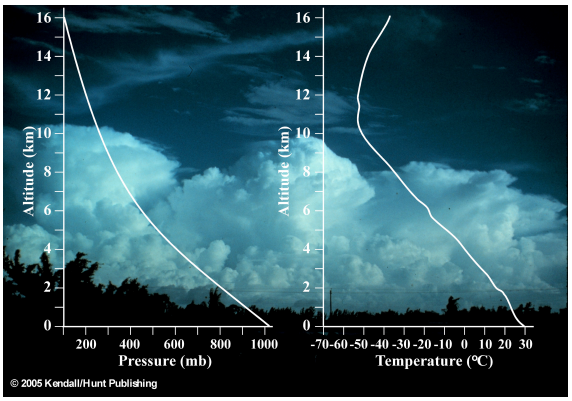


Chapter 1
Properties of the Atmosphere

What is the atmosphere?

What properties of the atmosphere do we care about for weather?

Temperature

What is temperature?

What happens when two objects with different temperatures are brought into contact?

How do we measure air temperature?

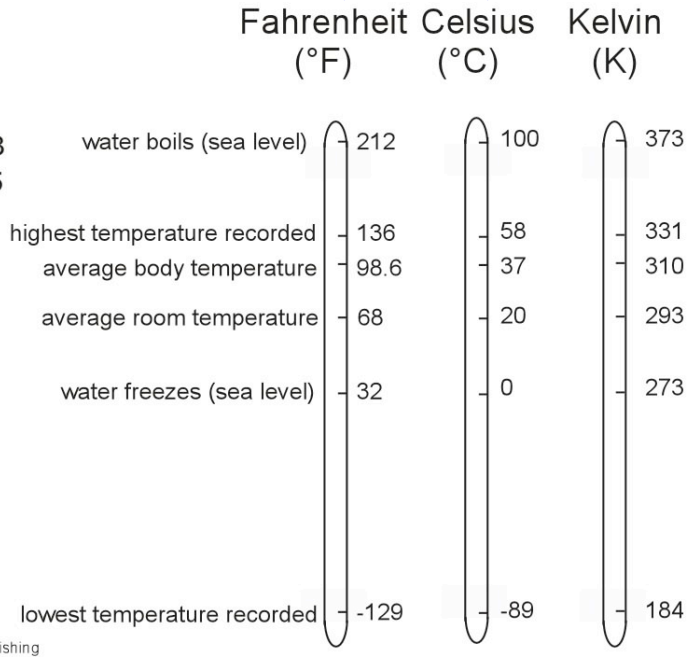
Temperature scales - Fahrenheit, Celsius, and Kelvin

Temperature Conversions

°C = (°F - 32)/1.8

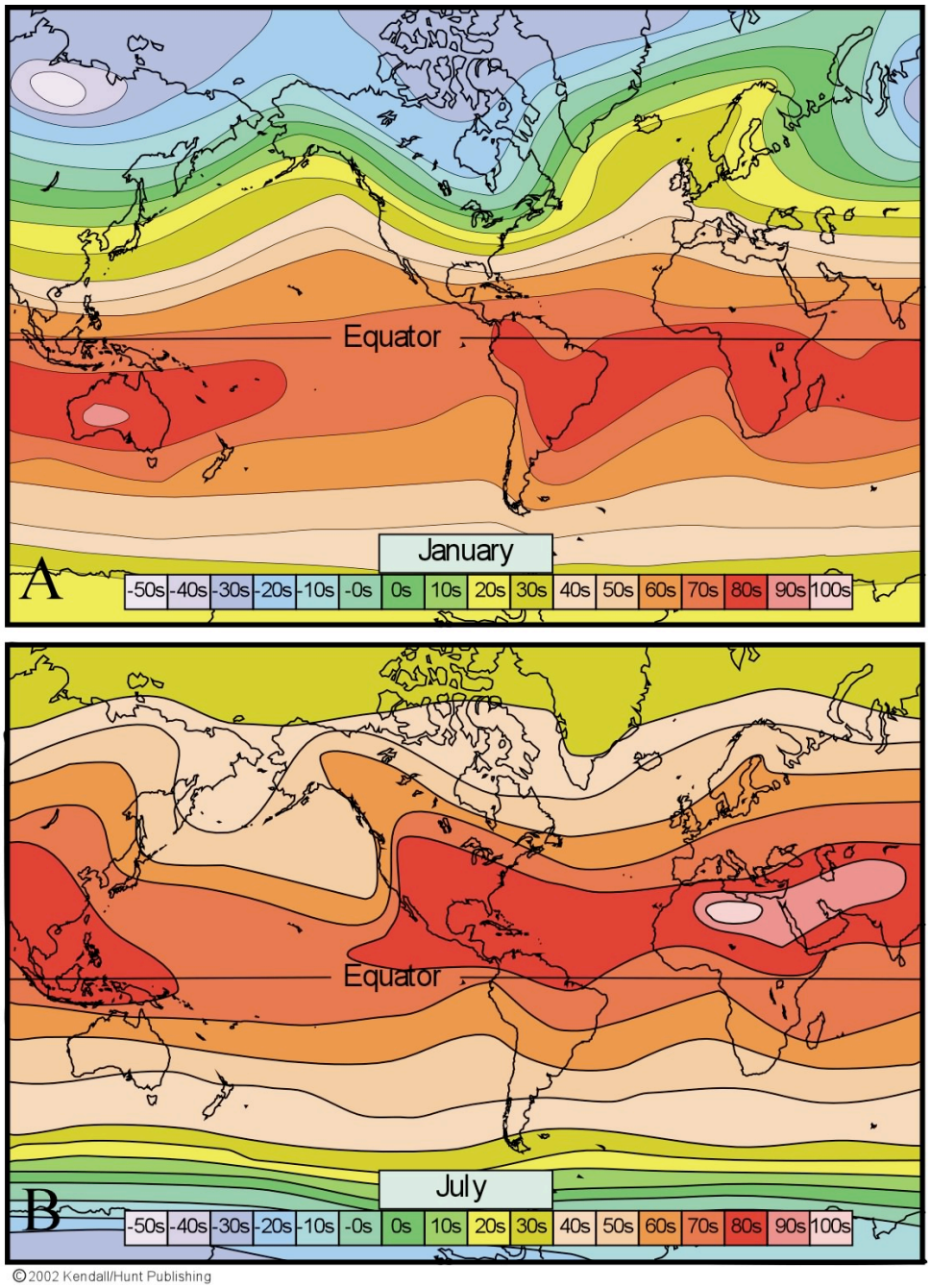
K = °C + 273.15

°C	°F
-10	14
0	32
10	50
20	68
30	86



©2002 Kendall/Hunt Publishing

How does temperature vary during the year and across the earth?

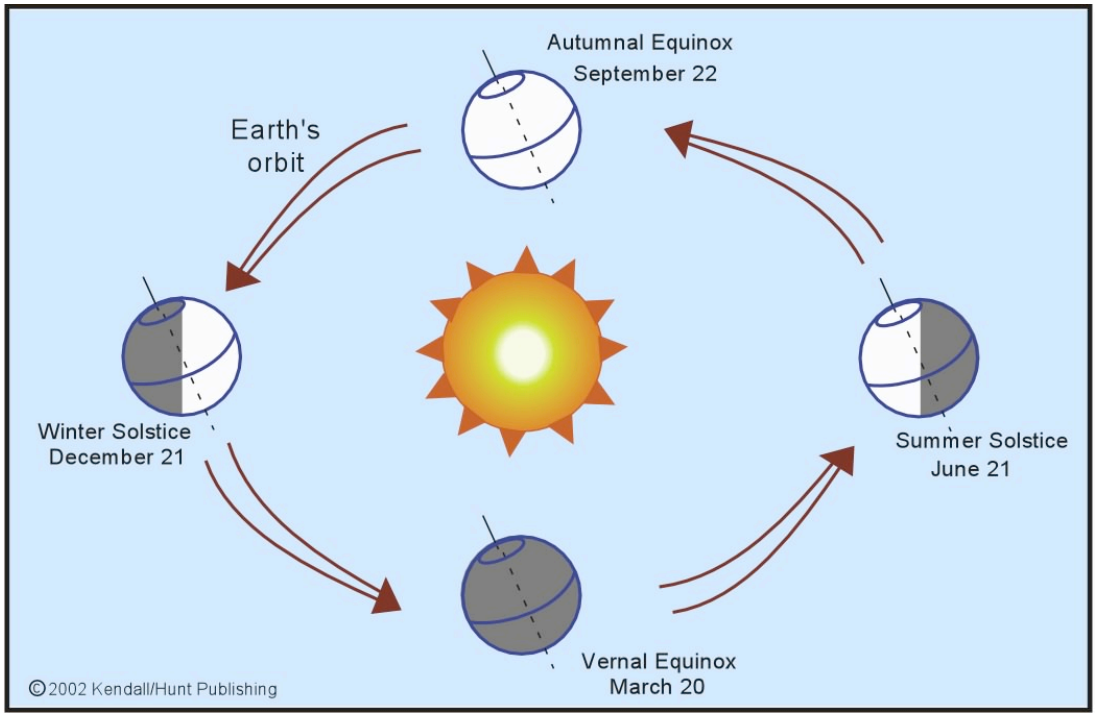


©2002 Kendall/Hunt Publishing

Seasons

Why does the temperature change during the year and why is this change larger in middle and high latitudes than in the tropics?

The seasons and the tilt of the earth:



How does the tilt of the earth cause seasons?

Length of daylight

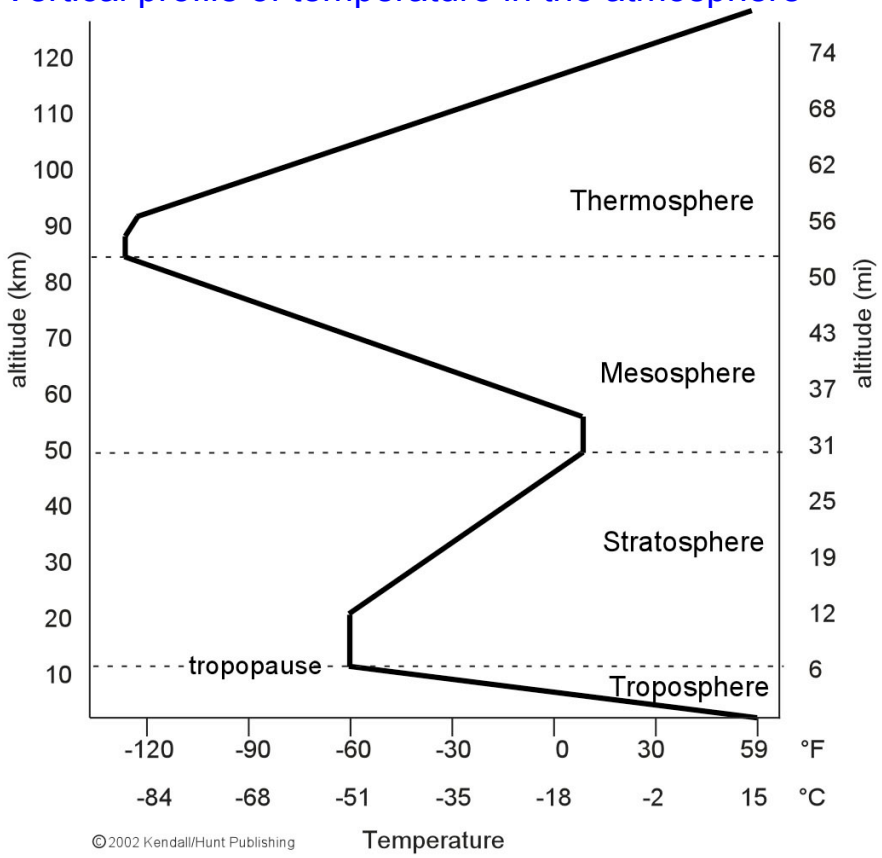
Amount of sunlight able to pass through the atmosphere

Area illuminated by the sun

How do these factors change as you move from the tropics to the poles?

Seasons, temperature differences and the weather

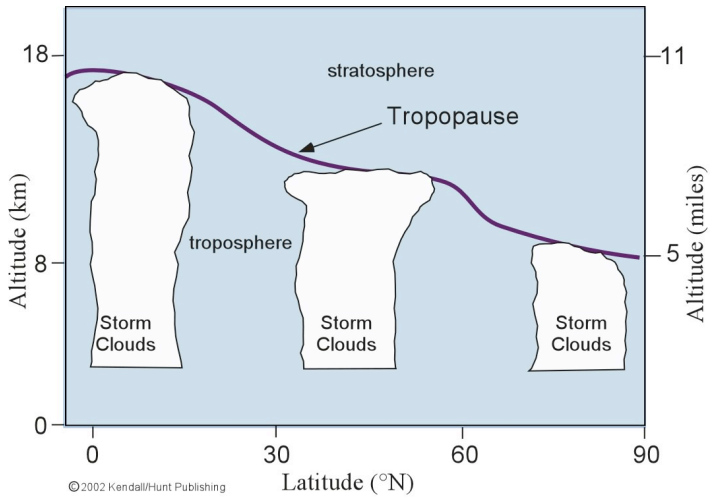
Vertical profile of temperature in the atmosphere



How are the different layers of the atmosphere defined?

Why does the temperature decrease with height in some layers, but increase with height in other layers?

The troposphere and the stratosphere



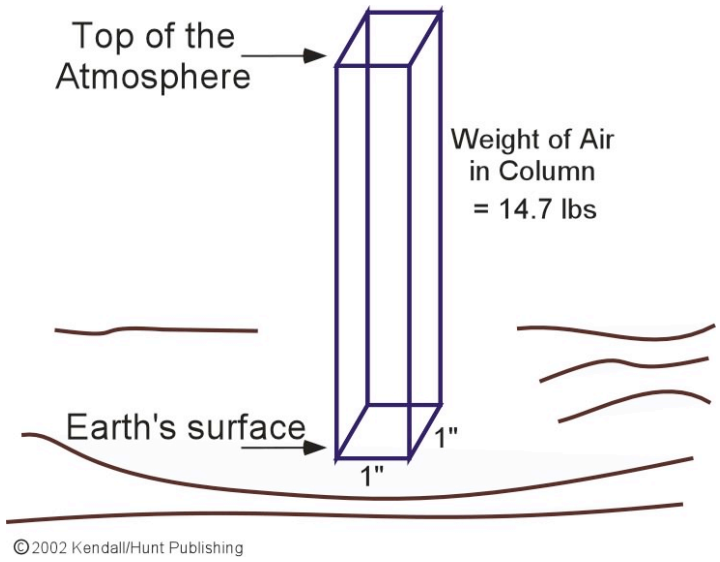
Tropopause height and storm depth

Pressure

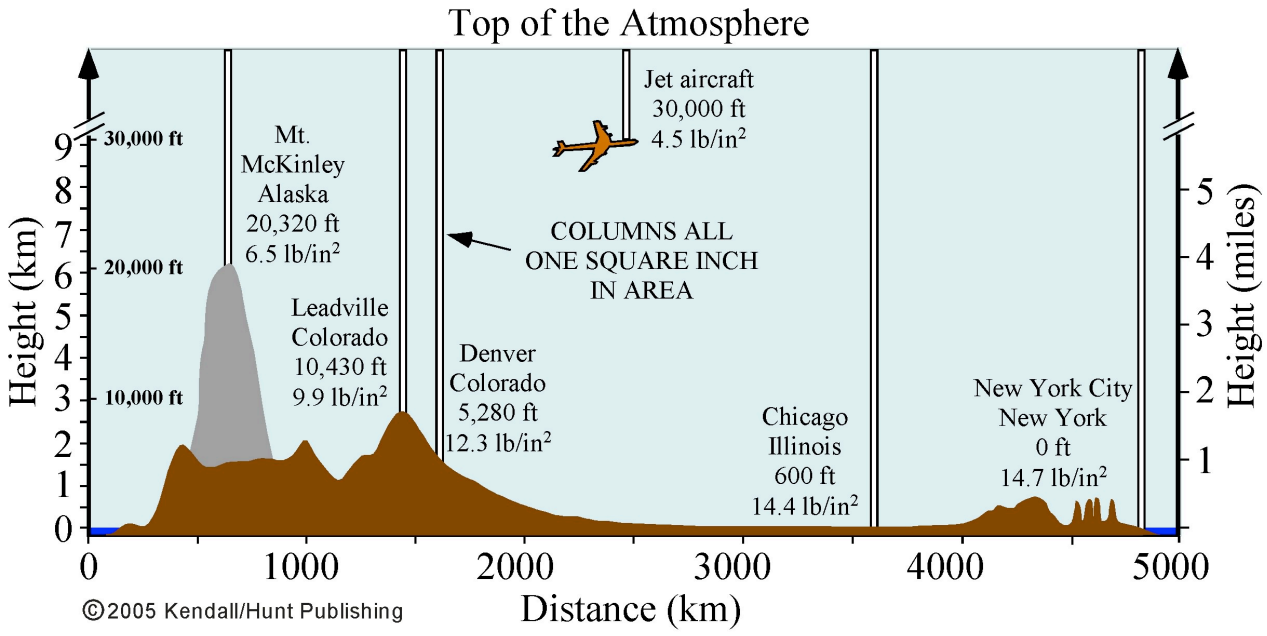
Air Pressure: The force applied by air to a unit area of surface

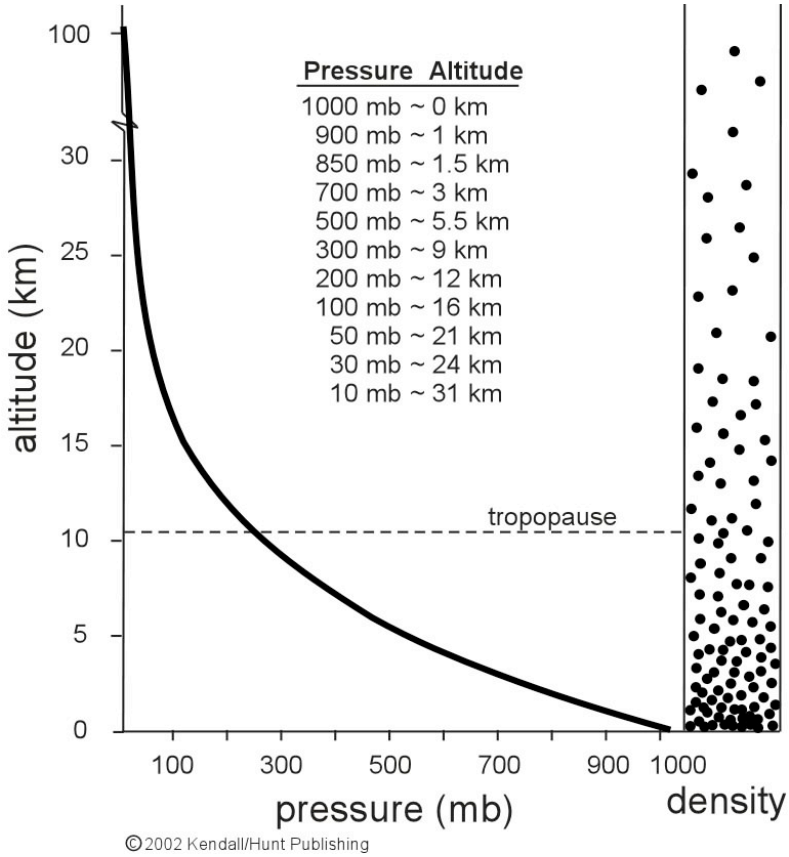
What do we use to measure atmospheric pressure?

The air pressure at a given point is equal to the weight of all of the air above that point.



How does air pressure change as we move up through the atmosphere?





Why does pressure decrease with altitude?

Remember, pressure always decreases as you move up through the atmosphere!!!!

How do we compare surface pressures at different locations?

Units of Pressure

$14.7 \text{ lb / in}^2 = 29.92 \text{ in Hg} = 1013.25 \text{ mb}$

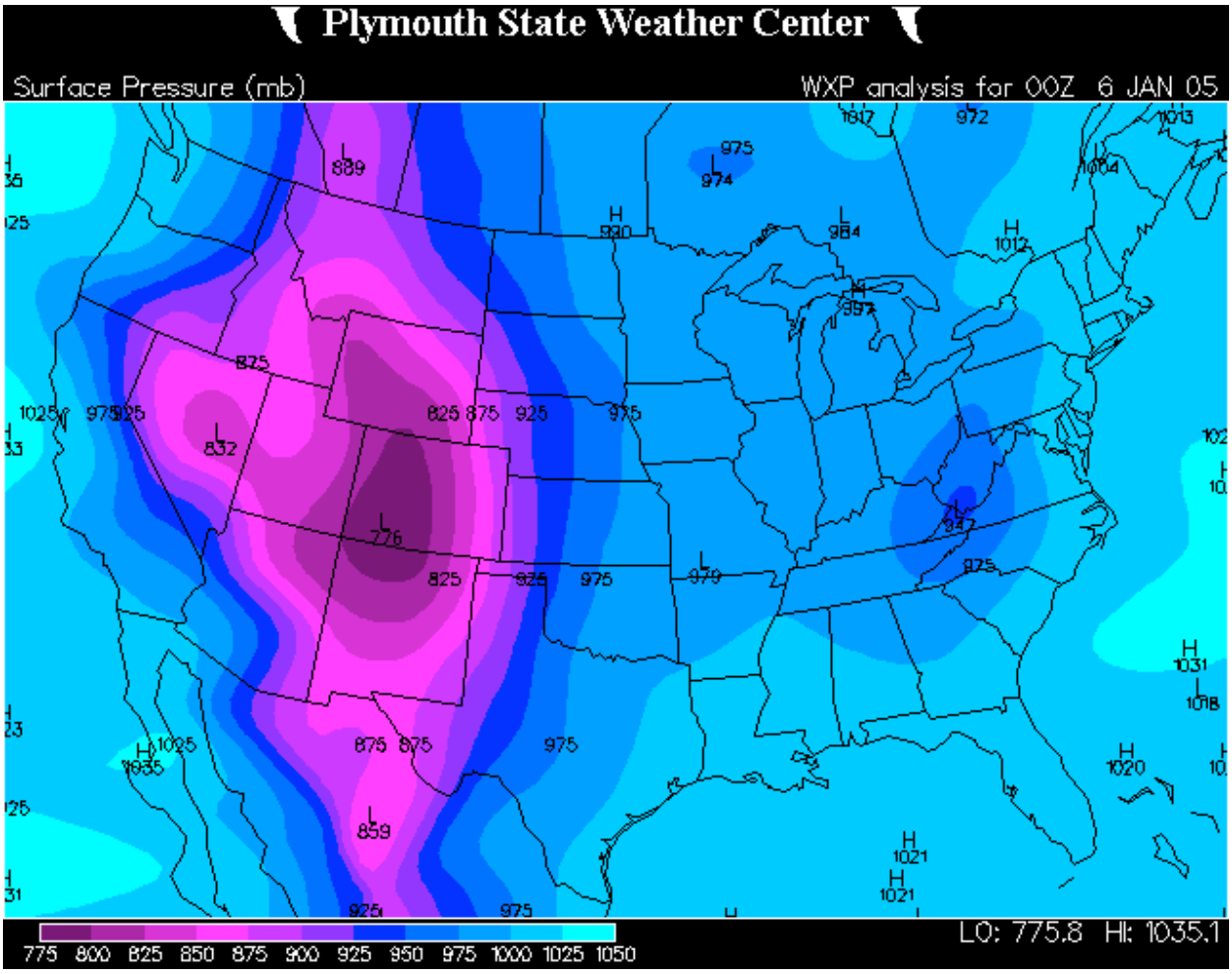
Range of Sea Level Pressures observed on Earth

Inches of Mercury		Millibars
32.01	highest sea level pressure recorded	1084
30.86	strong high pressure system	1045
29.92	average sea level pressure	1013
28.94	deep low pressure system	980
25.70	lowest sea level pressure recorded	870

©2002 Kendall/Hunt Publishing

Weather maps of pressure

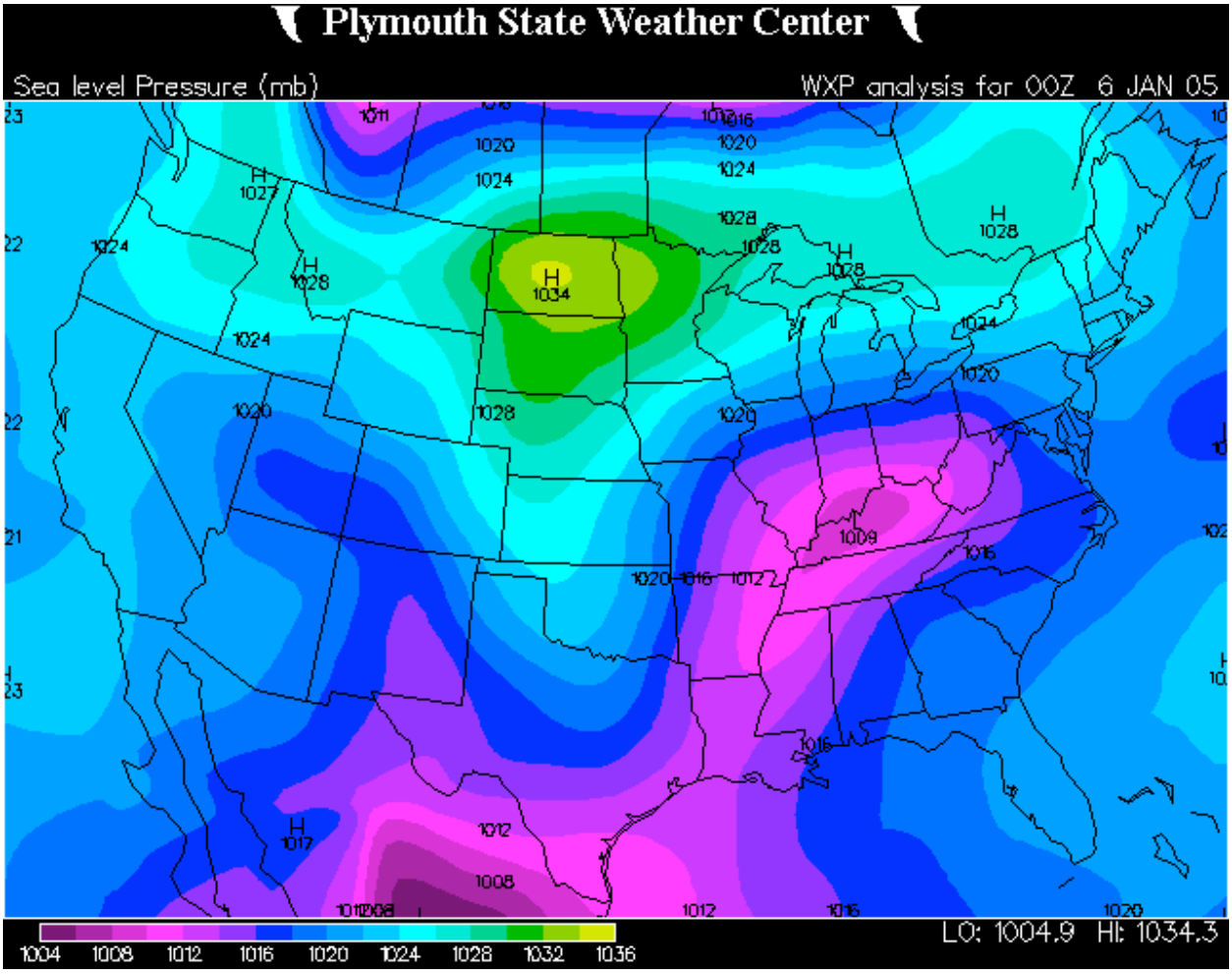
Station pressure: the air pressure measured at a surface weather station (this is also called surface pressure)



Where is the pressure high (or low) on this map?

What is responsible for this distribution of surface pressure?

Mean sea level pressure: the pressure that would be measured if the weather station were located at sea level



How does the location of the high (or low) pressure differ on this map compared to the map of surface pressure?

Which map is more useful for studying the weather?

Moisture

Water in the atmosphere exists as a:

- Gas (water vapor)
- Liquid (cloud droplets, fog, rain, ...)
- Solid (ice crystals, snow, hail, ...)

Vapor pressure: the pressure exerted by the water vapor molecules in the air

Vapor pressure increases as the amount of water vapor in the atmosphere increases.

Vapor pressure is an absolute measure of the amount of water vapor in the atmosphere.

Dewpoint Temperature: the temperature to which air must be cooled, at constant pressure, to just become saturated

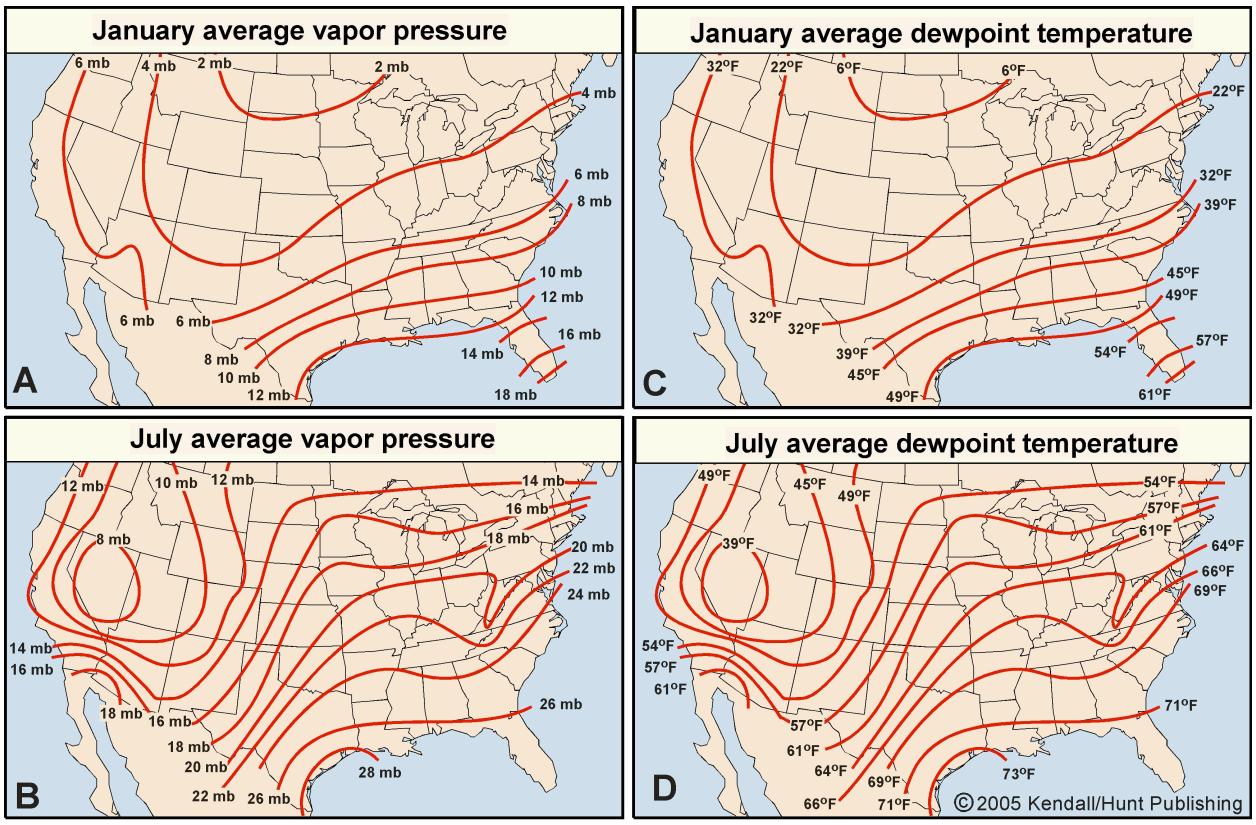
The dewpoint temperature increases as the amount of water vapor in the atmosphere increases.

Dewpoint temperature is an absolute measure of the amount of water vapor in the atmosphere.

Look at the maps of average vapor pressure and dewpoint temperature across the US in January and July:

How do maps of dewpoint temperature and vapor pressure compare?

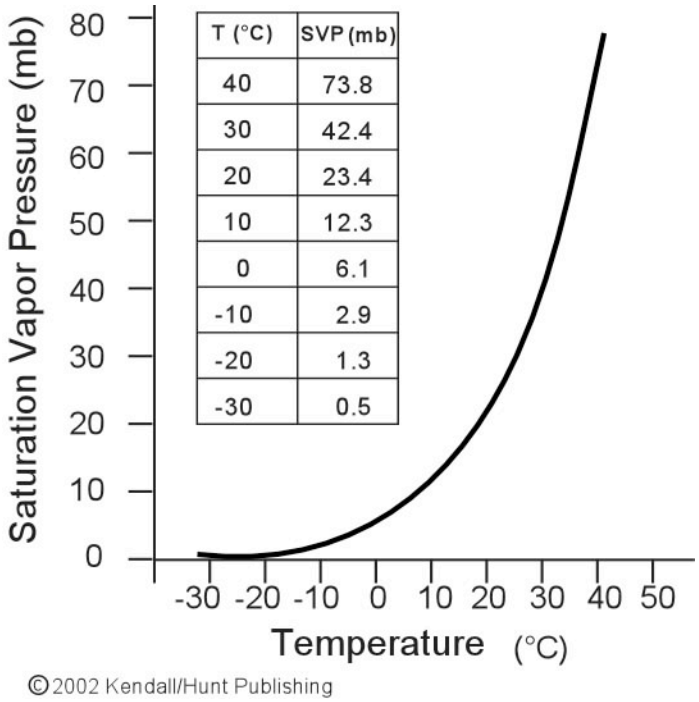
Where is the vapor pressure low and high?
How does the vapor pressure change from winter to summer?



The atmosphere is saturated when it cannot contain any more water vapor without having cloud droplets condense.

Saturation vapor pressure: The vapor pressure at which the atmosphere becomes saturated

What determines how much water vapor the atmosphere can contain to be saturated?



©2002 Kendall/Hunt Publishing

Why does the saturation vapor pressure increase as the temperature increases?

Remember, the saturation vapor pressure always increases as the air temperature increases!!!

Relative Humidity

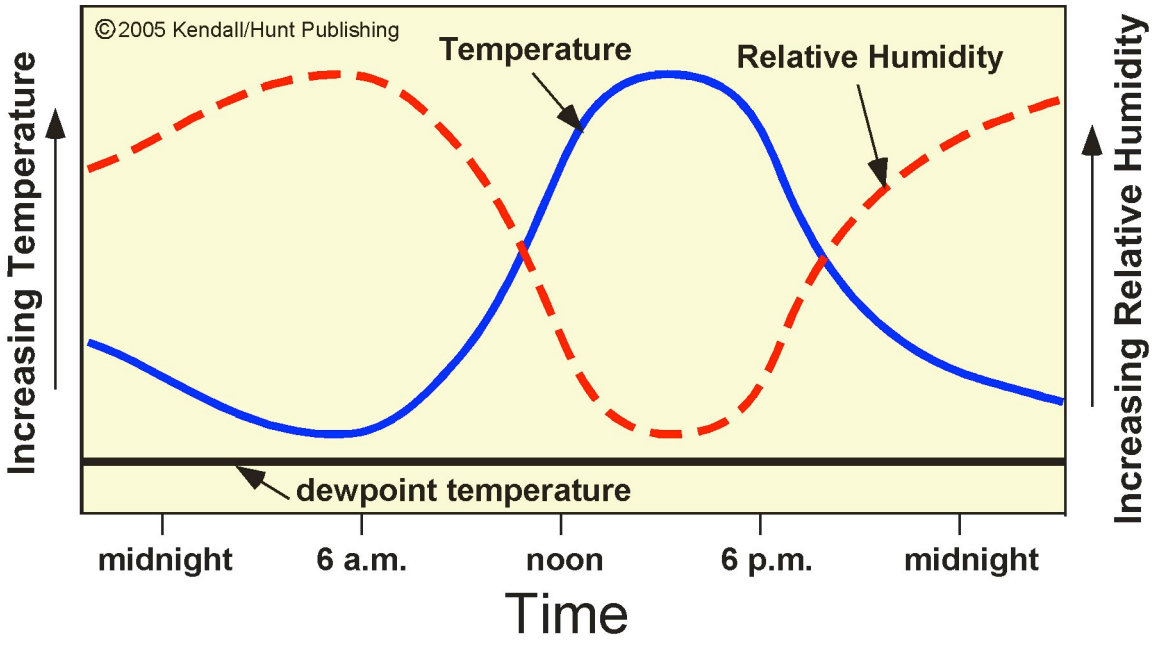
Relative humidity = vapor pressure / saturation vapor pressure x 100%

Relative humidity is a relative measure of the amount of water vapor in the atmosphere.

Relative humidity depends on both the amount of water vapor in the air (vapor pressure) and the amount of water vapor the air can hold (saturation vapor pressure) which depends on the temperature.

What changes can cause the relative humidity to increase?

What changes can cause the relative humidity to decrease?



Relative versus absolute humidity

The desert and the plains

Location	Vapor pressure	Temperature	Saturation Vapor Pressure (mb)	Relative Humidity
Desert SW in summer	8 mb	35 C (95 F)	60 mb	13%
Northern plains in winter	2 mb	0 C (32 F)	6 mb	33%

Which location has the higher absolute humidity?

What variable did you look at to answer the previous question?

At which location is the air closer to being saturated?

What variable did you look at to answer the previous question?

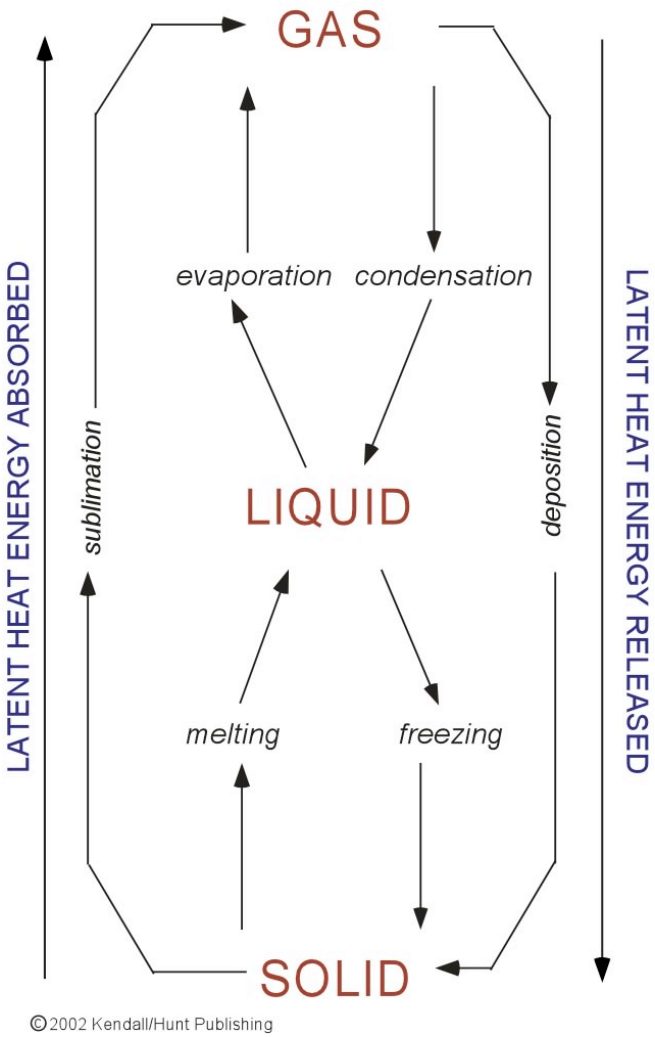
Temperature, dewpoint temperature, and relative humidity

The relative humidity is high when the difference between the temperature and dewpoint temperature is small.

The relative humidity is low when the difference between the temperature and the dewpoint temperature is large.

Phases of water in the atmosphere

Water is unique in the atmosphere because it can exist in all three phases (gas, liquid, or solid)



The energy associated with the phase changes of water is called the latent heat and is very important for the weather.

Latent heat is released from the water to the atmosphere as water goes from a gas to a solid (top to bottom of this figure).

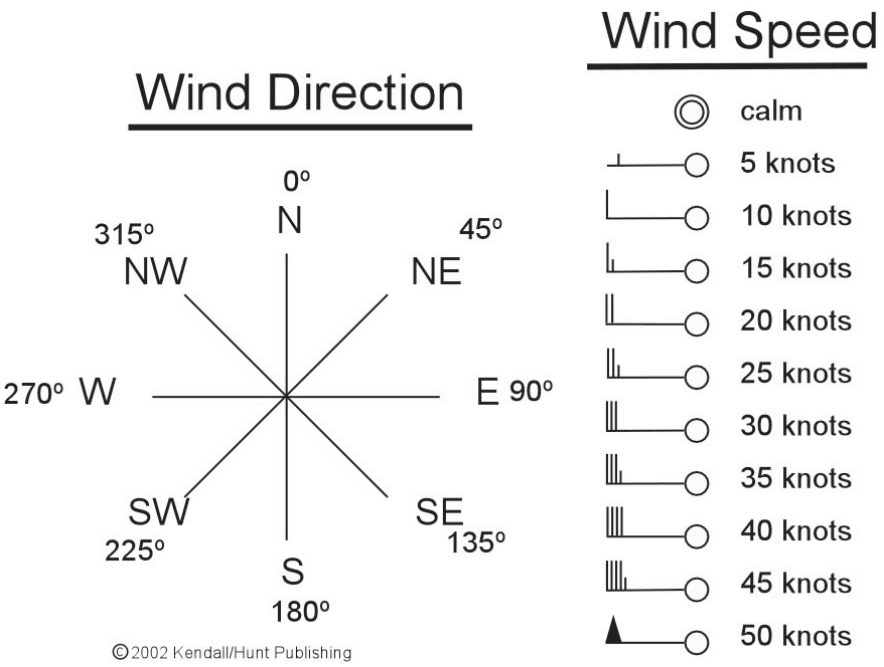
This causes the atmosphere to warm.

Latent heat is absorbed by the water and removed from the atmosphere as water goes from a solid to a gas (bottom to top of this figure).

This causes the atmosphere to cool.

Wind

Meteorologists are interested in both the wind direction and the wind speed.



Meteorologists report the wind direction as the direction from which the wind is blowing.

Why do meteorologists want to know the wind direction?

Meteorologists report wind speeds with units of knots.

1 knot = 1.15 mph