# PART 1

## Storms

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INTRODUCTION
What causes volcanoes in Hawaii? Why do earthquakes happen more often in California than in Virginia? Where do hurricanes and tornadoes form, and how are they different? You may have wondered about such questions. Natural catastrophic events are powerful and often dramatic forces. They can have a major effect on our planet Earth and on the living things on the planet. Each one appears to be an independent event. Yet the combination of these events over billions of years has helped to shape the earth as we know it. They will continue to change the earth in the future.

During this module, you will investigate some of the catastrophic events that have shaped the earth. In this lesson, you will use a map as well as a globe, which show the physical features of the earth’s surface and the clouds in its atmosphere. You will record where on the earth you think these catastrophic events take place. What do these events tell us about the earth? What questions do you have about them? Let’s find out.

OBJECTIVES FOR THIS LESSON
Record your ideas and questions about the earth’s natural catastrophic events.

Compare a globe with a map.

Use a globe and map to focus on the features of the earth.

Record where you think catastrophic events have occurred on the earth and why you think they occurred there.
Getting Started

1. To become familiar with the module, look through the Student Guide.

2. Read the Introduction and the Objectives for This Lesson in Lesson 1.

3. Discuss with the class what you consider to be a “catastrophic event.” What natural events on the earth would you consider to be catastrophic?

4. In your science notebook, create a concept map like the one your teacher has displayed. On it, write the names of as many natural catastrophic events as you can. Record what you know about each one. You may want to use color to distinguish one event from another.

5. Date and title your notebook entry. For the title, write the number and title of this lesson or its inquiry. Do this each time you write anything in your notebook.

MATERIALS FOR INQUIRY 1.1

For you
1 science notebook
1 set of colored pencils, crayons, or marking pens

For your group
1 large sheet of paper or newsprint
1 set of colored markers

MATERIALS FOR INQUIRY 1.2

For you
1 copy of Student Sheet 1.2a: Where on Earth? Pre-Module Assessment

For your group
1 inflatable globe
1 set of multicolored dots
1 Catastrophic Events World Map
Inquiry 1.1
Creating a Group Concept Map

PROCEDURE

1. Get together with your group. Your group will receive a group number to use throughout the module.

2. Pick up the materials you need for Inquiry 1.1. Share with your group the concept map you recorded in your notebook. Working together, create a group concept map on a large sheet of paper. Remember to date and label the sheet. Put your names, class period, and/or your group number on it.

3. Be prepared to share your group's concept map with the class when your teacher asks you to.

Inquiry 1.2
Using a Globe and a World Map

IMAGES OF THE EARTH
During the lessons in Catastrophic Events, you will use a globe, together with a map of the world, to make and record some of your observations of the earth and its catastrophic events. A globe is a spherical model of the earth. A map shows the earth or parts of it, usually on a flat surface.

Photographs such as the one below, taken from the spaceship Apollo 17, show how the earth looks from outer space. Look closely at the image. You can see the earth and some of its seven continents. Vast oceans surround the continents. Clouds, which usually cover about 50 percent of the earth’s surface, swirl above them.

How did the continents form? Why do we have mountains and seas? Why do clouds swirl in the atmosphere? Answers to questions like these will help you understand the causes of earthquakes, volcanoes, and storms on our active planet.

Which continents can you recognize in this photograph of the earth taken from Apollo 17?
PROCEDURE

1. Read “Images of the Earth.”

2. Record your ideas about the earth on Student Sheet 1.2a: Where on Earth? Pre-Module Assessment. Complete Table 1 on your own. Return the completed sheet to your teacher.

3. Your teacher will give your group an inflatable globe. Look at it carefully. Discuss your general observations with your group. How is the globe different from the Apollo image of the earth?

4. Answer the following questions in your science notebook:

   A. Is there any evidence on the globe that the earth’s surfaces are active (or moving)? If so, describe it.

   B. How might you use this globe to learn more about the catastrophic events you discussed in Inquiry 1.1?

   C. How might photographs of the earth taken from space help scientists predict or monitor catastrophic events?

   Be ready to share your ideas with the class.

5. When your group receives the Catastrophic Events World Map, discuss how it is like the globe. How is it different? How is the scale (or size of the objects in relation to the real thing) on the globe different from the scale on the map?

6. Get one set of multicolored dots. As a group, use the dots and the following key to record on your map where you think major catastrophic events might occur most frequently. Remember to color-code the key printed at the bottom of the map.

   Tornado = orange
   Hurricane = green
   Earthquake = blue
   Volcano = red
   Other = yellow

7. Be prepared to share with the class the data your group recorded on its map.

8. Clean up. Your group’s map should be labeled with your group number.

REFLECTING ON WHAT YOU’VE DONE

1. Answer the following questions:

   A. Are any of the catastrophic events that you listed in your notebook or recorded on your world map related to each other in any way? If so, how?

   B. Do any of these events help change the way the earth looks over time? If so, which ones? Why do you think this?

   C. What information do you think can be learned about the earth by studying catastrophic events?

   D. How do you think catastrophic events affect people?

   E. How might scientists predict these events?

2. Record in your notebook any questions you may have about catastrophic events on the earth. Share your questions with the class. As you complete each lesson, try to find answers to these questions.
How do scientists learn about the earth and the things that cause it to change over time? Different kinds of scientists study different aspects of our planet. Scientists who study catastrophic events and the places where they occur usually specialize in a particular area of study.

Meteorologists study the earth’s atmosphere and monitor, study, and forecast the weather. They use direct observation and sensors to learn more about the weather. For example, a thermometer is a sensor. It measures temperature. Anemometers measure wind speed and direction. More sophisticated equipment includes radar, satellites, and computers. Sometimes balloons, aircraft, or rockets fly instruments directly into a storm to obtain data.

Geologists study the history and structure of the earth as it is recorded in rocks. For example, they observe rocks in mountain ranges that formed millions of years ago. They examine how the crust of the earth bends and breaks under pressure.
Seismologists study earthquakes. They examine trenches dug at certain locations for evidence of past earthquakes, for example. They study records of earthquake waves to find out more about the earth’s interior.

Volcanologists study volcanoes and the earth’s internal heat. For example, they investigate active geysers shooting water and steam into the air. They might study steam, water, and mud oozing from cracks in the earth’s surface. They observe lava (melted rock) flowing from volcanic summits.

These and many other kinds of scientists observe catastrophic events for the information they reveal about the earth—from its interior to its constantly changing surface and atmosphere.

Seismologists examine the walls of a trench for evidence of ancient earthquakes.

Volcanologists in Yellowstone National Park study Old Faithful by taking temperature measurements and water samples from the geyser.
Since the beginning of time, people have wanted to view the earth from high in the sky. In 1860, James W. Black, a Boston photographer, took what is believed to be the first successful image of the earth from the sky. He was 370 meters high when he shot the picture.

The airplane was invented in the early 1900s. This led to more sophisticated techniques of taking photographs from the air. Aerial photography could be used for many different things, including assessing damage after an earthquake, tracking the movement of glaciers, and observing erosion along a coastline.

Photographs From Space
After the invention of the airplane, it was only natural that scientists would want to fly even higher—and view the earth from space. In the early 1960s, the National Aeronautics and Space Administration, often called NASA, launched the first satellite that was designed to see what planet Earth looked like from space. TIROS 1 (or Television Infrared Observing Satellite) was a weather satellite—an instrument that orbits the earth, taking photographs and collecting measurements. It took the first pictures of the earth from 640 kilometers above its surface. These photographs confirmed what meteorologists had suspected: clouds in the atmosphere have patterns that look like swirls, bands, or clusters.

Before the invention of weather satellites, scientists could not detect severe storms until the storms moved dangerously close to populated areas. People living in the path of a hurricane, for example, got almost no warning. Today, satellites can locate and track such storms while they are still far out in the ocean. Scientists transmit this information to
public officials who can warn people of the storm and sometimes tell them to evacuate.

**Satellites in Orbit**

How does a weather satellite get into orbit? A rocket launches it to a height, or altitude, where the earth’s gravitational force keeps it in orbit around the earth. Like the moon, a satellite must travel at just the right speed to stay in its orbit. If it moves too slowly, gravity will pull it back to the earth. If the satellite moves too fast, it will escape the earth’s gravitational pull and zoom out into space.

Scientists primarily use two kinds of satellites for viewing clouds: the Geostationary Orbiting Environmental Satellite, often called GOES, and the Polar Orbiting Environmental Satellite, called POES. Once in space, these satellites do not change their orbits around the earth unless they receive a command to do so from earth. Geostationary satellites are located about 35,000 kilometers above the earth. They orbit over the equator in sync with earth’s rotation. This way, they are always viewing the same area on the earth. Polar orbiting satellites are positioned about 850 kilometers above the earth. They have pole-to-pole orbits. Because the earth rotates but the orbit of a polar satellite does not change, this satellite can look at many different strips of the earth as the earth rotates beneath it.

**Images of the Earth**

Satellites collect images from space in different ways. All satellites have special devices called sensors that are sensitive to light, temperatures, or radiation, for example. Both GOES and POES have sensors and photographic equipment on board. Special radios transmit data from these instruments to earth. A receiving station analyzes and sends the data to forecasters and other scientists.

With the aid of satellites, scientists can gather information about the earth that was once thought beyond human reach. Satellites have changed how we study the earth, what we know about the earth, and what we can imagine learning about the earth in the future.
An artist’s version of the Earth Observing System (EOS-AM1) satellite launched in 1998. The EOS-AM1 collects information about land and ocean surfaces, clouds, and the atmosphere. A better understanding of how these features interact helps meteorologists make more accurate short-term weather forecasts.

A triangular “sweep” made by the Tropical Rainfall Measuring Mission (TRMM) satellite shows what is happening inside a hurricane. The TRMM satellite sends back information on the amount of rainfall over 24 hours in a given area. These data help meteorologists predict tropical storms more accurately.

This computer-enhanced satellite image shows the height of a cumulonimbus storm cloud, or thundercloud, which eventually turned into Hurricane Bonnie. The cloud was 18 kilometers high, twice the height of Mt. Everest, the highest mountain in the world. Scientists think that clouds like these are a sign that a hurricane system could be forming.
Environme ntal satellites do more than just track the movement of weather systems. They can monitor volcanoes, temperature changes in the earth’s oceans, and fires. This satellite image shows smoke, haze, and pollutants over the Gulf of Mexico and several southern states. These materials blew north from fires in Mexico and Central America during May 1998.