What is causing the Increase in Hurricane Activity?

Subject: Science

Grade Level: 8th – 12th Grades

Rationale or Purpose: The purpose of this activity is to demonstrate how different ecosystems are interrelated. The students will complete an activity that will help them to understand why hurricanes are increasing in number yearly. They will accomplish this by brainstorming some climatic changes that have taken place recently and create models to test variables that may be affecting hurricane activity.

Source of Lesson: *Hot Science – Cool Talks* CD-ROM # 44: "Is Climate Change Increasing Hurricane Activity?"

Materials per group:

- 3 glass jars, about the size of a medium mayonnaise jar; both mouths must be the same size
- masking tape
- a few small rocks to symbolize "earth"
- water (room temperature, warm and cold)
- thermometer
- salt
- dirt
- cooking oil
- lamp
- timer

Lesson Duration: 90 minutes (can be broken up into two 50 minute classes or one 90 minute class)

TEKS Objectives:

8th Grade Science 112.24.

(3D) evaluate the impact of research on scientific thought, society, and the environment; and
(3E) connect Grade 8 science concepts with the history of science and contributions of scientists.
(6C) describe interactions within ecosystems.
(10A) illustrate interactions between matter and energy including specific heat;
(10B) describe interactions among solar, weather, and ocean systems; and
(10C) identify and demonstrate that loss or gain of heat energy occurs during exothermic and endothermic chemical reactions.
(12B) relate the role of oceans to climatic changes

§112.42. Integrated Physics and Chemistry

(4B) investigate and describe applications of Newton's laws such as in vehicle restraints, sports activities, geological processes, and satellite orbits;
(6A) describe the law of conservation of energy;

(6C) analyze the efficiency of energy conversions that are responsible for the production of electricity such as from radiant, nuclear, and geothermal sources, fossil fuels such as coal, gas, oil, and the movement of water or wind;
(6H) analyze the effects of heating and cooling processes in systems such as weather, living, and mechanical.

§112.43. Biology
(12A) analyze the flow of energy through various cycles including the carbon, oxygen, nitrogen, and water cycles.

§112.45. Chemistry
(5A) identify changes in matter, determine the nature of the change, and examine the forms of energy involved;
(5B) identify and measure energy transformations and exchanges involved in chemical reactions;
(5C) measure the effects of the gain or loss of heat energy on the properties of solids, liquids, and gases.
(7A) describe interrelationships among temperature, particle number, pressure, and volume of gases contained within a closed system; and
(7B) illustrate the data obtained from investigations with gases in a closed system and determine if the data are consistent with the Universal Gas Law.

ENGAGE:

As the students come into class, have a video playing on the damage done by Katrina.

- www.stormvideo.com shows a lot of damage after the storm, for example cars on top of houses. You will need Microsoft Media or another media player to access and view the video.
- www.nasa.gov/mission_pages/hurricanes/main/index.html has several educational videos about hurricanes in general.

After the video(s), show the students some statistics of hurricanes in the last century:

- Tropical cyclones account for the bulk of natural catastrophes in U.S. insurance losses.
- Risk assessment is vital to the insurance industry and to government disaster preparedness programs.
- Losses vary roughly as the cube of the maximum wind speed.
- Katrina caused > 1300 deaths and > $130 billion in damage.
- Show students the amount of damage in the U.S. caused by hurricanes (figure 1).

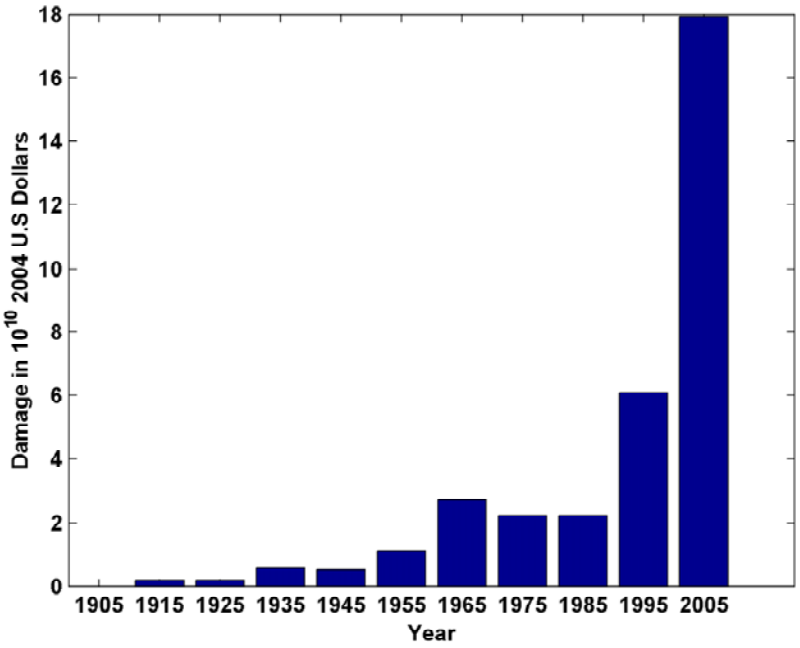

Figure 1. Total U.S. Hurricane Damage by Decade (Source: Roger Pielke, Jr.)

Questions:

- What are some possible causes for the increase in hurricane damage in the past 100 years? (possible answers – more people along coast, increased hurricane activity, etc.)
- What are some climatic changes that have been hot topics in the news lately?
  (possible answers – global warming, more pollution)

EXPLORE:

Students will create simplified models of the hydrologic cycle to make inferences about how certain variables may influence hurricane activity. Allow students to decide on what environmental factor they will test, whether it is water temperature, pollution, salinity, etc.

Set up experiment: Depending on what your students plan to test, you will need to help them modify their variables and possible demonstrate an example experiment.

Students will get 3 beakers, and create three different systems.

If students are testing the effects of temperature, they will fill one with hot water (90° F), one with cold ice water (60°F), and the last one with room temperature water (control). After they have added variables to their systems, they will tape the top of their jars closed with masking tape. Next, the students can either place

their models outside in the sun or simulate the sun by placing their three beakers under a strong lamp that gives off heat. They will observe what happens in each of their beakers and record their observations in their lab notebooks. One student will be asked to keep time and to denote when each beaker enters the hydrologic cycle. (Students will know when their systems enter the water cycle because they will witness condensation drops gathering on the upper jar, get denser, and then precipitate back into bottom of the beaker where the rest of the water is.) The system that enters the water cycle first contains the variable that increases the frequency of hurricanes.

If they are testing the effects of pollution, they will pollute one beaker with cooking oil, another with dirt and the last beaker will have clean water for the control.

If the students decide to test the effects of the salinity of the ocean, they can add two different amounts of salt to two of the beakers and then once again leave the third beaker as a control with fresh water.

EXPLAIN:

Allow the students to discuss their results with their classmates and how the changes in some ecosystems also effect other world ecosystems (i.e. industrialization in temperate ecosystems are causing the greenhouse effect which in turn is changing the water temperature and the ocean currents, which effects the formation of hurricanes and which areas get hit by the hurricanes).

Questions:

- If the greenhouse effect continues to worsen, how will it effect hurricane season?
- Can you think of any other climatic changes that are affecting us? (I.e. the polar ice caps are melting resulting in a rise in sea level.)

ELABORATE and EVALUATE:

- Have the students write or discuss knowledge and opinions about current policy decisions that may have an impact on global warming, such as the Kyoto protocol.
- Have the students create a plan to reduce global warming.

GLOBAL WARMING BACKGROUND [1]:

Researchers have recently turned to deep ocean sediments that span hundreds of thousands of years to study the Earth's temperature and how it has changed. What the researchers have revealed is a strong correlation between carbon dioxide concentrations and the Earth's temperature.

Carbon is considered to be a major player in the greenhouse effect. Other gases such as methane and water vapor contribute to the greenhouse effect as well, but not as significantly as Carbon. The greenhouse gases affect the Earth by trapping long wave radiation inside the Earth's atmosphere and transiently heating up the Earth. With the addition of more greenhouse gases to the normal layer the temperature of the atmosphere increases because the solar radiation received from the sun is not released back into the into space as it normally is, but rather it is deflected back into Earth's atmosphere. At cooler times there has been an average of 30% less Carbon in the atmosphere, reinforcing the direct relationship between carbon and global temperature.

The Earth's temperature is rising steadily. If you look at a history of the Earth's temperature fluctuations this data is not surprising. The Earth has bounced back and forth between glacial periods and warm periods forever, and that is part of its normal oscillations. However what is surprising about the recent data on Carbon concentrations is the rate at which it has been increasing. As the records from the ocean sediments show, a 1ºC change in temperature usually took thousands of years. With the current trends, climatologists have predicted that our mean global temperature will rise between 1 and 2.5 º C in less than one hundred years. Humans significantly contribute to this expedited warming. We burn fossil fuels for energy, cut down many thousands of acres of rainforests, and we have converted natural prairies into farmland. All of which release more carbon into the atmosphere. The initial release of carbon then starts a growing cycle because the oceans are a major source of carbon, and the amount of carbon that the ocean can sufficiently sequester is an inverse function of the temperature. So the carbon released by human activities described above warms the earth, and as the temperature increases, the ocean is no longer able to hold the same amount of carbon, and thus it releases more carbon into the atmosphere, once again increasing the severity of the cycle known as the run away greenhouse effect.

[1] Source: http://www.physicalgeography.net/home.html

ADDITIONAL RESOURCES

Dr. Kerry Emanuel's Homepage (expert on how climate change affects hurricane activity)
http://wind.mit.edu/~emanuel/home.html

Interview with Dr. Camille Parmesan, a biologist that studies how climate change impacts wildlife www.esi.utexas.edu/outreach/video/parmesan.html

"Global Warming: Impacts on Wildlife and Society"
www.esi.utexas.edu/outreach/ols/lectures/Parmesan/ppt/GlobalWarmingandWildlife_files/frame.htm

"Ice Adventures: Tracking Evidence of Abrupt Climate Change Across the Tropics"
www.esi.utexas.edu/outreach/ols/lectures/Thompson/index.html

United Nations Intergovernmental Panel on Climate Change
http://www.usgcrp.gov/ipcc/

U.S. Global Change Research Program
http://www.usgcrp.gov/

U.S. Environmental Protection Agency, Global Warming Page
http://www.epa.gov/globalwarming/

University Corporation for Atmospheric Research
http://www.ucar.edu/ucar/

National Corporation for Atmospheric Research
http://www.ncar.ucar.edu/ncar/index.html

U.S. Long Term Ecological Research Network, Global Change Research
http://www.lternet.edu/global_change/

Union of Concerned Scientists
http://www.ucsusa.org

Pew Center on Global Climate Change
http://www.pewclimate.org/