LEVELED BOOK • Z

Satellites

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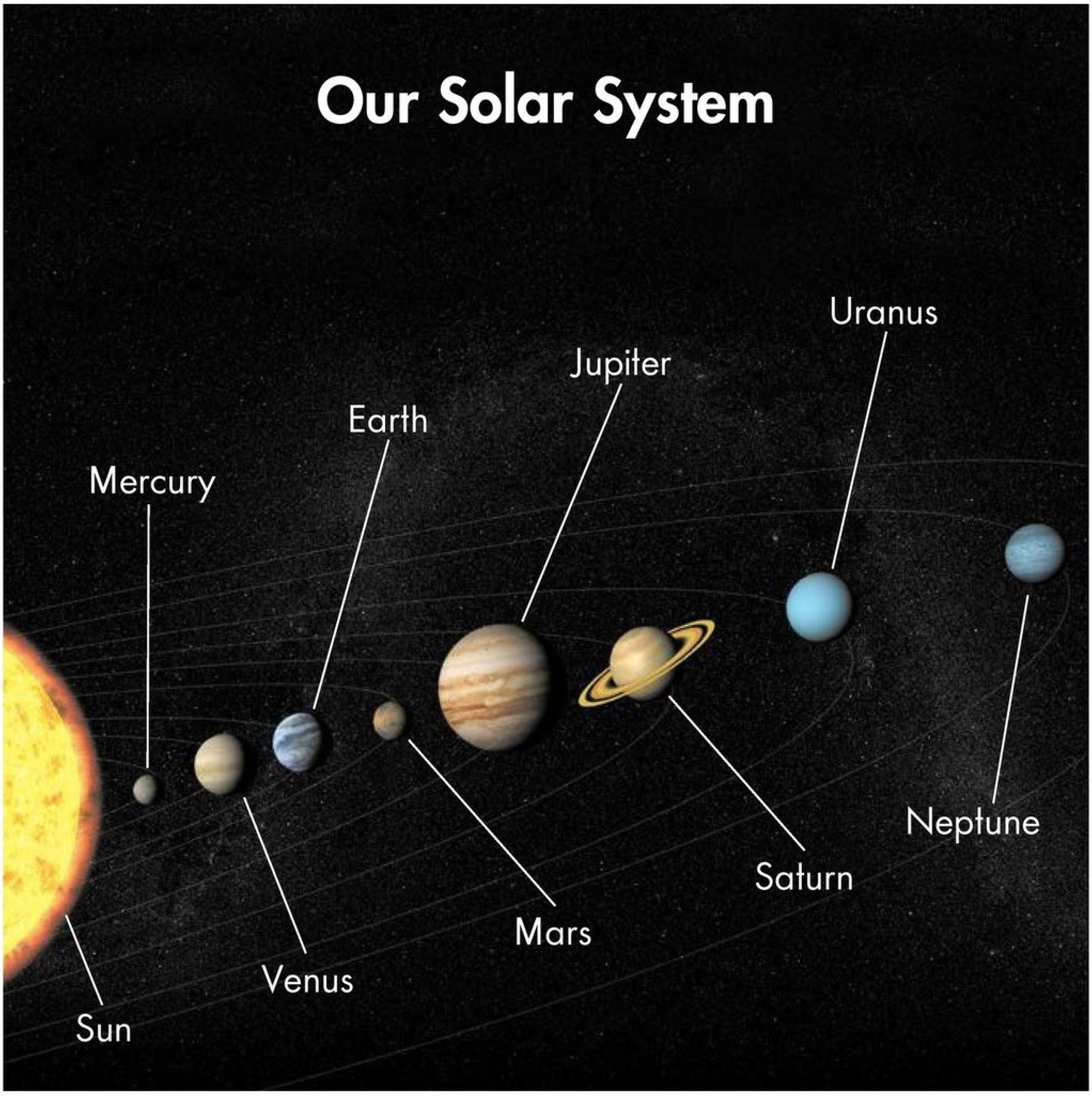


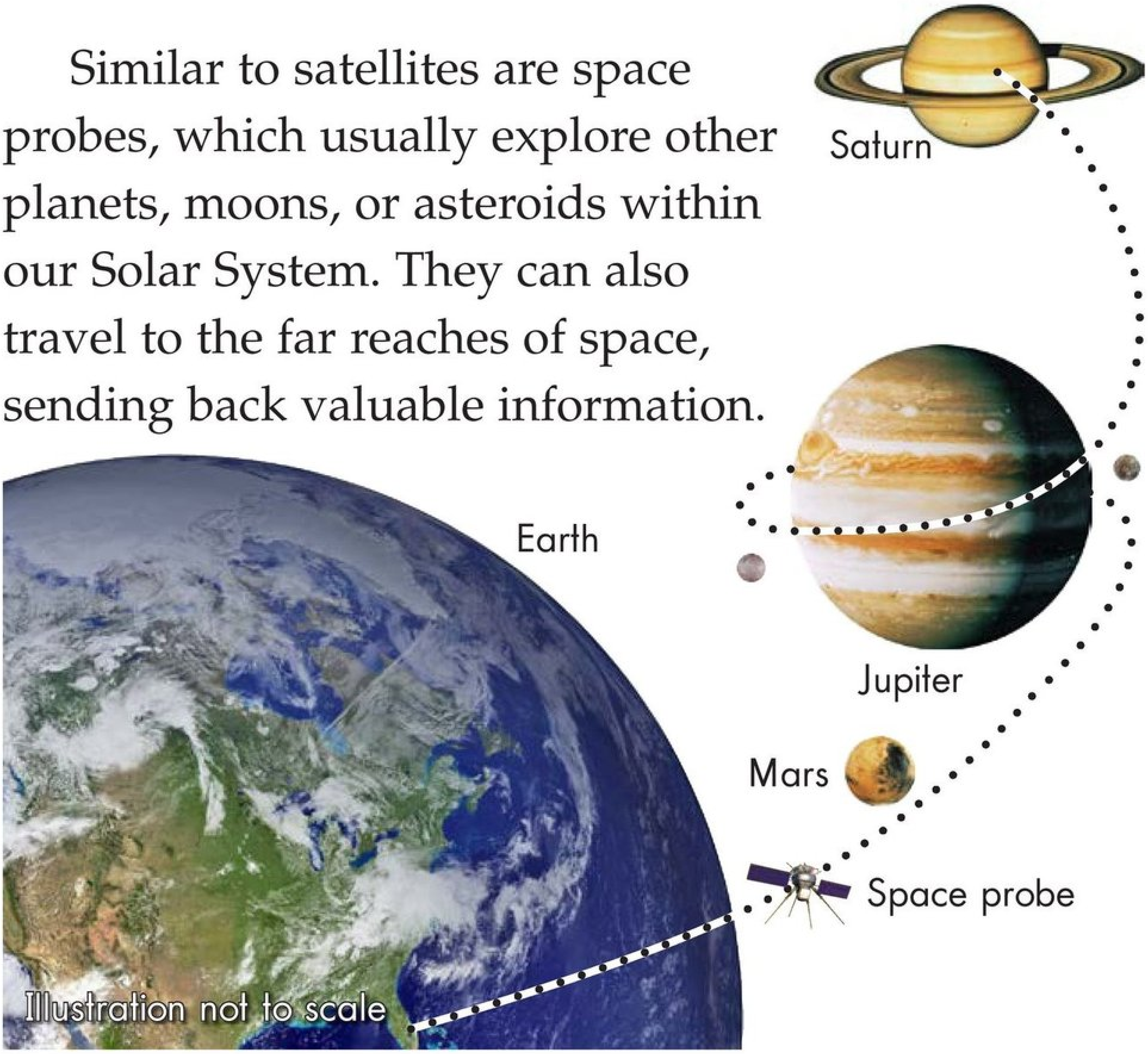
The eight planets of our solar system are satellites that orbit the Sun.

Satellites 101

A satellite is any object in space that **orbits**, or revolves around, another object. There are two kinds—natural and **artificial satellites**. The Moon is a natural satellite that revolves around Earth. All of the planets in our Solar System are natural satellites of the Sun. Artificial satellites are made by humans.

Artificial satellites are high-tech tools that orbit Earth. They are like space robots that do many jobs people can't. Even though we often aren't aware of them, artificial satellites have played an important part in our lives since *Sputnik I* was launched in 1957. Artificial satellites allow us to do everyday things, such as use our cell phones and select TV programs from hundreds of domestic and international channels. Satellites help captains navigate ships, and meteorologists predict the path of dangerous storms. Thousands of satellites now orbit Earth.

Similar to satellites are space probes, which usually explore other planets, moons, or asteroids within our Solar System. They can also travel to the far reaches of space, sending back valuable information.



Satellite Anatomy

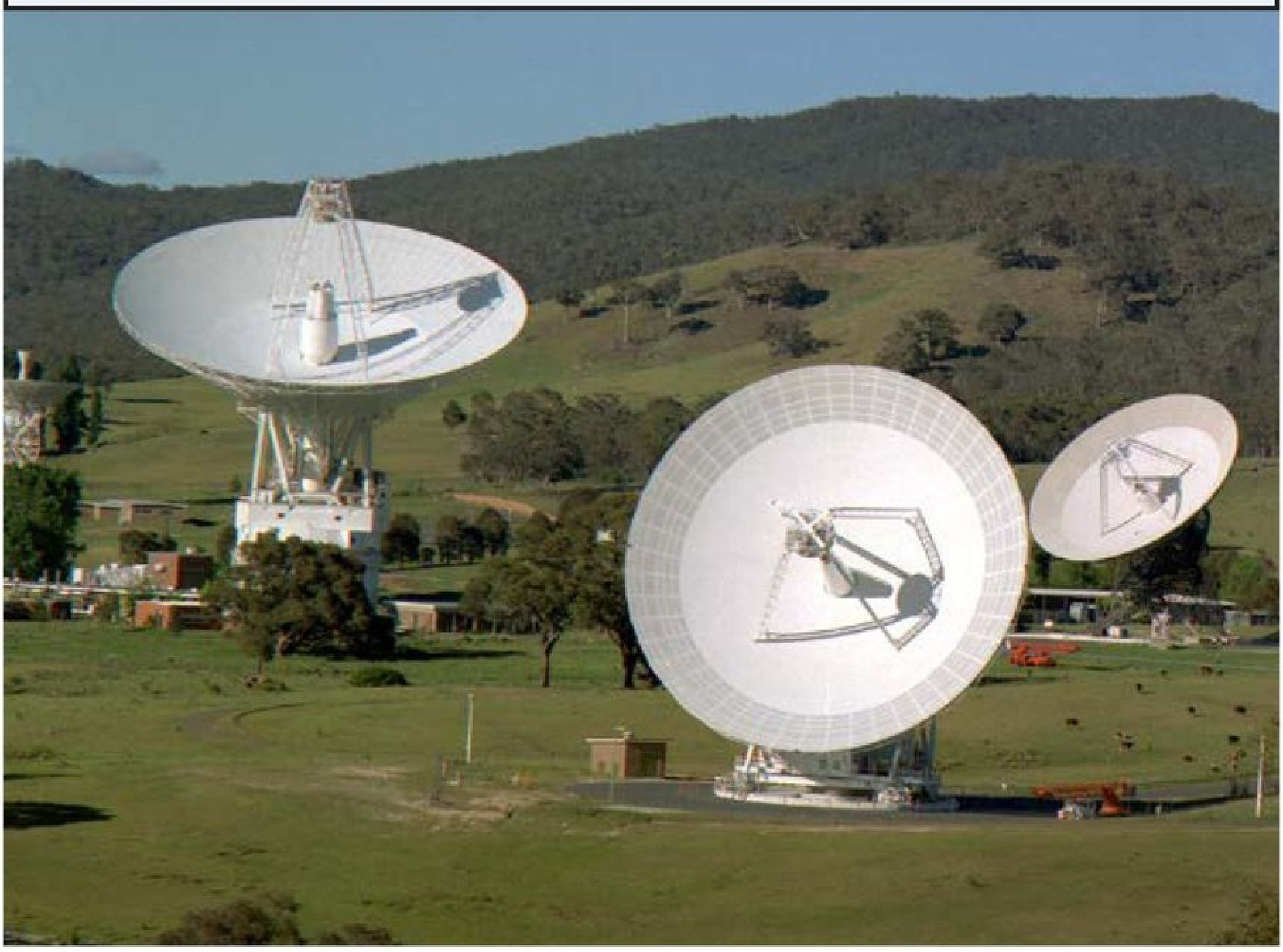
Satellites are built for specific jobs. On the outside, they may look like a barrel or a windmill and have paddles, solar panels, or sails. Inside, satellites contain mission-specific scientific instruments. The **payload** includes whatever tools the satellite needs to perform its work, such as sensitive antennas, high-resolution cameras, and communication electronics. The **bus** is the part that carries the payload. The bus holds all the parts together; provides the electrical power for the computers and communication equipment, and the power to move the satellite forward.

Solar Sensation

Satellites use solar energy from the Sun to run their equipment. The flaps, wings, panels, or the satellite's shell can be covered with solar cells. These cells convert the Sun's energy to electricity. A satellite never pays an electric bill!

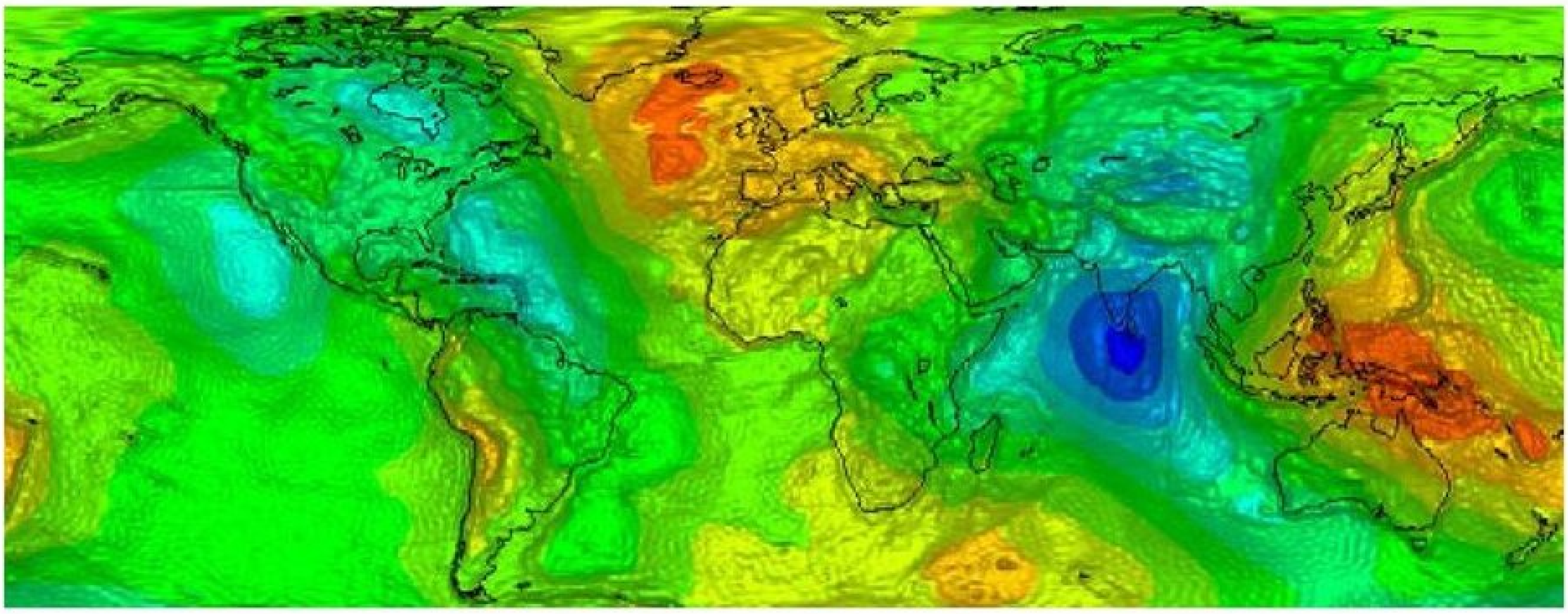
Linking Up!

Downlinking is when a satellite converts the information it collects into a radio signal and sends it back to Earth. These signals travel through space and are received at an Earth Station, or dish. Sending signals back up to a satellite is called uplinking.



A collection of Earth Stations are arranged to receive satellite signals.

Computers function as the satellite's brain. The computers receive information, interpret it, and send messages back to Earth. Advanced digital cameras serve as the satellite's eyes. Sensors are other important parts that recognize light and color, heat, water, minerals, and gases. Sensors record changes in what is being observed. Radios on the satellite send information back to Earth where antennas receive the signals.



The first global gravity model based on GOCE satellite data was presented in mid-2010. The GOCE satellite has the capability to map the tiny variations in Earth's gravity pull.

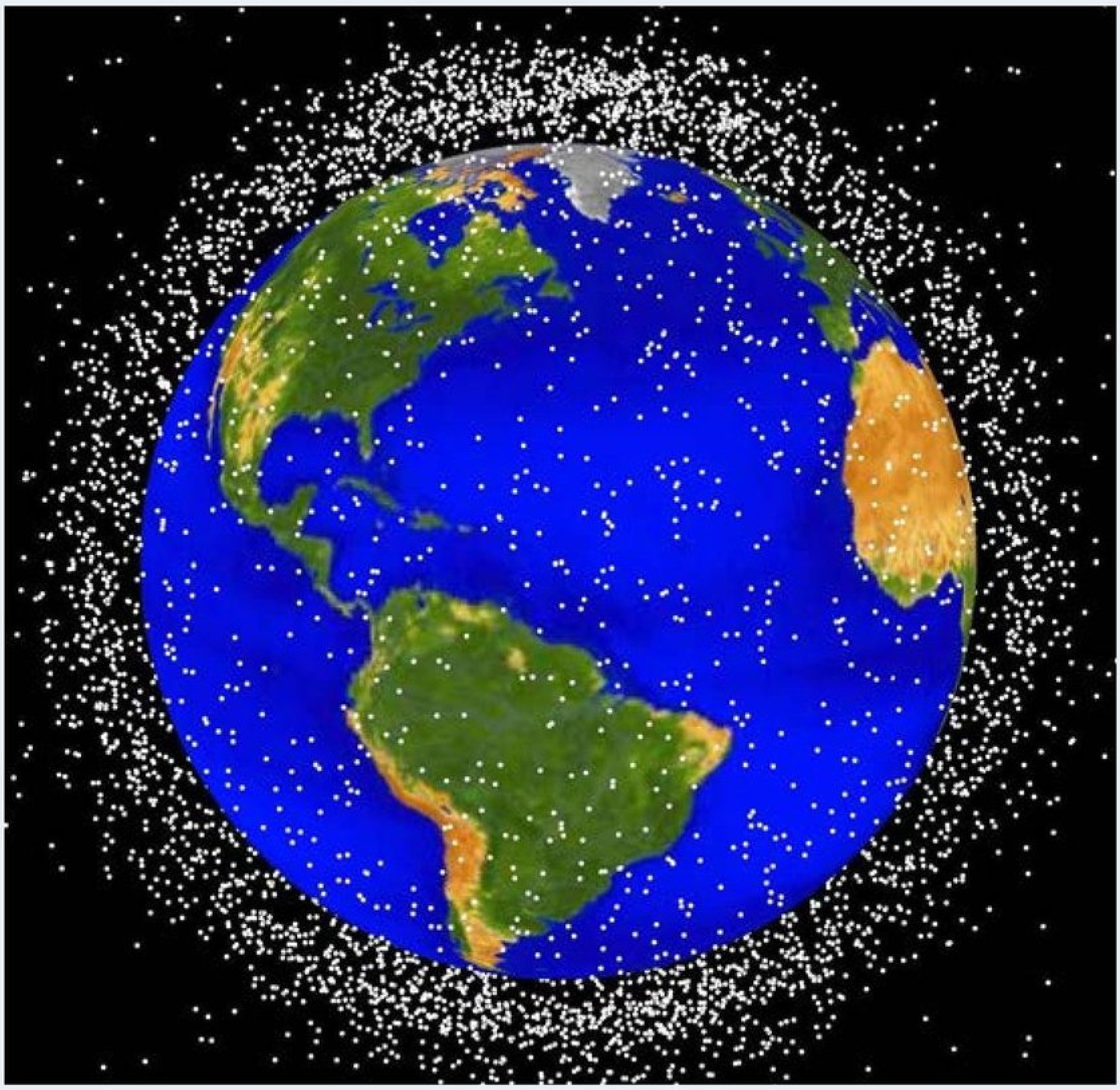
Outstanding Orbits

Artificial satellites use **gravity** to stay in their orbits. Earth's gravity pulls everything toward the center of the planet. To stay in Earth's orbit, a satellite's speed must adjust to the tiniest changes in the pull of gravity. The satellite's speed works against Earth's gravity just enough so that it doesn't go speeding into space or falling back to Earth.

Rockets carry satellites to different types and heights of orbits, based on the jobs they need to do. Satellites closer to Earth are in **low-Earth orbit**, which can be 200–500 miles (321–804 km) high. Gravity is stronger closer to Earth so these satellites must travel at about 17,000 miles per hour (27,358 kph) to keep from falling back to Earth. Higher-orbiting satellites can travel more slowly because gravity's pull isn't as strong.

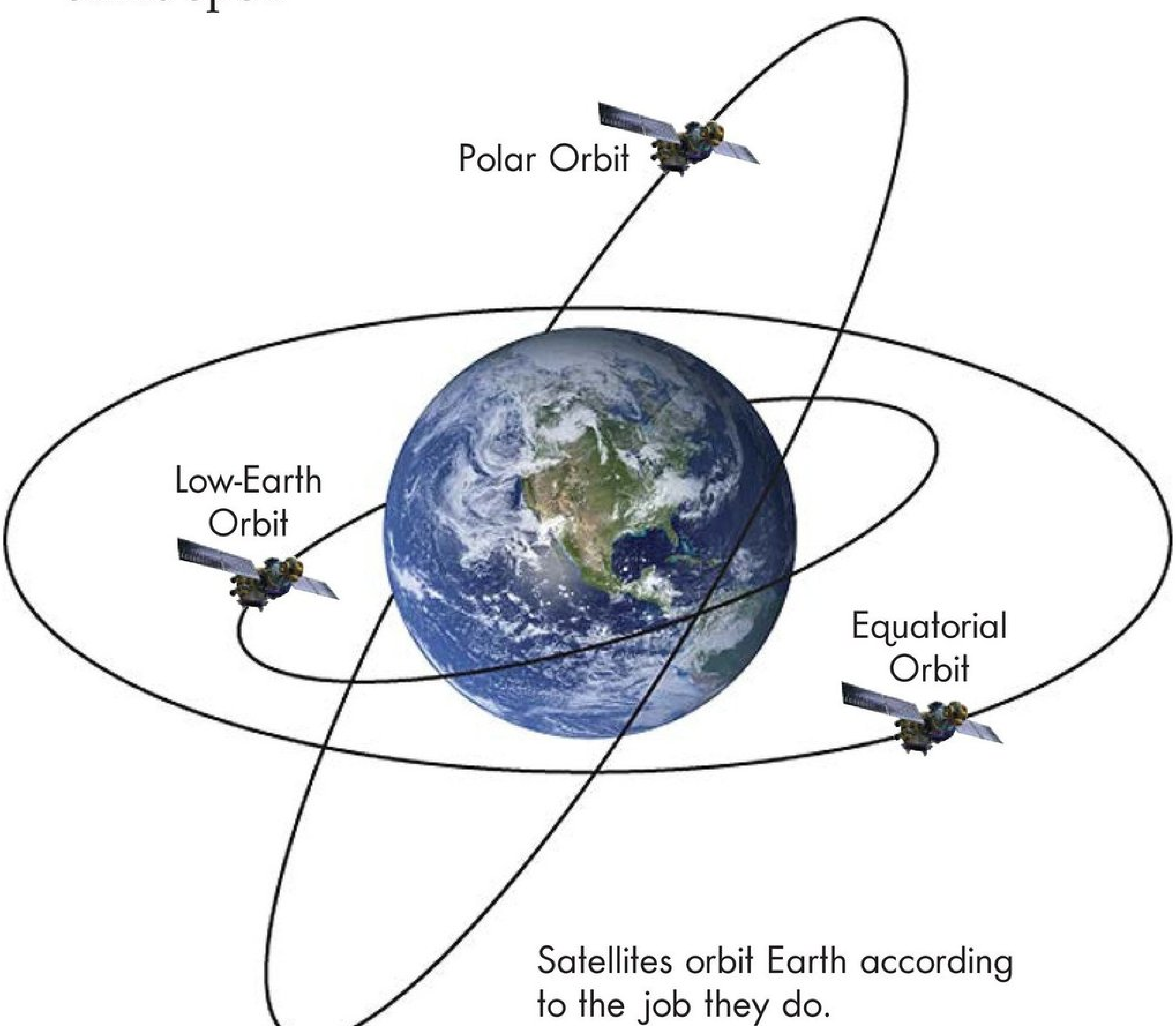
Hunks of Junk!

A space shuttle traveling in low-Earth orbit smacked into a fleck of paint that dug a pit in a window nearly a quarter-inch (6.35 mm) wide! Space might seem empty, but what's really out there is an orbiting garbage dump—leftovers from early space missions such as gloves, lens caps, bolts, rocket motors, and meteoroids, too. These objects slam into spacecraft at speeds of 170,000 mph (273,588 kph) or more, causing serious damage.



Satellite missions have helped NASA chart over 370,000 known pieces of space junk. After six years in space, the satellites came home riddled with pits, cracks, and holes from space debris!

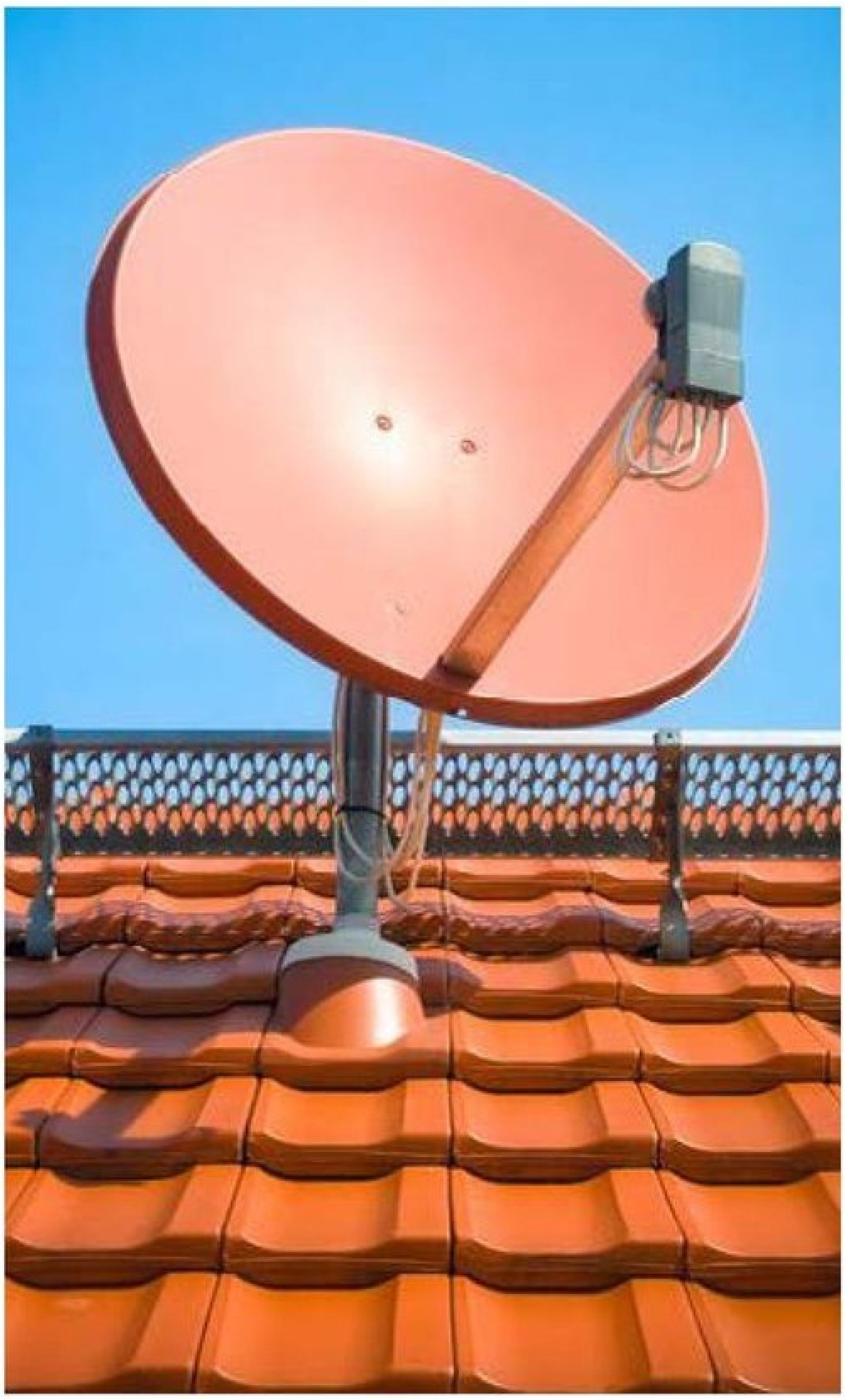
Satellites that follow a lopsided elliptical, or oval-shaped, orbit do so to get a closer view of Earth. At 540 miles (869 km) up, satellites in **polar orbit** travel from pole to pole and circle the Earth eighteen times a day! Other satellites orbit over the equator 22,300 miles (35,888 km) up. They move at the same speed that the Earth is turning. These satellites are in stationary orbits, meaning it takes 24 hours for the satellite to circle our planet. The Earth takes 24 hours to spin on its axis, so these satellites appear to stay over the same spot!



Satellites orbit Earth according to the job they do.

Satellites Work

Scientists design satellites to collect many different types of information. Scientists design and place them into orbit according to what kind of data they are collecting.



People with satellite TV downlink the satellite signal directly into their homes.

Communication satellites, or comsats, allow us to use cell phones and send emails and faxes across the globe. They allow us to broadcast television and radio programs around the world, and make phone calls while flying in an airplane!

The first live broadcast across the Atlantic Ocean was made in 1962 by an experimental satellite called *Telstar*. Before then, news had to travel by telegraph, telephone, or cables. Now, we can communicate with the most remote places by bouncing a signal across multiple satellites.

Environmental satellites monitor the impact from deforestation or sediment clogging rivers and harbors.

Earth observational satellites collect information on temperature, oceans, wildfires, animals, and even volcanoes! Sometimes, these satellites are called **environmental satellites**. They record changes in the Earth's surface and atmosphere, including pollution and destruction of forests caused by human activity. They use powerful cameras to take pictures using light rays, X-rays, and radio waves. Environmentalists, farmers, miners, and fishermen find this information increasingly valuable.

Other satellites such as military, or spy, satellites have taken pictures of Earth since 1960. Officially named **reconnaissance satellites**, or spysats, they spy on other nations. Spysats relay coded messages, monitor nuclear weapons, observe enemy armies, and can eavesdrop on many forms of electronic communication.

Strategic Defense Initiative (SDI or STAR WARS)

In 1983, then-U.S. President Ronald Regan announced research into the development of a space-based defense system. A network of defense satellites would detect enemy missiles in time for the missiles to be destroyed while they were in the air. The system was never completed.

The advanced technology developed for use in spysats has been expanded for other uses. Industries use imaging satellites to find oil or mineral sites. Law enforcement uses them to find where illegal drugs are grown. Satellites have even traced pollution back to the polluters. Research satellites have helped us map Earth in greater detail than we could ever do before.

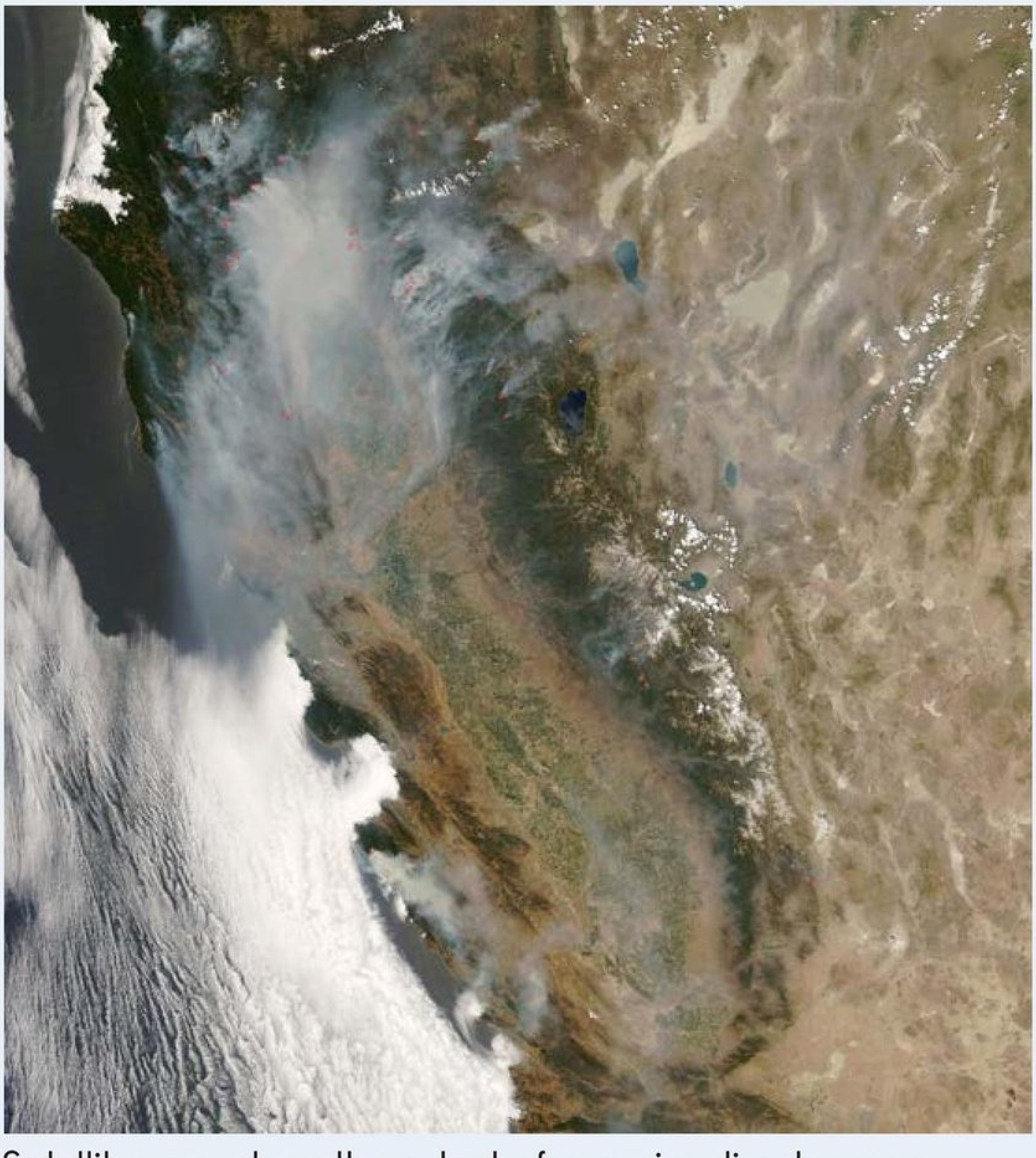
One satellite program tracks meteors that get too close to Earth. It also monitors ongoing tests of ways to divert or destroy threatening meteors before they can collide with Earth.

Image of New York City, taken from a research satellite

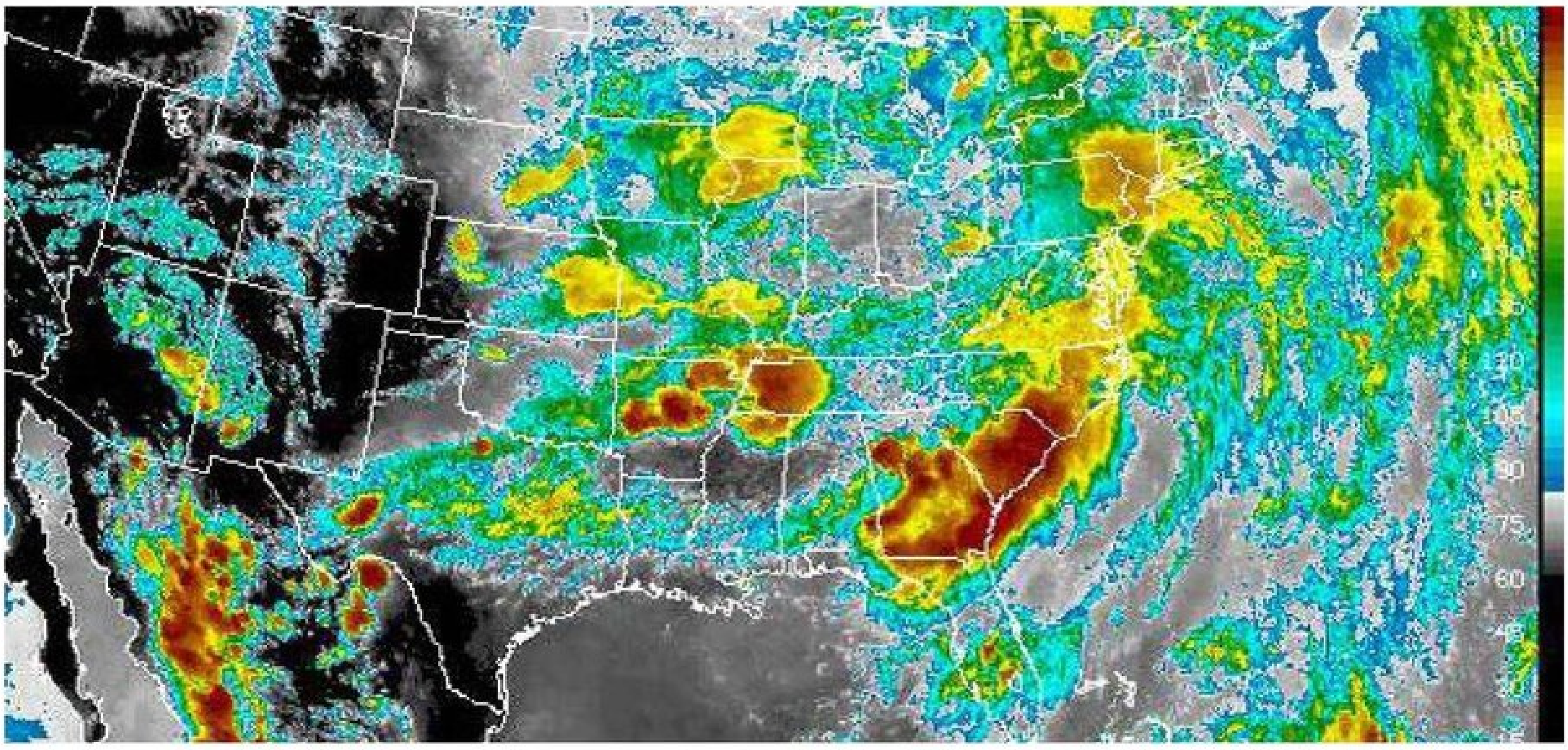
Satellites in Emergencies

Both communication and military spy satellites are important in major emergencies. Disasters often destroy all means of transportation and other forms of communication, but satellite signals are not affected.

Radio and TV stations use mobile satellite dishes as ground stations. This allows signals to be sent up to a communication satellite, which then beams the signal around the world or bounces it to another satellite.



Satellites can show the extent of a major disaster area.



Weather satellites predict and track storm systems around the world.

Weather satellites save lives. They monitor weather systems, wind speeds, rainfall, and much more. Weather satellites warn us about dangerous storms, such as hurricanes or typhoons. Earlier warning and more accurate information allow people more time to either prepare for the storm or evacuate the area. **Meteorologists**, scientists who study Earth's atmosphere, weather, and climate, can make better forecasts using satellites.

Weather satellites use cameras and tools that measure the temperature in the atmosphere. They can help ships in the ocean by detecting snow and ice at sea.

Working Together

Meteorologists use weather satellites in different orbits to help them make the best observations. Two satellites circle Earth over the poles. Another set of these satellites orbit Earth at the equator.

Go GPS!

GPS was originally developed for military use, but now people across the globe are using this satellite technology to determine where they are. Many cars now have small GPS monitors that can tell drivers how to get from one place to the next. But GPS isn't perfect—it can be disturbed by electrical storms, solar flares, computer failure, or power failures.

Large ships and planes cannot stay on course without **navigational satellites** to help them find their way. **Global Positioning System**, or **GPS**, receives radio signals from three satellites that are used to pinpoint an exact location anywhere.

Astronomical satellites have the ultimate view of the universe! They look deep into space at the Moon, Sun, planets, stars, and galaxies. Scientists use these research satellites to study waves and particles moving through space in the hope of understanding more about our universe. Infrared satellites are probing the darkest corners of space and relaying images never thought possible—of objects we couldn't see before.

The Hubble Space Telescope is the most famous U.S. astronomical satellite. The "ultimate telescope" was launched into its low-Earth orbit in 1990, and after twenty years of performance beyond any expectation, the last of its series of refurbishing missions gave it a final tune-up. It received new cameras, new batteries and gyroscopes, a Cosmic Origins Spectrograph, and a renewed expectation of perhaps another ten years of taking pictures in deep space.

As it continues to orbit Earth at 17,000 miles per hour, the Hubble's reflecting telescopes, high-powered cameras, sensors, and other tools act as "eyes" to the universe. In its first twenty years, these eyes have recorded more than 45 terabytes of data, which is enough information to fill about 5,800 DVDs. The Hubble helped scientists understand star birth and death, black holes, and the evolution of galaxies.

First Satellites

Famous scientist Isaac Newton first came up with the idea for an artificial satellite in 1687 after realizing that Earth's gravity held the Moon in its orbit. The former Soviet Union took Newton's advice almost 300 years later when it launched the first object into space, the satellite *Sputnik I*.

Sputnik I was about the size of a basketball and had four antennas that sent out radio signals. It circled Earth in 98 minutes in an elliptical orbit. The launch of *Sputnik I* surprised Americans and marked the beginning of the space race between the two countries. After six months, *Sputnik I* slowly fell back to Earth, burning up in the atmosphere.

Living Cargo

To prove that a living thing could survive in space, the Soviet Union sent a dog, named Laika, aboard its second satellite, *Sputnik II* in 1957. She became the world's first space traveler. Sadly, *Sputnik II* was not made to return to Earth and Laika died.

The International Space Station

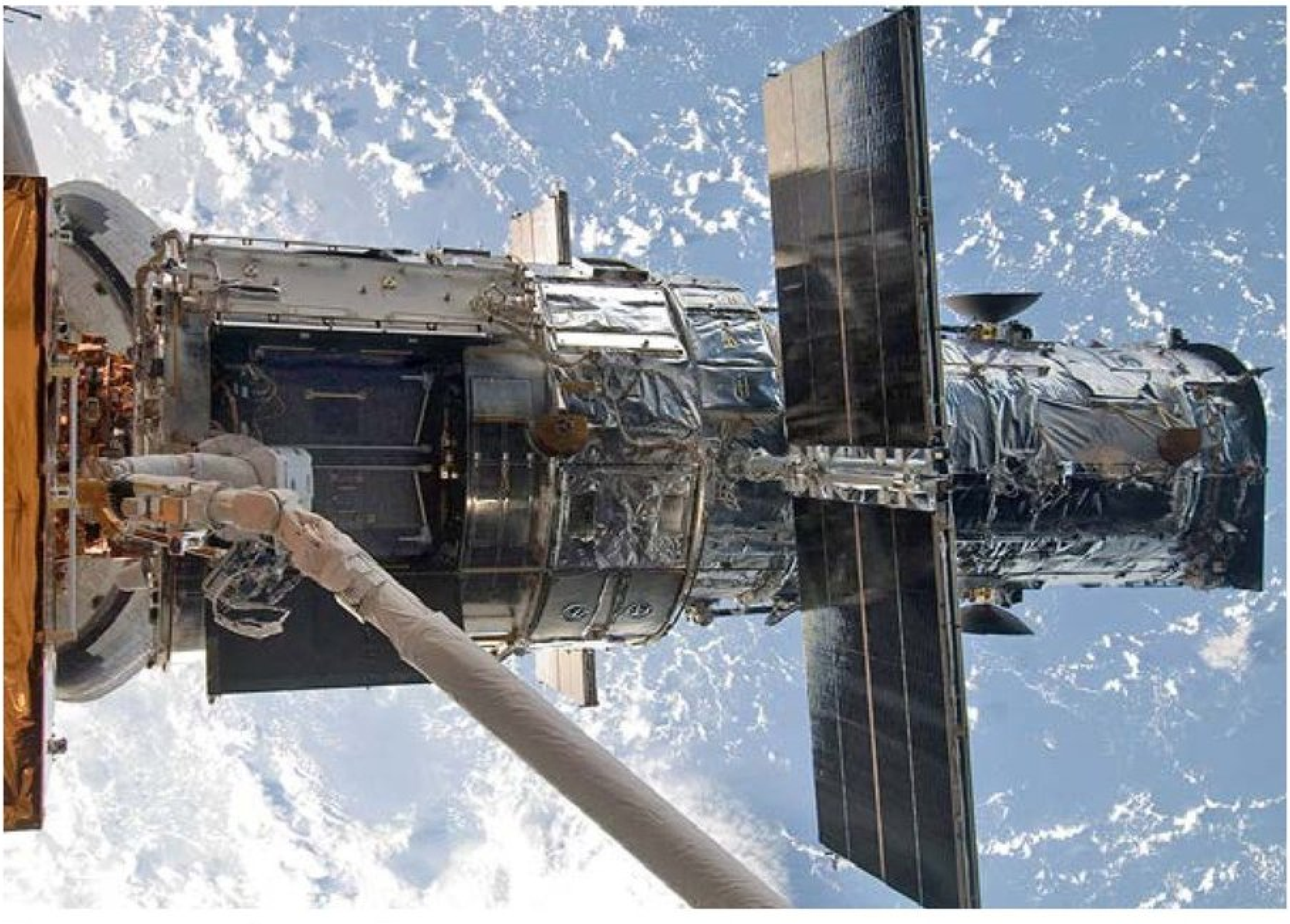
Space stations allow astronauts to live and work while orbiting Earth for extended periods of time. In 2000, the first crew boarded the *International Space Station*, or ISS. Then, it was the newest and largest thing in space. Before the ISS, the Russian space station, *Mir*, was the largest and most famous space station ever built. This 130-ton station stayed in space for 15 years. *Mir*'s final size was about 98 feet long and 45 feet wide and had six components. By 2010, the ISS had grown to be about four times larger than Mir, with a living and work space equal to a 747 jumbo-jet. The ISS has almost an acre of solar panels to power it!

Space Partners

The *International Space Station* is a joint effort of 16 countries: the United States, Canada, Japan, Russia, 11 countries from ESA, the European Space Agency, and Brazil. Each international partner contributes important elements, such as the highly maneuverable robotic arm built by Canada.

ISS travels in low-Earth orbit about 250 miles (402 km) up, which allows people and equipment to be ferried back and forth with launch vehicles, such as Russia's Soyuz rocket or the U.S. space shuttle. The ISS can make excellent Earth observations because it covers 85 percent of the globe at this orbit.

The ISS has the most state-of-the-art laboratory in orbit. Scientists hope to make many discoveries that will help people all over the world. Some of the research will include: testing the effects of long-term low gravity on humans, spaceflight-induced bone loss, and long-term observing of Earth's environment.



The Hubble Space Telescope is adjusted in orbit by astronauts in the space shuttle.

Satellite Rescue

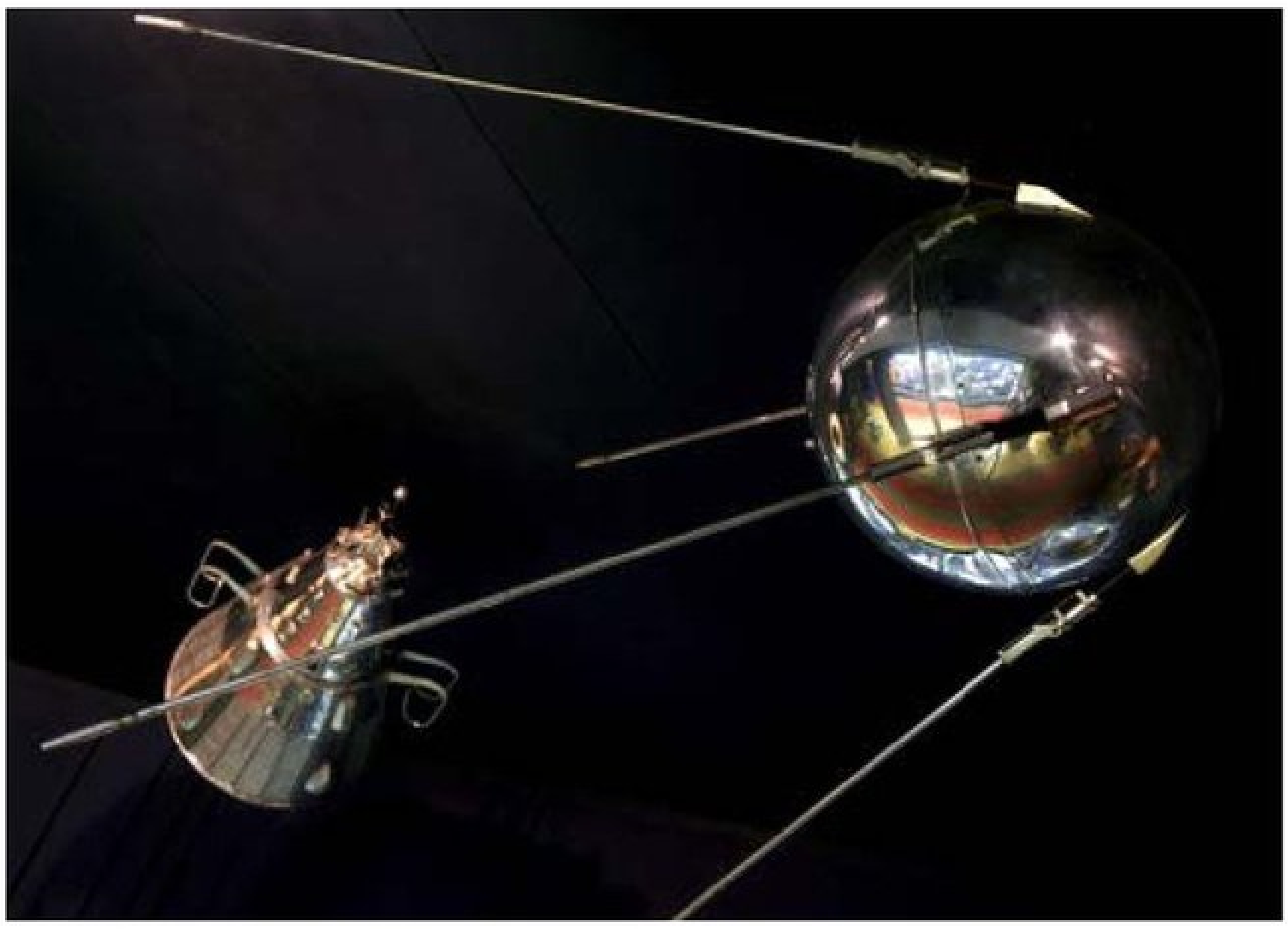
After the *Columbia* space shuttle was launched in 1981, satellite rescue missions became easier. Technology on board the shuttles improved the chances of success. Manned Maneuvering Units, which looked like legless chairs strapped to an astronaut's back, allowed astronauts to move freely outside the spacecraft without being tied to the shuttle. Robotic arms could snag satellites and retrieve them for use in different orbits. Since the U.S. Shuttle program shut down in 2011, NASA has tested and researched new techniques and equipment to ensure that there are other options for repairing satellites in orbit.

Satellite Funerals

Space is a busy place, especially with space junk and thousands of aging satellites in low-Earth orbit. Currently there is no international law that says old satellites must be removed from their orbit. Objects in orbit above 500 miles (804 km) can stay there for thousands of years! Over time, satellites in some orbits get pulled back into Earth's atmosphere where they most often burn up before reaching the ground. NASA and other agencies are working with innovative ideas to get rid of aging satellite traffic in space.

Conclusion

Satellites are clearly here to stay. Continually evolving satellite technology will continue to change our lives even more in the future. One recent development is Internet Routing In Space (IRIS), which allows for more instant transfer of voice, video, and data communication to remote areas. Researchers have recently developed satellite-imaging programs that let farmers track herd animals or monitor water supplies and irrigation levels.



The space race began with the launch of Russia's basketball-sized *Sputnik I* (right) and *Sputnik II* (left) in 1957.

Improving satellite technology adds greatly to scientific knowledge. Satellites make it possible for us to communicate information quickly to people all over the world. Satellite images help us to come up with better ways to protect our planet. Research satellites will continue to probe our galaxy, helping us unravel the mysteries of the universe.

Glossary

artificial satellites *(n.)*	human-made objects that orbit other objects in space (p. 4)
astronomical satellites *(n.)*	research satellites to monitor waves and particles in deep space (p. 16)
bus *(n.)*	the body of a satellite; contains basic functions and equipment (p. 6)
communication satellites *(n.)*	satellites that pick up sound, picture, and telephone signals (p. 11)
environmental satellites *(n.)*	satellites that monitor how the Earth is changing (p. 12)
GPS *(n.)*	Global Positioning System, uses radio signals from satellites to pinpoint locations (p. 16)
gravity *(n.)*	the Earth's force that pulls everything to its center (p. 8)
low-Earth orbit *(n.)*	an orbit close to the Earth, 200–500 miles (321–804 km) high (p. 8)
meteorologists *(n.)*	scientists that study the Earth's atmosphere, climate, and weather (p. 15)
navigational satellites *(n.)*	satellites that help ships and planes know where they are (p. 16)
orbits *(n.)*	the paths of objects around others (p. 4)
payload *(n.)*	part of a satellite that carries tools (p. 6)
polar orbit *(n.)*	orbiting the North and South poles (p. 10)
reconnaissance satellites *(n.)*	satellites that gather information about other countries (p. 12)
weather satellites *(n.)*	satellites that monitor weather (p. 15)

Explore More

On the Internet, use *www.google.com* to find out more about the topics presented in this book. Use terms from the text, or try searching for glossary or index words.

Some searches to try: *satellites*, *Global Positioning System*, or *Hubble Space Telescope*.

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Front cover: The STEREO mission studies Sun-Earth relationships, severe solar eruptions, and helps weather-detection satellites.

Back cover: The *Mir* Russian space station docked with the space shuttle *Atlantis* in 1995.

Title page: Environmental satellite GOES is designed to help with severe storm warnings and global resource management.

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Written by Lori Polydoros
Illustrations by Craig Frederick

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