Formative Assessment Exemplar - 8.4.5

Introduction:

The following formative assessment exemplar was created by a team of Utah educators to be used as a resource in the classroom. It was reviewed for appropriateness by a Bias and Sensitivity/Special Education team and by state science leaders. While no assessment is perfect, it is intended to be used as a formative tool that enables teachers to obtain evidence of student learning, identify gaps in that learning, and adjust instruction for all three dimensions (i.e., Science and Engineering Practices, Crosscutting Concepts, Disciplinary Core Ideas) included in a specific Science and Engineering Education (SEEd) Standard.

In order to fully assess students' understanding of all three dimensions of a SEEd standard, the assessment is written in a format called a cluster. Each cluster starts with a phenomenon, provides a task statement, necessary supporting information, and a sequenced list of questions using the gather, reason, and communicate model (Moulding et al., 2021) as a way to scaffold student sensemaking. The phenomenon used in an assessment exemplar is an analogous phenomenon (one that should not have been taught during instruction) to assess how well students can transfer and apply their learning in a novel situation. The cluster provides an example of the expected rigor of student learning for all three dimensions of a specific standard. In order to serve this purpose, this assessment is NOT INTENDED TO BE USED AS A LESSON FOR STUDENTS.

Because this assessment exemplar is a resource, teachers can choose to use it however they want for formative assessment purposes. It can be adjusted and formatted to fit a teacher's instructional needs. For example, teachers can choose to delete questions, add questions, edit questions, or break the tasks into smaller segments to be given to students over multiple days.

General Format:

Each formative assessment exemplar contains the following components:

1. Teacher Facing Information: This provides teachers with the full cluster as well as additional information including the question types, alignment to three dimensions, and answer key. Additionally, an example of a proficient student answer and a proficiency scale for all three dimensions are included to support the evaluation of the last item of the assessment.
2. Students Facing Assessment: This is what the student may see. It is in a form that can be printed or uploaded to a learning platform. (Exception: Questions including simulations will need technology to utilize during assessment.)

Accommodation Considerations:

Teachers should consider possible common ways to provide accommodations for students with disabilities, English language learners, students with diverse needs or students from different cultural backgrounds. For example, these accommodations may include: Providing academic language supports, presenting sentence stems, or reading aloud to students. All students should be allowed access to a dictionary.

References:

Moulding, B., Huff, K., & Van der Veen, W. (2021). *Engaging Students in Science Investigation Using GRC*. Ogden, UT: ELM Tree Publishing.

Teacher Facing Information

Standard: 8.4.5

Assessment Format: Online Only (Requires students to have online access)

Phenomenon	
Watch this animation and observe patterns in the 2005 hurricane season: https://serc.carleton.edu/eslabs/hurricanes/1a.html A person notices that hurricanes in the United States happen mostly on the East Coast and come from the Atlantic Ocean.	Proficient Student Explanation of Phenomenon: Students will **analyze and interpret** patterns of the occurrence of hurricanes. Using all of the data and information provided, students will choose 3 statements that accurately describe hurricane occurrence: A. Certain areas are at greater risk of hurricanes than other areas. B. Patterns of currents, winds, locations, and temperatures all have effects on the locations of hurricanes. C. Hurricane storms move from the equator towards the poles.
Cluster Task Statement	
(Represents the ultimate way the phenomenon will be explained or the design problem will be addressed) In the questions that follow, you will analyze, interpret, and ultimately explain the patterns shown in the animation using the data provided.	
Supporting Information	
Supporting Reading 1: What Are Hurricanes? Figure 1: Hurricane Earl from Space Station 	

Hurricanes are large, swirling storms with winds of 119 kilometers per hour (74 mph) or higher. That's faster than a cheetah, the fastest animal on land.

The storms form over warm ocean waters and sometimes strike land. When a hurricane reaches land, it pushes a wall of ocean water ashore. This wall of water is called a storm surge, which along with heavy rain can cause flooding, especially near the coast.

Once a hurricane forms, weather forecasters predict its path and how strong it will get. This information helps people prepare for the storm before it arrives.

Scientists don't know exactly why or how a hurricane forms. But they do know that two main ingredients are necessary: warm water and winds that don't change much in speed or direction as they go higher in the atmosphere.

Warm ocean waters provide the energy needed for a storm to become a hurricane. Usually, the surface water temperature must be 26 degrees Celsius (79 degrees Fahrenheit) or higher for a hurricane to form.

Animation 1: 2005 Hurricane Season- Storm Names and Paths:
https://serc.carleton.edu/eslabs/hurricanes/1a.html

Figure 2: Direct hurricane hits on US mainland (1851-2017)

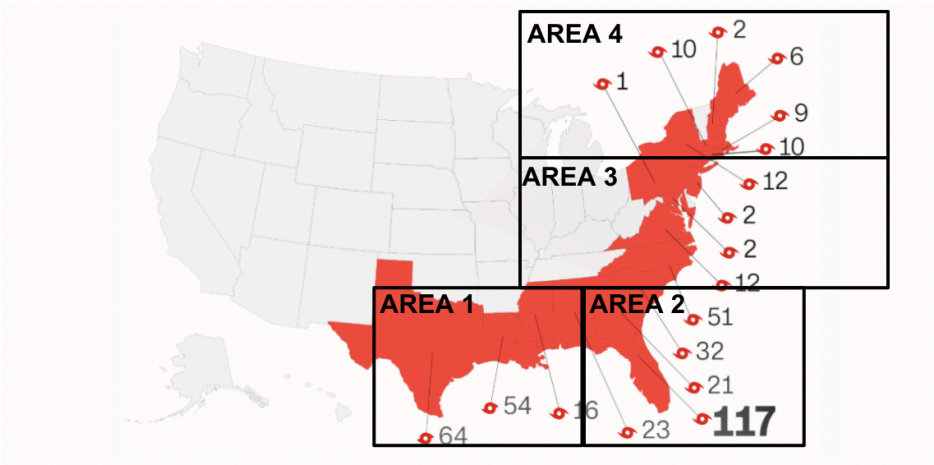
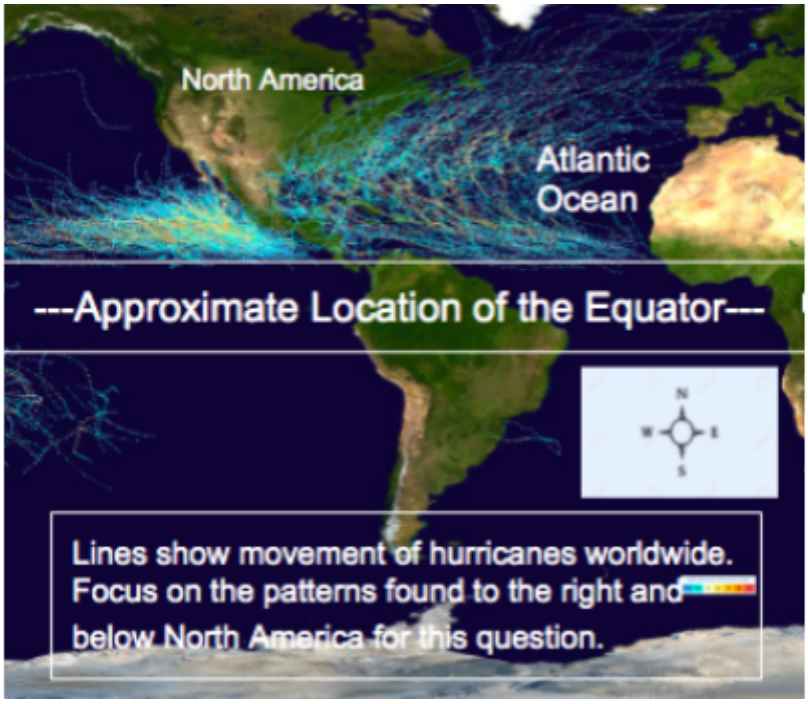


Figure 1 shows the areas in the US mainland which received direct hurricane hits between 1851 and 2017.

Figure 3: Map Showing Storm Paths (1985-2005)



This diagram indicates the path storms take from beginning to end. Most storms begin near the equator and move either north or south towards the poles. Each blue or yellow line indicates a separate storm.

Figure 4: Global Wind Patterns

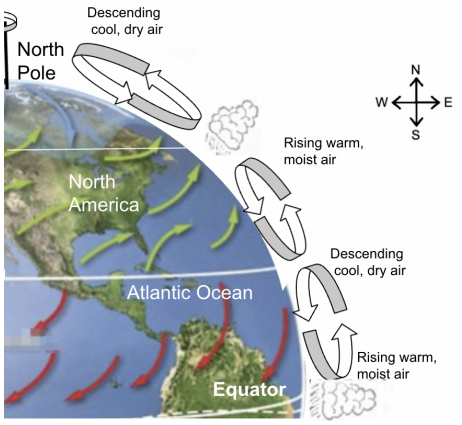
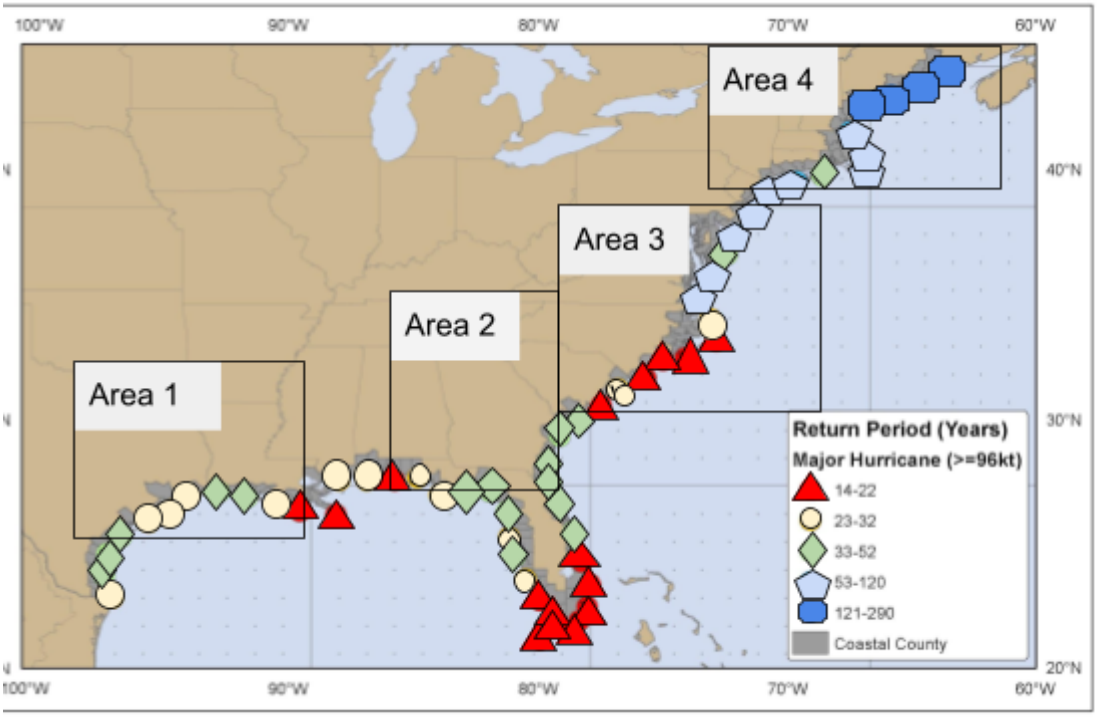


Figure 5: Predicted return period of major hurricanes in years.



Note: >=96kt indicates that these hurricanes are greater than 96 knots (a measurement of wind speed) Source: https://www.nhc.noaa.gov/climo/

Table 1: Saffir-Simpson Hurricane Scale

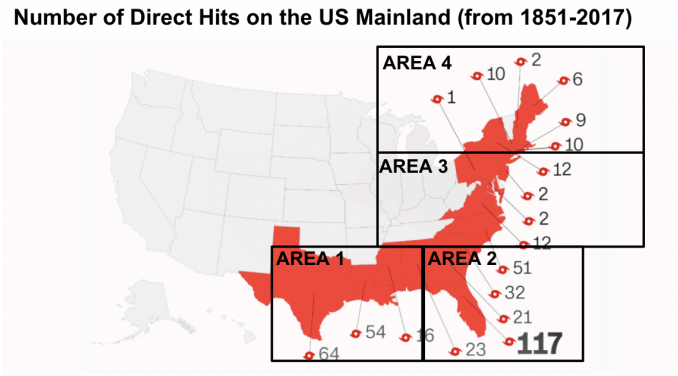
Saffir-Simpson Hurricane Scale		
Category	**Wind Speed**	
	mph (miles per hour)	**knots**
5	≥156	≥135
4	131-155	114-134
3	111-130	96-113
2	96-110	84-95
1	74-95	65-83
Non-Hurricane Classifications		
Tropical Storm	39-73	34-64
Tropical Depression	0-38	0-33

Cluster Questions

Gather:
Cluster Question #___1___
Question Type: Multiple choice
Addresses:
__x__ DCI: ESS3.B
__x__ SEP: Analyzing and Interpreting Data
___x_ CCC Using patterns to predict.
Answer:
Area 2

Question 1:
Using Figure 2 below, look for patterns of hurricane occurrence. Where is the area of greatest risk for hurricanes?

Figure 2: Direct hurricane hits on US mainland (1851-2017)



a) Area 1
b) Area 2
c) Area 3
d) Area 4
e) All areas are under the same threat.

Gather:
Cluster Question #__2____
Question Type: Table Match (put storm descriptions on one column and have them match with the category using the data table to classify wind speed).
Addresses:
__x__ DCI: ESS3.B
__x__ SEP: Analyzing and Interpreting Data
____ CCC Using patterns to predict.
Answer:

Column A Storm	Column B Category
Storm A currently has wind speeds of 120 mph.	*Category 3*
Storm B currently has wind speeds of 75 knots.	*Category 1*
Storm C currently has wind speeds of 64 mph.	*Tropical Storm.*
Storm D currently has wind speeds of 187 mph.	*Category 5*
Storm E currently has wind speeds of 33 mph.	*Tropical Depression*

Question 2:
Hurricane intensity is often measured by the Saffir-Simpson Scale of cyclone intensity and is based on measurements of sustained wind speed; it categorizes hurricanes from 1 (lowest intensity) to 5 (most intense). The technical definition of a hurricane is winds of 74 miles per hour or greater, sustained for 1 minute.

Using the Table 1 data table below, match the storm wind speed to the category.

Table 1 Saffir-Simpson Hurricane Scale

Saffir-Simpson Hurricane Scale		
Category	**Wind Speed**	
	mph (miles per hour)	**knots**
5	≥156	≥135
4	131-155	114-134
3	111-130	96-113
2	96-110	84-95

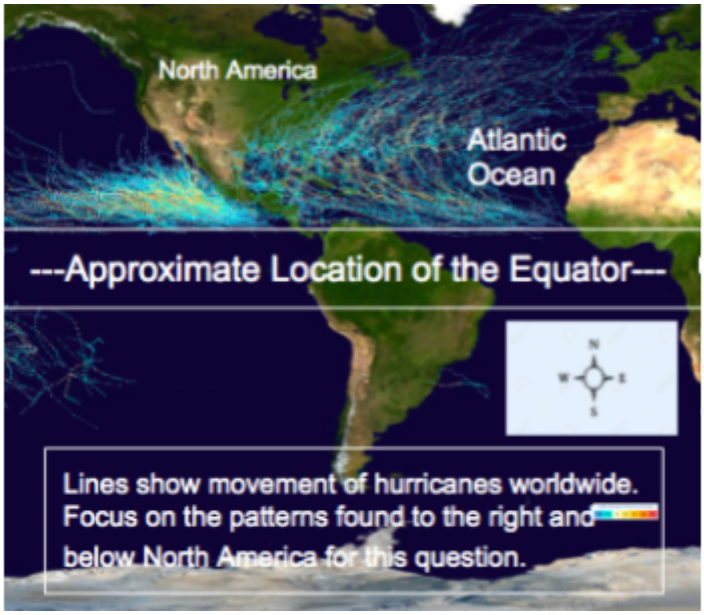
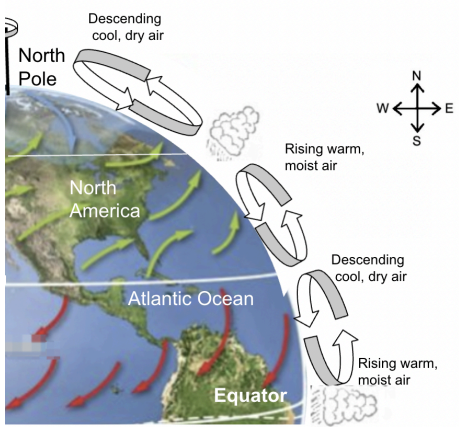
1	74-95	65-83
Non-Hurricane Classifications		
Tropical Storm	39-73	34-64
Tropical Depression	0-38	0-33

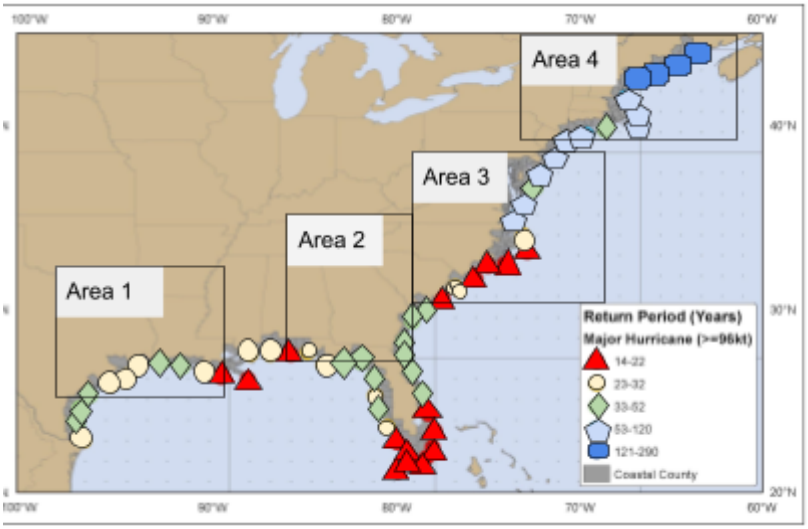
Column A: Storm	Column B: Category
Storm A currently has wind speeds of 120 mph.	
Storm B currently has wind speeds of 75 knots.	
Storm C currently has wind speeds of 64 mph.	
Storm D currently has wind speeds of 187 mph.	
Storm E currently has wind speeds of 33 mph.	

Reason:
Cluster Question #__3____
Question Type: Multiple Choice
Addresses:
__x__ DCI: ESS3.B
__x__ SEP: Analyzing and Interpreting Data
___x_ CCC Using patterns to predict.
Answer: B

Question 3:
Based on these two images below (Figures 3 and 4), determine if there is a connection between global wind patterns and the movement patterns of hurricanes. Which claim, evidence and reasoning below best explains that connection?

A) Yes there is a connection. In the Atlantic Ocean near North America, winds are flowing in the direction of south and east (Figure 3), similar to the direction of hurricane movement (FIgure 2).
B) Yes there is a connection. In the Atlantic Ocean near North America, winds are flowing in the direction of north and west (Figure 3), similar to the direction of hurricane movement (Figure 2).
C) No, there is no connection. In the Atlantic Ocean near North America, winds flow east and south (Figure 3) but hurricanes flow north and west (Figure 2).
D) No, there is no connection. In the Atlantic Ocean near North America, winds flow north and west (Figure 3) but hurricanes travel south and east (Figure 2).

	Figure 3: Map showing storm paths Note: This diagram indicates the path storms take from beginning to end. Most storms begin near the equator and move either north or south towards the poles. Each blue or yellow line indicates a separate storm.  **Figure 4: Global wind patterns** Note: Use data for the Northern Hemisphere only (above the Equator). 
Reason: Cluster Question #_ 4___ Question Type: Table Match Addresses: __x__ DCI: ESS3.B __x__ SEP: Analyzing and	Question 4: Using figure 5, make a prediction of which area is most likely and least likely to have a major hurricane within the next 20 years. **Figure 5: Predicted return period of major hurricanes in years.**

Interpreting Data ___x_ CCC Using patterns to predict. Answer: Most Likely = Area 3 Least Likely = Area 4	Note: >=96kt indicates that these hurricanes are greater than 96 knots (a measurement of wind speed) 
Communicate: Cluster Question #___5___ Question Type: Multiple Select Addresses: __x__ DCI: ESS3.B __x__ SEP: Analyzing and Interpreting Data ___x_ CCC Using patterns to predict. Answer: D, E, F	Question 5: Using all of the information provided, choose 3 statements that accurately describe hurricanes. A. Hurricanes are random events that can happen at any time or place. B. Hurricanes are only affected by wind speed and location. C. Hurricanes occur where warm water moves from the poles to the equator and produces high winds. D. Certain areas are at greater risk of hurricanes than other areas. E. Patterns of currents, winds, locations, and temperatures all have effects on the locations of hurricanes. F. Hurricane storms move from the equator towards the poles.
Proficiency Scale	
Proficient Student Explanation: Using all of the information provided, students will choose 3 statements that accurately describe hurricanes. A. Certain areas are at greater risk of hurricanes than other areas. B. Patterns of currents, winds, locations, and temperatures all have effects on the locations of hurricanes. C. Hurricane storms move from the equator towards the poles.	

Level 1 - Emerging	Level 2 - Partially Proficient	Level 3 - Proficient	Level 4 - Extending
SEP: Does not meet the minimum standard to receive a 2.	**SEP:** Analyze and interpret data to make sense of phenomena, using logical reasoning.	**SEP:** Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify relationships. Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. Distinguish between causal and correlational relationships in data. Analyze and interpret data to provide evidence for phenomena. Apply concepts of statistics and probability to analyze and characterize data. Analyze and interpret data to determine similarities and differences in findings.	**SEP:** Extends beyond proficient in any way.
CCC: Does not meet the minimum standard to receive a 2.	**CCC:** Uses similarities and differences in patterns to sort, classify, communicate, and analyze simple rates of change for natural phenomena. Uses patterns of change to make predictions. Uses patterns as evidence to support an explanation.	**CCC:** Recognizes that patterns in rates of change and other numerical relationships can provide information about natural systems. Uses patterns to identify cause and effect relationships. Uses graphs, charts, and images to identify patterns in data.	**CCC:** Extends beyond proficient in any way.
DCI: Does not meet the minimum standard to receive a 2.	**DCI:** A variety of natural hazards result from natural processes.	**DCI:** Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.	**DCI:** Extends beyond proficient in any way.

(Student Facing Format on following page)

Name: _____ Date: _____

Stimulus

Watch this animation and observe patterns in the 2005 hurricane season:
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A person notices that hurricanes in the United States happen mostly on the East Coast and come from the Atlantic Ocean.

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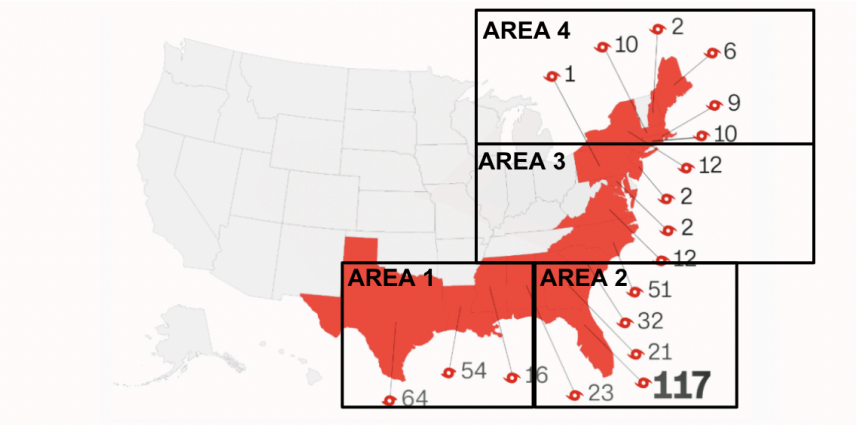

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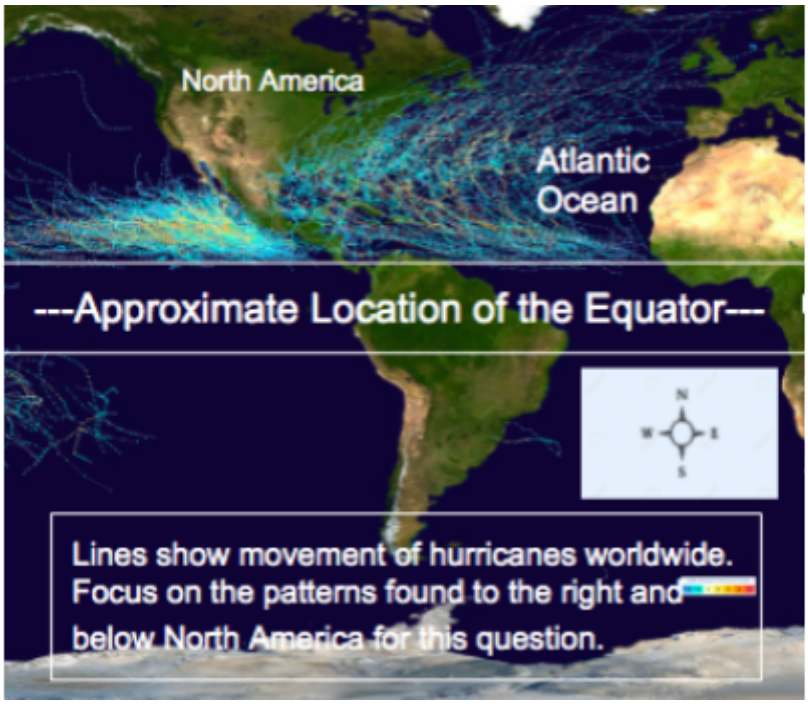


This diagram indicates the path storms take from beginning to end. Most storms begin near the equator and move either north or south towards the poles. Each blue or yellow line indicates a separate storm.

Figure 4: Global Wind Patterns

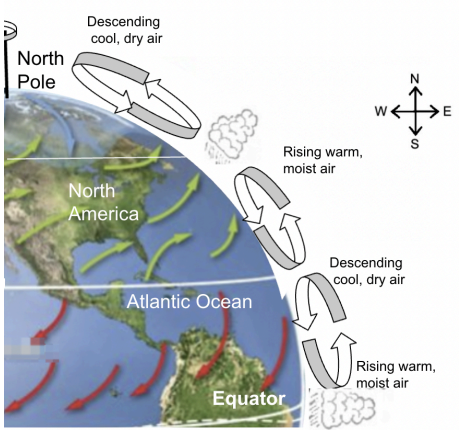
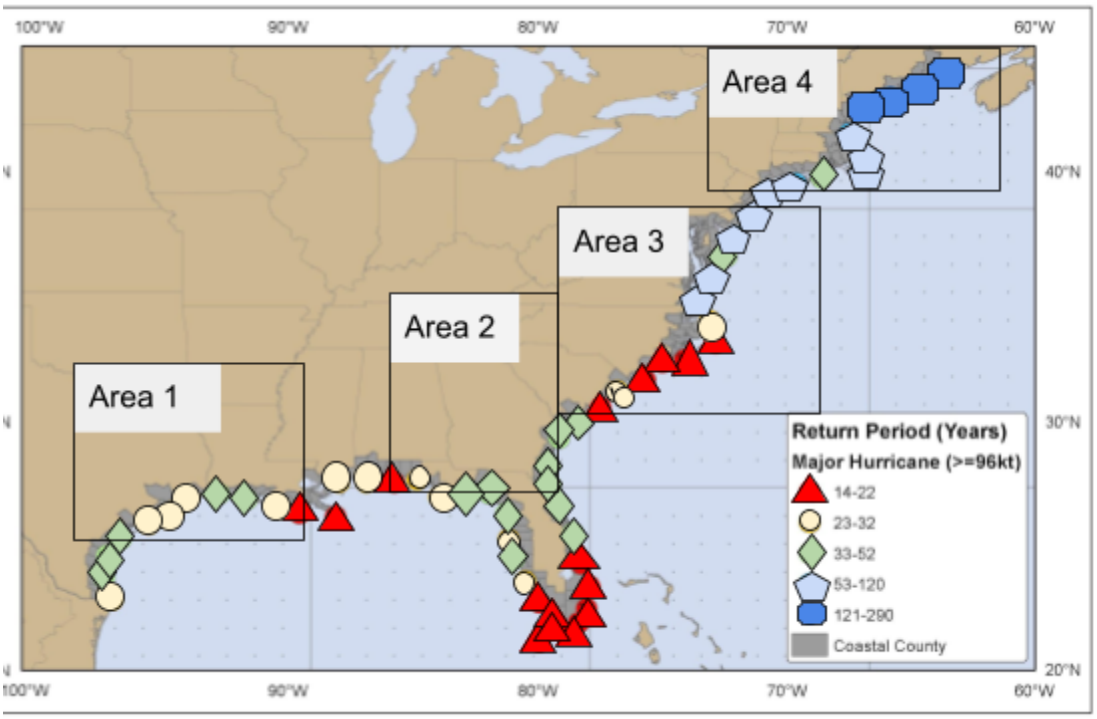


Figure 5: Predicted return period of major hurricanes in years.



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1	74-95	65-83
Non-Hurricane Classifications		
Tropical Storm	39-73	34-64
Tropical Depression	0-38	0-33

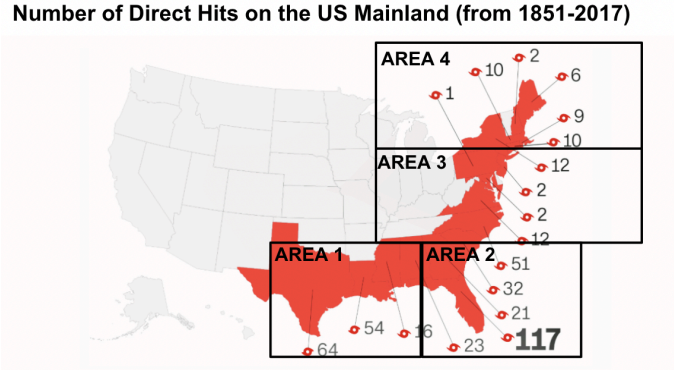
Your Task

In the questions that follow, you will analyze, interpret, and ultimately explain the patterns shown in the animation using the data provided.

Question 1

Using Figure 2 below, look for patterns of hurricane occurrence. Where is the area of greatest risk for hurricanes?

Figure 2: Direct hurricane hits on US mainland (1851-2017)



A. Area 1
B. Area 2
C. Area 3
D. Area 4
E. All areas are under the same threat.

Question 2

Hurricane intensity is often measured by the Saffir-Simpson Scale of cyclone intensity and is based on measurements of sustained wind speed; it categorizes hurricanes from 1 (lowest intensity) to 5 (most intense). The technical definition of a hurricane is winds of 74 miles per hour or greater, sustained for 1 minute.

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Non-Hurricane Classifications		
Tropical Storm	39-73	34-64
Tropical Depression	0-38	0-33

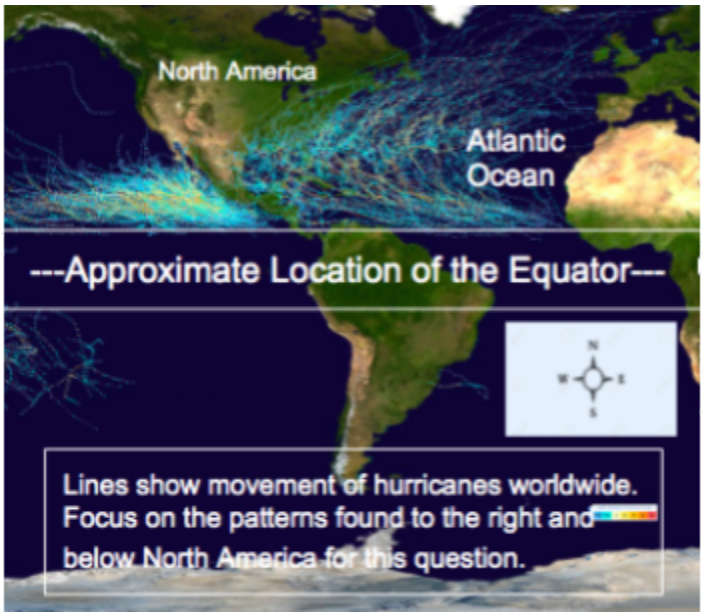
Column A: Storm	Column B: Category
Storm A currently has wind speeds of 120 mph.	
Storm B currently has wind speeds of 75 knots.	
Storm C currently has wind speeds of 64 mph.	
Storm D currently has wind speeds of 187 mph.	
Storm E currently has wind speeds of 33 mph.	

Question 3

Based on these two images below (Figures 3 and 4), determine if there is a connection between global wind patterns and the movement patterns of hurricanes. Which claim, evidence and reasoning below best explains that connection?

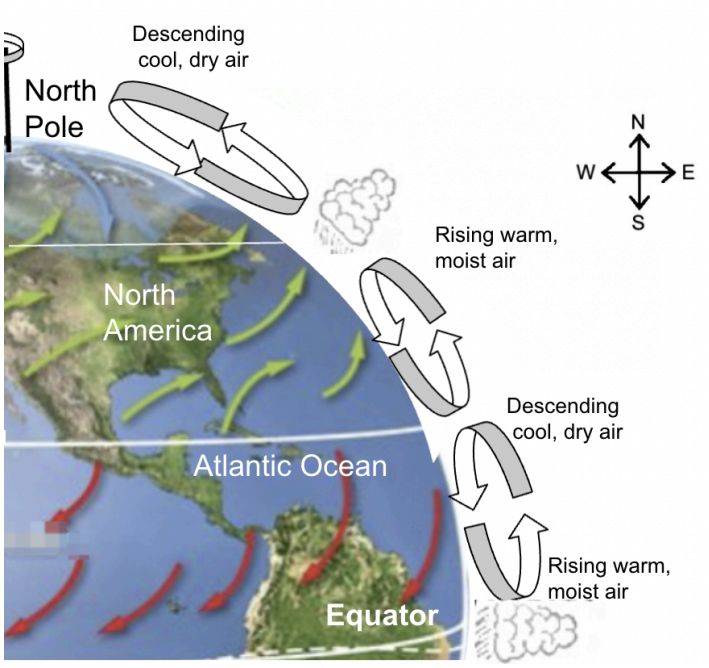
A) Yes there is a connection. In the Atlantic Ocean near North America, winds are flowing in the direction of south and east (Figure 3), similar to the direction of hurricane movement (FIgure 2).
B) Yes there is a connection. In the Atlantic Ocean near North America, winds are flowing in the direction of north and west (Figure 3), similar to the direction of hurricane movement (Figure 2).
C) No, there is no connection. In the Atlantic Ocean near North America, winds flow east and south (Figure 3) but hurricanes flow north and west (Figure 2).
D) No, there is no connection. In the Atlantic Ocean near North America, winds flow north and west (Figure 3) but hurricanes travel south and east (Figure 2).

Figure 3: Map showing storm paths



Note: This diagram indicates the path storms take from beginning to end. Most storms begin near the equator and move either north or south towards the poles. Each blue or yellow line indicates a separate storm.

Figure 4: Global wind patterns

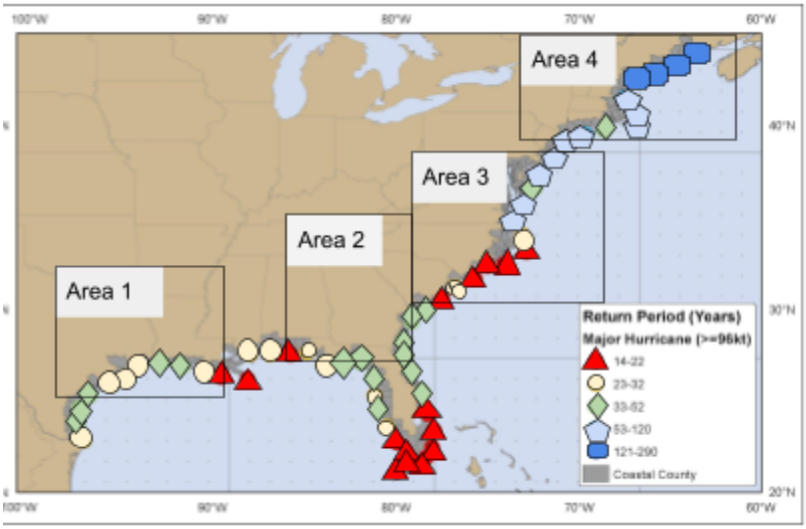


Note: Use data for the Northern Hemisphere only (above the Equator).

Question 4:

Figure 5: Predicted return period of major hurricanes in years.

Note: >=96kt indicates that these hurricanes are greater than 96 knots (a measurement of wind speed)



Using figure 5, make a prediction of which area is most likely and least likely to have a major hurricane within the next 20 years.

_____

_____

Question 5

Using all of the information provided, choose 3 statements that accurately describe hurricanes.

A. Hurricanes are random events that can happen at any time or place.
B. Hurricanes are only affected by wind speed and location.
C. Hurricanes occur where warm water moves from the poles to the equator and produces high winds.
D. Certain areas are at greater risk of hurricanes than other areas.
E. Patterns of currents, winds, locations, and temperatures all have effects on the locations of hurricanes.
F. Hurricane storms move from the equator towards the poles.