

Hurricane Frequency Over Time

MATERIALS

For the leader:

Projector

Whiteboard to project data graph onto

For the activity:

Copy of 1878-2007 North Atlantic Hurricane Counts data table

Computer program to graph in or graphing paper

Copy of student worksheet

OVERVIEW

There has been an increase in the average number of hurricanes per year in the North Atlantic Ocean since the late-1980s. However, to determine if climate change is influencing hurricane frequency, it is important to look at a longer time series (> 100 yr) of hurricane activity. Data demonstrates that there has been a century scale increase in global and tropical Atlantic Sea Surface Temperatures since the late 1800s. If climate change was causing an increase in hurricane frequency, then we would hypothesize that there would also be long-term increasing pattern in Atlantic hurricane frequency.

In this activity, students will look at hurricane frequency data for the North Atlantic Ocean over time. The activity places a strong emphasis on teaching students how to interpret data. The students first need to plot the data and then interpret it for conclusions. Through a series of questions, students are lead in their exploration and investigation of the data to think about how the time frame in which you look at a long-term dataset can influence what conclusions you draw from the data. Through gaining these data interpretation skills, students will also gain a better understanding of how scientists look at evidence

when asking questions about changes in the Earth's climate and extreme weather events over time and will observe that there is no overall pattern of increased frequency of hurricanes in the North Atlantic Ocean over the past century.

Motivating Questions: **What evidence do scientists use to study hurricane frequency over time? Are changes in hurricane frequency related to climate changes?**

TAKE HOME MESSAGE

Scientists collect data from multiple sources to track hurricanes over time. However, it is important to understand how those sources of data can influence conclusions you draw from the data and that the time frame in which you look at the data can influence your conclusions.

Engage: Lead the students in a discussion about what they know about the hurricanes and how we could determine if climate change is influencing hurricane frequency.	10 minutes
Explore: Students investigate data of the hurricane frequencies for the North Atlantic Ocean over the past century.	25 minutes
Make Sense: Students share their observations, ask questions, and discuss what they can learn from the hurricane frequency graph.	10 minutes
Total:	45 minutes

AUDIENCE

Late elementary and middle school students (5th-8th grade).

NEW JERSEY CORE CURRICULUM CONTENT STANDARDS - SCIENCE

Grade	Content Statement	CPI#
6	Weather is the result of short-term variations in temperature, humidity, and air pressure.	5.4.6.F.1
6	Climate is the result of long-term patterns of temperature and precipitation.	5.4.6.F.2
8	Mathematics and technology are used to gather, analyze, and communicate results.	5.1.8.B.2
8	Carefully collected evidence is used to construct and defend arguments.	5.1.8.B.3
8	Scientific reasoning is used to support scientific conclusions.	5.1.8.B.4
8	Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work.	5.1.8.D.1 / 5.1.12.D.1

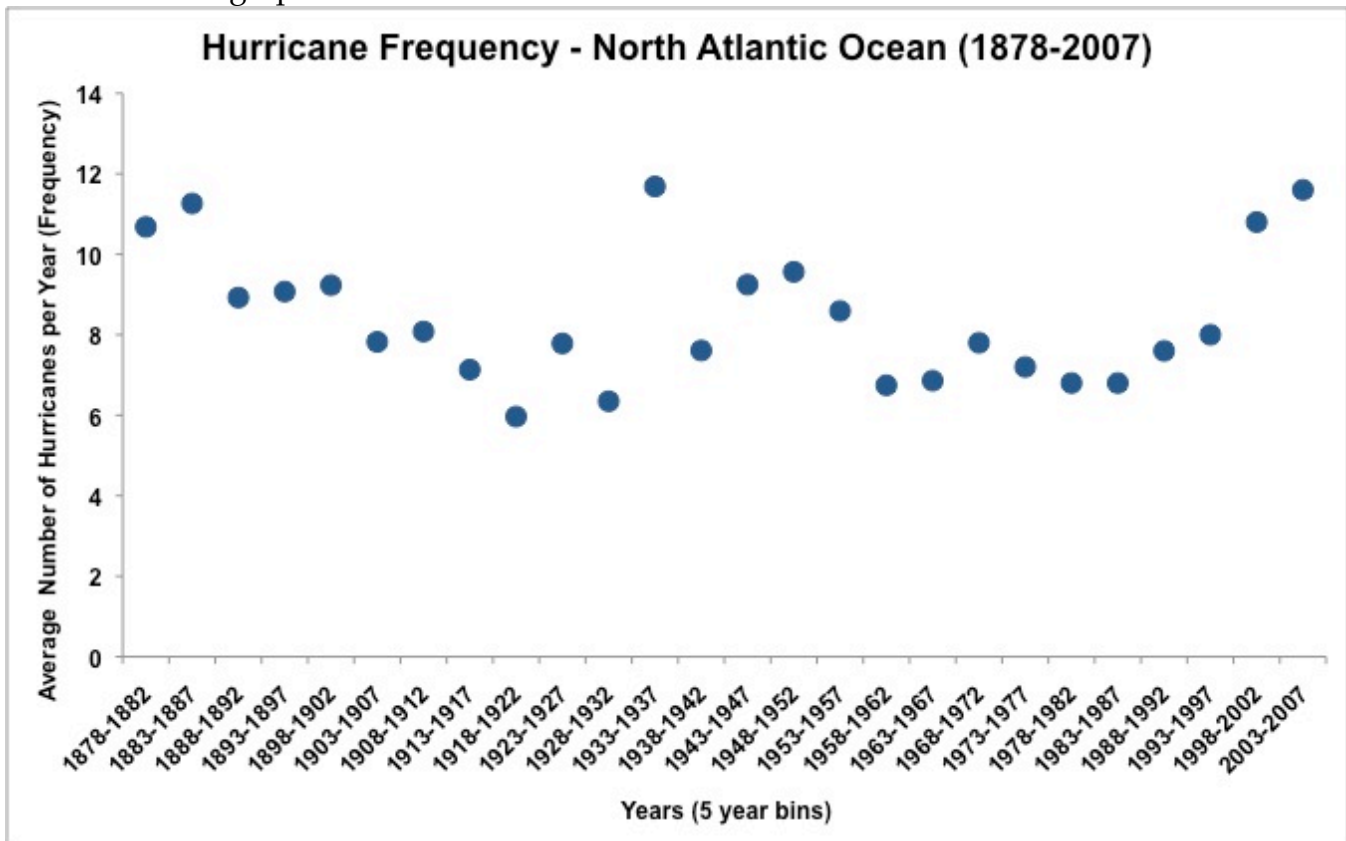
PREPARATION (20 MINUTES)

1. Write the motivating questions on the board:

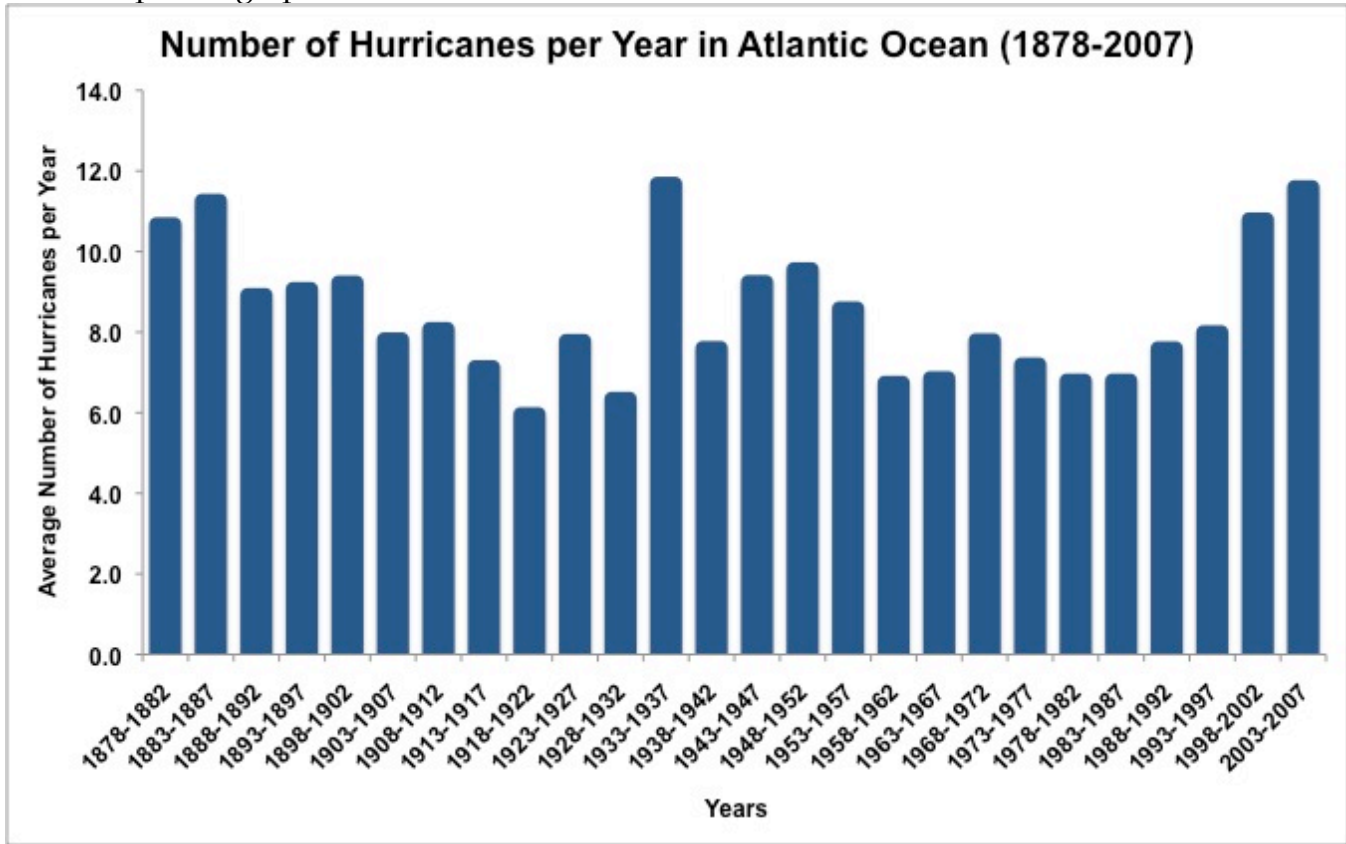
How do scientists study changes in hurricanes over time? Are changes in hurricane frequency related to climate changes?

2. Make copies of student worksheets, one for each student (at the end of this write-up).
3. Make or project a graph of the data on the board, but make sure it is hidden from the students.

More advanced graph:



More simplified graph:



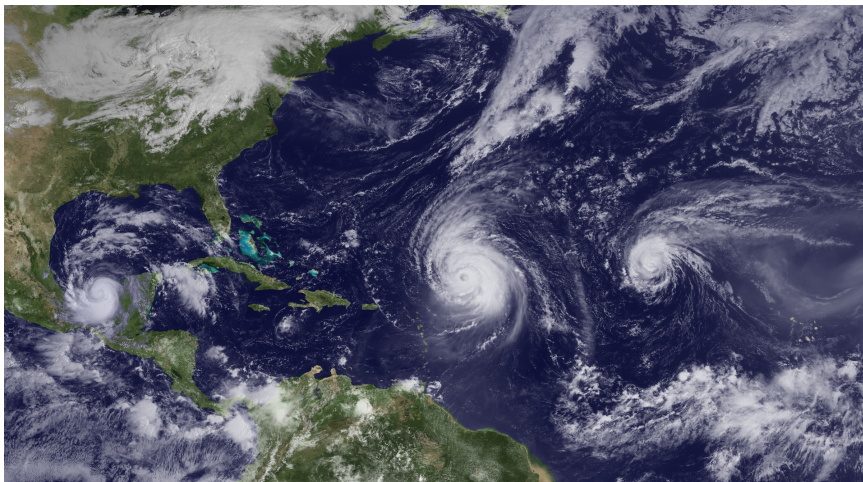
ENGAGE (10 MINUTES)

1. Lead the students in a discussion about what they know about the hurricanes and climate change(project the HurricanesAcrossAtlantic image below). Be accepting of all answers as this is a group brainstorming activity.

Q. What is a hurricane? Where do they occur? When do they occur?

Q. Why do scientists study hurricanes?

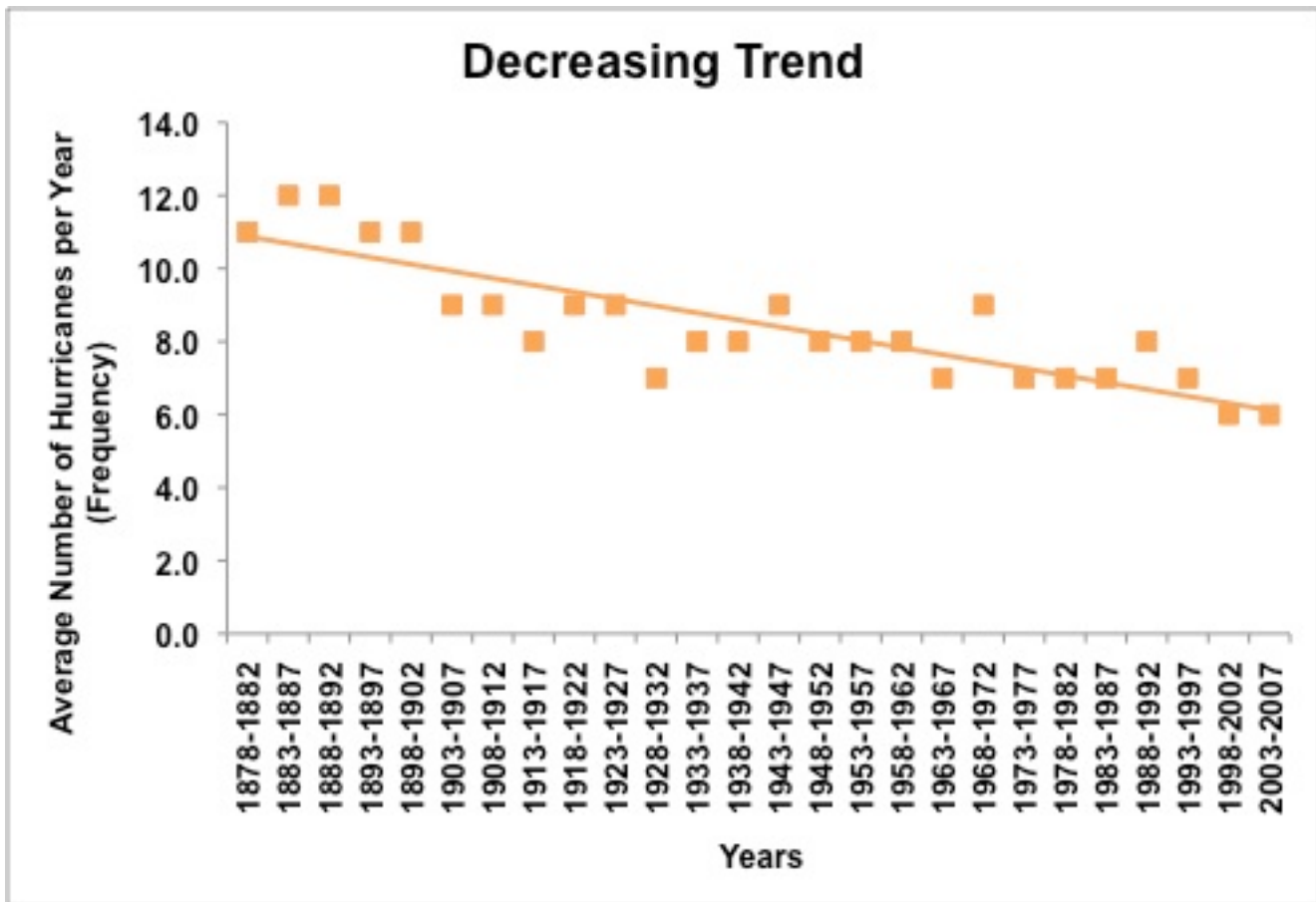
Q. Why would scientists be interested in understanding changes in the number of hurricanes over time in the North Atlantic Ocean?

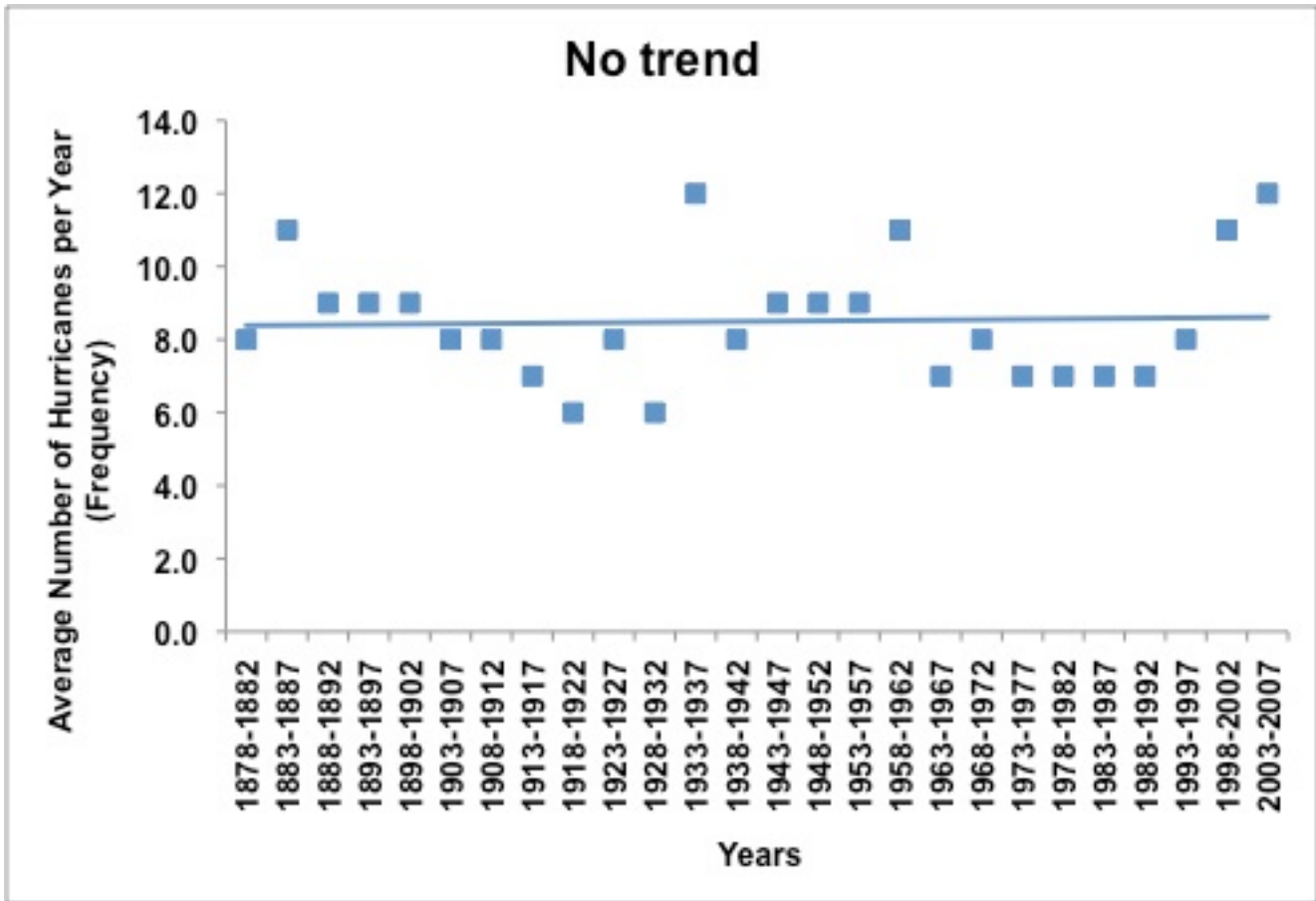
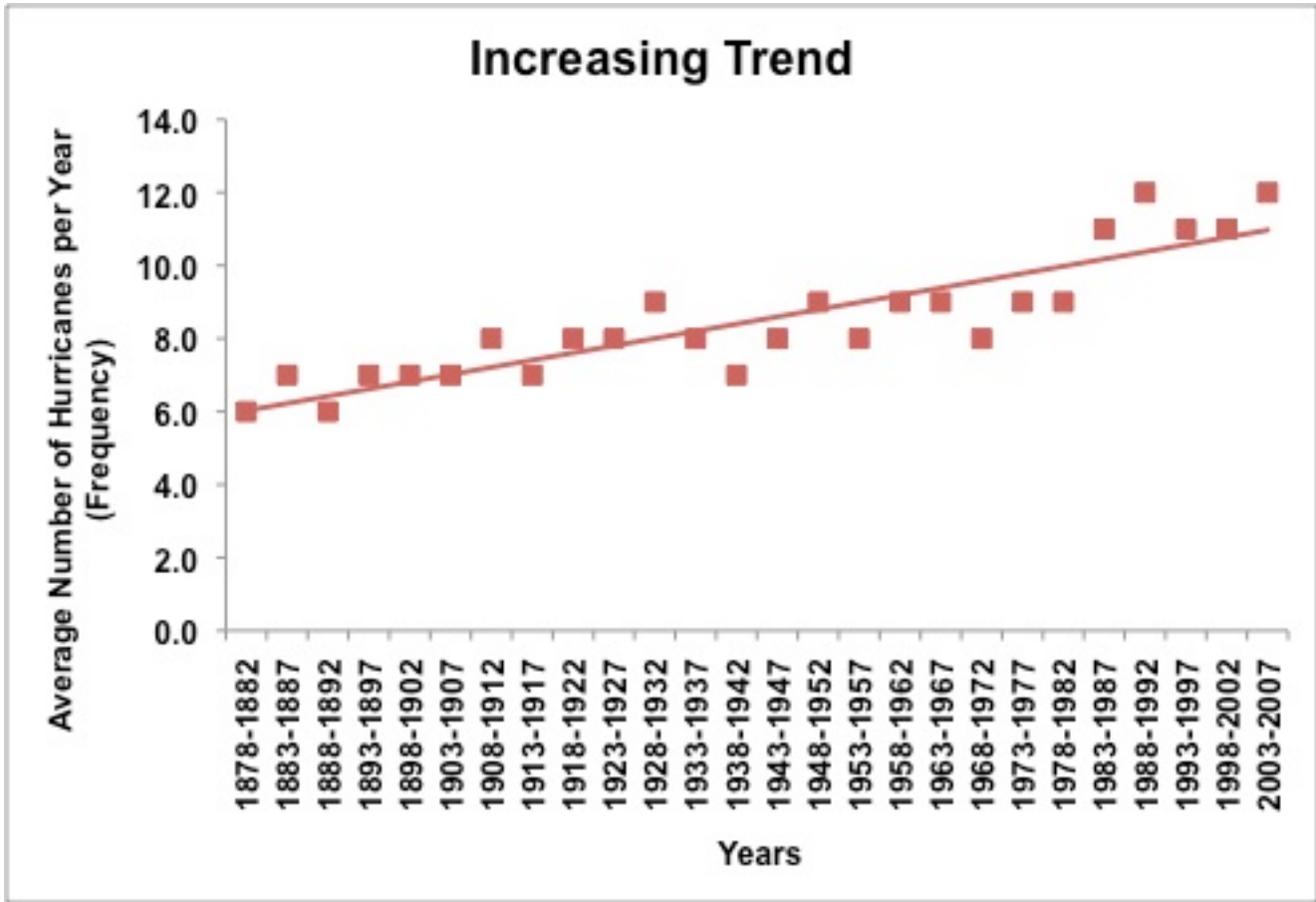


2. After a minute or two, and depending on what the students already know, share some information with them that you feel they need to know to understand the activity of the day.
3. Ask the students if they have heard about climate change. Some students might suggest that climate change is increasing the number of hurricanes in the world (if this does not come up, it's ok, continue to the next step).
4. Ask the students what they would need to look for to determine if there is an influence of climate change on hurricane frequency.

Q. Over what time scales should we look for data on the number of hurricanes?

5. Have the students come up with hypotheses about the relationship between climate change and the average number of hurricanes per year, start by showing the students the following graphs:





- Then have the students think about the following question and articulate their hypotheses, while you record them on the board.

Q. What pattern do we expect to see of the number of hurricanes in a year, if climate change is influencing hurricane frequency?

EXPLORE (25 MINUTES)

- Explain to the students that they will be taking a closer look at hurricane frequency in the North Atlantic Ocean over the past century. In fact, they will be making their own plots of the number of hurricanes to look for patterns in the dataset.
- Explain the data processing portion of the investigation to the students:
 - In a few moments they will receive a data table of the average number of hurricanes per year, in 5-year time spans, in the North Atlantic Ocean from 1878 to 2007.
 - First, they need to look at the data to check for outliers, this is called data processing. They can do this either by reading through the data table or by plotting the data and looking for values that are very different than the others (by an order of magnitude).

** Note – there are no outliers in this dataset, but this is to get the students familiar with checking their data before analyzing it.
 - If they find data points that are not actual data points, the students should decide what they want to do about those data points. Do they throw them out? Do they make them zero? Let them discuss this in their groups.
- If your students are confused by the average number of hurricanes per year for a 5-year time span, then make sure to explain how the data were calculated. The number of hurricanes for each year in the time span, for example 1878 through 1882, were collected: 14, 10, 13, 9, and 6. Then the average of these annual values was calculated to determine the “average number of hurricanes per year” for that 5-year time span. This was then repeated for each time span within the dataset and for the short-duration storms data.
- Ask the students if they have any questions about the data processing portion of the activity. Did they find any outliers in the dataset? Call on different students or student groups to share their opinions of whether they found outlier data. Allow them to discuss this for a few minutes but stress that they do NOT need to come to a consensus as a class. Every scientist is faced with this decision and each makes his/her own choice of how to proceed.
- Explain the data plotting and interpretation portion of the investigation:
 - Once they have processed the data and are comfortable that all of the data in the data table are actual data points, they should plot the average number of hurricanes per year for the North Atlantic Ocean 1878-2007.
 - Ask the students:
 - What kind of graph will we use? (Marked Line or Clustered Column)
 - What is the x-axis? (Years)
 - What is on the y-axis? (Average Number of Hurricanes Per Year (Frequency))

- iv. In the Marked Line graph do we connect the data points from each year? (No, because the average number of hurricanes per year for the 5 years is a discrete variable.)
 - c. Have the students look at the data to find patterns in the average number of hurricanes per year in the North Atlantic Ocean by completing the student worksheet.
6. As the students finish their graphs and answering the questions on the student worksheet, ask them to write a written response to:

Q. What patterns can you observe in the data? Is there a pattern between the number of hurricanes and time? If so, what is the pattern?

Q. Based upon the data, do you think that climate change is changing the number of hurricanes over time?

MAKE SENSE (10 MINUTES)

1. After a few minutes of writing their responses, tell the students that we are going to interpret and analyze the data as a class.
2. Have the students report out what patterns they observed in the data over different time scales in the dataset. Make sure to have the students support their statements of the patterns by stating what evidence they are using.
 - a. Help the students see that the pattern in average number of hurricanes per year is variable over time, but that overall the number of hurricanes has not changed over the course of the past century.
 - b. Help the students see that from 1878 to 2007 the overall pattern is no change in the average number of hurricanes per year. However, the observed pattern in number of hurricanes varies depending on what time scale you look at in the dataset: e.g., decreases from 1883 to 1922, stays the same from 1923 to 1972, and increases from 1983 to 2007.
3. Lead the students in a discussion about these differences in observed patterns of the average number of hurricanes per year data. Some discussion points you might want to hit on:
 - a. Help the students think about how if we are only looking at year-to-year or decade-to-decade variation in the number of hurricanes (as many talk about with the large number of hurricanes that have made landfall in the past few years) we will miss the larger patterns over time (aka those that could be influenced by climate change).
 - b. Help the students think about how the time frame that you use to talk about patterns in the number of hurricanes has a large influence on your conclusions of what the pattern in the data is.
 - i. What does that mean for making conclusions about data? – It is extremely important to know the time frame over which you would expect to see the phenomenon you are interested and determine if your data is longer than that time frame, in order for you to see the pattern.
 - ii. What time frame should we look at if we are interested in yearly or decadal patterns? – Yearly patterns can be observed by comparing data from different consecutive years. Decadal patterns can be observed by comparing data from different consecutive decades.

- iii. What time frame should we look at if we are interested in the potential influence of climate change? – There is no correct answer to this question, however the current impacts of climate change have been observed over multiple decades so having a longer timeseries of data than that would be at least a good place to start.
4. Once the discussion slows down, point to the motivating questions and ask:
Q. How do scientists study changes in hurricanes over time? Are changes in hurricane frequency related to climate changes?
5. Ask students to share their ideas about the questions with a partner. After a minute, ask volunteers to share the ideas they discussed with the entire class. Be accepting of all responses from the students. This is your opportunity to make sure the students understand the “take home message.”
6. Ask if the students have any final questions about the activity, data processing/graphing, or relationship between the number of hurricanes and climate change.

Hurricane Frequency Over Time Worksheet

Name: _____

Date: _____

Data Interpretation Questions:

1. What is the overall pattern in the number of hurricanes data from 1878 to 2007?
2. What is the pattern in the number of hurricanes data from 1983 to 2007?
3. What is the pattern in the number of hurricanes data from 1883 to 1922?
4. What is the pattern in the number of hurricanes data from 1923 to 1972?

Writing Prompts:

What patterns can you observe in the data? Is there a pattern between the number of hurricanes and time? If so, what is the pattern?

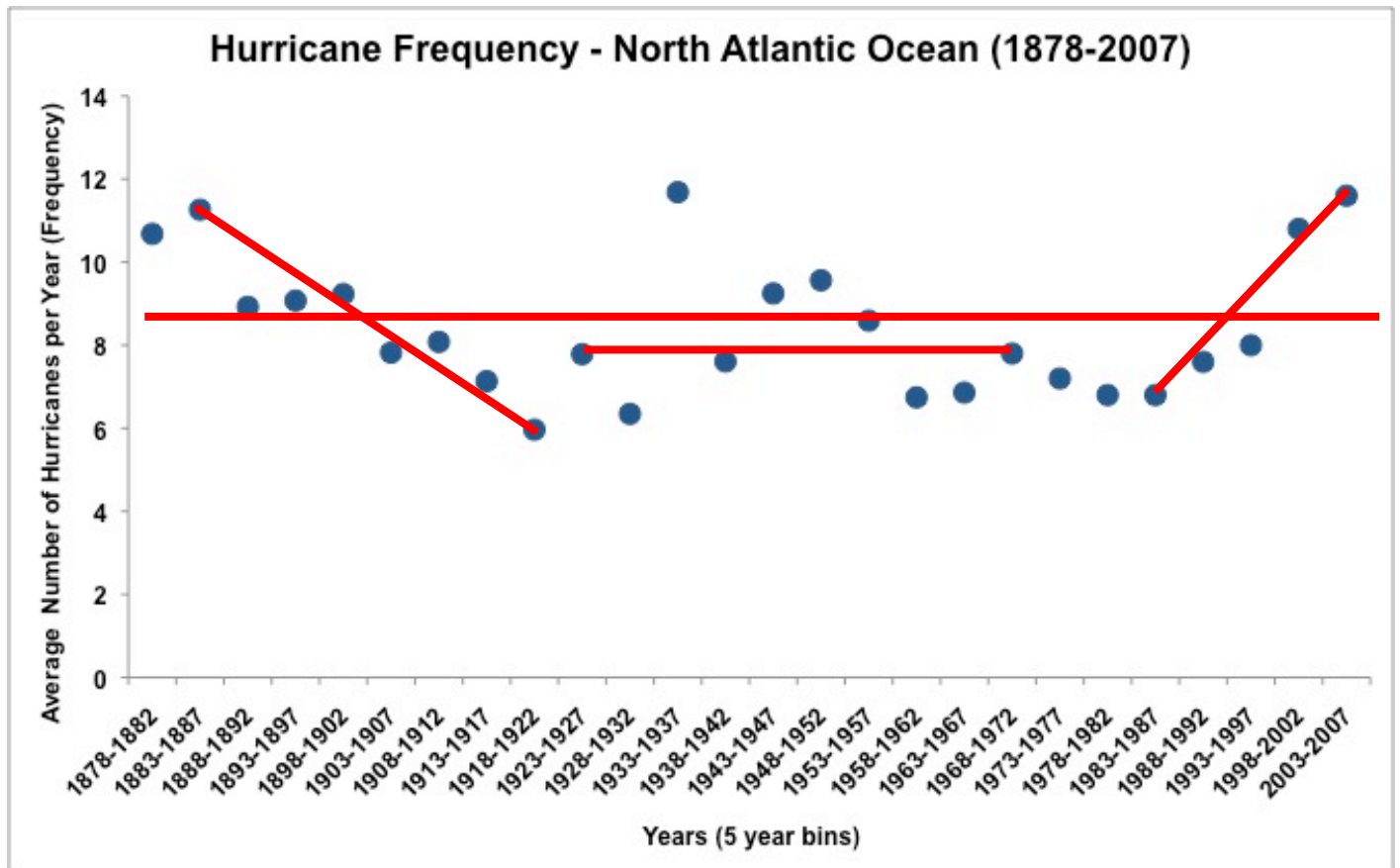
Based upon our hypotheses and these data, do you think that climate change is changing the number of hurricanes over time?

Hurricane Frequency Over Time – Advanced Graph/Data Table

Answer Key

Name: _____

Date: _____



Data Interpretation Questions:

1. What is the overall pattern in the number of hurricanes data from 1878 to 2007?

The pattern is variable throughout the dataset of highs and lows, but overall the average number of hurricanes is not changing with time. The average number of hurricanes is remaining consistent, from 10.7 in 1878-1882 to 11.6 in 2003-2007. The differences in the average number of hurricanes are not significant.

2. What is the pattern in the number of hurricanes data from 1983 to 2007?

The average number of hurricanes increased from 6.8 (1983-1987) to 11.6 (2003-2007) at a rate of +0.2 hurricanes/year.

3. What is the pattern in the number of hurricanes data from 1883 to 1922?

The average number of hurricanes decreased from 11.3 (1883-1887) to 6.0 (1918-1922) at a rate of -0.14 hurricanes/year.

4. What is the pattern in the number of hurricanes data from 1923 to 1972?

The average number of hurricanes did not change from 7.8 (1923-1927) to 7.8 (1968-1972).

Writing Prompts:

What patterns can you observe in the data? Is there a pattern between the number of hurricanes and time? If so, what is the pattern?

There is no overall pattern in the number of hurricanes over the past century.

Based upon our hypotheses and these data, do you think that climate change is changing the number of hurricanes over time?

If climate change were influencing the number of hurricanes we would have expected to see an overall increasing pattern in the number of hurricanes over time in the past century (as the global temperature, sea surface temperature, and greenhouse gas concentrations in the atmosphere have increased). However, we do not see such a pattern in the data, therefore the data demonstrates that there is not an influence of climate change on the number of hurricanes over the past century.

Advanced Data Table - 1878-2007 North Atlantic Hurricane Counts (corrected for "unobserved hurricanes")

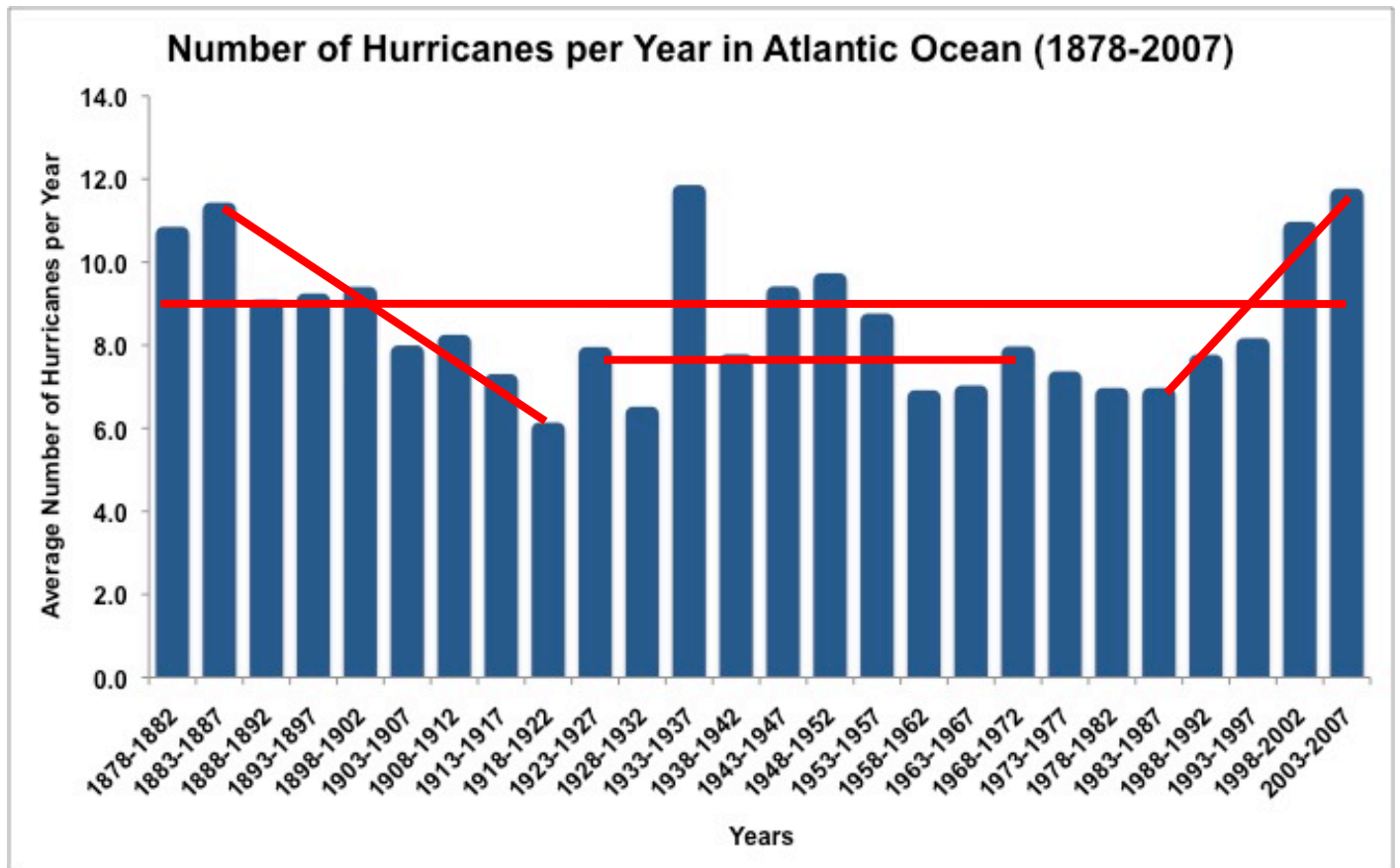
Years	Number of Hurricanes (5 Year Average)
1878-1882	10.7
1883-1887	11.3
1888-1892	8.9
1893-1897	9.1
1898-1902	9.2
1903-1907	7.8
1908-1912	8.1
1913-1917	7.1
1918-1922	6.0
1923-1927	7.8
1928-1932	6.3
1933-1937	11.7
1938-1942	7.6
1943-1947	9.2
1948-1952	9.6
1953-1957	8.6
1958-1962	6.7
1963-1967	6.9
1968-1972	7.8
1973-1977	7.2
1978-1982	6.8
1983-1987	6.8
1988-1992	7.6
1993-1997	8.0
1998-2002	10.8
2003-2007	11.6

Hurricane Frequency Over Time – Simplified Graph/Data Table

Answer Key

Name: _____

Date: _____



Data Interpretation Questions:

1. What is the overall pattern in the number of hurricanes data from 1878 to 2007?

The pattern is variable throughout the dataset of highs and lows, but overall the average number of hurricanes is not changing with time. The average number of hurricanes is remaining consistent, from 11 in 1878-1882 to 12 in 2003-2007. The differences in the average number of hurricanes are not significant.

1. What is the pattern in the number of hurricanes data from 1883 to 1922?

The average number of hurricanes increased from 7 (1883-1887) to 12 (2003-2007) at a rate of +0.2 hurricanes/year.

2. What is the pattern in the number of hurricanes data from 1883 to 1922?

The average number of hurricanes decreased from 11 (1883-1887) to 6 (1918-1922) at a rate of -0.13 hurricanes/year.

3. What is the pattern in the number of hurricanes data from 1923 to 1972?

The average number of hurricanes did not change from 8 (1923-1927) to 8 (1968-1972).

Writing Prompts:

What patterns can you observe in the data? Is there a pattern between the number of hurricanes and time? If so, what is the pattern?

There is no overall pattern in the number of hurricanes over the past century.

Based upon our hypotheses and these data, do you think that climate change is changing the number of hurricanes over time?

If climate change were influencing the number of hurricanes we would have expected to see an overall increasing pattern in the number of hurricanes over time in the past century (as the global temperature, sea surface temperature, and greenhouse gas concentrations in the atmosphere have increased). However, we do not see such a pattern in the data, therefore the data demonstrates that there is not an influence of climate change on the number of hurricanes over the past century.

Simplified Data Table - 1878-2007 North Atlantic Hurricane Counts (corrected for "unobserved hurricanes" and are presented in the average number of hurricanes for 5 years combined, to make it easier to look at the overall patterns/patterns in the data)

Years	Number of Hurricanes
1878-1882	11
1883-1887	11
1888-1892	9
1893-1897	9
1898-1902	9
1903-1907	8
1908-1912	8
1913-1917	7
1918-1922	6
1923-1927	8
1928-1932	6
1933-1937	12
1938-1942	8
1943-1947	9
1948-1952	10
1953-1957	9
1958-1962	7
1963-1967	7
1968-1972	8
1973-1977	7
1978-1982	7
1983-1987	7
1988-1992	8
1993-1997	8
1998-2002	11
2003-2007	12