



MISSION TO PLANET EARTH

Unit 4

Satellites: Observing the Whole Earth

Introduction

The Mission to Planet Earth is NASA's program to determine scientifically whether Earth's climate is changing and to assess the contribution of human activities. Scientists are using satellite-borne instruments to measure the interactions of the atmosphere, oceans, and solid Earth through hydrologic and biogeochemical cycles. Scientists need data from many sources to get a better picture of the whole system. You could compare the Mission to Planet Earth program to other NASA programs where the agency has developed sophisticated instruments and satellites to study the environments of other planets in our Solar System.

Satellites are particularly effective because they can cover the entire globe every few days. They can see a whole ocean at once to study wind, temperatures, and currents. Scientists use advanced computers to analyze the data from satellites and make predictions using mathematical "models." Models could be said to work like a computer game, but in this case, the game simulates the Earth system. With data about how Earth works as a system, we can understand human impacts and cooperate as nations to make sure the planet remains healthy and life-sustaining.

Materials

Scissors, cardboard, paper, string, paint or crayons, egg cartons, paper towel and toilet paper rolls, paper or foil cupcake holders, paper plates, aluminum foil, poster paint.

Objectives

Students will be able to:

- Identify satellite components: antennae, solar arrays, and instruments to study Earth from space.
- Associate color data images with NASA's Mission to Planet Earth program.
- Recognize that Earth's climate can be studied by a variety of professionals.

Visuals

- NASA Lithograph: TOPEX/Poseidon
- NASA Lithograph: First Image of Global Biosphere
- NASA Lithograph: Viking Orbiter 1 Mars Mosaic
- NASA Lithograph: Sea Surface Temperature
- NASA Lithograph: World Cloud Cover Pattern
- NASA Lithograph: Water is a Force of Change
- NASA Lithograph: Viking Orbiter 1 Mars Mosaic

Vocabulary

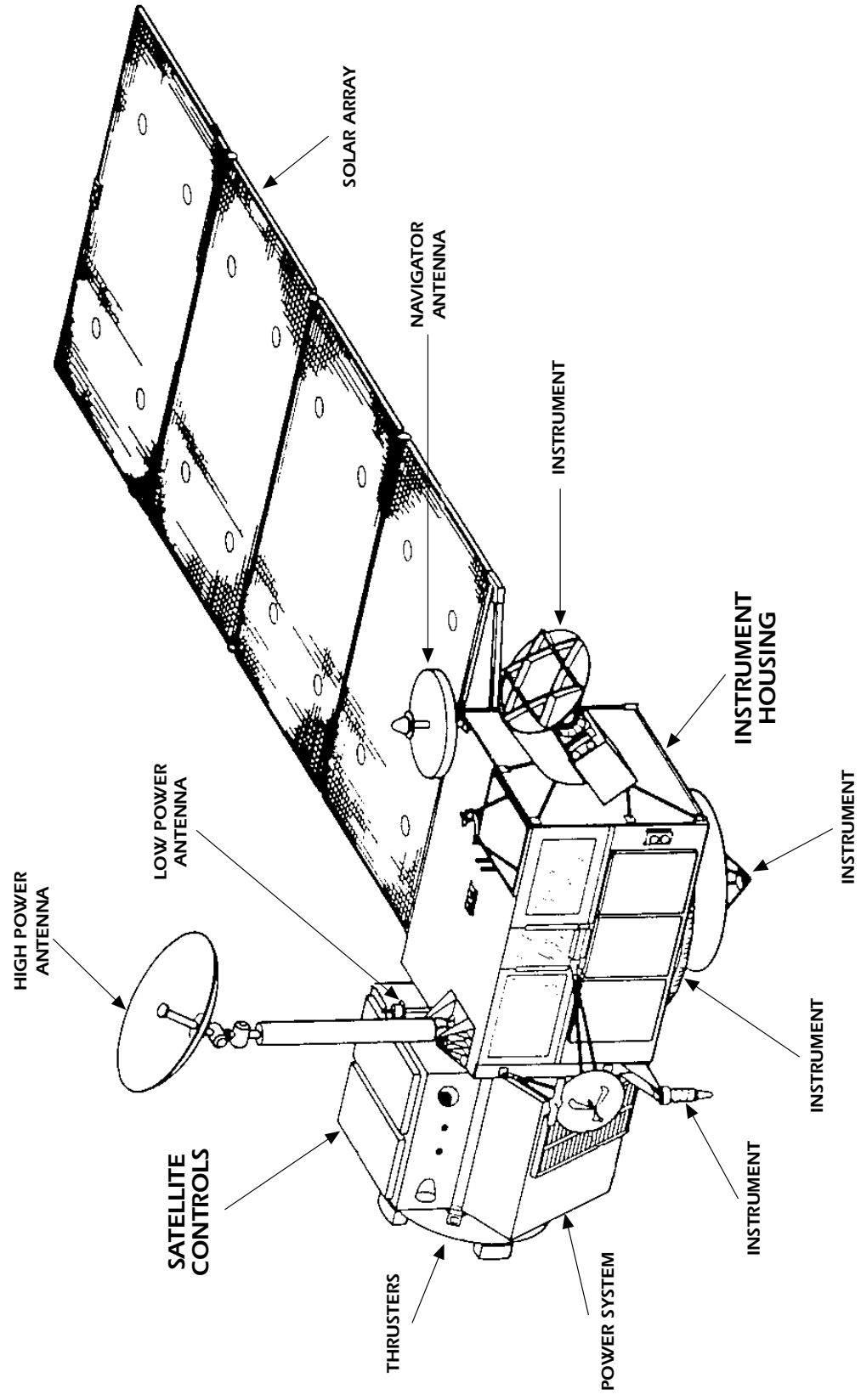
Computer

Model

Data

Satellite

Satellite Parts



TOPEX/Poseidon

Satellites

Earth-observing satellites observe our planet from paths called orbits, many of which are greater than 400 miles above the ground. That distance is at least as far as Washington, D.C. to Boston, Massachusetts. Satellites are so high above Earth and travel so quickly that, in the right orbit, a satellite can pass over every part of Earth once every few days. Such orbits allow satellites to study and take pictures of all of Earth's features: land, plant life, oceans, clouds, and polar ice. Some satellites, such as those used for weather forecasting, are placed in fixed orbits to look at Earth continuously.

Instruments

Satellite instruments are like special cameras that see and take pictures in different kinds of light, such as in ultraviolet (invisible energy from the Sun that causes sunburns) and infrared (heat waves). From satellite data, we can see farmers' fields and tell whether crops are healthy. This tells us about the food supply. We can see the forests and tell where something is killing trees. This tells foresters that they may need to look for blight or gypsy-moth infestations. We can see forest fires and tell how fast the forests are being cut down. Satellites also see clouds, hurricanes, lightning, and rain. In addition, we can see the temperatures and movements of ocean currents. And from the color of the oceans, we can see the abundance of tiny plants, called phytoplankton, which are an important food source for fish.

Satellite Design

Engineers design satellites to support instruments flown in space. Satellites must be light enough to be carried into space on rockets, yet strong enough to withstand the forces of launching. The materials used must handle hot and cold temperature extremes because most satellites will pass from the day to night side of Earth many times in 24 hours. Scientists use special paints on the instruments to control temperature. (In Unit One we learned that dark colors absorb solar heat and light colors reflect it.) Satellites' solar cells extend like wings to capture solar energy and convert it into electricity. When the satellite is on the night side of Earth, it runs on batteries that are recharged during the day from solar energy.

Data

Data come down as electronic signals from satellites, and engineers and scientists convert them into measurements useful to us on Earth. For studying weather, scientists create maps of clouds. Meteorologists compare the satellite maps to their ground data and learn more about weather patterns. Scientists compare ocean-color data gathered by a satellite to measurements taken by oceanographers on ships showing the abundance of phytoplankton. Microwave radar signals from space are compared to rainfall measurements on Earth. Computer engineers organize and store vast quantities of satellite data so that the information can be sent via computer networks to scientists around the globe.

Modeling

In the same way students made a terrarium as a model of Earth, scientists use computers to create models to predict what will happen when global changes occur. Will the temperatures rise because of warming caused by greenhouse gases? Can we see a warming trend even if a major volcano has erupted? A model is like a “what-if” game. When you play “what-if” using a computer model, your prediction is based only on available data and scientific principles.

Activities

Demonstrating Heat Sensors.

Show students how heat-sensing instruments work by letting them hold heat-sensitive cards (frequently given away at health fairs), “mood rings,” or aquarium thermometers. The warmer you are, the darker the color appears on the card or ring registering your body temperature. The data in the lithographs, “World Cloud Cover Pattern” and “Global Sea Surface Temperature,” were collected during observations from satellites carrying heat-sensing or infrared instruments.

Satellite Construction.

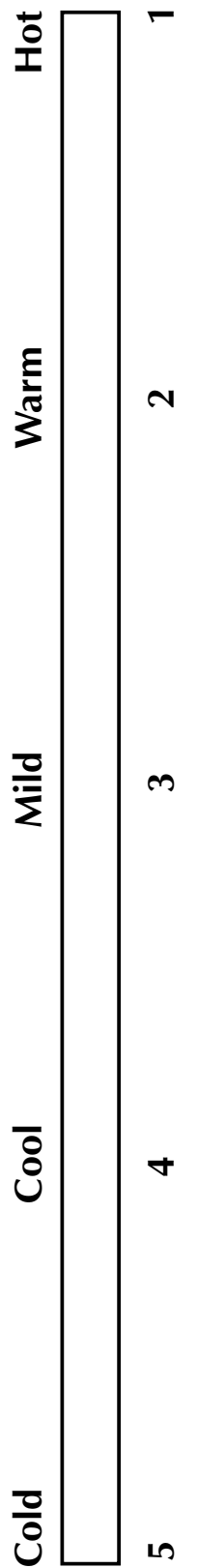
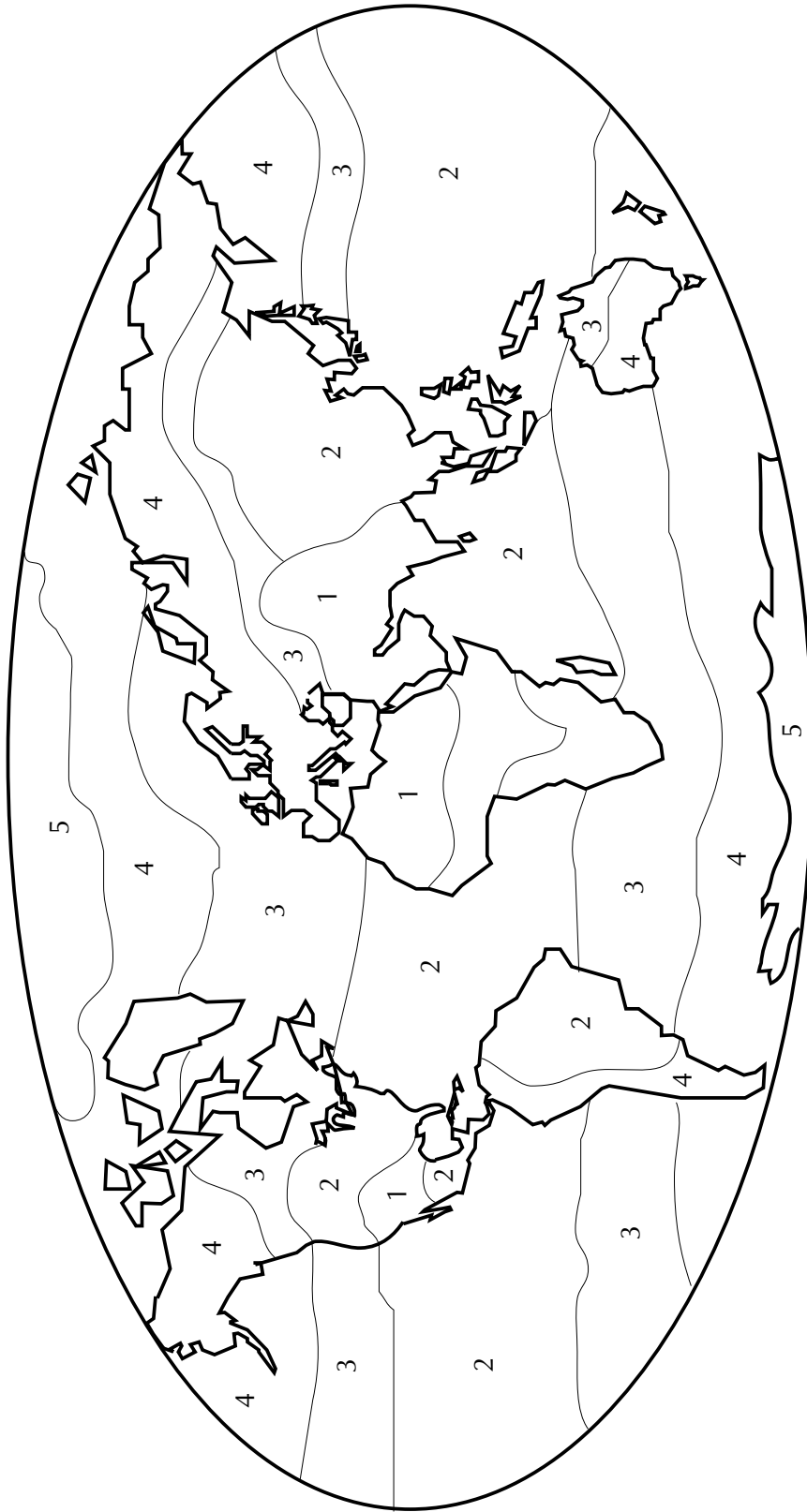
1. Satellite Construction: Students can make their own satellites out of paper, cardboard, and recycled containers. Use foil or plastic wrap on a cardboard frame for solar arrays; paper or foil plates could be antenna dishes; aluminum foil could be a heat-resistant metallic surface. Encourage the students to pretend that their satellites are going to observe components of the Earth system found in their terrariums or

aquariums. Let them use their imaginations to determine the satellite's shape, instruments, and the equipment it will need according to what they are going to observe. When they are finished, hang the satellites from the ceiling with fishing line. The satellites could be "observing" the terrariums or aquariums or their region of the country. Show students the lithograph, "TOPEX/Poseidon." Note in the illustration its orbit and what it is observing. Point to the solar arrays, antennae, and instruments.

2. **Satellite Launch and Deploy:** Divide the class into launch teams; let them pick roles and dramatize a Space Shuttle or rocket launch and satellite deploy. Use real or invented language for their missions. Each child could bring in baseball cap. Attach the job label to the cap; later have them try different jobs by switching labels. Such jobs are Mission Commander, Payload Commander, Pilot, Mission Specialists, Project Scientists, Flight Director.
3. **Data:** Scientists study Earth by taking measurements of light that we cannot see. They assign artificial colors to represent each measurement. It's as though you were coloring a picture, and you had to decide which crayon to use for each part of the picture. Each child should draw and color "data" collected by their satellites (see data map, page 29). Choose different colors to represent each kind of measurement. For example, the healthiest plants could be compared to the progressively more dried-out plants. The healthy plants could be represented by reds, oranges and yellows. Try the same color scheme to compare conditions in the different terrariums. Look at the lithograph, "The First Image of the Global Biosphere." These ocean data are indicated by red and orange for high concentrations of plant life in the oceans (phytoplankton), blue and violet for lower concentrations. On the land, forests are indicated by all shades of the color green. Semi-arid steppes and tundra are orange, and deserts and ice are yellow. A black and white map of Earth is included for classes that want to try coloring global Earth data.

Our Mission to Planet Earth

Surface Temperature



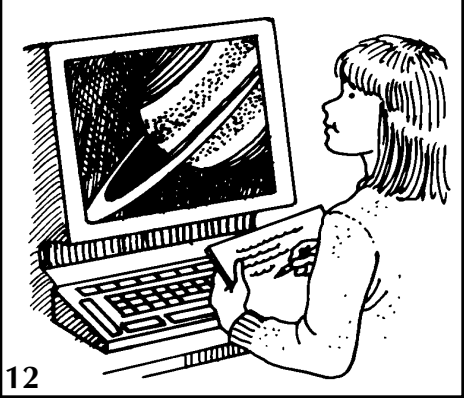
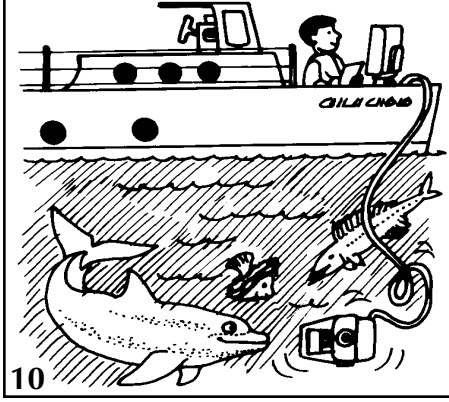
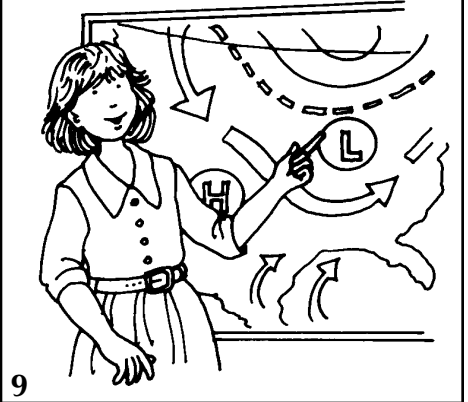
Careers

Activity

Mission to Planet Earth Careers.

Let students pick a career. Ask them to tell a story in the form of an autobiography about how their Earth science career (“what I want to be when I grow up”) could help improve knowledge of Earth or life on Earth. Improvise a costume and tools. Find or draw pictures of the Earth component they want to study, and ask the students to draw and color examples of data they will obtain.

1. Atmospheric Chemist: I study the atmosphere over time to understand what is natural and what has changed because of pollution. I take samples from aircraft or balloons, conduct laboratory experiments, and create computer models.
2. Climatologist: I study weather on a big scale over a long period of time—even centuries. I gather samples that show long-term histories, like those taken from the bottom of the ocean or from polar ice cores. I also study the growth rings of trees, and then I predict the future climate.
3. Mathematician Computer Scientist: I invent and improve computers and programs to study data about Earth. I know how to create programs on computers that are more complicated than computer games. I make the work of many scientists possible by keeping all the satellite information easy to access and understand.
4. Sociologist: I study people in large populations—how they live, grow food, and manufacture things. From what I learn about large numbers of people, I can help predict what people could do to the environment. My work helps decision makers make policies that help prevent damages to the environment.
5. Ecologist: I study various forms of life on Earth and how they interact. I go out in ships or use aircraft and satellites to measure where and how healthy the plants and animals are in their habitats. See the lithograph, “First Image of the Global Biosphere.” We can learn from observing the abundance of life what changes are occurring environmentally on Earth.



6. Geologist/Geophysicist: I study how Earth is formed, what has happened to it since then, and what might happen to it in the future. I study volcanoes, earthquakes, and landslides. I can study rocks and rock formations and determine the geological history of an area.
7. Glaciologist: I study glaciers in the Arctic and Antarctic as well as those formed in the tallest mountains. I study temperatures, snow accumulation, and deep ice cores to understand what is happening to the glaciers. I also use satellites and aircraft to get these data (see lithograph; “Water is a Force of Change”).
8. Hydrologist: I study the water cycle. I study where the water goes, what elements it contains, and whether its chemistry has changed. My research often is used to determine where droughts occur and why fish populations decline.
9. Meteorologist: I study weather, the local short-term changes that affect how we live every day. I use satellites and ground measurements to predict the weather. You can see some meteorologists on television news. See the lithographs, “World Cloud Cover Pattern” and “Water is a Force of Change” (hurricane photograph).
10. Oceanographer: I study oceans and how they change. I work on ships or in aircraft and get data from floats and satellites. See the lithograph, “Global Sea Surface Temperature.”
11. Volcanologist: Using ground instruments, I study volcanoes and how they influence the climate. I use satellite and robots to gather data when the volcanoes are active and become too dangerous to go near.
12. Planetologist: I study planets other than Earth. When I compare planets like Mars, which has very little water compared to Earth, I can learn more about what could happen to our planet. The only way I can study Mars is by observing the planet with large telescopes or using data collected by satellites, such as that obtained by Voyager. Compare the lithograph of Earth from space with the litho, “Viking Orbiter 1 Mars Mosaic.”