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# **Fundamentals of Remote Sensing**

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# Contents

## Fundamentals

- What is Remote Sensing
- Fields of Application
- What do we mean with Remote Sensing
- Energy sources & radiation principles
- Energy interaction in the atmosphere
- Energy interaction with earth surface features
  - Spectral reflectance of vegetation, Soil, water, etc
- Characteristics of real remote sensing systems

# Contents

## Satellite Sensors & Platforms

- Platform for remote sensing
- Satellite orbits
- Multispectral data acquisition
- Pushbroom system
- The resolution of Satellite images
- Characteristics of digital image data

# Contents

## Geometric aspects of image data

**Digital correction of image coordinates**

**Georeferencing, geocoding Image enhancement and visualization**

**Color composites**

**Visual image interpretation**

**Human vision and image understanding**

**Interpretation elements ( Tone/Hue, texture, shape, size, pattern, site & association)**

**Digital Image interpretation**

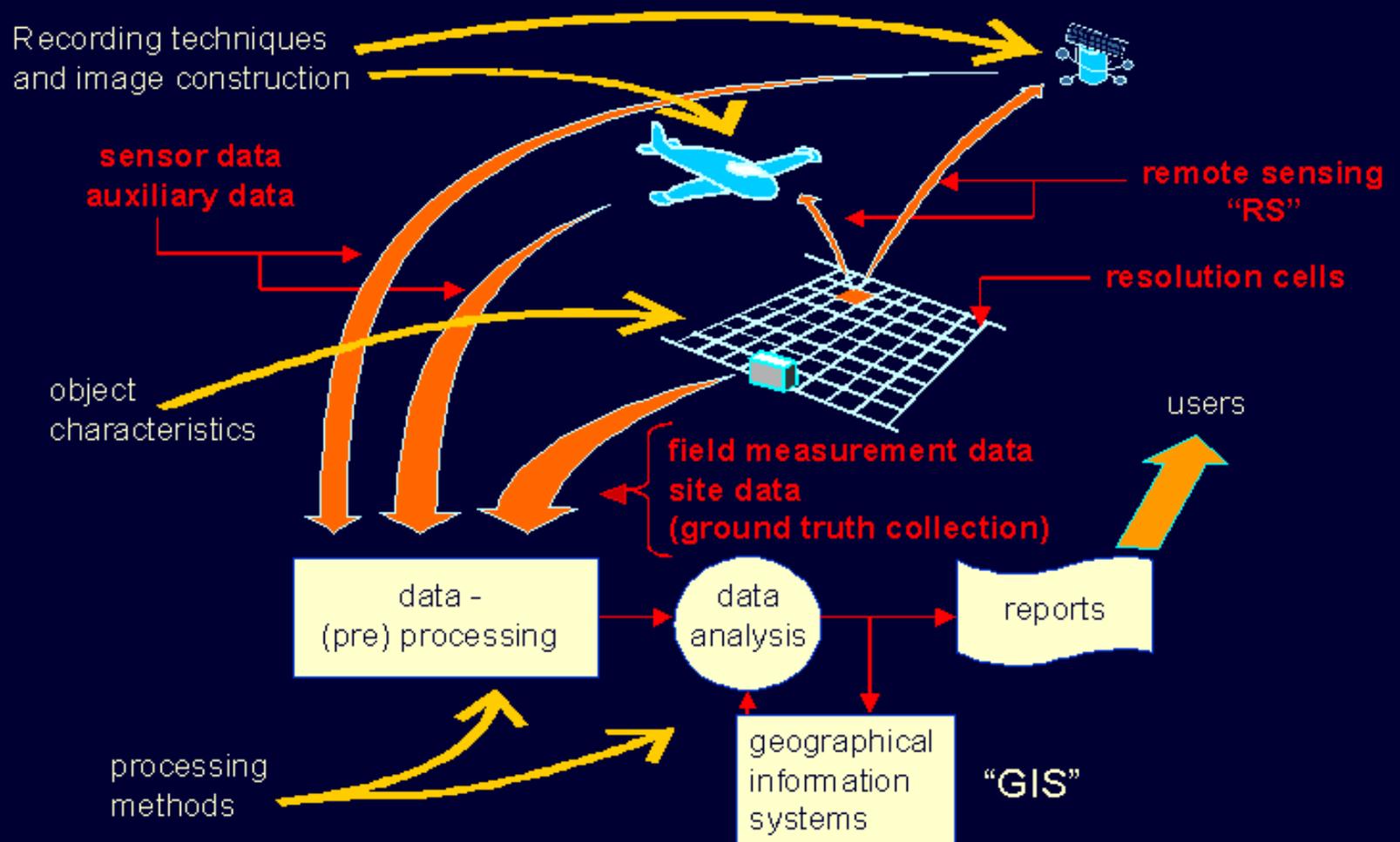
**Spectral characteristics**

# Definition of Remote Sensing

- Remote Sensing is the science of acquiring, processing and interpreting images that record the interaction between electromagnetic energy and matter (*Sabins, 1996*).
- Remote Sensing is the Science and art of obtaining information about an object, area or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area or phenomenon under investigation (*Lillesand and Kiefer, 1994*).

# What do we mean with RS ?

## The RS data & information system:



# Fields of Application

## Meteorology

Weather forecast  
Climate Studies  
Global Change

## Hydrology

Water balance  
Energy balance  
Agrohydrology

## Soil Science

Land evaluation  
Soil Mapping

## Biology/ Nature Conservation

Vegetation mapping/  
monitoring  
Vegetation condition  
assessment

## Forestry

Forest mapping  
de-/re-forestation  
forest fire dection

## Environmental Studies

Sources/effects  
pollution  
(Ground) water quality  
Climate Change

## Agricultural Engineering

Landuse development  
Erosion assessment  
Water management

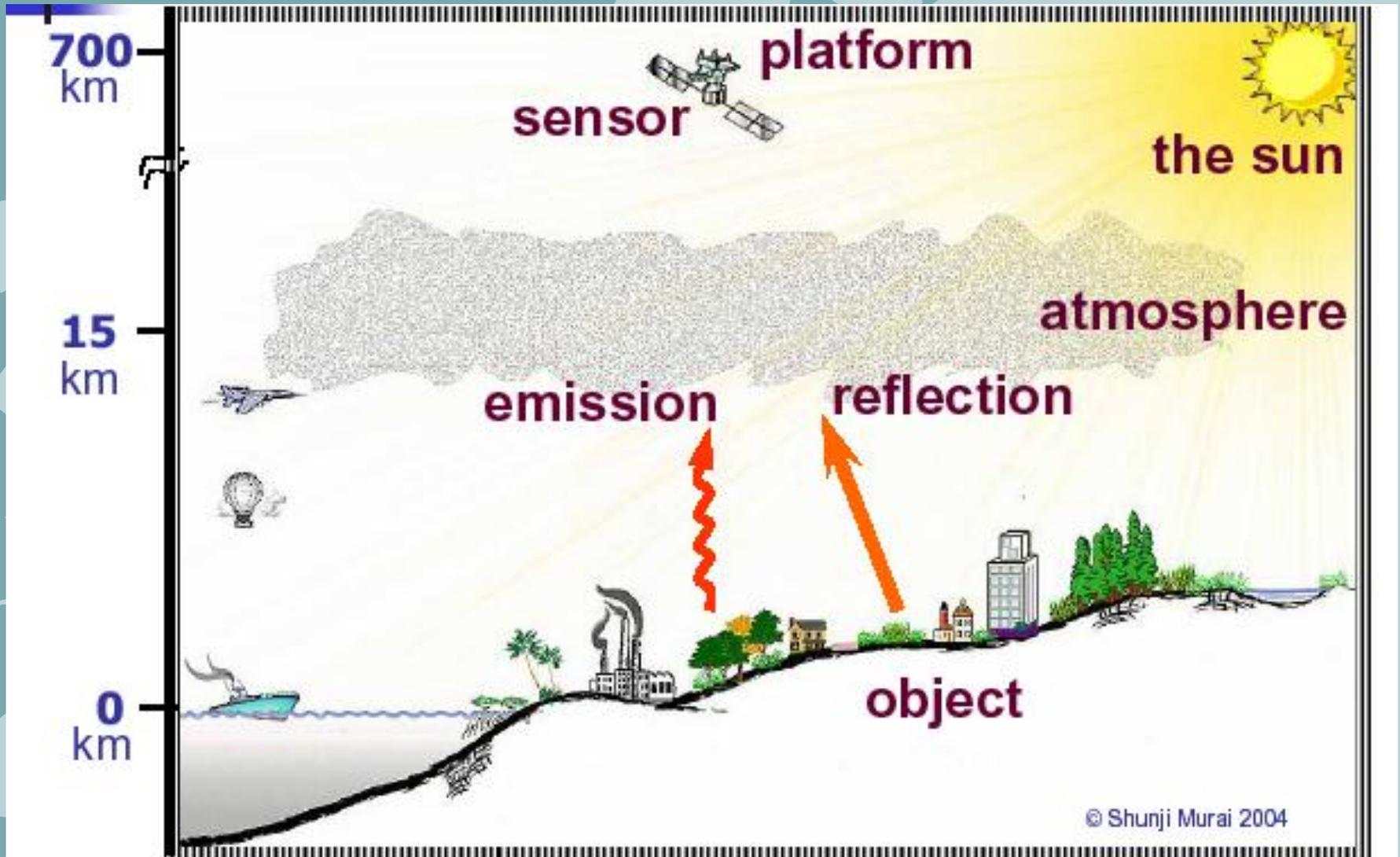
## Physical Planning

Physical Planning  
Scenario studies

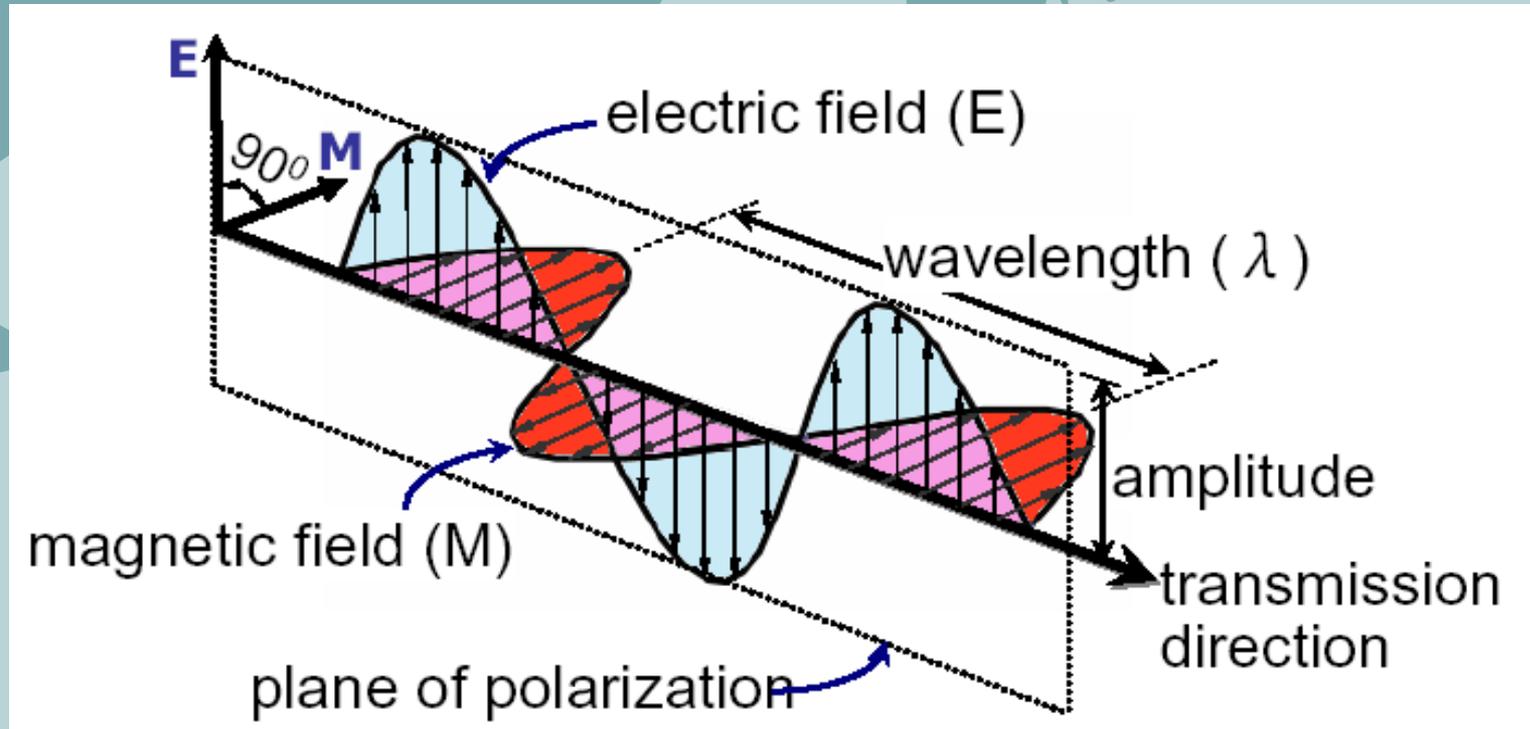
## Land Surveying

Topography (DTM)  
Spatial Data Models  
GIS

# Concept of Remote Sensing



# Electro Magnetic Radiation



Visible light is only one of many forms of Electro Magnetic energy. EM energy as traveling in a harmonic, sinusoidal fashion at the velocity of light

# RS & the EM Spectrum

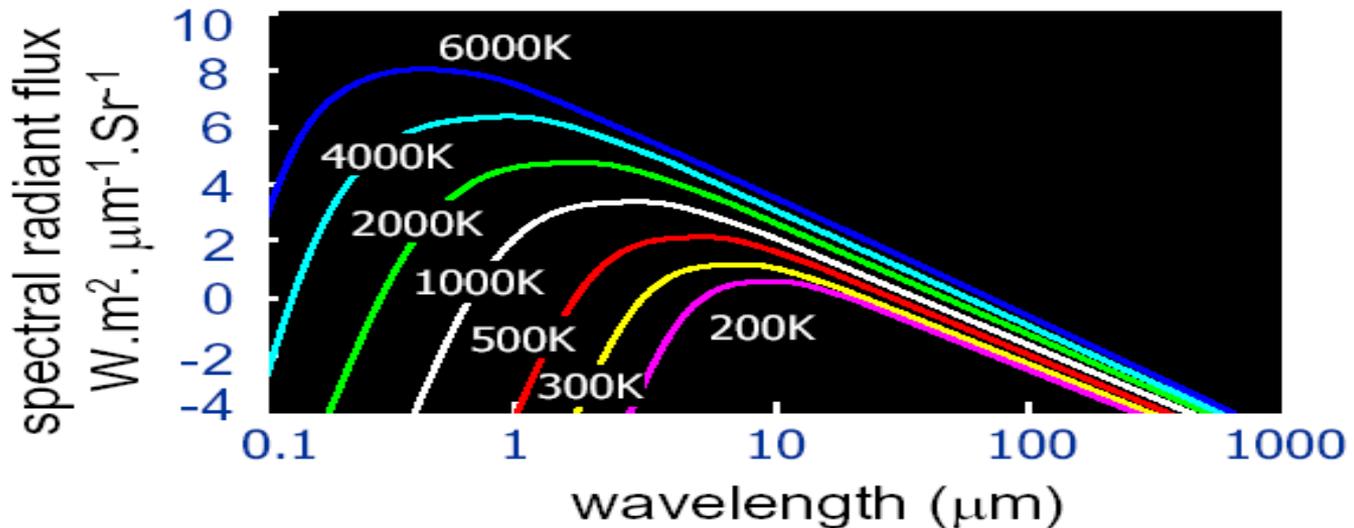
- Remote Sensing is based on measuring Electro Magnetic (EM) energy.
- Most remote sensing sensors are based on measuring the reflected Sun light.

# Energy sources

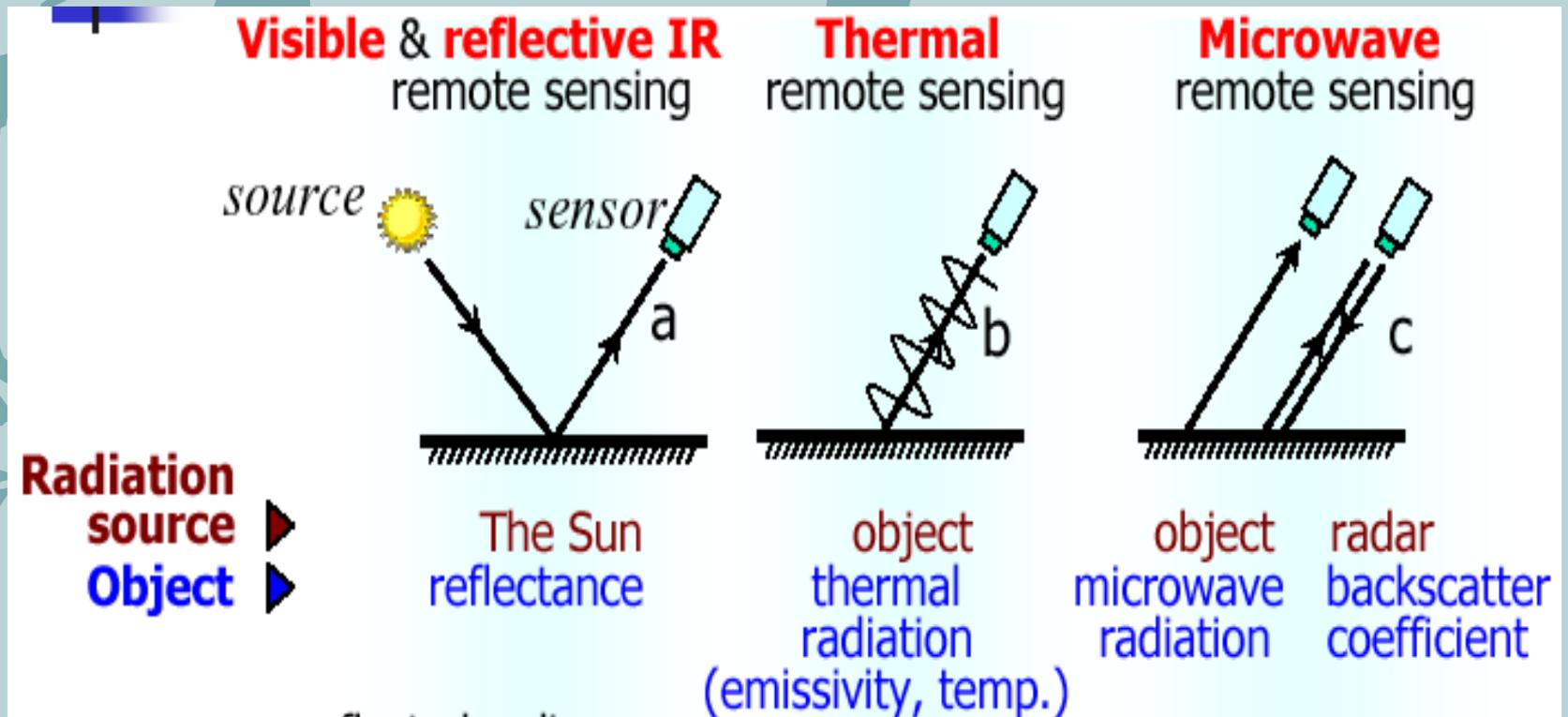
- **The Sun is the most obvious source of electromagnetic radiation for Remote Sensing.**
- **All matter at temperature above absolute zero (0 K or -273 C) continuously emit electromagnetic radiation.**

# Black body radiation

- The higher the temperature of an object, the greater the total amount of radiation it emits. The spectral distribution of the emitted energy varies with temperature.



# Three types of Remote Sensing



# Wavelength of EM Radiation

Class		Wavelength
Ultraviolet		100 – 0.4
Visible		0.4 – 0.7
Infrared	Near infrared	0.7 – 1.3
	Shortwave infrared	1.3 – 3
	Intermediate infrared	3 – 8
	Thermal infrared	8 – 14
	Far infrared	14 – 1mm



# Energy interactions in the atmosphere

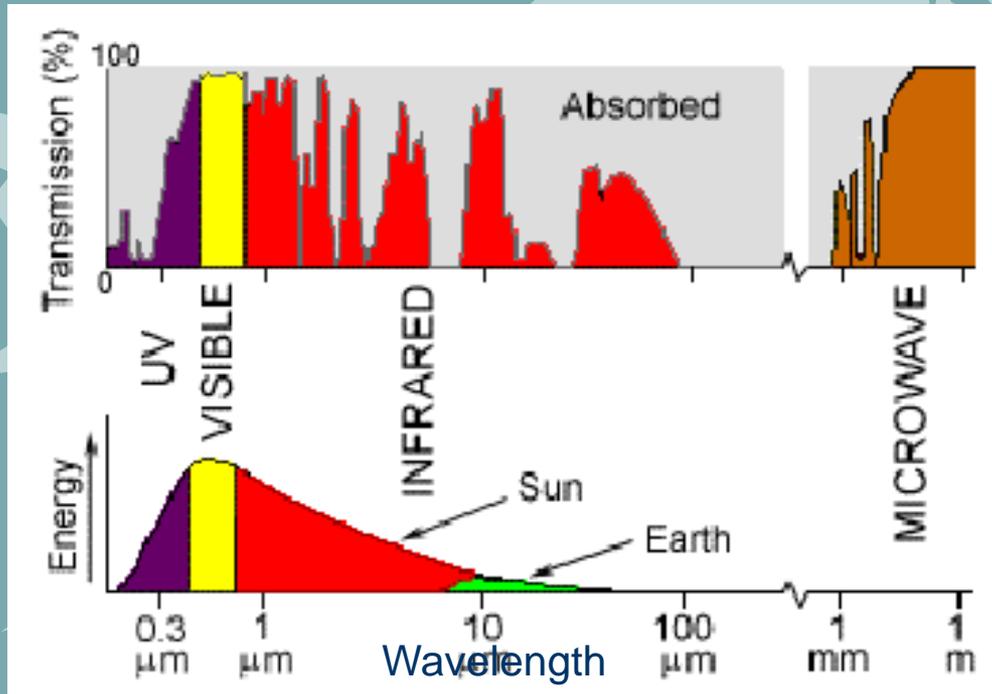
- Most of the radiation detected by remote sensing passes the atmosphere twice.
- These effects caused principally through the mechanism of atmosphere **scattering** & **absorption**.

Scattering is the unpredictable diffusion of radiation by particles in the atmosphere.

Absorption: Electromagnetic energy traveling through the atmosphere is partly absorbed by molecules.

# Atmospheric Windows

Those areas of the spectrum which are not severely influenced by atmospheric absorption and thus, are useful to remote sensors, are called atmospheric windows.



# Energy interactions with earth surface features

- When EM energy is incident on any given earth surface feature, three fundamental energy transactions with the feature are possible, namely
  - Absorption
  - Reflectance
  - Transmission

# Color Composites

Tm Band 1 – B

TM Band 2 – G

TM Band 3 - R

TM Image Band 3-2-1(R,G,B)

Tm Band 2 – B

TM Band 3 – G

TM Band 4 - R

TM Image Band 4-3-2 (R,G,B)

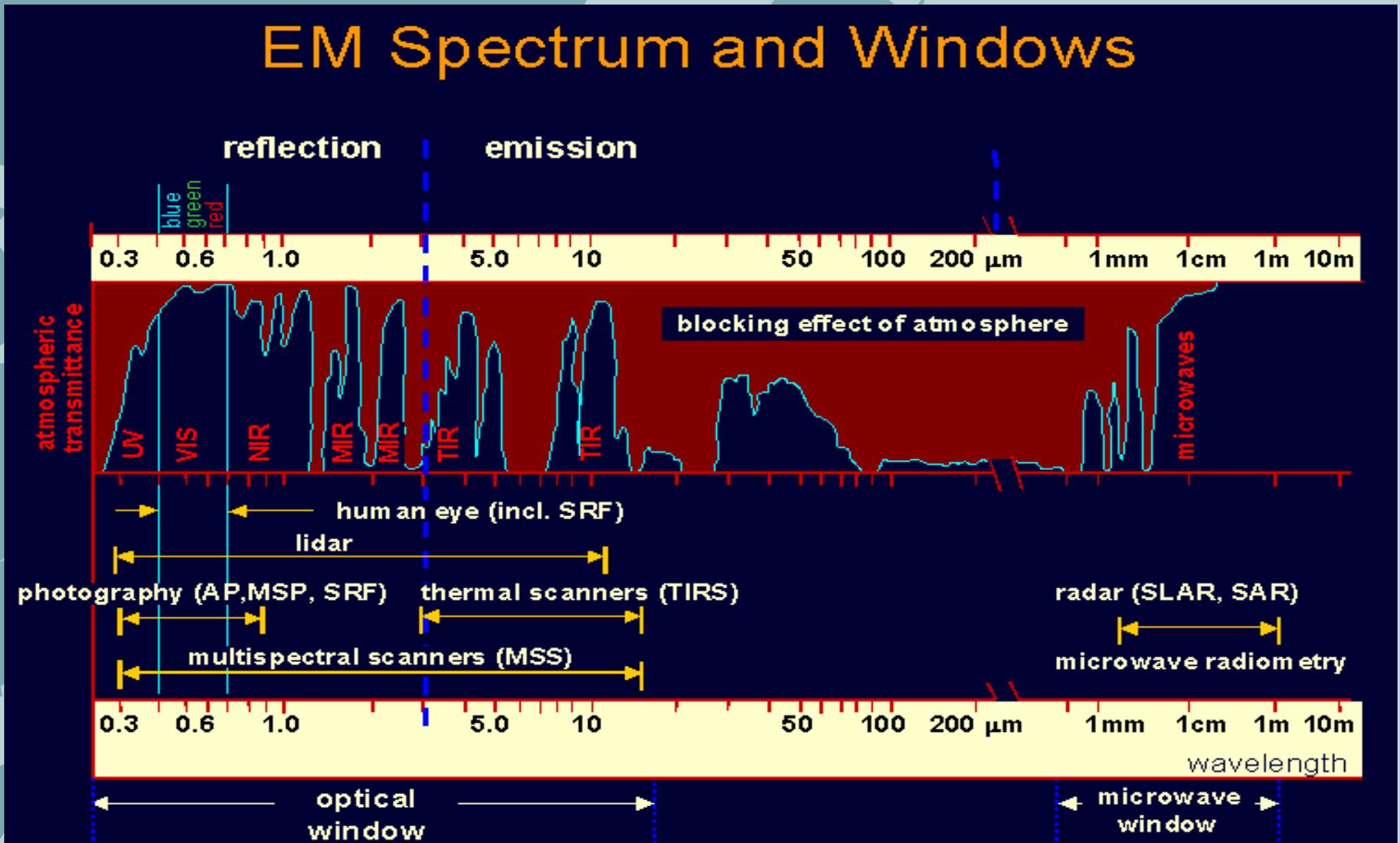
True Color

False Color



# Energy Sources & Radiation Principles

## EM Spectrum and Windows



## Detection of EM radiation reflected (scattered) or emitted by the earth's surface

<p>Reflection of solar radiation</p>  <p>REFLECTION ( MULTISPECTRAL )</p>	<p>Emission of thermal radiation</p>  <p>EMISSION</p>
<p>0.3 - 0.4 <math>\mu\text{m}</math>: ULTRAVIOLET            0.4 - 0.7 <math>\mu\text{m}</math>: VISIBLE LIGHT            0.7 - 2.5 <math>\mu\text{m}</math>: REFLECTIVE INFRARED</p>	<p>3 - 5 <math>\mu\text{m}</math>            8 - 14 <math>\mu\text{m}</math> } : THERMAL INFRARED            1 - 30 GHz : PASSIVE MICROWAVES</p>
<p>OBSERVATION BY DAY            IN THE ABSENCE OF CLOUD COVER</p>	<p>OBSERVATION BY DAY AND NIGHT            THERMAL INFRARED : IN THE ABSENCE            OF CLOUD COVER            PASSIVE MICROWAVES: NO INTERFERENCE            WITH CLOUD COVER</p>
<p>MULTISPECTRAL SCANNING (MSS)            AERIAL PHOTOGRAPHY (AP)            MULTISPECTRAL PHOTOGRAPHY (MSP)            SYSTEMATIC RECONNAISSANCE (SRF)</p>	<p>THERMAL INFRARED SCANNING (TIRS)            PASSIVE MICROWAVE DETECTION (MICRO-            WAVE RADIOMETRY)</p>
<p>"Passive" Remote Sensing            (sensor without its own source of radiation)</p>	<p>"Passive" Remote Sensing            (sensor without its own source of radiation)</p>

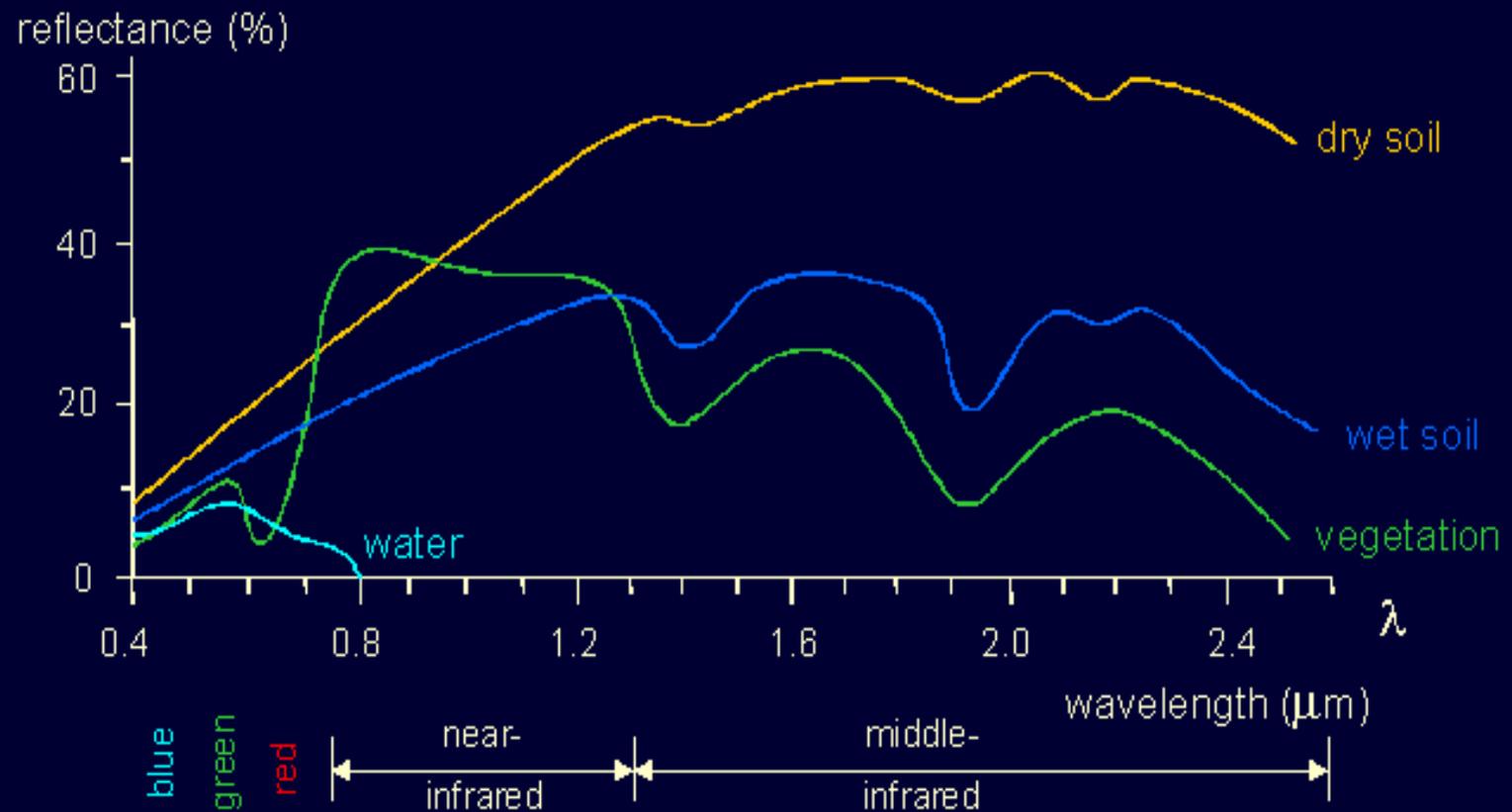
# Some parameters of Satellite

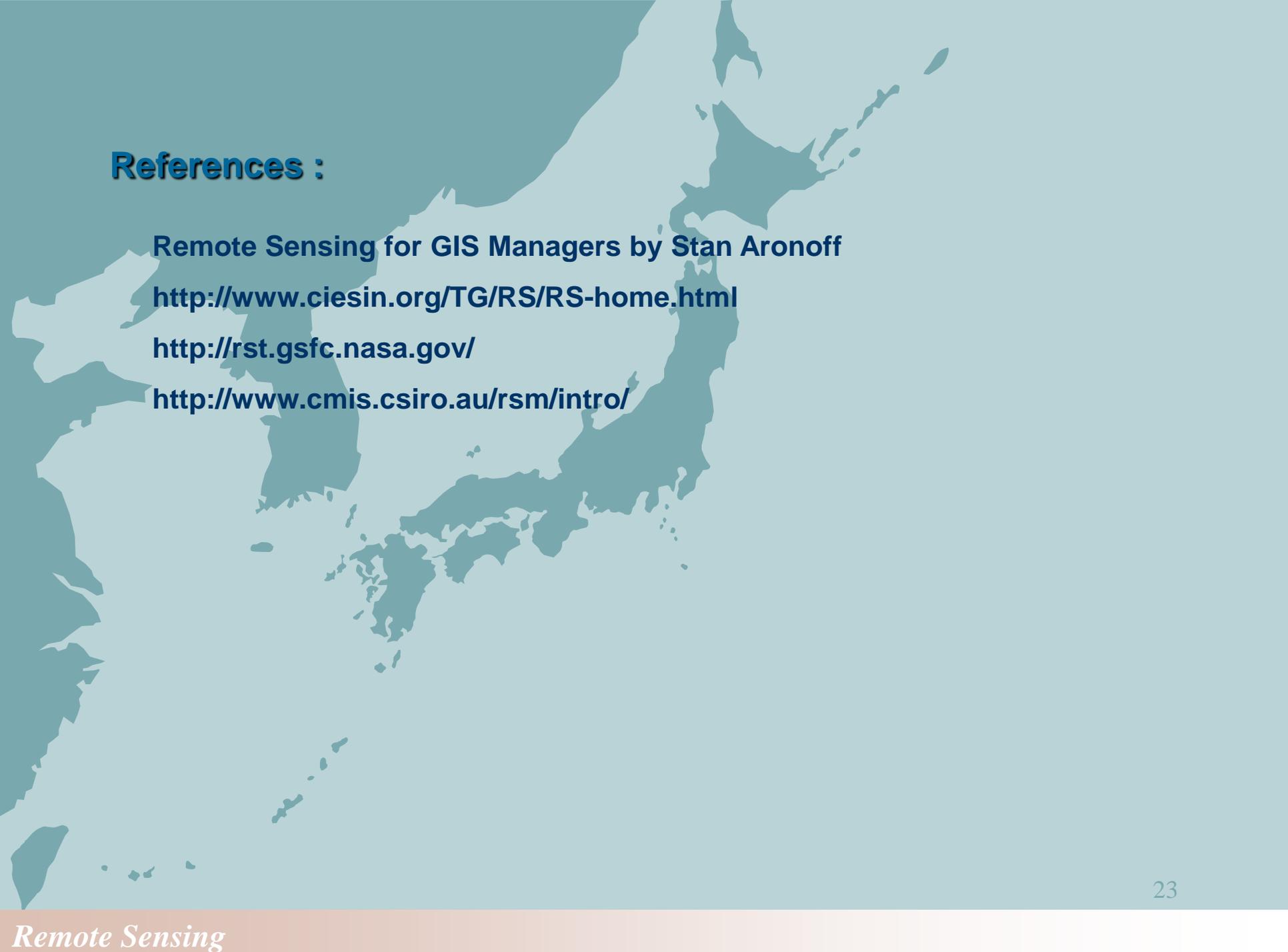
Satellite	Sensor	Altitude	Resolution
Landsat	TM	705 km	30/120 m
Landsat	MSS	705 km	80 m
SPOT	XS	832 km	20 m
SPOT	Pan	832 km	10 m
IRS	LISS II		
IRS	LISS III		
IRS	Pan		

# What do we measure with RS?

$$\rho(\lambda) = \frac{\text{reflected radiation}}{\text{incoming radiation}} \text{ per wavelength } \lambda$$

EM-energy





## References :

**Remote Sensing for GIS Managers by Stan Aronoff**

<http://www.ciesin.org/TG/RS/RS-home.html>

<http://rst.gsfc.nasa.gov/>

<http://www.cmis.csiro.au/rsm/intro/>