Purpose

The purpose of this lesson is for students to compare data displays to determine which best answers the driving question. To do this they will evaluate the spread of the data and what the displays show.

Learning Objectives

- Analyze how the phenomenon changes with location
- Identify patterns and relationships in data
- Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread of two or more different data sets.
- Represent data with plots on the real number line with a Histogram, Box Plot and Scatter Plot

Materials Required

- Histograms, Box Plots and Scatter Plots (student produced or copies of the versions provided)
- Student question sheets
- Paper or index cards for exit tickets

NASA Phenomenon Connection

Hurricanes are large, swirling storms with winds of 119 kilometers per hour (74 mph) or higher. That's quicker than a cheetah can run which is the fastest animal on land. Hurricanes are said to be the most violent storms on Earth. These storms are also called by other names, such as typhoons or cyclones, depending on where they occur. The scientific term for these storms is “tropical cyclone.” Only tropical cyclones that form over the Atlantic Ocean or eastern Pacific Ocean are called "hurricanes”. Whatever they are called, tropical cyclones all form the same way. (see https://pmm.nasa.gov/education/articles/how-do-hurricanes-form)

Because tropical cyclones are like giant engines that use warm, moist air as fuel, they form only over warm ocean waters near the equator. The number of hurricanes occurring each year varies widely from ocean to ocean, depending on how much warm ocean water exists. The most active area is the northwestern Pacific Ocean, which contains a wide expanse of warm ocean water. On average, twenty six tropical cyclones form in this region each year, of which seventeen reach hurricane (typhoon) status. In contrast, the Atlantic Ocean averages about ten storms annually, of which six reach hurricane status. Compared to the Pacific Ocean, the Atlantic is a much smaller area, and therefore supports a smaller expanse of warm ocean water to fuel storms. The Pacific waters also tend to be warmer, and the layer of warm surface waters tends to be deeper than in the Atlantic. Overall, about 80 tropical cyclones occur annually across the globe, one-third of which achieve hurricane status.The frequency and intensity of hurricanes varies significantly from year to year, and scientists haven’t yet figured out all the reasons for the variability. (see https://earthobservatory.nasa.gov/Features/Hurricanes/hurricanes_3.php)

Tropical cyclones usually weaken when they hit land, because they are no longer being "fed" by the energy from the warm ocean waters. (see https://pmm.nasa.gov/education/articles/how-do-hurricanes-form)

Teacher Preparation

- Student Questions and Information
- Student produced plots or copies of provided plots for each student/group

Procedure

Introduction

1. What is a tropical cyclone?
2. What are the dangers of tropical cyclones?

Driving Question

The driving question is the reason they will be investigating tropical cyclones and different types of data displays.

Which data display is most useful for determining the risk of a tropical cyclone in a given area and preparing an effective emergency plan?

Background Knowledge

Tropical Cyclones

1. Tropical cyclones are also called hurricanes or typhoons depending upon where they form.
2. Share background information from these options. Choose the best option for the class.
    - "What is a Hurricane?" https://oceanservice.noaa.gov/facts/hurricane.html
    - "What Are Hurricanes?" https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-are-hurricanes-58.html
    - "How does a Hurricane Form?" https://scijinks.gov/hurricane/
3. Inform students that some homeowners who live in high risk locations are required to purchase flood insurance. Homeowners can take steps to protect their homes from floods and high winds as well. It is also important to have a plan. Students can explore the following resources for more information.
    - FEMA Ready Check Hurricanes https://www.fema.gov/media-library-data/253331ac179d32652a4d0cbf7fb3e6eb/FEMA_FS_hurricanes_508_8-15-13.pdf
    - FEMA Hurricane Information https://www.ready.gov/hurricanes

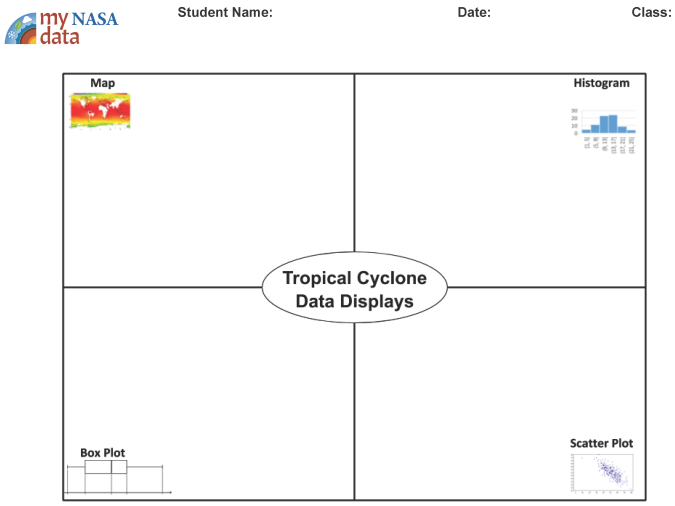
Assess Prior Knowledge of Data Displays

Group students to work on Frayer models. Each group should have at least 3 students.

1. Each group should write the types of questions that each type of data display can answer in the corresponding boxes.
2. Optional: If students completed the Tropical Cyclone Counts Model, Tropical Cyclone Counts Histogram, Tropical Cyclone Counts Box Plot or Tropical Cyclone Counts

Scatter Plot mini lessons, they can use their exit tickets and write the questions on the Frayer Model. If not available, do the next step.

3. Each group should also generate a question about tropical cyclones for each type of data display.



Analyze data

1. Option 1: Create one or more of the required data displays as directed in the following lesson.
    - Compare Graph Types Graphing Activity
    - Re-group students from Frayer model groups by data display, histogram, box plot, scatter plot.
    - Provide data to students and have them graph the type of plot assigned to their group.
    - Proceed to Analyze Plots
    - Extension: Use a software tool to make a scatter plot, histogram and/or box plot.
2. Option 2: Use data displays that are provided
    - Re-group students from Frayer model groups by data display, histogram, box plot, scatter plot.
    - Give each group copies of the plots for the type assigned to them to use in analyzing the data.
3. Analyze Plots
    - Jigsaw – Each group has a different type of plot.
    - Each group should analyze their plot (not the raw data) to determine the information the plot provides regarding tropical cyclone counts at different latitudes for the longitudes used.

- Have students look for information like minimum, maximum, median, mode, correlation, distribution, patterns in data. Not each plot will provide the same information.

Type of plot	Max	Min	Median	Mode	Correlation	Distribution	Patterns
Histogram	Range only	Range only	No	Range only	No	Skewed Right	Lot of latitudes with a low number of tropical cyclones
Box Plot	Yes	Yes	Yes	No	No	Skewed Right	Lot of latitudes with a low number of tropical cyclones
Scatter Plot	Yes	Yes	No	No	Yes – strong but not positive or negative	Non linear	As latitude increases, tropical cyclones increase to maximum and then decrease.

- Students go back to their original Frayer Model Groups to discuss patterns by latitude for all plot types.
- Students will share what they determined for their plot type with the group.
  - What did the plot show?
  - What patterns did you see?
  - Does the plot answer any of the questions your group asked in their Frayer Model for that type of plot?

4. Students will discuss the map image and compare it with the other three plot types.
   - Which type of graph is most useful for determining the latitudes with the highest and lowest tropical cyclone risk?
   - What can you conclude about the distribution of tropical cyclones?

Assessment

1. Revisit the driving question ***Which data display is most useful for determining the risk of a tropical cyclone in a given area and preparing an effective emergency plan?***
2. Students will use the Claim-Evidence-Reasoning technique to answer the question.

Graph Choice Chart

What question would you like to explore? Write your question as a complete sentence.

Does your question ask about the **variability** of a group of data points?

(i.e. the range of the data, the shape of the distribution, or what the center of the data is)

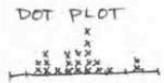
YES

Examples:
1. Do all high tides rise to the same height?
2. How variable are windspeeds here?
3. What is the range and distribution of incomes in the United States?

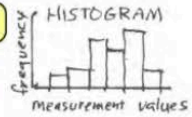
make a **FREQUENCY PLOT**

For each group make a

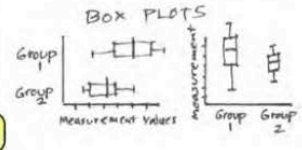
either
- **DOT PLOT**



- **HISTOGRAM**



- **BOX PLOT**



Does your question **compare two or more groups** to decide if the groups are the same or different?

YES

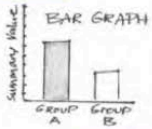
Do you want to compare the **variability of all data points** in each group to decide if any difference between the groups is *meaningful?*

Examples:
1. Which of the two car designs is most consistently the fastest?
2. Is there a meaningful difference in the heights of fertilized and unfertilized bean plants?

Are you comparing **single numbers** that summarize a group? (such as mean, median, or total...)

Examples:
1. Was the total snowfall greater this winter than last winter?
2. Do cats and dogs have the same average body temperature ?
3. How do the median incomes for the U.S. and Sweden compare?

make a **BAR GRAPH**



Does it ask if **two numeric factors are correlated** ?

Examples:
Is the temperature inside the house correlated with the temperature outside?

How did electricity used by the kitchen circuit fluctuate during the past week?

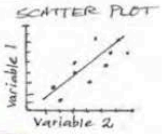
YES

Does it ask about how something changes through **linear TIME?**

NO

Examples:
1. Is the fuel efficiency of a car related to its weight?
2. Are smoking rates correlated with median income?
3. Given a fixed volume, how are temperature and pressure related?

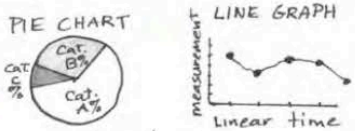
make a **SCATTER PLOT**



YES

Examples:
1. Have summer lake water temperatures warmed over the last ten years?
2. How did my weight change over the last 3 months?

make a **LINE GRAPH**

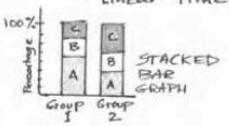


Does your question ask how a **total** is **proportioned** into sub-groups? (Or what proportion a sub-group is of a total?)

YES

Examples:
1. Which circuit accounts for the largest proportion of the electricity use by our household?
2. What proportion of U.S. energy comes from wind?
3. What proportion of U.S. residents take public transportation to work?

make either
- **PIE CHART**
- **STACKED BAR CHART**

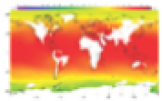


The Maine Data Literacy Project -- Graph Choice Chart

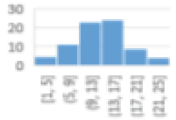
Student Name: Date: Class:

Tropical Cyclone Data Displays

Map

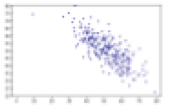


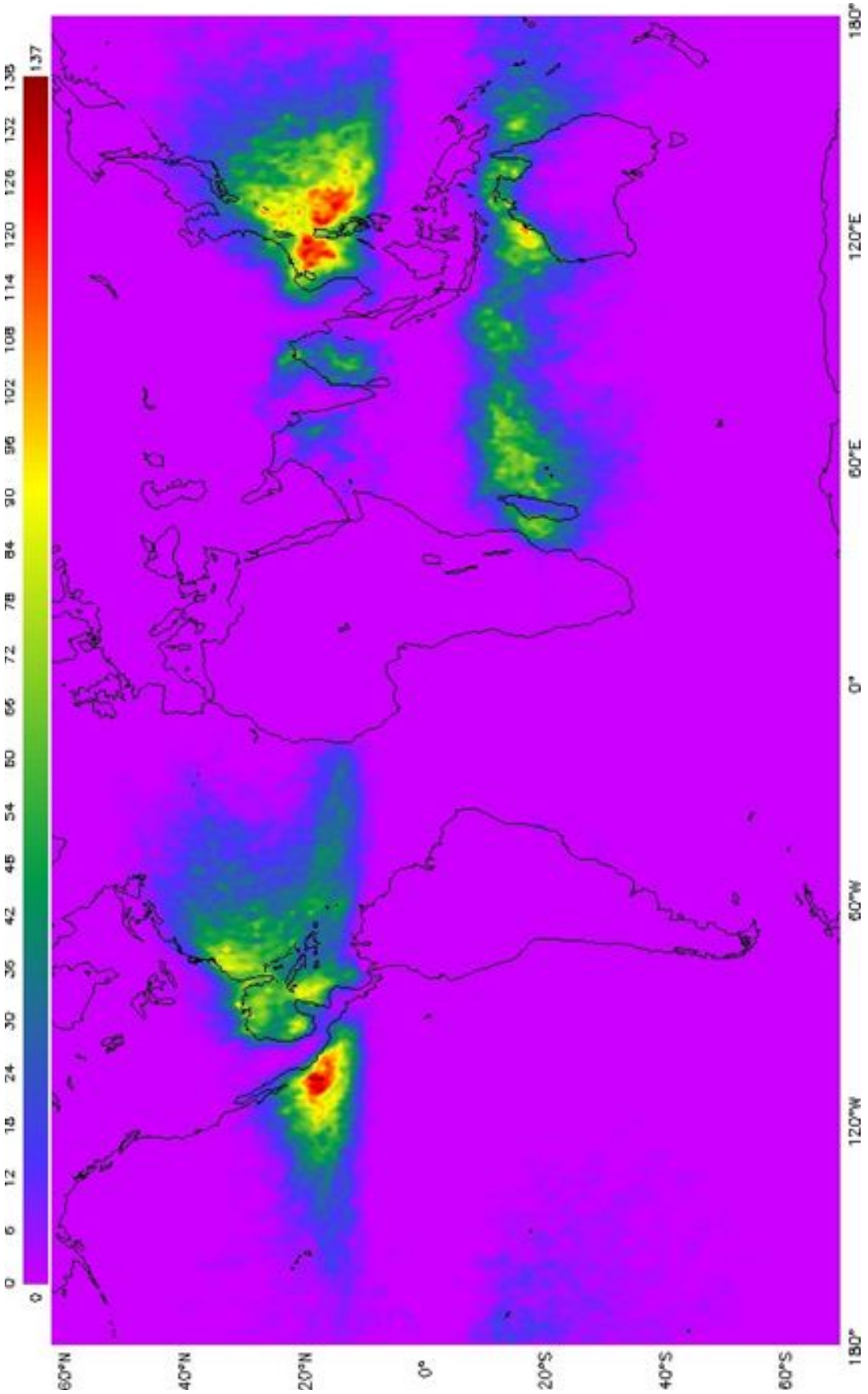
Histogram



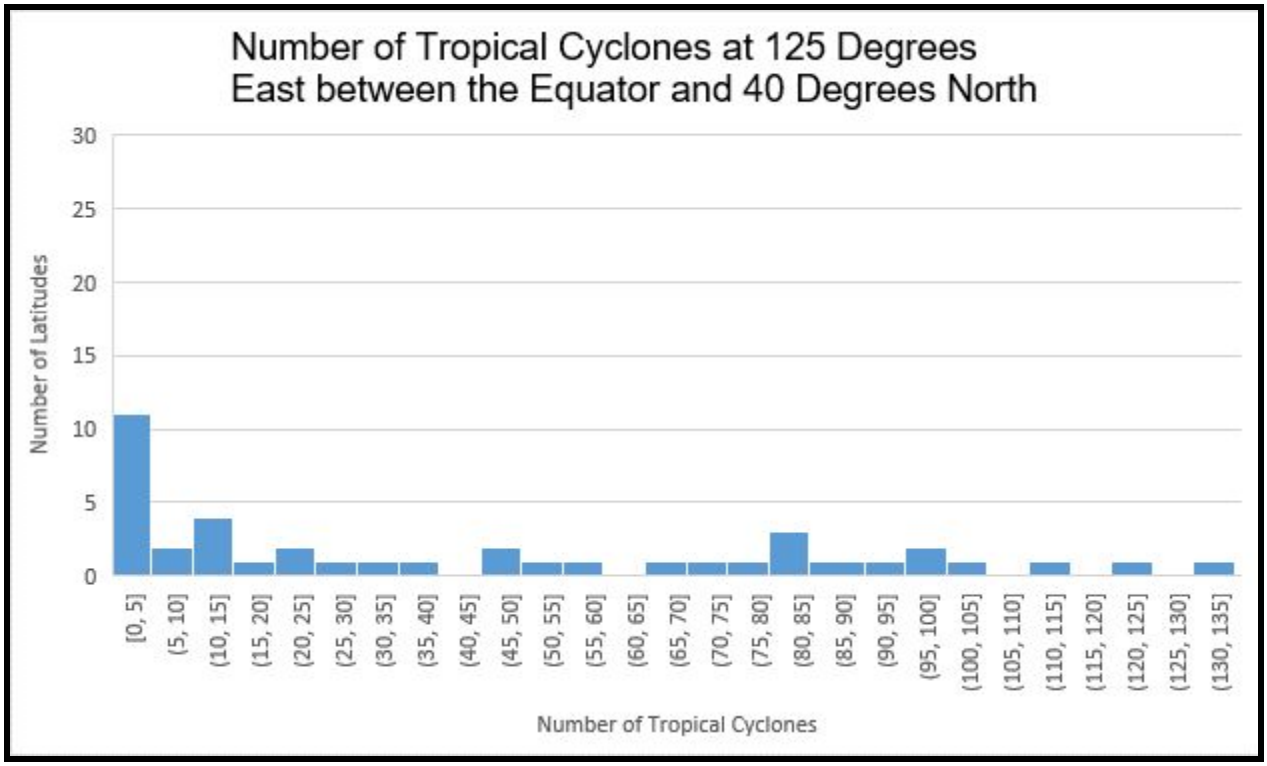
Box Plot

Scatter Plot




0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
102
108
114
120
126
132
138
137
60°N
40°N
20°N
0°
20°S
40°S
60°S
180°
120°W
60°W
0°
60°E
120°E
180°

Histograms


Number of Tropical Cyclones at 125 Degrees East between the Equator and 40 Degrees North
Number of Latitudes
30
25
20
15
10
5
0
[0, 5]
(5, 10]
(10, 15]
(15, 20]
(20, 25]
(25, 30]
(30, 35]
(35, 40]
(40, 45]
(45, 50]
(50, 55]
(55, 60]
(60, 65]
(65, 70]
(70, 75]
(75, 80]
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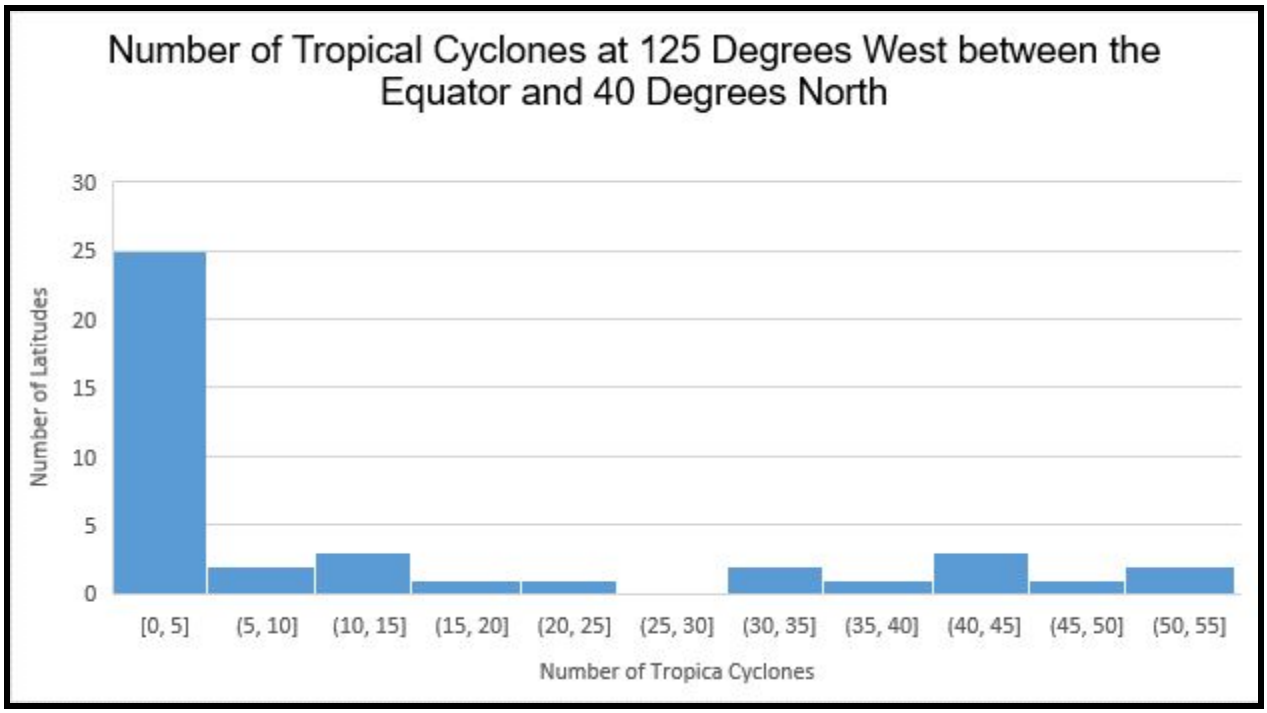
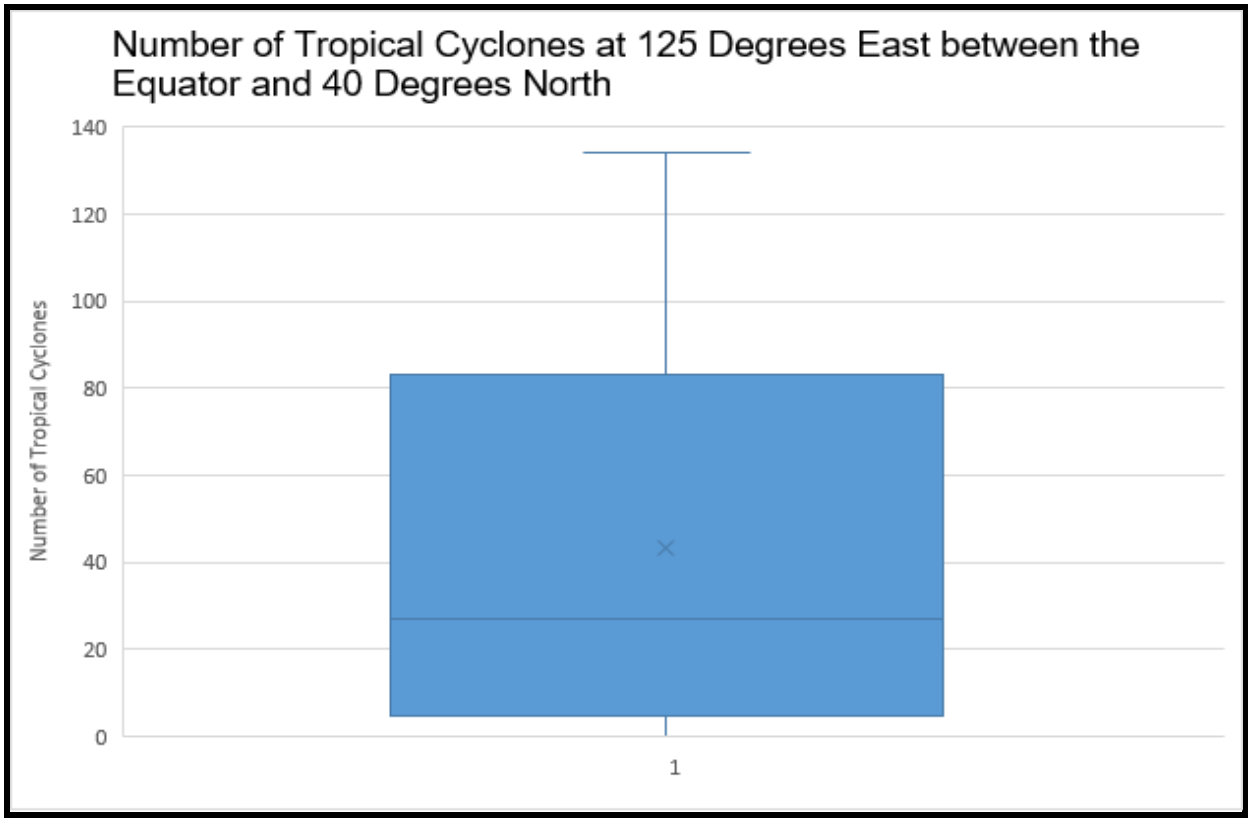
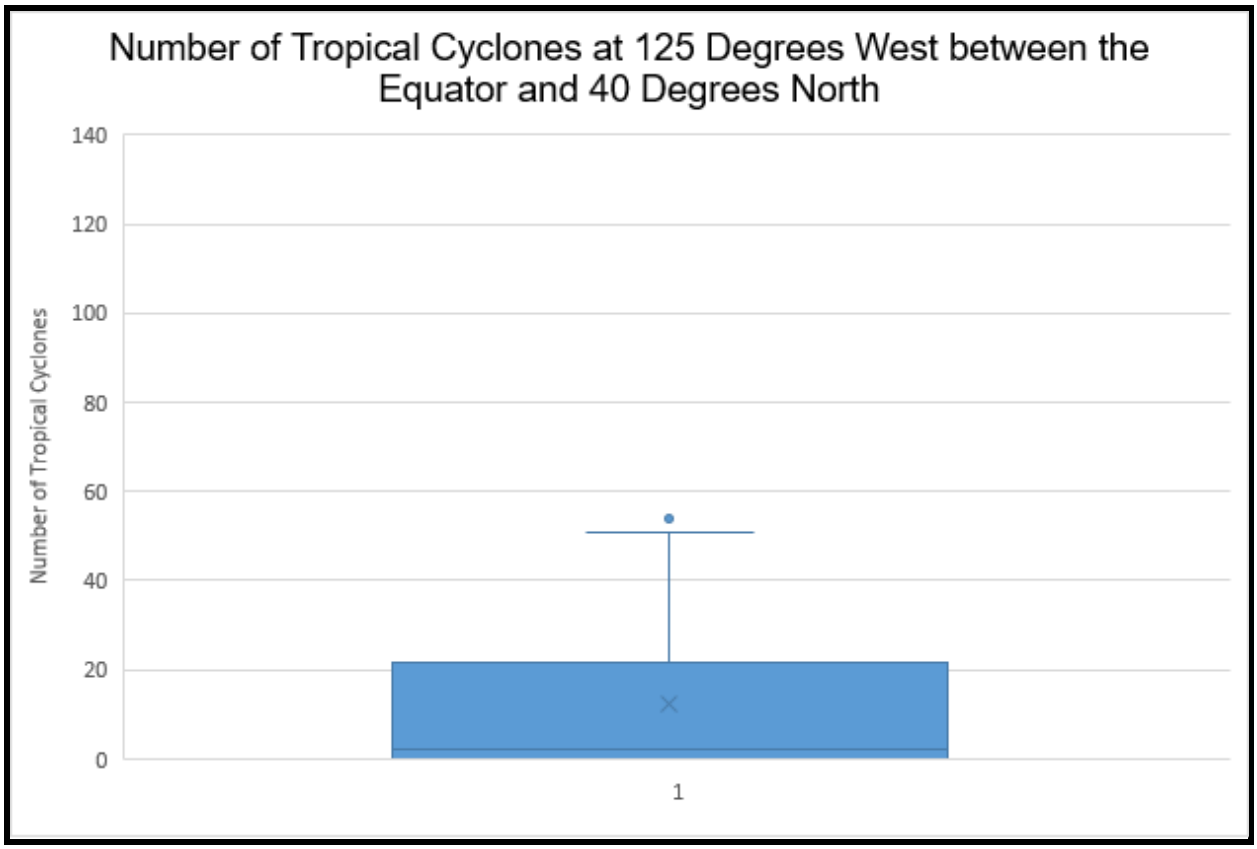
(90, 95]
(95, 100]
(100, 105]
(105, 110]
(110, 115]
(115, 120]
(120, 125]
(125, 130]
(130, 135]
Number of Tropical Cyclones

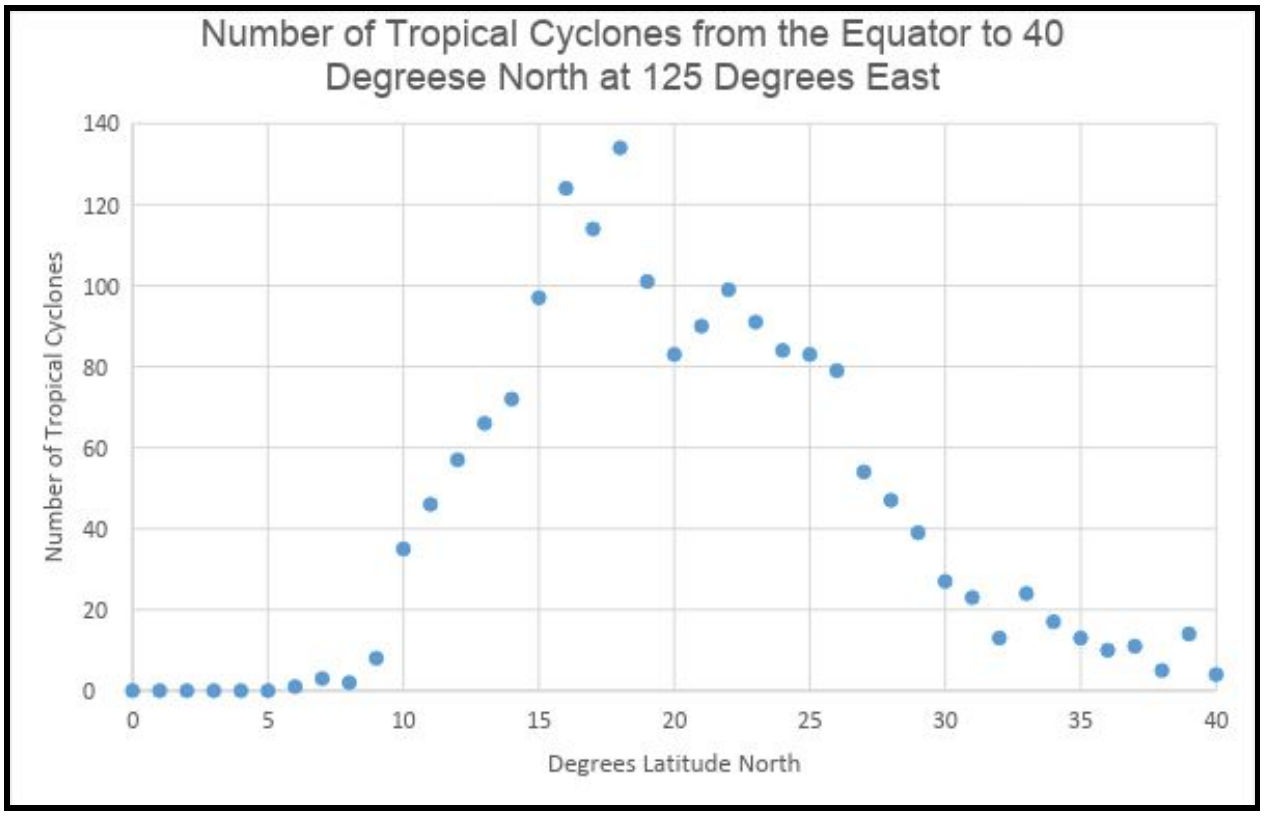

Number of Tropical Cyclones at 125 Degrees West between the Equator and 40 Degrees North
Number of Latitudes
30
25
20
15
10
5
0
[0, 5]
(5, 10]
(10, 15]
(15, 20]
(20, 25]
(25, 30]
(30, 35]
(35, 40]
(40, 45]
(45, 50]
(50, 55]
Number of Tropica Cyclones

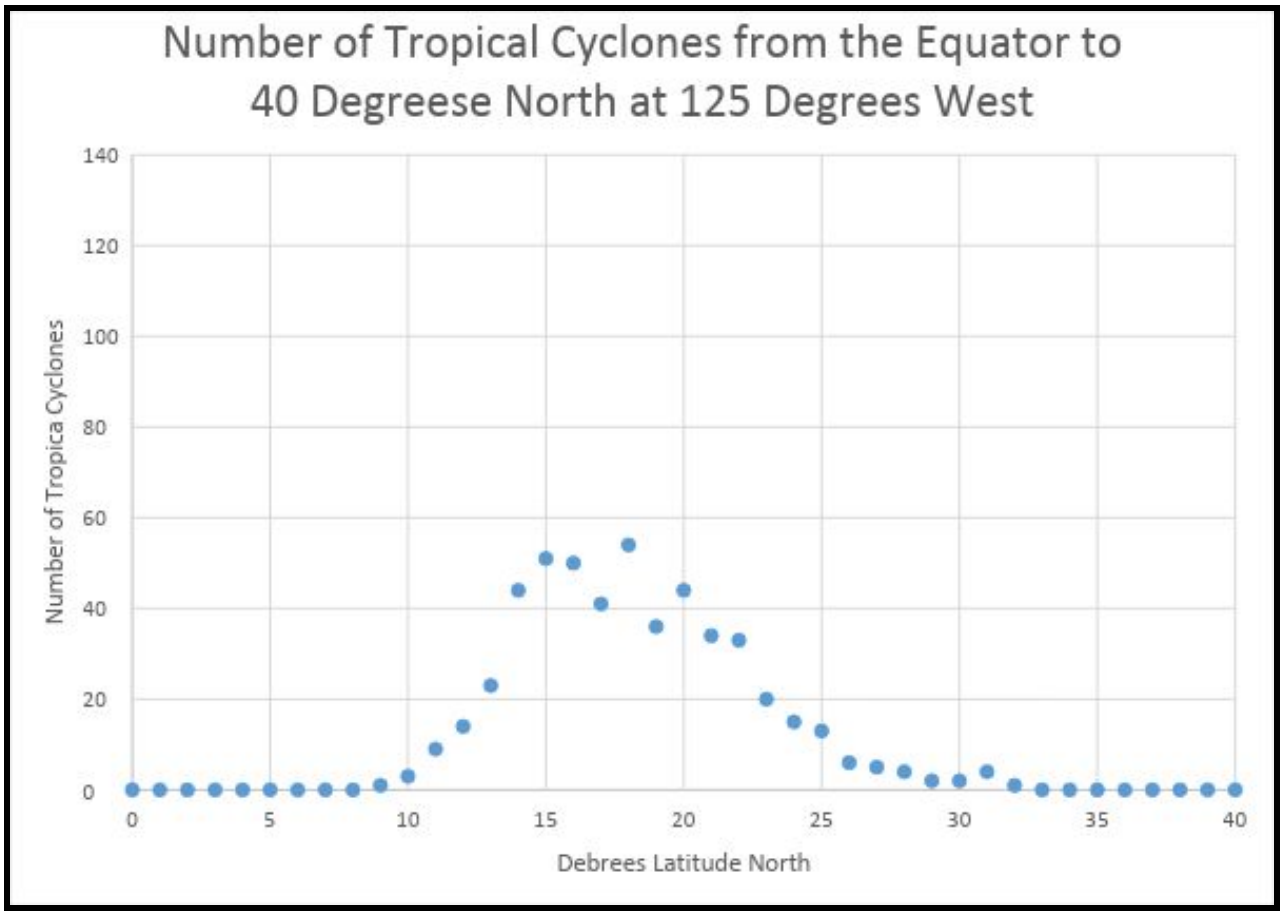
Box Plots


Number of Tropical Cyclones at 125 Degrees East between the Equator and 40 Degrees North
Number of Tropical Cyclones
140
120
100
80
60
40
20
0
1


Number of Tropical Cyclones at 125 Degrees West between the Equator and 40 Degrees North
Number of Tropical Cyclones
140
120
100
80
60
40
20
0
1

Scatter Plots





Student Data Sheet

Student Name: Date: Period:

Claim: (One sentence statement that addresses the driving question: *How can you determine the risk of experiencing a tropical cyclone in an area to make decisions about where to live, how to protect yourself and whether or not you need to make an emergency plan?"*)	
Evidence: Sufficient, Appropriate, and Observation Driven	**Reasoning**: (Why is this evidence important?)
Map Image 1. 2. 3. Histogram 1. 2. 3. Box Plot 1. 2. 3. Scatter Plot 1. 2. 3.	Map Image 1. 2. 3. Histogram 1. 2. 3. Box Plot 1. 2. 3. Scatter Plot 1. 2. 3.

C-E-R Rubric

Student Name: Date: Period:

Description	3 Points	2 Points	1 Point	0 Points
Claim	Makes an accurate and complete statement linking the functions of the data displays to the conclusion.	Makes an accurate but incomplete claim addressing only one type of data display.	Makes an inaccurate claim.	Does not make a claim.
Evidence	Provides sufficient evidence to support claim using qualitative and quantitative observations of the displays and their uses.	Provides appropriate but insufficient evidence to support claim.	Provides inappropriate evidence. The evidence does not support the claim.	Does not provide evidence.
Reasoning	Provides reasoning that connects each piece of evidence to the claim. Uses data analysis skills to explain why the evidence supports the claim.	Provides appropriate but incomplete reasoning. Each piece of evidence is not supported by a line of reasoning.	Provides inappropriate reasoning.	Does not provide reasoning.
Total				

C-E-R Rubric

Student Name: Date: Period:

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Total				

Data for Optional Graphing

125 Degrees East		125 Degrees West	
Latitude North	Number of Tropical Cyclones	Latitude North	Number of Tropical Cyclones
0	0	0	0
1	0	1	0
2	0	2	0
3	0	3	0
4	0	4	0
5	0	5	0
6	1	6	0
7	3	7	0
8	2	8	0
9	8	9	1
10	35	10	3
11	46	11	9
12	57	12	14
13	66	13	23
14	72	14	44
15	97	15	51
16	124	16	50
17	114	17	41
18	134	18	54
19	101	19	36
20	83	20	44
21	90	21	34
22	99	22	33
23	91	23	20
24	84	24	15
25	83	25	13
26	79	26	6
27	54	27	5
28	47	28	4
29	39	29	2
30	27	30	2
31	23	31	4
32	13	32	1
33	24	33	0
34	17	34	0
35	13	35	0
36	10	36	0
37	11	37	0
38	5	38	0
39	14	39	0
40	4	40	0