Hurricanes and Global Climate Change

Key Concepts:

- Cyclone
- El Niño
- Hurricane
- IPCC
- La Niña
- Saffir-Simpson scale
- Storm surge
- Typhoon

WHAT YOU WILL LEARN

1. You will learn the difference between hurricanes, typhoons, and cyclones.
2. You will learn how hurricanes are classified and named.
3. You will analyze data to see the impact of climate change, El Niño, and La Niña on hurricanes.
4. You will be asked to predict the frequency and intensity of future tropical storm seasons.

Engage Your Thinking

The Intergovernmental Panel on Climate Change (IPCC) has stated that:

- Hurricane intensity in the North Atlantic since the 1970s has increased, and that increase correlates with increases in sea surface temperature.
- The observed increase in hurricane intensity is larger than climate models predict for the sea surface temperature changes we have experienced.
- No clear trend in the number of hurricanes is apparent.
- Other regions appear to have experienced increased hurricane intensity as well, but scientists are concerned about the quality of the data in these regions.
- More likely than not the increases in hurricane intensity are due to some human contribution to climate change.
- Most likely we will see increases in hurricane intensity during the 21st century.

In this activity you will learn about hurricanes, typhoons, and cyclones and how their intensity is rated. You will also learn about how climate change might be affecting hurricane frequency and intensity. Before starting this activity, however, answer the following questions based on what you currently know and think.

1. How do hurricanes form?

2. What is the difference between hurricanes, typhoons, and cyclones?

3. How might global climate change affect the frequency, intensity, and location of hurricanes?

Explore and Explain

Hurricanes, cyclones, and typhoons are different types of tropical cyclones, or low pressure centers. Each forms over tropical or subtropical waters. In order for tropical cyclones to form, certain conditions must be met:

- The ocean water surface temperature needs to be at least 80°F (27°C).
- The air must be relatively moist.
- The hurricane has to form close to the equator.
- The change in wind speed with height must be minimal.

These storms are called:

- **hurricanes** in the Atlantic Ocean and Eastern Pacific Ocean,
- **typhoons** in the Western Pacific Ocean, and
- **cyclones** in the Indian Ocean.

The Atlantic Ocean hurricane season generally runs from June 1 to November 30, but a hurricane can form outside of these dates. September is statistically the busiest hurricane month of the year. A yearly pattern of hurricane frequency is also apparent (Figure 1). As shown in figure 1, the 2005 hurricane season had the most named storms of any season on record.

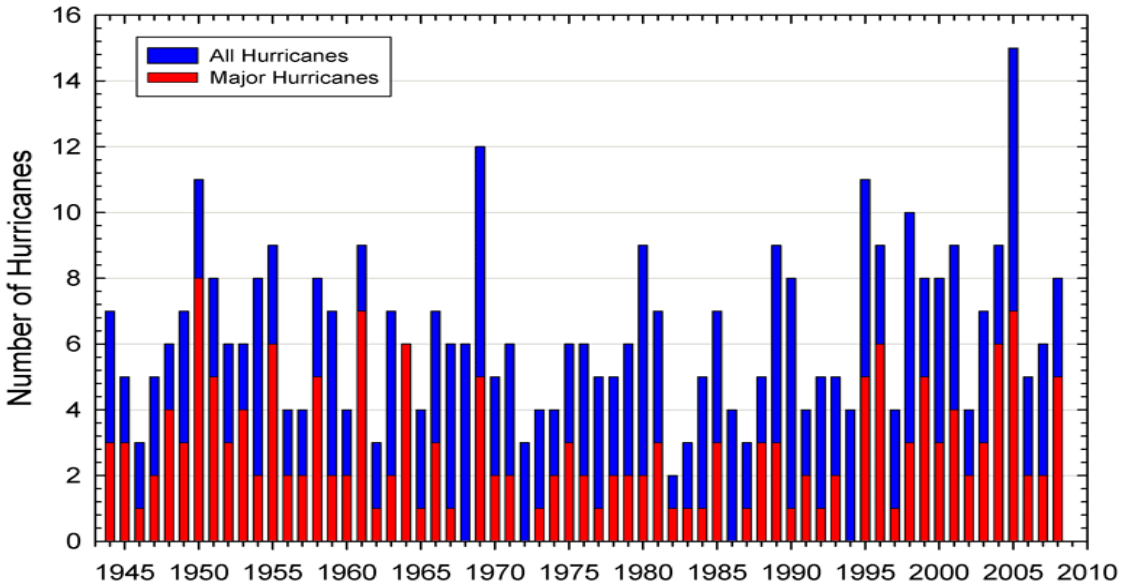

Figure 1. Atlantic Ocean Hurricane Frequency. Source: NOAA

4. Based on the graph (Figure 1), which four years stand out with the most major hurricanes, category 3 to category 5 hurricanes?

Scientists have developed a scale to rate the intensity of tropical storms known as the **Saffir-Simpson Scale** (see Figure 2 below). This scale, or set of categories, help predict the potential damage resulting from storms due to their high winds. Along coastal regions, a phenomenon called **storm surge** may cause substantially more damage than wind. The storm surge is a larger than usual high tide that is the combined result of the storm's high winds and the extreme low pressure in the center of the storm. A storm surge can exceed 15 feet during a category 5 storm.

Saffir-Simpson Category	Maximum sustained wind speed		
	mph	m/s	knots
1	74-95	33-42	64-82
2	96-110	43-49	83-95
3	111-130	50-58	96-113
4	131-155	59-69	114-135
5	156+	70+	136+

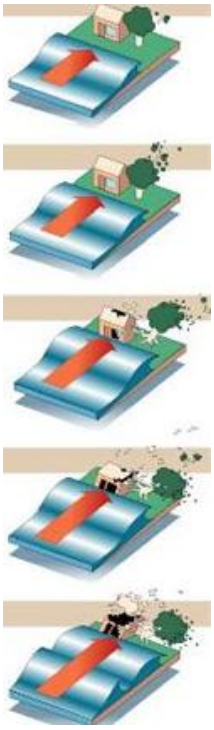

Figure 2. Saffir-Simpson Hurricane Scale. Source: NOAA

5. What is a storm surge?

You might have noticed that hurricanes are named alphabetically, and these names alternate between male and female names. Originally, hurricanes were named by their latitude and longitude, a practice that was cumbersome and sometimes repetitive. The next naming method called the hurricane the name of the closest saint's day in the Catholic calendar. During World War II, the practice of using common female names for hurricanes became widely accepted. The use of only female names was stopped in 1978, and now the storms alternate between male and female names. When a storm reaches grand proportions (such as Katrina), its name is retired from the list and will not be used again. If more than 21 names are used in a given season, the letters of the Greek alphabet are used. So far, the 2005 hurricane season was the only one that used all the letters of the 21-letter list (The letters Q, V, X, Y, and Z are not used to name hurricanes). The list of proposed Atlantic hurricane names to the year 2012 is shown in Table 1.

Table 1. Atlantic Hurricane List. Source: NOAA

2007	2008	2009	2010	2011	2012
Andrea	Arthur	Ana	Alex	Arlene	Alberto
Barry	Bertha	Bill	Bonnie	Bret	Beryl
Chantal	Cristobal	Claudette	Colin	Cindy	Chris
Dean	Dolly	Danny	Danielle	Don	Debby
Erin	Edouard	Erika	Earl	Emily	Ernesto
Felix	Fay	Fred	Fiona	Franklin	Florence
Gabrielle	Gustav	Grace	Gaston	Gert	Gordon
Humberto	Hanna	Henri	Hermine	Harvey	Helene
Ingrid	Ike	Ida	Igor	Irene	Isaac
Jerry	Josephine	Joaquin	Julia	Jose	Joyce
Karen	Kyle	Kate	Karl	Katia	Kirk
Lorenzo	Laura	Larry	Lisa	Lee	Leslie
Melissa	Marco	Mindy	Matthew	Maria	Michael
Noel	Nana	Nicholas	Nicole	Nate	Nadine
Olga	Omar	Odette	Otto	Ophelia	Oscar
Pablo	Paloma	Peter	Paula	Philippe	Patty
Rebekah	Rene	Rose	Richard	Rina	Rafael
Sebastien	Sally	Sam	Shary	Sean	Sandy
Tanya	Teddy	Teresa	Tomas	Tammy	Tony
Van	Vicky	Victor	Virginie	Vince	Valerie
Wendy	Wilfred	Wanda	Walter	Whitney	William

6. Do the even-numbered or odd-numbered years start out with female names?

Extend Your Thinking

Scientists are not in total agreement about the suggested connection between global climate change and hurricane intensity and frequency. One of the reasons for this disagreement has to do with the availability of complete data sets before the advent of satellites and computers. Also, multiple variables determine the intensity of hurricanes. Some data indicate that hurricanes are influenced by **El Niño** (warmer than normal surface temperatures in the Pacific Ocean), or **La Niña**, (unusually cold temperatures in equatorial Pacific water). In the Atlantic Ocean, this may mean fewer storms in El Niño years and more storms in La Niña years. Scientists, however, continue to debate this issue. The average number of hurricanes during El Niño and non El Niño years is shown in Table 2. Figures 3 and 4 show how El Niño and La Niña events affect hurricane location and movement or tracking.

Global warming has also been linked to increased intensity and frequency of hurricanes. Conflicting data occur in this area as well, especially since most projections are based on computer modeling. Until enough reliable data are available, the interpretation of the present data is open to debate.

Table 2. Number of Hurricanes during El Niño and Normal Hurricane Seasons
Source: NOAA

	Atlantic		**Eastern Pacific**	
	Average Hurricane Season	Average El Niño Hurricane Season	Average Hurricane Season	Average El Niño Hurricane Season
Named storms	9.4	7.1	16.7	17.6
Hurricanes	5.8	4.0	9.8	10.0
Intense Hurricanes	2.5	1.5	4.8	5.5

7. Based on Table 2, what relationship can you find between hurricane frequency and El Niño hurricane seasons?

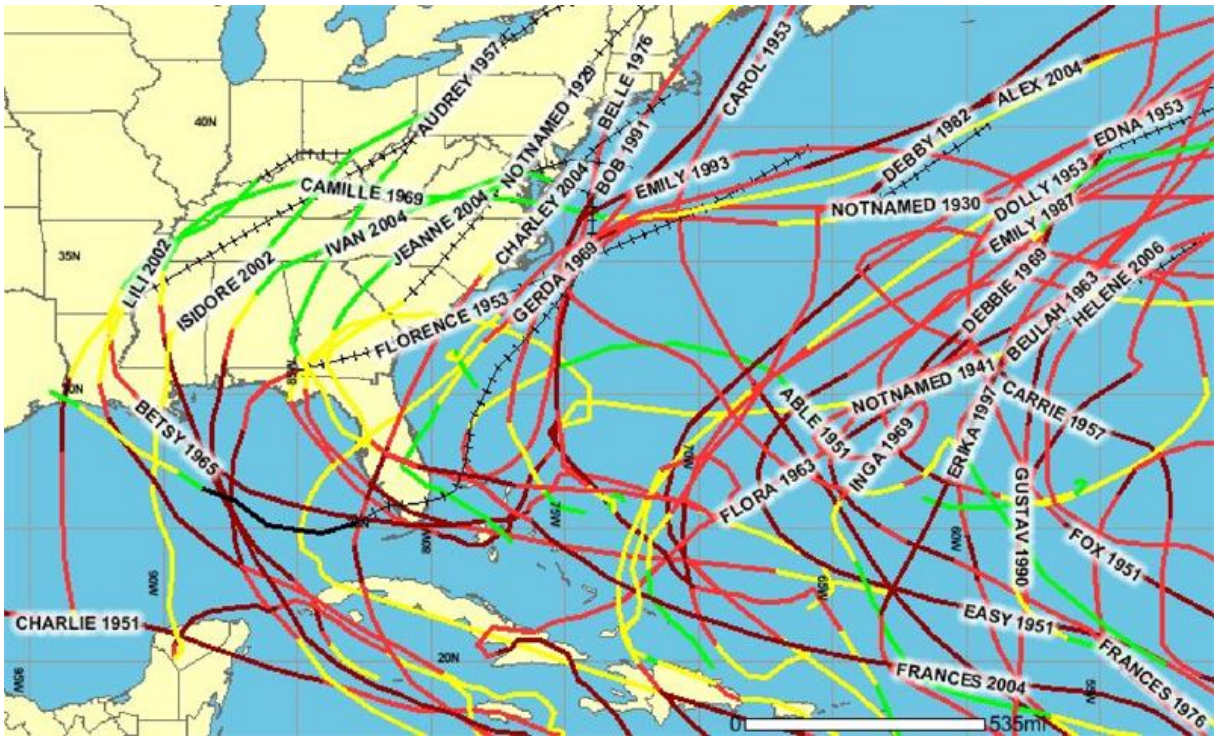

Figure 3. Historical Hurricane Tracks, El Niño Years. Source: NOAA

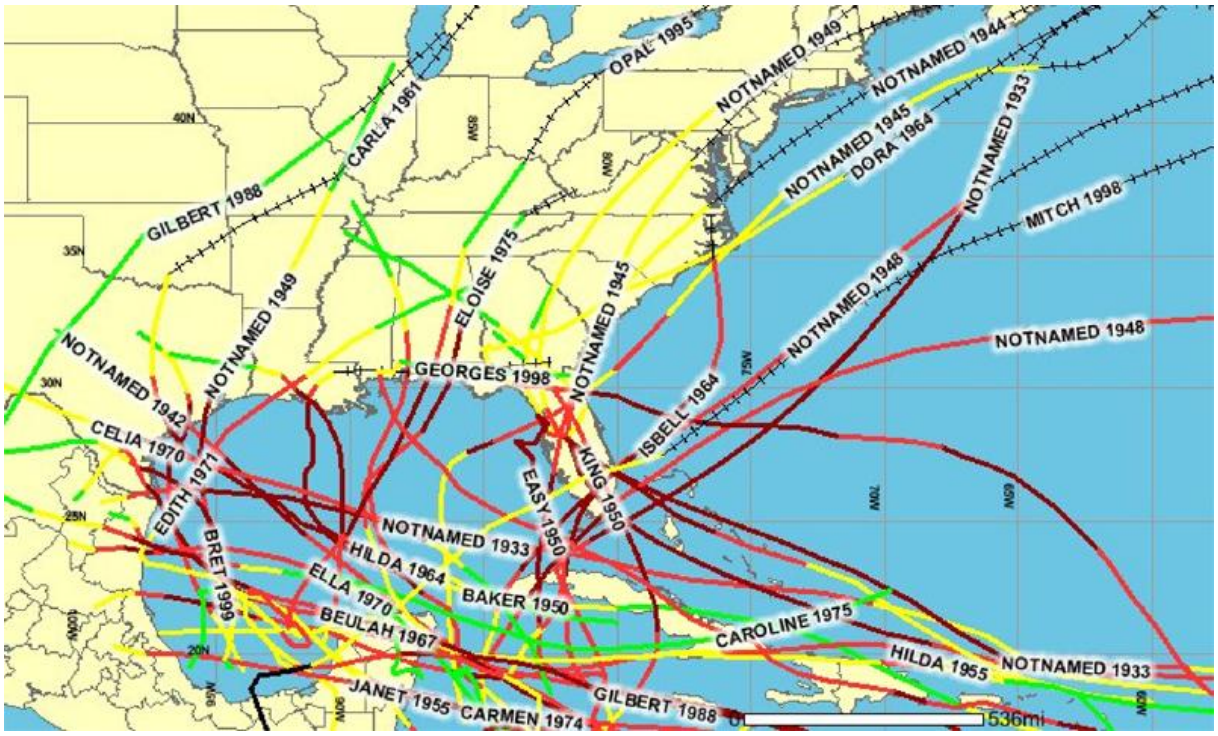

Figure 4. Historical Hurricane Tracks, La Niña Years. Source: NOAA

8. What general track do hurricanes take in El Niño years (Figure 3)?

9. What changes occur in the general path of hurricanes during La Niña years (Figure 4)?

Apply What You Have Learned

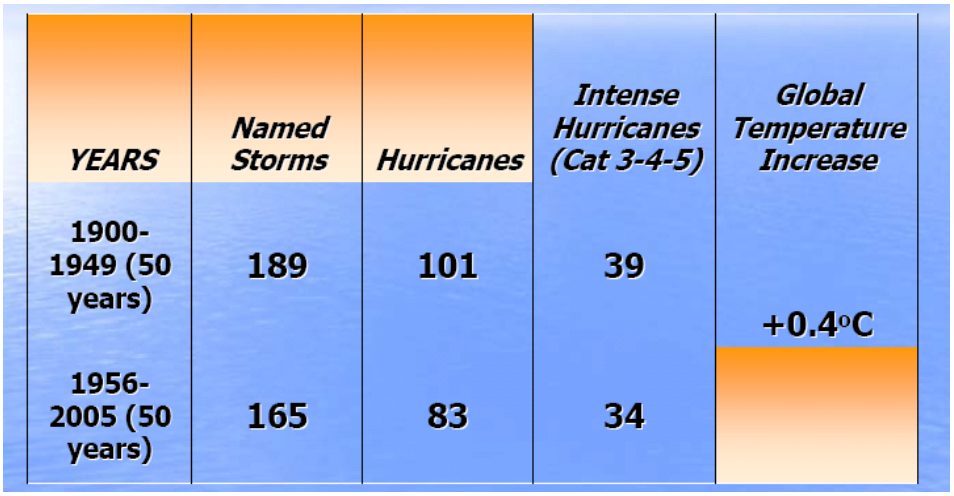

Figure 5. U.S. Hurricane Landfall by Intensity Source: William Gray

10. Based on the data in Figure 5, has the increase in temperature caused a change in the frequency of category 3, 4, or 5 storms? Explain your answer. (Hint: think about the percentage of intense hurricanes)

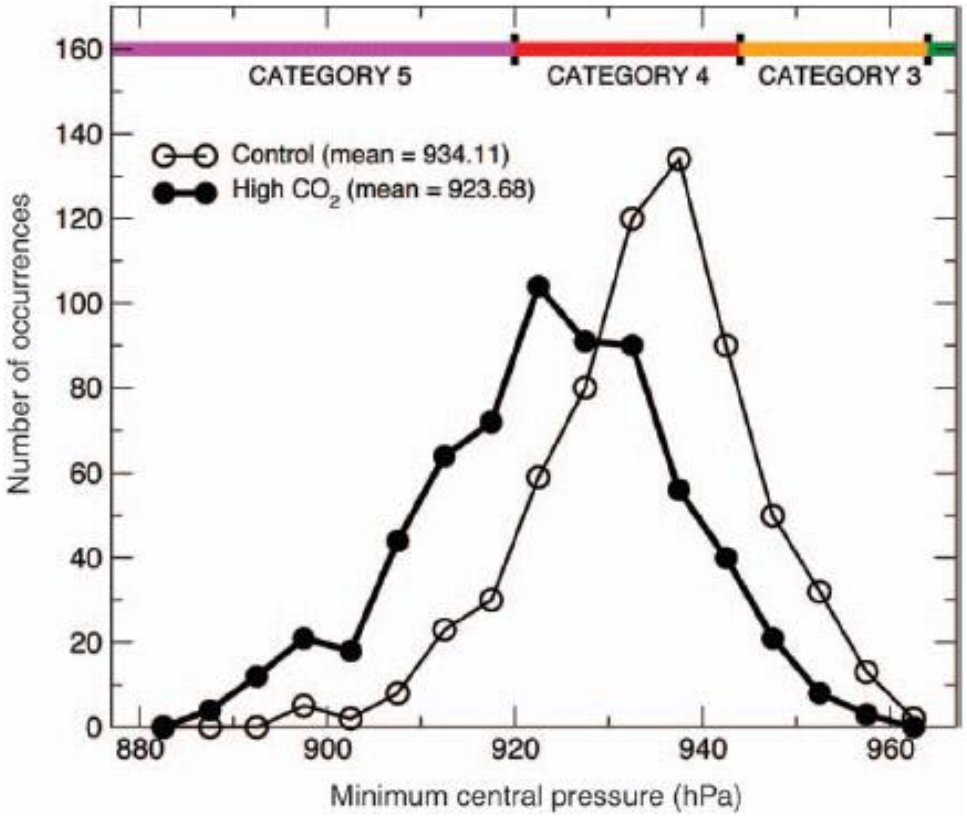

Figure 6. Comparison of Simulated Hurricane Intensities for Present and Future Climate Change (High CO_2) Conditions. Source: Kuntson & Tuleya

11. What does the comparison of present and future conditions (Figure 6) indicate about possible future hurricane intensity?

Reflect on What You Have Learned

12. How do hurricanes form?

13. What is the difference between hurricanes, typhoons, and cyclones?

14. Does a direct relationship exist between hurricane activity and global climate change? Explain.