Exam I Wednesday, September 16th

Study Guide: Today

Review Session: Monday

Water, Heat, and Climate

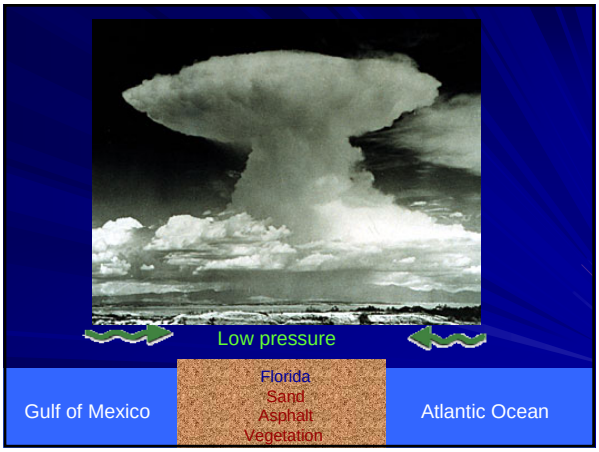
Heat capacity

$$1 \ \frac{Cal}{g \cdot {}^{o}C}$$

It requires 1 calorie of heat input to raise the temperature of 1 g of water by 1 degree Celsius

Heat Capacity

Temperatures of large standing bodies of water remain relatively constant.

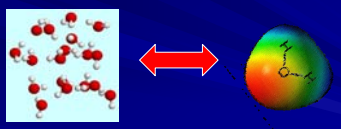


Vaporization and Condensation

How much heat?

Quantified by **Latent Heat**

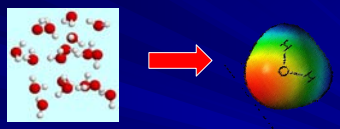
Amount of heat added or removed from water to effect a phase change.



Liquid Gas

Latent Heat of Vaporization

Amount of heat added to water to change it from a liquid to a gas.



Liquid Gas

580 cal/g

580 cal of heat added for each gram of water

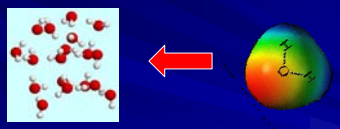
Latent Heats of Vaporization

Water	580 cal/g
Ammonia	350 cal/g
Alcohol	215 cal/g
Acetone	133 cal/g

Amount of heat input to the liquid to change it to a gas

Latent Heat of Condensation

Amount of heat removed from gaseous water to change it from a gas to a liquid.

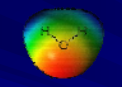


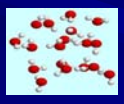
Liquid Gas

580 cal/g

580 cal of heat removed for each gram of water

Conservation of Energy



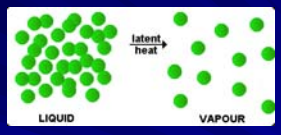


Gas

580 cal/g

Liquid

How much heat is needed to evaporate or condense 1 L of water?



Heat required to vaporize or condense 1 g of water = 580 cal

1 L of water = 1000 g water

$$1000\ g \times 580\ \frac{cal}{g} = 580{,}000\ cal$$

Importance

Latent Heat and Climate

580 cal/g

Water stores energy (heat) in the gas

580 cal/g

Water releases energy (heat) from gas

Liquid

gas

Liquid

How Much Energy?

Ocean Evaporation

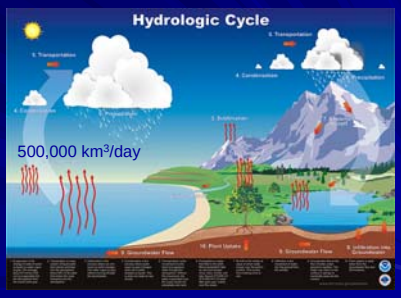
500,000 km^3/day

5 x 10^{14} L/day

5 x 10^{17} g/day

2.7 x 10^{20} cal/day

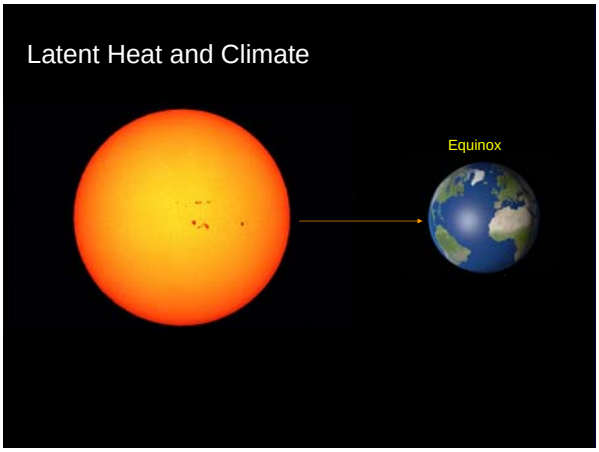
200,000 MT TNT



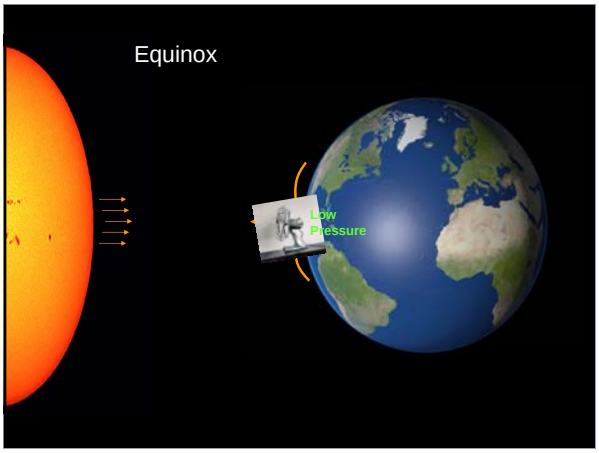
Roughly equivalent to 10,000 atomic bombs

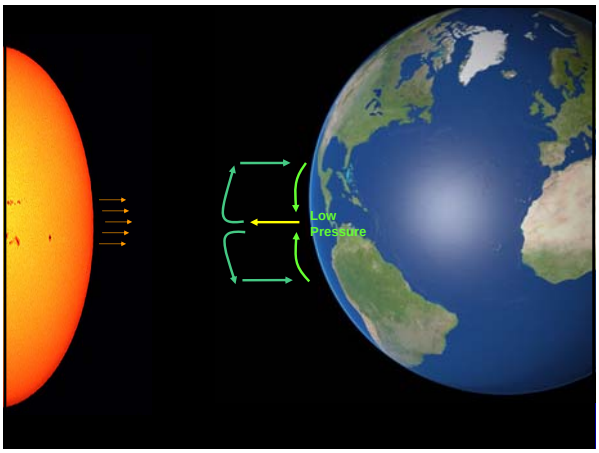
Effect on Climate

Latent Heat and Climate

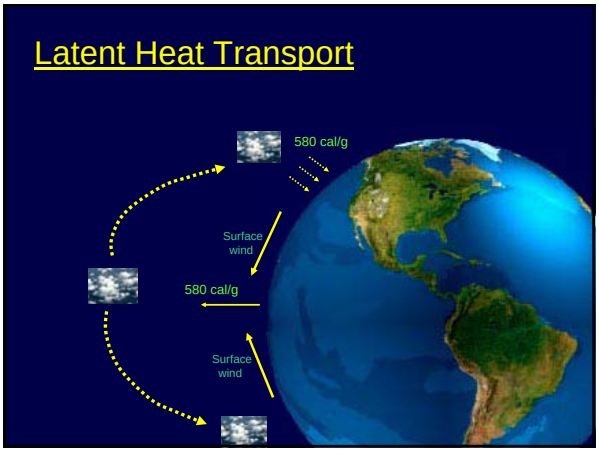


Equinox

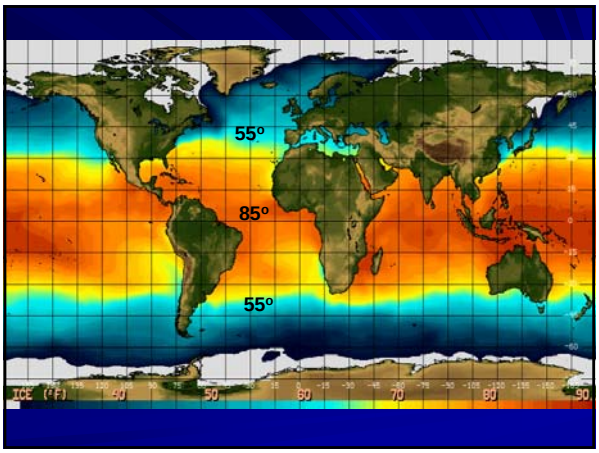


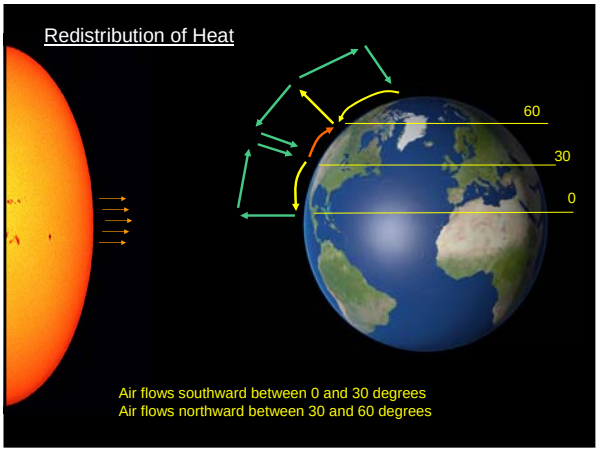


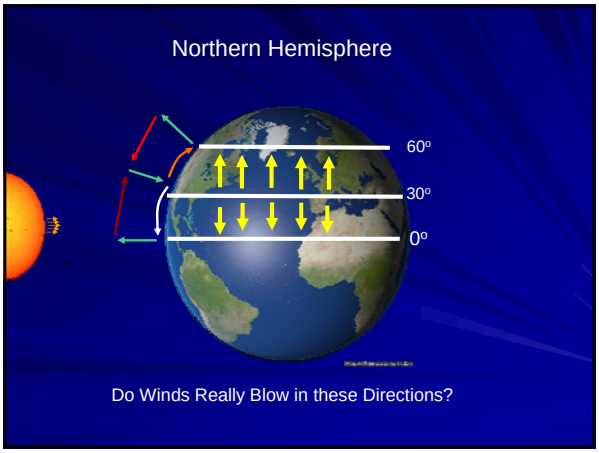
Latent Heat Transport



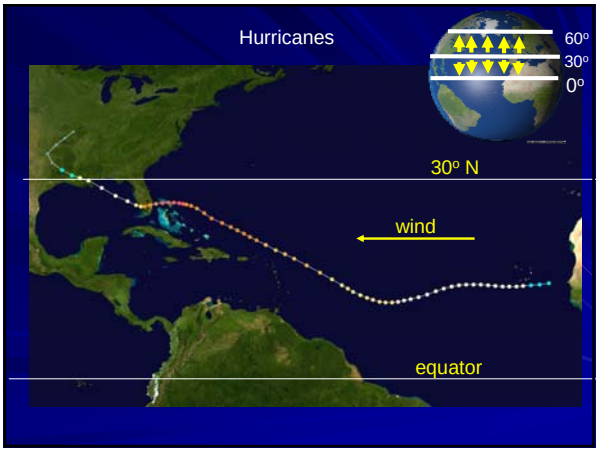
1. Equatorial latitudes receive more solar energy than other latitudes
2. Equatorial regions are dominated by oceans
3. Solar heat evaporates water near the equator (water absorbs 580 cal/g)
4. Warm, moist air rises from the equator
5. Rising moist air creates low pressure at the surface
6. Cooler air from northern and southern latitudes moves to the equator
7. Air rising from the equator eventually moves to northern and southern latitudes carrying latent heat of vaporization obtained at the equator.
8. This air eventually cools and descends near 30^{o} latitude
9. Cool air condenses, releasing energy (580 cal/g) obtained at equator
10. The overall process cools the equator and warms northern and southern latitudes, redistributing heat globally.

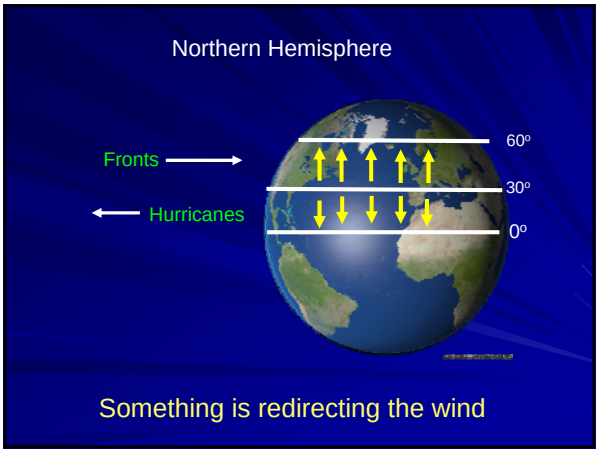

55°
85°
55°


Redistribution of Heat
60
30
0
Air flows southward between 0 and 30 degrees
Air flows northward between 30 and 60 degrees


Northern Hemisphere
60°
30°
0°
Do Winds Really Blow in these Directions?


National Doppler Radar
Today: mostly cloudy
Tomorrow: Rain
30º
60º
30º
0º


Hurricanes
60º
30º
0º
30º N
wind
equator


Northern Hemisphere
Fronts
Hurricanes
60º
30º
0º
Something is redirecting the wind

The Coriolis Effect

Due to the rotation of a spherical earth

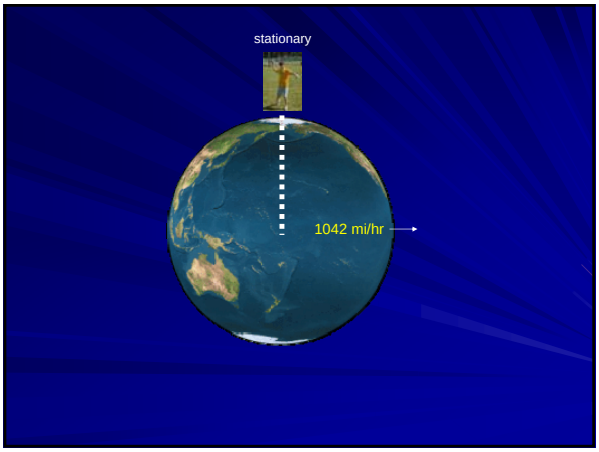
What is the circumference of the Earth? **~ 25,000 miles**

How long does it take for the earth to make one rotation? **24 hours**

0 mi/hr

25,000 mi at 0º latitude

1042 mi/hr



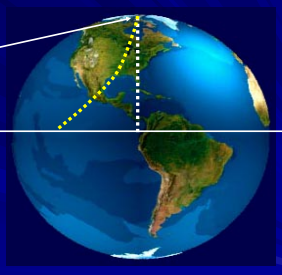
The Coriolis Effect

Velocity at 90º latitude

zero

Velocity at equator

1042 mi hr



Objects moving in the northern hemisphere deflect to the right of the direction of travel.

The Coriolis Effect

Velocity at 90º latitude

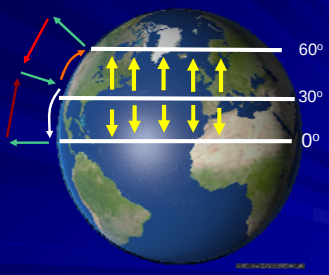
zero

Velocity at equator

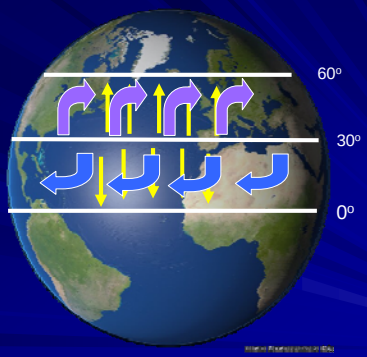
1042 mi hr

Objects moving in the northern hemisphere deflect to the right of the direction of travel.

Northern Hemisphere

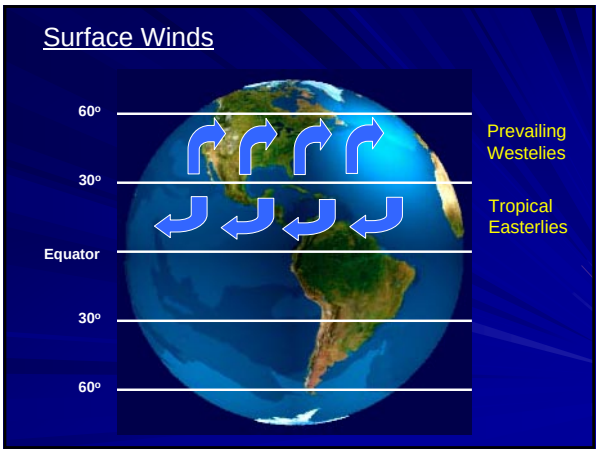


The Coriolis Effect deflects the wind to the right of the direction of travel



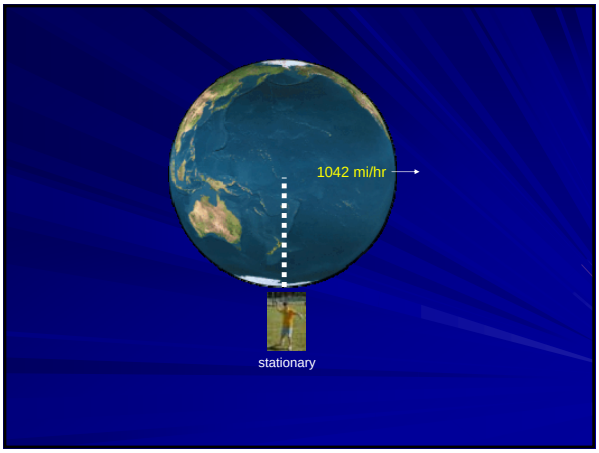
The Coriolis Effect deflects the wind to the right of the direction of travel

Surface Winds



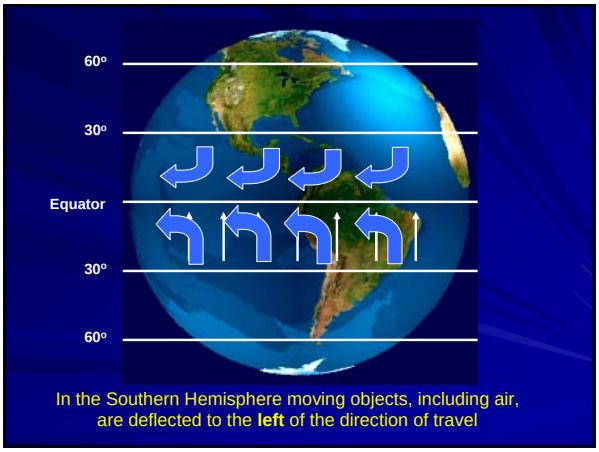
In the Northern Hemisphere moving objects, including air, are deflected to the **right** of the direction of travel

In the Southern Hemisphere moving objects, including air, are deflected to the **left** of the direction of travel

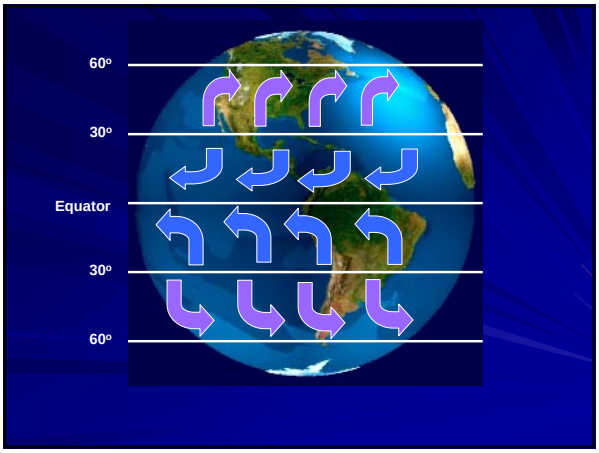


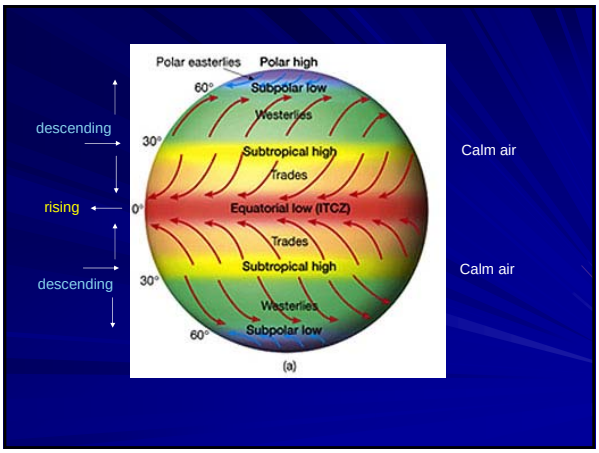
The Coriolis Effect

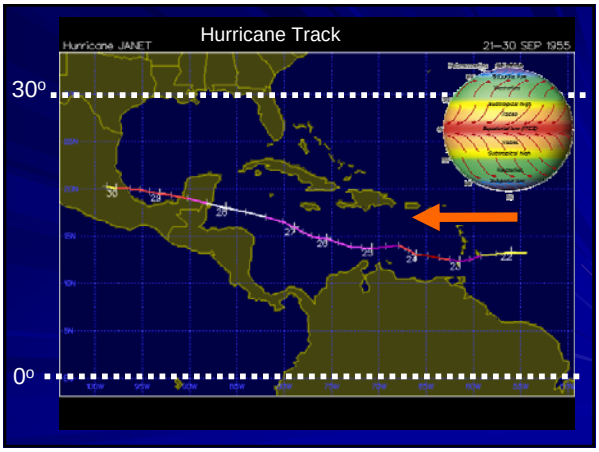
Objects moving in the southern hemisphere deflect to the left of the direction of travel.



In the Southern Hemisphere moving objects, including air, are deflected to the **left** of the direction of travel

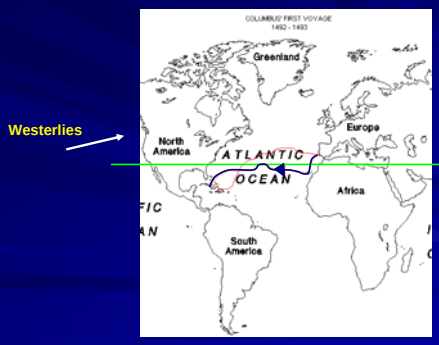



Polar easterlies
Polar high
60°
Subpolar low
Westerlies
30°
Subtropical high
Trades
0°
Equatorial low (ITCZ)
Trades
Subtropical high
30°
Westerlies
60°
Subpolar low
(a)
descending
rising
descending
Calm air
Calm air


Hurricane Track
Hurricane JANET
21–30 SEP 1955
30º
0º

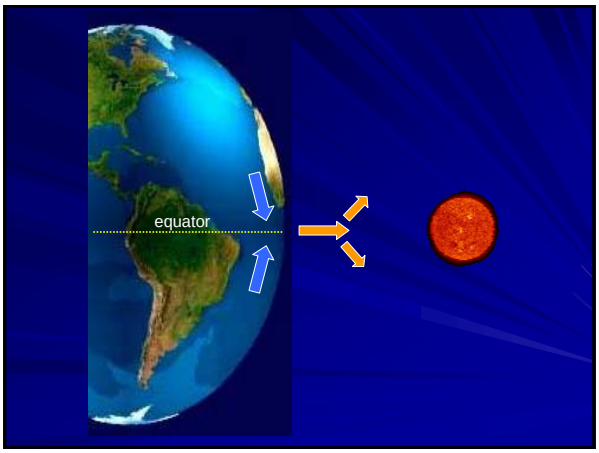

Current Surface
LT RAIN/DRIZZLE
MOD/HVY RAIN
FRZ RAIN/SLEET
LT SNOW/FLUR
MOD/HVY SNOW
FOG
H
L
L
30º
THE WEATHER CHANNEL
09 Feb 2001 18:45 GMT / 09 Feb 2001 01:45 PM EST

Sailing, sailing…



Summary

1. The Coriolis force is due to the spherical shape of the earth.
2. Points at the equator move faster than points at other latitudes.
3. In the northern hemisphere air is deflected to the right of the direction of travel
4. In the southern hemisphere air is deflected to the left of the direction of travel
8. Winds are named with respect to the direction from which they originate.
9. Winds between 30º and the equator are called easterlies.
10. Winds between 30º and 60º are called westerlies.


equator