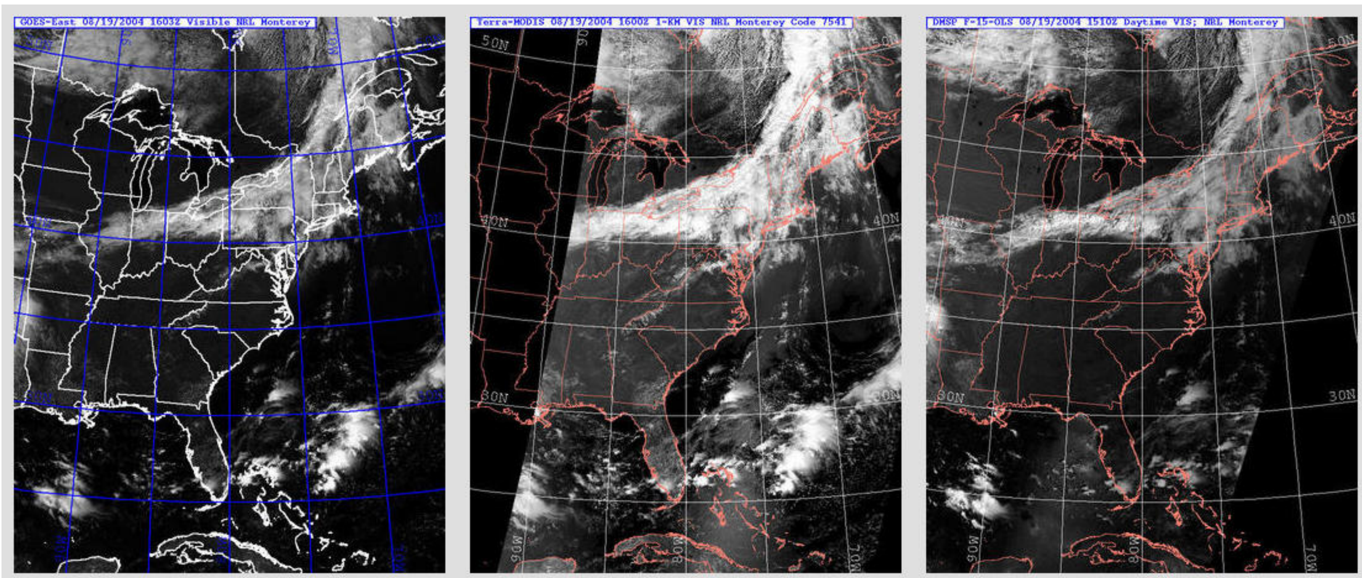
Satellite Product Tutorials:

Visible Imagery



GOES-12/GVAR | TERRA/MODIS, | DMSP/OLS

Daytime visible images

Above:

Examples of visible imagery from three different sensors are shown above. The left panel from the geostationary satellite GOES-12, sensor GVAR. The center panel is from the polar orbiting satellite Terra, sensor MODIS. The right most image is from the polar orbiting satellite DMSP, sensor OLS. In these examples, clouds appear white (high reflection of sunlight), land appears gray (moderate reflection), and oceans outside the region of sun glint appear black (low reflection).

Why We're Interested…

Visible imagery can be considered as a starting point for most remote sensing image interpretation. Clouds are where the weather is, and in visible imagery they are usually very easy to pick out since they are strong reflectors of sunlight. Mapping the location of cloud cover is easy to do using visible imagery is simple, as clouds associated with most weather systems are much larger than the resolving power of most weather satellites (for example, GOES partitions a scene into roughly half-mile wide boxes, whereas clouds associated with a cold front can span hundreds or even thousands of miles). Once cloud systems have been identified through simple interpretation of visible imagery, other satellite techniques can be used to provide additional information about the specifics of those clouds (their thickness, height, and even size of the droplets comprising them)

How This Product is Created…

Visible imagery is based on the same light that the human eye sees. The visible light is reflected from the Earth's surface and atmosphere (especially clouds) and detected by the satellite sensors. The amount of reflected light is converted into a digital number and sent back to antennas around the globe. These digital numbers are used in computer programs to create the visible satellite imagery that you can view. Each satellite scene is mapped to the Earth such that we can overlay coastlines, political boundaries, and reference points to aid in our interpretation of where the weather is and what it is doing.

White light is actually made up of a wide band of wavelengths—in fact, all the colors of the rainbow combine in forming it. Some satellite radiation detectors (called "radiometers") are capable of extracting individual components of the white light (for example, just the blue, green, or red part), and other detectors grab them all indiscriminately. True color images can be made from the former variety of detectors that are capable of recording the individual wavelengths, showing the blue, green, and red recorded by the satellite sensor. Black and white images are made for the sensors that grab all or most of the white light wavelengths, and are sometimes referred to as "panchromatic" images.

How to Interpret…

Visible light images only reveals what is reflected from the Earth's surface and atmosphere. It cannot penetrate past particles that are larger then its wavelength. So, light from the surface is blocked by clouds, smoke, or dust in the atmosphere. When these elements exist in the scene, all you will see are their topmost portions, and everything below will be obstructed.
For the black and white visible imagery examples on NexSat, anything bright white corresponds to a strong reflector of visible light, and any thing dark

corresponds to a poor reflector of visible light. Clouds tend to be good reflectors of visible light, whereas large bodies of water do not (unless the sun angle is just right, and the water acts like a mirror—this phenomenon is called sun glint).

Each picture element or pixel in the imagery represents all of the light coming to the satellite sensor over a discrete area of the earth. The size of this area is determined by the sensor's design. Visible light is the easiest wavelength to capture, so pixels for visible imagery are usually the smallest of all of the available channels. An important point to note is that everything within the area viewed contributes to how much light is displayed for this pixel. Therefore, if everything within this area is the same brightness (same reflection), the value is easy to interpret. More often than not, however, the area is heterogeneous and in these cases the measurement is in fact weighted sum of all of the elements of the pixel.

Visible imagery requires that the Sun be shining on the area being observed. As the Earth rotates around its axis, there is a line created called the day/night terminator that defines the location of sunrise or sunset. On the daytime side, visible imagery is produced. On the night side no visible information is available and the scene is left black. Some applications for visible light imagery (for example, detecting aerosol layers, or studying the vertical structure of clouds) are best when the Sun is just rising or setting in the imagery. Many other applications perform best under full Sun since the signal is very strong and there are fewer complicating effects arising from low sun angles.

Looking Toward the NPOESS Era…

The new National Polar-orbiting Operational Environmental Satellite System (NPOESS) era will show the maturity that satellite remote sensing science has obtained. The Visible/Infrared Imager/Spectrometer (VIIRS) instrument to fly on the NPOESS sensor suite has been designed with the compendium of knowledge gained over the 40-plus years that satellite sensors have been viewing the Earth. In addition, the NPOESS-VIIRS program has had the public's interest in mind from the project's inception. The VIIRS imagery will be processed and distributed to everyone (including those without direct broadcast receiving stations) in an unprecedented turn-around time of 30 minutes or less.

This means access to these images is as close to real time as possible. In this new paradigm, the world's weather will be available to everyone, not just the environmental scientist. For the newcomer, visible imagery is the best place to begin the learning experience. It is easy to understand, recognize, and relate to the weather we see out our window.

Did You Know…?

The first visible satellite image was recorded by Tiros 1, April 1, 1960. Because visible light wavelengths are small, visible light is interacts with many different kinds of particles of similar size that exist in the atmosphere. Cloud water droplets, smoke, or dust are large enough to change how much visible light makes it back to the satellite sensor. Even the gaseous constituents of the atmosphere itself (for example, Nitrogen and Oxygen) are sufficiently large to interact with the shorter wavelengths of visible light (blues and purples), and this explains the blue appearance of the daytime sky. The atmosphere is so efficient at scattering even shorter wavelength light that very little of it gets through to the surface—and that is a good thing for us, since these shorter wavelength light particles carry high energy and are very damaging to humans.

Want to Learn More?

GOES satellite information: http://rsd.gsfc.nasa.gov/goes/

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