Weather at the Extreme

How and why does it rain and how and why do storms form?

Module 15 LSR Intermediate Chapter 2 & Chapter 3

Module created by:

Grade Level

Middle School

Subject Areas

Earth Science: Atmospheric Science and Physical Geography (Meteorology; Climatology)
Geography

Duration

Preparation time:
Part I: 20 minutes
Part II: 20 minutes
Part III: 20 minutes
Part IV: 10 minutes (optional but recommended)
Part V: 10 minutes (optional)

Lesson Time:
Part I: 20 minutes
Part II: 20 minutes
Part III: 20 minutes
Part IV: 10 minutes (optional but recommended)
Part V: 10 minutes (optional)

Setting

Indoor or outdoor classroom;

Skills

Making Predictions, Applying prior knowledge to new concepts, Gathering Information from outside the classroom/sailing environment, Testing Predictions through experiments, building models to demonstrate scientific concepts

Sailing Skills

Weather prediction, Cruising and Racing Strategy

Vocabulary

Meteorology, Meteorologist, Convection Cycle, Thunderstorm, Coriolis Effect, High Pressure, Low Pressure, Front, Tropical Cyclone, Hurricane, Wind Shear, Tornado, (Optional: Thermal Circulation)

Standards

Click here to view aligned standards.

Summary

Students construct visual models to help them understand how rain showers, thunderstorms, and other low pressure phenomena occur. Students apply prior knowledge from Module 8 to new weather concepts. Students are introduced to the basic concepts of local and regional weather forecasting.

Objectives

Students will:

- Learn how rain and thunderstorms form
- Create a model to demonstrate how rain occurs
- Draw on prior knowledge from *Reach Module 8* to explain High and Low Pressure Systems
- *(Optional, not recommended: Learn about the different types of clouds and their significance)*
- Be introduced to concept of the Coriolis Effect
- Create a model to show the Coriolis Effect at work
- Learn why Tropical Cyclones (Hurricanes) spin in only one direction per hemisphere
- Be introduced to concept of Tornados and why they may form (wind shear)
- Create models to demonstrate tornados and hurricanes
- Learn the difference between cyclonic and anti-cyclonic rotation (circulation)
- Learn some basics of weather forecasting as applied to the sailing landscape

Materials

- *Small Boat Instructor Guide: Level 2*
- *Learn Sailing Right! Intermediate*
- Lesson plans that cater to your specific group dynamics
- White Board or other writing platform
- White Board markers or other appropriate writing utensil
- Notebooks and writing utensils for students
- 'Hot pot' or other device for heating water (may experiment with coffee maker)
- Party Balloons (x2 per team, teams of 2)
- Mason Jar with Lid (x1 per team)
- Small bowl (must nestle inside rim of Mason Jar) (x1 per team)
- Water
- Ice

- Dish Soap
- Vinegar or glitter (optional)
- *(Optional: x2 2L bottles per group and "vortex connectors" in lieu or as supplement to Mason Jars for Model #2)*
- Unsharpened Pencils (x2 per team, optional)
- Tape (clear or masking, optional)
- Permanent Markers (x1 per team)
- Aerosol hair spray or matches (setting dependent) – Extension Activity #1
- Plastic Wiffle Ball bats (x2 per class) or similar items

Procedure

Part I: Rain/Thunderstorm formation chalk talk and experiment - Indoor/Outdoor Classroom

5 minute chalk time

10 minute experiment

5 minute reflection

http://www.flickr.com/photos/41787352@N07/6818778750/

http://rusticremnants.blogspot.com/2012/03/weather-week.html

https://www.youtube.com/watch?v=3v98madaW1M

1. Prep for chalk time and 'Rain in a Jar' Experiment: Set up your hot pot or coffee maker to boil water. Prep your Mason jars and bowls. Prep student notebooks, white board, and any handouts you choose to use. Write "Experiment Materials: Jar, bowl, water, heat, ice" on the board.

2.a. Access Prior Knowledge: Ask students, "How does rain form?" Get several responses to engage students and explain their responses. If students have a hard time, have them reflect on what they learned about sea breezes in Module 8.

2.b. Have students reflect on Module 8 and ask them the question, "How does water get up into the sky?" Once they have answered this question, ask them, "Is this what you think or what you *know?*" How can you know something? How can you *test* what you think you know?

3. Have students design an experiment to test their hypothesis that answers "How does rain form?" They are only allowed to use the materials given on the board. Give help as needed.

4. Have students draw diagrams of what happened to the water as it turned into vapor and then condensed into water droplets. Have them identify what the pressure is doing as the water vapor flows up and then back down.

Students are welcome to share their reflections, and if they do small group reflections encourage large group sharing as well. Questions are encouraged.

5. Ask students the following question: “In addition to rain showers, what are some other *Low Pressure* events that occur locally and in other parts of the United States?” Prompt as needed to elicit “thunderstorm,” “hurricane,” and “tornado” (other answers are not excluded, however)

Part II: Introduction to the Coriolis Effect; Hurricane primer and model making – Indoor/Outdoor Classroom

10 minutes modeling with supplemental chalk time
5 minute chalk time on Low Pressure systems and cyclonic vs. anti-cyclonic rotation
5 minute reflection

http://www.carolina.com/teacher-resources/Interactive/modeling-the-coriolis-effect/tr10643.tr

1. Have your assistant prep balloons (and pencils & tape, optional) and permanent markers for students, x1 per pair. If you are by yourself, you will need to prep this in advance.

2. Ask the question, “Does anyone know which direction Hurricanes rotate?” Do they ever rotate in the opposite direction? If students don’t know, have them look up the answer. Someone is bound to have a smart phone on them.

3. “Why do hurricanes only spin counter clockwise in the northern hemisphere and clockwise in the southern hemisphere?” If someone knows, awesome! Likely, there will be lots of blank stares.

3.b. “What does the term “hemisphere” mean? Have students answer.

3.c. Introduce the term “Coriolis Effect.” Have students write this word down in their notebooks. The Coriolis Effect is caused by the rotation of the earth. “What direction does the earth spin?” (Answer: toward the east; In the northern hemisphere, the direction is considered “counter clockwise,” while in the southern hemisphere the world would appear to spin in a clockwise direction).

4. “Let’s build a model to help us understand how the earth rotates and how the earth’s rotation causes the Coriolis Effect. Build the model.

4.a. Students inflate the balloons and tie with figure-8 knots!
4.b. Students, in pairs, draw an equator. Have students label the poles.
4.c. (optional) Tape an unsharpened pencil to the “North Pole” and another to the “South Pole.” Have students label the poles.
4.d. Rotate the model from “west” to “east,” spinning the world in a counter-clockwise direction when viewed from above. Have students rotate positions, each one observing how the world spins.
4.e. Have one student try to draw a straight line down from the North Pole to the Equator while the other student spins the globe quickly.
4.f. Have students switch roles: the other student tries to draw a straight line from the South Pole to the Equator.

5. Have students reflect on their experiences, using their notebooks or interacting with a coach on the white board. Toward what direction did the line shift when it was drawn from the north pole down to the equator (to the right). Toward what direction did the line shift when the line went from the south pole toward the equator (to the left).

6. In our notebooks, draw a cloud above the ground. Hot air rises and takes water vapor with it to create the cloud, right? As the air cools, it sinks down from the edges of the cloud back toward the earth. “How do sea breezes work?” Hot air rises and cold air rushes in to take its place.

6.b. As the air heats up and rises, is the pressure lower or higher? (Answer: Lower)
Write a capital ‘L’ in the middle of your cloud.

6.c. Draw the same cloud again, but this time from a bird’s eye view above the cloud. How does air rush into that low pressure system? Draw arrows to represent the wind as it moves toward the center of the cloud (low pressure).

6.d. Now, on a new page in the notebook, this time instead of drawing a cloud, draw a circle and put a capital ‘H’ in the center of the circle. The ‘H’ stands for “What?” (Answer: High Pressure). Is the north pole hotter or colder than the equator? (Colder). Then is the North Pole representative of High Pressure or Low pressure? (High Pressure). Draw lines from the middle of the circle radiating out from the high pressure.

6.e. “What direction did the lines move on the model?” To the right in the northern hemisphere. Draw new lines radiating from the ‘H’ so they curve to the right. High Pressure systems are “Cold” air and the winds circle to the right” as the wind moves to the edges of the pressure system. High Pressure systems spin “clockwise” to the right. Low pressure systems, as opposites of high pressure systems, spin how? (Answer: Counter Clockwise). This is known as “Cyclonic” rotation.

6.f. While a small cloud might be a very small, very local Low Pressure system, a hurricane is a very large Low Pressure System. And it spins how in the northern hemisphere? In the southern hemisphere?

7. What are some other storms similar to Hurricanes that spin?

Part III: Modeling hurricanes and tornados – Indoor/Outdoor Classroom
10 minutes building and testing hurricane/tornado in a jar
5 minute chalk talk on wind shear
5 minutes re-modeling with hurricane/tornado in a jar

https://www.youtube.com/watch?v=0LfZFGcGc_I

https://www.youtube.com/watch?v=IF2ZByWaUMI

1. Build a tornado/hurricane in a jar. Use either the same Mason jars or use x2 2 Liter bottles with a "Vortex Connector." Have students practice spinning their hurricanes/tornadoes in cyclonic and anti-cyclonic directions.

2. Analyze the earlier model of a Low Pressure system. As air cools in the clouds, it moves how? (Answer: to the outside of the cloud and then back down to earth). This thermal cycle creates a downdraft on the edge of the low pressure system, which we'll call a storm.

2.b. Have students draw the thermal (or convection) cycles of the low pressure system in their notebooks.

2.c. Have the students write the words "Wind Shear" in their notebooks. Wind shear is a significant change in wind direction and speed over a short distance. Wind shear can be in a horizontal or vertical direction. Significant wind shear caused by superstorms can produce tornados. Huge superstorms can also spin in a cyclonic direction, creating Tornadoes. Small tornadoes may rotate cyclonically or anti-cyclonically, and waterspouts often spin in a clockwise direction.

Part IV: Modeling cyclonic and anti-cyclonic rotation through the use of the "dizzy bat" relay game: Outside preferred
2 minutes rules discussion
8 minutes play "dizzy bat" relay game

1. The objective of the game is to move your team from one side of the field to the other. In order to accomplish this objective, your team must:
    1. Form a single file line behind a set point.
    2. One at a time, on the word "Go," place your forehead on the dizzy bat and complete x2 full rotations in a cyclonic or anti-cyclonic rotation. Upon completing the two rotations, players shall WALK to the opposite side of the field.
    3. Once a player makes it to the opposite side, they must sit down with crossed legs.
    4. The next player may commence the dizzy bat, following suit, with the next player to follow (and so forth) until everyone is finished.
    5. When the entire team has made it over to the opposite side and is seated in a single file line, they must become absolutely silent.
    6. The first team to make it across the field to the opposite side and sit down with legs crossed in a single file line and become absolutely silent WINS!

2. The rules are as follows
    1. No horseplay – horseplay counts for immediate disqualification from the game and two teammembers must repeat the dizzy-bat.
    2. No foul language – same consequence, + student is put in time out.
    3. No taunting of any kind – same consequence as horseplay.
    4. People waiting their turn must use encouraging words – discouraging words result in one teammember to repeat the dizzy-bat.

5. Your team will not be judged for silence until all teammembers have their legs crossed and all teammembers are sitting in a single file line.
6. The objective is not complete until the entire team is silent.

Part V: Understanding the Convection Cycle through the Thermal Cycle: A chalk talk on sailing using the clouds

5 minute review of convection cycle and low pressure/high pressure through chalk time
5 minute chalk talk of localized thermal circulation in non-raining cumulus clouds
Sailing Practice to follow – must occur in a suitably large body of water

http://davidburchnavigation.blogspot.com/2014/03/wind-near-clouds.html