





This image of Hurricane Bonnie was taken from the NOAA/National Weather Services' NOAA-12 polar orbiting environmental satellite on the morning of August 26, 1998 (07:37 EDT). This image was taken as Sunlight glints off Hurricane Bonnie as it approaches the North Carolina coast.

The image was enhanced and rendered at the NASA Goddard Space Flight Center, Laboratory for Atmospheres, Greenbelt, Md. An approximation of photo-realistic colors were made using the following channels from the NOAA-12 spacecraft: the red is derived from the visible, the green is derived from an enhanced version of the visible and the blue is derived from the inverted 11 micrometer infrared channel.

The image appeared in the Sept. 7, 1998, issue of Time Magazine.

Hurricanes are products of the tropical ocean and atmosphere. Powered by heat from the sea, hurricanes are steered by the easterly trade winds and the temperate westerlies as well as by their own ferocious energy. Around their core, winds grow with great velocity, generating violent seas. Moving ashore, they can produce a tremendous storm surge while spawning tornadoes and producing torrential rains and floods. According to the National Hurricane Center, on average, 10 tropical storms (six of which become hurricanes) develop over the Atlantic Ocean, Caribbean Sea, or Gulf of Mexico each year.

Timely warnings have greatly diminished hurricane fatalities in the United States. NOAA's National Hurricane Center and National Weather Service field offices team up with federal and local agencies, rescue and relief organizations, the private sector, and the news media in the warning and preparedness effort.

Since 1978, NASA has developed polar-orbiting environmental observation satellites for the National Oceanic and Atmospheric Administration (NOAA). NOAA-K, the latest NOAA Spacecraft, was launched in May 1998.

The NOAA satellites carry instruments that observe our Earth and provide global data for NOAA's operational user requirements including short and long-range weather forecasts. The operational system consists of two polar-orbiting satellites. One crosses the equator at roughly 7:30 am local time and 7:30 pm local time, and the other satellite crosses the equator at roughly 1:30 am/pm local time.

These spacecraft monitor the entire Earth, providing atmospheric measurements of temperature, humidity, ozone and cloud images as they track weather patterns

that affect the global weather and climate. The satellites send millions of global measurements daily to NOAA's Command and Data Acquisition station and data processing center, adding valuable information to forecasting models, especially for ocean areas, where conventional ground based data are lacking.

Currently, NOAA has two operational polar orbiters: NOAA-12, launched in May 1991 in a 7:30 am local time orbit; and NOAA-14, launched in December 1994 in a 1:30 pm local time orbit. NOAA-K will replace NOAA-12 in the 7:30 local time orbit.

NASA and NOAA are actively engaged in a cooperative program to develop and launch the NOAA Polar-Orbiting Operational Environmental Satellites (POES). NASA's Goddard Space Flight Center in Greenbelt, Md., is responsible for the construction, integration, launch and verification testing of the spacecraft, instruments and unique ground equipment. NASA turns operational control of the spacecraft over to NOAA after a comprehensive on-orbit verification period, which is expected to last approximately 60 days.

NOAA is responsible for program requirements funding and the on-orbit operation of the multi-satellite system. NOAA also determines the need for satellite replacement. NOAA designs and develops the ground system needed to acquire, process and disseminate the satellite data.

The satellite operates in a circular, near-polar orbit of 450 nautical miles (833 kilometers) above the Earth with an inclination angle of 98 degrees to the equator. The NOAA-K orbit period, which is the time it takes to complete one orbit of the Earth, will be approximately 101 minutes.

The POES spacecraft serve as complementary satellites to the geosynchronous Geostationary Operational Environmental Satellites (GOES) system. Where the GOES satellites provide near-term data from the continental U.S. and Hawaii to NOAA's forecasters, the polar-orbiting spacecraft provide full global data for short and long-range forecast models, climate modeling, and various other secondary missions.

Data from the NOAA spacecraft are helping NASA scientists design instruments for follow-on missions for NASA's Earth Sciences program. NOAA has the responsibility to process, analyze, disseminate, and archive all operational data. These data are made available to NASA researchers and others for research and environmental applications.

More information on the POES program can be found on the Internet at: <http://poes2.gsfc.nasa.gov/> and at <http://www.2.ncdc.noaa.gov/doc/intro.htm>.

FOR THE CLASSROOM

1. The POES spacecraft serve as complementary satellites to the Geostationary Operational Environmental Satellites (GOES) system. The GOES satellites provide hourly observations, but only over limited areas centered about their equatorial locations. The two GOES satellites provide data from the continental U.S. and Hawaii, and well out into the Atlantic and Pacific Oceans to NOAA' forecasters. This is useful for monitoring severe weather and short term weather prediction. The polar-orbiting spacecraft, however, provide four times daily full global data useful for short and long-range forecast models, climate modeling, and various other secondary missions.

The POES satellite system provides (1) imaging and quantitative measurements of the Earth's atmosphere, its surface, and cloud cover. This information includes natural radiation leaving the earth's atmosphere, atmospheric ozone distribution, sea and land surface temperatures, vertical temperature profiles through the stratosphere, and water vapor profiles in the troposphere; (2) measurement of proton and electron flux at orbit altitude; (3) remote platform data collection. It also includes a Search and Rescue Satellite-aided Tracking (SARSAT) system. SARSAT is part of an international satellite system for search and rescue which includes the NOAA spacecraft and the Russian provided satellites (COSPAS).

Is a polar orbit a good orbit for a weather satellite? Why? Is it important to have both a polar and geostationary weather satellites? Have students read the newspaper or search the World Wide Web for any articles about people being rescued because of SARSAT?

2. Hurricanes are large storms that form in warm, moist, tropical air near the equator in summer and fall. Moisture from warm ocean water evaporates rapidly. Colder air from above moves down and pushes more warm air up. This is called convection; lighter, less dense, warm air rises when it meets dense, heavier, cooler air.

Convection may be observed in water

Materials for each group of students:

400 ml beaker, 1/2 cup small paper circles from a hole-punch, hot plate, (colored paper circles are easier to observe), water.

Use caution with the hot plate and boiling water! Can be demonstrated for younger students.

Have students fill a beaker with 300 ml. water. Place the hole-punch circles in the water. Place the beaker on the hot plate and bring the water to a boil. Have the students observe the behavior of the hole-punch circles and draw a diagram to show how they move.

To check for understanding, ask the following questions:

1. *When the water boils, what happens to the hole-punch circles? (They move in a circular pattern.)*

2. *Why does this happen? (As the water is heated, it rises. As it gets further from the heat source, it cools and then sinks. The heat again causes the water to rise, and the cycle continues. This movement of heat in currents is called convection.)*

When this transfer of warm air moving up and cold air moving down begins to spiral around a central core a potential hurricane is born!

For more hurricane images on the World Wide Web:

<http://pao.gsfc.nasa.gov/gsfcc/earth/pictures/earthpic.htm>

<http://globe3.gsfc.nasa.gov/cgi-bin/show.cgi/page=gallery-advanced.htm>