THE
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Examining the Atmosphere and Atmospheric Resource Management

Weather Satellites: Our Eyes in the Sky

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There are thousands of man-made satellites in orbit above the Earth. While they serve several purposes, a small segment of them are dedicated to observing Earth's weather. Meteorologists use data from weather satellites to better observe the atmosphere and create more detailed weather forecasts.

According to the National Oceanic and Atmospheric Administration (NOAA), weather satellites orbit the Earth at a range of 540 to 22,000 miles. Polar orbiting satellites typically occupy lower orbits and continually circle the Earth, while geostationary satellites occupy higher altitudes and remain in specified locations by moving at the same speed as the Earth's rotation.

Weather satellites have only been around for a short period of time. In fact, the first successful weather satellite, TIROS-1, was launched into orbit on April 1, 1960 by NASA. Television viewers were able to see a satellite picture of the Earth for the first time ever!

Before satellite imagery became available, meteorologists relied on observations from weather stations, aircraft, sea vessels, and radars to produce weather forecasts. Satellites were able to single-handedly increase the advanced warning times for hurricanes and other weather phenomena by days instead of hours.

So how do weather satellites work? Most weather satellites use instruments known as radiometers to measure temperature, water vapor, cloud cover and many other parameters within the Earth's atmosphere. Radiometers use mirrors to scan for various wavelengths of radiation. This radiation is reflected back to the satellite and then that data is transmitted down to Earth for collection and processing. According to the University of Wisconsin-Madison, there are five spectral bands of radiation measured by Geostationary Operational Environmental Satellites (GOES). One of the spectral bands is visible radiation and the other four are infrared. Of these five bands, visible light (0.6 microns), longwave infrared (10 to 12 microns), and water vapor (6.7 microns) are the primary channels used for weather products.

Red River Valley, April 6, 2009. Source: NASA/GSFC, MODIS Rapid Response.

Visible satellite images provide us with "snapshots" of the Earth's atmosphere and surface. (See image.) Cloud cover, topographic features, dust storms, and smoke are observed most frequently on visible satellite products. Infrared satellite images measure both atmospheric and Earth-based temperatures. This is extremely useful for scientists conducting research on the Earth's Sea Surface Temperatures (SSTs) or for climate change studies. Infrared imagers help fight forest fires and aid with search and rescue operations by locating people.

When it comes to determining whether moisture is available in the atmosphere for precipitation events, satellite water vapor imagery proves an invaluable resource. We occasionally experience a phenomenon called the "Pineapple Express" where moisture from the Hawaiian Island region of the Pacific Ocean is channeled eastward to the west coast of the US. This phenomenon is easily depicted on satellite water vapor imagery.

In the future, weather satellites will play an even greater role in the safety and well-being of our Earth's ever-growing population. Early warnings for tsunamis and tropical storms are increasingly important considering that approximately two-thirds of the world's population lives within 50 miles of a coastline. Satellites save thousands of lives every year with the data that they provide us. Think of them as our "eyes in the sky."

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