Weather R.A.T.S.

WE LIVE IN AIR:
SEVERE WEATHER - HURRICANES

Grade Level: 4	**Lesson # 9 in unit**
Time Required for Lesson: 4-5 hours	**Time Required for Unit: 15 wks.**

Unit Summary: This unit examines weather patterns in four different parts of the Weather RATS network: Puerto Rico, Oklahoma, Arizona, and Massachusetts. Students will learn how to measure and track daily weather readings and discover the global connections between weather events in the four places. They will investigate global weather connections via the Jet Stream and other factors. As part of this unit, students will also study global contrasts in the water cycle, as it exists in each area. They will uncover the issues and social problems surrounding severe weather events in each area. Students will investigate how weather impacts people living in these areas by communicating with peers via the discussion forum. They will notice that even though people's daily lives are impacted in different ways by local weather, there are fundamental connections between weather events in different geographic locations: that we all "live in air," and are joined together by the atmosphere that sustains us all.

Lesson Summary: This lesson examines the behavior of hurricanes as an example of a type of severe weather event. Students will examine web sites that demonstrate how hurricanes work, and look at causes and consequences of these weather disasters. Depending on the season in which this lesson is taught, students may have the opportunity to track hurricanes online with the National Hurricane Center. For this reason, it is best to teach this lesson in the fall, when hurricanes are most active. Students will investigate hurricanes and their human impact on a general level. Their understanding will be tied directly to the concepts of the water cycle and global wind patterns. They will culminate the unit with a team-based research experience. Each team will choose a recent severe hurricane and present evidence to classmates about their chosen storm's severity and manner of severity.

Lesson Standards:

MA Science/Technology/Engineering:

E8 *Describe how global patterns such as the jet stream and water currents influence local weather in measurable terms such as temperature, wind direction and speed, and precipitation.*

E10 *Describe how water on earth cycles in different forms and in different locations, including underground and in the atmosphere.*

MA Math:

4.D.1. Collect and organize data using observations, measurements, surveys, or experiments, and identify appropriate ways to display the data. (See also 3.D.1 for same standard)

4.D.2. Match representations of a data set such as lists, tables, or graphs (including circle graphs) with the actual set of data. (See also 3.D.2 for similar standard)

4.D.3. Construct, draw conclusions, and make predictions from various representations of data sets, including tables, bar graphs, pictographs, line graphs, line plots, and tallies. (See also 3.D.3. for similar standard)

MA Instructional Technology:

Standard 1. Demonstrate proficiency in the use of computers and applications as well as an understanding of concepts underlying hardware, software, and connectivity.

PreK-4 Exploratory Concepts and Skills

1.1 Develop basic skills for using hardware and applications (e.g., open/close a file, navigate using scroll bars, arrow keys, special keys, and mouse.

1.2 Use correct terminology for basic components of a computer system (e.g., monitor, keyboard, disk, printer, mouse), and develop understanding of their basic functions.

1.7 Collaborate with classmates to use teacher-selected web sites.

1.8 Collaborate with classmates and teacher to send a class e-mail message (online discussion forum hosted by UMass will meet this standard).

Standard 3. Demonstrate ability to use technology for research, problem solving, and communication. Students locate, evaluate, collect, and process information from a variety of electronic sources. Students use telecommunications and other media to interact or collaborate with peers, experts, and other audiences.

PreK-4 Exploratory Concepts and Skills

3.2 Explore the use of application programs (e.g., word processing, database, spreadsheet) for organizing information into charts, tables, and diagrams.

3.3 Explore the use of content-specific tools to enhance understanding of curriculum content (e.g., environmental probes, sensors, robotics, simulation software, and measuring devices).

3.5 Collaborate with classmates and teacher to exchange e-mail with another ` classroom (online discussion forum hosted by UMass will meet this standard).

Lesson Learning Objectives:

K-12 General:

• Be able to track local weather and compare it to weather in diverse geographic locations.
• Use emerging weather measurement and instructional technologies as tools to examine and address real-world problem situations, such as data collection, tracking and analyzing patterns in weather events.
• Develop an appreciation for the global nature of the atmosphere.
• Collect, analyze, and graph daily weather data for an extended period of time.
• Use mathematics as a tool for making sense of weather data.

Level-specific:

• Connect the dots: tornadoes, hurricanes, and floods in the CASA states: where does the weather go, and what does it do in different places?
• Connect the dots: anatomy of a natural disaster – how and why these weather events form;
• Connect the dots: warning and response issues, disaster preparation and mitigation, evacuations; impact of events on local populations.

CASA Connection:

This lesson goes to the heart of what CASA is doing. CASA's mission is to mitigate the loss of life and property from severe weather events by designing a DCAS radar system that will allow meteorologists and emergency management personnel to observe the lowest part of the troposphere with vastly improved accuracy. CASA's personnel include sociologists who study how people prepare (or don't prepare) for and respond to emergencies, and how emergency management personnel can better communicate with the general public. These issues will be touched on in this lesson, thus encouraging students to carefully consider the same issues that professional meteorologists, engineers, and sociologists are wrestling with.

Lesson Background and Concept for Teachers:

Hurricanes are an extreme example of the water cycle behaving badly. They are a type of tropical cyclone. A tropical cyclone is a warm-core, low-pressure system without any "front" attached that develops over the tropical or subtropical waters, and has an organized circulation. Depending upon location, tropical cyclones have different names around the world. In the Atlantic and Pacific oceans, these cyclones are called hurricanes.

Hurricanes only form under certain environmental conditions. These conditions are:

• Warm ocean waters (at least 80°F / 27°C) throughout a depth of about 150 ft (46 m).

• An atmosphere which cools fast enough with height such that it is potentially unstable to moist convection.
• Relatively moist air near the mid-level of the troposphere (16,000 ft / 4,900 m).
• Generally, a minimum distance of at least 300 miles (480 km) from the equator.

• A pre-existing near-surface disturbance.
• Low values (less than about 23 mph / 37 km/h) of vertical wind shear between the surface and the upper troposphere. Vertical wind shear is the change in wind speed with height.

Once a disturbance forms and sustained convection develops, it can become more organized under certain conditions. If the disturbance moves or stays over warm water (at least 80°F), and upper level winds remain weak, the disturbance can become more organized, forming a depression.

The warm water is one of the most important keys as it is water that powers the tropical cyclone. As water vapor (water in the gaseous state) rises, it cools. This cooling causes the water vapor to condense into a liquid we see as clouds. In the process of condensation, heat is released. This heat warms the atmosphere making the air lighter, still which then continues to rise into the atmosphere. As it does, more air moves in near the surface to take its place, which is the strong wind we feel from these storms.

Therefore, once the eye of the storm moves over land will begin to weaken rapidly, not because of friction, but because the storm lacks the moisture and heat sources that the ocean provided. This depletion of moisture and heat hurts the tropical cyclone's ability to produce thunderstorms near the storm center. Without this convection, the storm rapidly diminishes.

Before the hurricane's final hours over land, when it weakens and deteriorates into heavy rain, the damage to life, property, and economy can easily run into billions of dollars. Entire communities, cities, states, and entire regions of our country and others have been demolished in a matter of hours, as Hurricane Katrina tragically demonstrated in 2005. How to improve early warning and community mobilization is an ongoing issue in Federal and state government. How to prevent unnecessary damage to communities from flooding, broken dams and levees, and damage to infrastructure is in the domain of engineers as well as sociologists. We have not begun to effectively address these issues on a national level.

Perhaps the most valuable lesson that government can convey to its citizens regarding hurricanes is this: water always wins.

Key Vocabulary/Definitions:

- *Hurricane:* A severe tropical cyclone (an organized, rotating weather system) with well-defined, organized circulation and *sustained wind speeds in excess of 74 mph*. As they move ashore, they bring high winds, tornadoes, torrential rains, and flooding. The term comes from indigenous Native American languages. The Mayan storm god was named *Hunraken*. An evil god of the Taino people in the Caribbean was names *Huracan*. In the western North Pacific, these storms are called *typhoons.*
- *Tropical Storm:* An organized system of strong thunderstorms with a well-defined circulation and maximum sustained winds of 39 – 73 mph.

- *Tropical Depression:* An organized system of persistent clouds and thunderstorms with a closed low-level circulation and maximum sustained winds of 38 mph. or less.
- *Eye:* The center of the storm, relatively calm with sinking air, light winds, low pressure, and few clouds.
- *Eyewall:* The most violent winds and rain take place in the eyewall, the ring of thunderstorms immediately surrounding the eye. At the top of the eyewall (about 50,000 feet), most of the air is propelled outward, increasing the air's upward motion. Some of the air, however, moves inward and sinks into the eye, creating a cloud-free area.
- *Storm Clouds:* Clouds that spiral counterclockwise in the upper atmosphere.
- *Rainbands:* Bands of thunderstorms that help warm the air and raise it higher into the atmosphere.
- *Inflow:* In the lower region of the hurricane, air flows toward the center and whirls upward, gaining speed as it approaches the eye.
- *Vertical flow:* Sub cloud air entering the eyewall. This air flows into the hurricane along the ocean's surface to the eyewall clouds, and out in the exhaust flow.
- *Exhaust flow:* Hot air that is drawn upward and outward through the eye, inside the eyewall.
- *Storm Surge:* a large dome of water often 50 to 100 miles wide that sweeps across the coastline near where a hurricane makes landfall. The surge of high water topped by waves is devastating. The stronger the hurricane and the shallower the offshore water, the higher the surge will be. Along the immediate coast, storm surge is the greatest threat to life and property.
- *Storm Tide:* the combination of the storm surge and the astronomical tide. If the storm surge arrives at high tide, the water height will be even greater. For example, as a hurricane moves ashore, a 15-foot surge added to the 2-foot high tide creates a storm tide of 17 feet. This mound of water, topped by battering waves, moves ashore along an area of the coastline as much as 100 miles wide. The combination of the storm surge, battering waves and high winds is deadly and causes great property damage.
- *Disaster:* Losses that result when a severe weather event affects humans and society.
- *Vulnerability:* People's capacity to resist and recover from extreme weather events. There are two dimensions to vulnerability: a weather event that people cannot control, and a societal exposure and response, which can be controlled.

Materials Needed:

- Hurricanes – Unleashing Nature's Fury, a booklet written and published by NOAA, NWS, and the U.S. Department of Commerce. One booklet per student.
- Access to Internet and computer lab.
- Post-it Notes for concept map initial deveopment.
- Materials for making posters, overhead transparencies, or other visual aids to presentations.

Lesson Sequence:

Introduction/Motivation:

Introduce the lesson by asking students what they think it would be like to be caught in a storm that was a 12 on the Beaufort Scale? That would be a hurricane! Ask students to do a Think/Pair/Share activity. They will address 3 questions in the Think/Pair/Share: 1.) What is a hurricane; 2) How is it different from other storms; 3) How does a hurricane work?

After students share their baseline knowledge of hurricanes, as them to remember Hurricane Katrina. What do they recall about that storm? Are there other hurricanes that students remember? Encourage some class discussion about memories, experiences, news stories, or current events that pertain to hurricanes.

Explain to students that they will learn how hurricanes form, where they go, how they behave, and what damage they can cause. They will have an opportunity to research some severe hurricanes in recent history and discuss them with their classmates.

Body of Lesson:

Students will spend time in both the computer lab and classroom/science lab (depending on scheduling) investigating different aspects of hurricanes. In the computer lab, students will visit the NASA Observatorium web site on hurricane formation and anatomy. This animated site gives a good background on what hurricanes look like and act like. Give students a copy of the key words and concepts they need to know for this lesson. As they read through the web site, they should record notes and definitions of these terms.

In the classroom/science lab, students will read through the NOAA booklet on hurricane strength and preparedness. Students should continue to developing the key words and concepts they need for the unit when reading the booklet. Students should be encourage to collaborate with classmates as they work on key words.

After students go through the web site and NOAA booklet, and after their work defining key words and concepts is complete, they should put these key words and concepts into a concept map. The first map may be somewhat rudimentary, but should show linkages between the concepts. Students can do the first draft of their concept map using Post-It Notes. The concepts can be written on the Post-It Notes, and moved easily around the paper until students are satisfied with the placement of the terms. Inspiration software can also be used for this same purpose, if there is ready access to a computer lab. On the draft version of the concept map, students should draw linkages (arrows) between the concepts, and label them with propositions (linking words). Each student should work independently. After students complete their first draft, they should exchange drafts with a neighbor. Each student will review and discuss the neighbor's concept map and offer comments and suggestions for improvement or clarification. Students should revise their maps if peer feedback clarifies the linkages between the concepts.

After students have done the initial work on their concept maps and have a reasonable grasp of the key concepts and terms, they should proceed to the research phase of the lesson. Introduce students to the "You Be the Expert!" guidelines. Each team should be given time to find and choose a hurricane. The "expert panels" will make a case for why the hurricane they studied was *the most disastrous* in terms of storm behavior, damage to life and property, and/or both. There are 5 categories of severity. Student teams must make a case for "their" hurricane ranking #1 in at least one category of severity. Student teams can begin their research with the

bookmarked NOAA web sites, but may expand beyond those. Teams must also decide on a format for presentation of visual aids. They have many formats to choose from, but must reach a consensus early in the research in order to have time to gather and organize appropriate materials.

Closure:

Expert panels will present their chosen storm to the class, and will take questions from audience. After each panel presents, the class will vote on the hurricanes ranked most extreme for every category. There will be a class list of the most severe hurricanes for each category, based on the evidence presented by each team and ensuing class discussion.

As a wrap-up summary assessment, students will revise and finalize their concept maps. These will be done on paper without Post-It Notes. Students should show more linkages and propositions between words. This will be an individually assessed piece.

Assessments:

Pre-lesson:

Think/Pair/Share on background knowledge about hurricanes.
Whole-class discussion of well-known hurricanes and their impact on life and property.

In Process:

Key words and concepts definitions.
Concept map initial development. Feedback from peers and subsequent revision.

Summary:

Concept map final development.
"Expert panel" presentations and debate.

Lesson Extension Activities:

If this lesson is taught during the active hurricane season, students can maintain a bulletin board in the school foyer, which informs the entire school community about current and potential hurricanes that are active every day. Students can check the NOAA/NWS web sites for daily updates on active Atlantic hurricanes.

References:

Jetstream Online Weather School – Tropical Cyclones: An Introduction.
http://www.srh.weather.gov/srh/jetstream/tropics/tc.htm

NASA's Observatorium – Hurricanes.
http://observe.arc.nasa.gov/nasa/earth/hurricane/splash.html
This site has links to other NASA and NOAA sites regarding satellite imagery and storm prediction.

NOAA/National Weather Service - National Hurricane Center:

http://www.nhc.noaa.gov/

National Weather Service – Hurricane Awareness:
http://www.nws.noaa.gov/om/hurricane/index.shtml

FEMA Hurricane Facts:
http://www.fema.gov/hazard/hurricane/index.shtm

U.S. Department of Commerce, NOAA, NWS, and the American Red Cross. Hurricanes – Unleashing Natures Fury; A Preparedness Guide. August, 2001. Booklet can be found here: http://www.nws.noaa.gov/om/hurricane/index.shtml under Hurricane Awareness, What is a Hurricane?

NASA: For Kids Only: http://kids.earth.nasa.gov/

NSTA: Using Concept Maps in the Science Classroom. Science Scope, July 2005, p. 27-31.
http://www.nsta.org/main/news/stories/science_scope.php?category_ID=87&news_story_ID=50627
Available online to members only.

Additional Resources and Information:

Dixon, Dougal. *Hurricane Destruction.* Columbus, Ohio: Waterbird Books, 2004.

Estigarribia, Diana. *Learning About the Effects of Natural Events with Graphic Organizers.* New York: PowerKids Press, 2005.

Green, Jen. *Hurricane Andrew.* Milwaukee, Wisconsin: Gareth Stevens, 2005.

Newson, Joyce E. and Longman, Christina. *Natural Disasters.* Milwaukee, Wisconsin: Gareth Stevens, 2002.

Chambers, Catherine. *Hurricanes.* Chicago: Heinemann Library, 2001.

Latham, Donna. *Hurricane! The 1900 Galveston Night of Terror*. New York: Bearport Publishing Co., 2006.

MacAulay, Kelley and Kalman, Bobbie. *Changing Weather: Storms.* New York: Crabtree, 2006.

Meister, Cari. *Hurricanes.* Edina, MN: Abdo & Daughters, 1999.

Nicholson, Cynthia Pratt. *Hurricane!* Toronto, ON: Kids Can Press, 2002.

Pedersen, Traci Steckel. *Hurricanes.* Logan, Iowa: Perfection Learning, 2006.

Simon, Seymour. *Hurricanes.* New York: HarperCollins, 2003.

Contributors:

Mary M. Taft, Science Specialist, Soule Road School, Hampden-Wilbraham Regional School District, Wilbraham, MA
Mary Ellen Bergeron, Information Specialist, Hampden-Wilbraham Regional School District, Wilbraham, MA, contributed the bibliographic references.

HURRICANES:
KEY WORDS AND CONCEPTS

The following words and concepts are important for understanding what hurricanes are, how they form, how they behave, and the damage they cause. Record the definitions for these words and concepts. They will be handed in for a grade. These ideas will also be used to construct a concept map showing how they are related.

1. Hurricane

2. Tropical Storm

3. Tropical Depression

4. Eye

5. Eyewall

6. Storm Clouds

7. Rainbands

8. Saffir-Simpson Scale

9. Storm surge

10. Hurricane preparedness

11. Flooding

12. Watches and warnings

YOU BE THE EXPERT!
PANEL DISCUSSION GUIDELINES

Your team will research and present information to the class on a major hurricane that has hit the United States and/or territories within the last 100 years. Each team must choose a different hurricane. The guidelines for your research and discussion are found below. Each person on your team must choose a different aspect of the hurricane on which to present. The required categories of information are:

1. Most violent winds (Saffir-Simpson scale).
2. Highest storm surge.
3. Greatest property damage (in terms of dollars).
4. Greatest number of fatalities.
5. Worst economic impact and disruption.

Your team must present evidence that your chosen hurricane was "the worst" in *at least* one of these areas. You will research specific information about each of these categories, and present that information to the class. After each team presents, the class will vote on "the overall worst" storm in each category based on the data that were presented.

Your team must present visual aids during your presentation. Examples of these are:

1. A poster.
2. Handouts for the class.
3. A short Power Point presentation.
4. Overhead transparencies.

In your visual aids, you should include maps, pictures, or any evidence you can discover that will support your claim that "your" hurricane was "the worst" in at least one category. Each team member is responsible for doing part of the research and presenting that to the class. There are several web sites bookmarked in the computer lab that will help you get started with research. You can look elsewhere for information. Try Google.

Your team will be assessed with the rubric below. This is a team grade, so each team member needs to give the group his/her full effort! Absences do not count against a student or the team.