Electromagnetic Radiation (EMR)

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160 PUBLICATIONS **4,167** CITATIONS

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Cross-references

Earthquake
Earthquake Prediction and Forecasting
Epicenter
Fault
Hypocenter
San Andreas Fault
Seismology

ELECTROMAGNETIC RADIATION (EMR)

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Synonyms

Electromagnetic waves; Radiant energy

Definition

Energy propagating through space at the speed of light in the form of sine-shaped electromagnetic waves, composed of perpendicularly arranged electric and magnetic fields. EMR ranges from gamma rays with very short wavelength to long radio waves. The shortest wavelengths can also be modeled as particles (photons). The interaction of EMR with matter forms the basis for remote sensing.

Overview

Electromagnetic radiation (EMR) is composed of sine-shaped waves that propagate through space at the speed of light (approximately 300,000 km s^{-2}), characterized by electrical and magnetic fields that are arranged perpendicular to each other (Lillesand et al., 2004). The central property of EMR is wavelength, inversely proportional to frequency. It ranges from high-frequency gamma rays (with picometer [10^{-16} m] wavelength and that are better thought of as particles or photons) to radio waves many kilometers long and with low frequencies, collectively known as the electromagnetic spectrum (EMS). Wave energy is also proportional to frequency.

EMR forms the basis for remote sensing (RS), which has gained great relevance in studying and monitoring of hazards (Tralli et al., 2005). RS is divided into passive and active methods: reflected or emitted radiation is recorded (passive), or the response of an artificial signal is received (active, for example radar). To detect or monitor phenomena related to hazards, a careful selection of the appropriate part of the EMS is critical. Most Earth observation instruments, such as regular cameras, passively record EMR in the visible part of the spectrum (approximately 0.4–0.7 μm [10^{-6} m]), and in the adjacent near-infrared (NIR, 0.7–1.4 μm). This is ideal to detect the state of vegetation, as the cell structure of healthy green leaves strongly reflects NIR energy, which declines in stressed leaves. Vegetation stress possibly leading to crop failure can thus be detected early.

Less common are detectors that record thermal infrared (TIR) radiation (8–14 μm), for example, to measure surface temperatures. The main forms of active RS are lidar (laser scanning), radar, and sonar (*li*ght/*ra*dio/*so*und *d*etection *a*nd *r*anging, respectively). Lidar uses very short waves between about 400 nm and 1 μm, whereas radar waves range between approximately 0.1–1 m. Sonar uses acoustic waves several meters long. An advantage of all active sensors is that they are largely weather-independent and may also be applied at night.

EMR is also the basis for other tools important in hazard work, for example, GPS, which uses radio waves of about 20 cm, marginally more than other important communication systems, such as wireless networks.

EMR itself can constitute a hazard to living organisms. Well-known examples of radiation to which exposure should be minimized or avoided are X-rays (wavelength of a few nm), ultraviolet rays than cause sunburn (about 0.3–0.4 μm), but also microwaves (wavelength of about 12 cm).

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Cross-references

Global Positioning System and Natural Hazards
Remote Sensing of Natural Hazards and Disasters

EL NIÑO/SOUTHERN OSCILLATION

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Synonyms

El Niño; Southern oscillation; Tropical pacific warming