



Hurricane Katrina, GOES-12 1 km visible imagery

Global Environmental Satellites: Watching Our World

The April 1960 launch of the first environmental satellite, TIROS, or Television Infrared Observation Satellite, ushered in the era of modern space-based environmental monitoring and remote sensing. Today, the National Oceanic and Atmospheric Administration (NOAA) is one of many international organizations that have launched hundreds of satellites designed to monitor the global environment.

NOAA's Satellite and Information Service (NESDIS) is charged with the acquisition and operation of several key environmental satellite programs, including ground systems needed to bring down the data from satellite sensors. NESDIS also processes the data to create products useful to research scientists, weather forecasters, and the public.

Satellites and Weather Forecasting

Weather forecasters around the country routinely use satellite images to show the progress of clouds and storms. To the casual observer, a satellite image is a picture of the Earth as seen from space. In reality, computers use millions of bits of data from instruments aboard satellites to create images with white clouds, green land, brown mountains, and blue oceans to simulate what an observer would see if they were hovering above the Earth.

The satellite ground systems use complex mathematical algorithms to create products from the raw data produced by satellite instruments. The resulting output can be displayed in graphical form or sent directly to other computer systems that produce National Weather Service numerical weather prediction models.

Data, Data, and More Data

These products, which now number in the thousands, are produced many times every day, 365 days per year. NESDIS ingests processes, generates, and distributes several terabytes of data each day. To put this into perspective, it would take over 30 iPods each with 80 GB of storage to hold all of the data processed and distributed by NESDIS every day.

Satellites have several advantages over other environmental monitoring mechanisms, such as weather balloons, aircraft, and radar. Satellites maintain a constant wide-area view of the Earth and its atmosphere providing massive amounts of data for weather forecasting and climate monitoring. In addition, satellites play a key role in detecting and monitoring volcanic eruptions, large wildfires and associated smoke, El Niño and La Niña, snow and ice recession, severe droughts, and tsunamis.

Many different types of satellite products can assist weather forecasters. While many people focus on satellite images of a hurricanes bearing down on populated areas, there are other types of satellite data used for similar purposes. For example, infrared measurements of oceans are made into maps of sea surface temperature critical to forecasting the intensity of hurricanes. Special sensors on environmental



satellites can emit pulses of energy toward the ocean surface, measure the reflection of that energy, and create a map of surface winds located in the center of a storm. Other sensors can measure the internal temperature of a hurricane and the temperature of the cloud tops to determine the strength of the storm. Ahead of the storm, we can estimate atmospheric winds using algorithms that track cloud movement. Temperature and moisture data from other types of sensors can be used in computer models to forecast storm movement.

Satellite Data Charts a Changing World

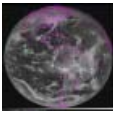
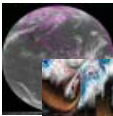
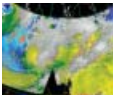


Environmental satellites can support many disciplines other than weather forecasting; they can be used to

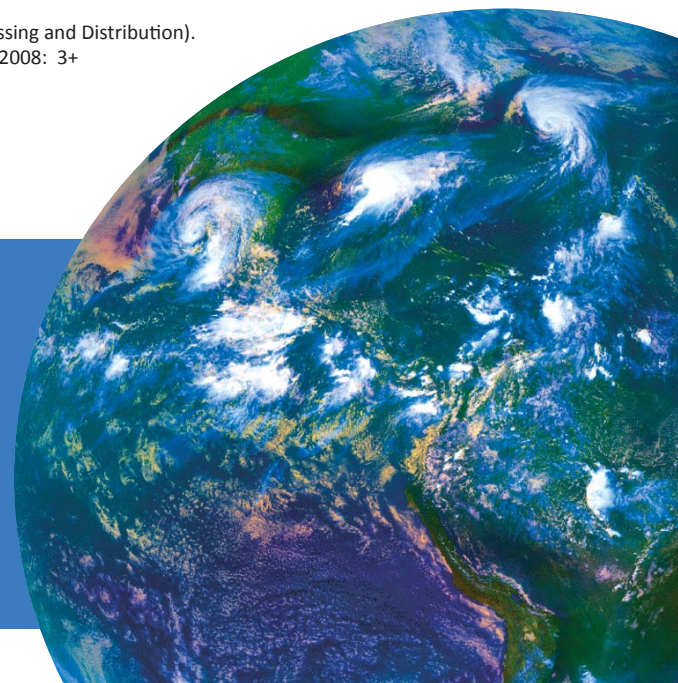
study climate, land science, ocean science, ecosystems, space weather, air quality, and many others. We also use satellites to explore connections across these disciplines. For example, pollutants affecting air quality can be detected by a satellite, and their long-term effects can be measured by climate sensors. In addition, dust from the Sahara Desert in Africa, as “seen” from a satellite sensor, can inhibit the development of tropical storms in the Atlantic. Also, atmospheric moisture detected by special sensors aboard polar-orbiting satellites can influence the amount of rainfall thousands of miles away.

Sensing the Future

The future is exciting yet challenging for the environmental satellite community. New instruments with cutting edge technology are set to be launched on the next generation of satellite platforms, increasing the number of measurements that can be taken and providing hundreds of new products or improvements to existing products. These new sensors will give scientists a more complete picture of Earth’s environment, thus saving more lives and enhancing the Nation’s economy.¹

¹Hughes, Brian, (Staff Physical Scientist and Operations Manager, Office of Satellite Data Processing and Distribution). “Global Environmental Satellites—Past, Present, and Future.” *Earth System Monitor* February 2008: 3+

Raw Measurement	Environmental Parameter	Scientific Application
 GOES/Polar Imager Visible Channel	Albedo, or “brightness” of the Earth or clouds	Land type Snow and ice cover Clouds - thunderstorm tops, mid-level clouds, low cumulus. Cloud patterns. Smoke from fires or Volcanic ash or Dust Winds from movement of clouds Solar reflection
 GOES/Polar Imager Infrared Channels	Temperature and moisture – land surface, atmosphere, and cloud tops	Atmospheric temperature/moisture Cloud Top Temperature Land temperature; Fire detection Winds from cloud movement Jet stream patterns Non-water cloud detection: ash, Sulfur Dioxide, smoke Sea surface temperatures
 GOES/Polar Sounder Infrared Channels	Temperature and moisture – multiple levels of the atmosphere	Atmospheric temperature/moisture profiles Severe weather prediction Atmospheric moisture measurements for flash flooding Fire weather Atmospheric temperature Cloud properties – phase, cloud masking, cloud height
 Polar Microwave Measurements	Temperature and moisture from top of atmosphere to surface	Atmospheric moisture measurements over oceans Rain rate measurements in storms/hurricanes Temperature structure of hurricanes Low cloud patterns Sea ice measurements Sea surface wind speed
 Active Sensors	Properties of Earth’s surface	Wind speed and direction Ocean surface height (altimeter) High resolution radar measurements of ocean/land properties



Links

- More about satellites and products: www.nesdis.noaa.gov
- Satellite data and products: www.nesdis.noaa.gov/sat-products.html
- NOAA satellite programs: www.nesdis.noaa.gov/satellites.html
- Archived data and products: www.nesdis.noaa.gov/datainfo.html
- Geostationary satellite images: www.goes.noaa.gov
- Polar-orbiting satellite images: www.oso.noaa.gov/poes
- Visualizations of significant weather events: www.nnvl.noaa.gov
- Education and Outreach: www.nesdis.noaa.gov/outreach_edu.html
- Image of the Day: www.osei.noaa.gov/ioid.html
- Hurricane Imagery: www.nhc.noaa.gov/satellite.shtml
- Search and Rescue/Beacon Registration: www.sarsat.noaa.gov