



## NAME OF THE LESSON

*Grade(s): 9-12*  
*Lesson Duration: Class Nine 55-minute class periods*  
*Course Name(s): Regents Earth Science*  
*Lesson Author: Lynsey Spaeth, New York City, New York*

### BIG IDEAS

*In this 5E lesson sequence, students will explore how hurricanes (cyclone) frequency has occurred over time and around the world. Students will begin by examining NASA images of recent Tropical Storms and Hurricanes that have affected New York State. Students will connect their prior experience with these weather systems to share with the class their initial ideas about these types of storms. Then students will engage in an activity where they map frequency and distributions of hurricanes, the time of year the hurricanes occur, and track a hurricane using latitude and longitude over the course of the tropical storm/hurricane's existence. Students will read a grade-level text about tropical storm and hurricane formation and then construct a scientific explanation of why hurricanes are more frequently experienced in the Gulf of Mexico/Caribbean rather than in New York State. Students will watch a TED talk on climate resilient/hurricane safe buildings, design a building and create a "prototype" out of classroom materials using hurricane safety principles. Finally, the student prototypes will be tested using a hurricane simulator (a fan set on high).*

### EDUCATION STANDARDS

NGSS Performance Expectation(s):

**HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Science and Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
<p><b>Constructing Explanations and Designing Solutions</b>            Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural</p>	<p><b>ESS3.B: Natural Hazards</b>            Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.</p>	<p><b>Cause and Effect</b>            Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p>

world operate today as they did in the past and will continue to do so in the future.		
<p><b>Common Core State Standards:</b></p> <p><b>Math: MP.2</b> Reason abstractly and quantitatively.  <b>AI-N.Q.1</b> Select quantities and use units as a way to: i) interpret and guide the solution of multi-step problems; ii) choose and interpret units consistently in formulas; and iii) choose and interpret the scale and the origin in graphs and data displays.  <b>AI-N.Q.3</b> Choose a level of accuracy appropriate to limitations on measurement and context when reporting quantities.</p> <p>and</p> <p><b>ELA:9-10.WHST.2</b> Write informative/explanatory text focused on discipline-specific content.  <b>11-12.RST.1</b> Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc., attending to the precise details of the source, and attending to important distinctions the author makes and to any gaps or inconsistencies in the account.</p> <p><b>State Standards:</b>  New York State Physical Setting/Earth Science Core Curriculum  <b>4.2.1h</b> Atmospheric moisture, temperature and pressure distributions; jet streams, wind; air masses and frontal boundaries; and the movement of cyclonic systems and associated tornadoes, thunderstorms, and hurricanes occur in observable patterns. Loss of property, personal injury, and loss of life can be reduced by effective emergency preparedness.  <b>4.2.1i</b> Seasonal changes can be explained using concepts of density and heat energy. These changes include the shifting of global temperature zones, the shifting of planetary wind and ocean current patterns, the occurrence of monsoons, hurricanes, flooding, and severe weather.</p> <p><b>2.IS.3</b> Information technology can have positive and negative impacts on society, depending upon how it is used. For example:  • discuss how early warning systems can protect society and the environment from natural disasters such as hurricanes, tornadoes, earthquakes, tsunamis, floods, and volcanoes</p>		
<p><b>ITEEA Standards:</b>  <b>STEL-1N.</b> Explain how the world around them guides technological development and engineering design.  <b>STEL-1Q.</b> Conduct research to inform intentional inventions. And innovations that address specific needs and wants.  <b>STEL-1R.</b> Develop a plan that incorporates knowledge from science, mathematics, and other disciplines to design or improve a technological product or system.</p>		
<p><b>Other Standards: None</b></p>		

## MEASURABLE STUDENT LEARNING OBJECTIVES

Students will be able to:

- Examine NASA images and NY Times Videos of tropical storms and hurricanes
- Recall tropical storms and hurricanes that they have experienced

- Describe their personal experiences with tropical storms or hurricanes
- Map frequency and distribution of hurricanes
- Graph time of year that hurricanes typically occur by region
- Map the distribution of warm water
- Plot the track of a hurricane using latitude and longitude over the course of the storm's existence
- Read a grade-level text about tropical storm/hurricane formation
- Construct a scientific explanation of why hurricanes are more frequently experienced in the Gulf of Mexico rather than in New York State
- Research, design, and build a "prototype" of a hurricane safe building
- Test "prototype" of the hurricane safe building
- Reflect on "prototype's" success/failure

## MATERIALS NEEDED

- Engage: [NASA Image of Hurricane Lee](#)
- Engage: [NASA Image of Tropical Storm Franklin over the Dominican Republic](#)
- Engage: [NY Times Video of Tropical Storm Ophelia](#)
- Engage Worksheet: See-Think-Wonder
- Explore 1 Worksheet: Where do hurricanes happen? How many hurricanes happen? When do hurricanes happen? Where's the warm water? (*modified from [https://www.windows2universe.org/teacher\\_resources/hurricane\\_climate/teach\\_hurricane\\_climate.html&nl=](https://www.windows2universe.org/teacher_resources/hurricane_climate/teach_hurricane_climate.html&nl=)*)
- Explore 2 Worksheet: Tracking Hurricane Sandy (modified from an activity by Kaitlyn Coder – [Teachers Pay Teachers](#))
- Explain 1 Worksheet: How Do Hurricanes Form? (Modified from Earth Science Interactive Textbook (by Holt, Rinehart and Winston) and [CK-12 Earth Science Concepts for High School](#))
- Explain 1: [NOAA SciJinks YouTube Video](#)
- Explain 2 Worksheet: Constructing a Scientific Explanation Tool ([Modified from AMNH](#))
- Elaborate: [TED Talk on climate resilient \(hurricane safe\) buildings](#)
- Elaborate Worksheet: Designing a prototype
- Elaborate: Building materials (tooth picks, sticks, straws, paper, cotton balls, etc.)
- Evaluate Worksheet: Reflection questions

## ENGAGING CONTEXT/PHENOMENON

This lesson will begin with images of Hurricanes or Tropical Storms from NASA's EARTHDATA Website. The images show various hurricanes (Hurricane Lee, 2023, and Tropical Storm Franklin, 2023) and the New York Times video of Hurricane Ophelia (2023). Students will complete a See-Think-Wonder chart making observations, inferences, and asking questions based on the images and videos. Students will also be asked to recall recent hurricanes or tropical storms experienced in New York (or places they have lived in). Students will share their personal stories about the phenomenon.

## DATA INTEGRATION

Students will be using already collected data to make color-coded maps to analyze and interpret where hurricanes happen, graph how many hurricanes happen, and creating a histogram of hurricane occurrence around the world. Then students will explore where water is warm around the world and plot that data on a map followed by examining data from Hurricane Sandy and plotting the latitude and

longitude of the hurricane over time on a map. Students will interpret their data and answer analysis questions.

## TEACHER BACKGROUND KNOWLEDGE

The teacher should be familiar with high and low air pressure cells and how they interact to create storms. Additionally, teachers should be able to describe how hot air is often found near the equator and rises creating clouds. The rising hot air causes low pressure cells. Thunderstorms can begin to form around the cell. When this occurs over warm, open ocean water, the heat from the ocean can fuel more evaporation and the storm will grow continuing to form a hurricane. [This YouTube video from NOAA SciJinks explains the formation of hurricanes well.](#)

## DIFFERENTIATION OF INSTRUCTION

Accommodations:

1. Vocabulary comprehension (for ELLs and struggling readers/writers): New vocabulary will be added to the word wall and sentence starters on worksheet.
2. Graphing (for students who struggle with math): Give students a modified worksheet with one piece of data completed on the worksheet as an example.
3. For students who struggle plotting latitude and longitude: teacher will remind student to utilize notes from prior lessons on latitude and longitude
4. Constructing explanations (for ELLs and struggling writers): sentence stems will be provided in their graphic organizer
5. For students who struggle with research: a list of articles and videos will be provided to students upon request

### Groups:

Students work in groups of three to four students to complete the Elaborate sections. These heterogenous groups will be based on prior assessments. Some students may be grouped homogeneously so the teacher can better support their group. Students with extensive social-emotional needs may also be placed in particular groups to provide additional support.

## REAL-WORLD CONNECTIONS FOR STUDENTS

On Friday September 29, 2023, New York City was inundated by rain from Tropical Storm Ophelia. The massive amounts of rain that fell across the five boroughs led to extensive flooding of subways and highways limiting travel inside and outside of the greater NYC metro area. Students in NYC were impacted by this event. Previously in 2021 NYC experienced similar flooding and massive casualties during Hurricane Ida. Many NYC students also are from Dominican Republic or have been to the Caribbean and have experienced hurricanes first hand. Students are able to relate the damage they have experienced from hurricanes in the classroom and discuss ways lives are impacted by these massive storms. As the climate changes, hurricanes will continue getting stronger and more frequent. This will result in additional flooding and wind damage to buildings will become more commonplace.

## POSSIBLE PRIOR or MISCONCEPTIONS

1. Winds are the deadliest aspect of hurricanes.
2. If sea surface temperatures are warm, the hurricane will intensify.
3. Taping your windows will prevent them from breaking.
4. Tropical storms are not as serious as a hurricane

Misconceptions taken from: [UCF Expert Debunks 4 Myths about Hurricanes](#)

## LESSON PROCEDURE

5E	<b>Details of 5E Lesson Implementation</b> <i>(Visit <a href="#">BSCS</a> to learn more about the 5E instructional model)</i>
<p><b>Engage</b>  <i>Expected time frame: one 55-minute lesson</i></p>	<p><b>Lesson Objective:</b></p> <ul style="list-style-type: none"> <li>• Examine NASA images and NY Times Videos of tropical storms and hurricanes</li> <li>• Recall tropical storms and hurricanes that they have experienced</li> <li>• Describe their personal experiences with tropical storms or hurricanes</li> </ul> <p><b>Procedure:</b>            Students examine images of Hurricanes or Tropical Storms from NASA's EARTHDATA Website. The images show various hurricanes (Hurricane Lee, 2023, and Tropical Storm Franklin, 2023) and the New York Times video of Hurricane Ophelia (2023). Students will complete a See-Think-Wonder chart making observations, inferences, and asking questions based on the images and videos. Students will also be asked to recall recent hurricanes or tropical storms experienced in New York (or places they have lived in). Students will share their personal stories about the phenomenon. Teacher monitors student's completion of See-Think-Wonder chart and facilitates class discussion of student experiences of hurricanes.</p> <p><b>Modifications</b></p> <ol style="list-style-type: none"> <li>1. Vocabulary comprehension (for ELLs and struggling readers/writers): New vocabulary will be added to the word wall and sentence starters on worksheet.</li> </ol> <p><b>Standards Addressed</b> See standards listed above on page 1 and 2</p> <p><b>Formative/Summative Assessments</b> Student's worksheets will be collected and feedback will be provided. Informal assessment will occur as teacher checks in with students during the lesson.</p> <p><b>Resources</b></p> <ul style="list-style-type: none"> <li>• <a href="#">NASA Image of Hurricane Lee</a></li> <li>• <a href="#">NASA Image of Tropical Storm Franklin over the Dominican Republic</a></li> <li>• <a href="#">NY Times Video of Tropical Storm Ophelia</a></li> <li>• Engage Worksheet: See-Think-Wonder</li> </ul>
<p><b>Explore</b>  <i>Expected time frame: two 55-minute lessons</i></p>	<p><b>Lesson Objective:</b></p> <ul style="list-style-type: none"> <li>• <b>Day 1:</b> Map frequency and distribution of hurricanes</li> <li>• <b>Day 1:</b> Graph time of year that hurricanes typically occur by region</li> <li>• <b>Day 2:</b> Map the distribution of warm water</li> <li>• <b>Day 2:</b> Plot the track of a hurricane using latitude and longitude over the course of the storm's existence</li> </ul> <p><b>Procedure:</b></p>

**Day 1:** Students will be using already collected data to make color-coded maps to analyze and interpret where hurricanes happen, graph how many hurricanes happen, and create a histogram of hurricane occurrence around the world. Students will interpret their data and answer analysis questions. **Day 2:** Then students will explore where water is warm around the world and plot that data on a map followed by examining data from Hurricane Sandy and plotting the latitude and longitude of the hurricane over time on a map. Students will interpret their data and answer analysis questions. Teacher will need to project images onto a SmartBoard for students to use to graph the distribution of hurricanes and distribution of warm water. Teacher will circulate among students making sure they are on task and completing each of the graphs, maps, or latitude/longitude tracking.

**Modifications**

1. Graphing (for students who struggle with math): Give students a modified worksheet with one piece of data completed on the worksheet as an example.
2. For students who struggle plotting latitude and longitude: teacher will remind student to utilize notes from prior lessons on latitude and longitude

**Standards Addressed** See standards listed above on page 1 and 2

**Formative/Summative Assessments** Student's worksheets will be collected and feedback will be provided. Informal assessment will occur as teacher checks in with students during the lesson.

**Resources**

- Explore 1 Worksheet: Where do hurricanes happen? How many hurricanes happen? When do hurricanes happen? Where's the warm water? (modified in organization and formatting to fit the needs of my students from [https://www.windows2universe.org/teacher\\_resources/hurricane\\_climate/teach\\_hurricane\\_climate.html&nl=](https://www.windows2universe.org/teacher_resources/hurricane_climate/teach_hurricane_climate.html&nl=))
- Explore 2 Worksheet: Tracking Hurricane Sandy (modified in organization and formatting to fit the needs of my students from an activity by Kaitlyn Coder – [Teachers Pay Teachers](#))

**Explain**

*Expected time frame: two 55-minute lessons*

**Lesson Objective:**

- **Day 1:** Read a grade-level text about tropical storm/hurricane formation
- **Day 2:** Construct a scientific explanation of why hurricanes are more frequently experienced in the Gulf of Mexico rather than in New York State

**Procedure:**

**Day 1:** Students will read a grade-level text about tropical storm/hurricane formation. Teacher will circulate around the room and work with students who struggle with reading or are learning English.

Students will complete the comprehension questions. Teacher will show a video summarizing how hurricanes form. **Day 2:** Students will construct a scientific explanation of why hurricanes occur more frequently in the Gulf of Mexico (Caribbean) than in New York State. Students will use the constructing scientific explanations tool to assist in identifying the evidence and science reasoning that supports the claim that New York State has fewer hurricanes because of its latitude in relation to the equator. Teacher will be going around the room to assist students as they identify their evidence and reasoning.

**Modifications**

1. Vocabulary comprehension (for ELLs and struggling readers/writers): New vocabulary will be added to the word wall and sentence starters on worksheet.
2. Constructing explanations (for ELLs and struggling writers): sentence stems will be provided in their graphic organizer

**Standards Addressed** See standards listed above on page 1 and 2

**Formative/Summative Assessments** Student’s worksheets will be collected and feedback will be provided. Informal assessment will occur as teacher checks in with students during the lesson.

**Resources**

- Explain 1 Worksheet: How Do Hurricanes Form? (*Texts modified to be at grade-level reading from Earth Science Interactive Textbook (by Holt, Rinehart and Winston) and [CK-12 Earth Science Concepts for High School](#)*)
- Explain 1: [NOAA SciJinks YouTube Video](#)
- Explain 2 Worksheet: Constructing a Scientific Explanation Tool (*Modified from AMNH with guiding questions for the specific explanation question students are answering and re-formatted into easier to follow organization to place evidence, reasoning, and completed paragraph explanation*)

**Elaborate**

*Expected time frame: three 55-minute lessons*

**Lesson Objective:**

- Research, design, and build a “prototype” of a hurricane safe building

**Procedure:**

Students will watch a TED Talk on climate resilient buildings. Then, working in groups, they will research buildings that are better in hurricanes. Students will work together to design and build a prototype of their building based on their researched ideas to later test. The teacher will be supporting group of students as they research different building materials in the real-world, and helping students compare those materials to real-world items such as ply wood, brick, window glass, etc. Students then spend their time designing and building a prototype to test during the evaluate stage of the unit.

	<p><b>Modifications</b></p> <ol style="list-style-type: none"> <li>1. For students who struggle with research: a list of articles and videos will be provided to students upon request</li> </ol> <p><b>Groups:</b></p> <p>Students work in groups of three to four students to complete the Elaborate sections. These heterogenous groups will be based on prior assessments. Some students may be grouped homogeneously so the teacher can better support their group. Students with extensive social-emotional needs may also be placed in particular groups to provide additional support.</p> <p><b>Standards Addressed</b> See standards listed above on page 1 and 2</p> <p><b>Formative/Summative Assessments</b> Student's worksheets will be collected and feedback will be provided. Informal assessment will occur as teacher checks in with students during the lesson.</p> <p><b>Resources</b></p> <ul style="list-style-type: none"> <li>• TED Talk on climate resilient (hurricane safe) buildings</li> <li>• Elaborate Worksheet: Designing a prototype</li> <li>• Building materials (tooth picks, sticks, straws, paper, cotton balls, etc.)</li> </ul>
<p><b>Evaluate</b>  <i>Expected time frame: one 55-minute lesson</i></p>	<p><b>Lesson Objective:</b></p> <ul style="list-style-type: none"> <li>• Test "prototype" of the hurricane safe building</li> <li>• Reflect on "prototype's" success/failure</li> </ul> <p><b>Procedure:</b> Teacher will use a fan on high speed to test the prototype building for each group. Teacher will turn on fan at low, medium, and finally high speed to determine what type of "hurricane" each building would be rated to withstand. Students then must reflect on the successes and failures of their specific prototypes and then answer reflection questions.</p> <p><b>Modifications</b></p> <ol style="list-style-type: none"> <li>1. Vocabulary comprehension (for ELLs and struggling readers/writers): New vocabulary will be added to the word wall and sentence starters on worksheet.</li> <li>2. Constructing explanations (for ELLs and struggling writers): sentence stems will be provided in their graphic organizer</li> </ol> <p><b>Standards Addressed</b> See standards listed above on page 1 and 2</p> <p><b>Formative/Summative Assessments</b> Student's project will be tested. Students must reflect on the success/failure of their design. Teacher will collect final reflection on prototype for final grade.</p> <p><b>Resources</b></p>

## REFERENCES

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