ARCSSTE-E PGD Program

Fundamentals and Principles of Remote Sensing and GIS (SST 800)

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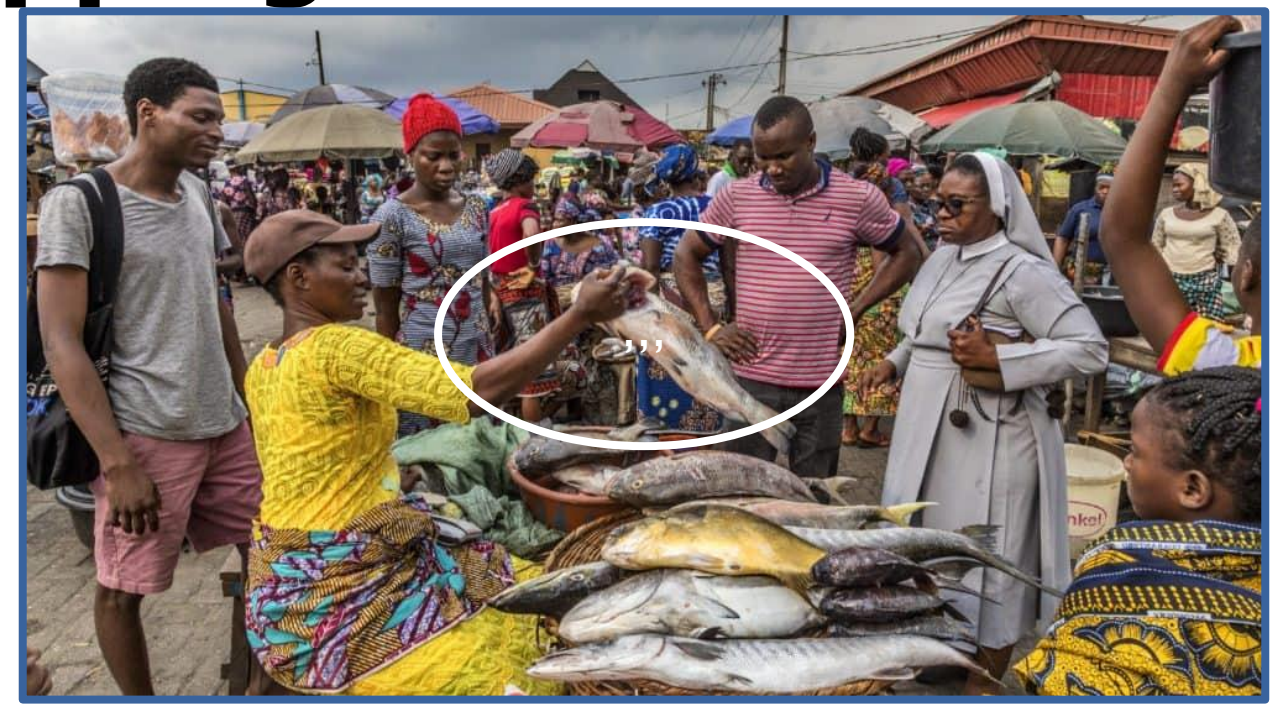
What is Remote Sensing?

A ***process*** of obtaining ***information*** of some property of a ***target (object or phenomena)*** by a ***sensor*** that is ***not in direct physical contact*** with the object

- **The Target:** is the entity from which **information** is obtained
- **The Sensor:** is the device used to obtain information from the target.
- **Remote:** indicates no physical contact between Target and Sensor
- **Data Collection:** from target by sensor
- **Data Transmission:** by electromagnetic waves

Is this Remote Sensing?

Shopping in the local Market



Target: The Fish
Information Required: Is it fresh? (Bright **red** gills)
Sensor: The ***Eyes*** of Reverend Sister
The Information required is transferred from the target to the sensor by ***visible light***

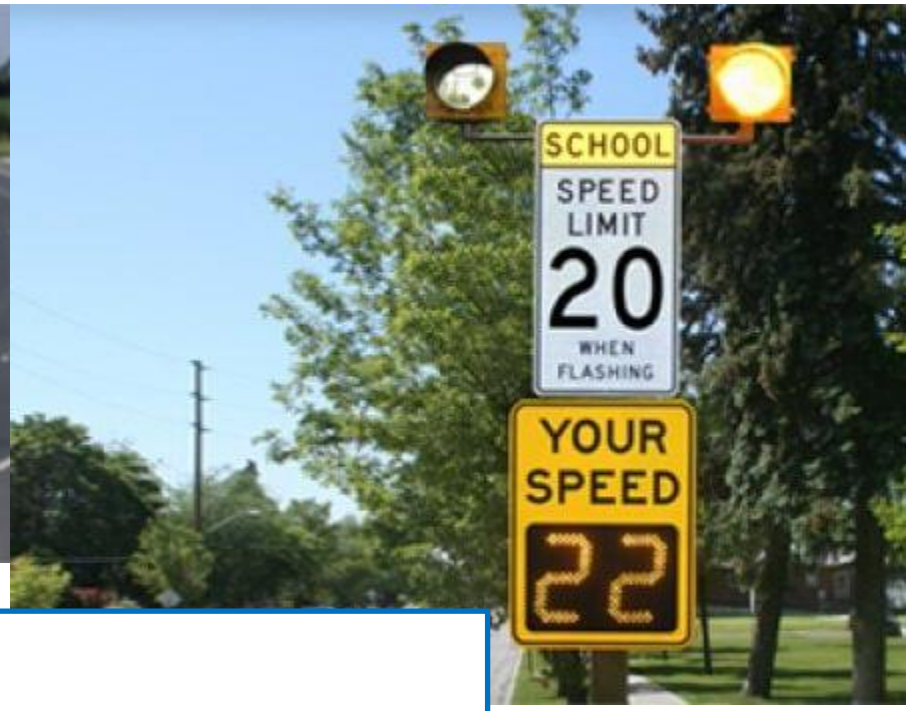
Is this Remote Sensing?

Measure Body Temperature

Target: The Child
Information Required: **Temperature** of the body
Sensor: The ***Thermometer***
The Information required is transferred from the target to the sensor by ***Infrared radiation***

Is this Remote Sensing?

Speed Limit Control by Radar



Target: The Car
Information Required: **Speed** of the Car
Sensor: The ***Radar Machine***
The Information required is transferred from the target to the sensor by ***Microwaves***

Is this Remote Sensing?

➢Production of X-Ray Image

Target: The Teeth of the man
Information Required: **Image** of the Teeth
Sensor: The ***X-Ray Machine***
The Information required is transferred from the target to the sensor by ***X-Rays***

Platforms for Remote Sensing

Platform depends on application:

- What type of information?
- How much detail?
- How frequent?

Satellite Remote Sensing

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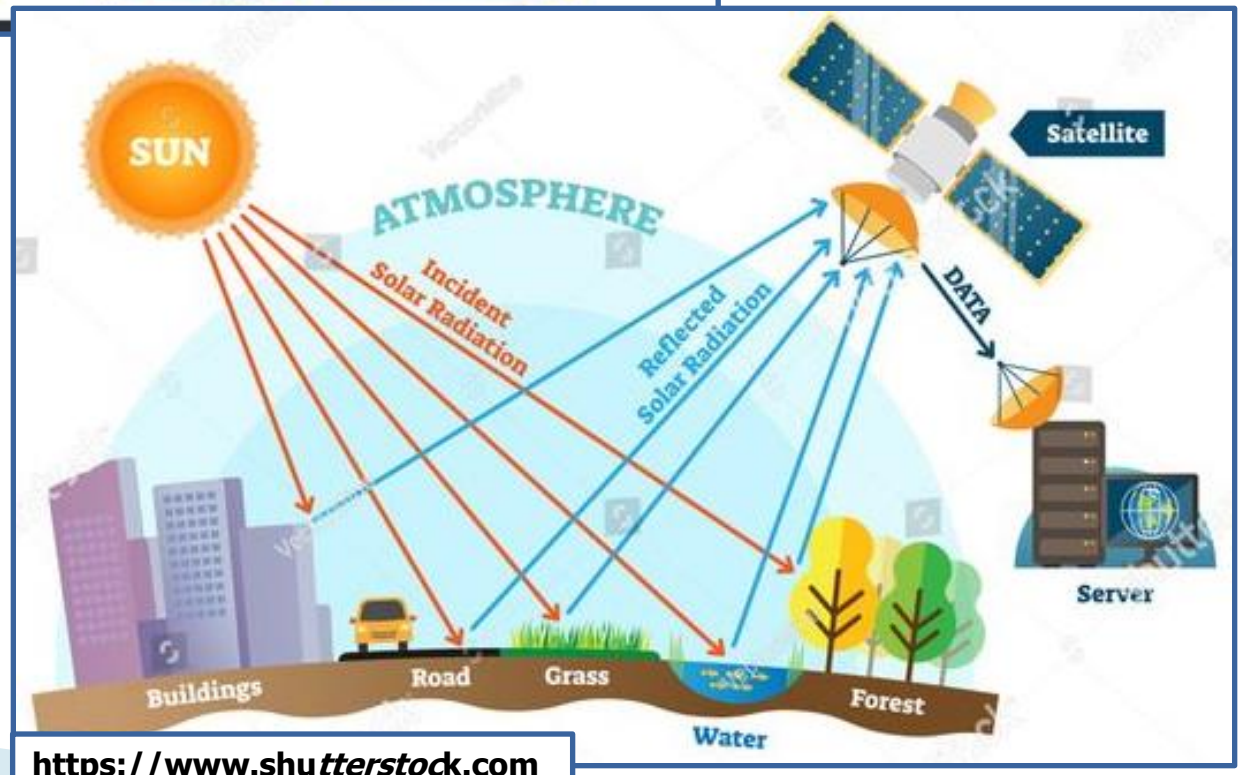
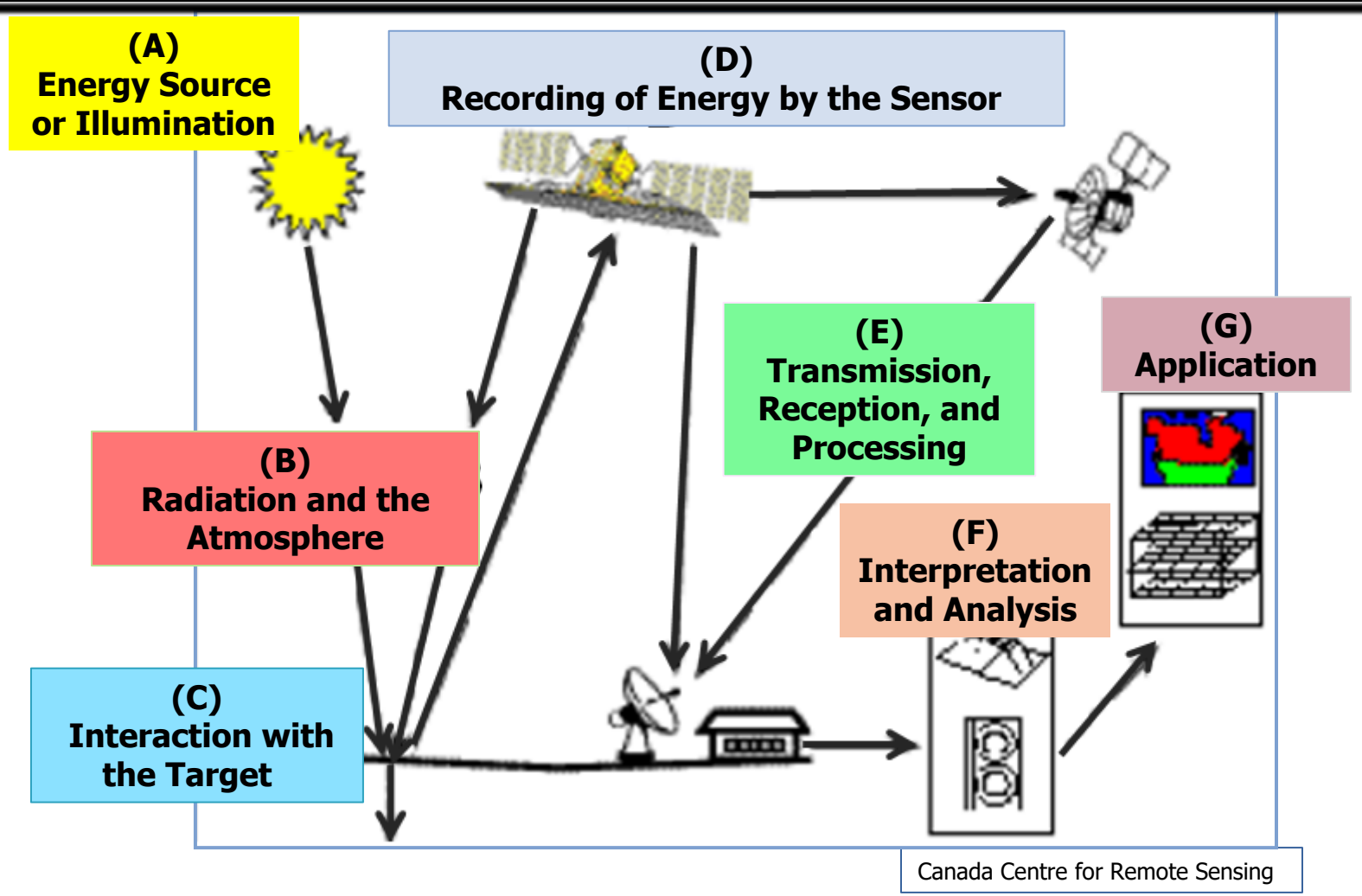


https://www.shutterstock.com

Types Remote Sensing

- Remote sensing can be active or passive, and the principal determinant of the type of remote sensing, is the sensor.
- ***Passive remote*** sensing occurs if the ***sensor can only receive information from the target***. For passive remote sensing, the energy is supplied by an external source, such as the sun
- While ***active remote sensing*** takes place when the ***sensor can send out signals and receive a response from the target***. For active remote sensing, the energy for the process is supplied by the sensor.
- The sensor can be located on different types of platforms, and for this course, our focus is on satellite remote sensing, where the sensor is located on a satellite.

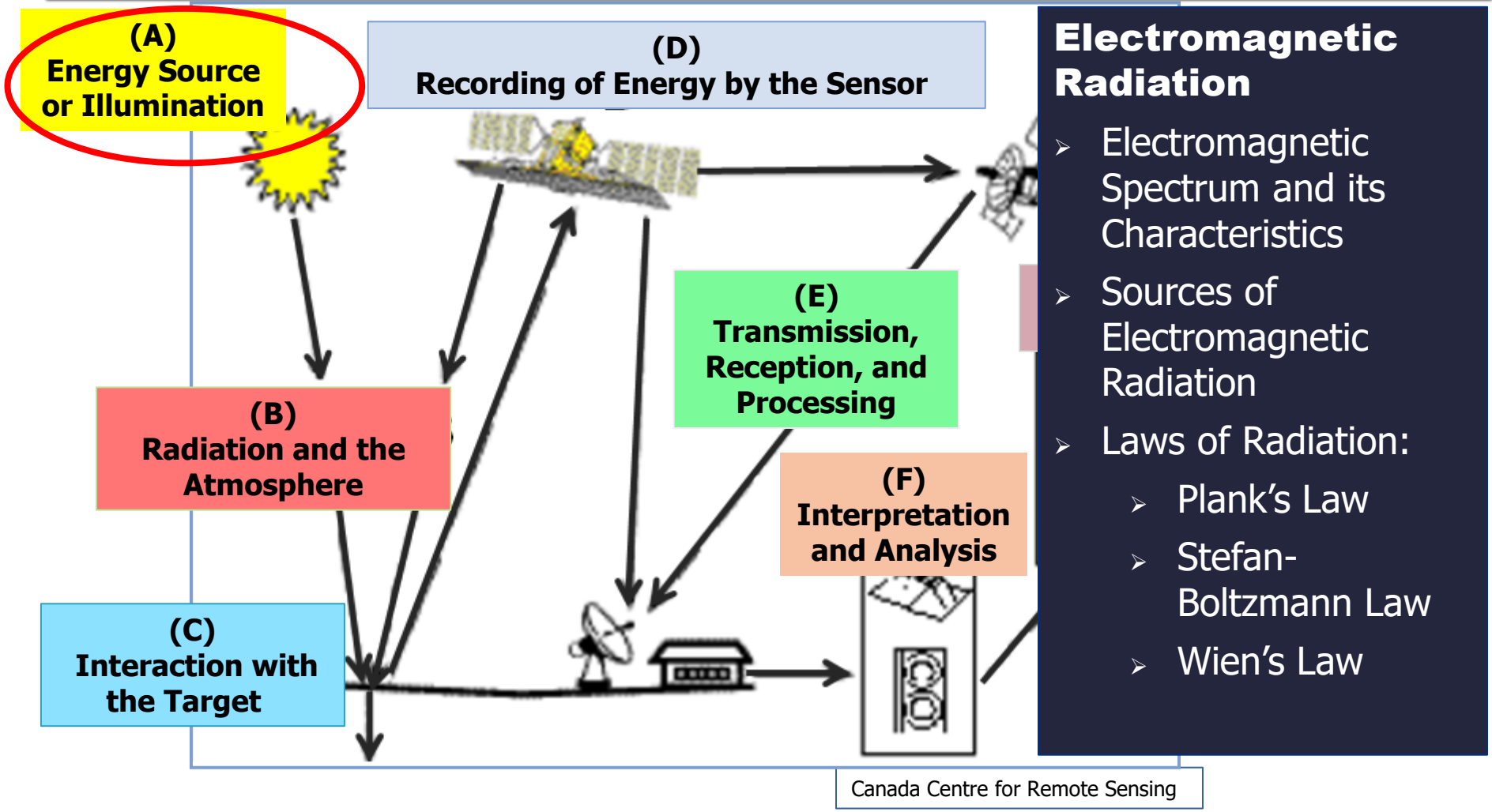
Schematic Representation of Satellite Remote Sensing



The **PROCESS** of remote sensing involves an interaction between the incident radiation and the target of interest

These **7 elements** comprise the remote sensing process for an imaging system.

Schematic Representation of Satellite Remote Sensing

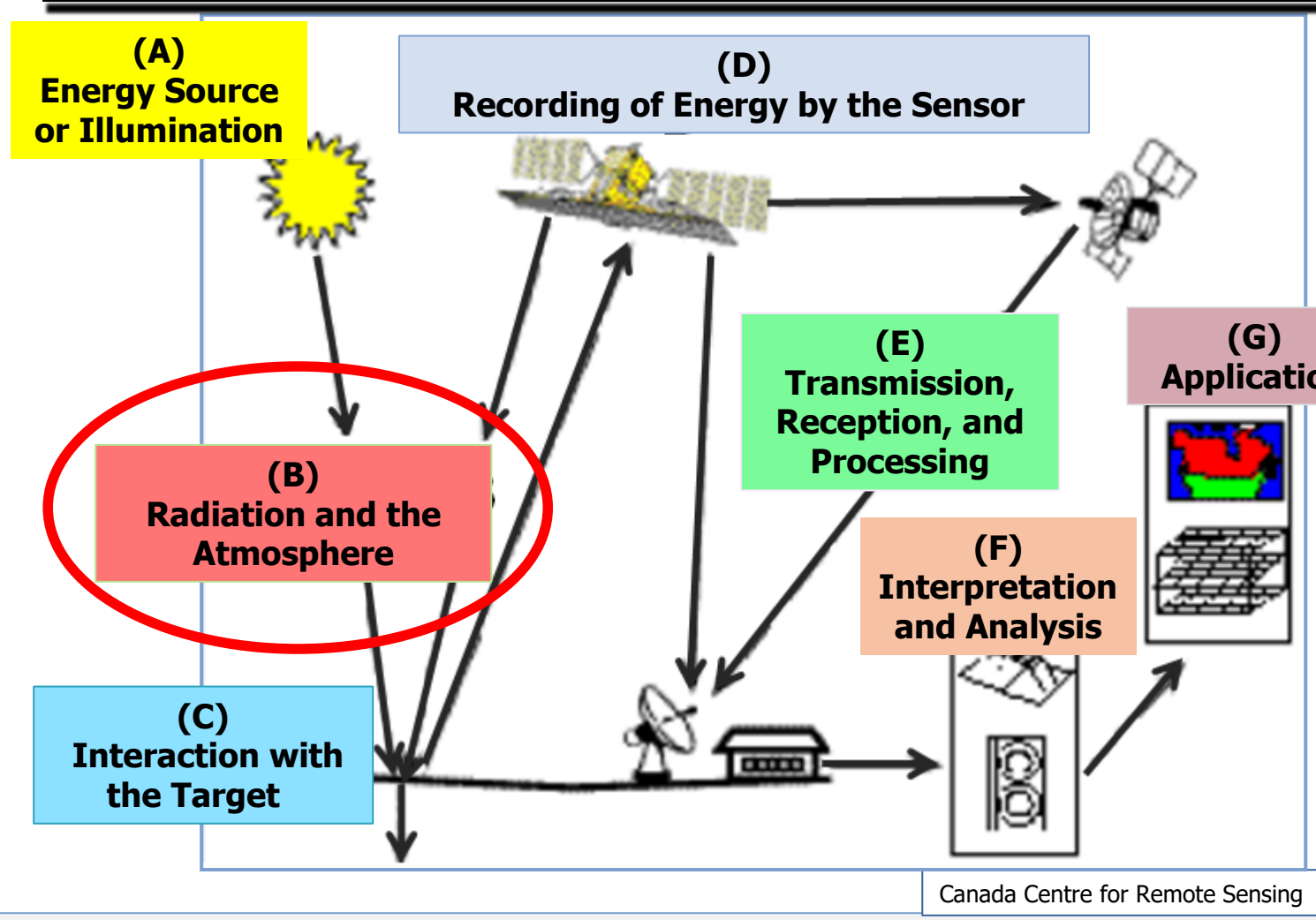


Electromagnetic Radiation

- Electromagnetic Spectrum and its Characteristics
- Sources of Electromagnetic Radiation
- Laws of Radiation:
  - Plank's Law
  - Stefan-Boltzmann Law
  - Wien's Law

1. Energy Source or Illumination (A): the first requirement for remote sensing is to have an **energy source to illuminate the target** (unless the sensed energy is being emitted by the target). This energy is in the form of electromagnetic radiation.

Schematic Representation of Satellite Remote Sensing



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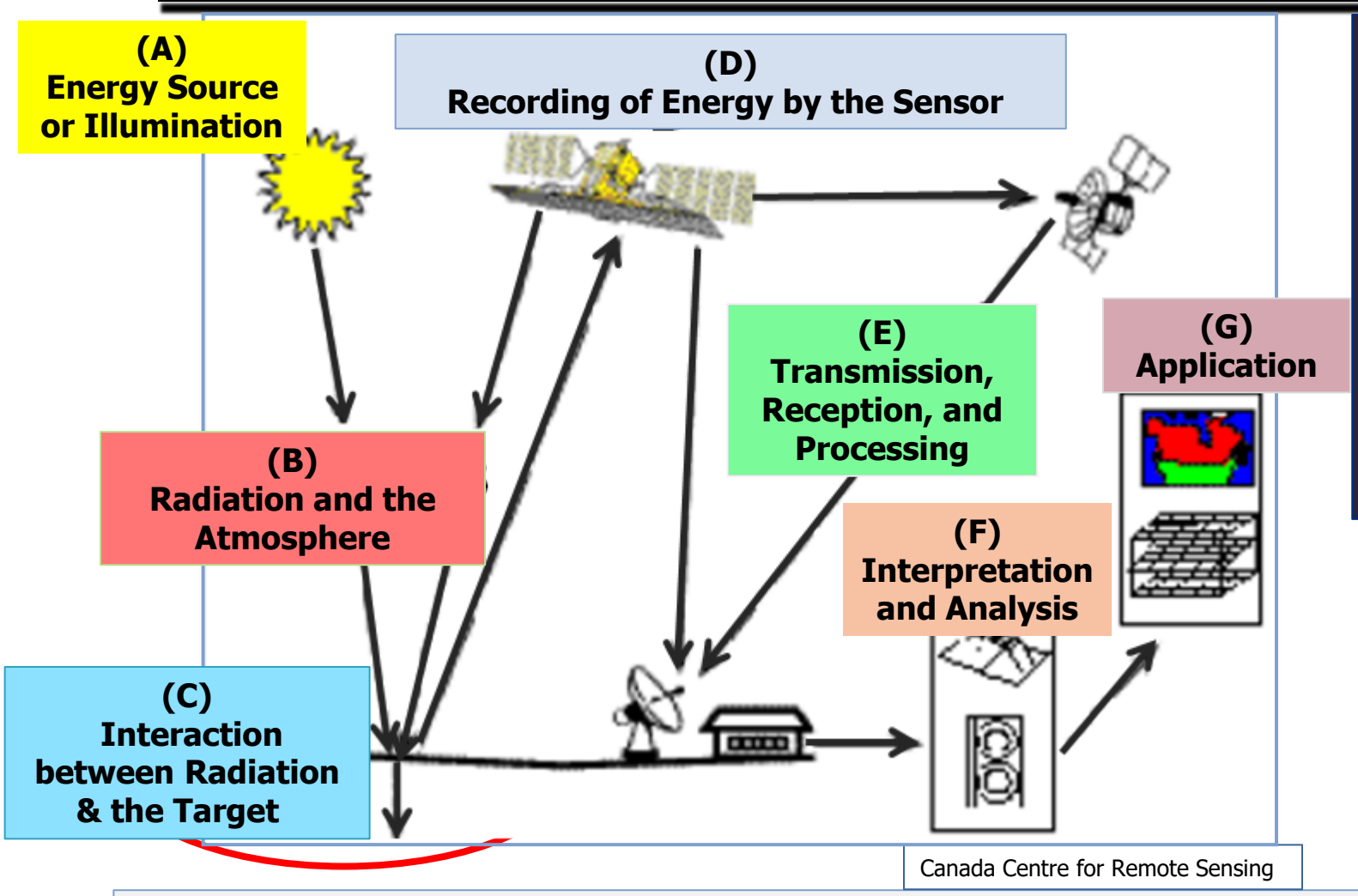
Interactions between EMT & the Atmosphere

- Atmospheric Composition
- Atmospheric Properties
- The Lapse Rate
- Atmospheric Contaminants
- Aerosols
- Scattering Mechanisms
- Clouds
- Temporal Variations
- Absorption
- Dispersion
- Atmospheric Soundings

2. Radiation and the Atmosphere (B): The intensity of reflected and emitted radiation to space is influenced by surface and atmospheric conditions. Thus, satellite measurements contain information about atmospheric conditions.

Schematic Representation of Satellite Remote Sensing



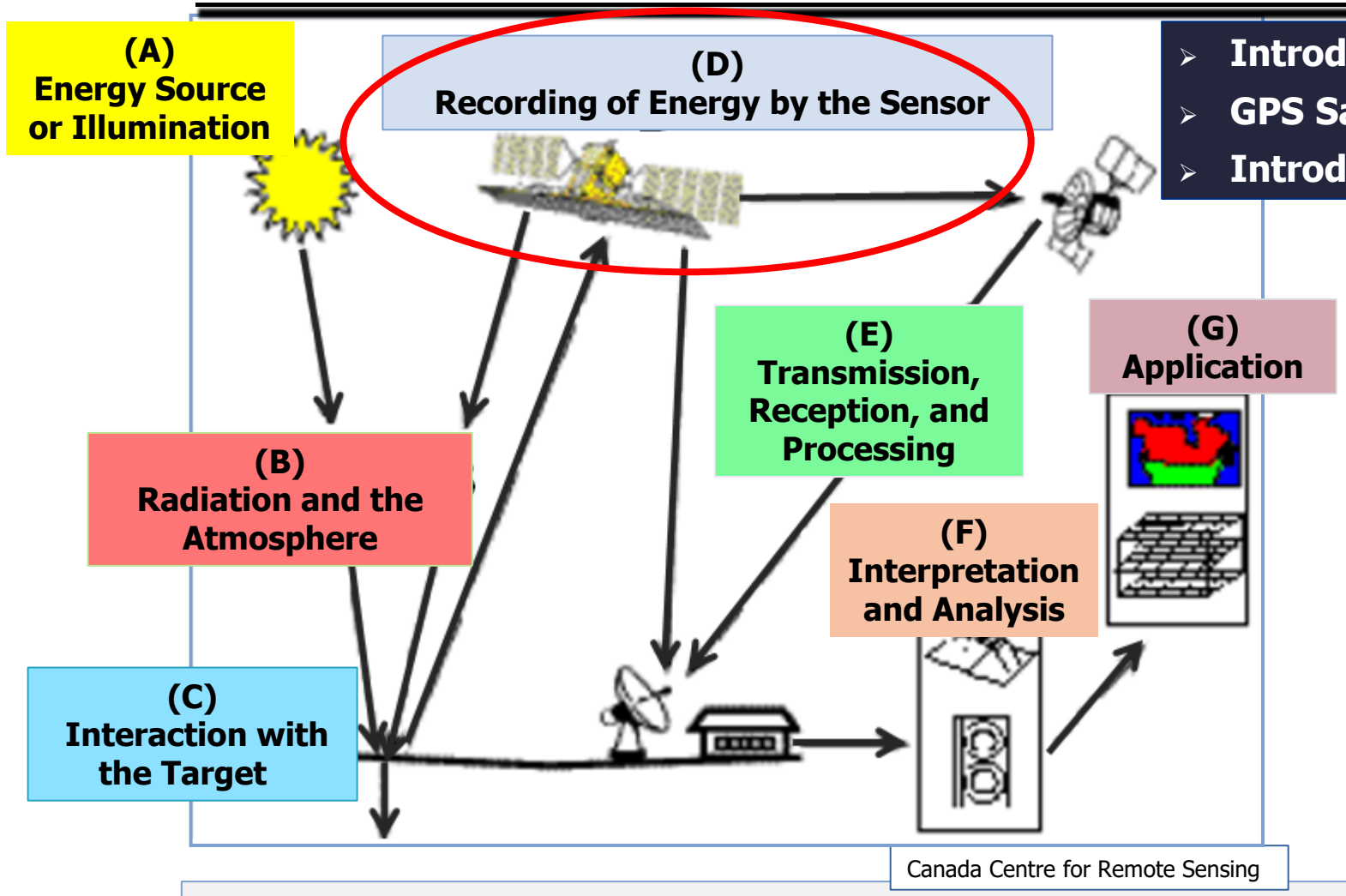
Interactions of EMT with Earth Surface

- Black Body Radiation
- Absorption
- Albedo
- Photoelectric effect
- Spectral Signature
- Spectral Characteristics of Vegetation, Soils, and Water

3. Interaction between Radiation & Target (C): Once the energy makes its way through the atmosphere, it interacts with the target. The nature of the interaction with the target depends on both the target and the radiation

Schematic Representation of Satellite Remote Sensing

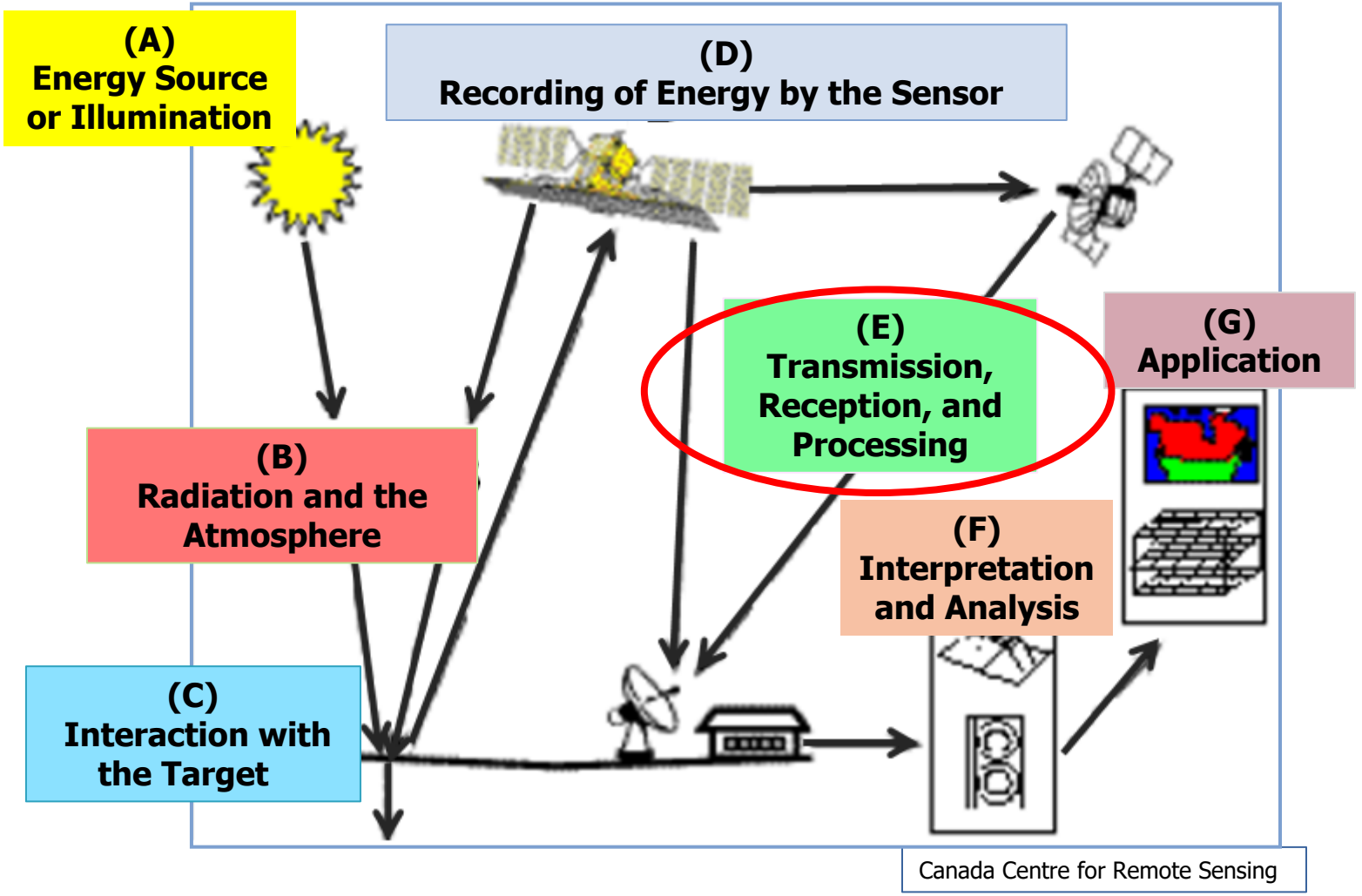
- Introduction to Satellites
- GPS Satellites
- Introduction to Passive & Active Sensors



Canada Centre for Remote Sensing

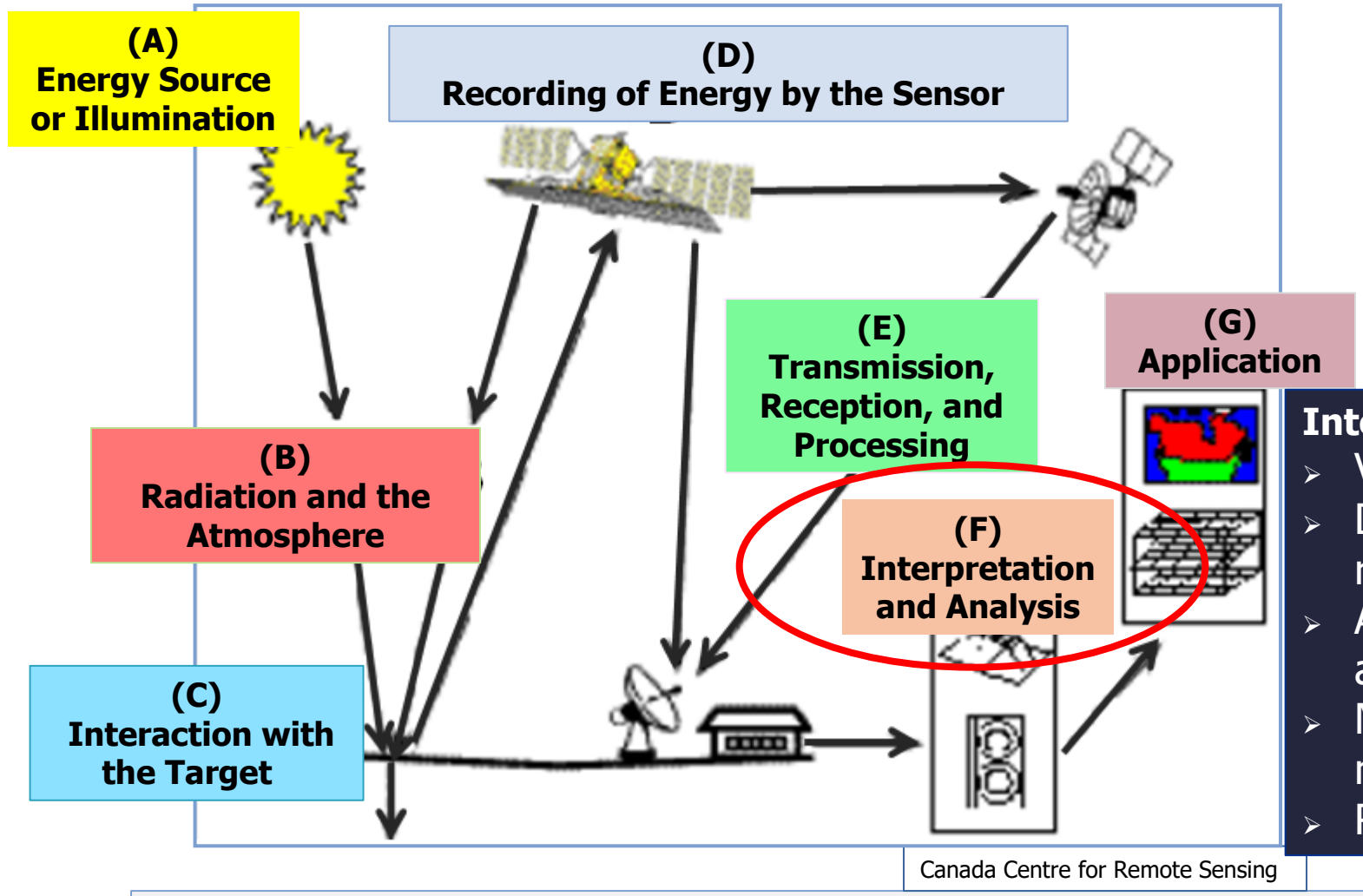
4. Recording of Energy by the Sensor (D): After the energy has been reflected by, or emitted from the target, a sensor is required to collect and record the information received from the target. This sensor is usually placed on a platform (**Satellite**).

Schematic Representation of Satellite Remote Sensing



5. Transmission, Reception and Processing (E): The energy recorded by the sensor is transmitted, often in electronic form, to a receiving station where the data are processed into an image (hardcopy and/or digital)

Schematic Representation of Satellite Remote Sensing



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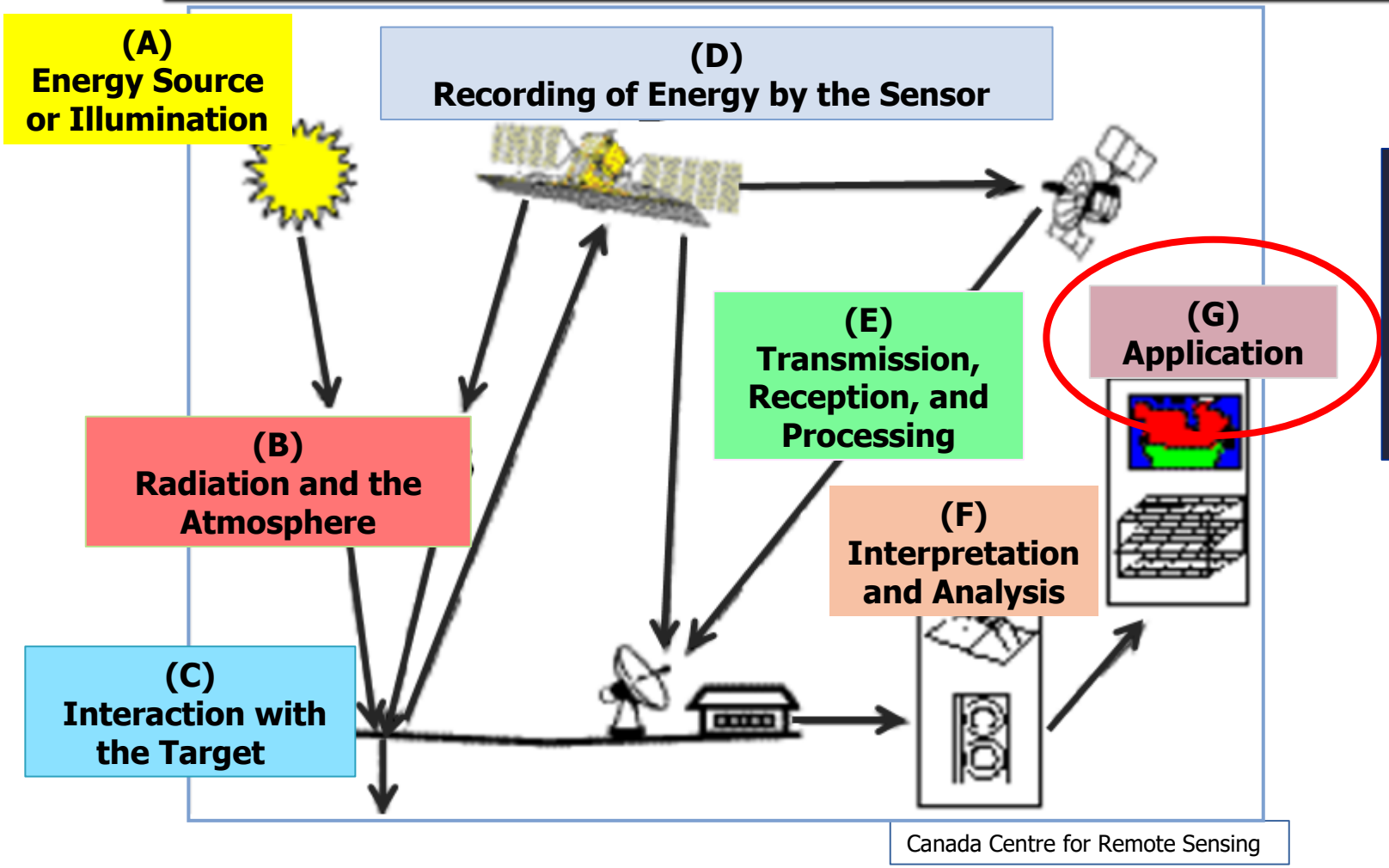
Interpretation and Analysis

- Visual image interpretation;
- Digital image processing and rectification;
- Advanced image classification and validation;
- Mosaicking of aerial photo and multispectral images;
- Re-sampling and calibration.

6. Interpretation and Analysis (F): The processed image is interpreted, visually and/or digitally or electronically, to extract the information obtained by the sensor, from the target.

Schematic Representation of Satellite Remote Sensing



Applications

- Integration of remote sensing and GPS data into GIS for practical applications in environmental studies.

7. Application (G): The final element of remote sensing is achieved when the information extracted from the imagery about the target is applied, in order to better understand the target, reveal some new information, or assist in solving a particular problem.

Why Satellite Remote Sensing?

- The Data obtained from Satellite Remote Sensing, combined with other data, in a GIS, can be used to promote the implementation of the UN-SDGs

https://news.un.org/

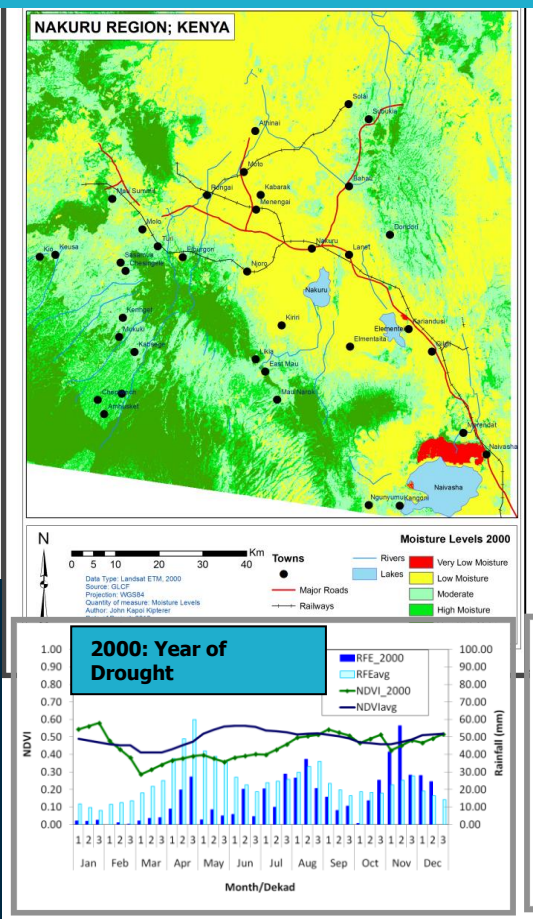
Agricultural Drought Severity Assessment Using Land Surface Temperature and NDVI in Nakuru, Kenya

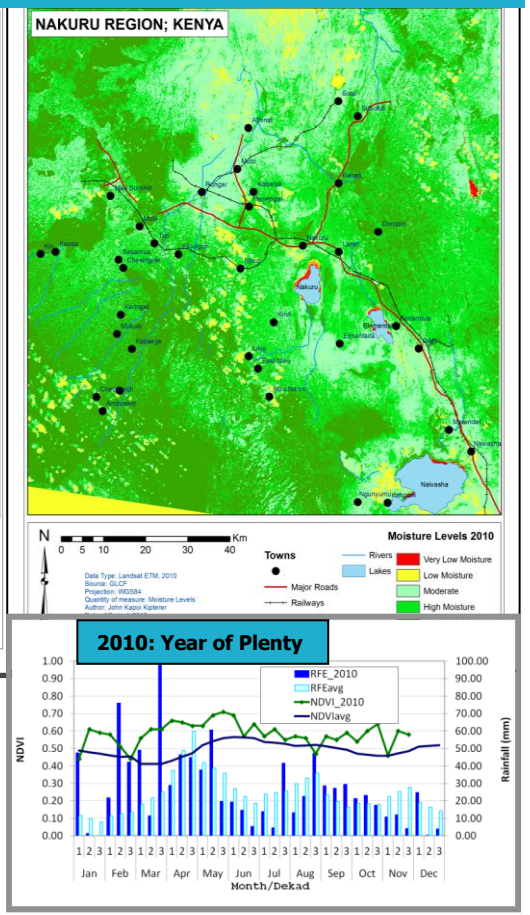
- **One of the United Nations Sustainable Developmental Goals (Goal 2) is zero hunger.**

https://sokodirectory.com/2017/02/impact-ongoing-drought-kenyan-economy

https://www.trtworld.com/mea/drought-in-kenya-worsens-8583

- Using *GIS* and satellite-derived data, this study identified the areas (in Nakuru, Kenya) where the drought was most pronounced in 2000, to guide the distribution of humanitarian aide and food distribution within the communities affected.



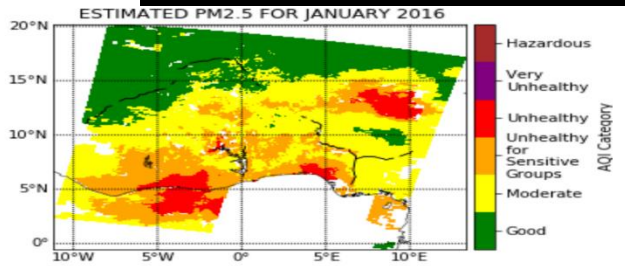


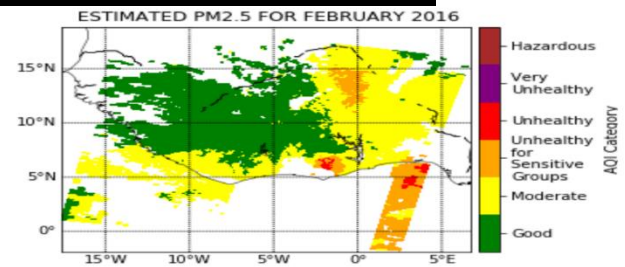
Example of Participant's Research Project (2)

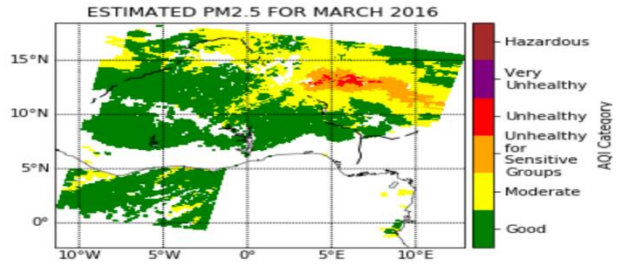
USING MODIS TO OBSERVE THE SPATIO TEMPORAL VARIATION OF AEROSOLS OVER GHANA

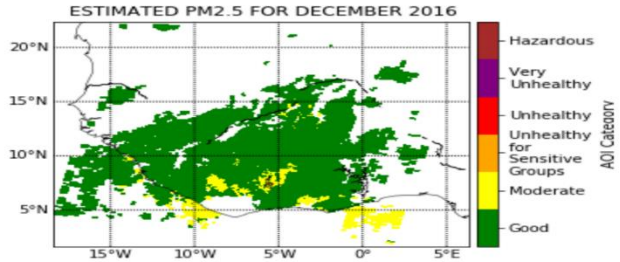
➢One of the United Nations Sustainable Developmental Goals (Goal 11, Target 11.6, Indicator 11.6.2) is to have a clean global environment by monitoring air quality.

Satellite-derived Estimated $PM_{2.5}$ over Ghana for 2016









https://www.ghanabusinessnews.com/2019/04/10/ghana-epa-asked-to-provide-data-on-air-pollution/

- This study applied GIS and data from the MODerate resolution Imaging Spectroradiometer (MODIS) to monitor the spatio-temporal variations of aerosols over Ghana.
- The study observed that the particulate matter concentration occurred at the peak of dry season (December and January) which mostly rendered the southern part of Ghana unhealthy (between 65.0 and 150.0 μg/m^3) to human health. The value observed exceeded the World Health Organization Air Quality PM2.5 Interim Target-2 (25 μg/m^3)

University of Massachusetts Amherst

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About **Projects** People Partnerships Outreach Events

Pathways to Equitable Healthy Cities

Alumnus of ARCSSTEE

An Alumnus of ARCSSTE-E, testing air pollution monitoring equipment, with collaborators at the University of Ghana

Open access Protocol

BMJ Open

High-resolution spatiotemporal measurement of air and environmental noise pollution in Sub-Saharan African cities: Pathways to Equitable Health Cities Study protocol for Accra, Ghana

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► Prepublication history and additional material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2019-035798).

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ABSTRACT

Introduction Air and noise pollution are emerging environmental health hazards in African cities, with potentially complex spatial and temporal patterns. Limited local data are a barrier to the formulation and evaluation of policies to reduce air and noise pollution.

Methods and analysis We designed a year-long measurement campaign to characterise air and noise pollution and their sources at high-resolution within the Greater Accra Metropolitan Area (GAMA), Ghana. Our design uses a combination of fixed (year-long, n=10) and rotating (week-long, n =~130) sites, selected to represent a range of land uses and source influences (eg, background, road traffic, commercial, industrial and residential areas, and various neighbourhood socioeconomic classes). We will collect data on fine particulate matter ($PM_{2.5}$), nitrogen oxides (NO_x), weather variables, sound (noise level and audio) along with street-

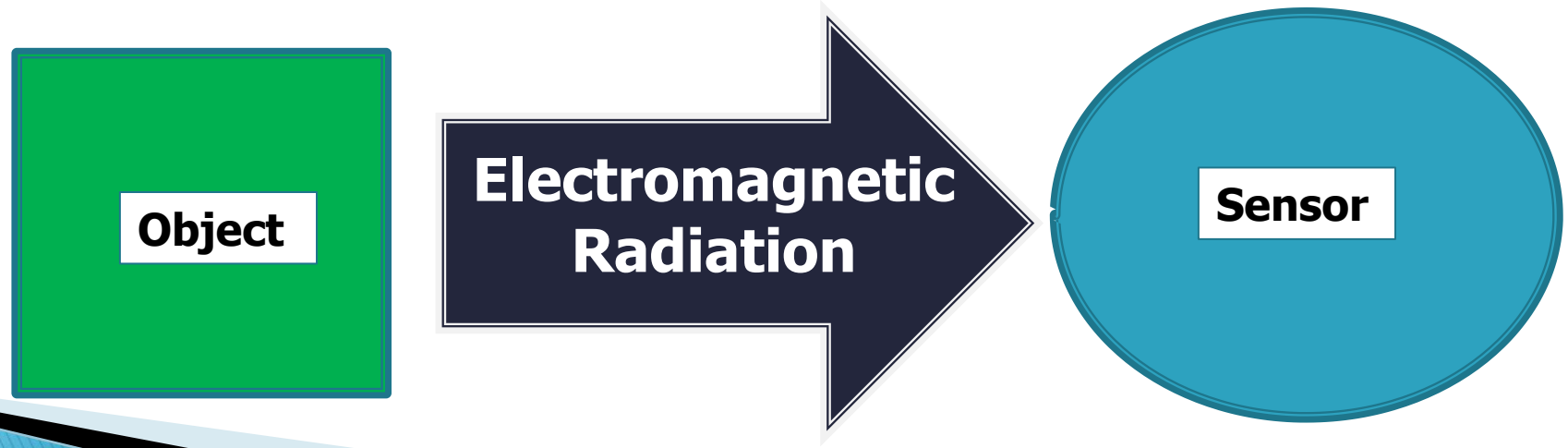
Strengths and limitations of this study

- Our study is the largest air and noise pollution measurement campaign conducted in a Sub-Saharan African city and serves as a prototype for other cities in SSA.
- The study relies on new sensor technologies to generate rich datasets on air and noise pollution along with imagery and audio recordings that help identify sources across ~140 locations.
- Data from a combination of fixed (1 year, n=10) and rotating (7 days, n=~130) monitoring sites representing a diversity of areas will allow for an assessment of both the temporal and spatial variability of pollution.
- While our study makes use of next-generation low-cost technologies, significant need for human resources is required for site identification and

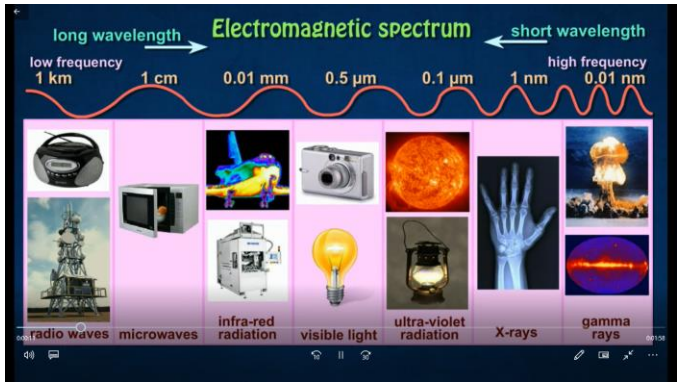
https://www.umass.edu/globalhealth/projects/pathways-equitable-healthy-cities

Satellite Remote Sensing

How is Information Transferred from the Object to the Sensor?



The Electromagnetic Spectrum



- In this video we cover the following:
  - The 7 different types, and order, of the waves in the electromagnetic spectrum –
  - The phrase ROYGBIV to help you remember the order of colours in the visible light spectrum –
  - The inverse relationship between wavelength and frequency as you move through the spectrum –
  - What sort of things emit these waves –
  - That when electromagnetic waves contacts an object they can be reflected, absorbed, or transmitted - or some combination of the three

Quiz