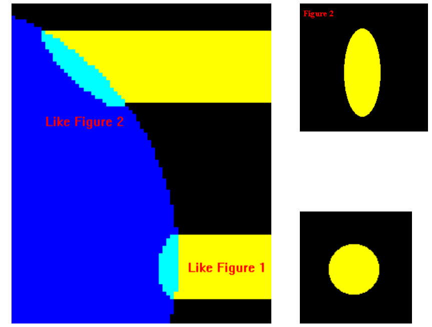
Regents Earth Science – Unit 7: Weather

Weather – the condition of the atmosphere for a location at a given time

- caused by unequal heating from the sun
- the uneven heating of the Earth's surface through the seasons heats some parts of the world more than others – this heat energy is distributed from warm regions to cold regions by **convection**



The sun's energy is far more concentrated near the equator than it is near the poles – this is why equatorial regions are warmer

Atmosphere

Atmosphere – the 4 layers of gases that surround the Earth

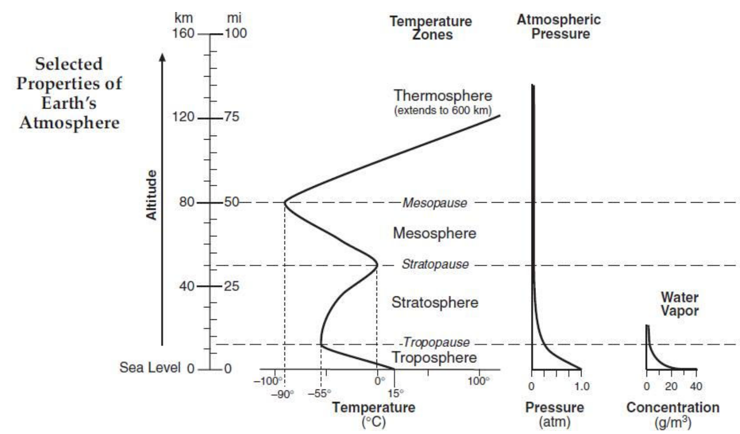
- composed of 78% nitrogen, 21% oxygen, and small amounts of other gases
- Earth's atmosphere has 4 distinct layers – called *spheres* (determined by temperature differences)
    1. **Troposphere** – the bottom layer, where we live, contains over half of the air molecules, is the only layer with "weather"
    2. **Stratosphere** – 2nd layer from Earth, where planes fly, contains the *ozone layer*
    3. **Mesosphere** – 3rd layer from Earth, ionosphere is here
    4. **Thermosphere** – top layer, few molecules, the beginning of space
- the interface (boundary) between layers is called a "*pause*" and determined by where the temperature trend changes

Average Chemical Composition of Earth's Crust, Hydrosphere, and Troposphere

ELEMENT (symbol)	CRUST		HYDROSPHERE	TROPOSPHERE
	Percent by mass	Percent by volume	Percent by volume	Percent by volume
Oxygen (O)	46.10	94.04	33.0	21.0
Silicon (Si)	28.20	0.88		
Aluminum (Al)	8.23	0.48		
Iron (Fe)	5.63	0.49		
Calcium (Ca)	4.15	1.18		
Sodium (Na)	2.36	1.11		
Magnesium (Mg)	2.33	0.33		
Potassium (K)	2.09	1.42		
Nitrogen (N)				78.0
Hydrogen (H)			66.0	
Other	0.91	0.07	1.0	1.0

Reference Tables p. 1

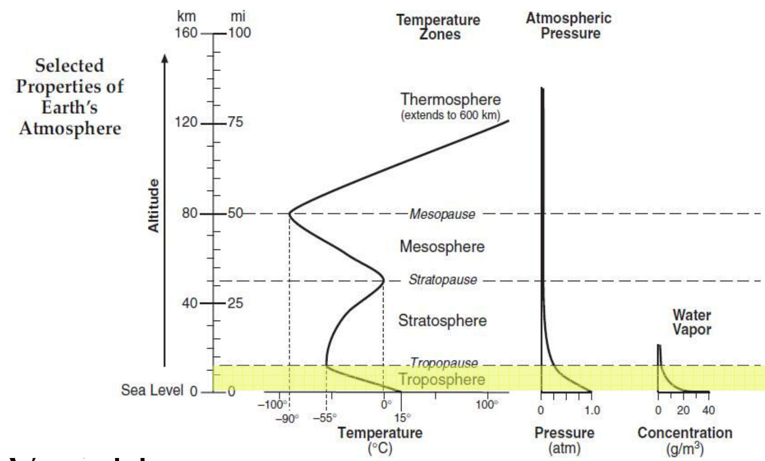
- Note: air pressure decreases as altitude increases, and the troposphere is the only layer that contains water vapor (weather occurs here)



Reference Tables p. 14

Atmosphere

- we live in the Troposphere, the bottom of the ocean of air
- the troposphere is the only layer with "weather" because it is the only layer with water vapor



Weather Variables

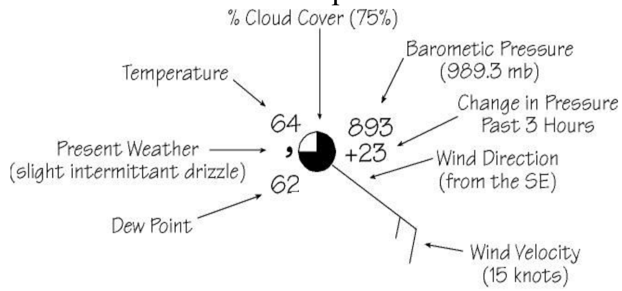
Variable	Unit	Instrument	Definition
Temperature	ºC; ºF	thermometer	average kinetic energy of the particles of matter
Barometric Pressure	mb; in.	barometer	weight of the overlaying atmosphere pushing down on a unit of area
Relative Humidity	%	sling psychrometer	ratio of amount of water vapor in the air to the maximum it can hold
Dew Point Temperature	ºC; ºF	sling psychrometer	temperature at which the air becomes saturated
Cloud Cover	%	---	percent of the total sky that is covered by clouds
Visibility	mi.	---	how far one can see – decreased by clouds, fog, precipitation
Wind Direction	---	wind vane	direction the wind is blowing from
Wind Velocity	mi./hr.;km./hr	anemometer	how fast the wind is blowing
Present Weather	---	---	conditions of the atmosphere for a short period of time at a location
Precipitation	in.	rain gauge	falling liquid or solid water from clouds

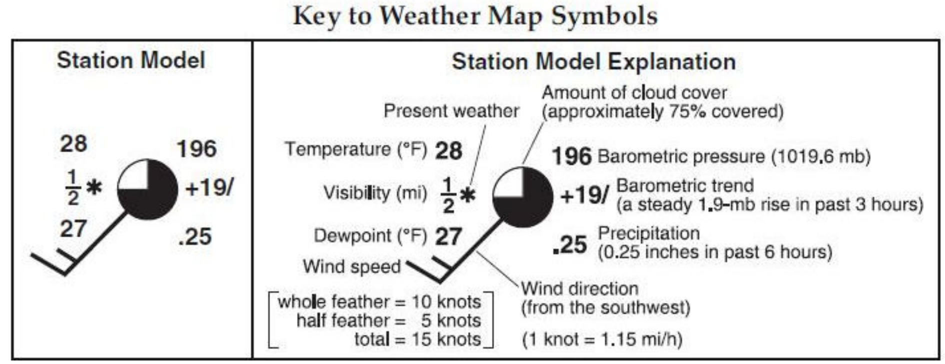
Station Model

Station Model – a diagram showing the weather conditions for a city on a map – (gives the latest readings for the most important weather variables)

Weather Variables – the conditions of the atmosphere –include:

- temperature
- moisture
- air pressure
- Wind speed
- cloud cover
- precipitation
- visibility





All weather variables are located in specific places on the station model and are given in symbolic form *without the units* (to keep the station model easy to read)

Reference Tables p. 13

Cloud Cover

clear sky
partly cloudy sky
partly cloudy sky
mostly cloudy sky
overcast sky

Barometric Pressure

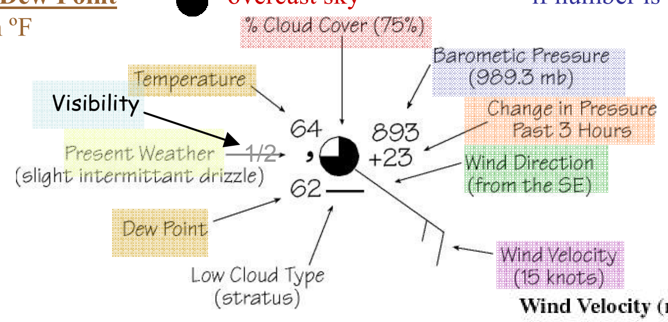
decimal point is omitted in front of the last digit of the number

if number is >500, place 9 in front of reading

if number is <500, place 10 in front of reading

Temperature and **Dew Point** are always given in °F

Visibility given in miles

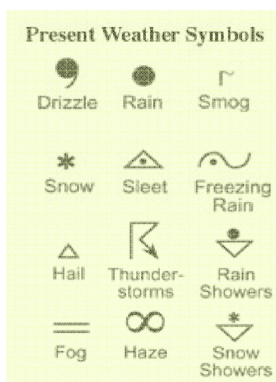


Change in Pressure

decimal point omitted from reading

symbols before number:
+ pressure higher than 3 hrs ago
- pressure lower than 3 hrs ago

symbols after number:
/ pressure rising steadily
\ pressure falling steadily
- pressure has remained steady



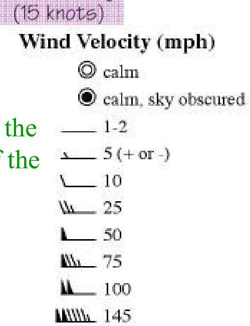
Wind Direction

winds always blow along the shaft toward the center of the station

Wind Speed

half feather = 5 knots

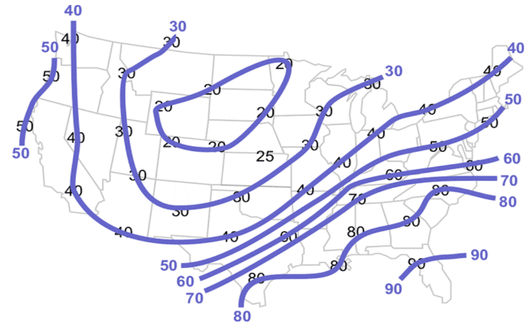
whole feather = 10 knots



Temperature

Temperature – shown on maps and charts using isotherms

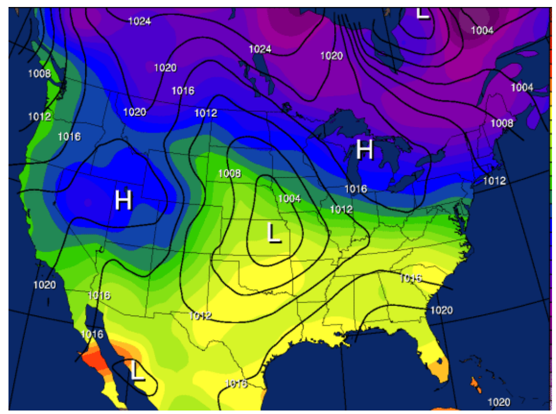
- Isotherms usually make parallel lines similar to latitude



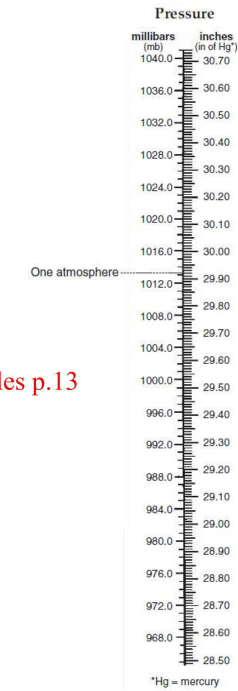
Air Pressure

Air Pressure – the weight of the air over a given surface area due to the force of gravity (pulls air down – creates pressure)

- measured using a barometer
- units: inches of mercury or **millibars**



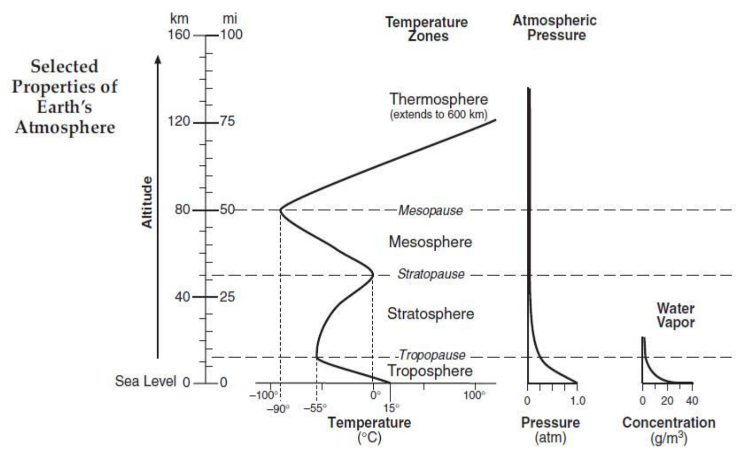
- Air pressure is shown on maps using isobars
- isobars tend to form circular patterns (showing large masses of air)



Reference Tables p.13

Factors that Cause Atmospheric Pressure to Change:

1. **Temperature** – as temperature increases (air molecules move further apart), air pressure decreases
2. **Moisture** – as humidity (moisture in the air) increases, air pressure decreases (water molecules H_2O are lighter than a molecules O_2 , N_2)
3. **Altitude** – as altitude increases, air pressure decreases (the air is less dense)

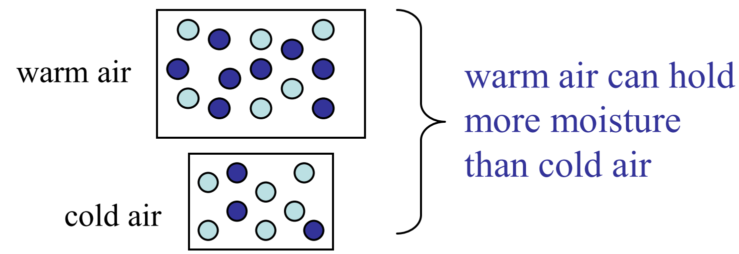


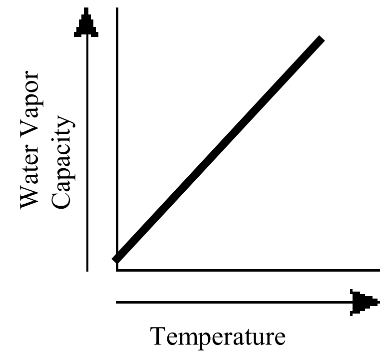
Reference Tables p.14

Moisture

Water Vapor – water in the gaseous state (phase)

- water enters the atmosphere by **evaporation** (liquid changes to a gas), **sublimation** (ice changes directly to a gas), and **transpiration** (plants release water vapor)
- as temperature increases, the amount of water vapor the air can hold increases
- **Saturation** – when the air holds as much water vapor as it can at a given temperature
- occurs when the rate of evaporation equals the rate of condensation





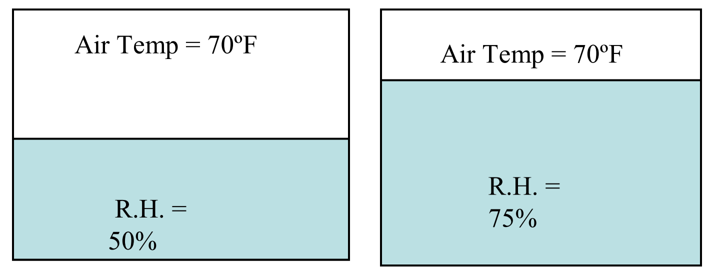
Factors that Effect the Rate of Evaporation:

1. **Temperature** – as temperature increases, the rate of evaporation increases (T ↑ = Evap ↑)
2. **Humidity** – as humidity increases, the rate of evaporation decreases (H ↑ = Evap ↓)
3. **Wind** – as wind increases, the rate of evaporation increases (W ↑ = Evap ↑)
4. **Surface Area** – as surface area increases, rate of evaporation increases (SA ↑ = Evap ↑)

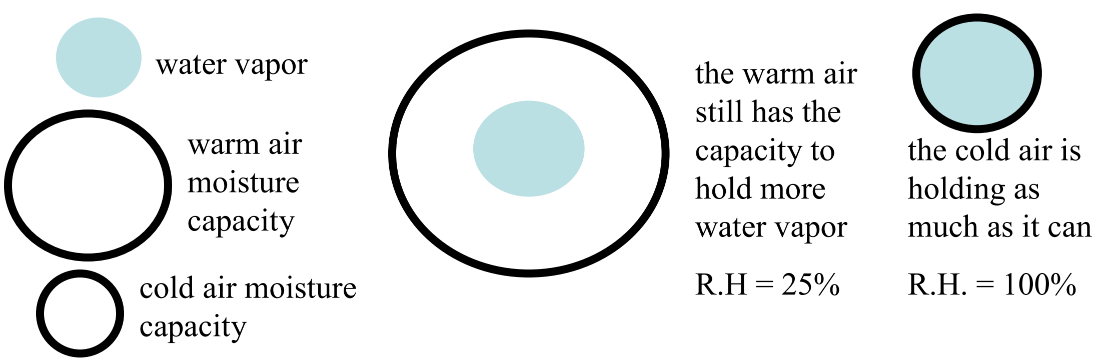
Humidity – the amount of water vapor in the air

1. **Absolute Humidity** - the actual amount (mass) of water vapor in the air
2. **Relative Humidity** – the amount of water vapor in the air compared to what the air could hold at that temperature

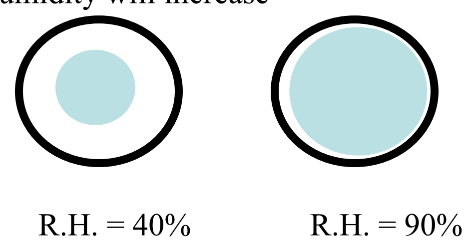
- always given as a percentage (%)
- 50% humidity means the air is holding half of the water vapor it is capable of holding (or the air is half full)



- **Warm air can hold more moisture than cold air:**



- if the moisture content of the air increases and the temperature remains the same, the relative humidity will increase



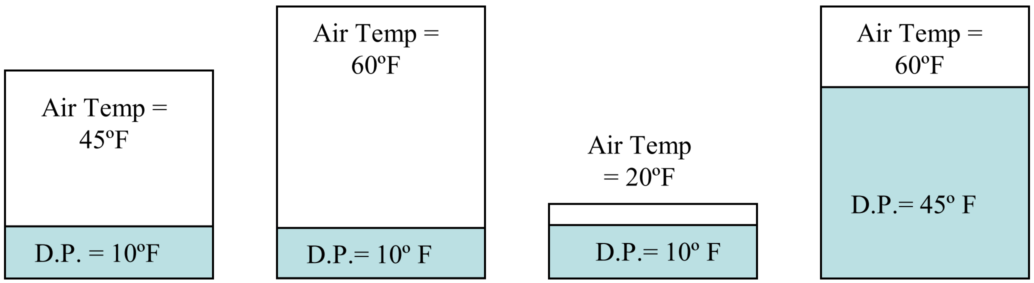
Moisture

- Relative Humidity will change with a change in temperature:
- if the amount of water stays the same, but it gets cooler, the **relative humidity** *increases* because the water fills up the smaller air space more
- if the amount of water stays the same, but it gets hotter, the **relative humidity** *decreases* because the water does not fill up the larger air space as much

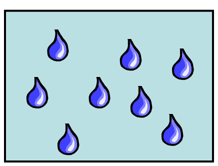
Question: at what time of the day is the relative humidity highest? lowest?

Dew Point – the temperature to which the air must be cooled to reach saturation (the air is full of water vapor)

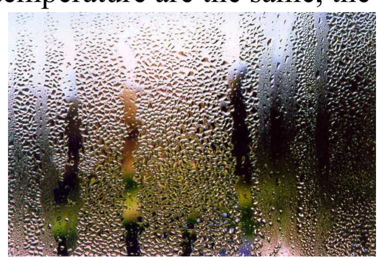
- depends upon the amount of water vapor in the air (not relative humidity)

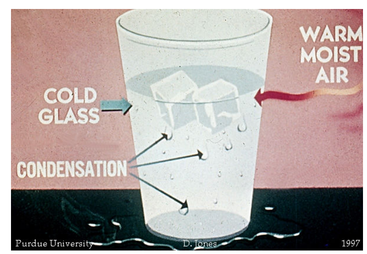


- when the air temperature and dew point temperature are the same, the air is saturated and condensation occurs

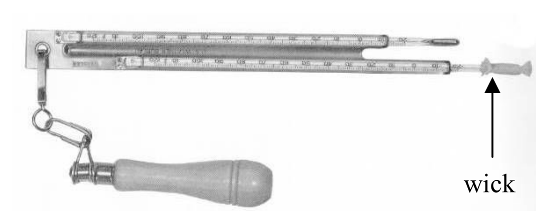


Air Temp + Dew Pt are 30ºF (air is saturated)





- Relative Humidity and the Dewpoint are found by using an instrument called a **sling psychrometer**
  - contains an ordinary thermometer called a **dry bulb thermometer** and another thermometer with a wick around its bulb called a **wet bulb thermometer**
  - when the wick is moistened, and the psychrometer is spun, the temperature of the wet bulb drops because of the cooling effect of evaporation
  - the amount of cooling depends upon how fast evaporation occurs (which depends on how dry the air is)



Moisture

- To determine the Dewpoint, you need the dry bulb and wet bulb temperatures and the Dewpoint Temperatures Chart:

1. locate the dry bulb reading on the left
2. Subtract to find the difference between the wet bulb and dry bulb readings along the top of the chart
3. follow the dry bulb reading until it meets the difference between the wet and dry bulb temperatures – this is the Dewpoint temperature

Make sure you are using CELSIUS temperatures !

Dewpoint (°C)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	−20	−33														
−18	−18	−28														
−16	−16	−24														
−14	−14	−21	−36													
−12	−12	−18	−28													
−10	−10	−14	−22													
−8	−8	−12	−18	−29												
−6	−6	−10	−14	−22												
−4	−4	−7	−12	−17	−29											
−2	−2	−5	−8	−13	−20											
0	0	−3	−6	−9	−15	−24										
2	2	−1	−3	−6	−11	−17										
4	4	1	−1	−4	−7	−11	−19									
6	6	4	1	−1	−4	−7	−13	−21								
8	8	6	3	1	−2	−5	−9	−14								
10	10	8	6	4	1	−2	−5	−9	−14	−28						
12	12	10	8	6	4	1	−2	−5	−9	−16						
14	14	12	11	9	6	4	1	−2	−5	−10	−17					
16	16	14	13	11	9	7	4	1	−1	−6	−10	−17				
18	18	16	15	13	11	9	7	4	2	−2	−5	−10	−19			
20	20	19	17	15	14	12	10	7	4	2	−2	−5	−10	−19		
22	22	21	19	17	16	14	12	10	8	5	3	−1	−5	−10	−19	
24	24	23	21	20	18	16	14	12	10	8	6	2	−1	−5	−10	−18
26	26	25	23	22	20	18	17	15	13	11	9	6	3	0	−4	−9
28	28	27	25	24	22	21	19	17	16	14	11	9	7	4	1	−3
30	30	29	27	26	24	23	21	19	18	16	14	12	10	8	5	1

Reference Tables p.12

- Ex.: dry bulb temperature = 8ºC
  wet bulb temperature = 6ºC
  } difference = 2ºC

  - Dewpoint Temperature = 3ºC

Dewpoint (°C)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	−20	−33														
−18	−18	−28														
−16	−16	−24														
−14	−14	−21	[illegible]													
−12	−12	−18	[illegible]													
−10	−10	−14	[illegible]													
−8	−8	−12	[illegible]	−29												
−6	−6	−10	[illegible]	−22												
−4	−4	−7	[illegible]	−17	−29											
−2	−2	−5	[illegible]	−13	−20											
0	0	−3	[illegible]	−9	−15	−24										
2	2	−1	[illegible]	−6	−11	−17										
4	4	1	[illegible]	−4	−7	−11	−19									
6	6	4	[illegible]	−1	−4	−7	−13	−21								
8	[illegible]	[illegible]	3	1	−2	−5	−9	−14								
10	10	8	[illegible]	4	1	−2	−5	−9	−14	−28						
12	12	10	8	6	4	1	−2	−5	−9	−16						
14	14	12	11	9	6	4	1	−2	−5	−10	−17					
16	16	14	13	11	9	7	4	1	−1	−6	−10	−17				
18	18	16	15	13	11	9	7	4	2	−2	−5	−10	−19			
20	20	19	17	15	14	12	10	7	4	2	−2	−5	−10	−19		
22	22	21	19	17	16	14	12	10	8	5	3	−1	−5	−10	−19	
24	24	23	21	20	18	16	14	12	10	8	6	2	−1	−5	−10	−18
26	26	25	23	22	20	18	17	15	13	11	9	6	3	0	−4	−9
28	28	27	25	24	22	21	19	17	16	14	11	9	7	4	1	−3
30	30	29	27	26	24	23	21	19	18	16	14	12	10	8	5	1

Moisture

- To determine the Relative Humidity, you need the dry bulb and wet bulb temperatures and the Relative Humidity (%) Chart:

1. locate the dry bulb reading on the left
2. Subtract to find the difference between the wet bulb and dry bulb readings along the top of the chart
3. follow the dry bulb reading until it meets the difference between the wet and dry bulb temperatures – this is the Relative Humidity

Make sure you are using CELSIUS temperatures !

Relative Humidity (%)

Dry-Bulb Tempera-ture (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	100	28														
−18	100	40														
−16	100	48														
−14	100	55	11													
−12	100	61	23													
−10	100	66	33													
−8	100	71	41	13												
−6	100	73	48	20												
−4	100	77	54	32	11											
−2	100	79	58	37	20	1										
0	100	81	63	45	28	11										
2	100	83	67	51	36	20	6									
4	100	85	70	56	42	27	14									
6	100	86	72	59	46	35	22	10								
8	100	87	74	62	51	39	28	17	6							
10	100	88	76	65	54	43	33	24	13	4						
12	100	88	78	67	57	48	38	28	19	10	2					
14	100	89	79	69	60	50	41	33	25	16	8	1				
16	100	90	80	71	62	54	45	37	29	21	14	7	1			
18	100	91	81	72	64	56	48	40	33	26	19	12	6			
20	100	91	82	74	66	58	51	44	36	30	23	17	11	5		
22	100	92	83	75	68	60	53	46	40	33	27	21	15	10	4	
24	100	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4
26	100	92	85	77	70	64	57	51	45	39	34	28	23	18	13	9
28	100	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12
30	100	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16

Reference Tables p.12

- Ex.: dry bulb temperature = 4ºC
  wet bulb temperature = -2ºC
  } difference = 6ºC

- Relative Humidity = 14%

Relative Humidity (%)

Dry-Bulb Tempera-ture (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	100	28														
−18	100	40														
−16	100	48														
−14	100	55	11													
−12	100	61	23													
−10	100	66	33													
−8	100	71	41	13												
−6	100	73	48	20												
−4	100	77	54	32	11											
−2	100	79	58	37	20	1										
0	100	81	63	45	28	11										
2	100	83	67	51	36	20	6									
4	100	85	70	56	42	27	14									
6	100	86	72	59	46	35	22	10								
8	100	87	74	62	51	39	28	17	6							
10	100	88	76	65	54	43	33	24	13	4						
12	100	88	78	67	57	48	38	28	19	10	2					
14	100	89	79	69	60	50	41	33	25	16	8	1				
16	100	90	80	71	62	54	45	37	29	21	14	7	1			
18	100	91	81	72	64	56	48	40	33	26	19	12	6			
20	100	91	82	74	66	58	51	44	36	30	23	17	11	5		
22	100	92	83	75	68	60	53	46	40	33	27	21	15	10	4	
24	100	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4
26	100	92	85	77	70	64	57	51	45	39	34	28	23	18	13	9
28	100	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12
30	100	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16

Clouds

Clouds – tiny droplets of water or ice crystals suspended in the air

- in order for clouds to form, there must be:
    1. moisture in the air
    2. cooling temperatures (due to rising air)
    3. **condensation nuclei** (aerosols, dust particles) – surface for water to condense onto

Cirrus Clouds

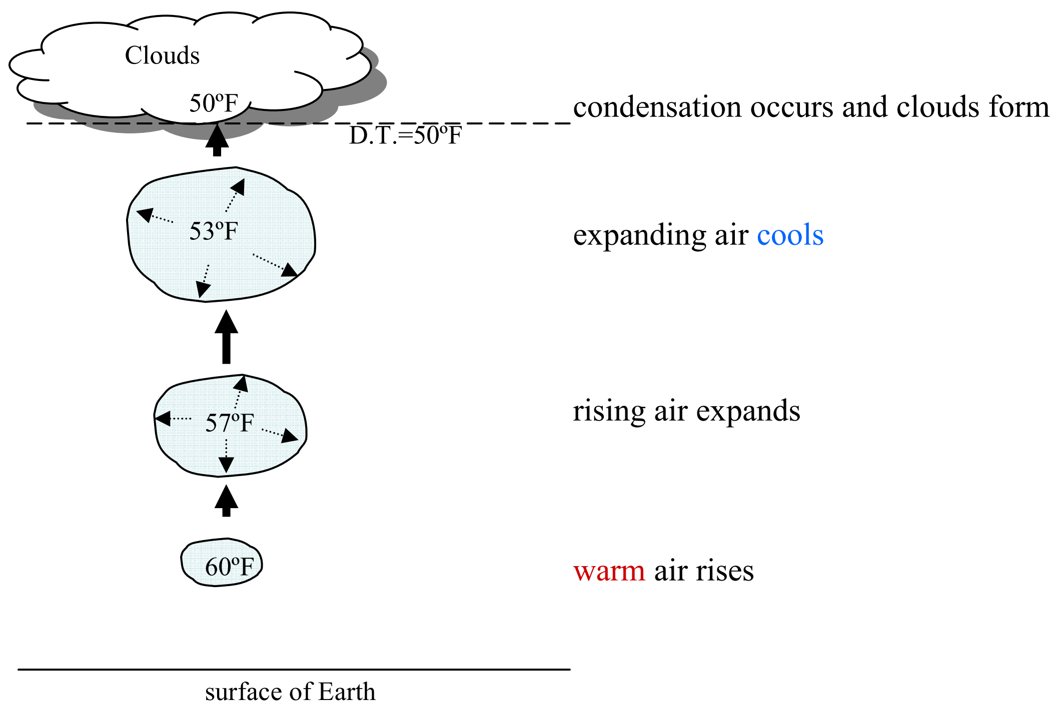
Cumulus Clouds

Stratus Clouds

Cloud Formation

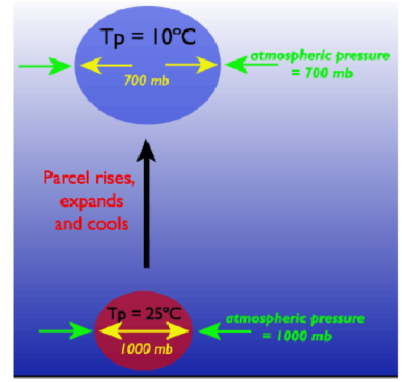
Cloud Formation:

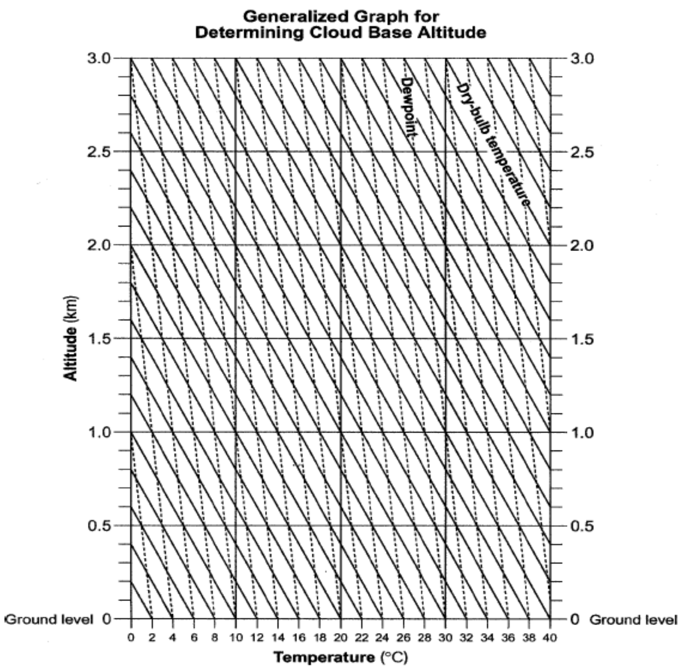
1. warm air rises
2. rising air expands
3. expanding air cools to the dewpoint temperature
4. at the dewpoint temperature, condensation occurs and clouds form (if condensation nuclei are present)



Cloud Formation

- Clouds form as condensation occurs when moist air cools and reaches the dew point temperature
  - **Adiabatic Cooling** – the cooling of the air due to *expansion*
  - rising air expands and cools
  - forms clouds in Low Pressure systems (systems of rising air)
  - **Adiabatic Warming** – the warming of the air due to *compression*
  - sinking air compresses and warms
  - no clouds form in High Pressure system (systems of sinking air)
- as air rises, moist air will cool at a slower rate than dry air (wet adiabatic rate: 2ºC/km.; dry adiabatic rate: 10ºC/km)
- if the air temperature and dewpoint temperature are known at the Earth's surface, the altitude at which a cloud will form can be determined – **Cloud Base Altitude**

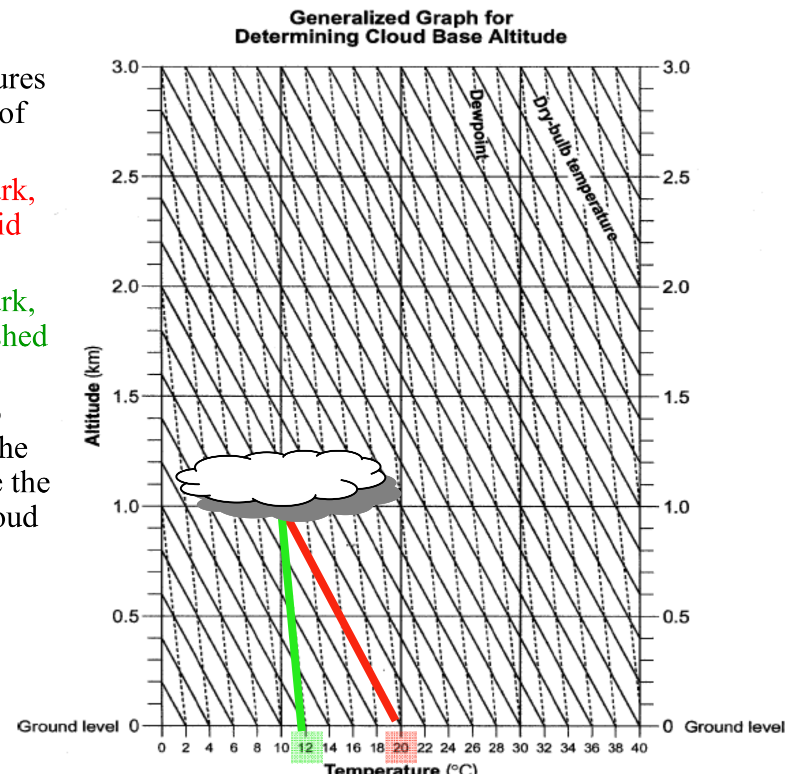




- solid diagonal lines represent the decrease in air temperature with altitude
- dashed diagonal lines represent the decrease of the dewpoint temperature with altitude

- Ex.: at surface: Air Temp. = 20ºC Dewpoint Temp. = 12ºC

1. find temperatures along bottom of chart
2. from 20ºC mark, follow the solid line
3. from 12ºC mark, follow the dashed line
4. where the two lines meet is the altitude where the base of the cloud forms



cloud base altitude = 1 km.

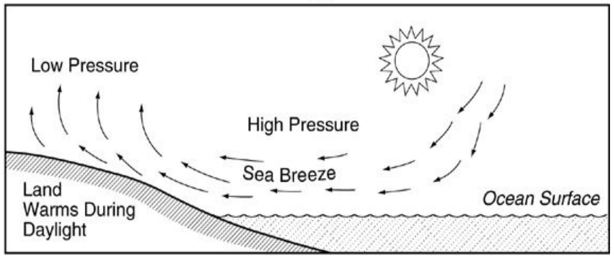
Wind

Wind – the horizontal movement of air due to pressure differences (it's the bottom part of a convection cell)

- winds always blow from regions of high to low pressure
- the bigger the difference in pressures (pressure gradient), the faster the wind blows
- caused by the uneven heating of the Earth's surface:
    - **Land vs.Water** – land has a lower specific heat than water
        - land heats and cools faster than water
    - **Latitude** – poles vs. equator – angle of insolation
        - the higher the angle of insolation, the greater the heating
    - **Color/Texture** – dark forest vs. snow field
        - the darker the color/rougher texture, the greater the heating

Sea Breeze – cool breeze from water to land during the daytime

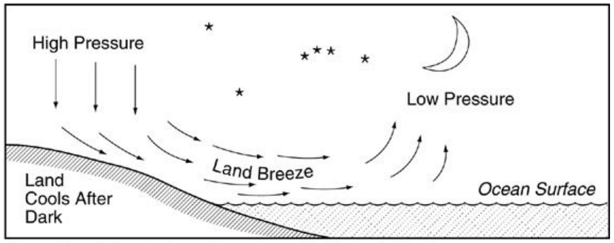
- land heats faster than water (lower specific heat)
- causes the air over land to become less dense and rise
- cool air over water moves in to replace the rising warm air, making wind blow from water to land



Sea Breeze

Land Breeze – cool breeze from the land at night

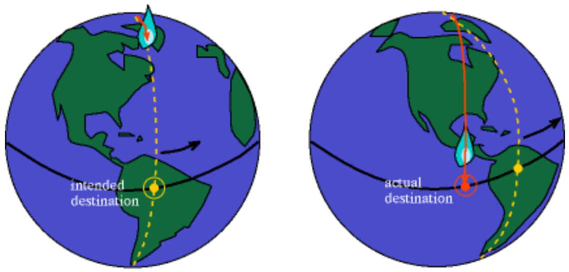
- land cools more quickly than water (lower specific heat)
- causes the air over the land to become more dense and sink
- warm air over the water rises (less dense) and cooler, dense air replaces the risen warm air over the water making a wind from land to water



Land Breeze

Coriolis Effect – the observed paths of objects (air molecules) at the Earth's surface is deflected due to the Earth's rotation

- winds are deflected to the right in the northern hemisphere
- winds are deflected to the left in the southern hemisphere



Coriolis effect: Original path of air is deflected westward by the rotation of the planet.

Global Winds

Global winds are caused by the unequal heating of the Earth's surface (and the resulting differences in air pressure)

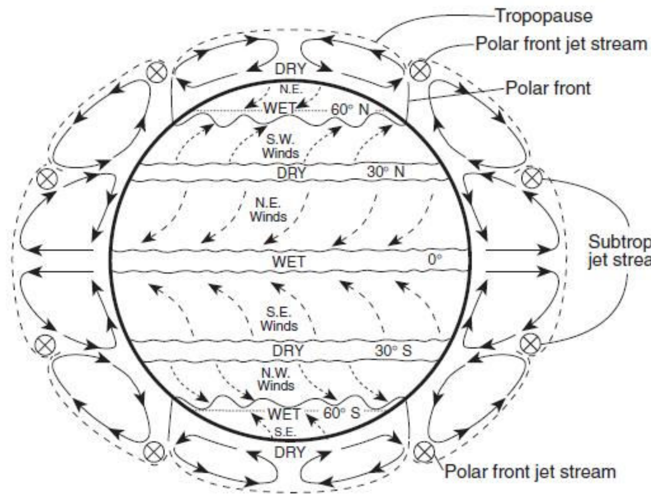
- cool air is dense and sinks while warm is less dense and rises – heat circulates by convection
- this circulation produces convection cells at various latitudes around the Earth
- heat is transferred throughout the atmosphere by this process

Planetary Wind and Moisture Belts in the Troposphere

The drawing on the right shows the locations of the belts near the time of an equinox. The locations shift somewhat with the changing latitude of the Sun's vertical ray. In the Northern Hemisphere, the belts shift northward in the summer and southward in the winter.

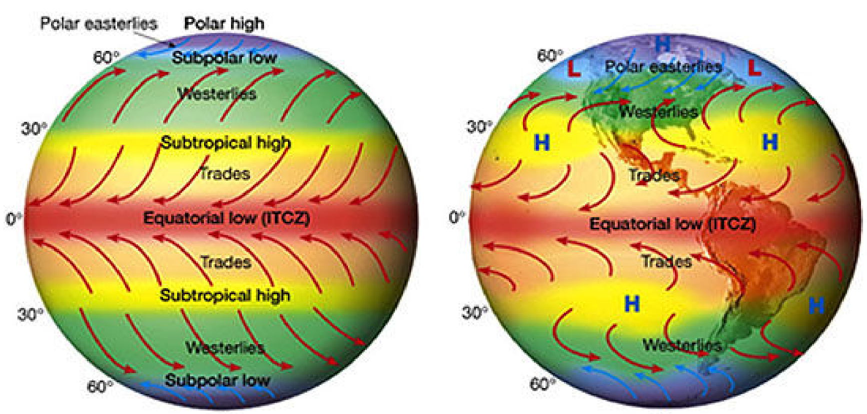
(Not drawn to scale)

Reference Tables p.14



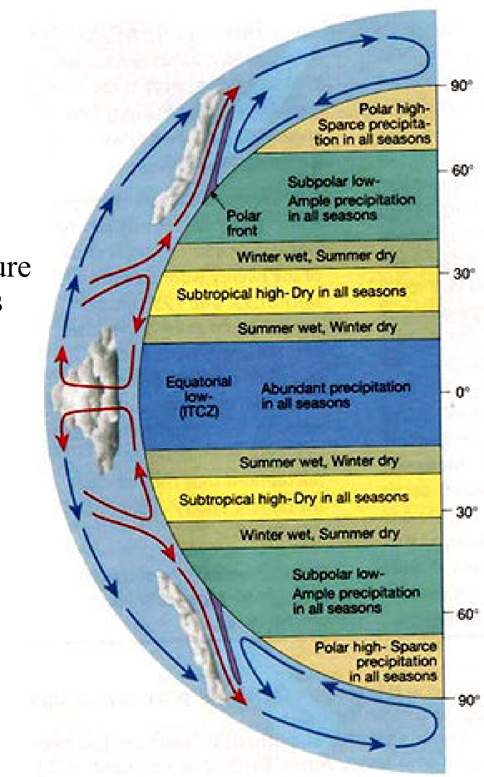
Because of the coriolis effect, winds moving away from a high pressure zone are deflected to the right in the northern hemisphere and to the left in the southern hemisphere

- this results in planetary wind belts where winds generally blow in one direction – **prevailing winds**



(a) (b)

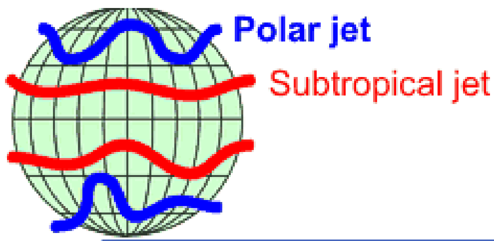
- rain forests are often found along low pressure zones where air rises and forms clouds
- deserts are found along high pressure zones where air sinks and becomes dry
- Low Pressure Zones exist at 0º (equator), 60ºN, and 60ºS latitude
- High Pressure Zones exist at 30ºN, 30ºS, 90ºN, and 90ºS latitude

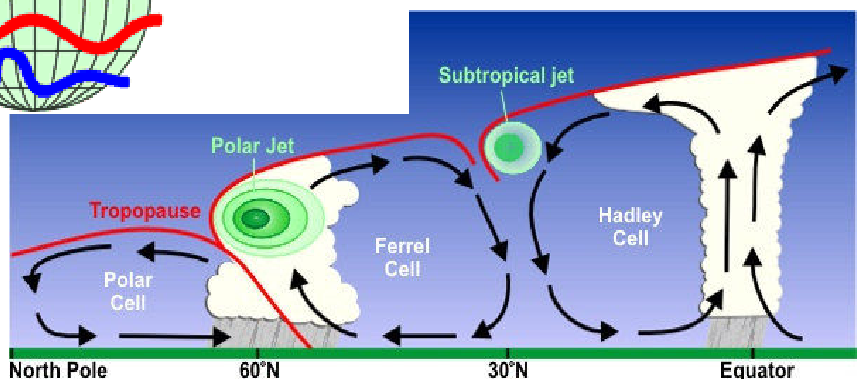


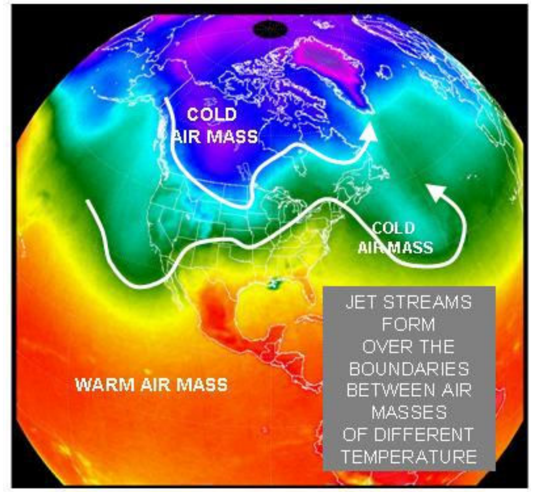
Global Winds

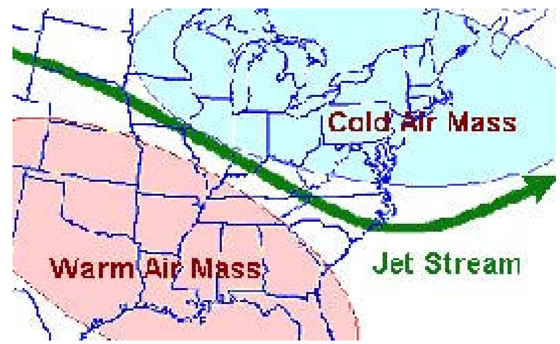
Jet Streams – bands of easterly moving air at the top of the troposphere

- form at the boundary between two air masses of different temperatures
- winds blow at ~200 mph
- very important in the formation and movement of low pressure systems









- the jet stream often separates cold air found at high latitudes from warm air found at low latitudes

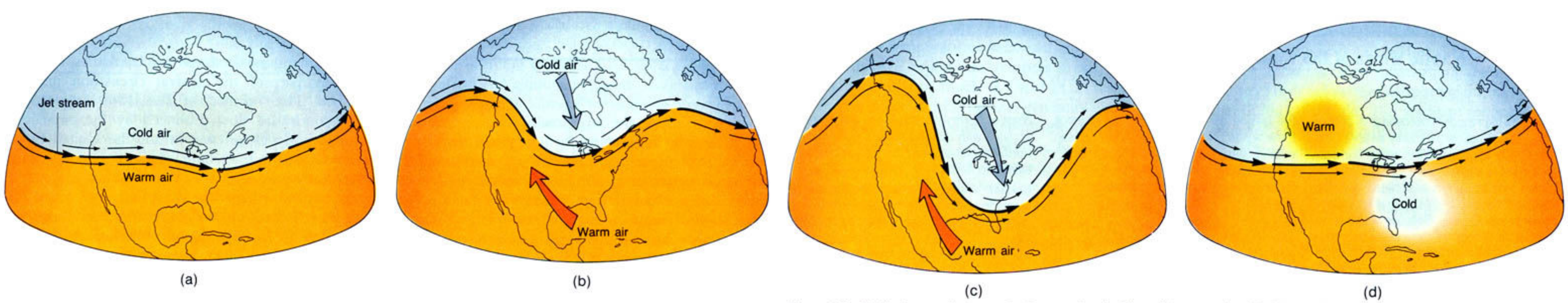
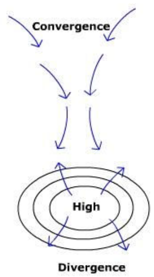
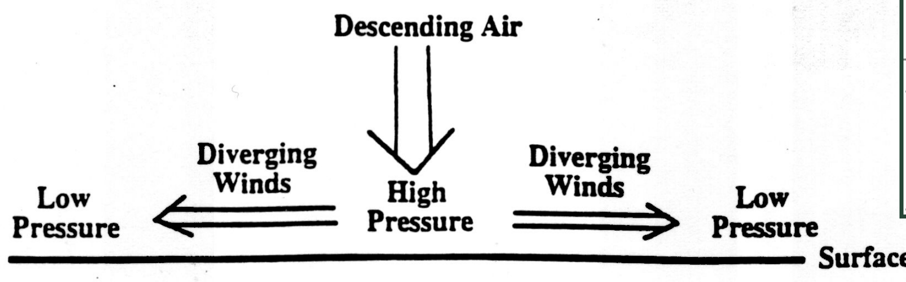


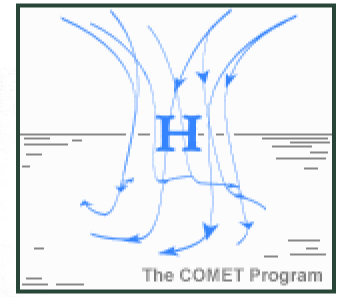
Figure 8•9 Cyclic changes that occur in the upper-level airflow of the westerlies. The flow, which has the jet stream as its axis, starts out nearly straight and then develops meanders that are eventually cut off. *(After J. Namias, NOAA)*

Wind

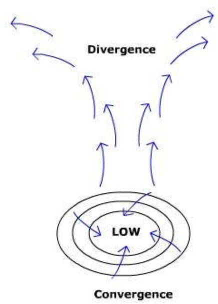
High Pressure System (anticyclone) – winds blow clockwise and away from the center

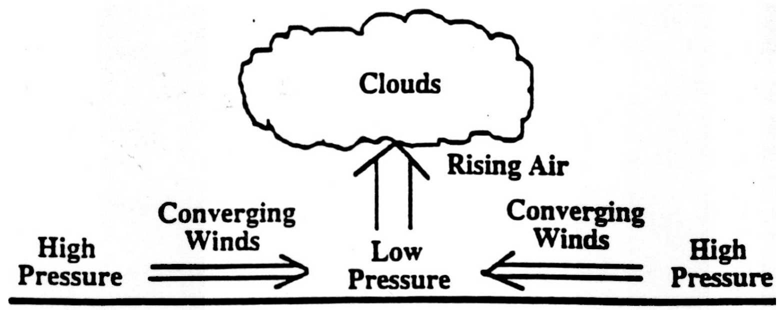


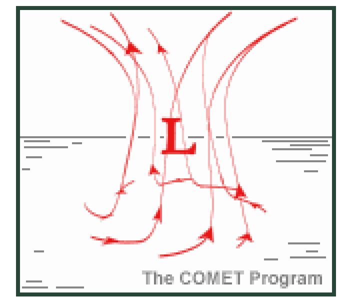




Low Pressure System (cyclone) – winds blow counterclockwise and towards the center

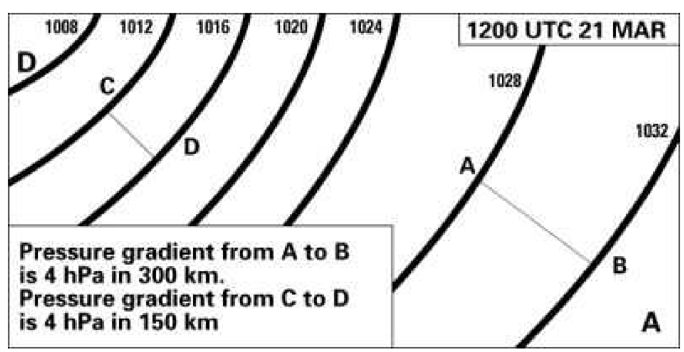


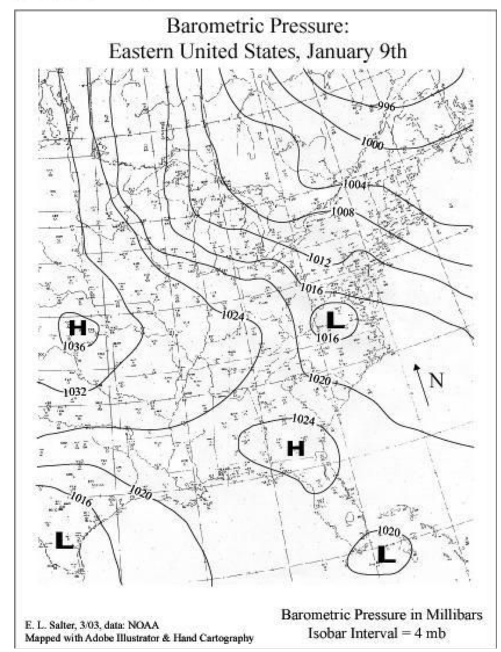




Pressure Gradient – the speed of the wind as determined by the difference in air pressure between two places

$$G = \frac{\Delta FV}{\Delta d}$$





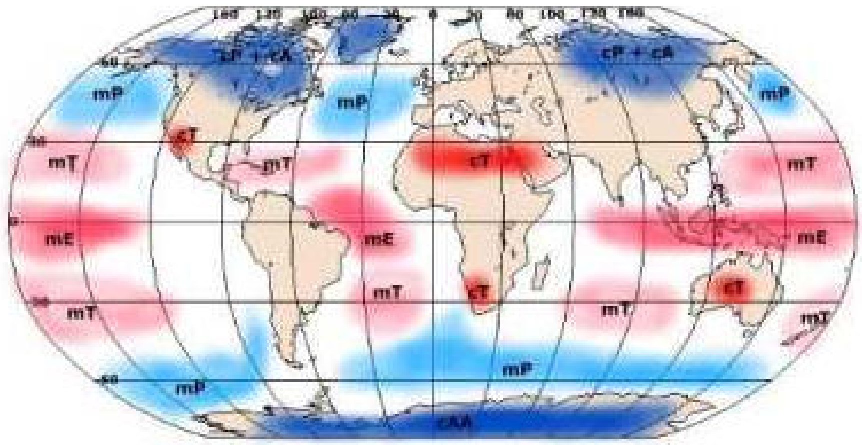
- as the pressure gradient increases (isobars closer together), the wind speed increases

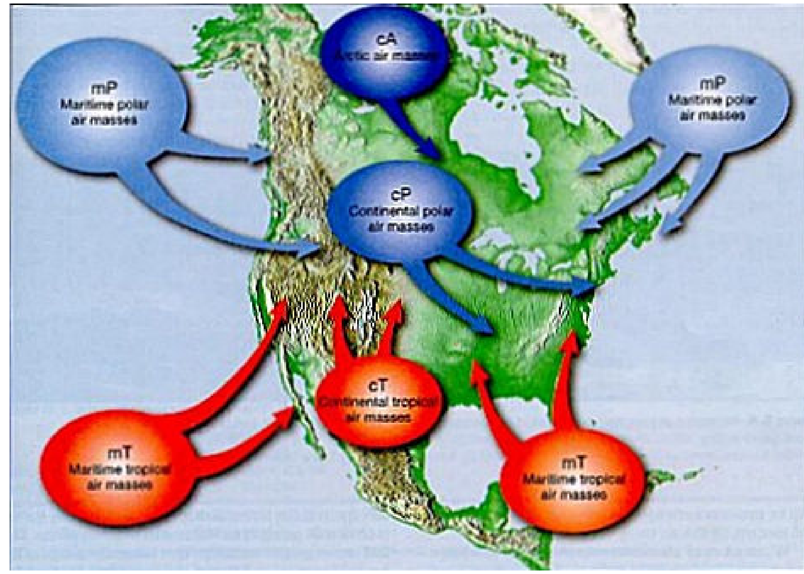
Air Masses

Air Mass – a large body of air in the troposphere with similar characteristics of temperature, moisture, and air pressure

Source Region – a geographic region where an air mass forms

- an air mass will take on the characteristics of the surface over which it forms





Types of Air Masses:

1. **Tropical** – originate at low latitudes (tropics) - high temperatures
2. **Polar** – originate at high latitudes (polar) - low temperatures
3. **Continental** – originate over land – dry
4. **Maritime** – originate over water - wet

Reference Tables p.13

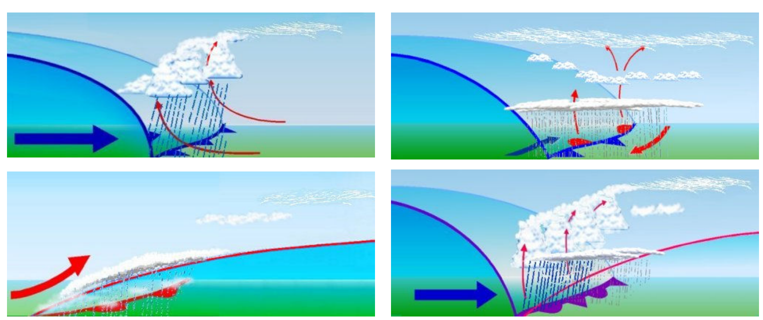
Air Masses

cA	continental arctic	- very cold and dry
cP	continental polar	- cold and dry
cT	continental tropical	- hot and dry
mT	maritime tropical	- warm and moist
mP	maritime polar	- cold and moist

Air Fronts

Front – boundary (interface) between two different air masses

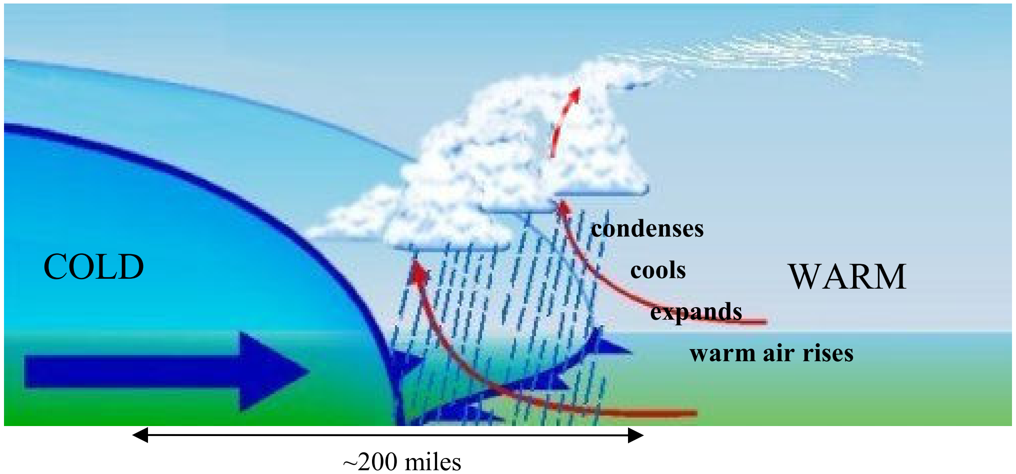
- Types of Air Fronts:
  1. Cold Front
  2. Warm Front
  3. Stationary Front
  4. Occluded Front



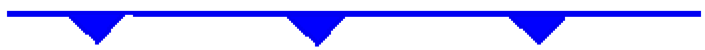
Air Fronts

Cold Front – a cold air mass moves into a region of warm air

- cold air is dense and stays near the surface
- cold air forces the less dense warm air the rise over the denser cold air

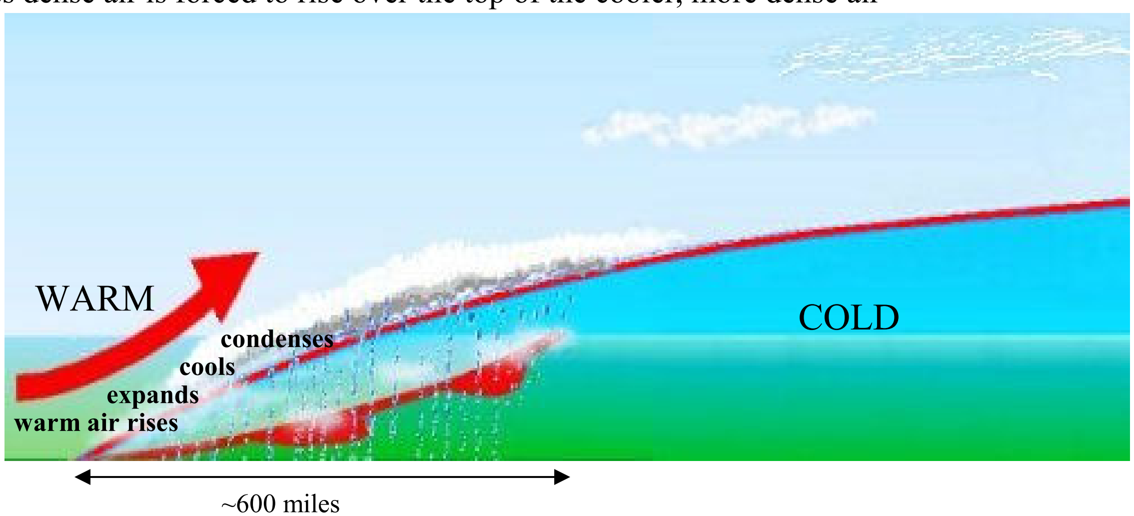


- precipitation occurs along the frontal boundary at the surface
- narrow band of heavy rain/thunderstorms

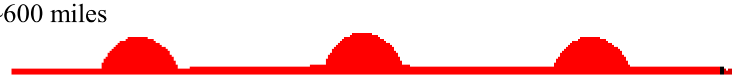
Map Symbol: 

Warm Front – a warm air mass moves into a region of cold air

- warm, less dense air is forced to rise over the top of the cooler, more dense air

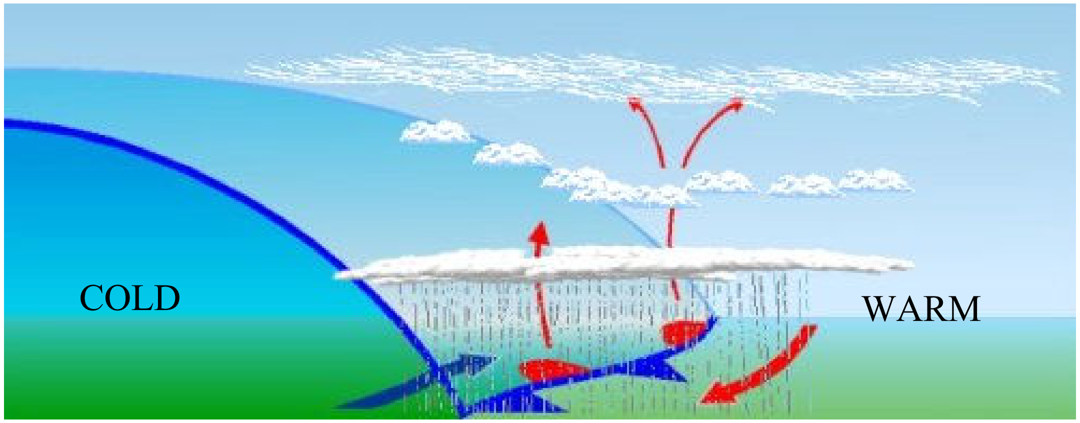


- precipitation occurs before the frontal boundary at the surface
- wide band of steady, all day showers

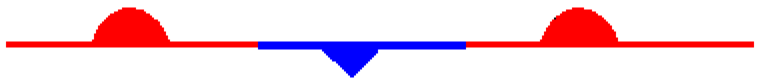
Map Symbol: 

Air Fronts

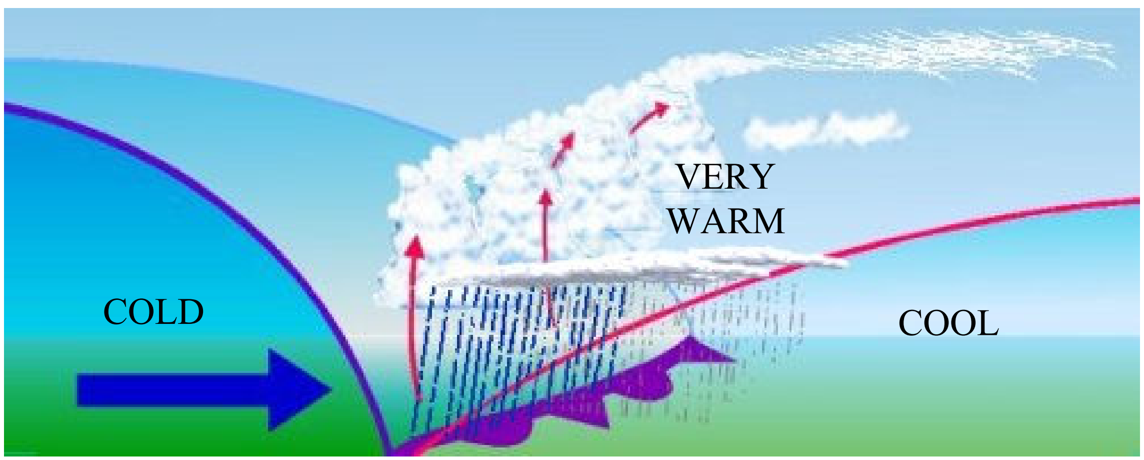
Stationary Front – two different air masses not moving relative to one another



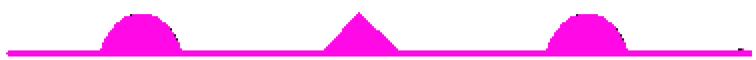
- precipitation occurs in a wide band along the front at the surface
- steady/heavy rain

Map Symbol: 

Occluded Front – a cold air mass moves into and over takes a region of warm air



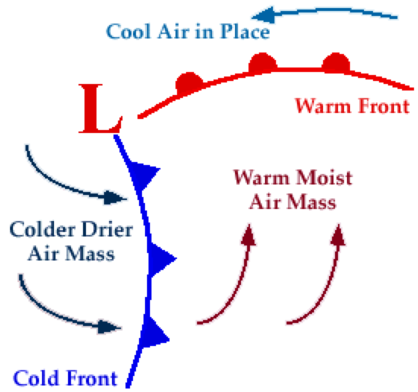
- precipitation occurs in a wide band before and along the front
- steady, all day rains followed by heavy rain/thunderstorms

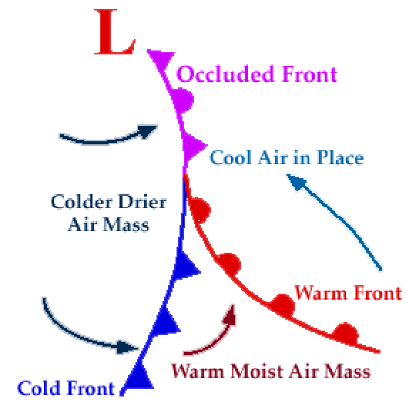
Map Symbol: 

Air Fronts

Air fronts are always associated with low pressure systems:

- the counterclockwise circulation of air around a low pressure center draws warm, moist air up from lower latitudes and colder, dry air down from high latitudes



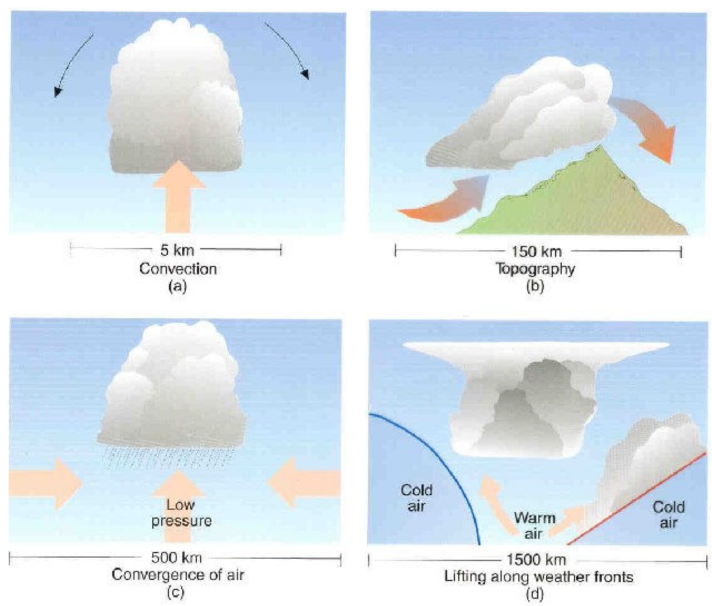


Rain

Rain occurs where **air rises**, **expands**, **cools** (adiabatically) **to the dewpoint temperature** (air is saturated), **condenses** to form clouds (if condensation nuclei are present), and precipitates because the air is saturated (cold air cannot hold as much moisture as warm air)

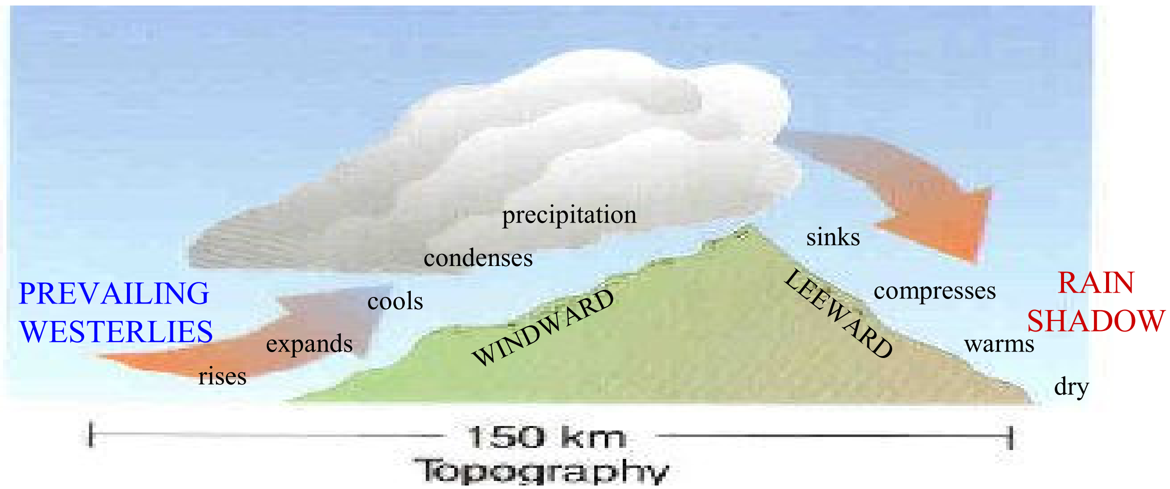
- Areas of Rain:

1. Windward side of a Mountain
2. Equatorial Regions
3. Low Pressure Systems
4. Fronts



Rain

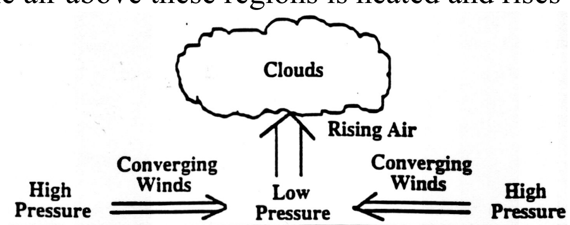
Windward Side of a Mountain (Orographic Effect) – air rises as it is forced over a mountain

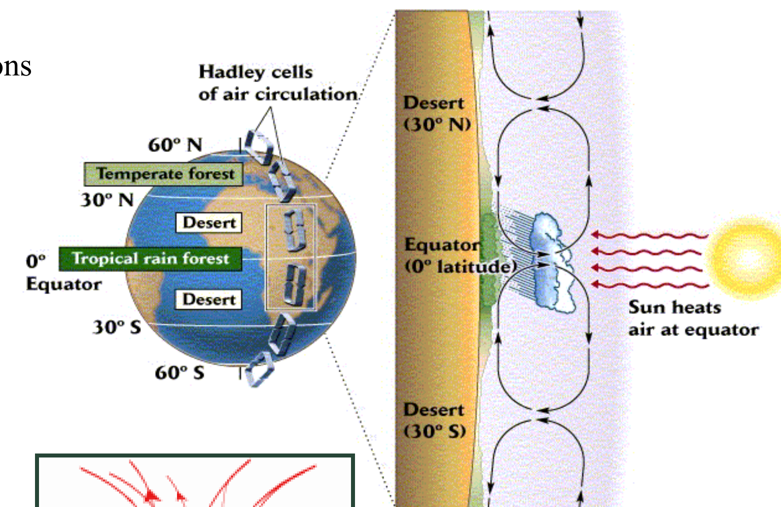


- the windward side of a mountain is cool and wet
- the leeward side of a mountain is warm and dry
- **rain shadow** – very dry region on the leeward side of a mountain due to sinking air

Equatorial Regions (Low Pressure Belts) – warm air rises due to convection

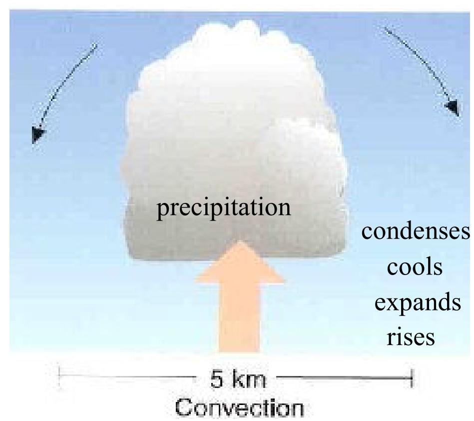
- equatorial regions of Earth receive the most direct insolation – these regions are heated the most so the air above these regions is heated and rises

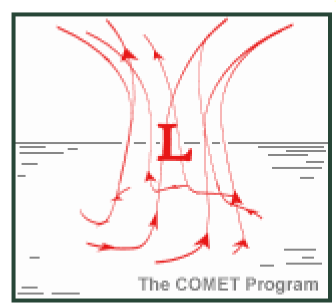




Low Pressure Systems – surface air converges and rises at the center of a low pressure system

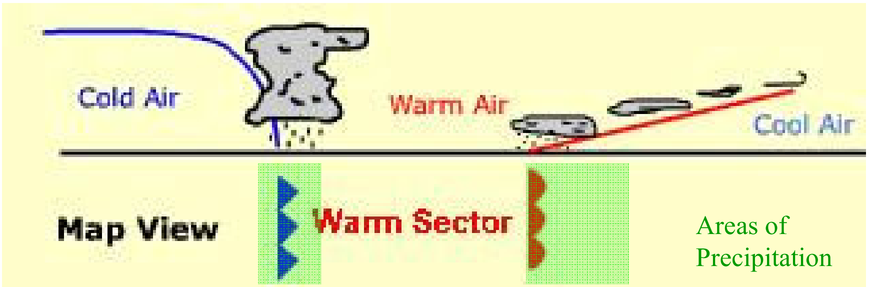
- rain/poor weather is always associated with low pressure centers

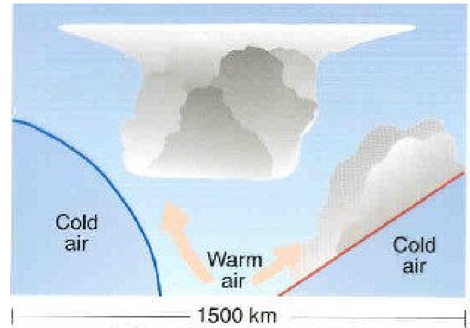




Rain

Fronts – warm, less dense air rises over colder, more dense air

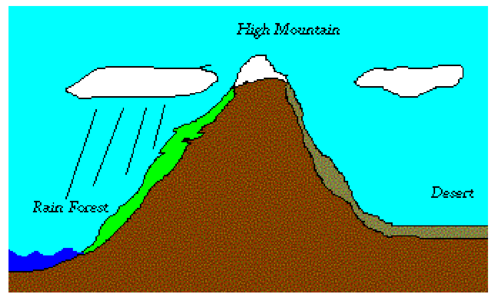


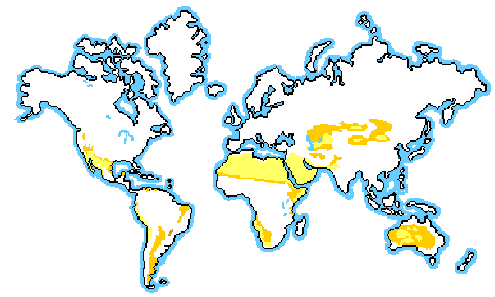


Lifting along weather fronts

Places that receive little/no precipitation are regions where air is sinking, compresses, warms (adiabatically), and becomes dry (warm air can hold more moisture than cold air):

1. Leeward Side of a Mountain (rain shadow)
2. Doldrums (30ºN, 30ºS)
3. High Pressure Systems

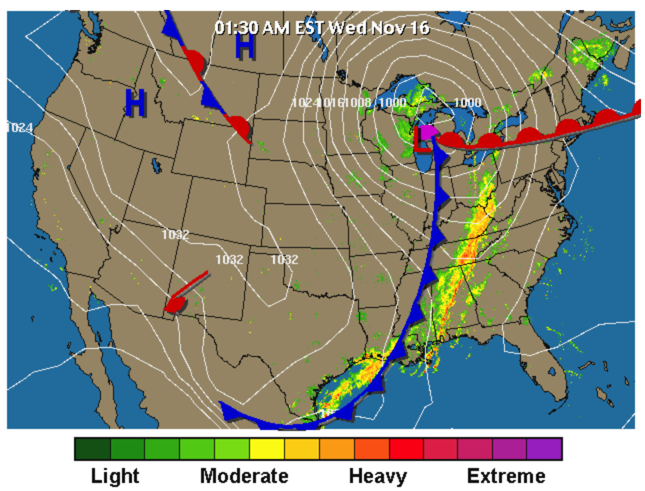


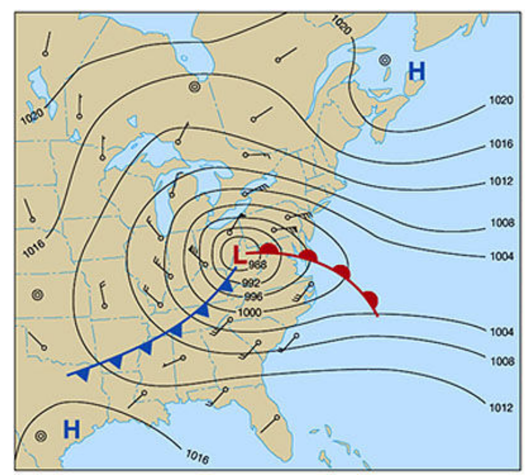


Weather Maps

Synoptic Weather Map – a composite map show weather variables

- uses data gathered from hundreds of weather stations to plot many weather variables onto a single (or series of) maps
- used to predict short-term weather conditions

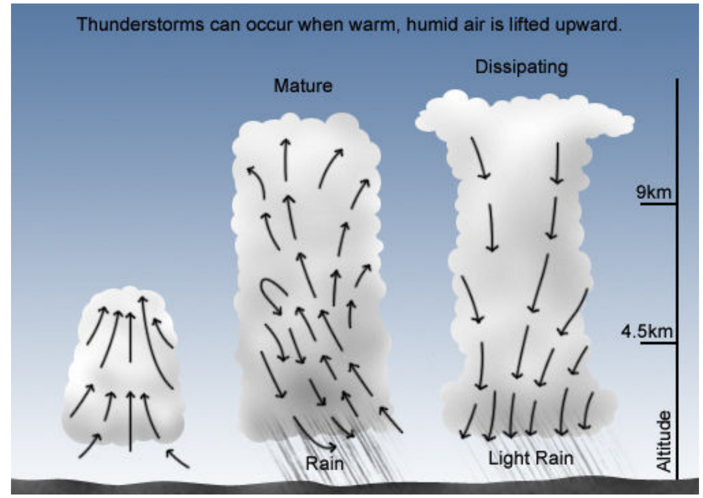




Storms

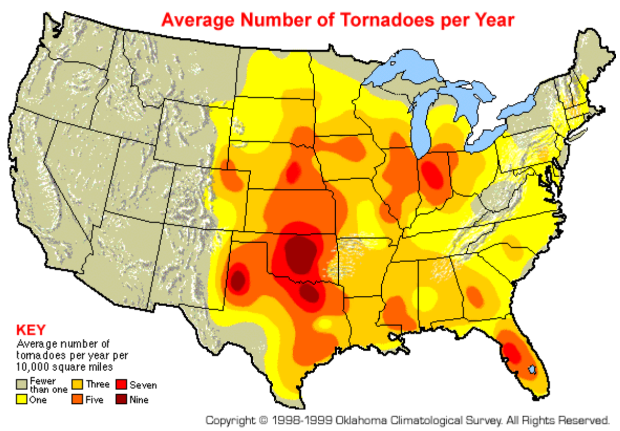
Thunderstorms – form from uplifting warm air associated with **cold fronts**

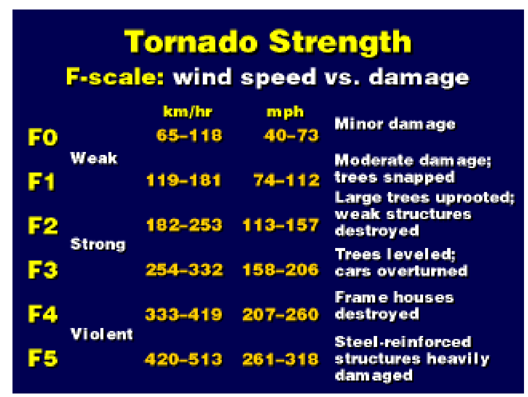
- located in inland regions
- produce heavy rains, hail, winds, thunder/lightning



Tornadoes – a rapidly rotating low pressure funnel associated with strong thunderstorms and cold fronts in the spring

- very narrow: 100 ft – 1 mile in diameter
- produce winds up to 300 mph
- last for a few minutes to an hour





Tornado Strength

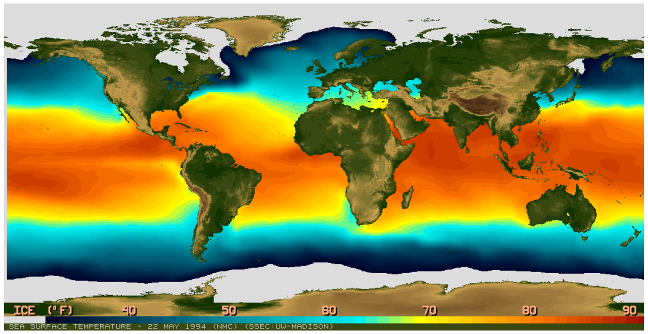
F-scale: wind speed vs. damage

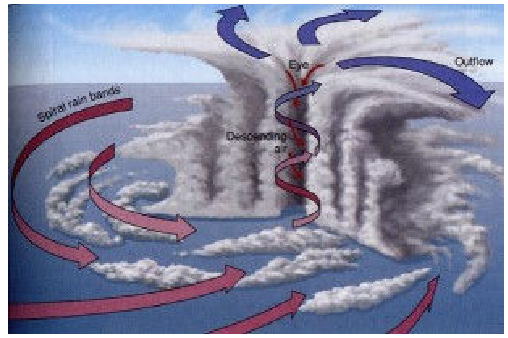
		km/hr	mph	
F0	Weak	65-118	40-73	Minor damage
F1		119-181	74-112	Moderate damage; trees snapped
F2	Strong	182-253	113-157	Large trees uprooted; weak structures destroyed
F3		254-332	158-206	Trees leveled; cars overturned
F4	Violent	333-419	207-260	Frame houses destroyed
F5		420-513	261-318	Steel-reinforced structures heavily damaged

Storms

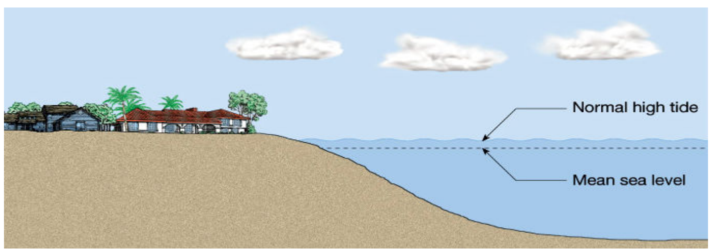
Hurricanes – form as low pressure centers over warm tropical waters in late summer/early fall

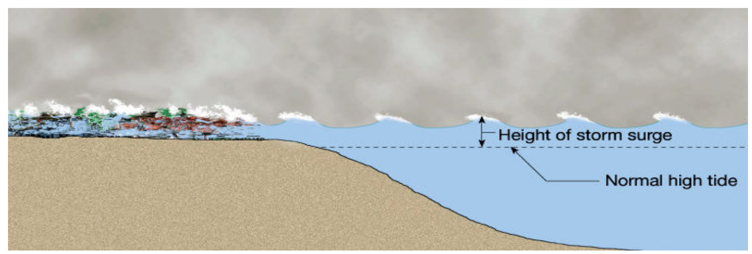
- gain energy from the condensation of moisture evaporated over warm ocean waters
- warm rising air produces a very strong low pressure system (large pressure gradient)



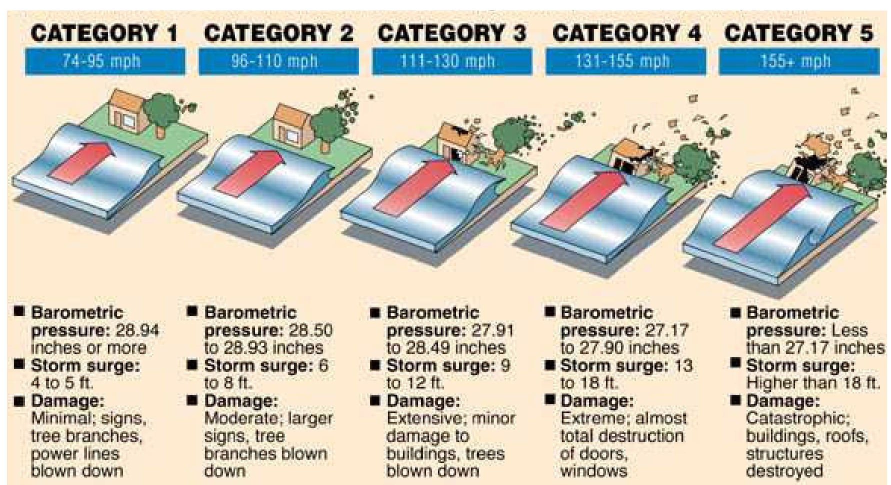


- Hurricanes quickly loose strength as they move over land – the energy source (warm ocean water) no longer available
- flooding along coastal areas cause most damage – called the **storm surge**





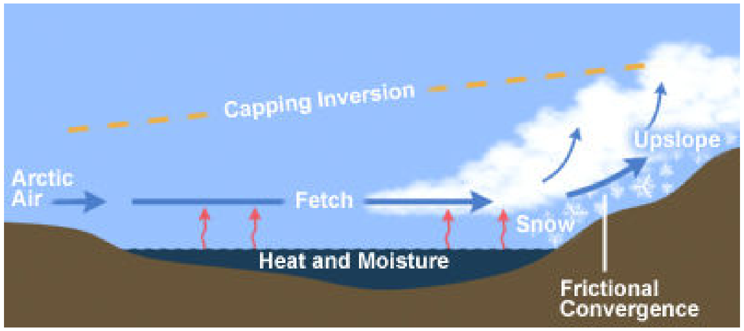
- minimum winds = 74 mph (120 km/hr)

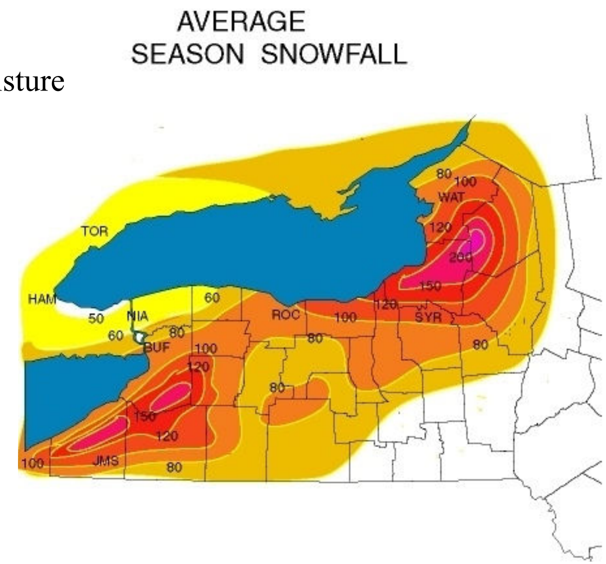


Storms

Lake Effect Snow – prevailing winds move across the relatively warm Great Lakes and pick up moisture

- this moist air is uplifted over the Tug Hill where it snows due to the orographic effect

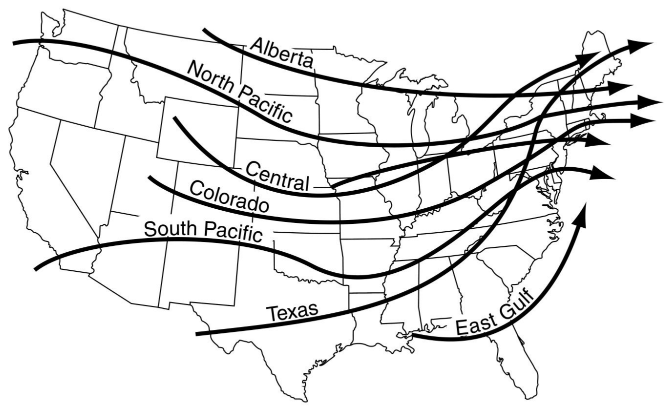


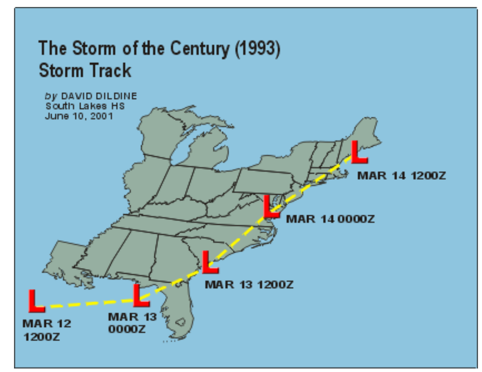


Storm Tracks

Prevailing Westerlies – the winds over the U.S. generally blow from west to east across the country

- storms (low pressure centers) are steered by the prevailing westerlies
- storms generally move from west to east across the U.S.





- Tropical storms that affect the U.S. develop in the waters off the west coast of Africa
- these storms are carried by the trade winds towards the southeast coast of the U.S.
- as they track across the Atlantic ocean, they build in strength and can turn into hurricanes
- as hurricanes move over land, they loose strength