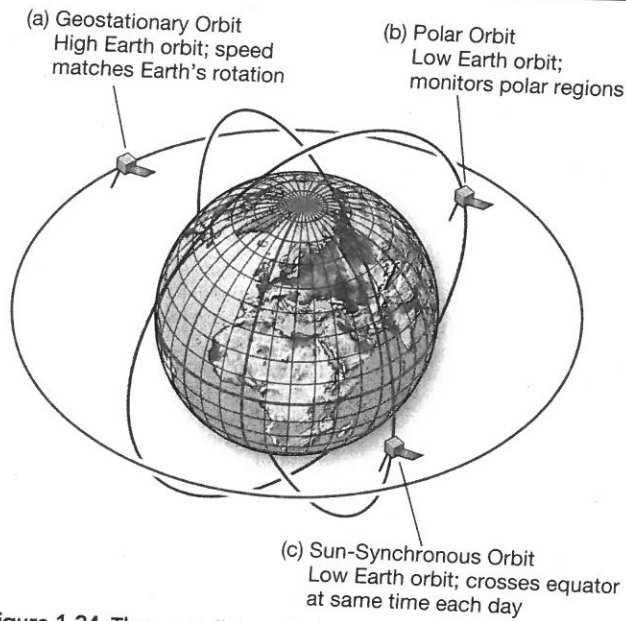




▲Figure 1.24 Three satellite orbital paths.

tropics (see example images in Geosystems in Action 4 on page 121). Monitoring the polar regions requires a satellite in polar orbit, with a higher inclination of about 90° (Figure 1.24b).

One type of polar orbit important for scientific observation is a Sun-synchronous orbit (Figure 1.24c). This low Earth orbit is synchronous with the Sun, so that the satellite crosses the equator at the same local solar time each day. Ground observation is maximized in Sun-synchronous orbit because Earth surfaces viewed from the satellite are illuminated by the Sun at a consistent angle. This enables better comparison of images from year to year because lighting and shadows do not change.

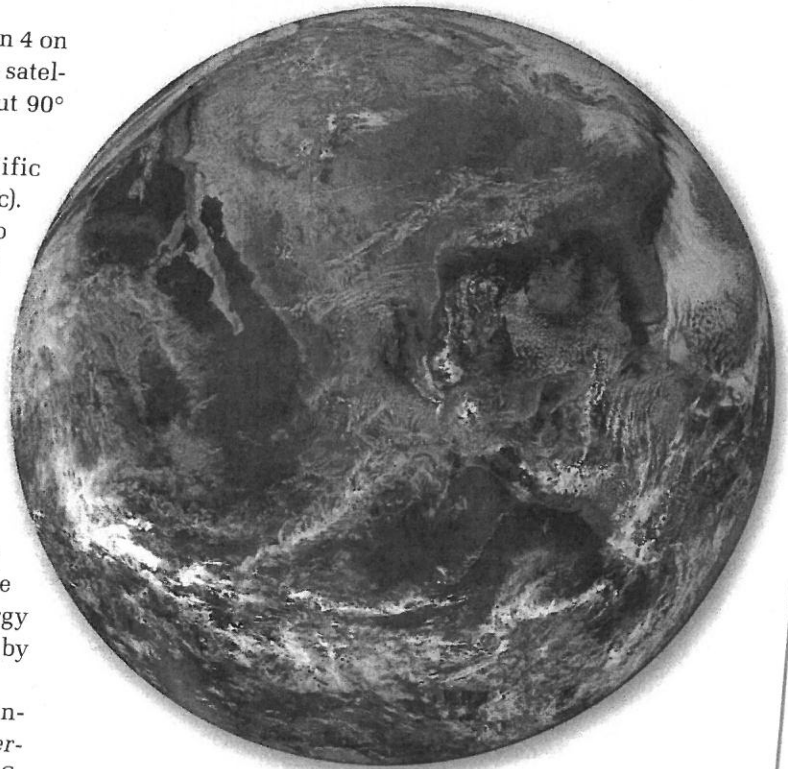
Passive Remote Sensing Like the human eye, passive remote-sensing systems record wavelengths of energy radiated from a surface, particularly visible light and infrared. Thus, passive sensors detect energy that is naturally emitted by the object or that is reflected by sunlight.

A number of satellites carry passive remote sensors for weather forecasting. The *Geostationary Operational Environmental Satellites*, known as *GOES*, became operational in 1994 and provide the images you see on television weather reports. *GOES-12*, -13, -14, and -15 are operational; *GOES-12* sits at 60° W longitude to monitor the Caribbean and South America.

Think of these satellites as hovering over these meridians for continuous coverage, using visual wavelengths for daylight hours and infrared for nighttime views.

Scientists use data from *Landsat* satellites, which began imaging Earth in the 1970s, for comparison of changing Earth landscapes over time, among other applications (see examples in Chapter 13, Visual Analysis 13, on page 437; view more images at <http://earthobservatory.nasa.gov>). *Landsat-5* retired in 2012 after 29 years, the longest-running Earth-observing mission in history; *Landsat-8* launched in 2013, beginning the new *Landsat* program managed by the USGS.

Although the *Landsat* satellites far surpassed their predicted lifespans, most satellites are removed from orbit after 3 to 5 years. Launched in 2011, *Suomi NPP* is part of the National Polar-orbiting Partnership (NPP), the next generation of satellites that will replace NASA's aging Earth Observation Satellite fleet. Many of the beautiful NASA "Blue Marble" Earth composite images are from the *Suomi* satellite (Figure 1.25).



▲Figure 1.25 *Suomi NPP* Blue Marble image. This composite view of Earth was imaged January 2, 2012. NASA scientist Norman Kuring combined VIIRS instrument data from six orbits of the *Suomi NPP* satellite. VIIRS acquires data in 22 bands covering visible, near-infrared, and thermal infrared wavelengths. [NASA/NOAA.]



GEOREPORT 1.5 Polar-orbiting satellites predict Hurricane Sandy's path

Scientists at the European Centre for Medium-Range Weather Forecasts report that polar-orbiting satellites, such as the National Oceanic and Atmospheric Administration (NOAA) *Suomi NPP* satellite, were critical for predicting Hurricane Sandy's track. Without data from these satellites, predictions for Hurricane Sandy would have been off by hundreds of miles, showing the storm heading out to sea rather than turning toward the New Jersey coast. *Suomi* orbits Earth about 14 times each day, collecting data from nearly the entire planet (find out more at <http://npp.gsfc.nasa.gov/>).