Lab 3 GEO 302C
Week of 2/8/10

Goal: Discuss the general circulation of the atmosphere.

Topics:

Pressure and the Pressure Gradient Force

High and Low Pressure (physical characteristics and weather/climate characteristics)

Pressure Gradient Force

Coriolis Force

General Circulation Patterns

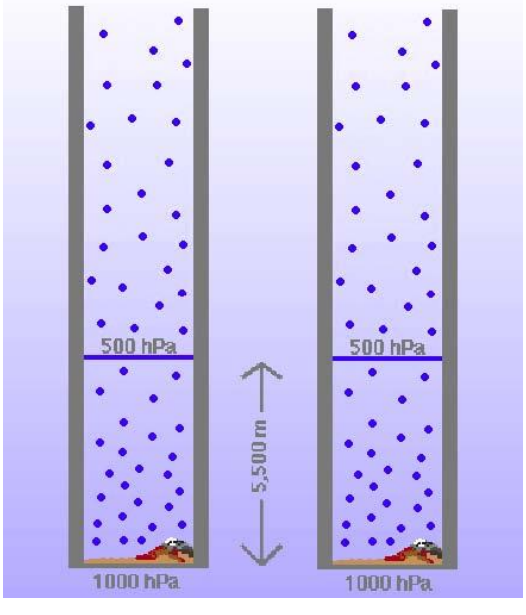
If time allows:
Land and Sea Breeze
Monsoon Circulations
Precipitation Review

Pressure

What is pressure?

What causes pressure differences in the atmosphere?

Say we have two identical columns of air each with an identical number of molecules.



What happens if we heat these columns of air?

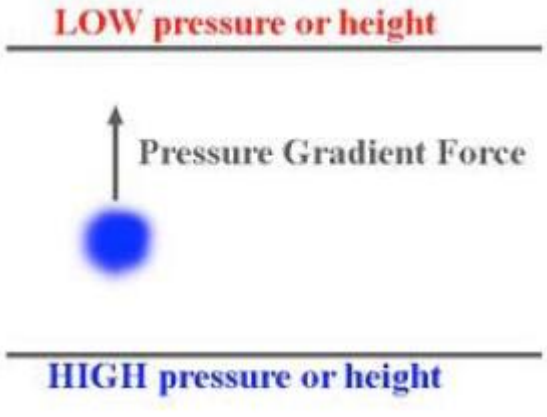
What happens if we cool these columns of air?

What will happen to the height at which a pressure of 500 hPa is found in the case where the air was cooled (relative to the initial case)?

What will happen to the height where the 500 hPa pressure is found in the case where the air was heated (relative to the initial case)?

If this situation happens in the atmosphere, we will have a horizontal pressure imbalance. At a specific height, the pressure in the cold column will be lower than the pressure in the warm column next to it. If this happens the air will want to move from the higher pressure to the lower pressure (just like a ball rolling down a hill), and this is what causes the wind to blow!

This difference in pressure between two points is called the *Pressure Gradient Force*, and is ALWAYS directed from high pressure to low pressure.



So if there is nothing else acting on this piece of air, it would flow from high pressure to low pressure.

Vertically in the atmosphere, we always have a pressure imbalance (remember that pressure decreases with height). If this is the case how come all of the air molecules don't flow from high to low pressure and therefore out to space?

If air always flowed directly from high pressure to low pressure, we would have air rising in the tropics and sinking at the poles (because there is more heating in the tropics than at the poles). However, this isn't what happens, what are we missing?

Coriolis Force

The Coriolis force causes the wind to "turn" towards which direction in the Northern Hemisphere?

The Coriolis force causes the wind to "turn" towards which direction in the Southern Hemisphere?

If we have a low pressure system, the wind will want to flow into it, but because of the Coriolis force it will be turned and will therefore flow around it instead.

Which way do the winds flow around low-pressure systems in the northern hemisphere (note that this is called *cyclonic* flow)?

Which way do the winds flow around high-pressure systems in the northern hemisphere (note that this is called *anti-cyclonic* flow)?

Which way do the winds flow around low-pressure systems in the southern hemisphere?

Which way do the winds flow around high-pressure systems in the southern hemisphere?

In the figure above (in the previous section) where we have high pressure on the bottom (towards the south), and lower pressure towards the north, which way will the wind actually blow if we are in the northern hemisphere?

The Coriolis force is called an *apparent* force because it doesn't actually force the wind to change direction, it just appears to us at the surface that it is changing direction (because we are spinning with the earth too as it rotates around its axis).

General Circulation
As we discussed above, winds will flow clockwise around low pressures and clockwise around high. This is true that this happens high in the atmosphere, but at the surface we have another force that we have to consider: *friction*. Because of this, the wind actually turns into the low pressure and out of the high pressure.

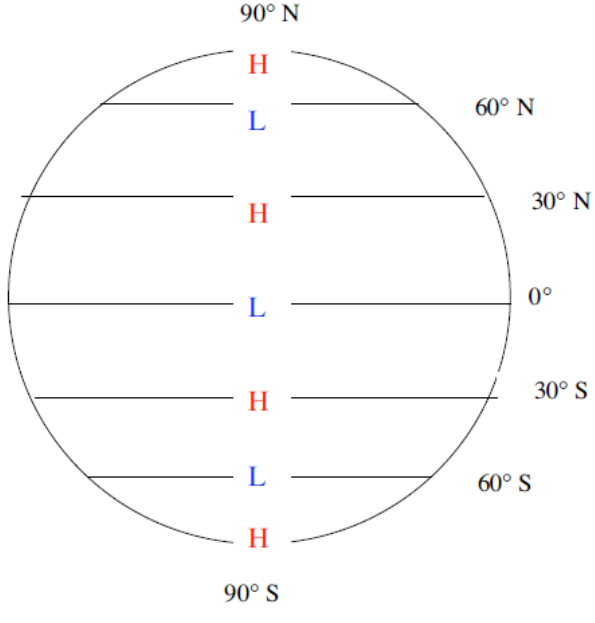
If we have a low pressure at the surface, will the air at the low pressure rise or sink?

If we have a high pressure at the surface, will the air at the high pressure rise or sink?

Note: As discussed in lecture, you need rising motion for clouds and precipitation to form, so this will have large impacts on our climate.

Now let's look at the general circulation of the atmosphere.

The Earth has a general pressure pattern that looks something like this:



Using this information and the information we have learned about how the winds respond to pressure, we can draw the general winds on earth.

First let's draw the vertical motions. Upward motions in the atmosphere are generally very small, therefore we can neglect the Coriolis force when drawing vertical motion. Remember that air rises in low pressure regions and sinks in high pressure regions.

Around the edge of the figure, draw arrows indicating the direction of the motion.

Now for the horizontal: First, on the figure above, draw the direction in which the pressure gradient force is acting.

Now include the Coriolis force, and draw arrows indicating how the air is moving. (remember which way the Coriolis force acts in the northern and southern hemisphere)

Congratulations, you have just drawn the general circulation of the atmosphere!

Now, looking only at this figure and keeping in mind that rising air causes precipitation and sinking air suppresses it, what can we say about the climate of the various regions?

Lab 3 Home work GEO 302C This is due at the beginning of your section, in your section, next week.

Name:

EID:

True or False:

1. (4 pts) Up high in the atmosphere the forces that affect the wind direction are: the pressure gradient force, the Coriolis force. (True or False)
2. (4 pts) The winds that blow between both 30° S and 60° S and 30° N and 60° N are called Westerlies (Hint, look at your picture you drew, winds are named from where they come)? (True or False)
3. (4pts) The pressure of the atmosphere decreases with altitude because gravity holds more molecules (high pressure) close to the surface. (True or False)
4. (4 pts) The pressure gradient force is always directed from low to high pressure (True or False)
5. (4 pts) In the United States, most of our weather comes from the east. (Hint: look at the generation circulation picture again, which way are the winds blowing?)

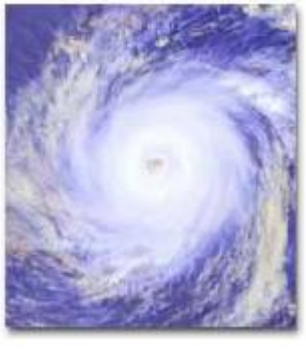
6a. (5 pts) If you have a pressure in Dallas of 1000 hPa and you have a pressure here in Austin of 990 hPa, in which direction (N,S,E,W) does the wind WANT to blow (ignoring the rotation of the earth and friction)? Mark the wind direction in the map below.

6b. (5 pts) If you have the pressure system from 6a, which direction will the wind actually blow (up high in the atmosphere, ignoring friction)? Mark the wind direction in the map below.

6c. (10 pts) Briefly explain why you came to the conclusion you did for 6a and 6b.

7. (10 pts) Why are the world's deserts generally found at 30° N and S?

8. (5pts) In the picture of a hurricane shown below, what hemisphere is this in (hint, which way is it rotating)?



9. (5 pts) What is the basic driving force behind the Hadley Cell Circulation?

10a. (10 pts) Explain the process of conduction.

10b. (10 pts) Explain the process of convection.

11. (10 pts) Explain why low-pressure systems are generally associated with clouds and precipitation. (Make sure to discuss not only how the air is moving, but also why it is moving that way)

12. (10 pts) Explain why the air flows clockwise around high pressures in the southern hemisphere.

13. (10 pts). On the coast you have a land surface adjacent to an ocean surface. During the day the land heats up more rapidly than the ocean. This gives us a temperature difference where the land is a warm column of air and the ocean is a cold column of air (relative to what is over the land). Using what you have learned, draw the high and low pressures and which way the wind would flow on the picture below.