

## Hurricanes and Climate

<b>Summary:</b>	Students investigate maps and data to learn about the connections between hurricanes and climate including (1) regional climate conditions where hurricanes form and (2) how global climate change may be affecting hurricanes.
<b>Source:</b>	<i>A Windows to the Universe activity by Lisa Gardiner</i>
<b>Grade level:</b>	6 - 9
<b>Time:</b>	Two to three class periods
<b>Student Learning Outcomes:</b>	<ul style="list-style-type: none"> <li>• Students will be able to describe the 6 regions where hurricanes happen.</li> <li>• Students will graph and interpret data to learn that different regions have varying numbers of hurricanes.</li> <li>• Students will be able to explain that hurricanes happen during the warmest times of year and in regions that have warm sea surface temperatures.</li> <li>• Students will graph and interpret data about how hurricanes have changed over recent decades as the Earth has warmed.</li> </ul>
<b>Lesson format:</b>	Map interpretation, worksheets, graphing
<b>National Standards Addressed:</b>	<p><b>National Science Content Standards</b></p> <ul style="list-style-type: none"> <li>• 5-8: Content Standard A: Inquiry: Partial Inquiry</li> <li>• 5-8: Content Standard D: Structure of the Earth System</li> <li>• 5-8: Content Standard F: Science in Personal and Social Perspectives: Populations, Resources, and Environments</li> </ul> <p><b>National Geography Standards</b></p> <ul style="list-style-type: none"> <li>• Standard 1: How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information.</li> <li>• Standard 3: How to analyze the spatial organization of people, places, and environments on Earth's surface.</li> </ul> <p><b>Standards for School Mathematics</b></p> <ul style="list-style-type: none"> <li>• Data Analysis and Probability Standard: Grade 6-8</li> </ul>

<b>Materials:</b>	<p><b>For each student:</b></p> <ul style="list-style-type: none"> <li>• Introduction to Hurricanes Worksheet (<a href="http://www.windows2universe.org/teacher_resources/hurricane_climate/hurricane_intro.pdf">http://www.windows2universe.org/teacher_resources/hurricane_climate/hurricane_intro.pdf</a>)</li> <li>• Part 1 Worksheets (<a href="http://www.windows2universe.org/teacher_resources/hurricane_climate/hurricane_part1.pdf">http://www.windows2universe.org/teacher_resources/hurricane_climate/hurricane_part1.pdf</a>) (The Climate of Hurricanes)</li> <li>• Part 2 Worksheets (<a href="http://www.windows2universe.org/teacher_resources/hurricane_climate/hurricane_part2.pdf">http://www.windows2universe.org/teacher_resources/hurricane_climate/hurricane_part2.pdf</a>) (Hurricanes and Climate Change)</li> <li>• Colored pencils - 6 colors</li> <li>• Ruler</li> </ul> <p><b>For student pairs or group:</b></p> <ul style="list-style-type: none"> <li>• Map of Tropical Cyclones 1985-2005 (two formats available) <ul style="list-style-type: none"> <li>◦ Web page: Map of Tropical Cyclones 1985-2005 (<a href="http://www.windows2universe.org/earth/images/Cyclone_tracks_w2u_lg_jpg_image.html">http://www.windows2universe.org/earth/images/Cyclone_tracks_w2u_lg_jpg_image.html</a>)</li> <li>◦ Printable PDF: Map of Tropical Cyclones 1985-2005 (<a href="http://www.windows2universe.org/teacher_resources/hurricane_climate/hurricane_tracks_11x17.pdf">http://www.windows2universe.org/teacher_resources/hurricane_climate/hurricane_tracks_11x17.pdf</a>) (4.5MB)</li> </ul> </li> <li>• Map of Sea Surface Temperatures (two formats available) <ul style="list-style-type: none"> <li>◦ Web page: Map of Sea Surface Temperatures (<a href="http://www.windows2universe.org/earth/images/sst_w2u_lg_jpg_image.html">http://www.windows2universe.org/earth/images/sst_w2u_lg_jpg_image.html</a>)</li> <li>◦ Printable PDF: Map of Sea Surface Temperatures (<a href="http://www.windows2universe.org/teacher_resources/hurricane_climate/sst_map_11x17.pdf">http://www.windows2universe.org/teacher_resources/hurricane_climate/sst_map_11x17.pdf</a>) (5.3 MB)</li> </ul> </li> </ul>
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## **DIRECTIONS:**

### **Introduction**

1. Survey student knowledge about hurricanes. Have students visit the Windows to the Universe hurricane section (<http://www.windows2universe.org/earth/Atmosphere/hurricane.html>) for general information.
2. Divide students into pairs or groups and provide each with either a paper or web page *Map of Tropical Cyclones 1985-2005*. Explain that the lines on the map show the paths of hurricanes and other tropical storms. Ask students to describe where hurricanes form. As students notice where hurricanes do and do not occur, you may wish to share the following:
  - They are usually over the ocean because the ocean provides warm, moist air that fuels the storms.
  - They do not form at the equator because there is no Coriolis force at the equator and it takes Coriolis to get the storm rotating.
  - They do not form at the poles because these are tropical cyclones and it's too cold there. However, there are other storms called polar cyclones.
3. Explain that there are six areas of the world where hurricanes occur. Have students choose a color for each region and then fill in the key to regions at the bottom of their Introduction to Hurricanes Worksheet. Referring to the map, students color the approximate locations of these six regions on their worksheets.

### **Part 1: The Climate of Hurricanes**

1. Ask students if they think that the same number of hurricanes occur in each region. Looking at the Map of Tropical Cyclones 1985-2005, they should notice that there are more hurricane paths in

- some regions than others.
2. Students create a bar graph (histogram) with the hurricane data on the first page of their Part 1 Worksheet. Ask students if their bar graph supports the idea that hurricanes are not equally distributed between regions.
  3. Students investigate the seasonal timing of hurricanes on the second page of their Part 1 Worksheet. Have students use the same colors they used for the map to indicate the hurricane season for each region on the timeline. The questions at the bottom of the worksheet are intended to point out that hurricanes happen at different times of year in the Southern and Northern Hemispheres and also that hurricanes happen during the warm time of year.

## **Part 2: Hurricanes and Climate Change**

1. Provide student pairs or groups with either a paper or web page Map of Sea Surface Temperatures. Tell students that this map shows the temperature of the water that is at the ocean surface as measured by satellites. Review the key with students.
2. Have students compare the Map of Sea Surface Temperatures and the Map of Tropical Cyclones 1985-2005 and notice that hurricanes happen in areas where the ocean water is warm. Remind students that they had also figured out that hurricanes happen at warm times of year. Ask students to predict what might happen to hurricanes as the Earth becomes warmer.
3. Introduce the data tables on the Part 2 Worksheet. The top table shows the total number of hurricanes that happened in each region during two different time periods. The bottom table shows the number of very strong hurricanes that happened during those time periods. Instruct students to answer the questions on the right and consider the ideas they generated about how warmer climate could affect hurricanes.
4. On the second page of the worksheet, students represent the data from the lower table (strong hurricanes) in small bar graphs.
5. Discuss as a class:
  - Does this data indicate that there are more hurricanes now?
  - Does this data show that there are more stronger storms?
  - Why might global warming cause changes in hurricanes?

## **BACKGROUND INFORMATION:**

Hurricanes form in the tropics over the ocean where the sea surface is warm and so is the air. They go by different names in different places - like tropical cyclones and typhoons. Scientists use the Saffir-Simpson scale to describe the strength of hurricanes (Category 1-5).

Hurricanes form in areas of low pressure over a large area of warm water. Air that is drawn into the low pressure is curved due to the Coriolis Effect (<http://www.windows2universe.org/earth/Atmosphere/wind.html>) and it spirals towards the center. The air that is drawn into the low pressure rises and cools, which allows the vapor within in to condense forming clouds. The latent heat given off when the water condenses causes the upper air to warm and increase in pressure. This makes a small high pressure area in the center of the hurricane known as the eye.

Hurricanes draw energy from the warm water they move over. Once a hurricane moves over land, the large energy supply from the ocean is no longer available and it begins to lose strength.

Scientists have determined that the strength and length of storms is probably affected by global warming. There is also evidence that the number of hurricanes changes over time with a natural cycle that does not relate to global warming, so there are probably multiple factors at work. Researchers

are currently trying to learn more about the connection between warming and hurricanes and whether other climate cycles play a role.

As global warming causes oceans to become warmer, and more moisture is held in the atmosphere, the intensity of hurricanes will likely increase. The warming ocean is correlated with an increase in the intensity of hurricanes. Hurricanes take heat energy from the oceans and convert it into the energy of the storm. Thus, warmer oceans offer more heat energy to hurricanes, allowing them to become stronger storms.

The data in Part 2 of this activity comes from a study by Webster et al. (2005) in which they compared hurricane data from two 15-year time periods similar to how students compare the time periods in this activity. The timeframe for the data starts in 1975 because we have satellite data records of hurricanes from this time onward. (*For more information, please see Webster et al., 2005, Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment. Science 309, 1844-46.*)

The ocean has warmed about 0.1 degree Fahrenheit over the past 30-50 years and there is strong evidence that global warming has been increasing the intensity of hurricanes over that timeframe too. The data that students explore in Part 2 of this activity shows this change.

#### **RELATED SECTIONS OF THE WINDOWS TO THE UNIVERSE WEBSITE:**

- Hurricanes (<http://www.windows2universe.org/earth/Atmosphere/hurricane.html>)
- Are hurricanes becoming stronger and more frequent?  
([http://www.windows2universe.org/earth/climate/hurricane\\_climate.html](http://www.windows2universe.org/earth/climate/hurricane_climate.html))
- Climate and Global Change (<http://www.windows2universe.org/earth/climate/climate.html>)
- Effects of Climate Change ([http://www.windows2universe.org/earth/climate/cli\\_effects.html](http://www.windows2universe.org/earth/climate/cli_effects.html))
- Hurricane Classification  
([http://www.windows2universe.org/earth/Atmosphere/hurricane/saffir\\_simpson.html](http://www.windows2universe.org/earth/Atmosphere/hurricane/saffir_simpson.html))