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Radiometric Correctionradiometric correction

Radiometric correction is important to ensure that terrestrial variables retrieved from optical satellite sensor systems are calibrated to a common physical scale. Radiometric correction is one of several corrections performed on satellite image data prior to the retrieval of land, atmosphere, and ocean information. These preprocessing procedures are essential for ensuring high-quality information from remote sensors. Radiometric correction ensures that measurements and methods yield self-consistent and accurate geophysical and biophysical data, even though the measurements are made with a variety of different satellite sensors under different observational conditions and the parameter retrieval methodologies vary.

Overview

Radiometric correction is important for the successful conversion of digital image data from satellites to calibrated surface quantities in the Earth science context. Figure 1 shows the many possible paths that photons take from their source—the sun—to the entrance aperture of the satellite sensor imaging Earth, with five main pathways and associated interactions.

Radiometric corrections of optical sensor data consider sensor radiometric calibration, surface reflectance retrieval, spectral characterization, and georadiometric effects on image radiometry. By convention, raw image data and calibrated radiances at the top of the atmosphere (TOA) are referred to as Level 0 and Level 1 data, respectively. For analysis in quantitative applications, Level 2 data, consisting of radiometrically calibrated and geolocated physical variables such as surface reflectance, emittance, temperature, and so on, are preferred or required. Still higher data product levels consist of information products that are integrations, temporal aggregates, or spatial aggregates of lower-level data.

Sensor Radiometric calibration

Sensor radiometric calibration is a broad and complex field that imposes the greatest limitations on quantitative applications of remote sensing. The methods and instrumentation involved can be grouped into three domains: (1) on the ground prior to launch, (2) onboard the spacecraft post-launch (including reference to lamp sources and/ or solar illumination or lunar illumination), and (3) vicarious approaches using Earth scenes imaged in flight.

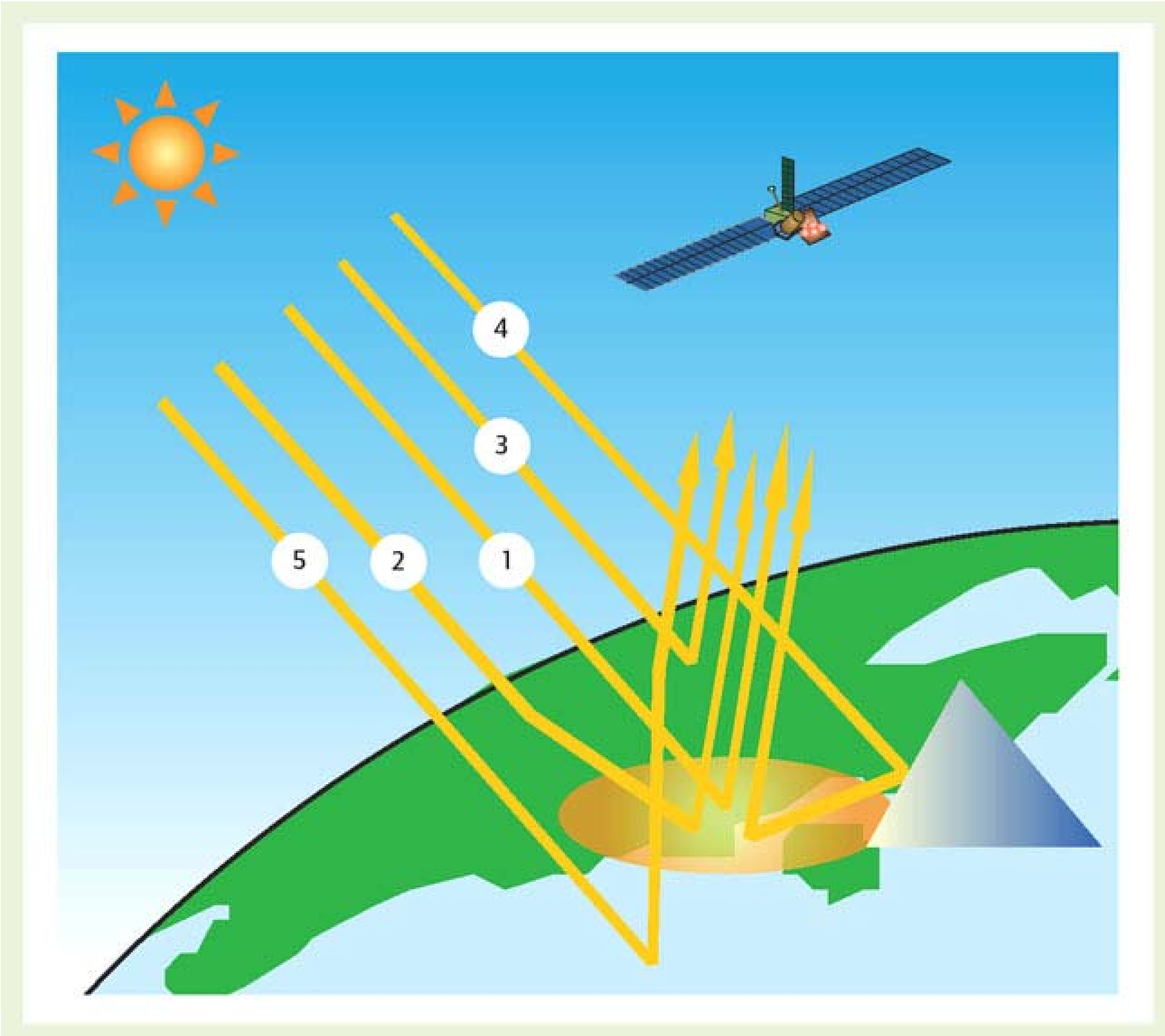

Figure 1 Radiometric correction

Source: Adapted from Teillet, P. M. (2005, September/October). Satellite image radiometry: From photons to calibrated Earth science data. *Canadian Journal of Physics, 61(5),* 301-310.

Note: Schematic of photon pathways from the sun to the entrance aperture of the satellite sensor: (1) direct solar illumination, (2) diffuse shy illumination, (3) atmospheric path radiance, (4) background object reflections, and (5) adjacent target effects.

Surface Reflectance Retrieval

In many applications, surface reflectance is the geophysical variable of particular interest in the solar reflective part of the electromagnetic spectrum. However, scattering and absorption due to gas molecules and aerosols in the atmosphere modify surface reflectance propagated through the atmosphere to the satellite sensor. Given that the optical properties of Earth's atmosphere are not uniform spatially or temporally, image corrections for these effects in the solar-reflective spectral bands are needed on a case-by-case basis to put satellite data on the same radiometric scale for investigations intended to monitor terrestrial surfaces over time and space.

Spectral Characterization

Spectral bands are designed for specific applications, and data products are susceptible to post-launch variations in spectral bandpasses or to spectral band differences between different sensors used in a given applications algorithm or model. In practice, there is little that users can do to take into account the changes in the spectral band performance. However, even when spectral bands perform as designed, users should be aware that similar information products derived from different sensors with analogous spectral bands that do not match exactly are not necessarily directly comparable.

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Further Readings

Schott, J. (1997). *Remote sensing: The image chain approach.* Oxford, UK: Oxford University Press.

Teillet, P. M. *Satellite image radiometry: From photons to calibrated Earth science data. Canadian Journal of Physics* vol. 61 no. (5) pp. 301–310. (2005, September/October).

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