Weather Maps Revisited

Adapted from "A New Perspective on Surface Weather Maps" by Steve Meyer from *Science Activities, 42-4 Winter 2006* pp 3-9.

Purpose:

This exercise will help SMILE Club members interpret 2-D weather maps by creating a 3-D physical model of a weather map. While this 3-D model is not an exact replication of the atmosphere, it is a useful tool to help SMILE Club members visualize the data that a weather map is conveying.

Background:

Differences in atmospheric pressure drive most of what we consider to be weather, yet atmospheric pressure is an extremely abstract concept. Many things make atmospheric pressure difficult to understand – air feels weightless, pressure differences that can cause weather are difficult to feel, air cannot be seen… However, the importance of air pressure in interpreting atmospheric conditions is unparalleled. In general, high pressure systems cause fair weather because vertical air movement in a high pressure system is downward. Air in the upper atmosphere is dry because water weights more than air. This phenomenon is easily observed in Oregon. As moist air from the ocean rises as it moves East over the state it rains on the west side of the Cascades and then is dry as it moves further East across the state. Look at a map of precipitation in the state of Oregon and compare the annual precipitation in Toledo, Madras, and Ontario (or another group of towns picking one west of the Cascades, one in the high desert area, and one in Eastern Oregon). The latitudes and longitudes of all the SMILE communities and a map of Oregon (paper and overhead) will help with this task. Low pressure systems, in general, bring foul weather – clouds and often rain because the air is moving upward taking surface moisture into the atmosphere through a process called convergence. Convergence pushes moist surface air up into the atmosphere where it can condense and make clouds, and possibly precipitate and cause rain or snow. The leading edge of a high or low pressure system is called a front. When a front passes an area there is usually active weather caused by the interaction air masses of different pressures and temperatures on either side of the front.

Air pressure is defined as "the force exerted by the weight of a column of air above a given point" (Meyer, 2006). The greater concentration of air molecules above a point, the greater the air pressure. On weather maps high pressure areas are marked with big blue H's and lows are marked with big red L's. What we consider 'weather' is just the process of the atmosphere trying to reach a state of equilibrium. Wind is the movement of air from high pressure areas to low pressure areas. The greater the pressure difference (concentration difference) between low and high pressure areas the stronger the winds and vice versa. On weather maps, pressure is reported in millibars and is usually represented with isobars (lines of constant pressure) every 4 millibars. Isobars are similar to lines on a topographic or bathymetric map where each line represents a constant elevation or depth. So, like on topographic maps, areas where there are a lot of isobars clustered together are areas with large pressure gradients (strong winds), and areas with isobars spaces far apart will have small pressure gradients (weak winds). However, instead of actual height, isobars represent a concentration of molecules.

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As air molecules attempt to move from high pressure to low pressure areas, they are influenced by the Coriolis force so that in the Northern hemisphere winds blow outward and clockwise from a high pressure center and move in and counterclockwise around a low pressure center. Check out this demonstration of Coriolis force: http://www.eoascientific.com/campus/earth/multimedia/coriolis/view_interactive for a good visual demonstration. (This computer program was also suggested for some of the "Comprehending Currents" activities from the August 2004 TWS.)

Materials: materials in **bold** are provided by SMILE

- **Surface weather maps (1 color copy and overhead per team and multiple black and white copies for cutting out)**
- **Map of Oregon (paper and overhead)**
- **Foam core board 30" x 40" sheet per group.**
- Utility knives
- Pieces of corrugated cardboard to use as cutting surfaces
- Eye protection for using utility knives
- **Glue sticks**
- Metal straight edge (for use with utility knives)
- Markers or highlighters
- **Pins**

Procedure:
Time note: this should take about 2 club meetings. The activity could be simplified by cutting out every other isobar line or having bigger groups divide up the task of cutting out the sheets of foam core.

Weather maps have been included for the Gulf of Mexico before, during and after Hurricane Katrina**. August 27, August 28, August 29, August 30, August 31 found at daily weather map http://www.hpc.ncep.noaa.gov/dailywxmap/index.html**

Choosing your own maps:
If you want to use other weather maps make sure to choose one with a good contrast between high and low pressure centers. Make sure to enlarge or shrink it so that it is 8 ½" x 11". Also you will need to have enough copies of the maps so that there is one copy per isobar plus one extra for the base map. There is an archive of daily weather maps at http://www.hpc.ncep.noaa.gov/dailywxmap/index.html with an archive back to January 2, 2002. If you choose to use your own maps you may need to make sure that the labeling on the isobars is clear. I had to go back through with the ones I provided and clarify some of the number values.

Making the model:

1. Firmly glue the copies of the weather maps side by side onto the foam core board. Place the maps right next to one another to use as much foam core board as possible.

2. Using the straight edge as a guide, carefully cut the maps apart using the utility knife. When stacked up, the maps should all be the same size. Make sure that there is a piece of cardboard under the foam core to prevent cutting the table below.
3. Take one of the maps and leave it as is to use as the base map. This will be the lowest point on the map and will represent the lowest pressure areas.
4. Take another map and find the lowest isobar. *Pressure levels may occur in multiple places on the map*. Color in the areas within these isobars – this is the area that will be removed. Use the utility knife to trace these isobars and remove the areas of lowest pressure. Make sure to cut on the piece of cardboard. Stack this map on top of the base map.
5. On the third map follow the next area of low pressure, shade it in and cut it out. Place this map on top of the other two.
6. Continue this process until the 3-D map is completed.

As your stack of maps gets tall it might be a good idea to glue the layers together or to use the pins provided.

Discussion:

A weather map is a snap-shot of atmospheric conditions at a particular point in time (sometimes they are a composite of conditions over a period of time). By looking at this model it is clear to see why TV meteorologists or weather-casters often refer to high pressure centers as domes and low pressure centers as depressions or troughs. HOWEVER, this model is not exactly true to life. High pressure areas do not really rise above low pressure areas in a physical sense. This model uses height as a way to visualize different concentrations of air molecules. Air molecules move from high pressure to low pressure like something would move downhill. The idea of physical slope is easier to visualize which will help club members interpret air movement from high to low pressure and why the winds are stronger in some places than in others. This can also be a good way to review the effects of the Coriolis force.