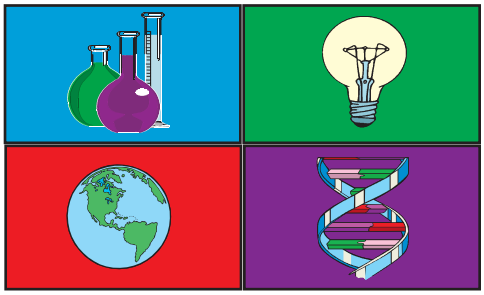
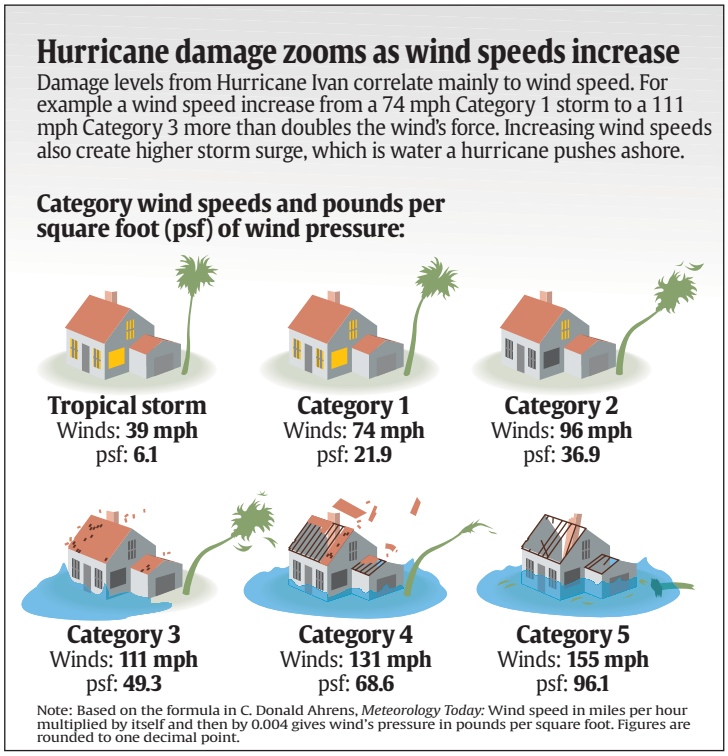
Science TODAY™ Teacher Edition

USA TODAY
NO. 1 IN THE USA



Hurricane damage zooms as wind speeds increase

By: Jeff Lukens



Activity Overview:

After examining the USA TODAY Infograph "Hurricane damage zooms as wind speeds increase," students will construct a graph and a regression model which shows the relationship between wind speed and the force of the wind. The students will then analyze the mathematical model that fits the data, and make predictions from the model.

Concepts:

- Tropical storms and hurricanes
- Wind speeds and their corresponding forces
- Reading and interpreting graphs
- Analyzing regression models
- Making predictions based on a mathematical model

Activity at a Glance:

- Grade level: 10-12
- Subject: Physics, Meteorology
- Estimated time required: 45 minutes

Materials:

- TI-83 Plus family or TI-84 Plus family
- Overhead view screen calculator for instruction/demonstration
- Student handout
- Transparency
- TI-Navigator system, if available

Prerequisites:

Students should be able to:

- enter data into the List Editor.
- create a power regression model.
- make predictions from the model.
- determine independent and dependent variables.
- distinguish between linear and non-linear graphical representations.

This activity works with TI navigator A Classroom Learning System

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Objectives:

Students will:
- build and analyze a wind speed vs. wind force model for various categories of tropical storms and hurricanes.
- interpolate and extrapolate from a mathematical model.
- identify independent and dependent variables.
- develop a better understanding of the destructive impact of hurricanes.

Background:

In this activity, students will examine the relationship between hurricane force winds and the force that is exerted by those winds. Upon entering data in the graphing calculator, the students will analyze the data by creating a scatterplot, and then a "power" regression model. From this model, they will be able to see that the relationship is not linear, but that the force increases at a greater rate as the wind speed increases. Severe weather is a potential issue in virtually all of the United States, and this activity is designed to help students understand how potentially disastrous severe weather can be. Students will have the opportunity to incorporate more advanced algebraic thinking into their science class by examining and analyzing non-linear models.

Preparation:

- Provide one graphing handheld for each student.
- Each student should have a copy of the corresponding student activity sheet.
- Familiarize students with power regression models.

Classroom Management Tips:

- Students will have a better understanding of how to read the graphic and retrieve data if you use the transparency for a class discussion before the students start working.
- Remind students to read carefully all parts of the graphic before they start collecting data.
- Students can work either individually or in pairs for this activity.
- Ask students what they know (or think they know) about hurricanes prior to the activity.

Data Source:

USA TODAY research

National Science Education Standards:

Grades 9-12: Science in Personal and Social Perspectives

Natural and human-induced hazards

- Normal adjustments of earth may be hazardous for humans. Humans live at the interface between the atmosphere driven by solar energy and the upper mantle where convection creates changes in the earth's solid crust. As societies have grown, become stable, and come to value aspects of the environment, vulnerability to natural processes of change has increased.

  Some hazards, such as earthquakes, volcanic eruptions, and severe weather, are rapid and spectacular. Natural and human-induced hazards present the need for humans to assess potential danger and risk.. Students should understand the costs and trade-offs of various hazards--ranging from those with minor risk to a few people to major catastrophes with major risk to many people. The scale of events and the accuracy with which scientists and engineers can (and cannot) predict events are important considerations.

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Activity Extension:

- Ask students to find articles and/or other data from USA TODAY that report actual damage from tropical storms, hurricanes or typhoons. Then, have them describe the effect of storm strength on damage estimates.
- Have students investigate USATODAY.com's online hurricane feature at www.usatoday.com/weather/hurricane/whscale.htm and ask them to click on the link for storm surge. Then, have them explain the effects of storm surge during a hurricane.
- Barometric pressure is also an important indicator of storm strength. Ask students to research the ranges of barometric pressures that correspond to the various categories of storms.
- Warm, tropical waters provide the "fuel" for hurricane development and intensification. Ask students to research the various reasons for this escalating strength.
- Have students examine the power regression equation. Power regression model is a "perfect fit" for the wind speed/force graph because the force values are generated directly from the wind speed values. Squaring the wind speed value and then multiplying by 0.004 will give you the force of the wind in psf. It is enlightening for students to see the power regression equation that the calculator generates for them: Y = .004X2.
- Instruct students to research similar information on tornadoes. Powerful tornadoes can generate wind speeds that are much higher than hurricanes. It may be interesting for students to extrapolate from the hurricane model to the wind speeds of tornadoes.
- Advanced students may want to investigate why the force of wind is 0.004 times the wind speed squared. This relation is derived from Bernoulli's equation for streamline flow.

Curriculum Connections:

- Algebra II
- Pre-calculus
- Earth Science

Additional Resources:

- Student handout
- Transparency
- TI Technology Guide, for information on the following: TI-83 Plus family, TI-84 Plus family, List Editor and building regression models
- TI-Navigator™ Basic Skills Guide for information on using the TI-Navigator Classroom Learning System

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Assessment and Evaluation:

Q. In this activity, what were you asked to plot as the independent variable?
A. Wind Speed

Q. What were you asked to plot as the dependent variable?
A. Force (in pounds per square foot: "psf")

Q. Describe the shape of the graph after you have created a power regression model and graphed it.
A. Curving up. Increasing, but not linear.

Q. Is there a constant slope for your graph? Explain your answer.
A. No. The slope increases as the wind speed increases, thereby making the graph non-linear.

Q. What would be the force of the wind in psf if the wind speed were 100 miles per hour?
A. 40 psf.

Q. What would be the force of the wind in psf if the wind speed were 200 miles per hour?
A. 160 psf.

Q. Compare the forces of the wind at 100 and 200 miles per hour. The wind speed has doubled. How much has the force increased?
A. Four times.

If you are using the TI-Navigator Classroom Learning System, send the provided LearningCheck assessment to your class to gauge student understanding of the concepts presented in the activity. See the TI-Navigator Basic Skills Guide for additional information on how this classroom learning system may be integrated into the activity.