More than Meets the Eye

How multispectral imaging helps us learn about our environment

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The reds, greens, and violets our eyes see are only a small part of the “light” that exists in the world. We don’t see the other forms of light — also called electromagnetic radiation — because our eyes are only sensitive to the tiny visible spectrum ranging from red to violet.

Photographs of the world at different wavelengths (colors) show how passive remote sensing can be used to learn about our environment through multispectral observations. From images at different wavelengths we can detect distant galaxies, measure atmospheric gases, find people at night, and gather a wealth of information about the world around us.

The electromagnetic spectrum is the continuum of all forms of electromagnetic radiation, characterized by frequency and wavelength. Electromagnetic radiation is a wave that moves in a manner similar to water, except that what “waves” are oscillating electric and magnetic fields. The distance between the high points of each wave is called the wavelength.

<table>
<thead>
<tr>
<th>Radio waves</th>
<th>Microwaves</th>
<th>Thermal infrared</th>
<th>Ultraviolet</th>
<th>X-rays</th>
<th>Gamma rays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength (m)</td>
<td>10⁻³</td>
<td>10⁻²</td>
<td>10⁻¹</td>
<td>10⁻⁰</td>
<td>10⁻⁸</td>
</tr>
</tbody>
</table>

Why do these images look the way they do?

Object also reflects radiation. The variation of reflectance with wavelength helps determine what an object looks like in visible and near-infrared images. For example, the high reflectance at wavelengths near 1000 nm accounts for vegetation appearing so bright in near-infrared images.

Light gets scattered into different directions when it runs into particles in the air.

Particles smaller than the wavelength of incoming light scatter short wavelengths more than long wavelengths with no preferred direction. This is called Rayleigh scattering and explains why scattering of sunlight by air molecules makes the sky appear blue.

Particles larger than the wavelength of incoming light scatter with no strong wavelength dependence and predominantly in the forward direction. This is called Mie scattering and explains why scattering of sunlight by large particles makes clouds or polluted skies appear white or gray.