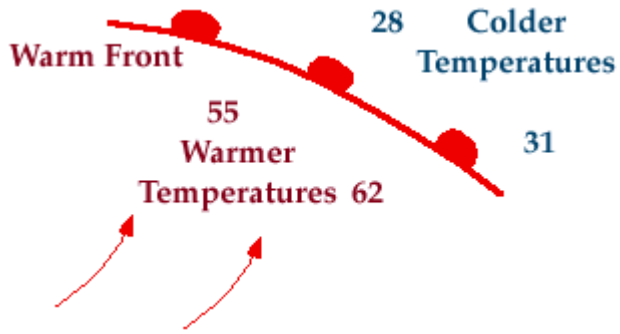
There is typically a noticeable temperature change from one side of a cold front to the other. In the map of surface temperatures below, the station east of the front reported a temperature of 55 degrees



b. <u>Warm Front</u>

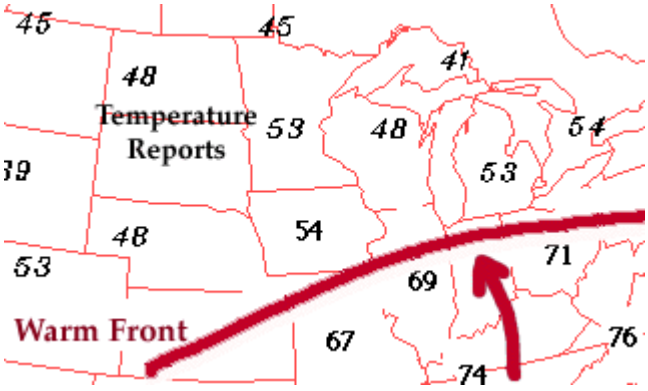
Define : Transition zone from cold air to warm air

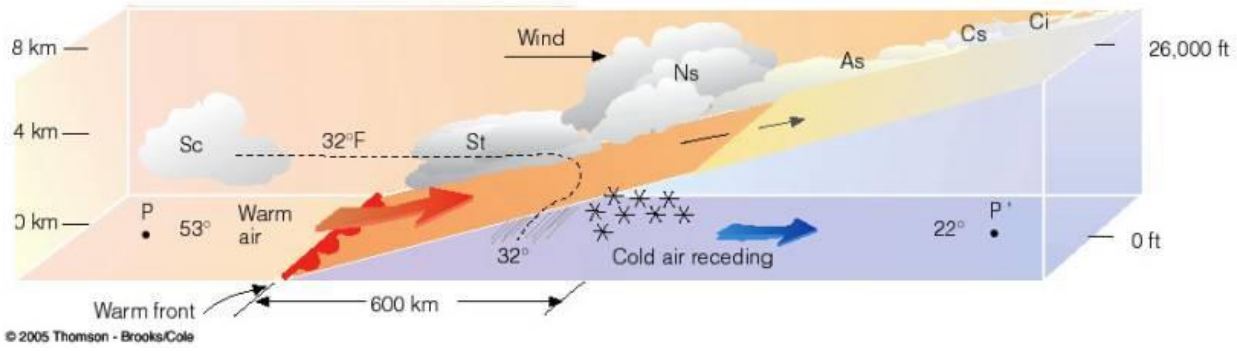
A warm front is defined as the transition zone where a warm air mass is replacing a cold air mass. Warm fronts generally move from southwest to northeast and the air behind a warm front is warmer and more moist than the air ahead of it. When a warm front passes through, the air becomes noticeably warmer and more humid than it was before.



Symbolically, a warm front is represented by a solid line with semicircles pointing towards the colder air and in the direction of movement. On colored weather maps, a warm front is drawn with a solid red line.

There is typically a noticeable temperature change from one side of the warm front to the other. In the map of

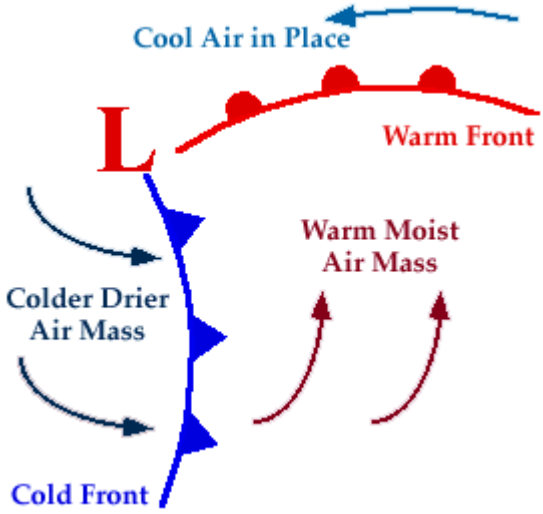




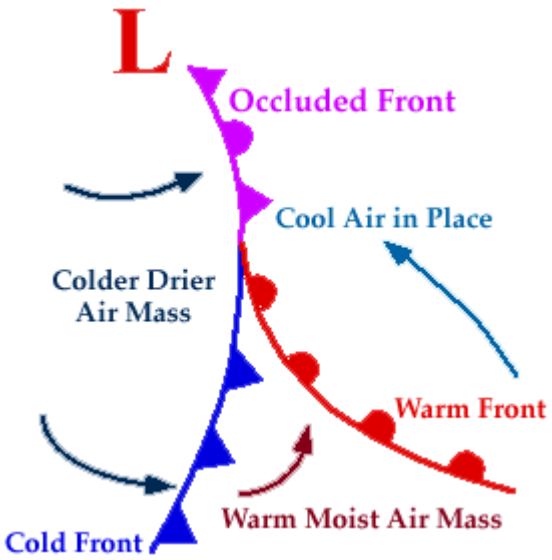
Occluded Front

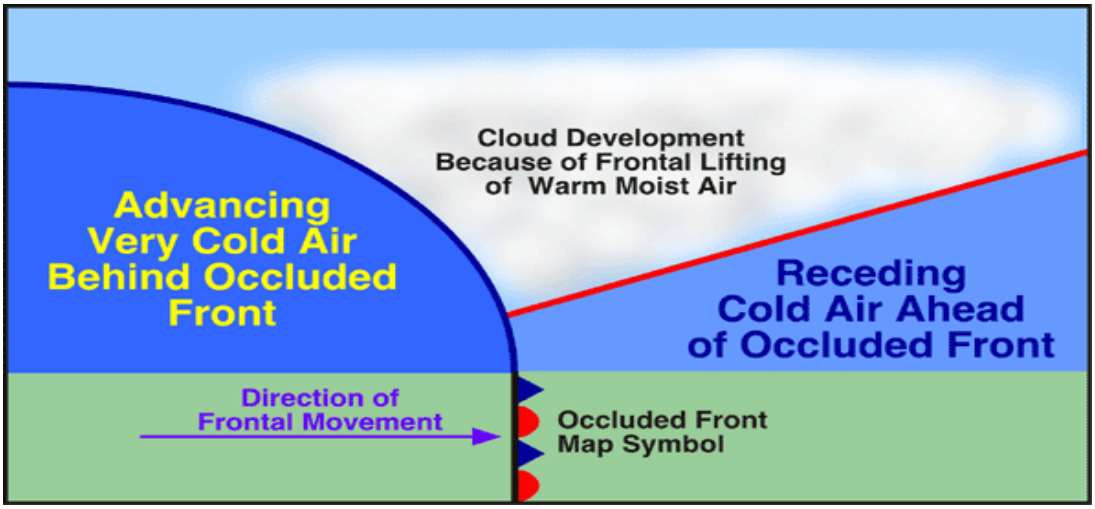
when a cold front overtakes a warm front

A developing cyclone typically has a preceding warm front (the leading edge of a warm moist air mass) and a faster moving cold front (the leading edge of a colder drier air mass wrapping around the storm). North of the warm front is a mass of cooler air that was in place before the storm even entered the region.

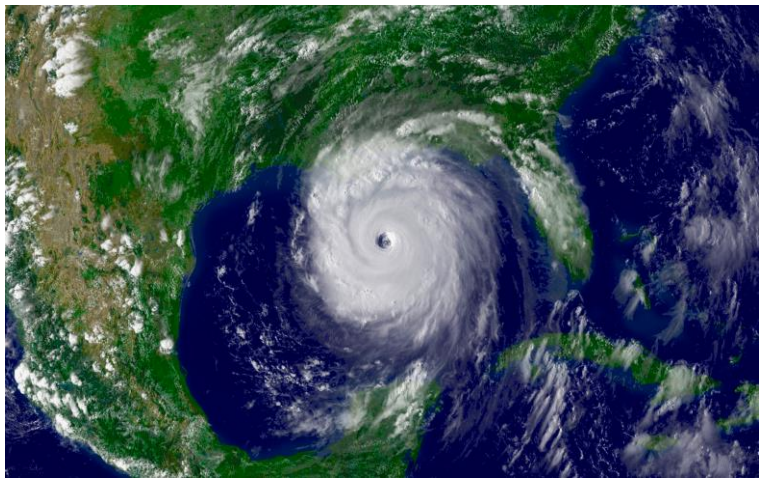


As the storm intensifies, the cold front rotates around the storm and catches the warm front. This forms an occluded front, which is the boundary that separates the new cold air mass (to the west) from the older cool air mass already in place north of the warm front. Symbolically, a solid line with alternating triangles represents an occluded front and circles pointing the direction the front is moving. On colored weather maps, an occluded front is drawn with a solid purple line.





Storms and Severe Weather:



- **Hurricanes:**

- **A hurricane is a severe tropical storm that forms in the North Atlantic Ocean, the Northeast Pacific Ocean east of the dateline, or the South Pacific Ocean east of 160E.**
- **Hurricanes need warm tropical oceans, moisture and light winds above them.**
- **If the right conditions last long enough, a hurricane can produce violent winds, incredible waves, torrential rains and floods. In other regions of the world, these types of storms have different names.**
  - **Typhoon — (the Northwest Pacific Ocean west of the dateline)**
  - **Severe Tropical Cyclone — (the Southwest Pacific Ocean west of 160E or Southeast Indian Ocean east of 90E)**
  - **Severe Cyclonic Storm — (the North Indian Ocean)**
  - **Tropical Cyclone — (the Southwest Indian Ocean)**
- **Hurricanes rotate in a counterclockwise direction around an "eye." A tropical storm becomes a hurricane when winds reach 74 mph.**
- **There are on average six Atlantic hurricanes each year; over a three-year period, approximately five hurricanes strike the United States coastline from Texas to Maine.**
- **The Atlantic hurricane season begins June 1 and ends November 30.**
- **When hurricanes move onto land, the heavy rain, strong winds and heavy waves can damage buildings, trees and cars.**
- **The heavy waves are called a <u>storm surge</u>. Storm surge is very dangerous and a major reason why you MUST stay away from the ocean during a hurricane.**

Scale Number (Category)	Winds (Mph)	Typical characteristics of hurricanes by category			
		(Millibars)	(Inches)	Surge (Feet)	Damage
1	74-95	> 979	> 28.91	4 to 5	Minimal
2	96-110	965-979	28.50-28.91	6 to 8	Moderate
3	111-130	945-964	27.91-28.47	9 to 12	Extensive
4	131-155	920-944	27.17-27.88	13 to 18	Extreme
5	> 155	< 920	< 27.17	> 18	Catastrophic

10 worst in human life in United States History
1. Great Galveston Hurricane, Texas - 1900 - Category 4 - 8,000 deaths
2. Lake Okeechobee, Florida - 1938 - Category 4 - 2,500 deaths
3. Katrina, LA/MS/FL/GA/AL - 2005 - Category 3 - 1,833 deaths
4. Cheniere Caminanda, Louisiana - 1893 - Category 4 - 1,100-1,400 deaths
5. Sea Islands, SC/GA - 1893 - Category 3 - 1,000-2,000 deaths
6. GA/SC - 1881 - Category 2 - 700 deaths
7. Great Labor Day Hurricane, Florida Keys - 1935 - Category 5 - 408
8. Last Island, Louisiana - 1856 - Category 4 - 400
9. Audrey, SW LA/N TX - 1957 - Category 4 - 390
10. Grand Isle, Louisana - 1909 - Category 4 - 350

Rank	Hurricane	Location	Year	Cate-gory[2]	Damage (in billions)
1.	Katrina	La./Miss.	2005	3	$96.0[3]
2.	Andrew	Fla./La.	1992	5	26.5
3.	Charley	Fla.	2004	4	15.0
4.	Wilma	Fla.	2005	3	14.4[3]
5.	Ivan	Ala./Fla.	2004	3	14.2
6.	Rita	Tex./La.	2005	3	$9.4[3]
7.	Frances	Fla.	2004	2	8.9
8.	Hugo	S.C.	1989	4	7.0
9.	Jeanne	Fla.	2004	3	6.9
10.	Allison	Tex.	2001	TS[4]	5.0

Tornadoes

Tornadoes are one of nature's most violent storms. In an average year, about 1,000 tornadoes are reported across the United States, resulting in 80 deaths and over 1,500 injuries. A tornado is a violently rotating column of air extending from a thunderstorm to the ground. The most violent tornadoes are capable of tremendous destruction with wind speeds of 250 mph or more. Damage paths can be in excess of one mile wide and 50 miles long.

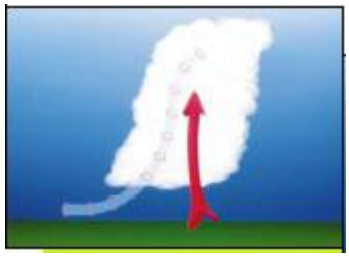
Tornadoes come in all shapes and sizes and can occur anywhere in the U.S. at any time of the year. In the southern states, peak tornado season is March through May, while peak months in the northern states are during the summer.

Most Tornadoes in 24 hr period

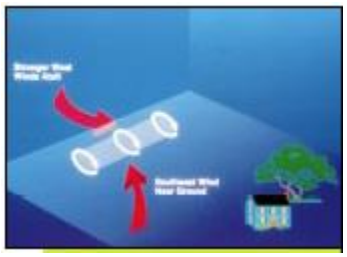
- **The record number of tornadoes in a 24-hour period is 148, which swept through the southern and mid-western states of the USA on 3–4 April 1974.**
- **The southern and mid-western states of the USA are often referred to as "Tornado Alley". The northern and southern borders of this weather hotspot vary, but they extend on average from central Texas to Iowa and Nebraska.**
- **In these central regions of the USA, these conditions are quite common, with plenty of moist warm air being supplied from the Gulf of Mexico.**

Longest Discontinuous Tornado

A tornado traveled 471.5 km (293 miles) across the US midwestern states of Illinois and Indiana on May 26, 1917, but it was not continuous on the ground



Before thunderstorms develop, a change in wind direction and an increase in wind speed with increasing height create an invisible, horizontal spinning effect in the lower atmosphere.



Rising air within the thunderstorm updraft tilts the rotating air from horizontal to vertical.

An area of rotation, 2-6 miles wide, now extends through much of the storm. Most strong and violent tornadoes form within this area of strong rotation.

Tornado Myths:

MYTH: Areas near rivers, lakes, and mountains are safe from tornadoes.
FACT: No place is safe from tornadoes. In the late 1980's, a tornado swept through Yellowstone National Park leaving a path of destruction up and down a 10,000 ft. mountain.
MYTH: The low pressure with a tornado causes buildings to "explode" as the tornado passes overhead.
FACT: Violent winds and debris slamming into buildings cause most structural damage.
MYTH: Windows should be opened before a tornado approaches to equalize pressure and minimize damage.
FACT: Opening windows allows damaging winds to enter the structure. Leave the windows alone; instead, immediately go to a safe place.

Date	Location	Deaths
16 December 2000	Englewood, AL	11
3 May 1999	Oklahoma City, OK	36
10 April 1979	Wichita Falls, TX	42
21 February 1971	Cary-Pugh City, MS	58
25 May 1955	Blackwell, OK-Udall, KS	80
9 June 1953	Worcester, MA	94
8 June 1953	Flint, MI	115
22 May 2011	Joplin, MO	159
9 April 1947	Woodward, OK	181
6 April 1936	Gainesville, GA	203
5 April 1936	Tupelo, MS	216
18 March 1925	Tri-State (MO-IL-IN)	695