Pressure & Storms

Objectives:

Students will understand that density differences drive global and local patterns winds. They will recognize that barometric pressure is a measure of the density of air, and can be used to predict changes in weather. They will understand how the Coriolis effect influences wind patterns, and how this can create cyclones.

Concept:

Temperature-dependent gradients of density drive the movement of air. As warm air rises, cool air moves in to fill the space left behind. This wind is deflected by the rotation of the earth, called the Coriolis effect. Barometric pressure, which measures the density of air, is a way to predict weather patterns. In this activity, students will create their own tool to measure barometric pressure and use the data they collect to predict weather patterns. In tropical areas, warm water can fuel the movement of air. This movement, combined with the Coriolis effect, can create cyclones (typhoons and hurricanes).

Materials:

- Science notebooks
- Pencils
- Colored pencils
- Computer/laptop and projector or SmartBoard
- Desktop computesr, laptop or tablets
- Handout: Pressure Chart February 7, 2014
- Handout: Wind Speed & Direction Forecast Chart February 7, 2014
- Handout: Make a Weather Barometer Lab
- Tin cans or glass jars
- Latex or rubber balloons
- Straws
- Rubber bands
- Tape
- Scissors
- Pieces of paper

Preparation:

Load the "Earth Wind Map" (http://earth.nullschool.net/).

Load National Geographic's Hurricane 101 video (http://video.nationalgeographic.com/video/environment/environment-natural-disasters/hurricanes/hurricanes-101/) or NOAA Ocean Explorer's Hurricane video (http://oceanexplorer.noaa.gov/edu/learning/player/lesson14.html).

Make enough copies of the "Pressure Chart: February 7, 2014" for every 2-4 students, or download a current pressure chart from NOAA (http://weather.noaa.gov/fax/aksfc.shtml#anal). If you choose to download a current pressure chart for your area, choose option 1a- Plot Chart Analysis Northern Hemisphere Pacific. This chart encompasses the entire North Pacific, but you may want copy only the area surrounding Alaska.

Make copies of the "Wind Speed and Direction Forecast Chart: February 7, 2014" for each group or download and print a current wind forecast chart from NOAA (http://graphical.weather.gov/sectors/aktrimmed.php). If you choose to download a current chart, click on the "Wind Speed & Direction" for as close to the current date and time as possible. Click on the printer icon in the upper right corner. Depending on your browser, it may be easier to go to the "Image List" link in the upper left hand corner and choosing the "WindSpd" link valid for the appropriate date.

Introduction:

Review what you have learned during the "Density Differences: Air" and "Currents & Coriolis" lessons.

Pressure & Storms *Continued*

Ask students to think about a recent wind storm. What direction did the wind come from? Based on student knowledge of how air moves along density gradients *(from areas of high pressure to areas of low pressure)* and is affected by Coriolis *(deflected to the right in the Northern Hemisphere, and to the left in the Southern Hemisphere)*, ask students to write a hypothesis in their science notebooks about where the area of high pressure was and where the area of low pressure was in the recent storm.

Procedures & Activities:

Divide students into groups of 2-4. Pass out the "Pressure Chart: February 7, 2014" or the current pressure chart you have downloaded from NOAA.

Ask them to work with their group to first find and outline the state of Alaska on the chart. Next, they should shade areas of high pressure in blue and areas of low pressure in red.

Then, have students predict the wind patterns based on the areas of high and low pressure on the chart. Once they have discussed the possibilities with their group, they should come to a consensus and draw their predicted wind directions onto the chart.

Instruct students that if they predict strong winds, they should make their lines thick and if they predict weak winds, they should make their lines thin.

Have groups share their wind predictions with the class.

Then show groups the "Wind Speed and Direction Chart: February 7, 2014" or the current wind chart you have downloaded from NOAA.

Discuss any differences between their predictions and NOAA's predictions. This is a great opportunity to reinforce knowledge about Coriolis effect, or introduce the concept if your students haven't done much with Coriolis effect up to this point.

Show students the real time Earth Wind Map (http://earth.nullschool.net/). Examine patterns of local surface winds.

Look globally for wind storms rotating in a circular pattern – the spiral of winds should be fairly easy to spot. The winds are caused by pressure gradients, and the rotation is caused by the Coriolis effect.

Compare storms in the Northern Hemisphere to storms in the Southern Hemisphere. What direction are they rotating? *(Storms in the Northern Hemisphere tend to rotate counter-clockwise, while storms in the Southern Hemisphere tend to rotate clockwise.)*

To see how pressure gradients affect these winds, click on the word "Earth" in the lower left corner. In the options, scroll down to "Overlay" and choose "MSLP" for mean surface level pressure. Areas in purple indicate low pressure, while areas in grey indicate high pressure. Yellow-green areas have moderate barometric pressure.

Ask students what they notice about the pressure and winds. *(Most storms you observed earlier are likely to be centered around areas of low pressure.)* Why is this? *(Air from high pressure areas is flowing to areas of low pressure, and these winds are deflected into a spiral by the Coriolis effect.).*

Pressure & Storms *Continued*

Explain that the Coriolis effect has a strong impact on the formation of storms. In tropical climates, the Coriolis effect is a driving force in the creation of cyclones, also called hurricanes and typhoons.

Watch the National Geographic video "Hurricanes 101" (http://video.nationalgeographic.com/video/environment/environment-natural-disasters/hurricanes/hurricanes-101/) or the NOAA Ocean Explorer "Hurricanes" video (http://oceanexplorer.noaa.gov/edu/learning/player/lesson14.html).

Have students work with their earlier group, or divide them into new groups of 2-4 students, and ask them to use what they learned from the video to create their own hurricane by visiting the "Create a Cane" online lab (http://www.nhc.noaa.gov/outreach/games/canelab.htm) on their computer, laptop, or tablet.

After they have created a hurricane, discuss as a class the water and air characteristics that help to form a cyclone. Are cyclones likely to form in Alaska? *(No, our waters are not nearly warm enough to fuel a hurricane.)*

Explain that, even though our waters are too cold to fuel a cyclone, lots of other interesting weather affects our state. Meteorologists use information about pressure systems, among other things, to predict the weather.

Tell students that they are going to do the same by making their own barometer.

Pass out the "Make a Weather Barometer" lab directions to each group and give them time to construct the barometer.

Have students check the barometer every day and record their observations in their science notebooks.

After 5-10 days, ask them to analyze their data. What sort of weather patterns do they see when the barometric pressure drops? *(Generally associated with an increase in clouds and precipitation, may be accompanied by wind.)* What sort of weather patterns do they see when the barometric pressure rises? *(Generally associated with a decrease in clouds and precipitation, may be accompanied by wind.)* What if it is low and stays low? *(Rain and clouds.)* What if it is high and stays high? *(Clear and sunny.)*

Once they have analyzed their data, ask student groups to begin making weather predictions based on the changes they observe in the barometric pressure and charts of nearby pressure systems.

Show them how to access current Pressure Charts for the North Pacific: http://weather.noaa.gov/fax/aksfc.shtml#anal or print them out for students to use. Make sure they don't look at any of NOAA's predictions before making their own!

Have students write their predictions for the weather in the next 48 hours in their science notebooks.

Wrap-Up:

Ask students to use their weather predictions – based on their barometric pressure readings and the observed pressure charts from NOAA - to create a weather report for the classroom or school.

Pressure & Storms *Continued*

Have each group present their predictions, reasoning, and advice for how to prepare/what to wear on a different day.

Then, have students compare their predictions with NOAA predictions or real-time weather observations they make over the next 48 hours. Discuss other factors that influence the weather that they may not have taken into account.

Have students revisit their initial analysis of a wind storm. Based on what they have learned throughout their exploration of pressure, wind, and weather, ask students to rewrite their hypothesis about where the area of high pressure was likely located and where the area of low pressure was likely located during the storm.

Ask them to explain their hypothesis and identify any other information they would like to strengthen their hypothesis (examples of additional information include ocean and land temperatures, geographic features like mountains, etc.)

Extensions & Lesson Connections:

Ask students to create an easy-to-use guide to predicting weather based on what they learned. Place a student-made barometer in a prominent area of the school, along with the guide so that other students can predict the weather using the barometer.

This lesson works well as a follow up to the "Density Differences: Air" and "Currents & Coriolis" lessons. The collection of barometric pressure and weather observations pairs well with the "GLOBE Weather Monitoring" lesson.

Evaluation:

Assess student comprehension and application of material through their weather predictions. Your assessments should be based not on the actual weather, but on their application of the following general principles:

- **Decrease in pressure**: increase in clouds and precipitation, may be accompanied by wind
- **Increase in pressure**: decrease in clouds and precipitation, may be accompanied by wind
- **Steady low pressur**e: rain and clouds
- **Steady high pressure**: clear and sunny
- Surface winds should normally flow from areas of high pressure to areas of low pressure, deflected about 45-90 degrees to the right. So, if there is a high pressure system to the north and a low pressure system to the south, you would expect winds from the Northeast or East.
- The greater the difference between high and low pressure, the greater the wind speed.

The initial hypothesis about pressure systems associated with a recent wind storm serves as a pre-assessment, while the revised hypothesis should illustrate student comprehension of the effect of pressure gradients and Coriolis effect on winds. Observe student participation and cooperation during group work, and assess student maps and entry of data in science notebooks for completeness, neatness, and accuracy.

Make Your Own Barometer Lab Instructions

1. Assemble your materials: 1 tin can or glass jar, 1 balloon, 1 straw, 1 rubber band, scissors, tape, paper.

2. One person in your group needs to blow up the balloon once and let the air out to stretch it.

3. Cut the balloon in half, so that you have a top half and a bottom half with the neck attached to it. Discard the half with the neck.

4. Work together to stretch the top half of the balloon firmly across the jar.

5. Seal the balloon in place with the rubber band, around the rim of the glass jar. To make an airtight seal, avoid gaps between the balloon and the glass.

6. Use the straw to create an "indicator needle." Arrange the straw so that about ¼ of it is on the balloon and ¾ of it hangs off the balloon. Tape the straw onto the middle of the balloon lid so that about 1 inch of straw extends beyond the tape. Trim the straw if it's too long, but leave at least half extending off the jar.

8. Put your finished jar next to a wall where it won't be disturbed.

9. Tape a piece of paper to the wall behind the indicator needle of your barometer.

10. Write the names of the people in your group at the bottom of the piece of paper.

11. Mark the height of your indicator needle on the piece of paper. Make a note about the current weather conditions (clear, cloudy, rainy, windy, calm, etc.)

12. Check the barometer indicator needle every day. Mark the height of the indicator needle on the paper along with the current weather conditions.