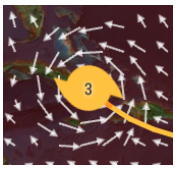

Hurricane Module: Introduction

"The intensity, frequency, and duration of North Atlantic hurricanes, as well as the frequency of the strongest hurricanes, have all increased since the early 1980s. Hurricane intensity and rainfall are projected to increase as the climate continues to warm." -National Climate Assessment, 2014
https://nca2014.globalchange.gov/report/our-changing-climate/changes-hurricanes

Increasingly destructive hurricanes are putting a growing number of people and structures at risk. While hurricanes are a natural part of our climate system, the majority of scientists agree that the trend in increased hurricane intensity will continue as global temperatures rise. The NSF-funded **GeoHazard: Modeling Natural Hazards and Assessing Risks** project has developed an online curriculum for middle and high school students to explore this issue. The Hurricane Module has been designed to reveal important concepts necessary for students to develop a deep understanding of what factors impact hurricane tracks and intensity. As students explore these variables through our interactive Hurricane Explorer model and real-world case studies, they also consider how hurricanes impact people and their communities, exploring the potential risks associated with higher intensity storms, and the associated increase in wind speeds, storm surge, and precipitation levels.

Using the Hurricane Explorer model, students can adjust the location and magnitude of low and high pressure systems, change the seasons (winter, spring, summer and fall), and observe how the path and intensity of hurricanes in the Atlantic Ocean are affected by these variables. Students will learn that the people living in highly populated cities along the east coast of the United States and the Caribbean are at the most risk of being impacted by hurricane hazards. Coastal communities are especially vulnerable to flooding due to both precipitation and storm surge; however, as sea levels rise, these hazards will be both more severe and impact communities further and further inland. In addition to the model, students will explore real-world case studies to investigate the ways in which hurricane hazards impact people, infrastructure and the environment.

Throughout the five-activity module, students build their understanding of both hurricanes and their associated risks. By the final activity, students will be better able to answer the guiding question:

How will hurricane risks and impacts change over the next 100 years?

There are five activities in this module.

- **Activity 1: Intro to Hurricanes** The goal of this activity is to introduce students to the topic of hurricanes using a real-world example, Hurricane Florence (September, 2018). Students will explore the factors related to hurricane predictions and *consider how hurricanes impact people and their communities when they make landfall*.
- **Activity 2: Pressure Systems** In order for students to understand how rising global temperatures affect the intensity and risk of hurricanes, they first need to learn more about how hurricanes move. While we cannot predict exactly where a hurricane will hit, understanding how high and low pressure systems affect the path of hurricanes can help understand hurricane tracks. The goal of this activity is to have students *investigate how high and low pressure systems affect the movement of hurricanes* as they travel across the southern Atlantic ocean.
- **Activity 3: Hurricane Formation and Strength** The goal of this activity is to have students use Hurricane Explorer to investigate the role of seasonal changes on hurricane formation and *the effect of sea surface temperature on hurricane intensity*. Students will use the Hurricane Explorer to investigate how these factors influence hurricane formation, growth and, ultimately, dissipation.
- **Activity 4: Hurricane Hazards** In this activity, students will investigate Hurricane Maria, which struck Puerto Rico in 2017. The goal of this activity is to help clarify what makes a hazard and who is at risk from a hurricane. Only those hurricanes that make landfall are considered hazardous to people and their communities. *While the people living in the direct path of the hurricane are at most at risk, any community located next to a hurricane's path can sustain storm damage including wind damage as well as flooding from rain and storm surge.* By the end of this activity, students will be able to use both models and real-world data to describe the dangers that a hurricane might pose to people and communities when it makes landfall including damage from storm surges, strong winds, and heavy precipitation.
- **Activity 5: Hurricane Impacts** This is the final activity in the module where students try to answer the question: **How will hurricane risks and impacts change over the next 100 years?** Only those hurricanes that hit land are considered hazardous to people and their communities. In this activity, students will investigate Hurricane Florence, which like Maria, made landfall in 2018. By the end of this activity, students will combine the evidence that they have collected through models and real-world data to describe the dangers that a hurricane might pose to people and communities when it makes landfall. *After students consider the impact that rising global temperature makes on hurricane risks including damage from storm surges, strong winds, and heavy precipitation, they will consider ways to mitigate these risks.*

This is an inquiry-based module, containing multiple investigations. There are many times where explanations and understanding develop over time. You will need to help facilitate this without jumping the gun and providing students with the answers. In service of this facilitation, we provide teacher tips, discussion points, and offline activities that are in alignment with the theory and concepts of Ambitious Science Teaching (AST). AST is a collection of high-leverage practices that seek to support student learning of science through inquiry and authentic science

discussion. With these practices, student understanding will be developed over time through collaborative sensemaking and purposefully scaffolded opportunities to develop and amend models and explanations. Remember, simulations/visualizations allow students to experiment with otherwise inaccessible concepts. Allow students time for experimentation and discussion.

The module that you will run is the same as the student version except that, as a teacher, you are able to view an additional layer of teacher tips and support materials. In each activity, you will find tips covering the following categories. To ensure success, **make sure to run the entire Teacher Edition of the module and open and read all of the tips!**

Theory & Background will provide you with the learning objectives of the instructional model developed for this sequence of activities.

Teacher Tips are instructional resources and methods that you may find useful to help your students achieve their learning goals.

Digging Deeper components provide additional subject matter and related topics that you may find helpful in furthering your students' deeper understanding of the content.

Discussion Points highlight questions that may help prompt classroom discourse with the goal of expanding students' understanding.