

Introduction

In this module, students explore the occurrence, characteristics, and hazards of tropical cyclones by examining world data sets of storms occurring during the past century.

Module goal

By completing this module, students will understand where, when, and how tropical cyclones form. They will learn about the forces that generate and sustain tropical cyclones. Further, they will understand the risks associated with hurricanes in the US and their impact on society.

Key concepts

The module emphasizes six basic concepts.

- Heat is a driving force in generating tropical cyclones.
- The Coriolis effect initiates rotation of tropical cyclones.
- Differences in temperature and pressure create winds.
- The physics and behavior of tropical cyclones can be understood, allowing predictions to be made.
- The high population density on the coastlines of the US results in high levels of hurricane risk.
- Better observation, forecasting, and communication can minimize hurricane-related damage and fatalities.

Module overview

This module contains four units that introduce students to the causes and effects of tropical cyclones.

Learning objectives

Unit 1 objectives

In this unit, students will

- explore where tropical cyclones do and do not form;
- explain when tropical cyclones form, and relate their seasonal nature to the hemisphere in which they form; and
- relate seasonal sea surface temperature conditions to tropical cyclone formation.

Unit 1 – Recipe for a Cyclone

- 1.1 – **The Great Hurricane of 1900** draws students into thinking about tropical cyclones and their hazards by reading and discussing a historical eyewitness account of the 1900 Galveston Island hurricane, the most deadly natural disaster in US history.
- 1.2 – **Discovering cyclone patterns** examines where and when tropical cyclones occur as well as where they *do not* occur. Exploring data for global tropical cyclones over the past century, students discover patterns and form hypotheses about the factors that control tropical cyclone development and movement.
- 1.3 – **Understanding tropical cyclone physics** introduces the forces involved in tropical cyclone formation and movement.
- 1.4 – **Powering tropical cyclones** tests the hypothesis that cyclone formation is dependent on sea surface temperature, and determines the threshold temperature required for cyclogenesis.
- 1.5 – **Solving the cyclone puzzle** explores the factors that prevent tropical cyclones from forming in certain areas where they are otherwise expected.

Unit 2 objectives

In this unit, students will

- identify basic tropical cyclone structure and rotation;
- identify the stages in the life cycle of a tropical cyclone, from tropical disturbance through hurricane;
- relate tropical cyclone images to data describing central pressure and wind speed; and
- show where Atlantic hurricanes form, how they move, where they die out, and how their location affects their wind speed.

Unit 3 objectives

In this unit, students will

- use appearance and surface data to determine hurricane category;
- describe the relationship between Saffir-Simpson category and economic impact on society;
- compare characteristics of destructive hurricanes to those of “average” hurricanes;
- investigate hurricanes and society in pre-historical, historical, and present-day context, focusing on the role of coastal population growth on increasing hurricane hazards; and
- identify hurricane risks for major East Coast cities using hurricane landfall probability data.

Unit 4 objectives

In this unit, students will

- identify the physical factors that increase hurricane damage;
- determine the probability of a hurricane striking New York City;
- identify at-risk populations and propose strategies for allocating resources in the event of an emergency;
- use their knowledge of hurricane risks to establish emergency management procedures; and
- conduct a study of the effects of a hurricane on community infrastructure.

Unit 2 – The Life of a Cyclone

- 2.1 – **Observing tropical cyclones** compares and contrasts the various technologies used to observe and measure tropical cyclones.
- 2.2 – **Tracking Hurricane Georges** follows the development of Hurricane Georges from a tropical storm until it makes landfall. Students examine daily satellite views and surface conditions to see how these characteristics are related to each stage in the cyclone’s development.
- 2.3 – **Classifying tropical cyclones** describes the four stages in the development of tropical cyclones and introduces the Saffir-Simpson intensity scale. Students use surface data to practice classifying hurricanes.
- 2.4 – **Monitoring cyclone growth** uses surface data and satellite images of Hurricane Georges to reinforce the linkage between a storm’s appearance and its classification. Finally, students examine wind speed data for Atlantic basin hurricanes and look for patterns related to the development of major hurricanes.

Unit 3 – Hurricane Hazards

- 3.1 – **Sources of hurricane risk** explores the major hazards from hurricanes and the causes and implications of each.
- 3.2 – **The top ten US hurricanes** examines characteristics of the 10 most damaging hurricanes on the US Atlantic and Gulf Coasts and how they differ from less devastating major hurricanes.
- 3.3 – **Exploring hurricane hazards** discusses hurricane damage throughout history and highlights hazards from famous storms.
- 3.4 – **Risk to coastal communities** uses risk probability maps and census data to rank the risk level of major cities near the Atlantic and Gulf Coasts, and estimates the number of people at risk in coastal counties.

Unit 4 – Hurricanes in the Big Apple

- 4.1 – **Analyzing physical factors** examines the relationship between topography and damage in a direct hit on New York City by hurricanes of various intensities. Students find and compare the area affected by storm surge for each category.
- 4.2 – **Managing emergencies** looks at how emergency management agencies plan for hurricanes and their effects.
- 4.3 – **Addressing demographic factors** quantifies the effects of storm surge on three at-risk populations in New York City: the poor, the elderly, and non-English speakers.
- 4.4 – **Assessing infrastructure** is an open-ended investigation of the effects of a major hurricane on city infrastructure. Given demographic data, locations of schools and hospitals, exit routes from the city and other information, students are challenged to identify areas requiring higher levels of assistance from emergency management personnel. This open-ended investigation provides data and suggestions for getting started with the analysis, but allows students to pursue their own directions and apply their GIS skills and knowledge of tropical cyclones.