HI-511: APPLICATION OF REMOTE SENSING & GIS IN CIVIL ENGINEERING

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September 2018

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Lecturer:	***1992-1993***
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Director Hydraulics & Irrigation Engg. Laboratories, CED

HI-511 APPLICATION OF RS & GIS IN CIVIL ENGINEERING (2 + 1)

- **REMOTE SENSING**
  - **Introduction and significance**
  - **Optical Remote Sensing**
  - **Microwave Remote Sensing**
  - **Image Processing**
  - **Applications**

GIS is defined as IS that is used to input, store, retrieve, manipulate, analyze and output the geographically referenced data in order to help in decision making.

Course Outline (cont…)

- **GEOGRAPHIC INFORMATION SYSTEM (GIS)**
  - **Introduction**
  - **Basic data operations and data structures for GIS**
  - **Spatial query and analysis**
  - **Applications of GIS**
    - **Data generation for Hydrological Modelling**

Assignments List

- Comparison of different satellites, platforms & sensors
- Spectral reflectance of Various objects
- To explore high resolution images and study the true color composite, false color composite, x,y and z profiles on ENVI.
- Use of High resolution remote sensing
- Classification of Rs images using Envi 5.1
- Supervised and unsupervised classifications ENVI software

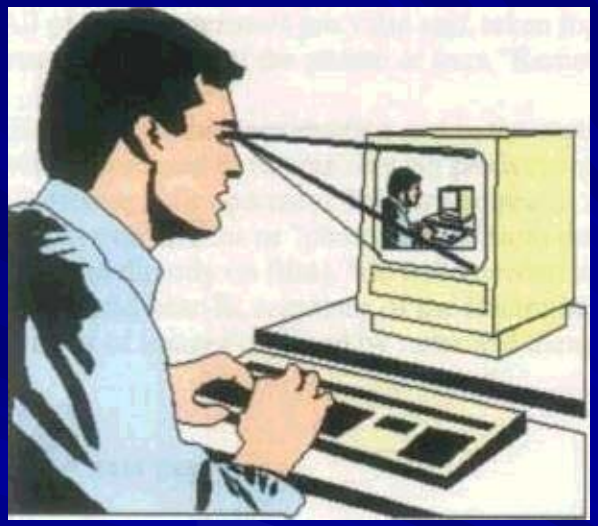
- Basic use of ARCGIS software and preparation of map using esri's ARCGIS
- Change detection using ARCGIS
- PROJECT

Definition of RS

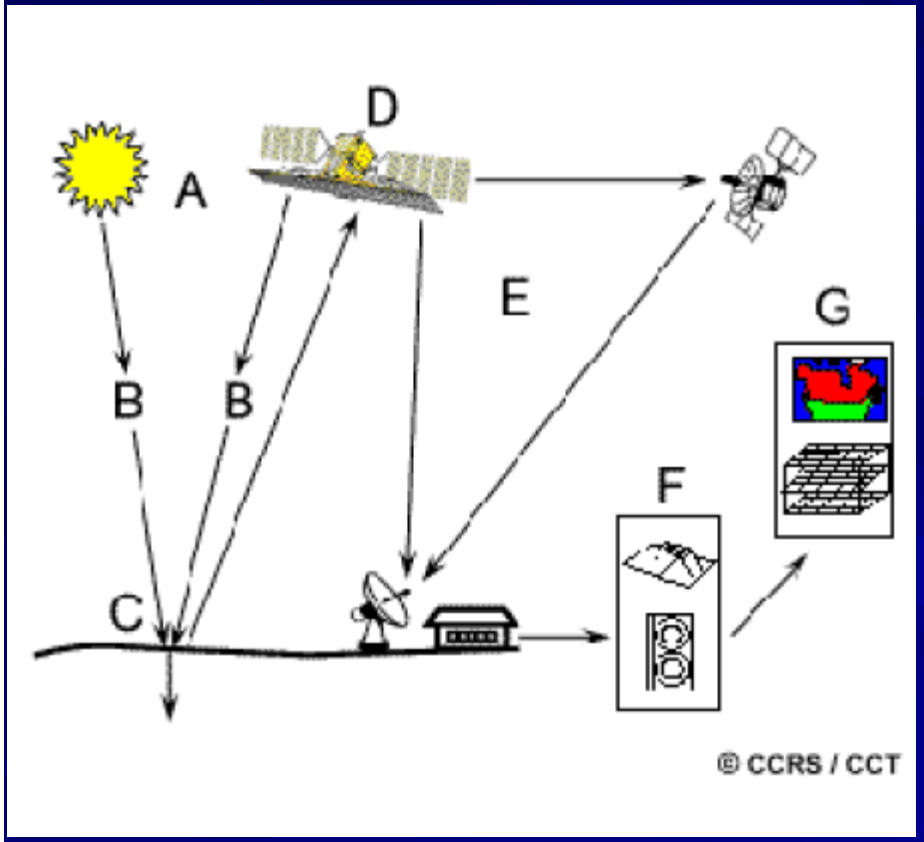
- Remote sensing is the science (and to some extent, art) of acquiring information about the Earth's (or others) surface without actually being in contact with it.
- “This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information.“ Ref: Fundamental of RS by Canada Centre for RS

REMOTE SENSING

- BASIC CONCEPTS
  - DEFINITION:
    - NATURAL (Passive)
      - Radiation Source?
      - Sensor?
      - Data Processor?
      - Image Interpretation?
    - TECHNOLOGICAL ASSISTED REMOTE SENSING (Active / Passive)
      - Radiation Source?
      - Sensor?
      - Data Processor?
      - Image Interpretation?

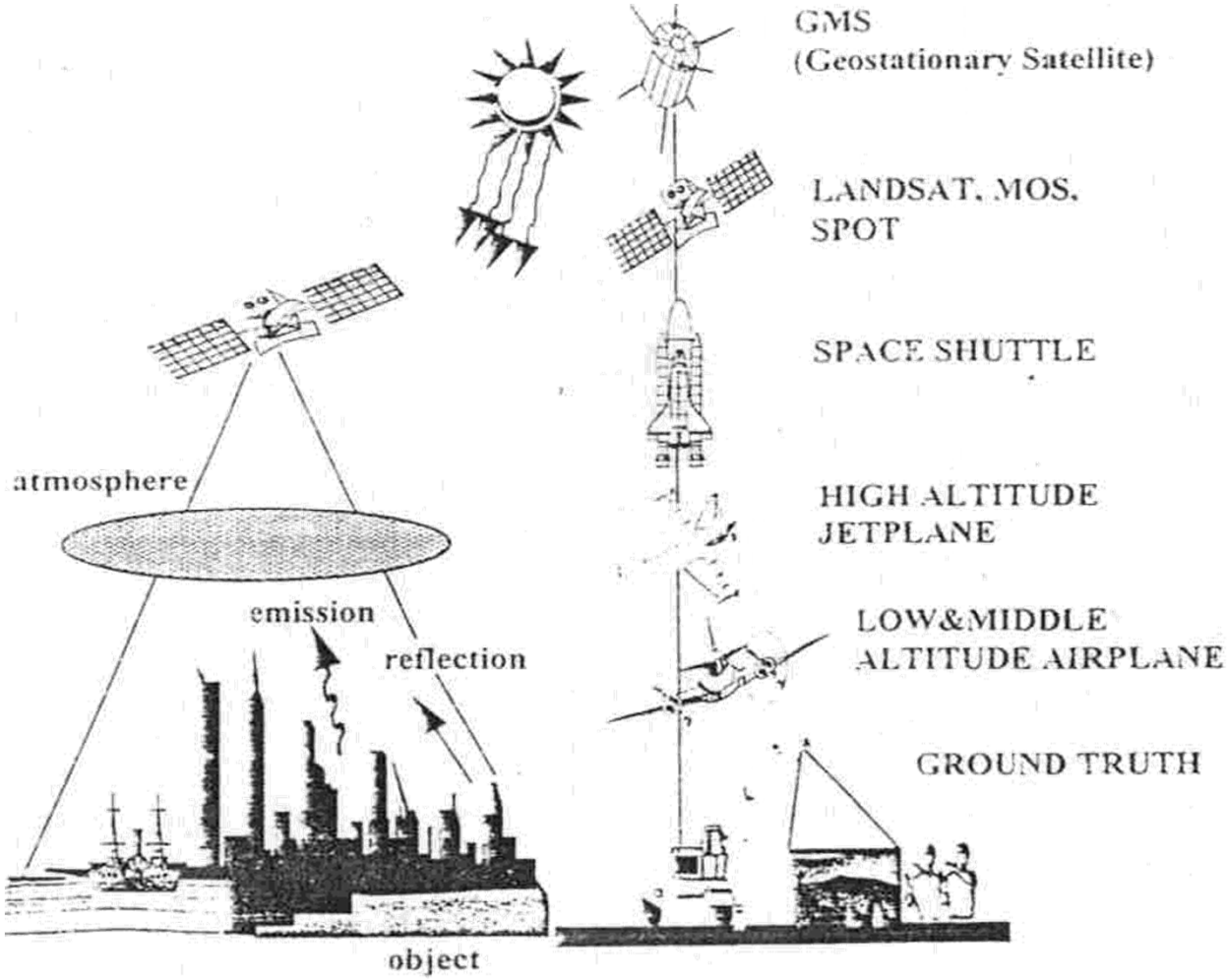


Various Steps in RS



Energy Source (A)
Radiation and the Atmosphere (B)
Interaction with the Target (C)
Recording of Energy by the Sensor (D)
Transmission, Reception, and Processing (E)
Interpretation and Analysis (F)
Application (G)

Various Platforms



EM RS of Earth Resources

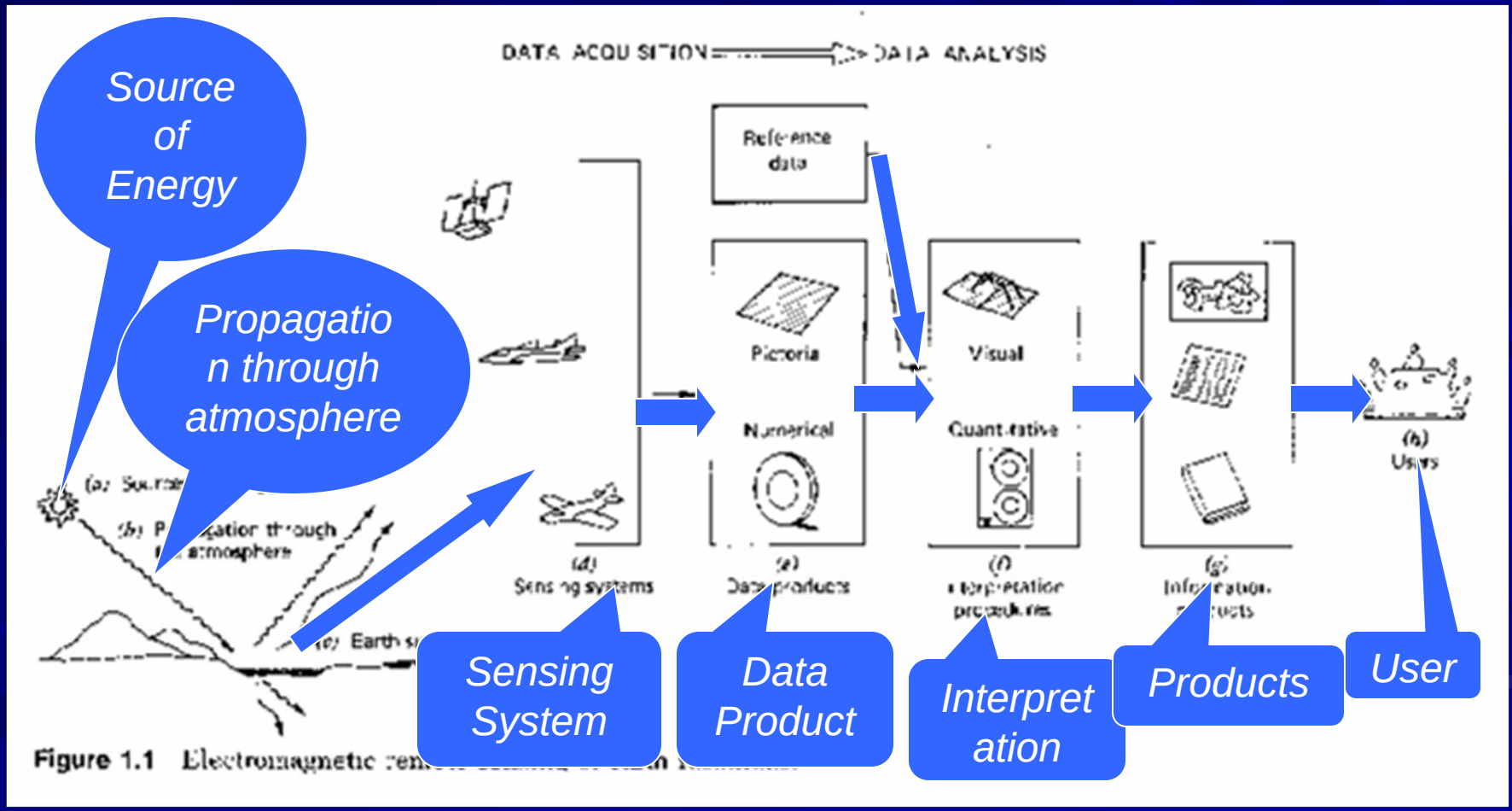
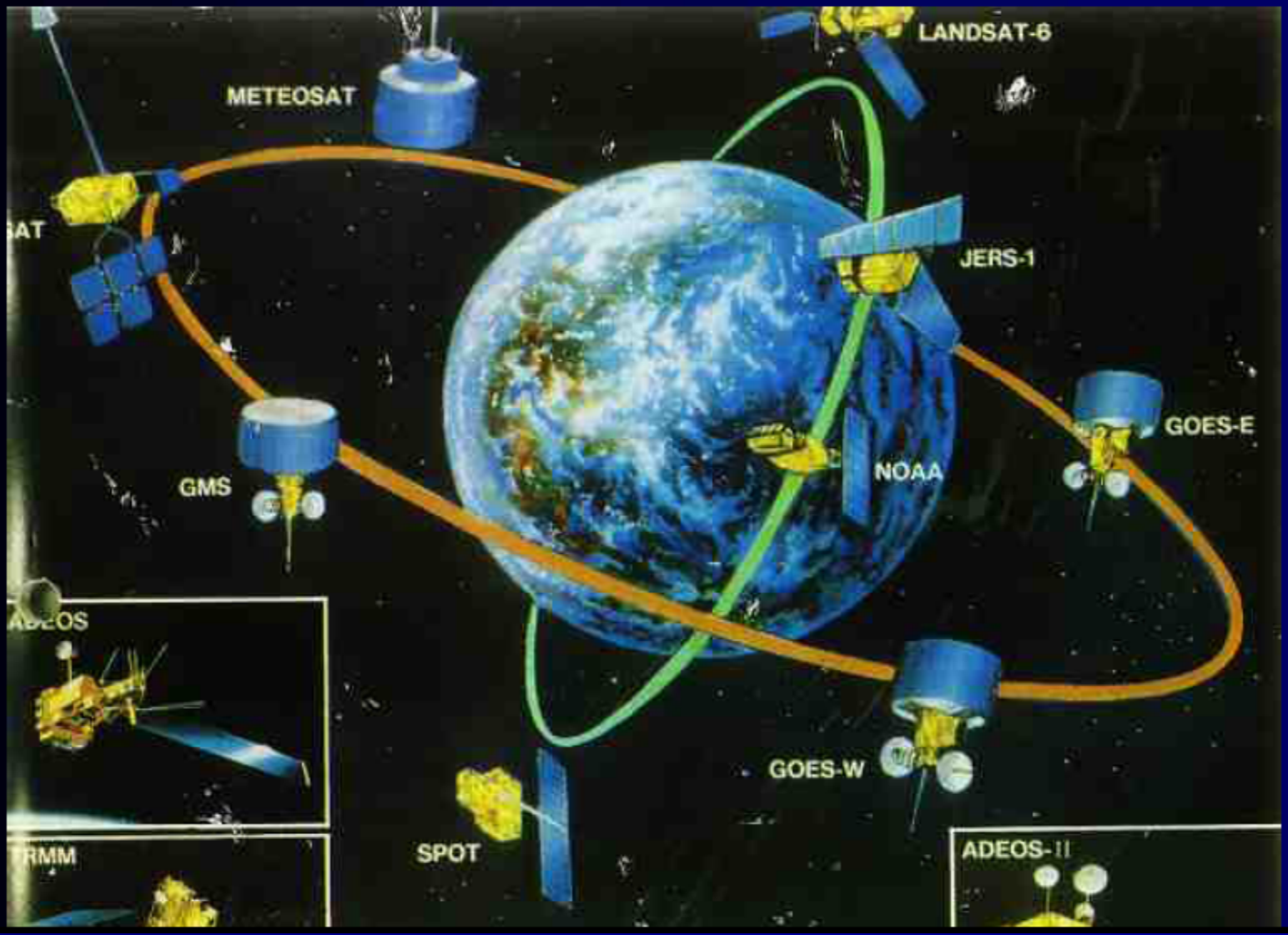


Figure 1.1 Electromagnetic remote sensing of Earth resources

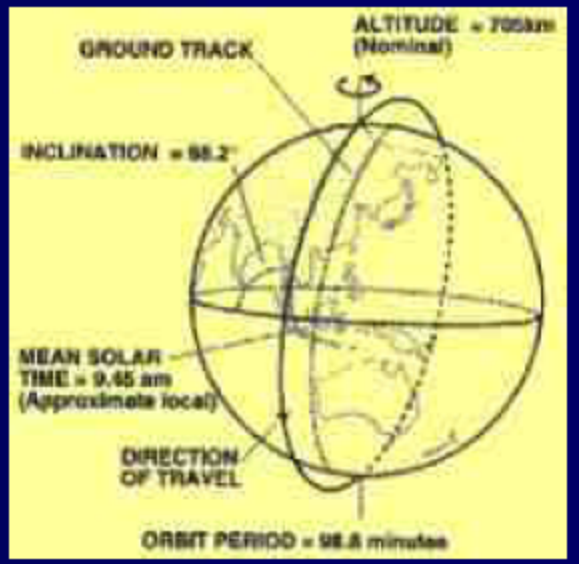
History of RS

- Natural:
  - Oldest Compound Eyes
- Artificial:
  - Niepce (1822)
  - First Arial Photo (1840) (Platform ?)
  - Arial Photo for Military (1862)
  - Airplane as Platform (1909)
  - World War – 1 (1918)
  - 1925-45
  - 1945-55
  - 1955-60
  - RS from Space 1960
    - Land Sat (1972), SPOT (System Probatoir d Observation de la Terra) 1986, NOAA (National Oceanic and Atmospheric Administration) AVHRR (advance very high resolution radiometer), …

Polar Orbit Satellite and Geostationary Satellite

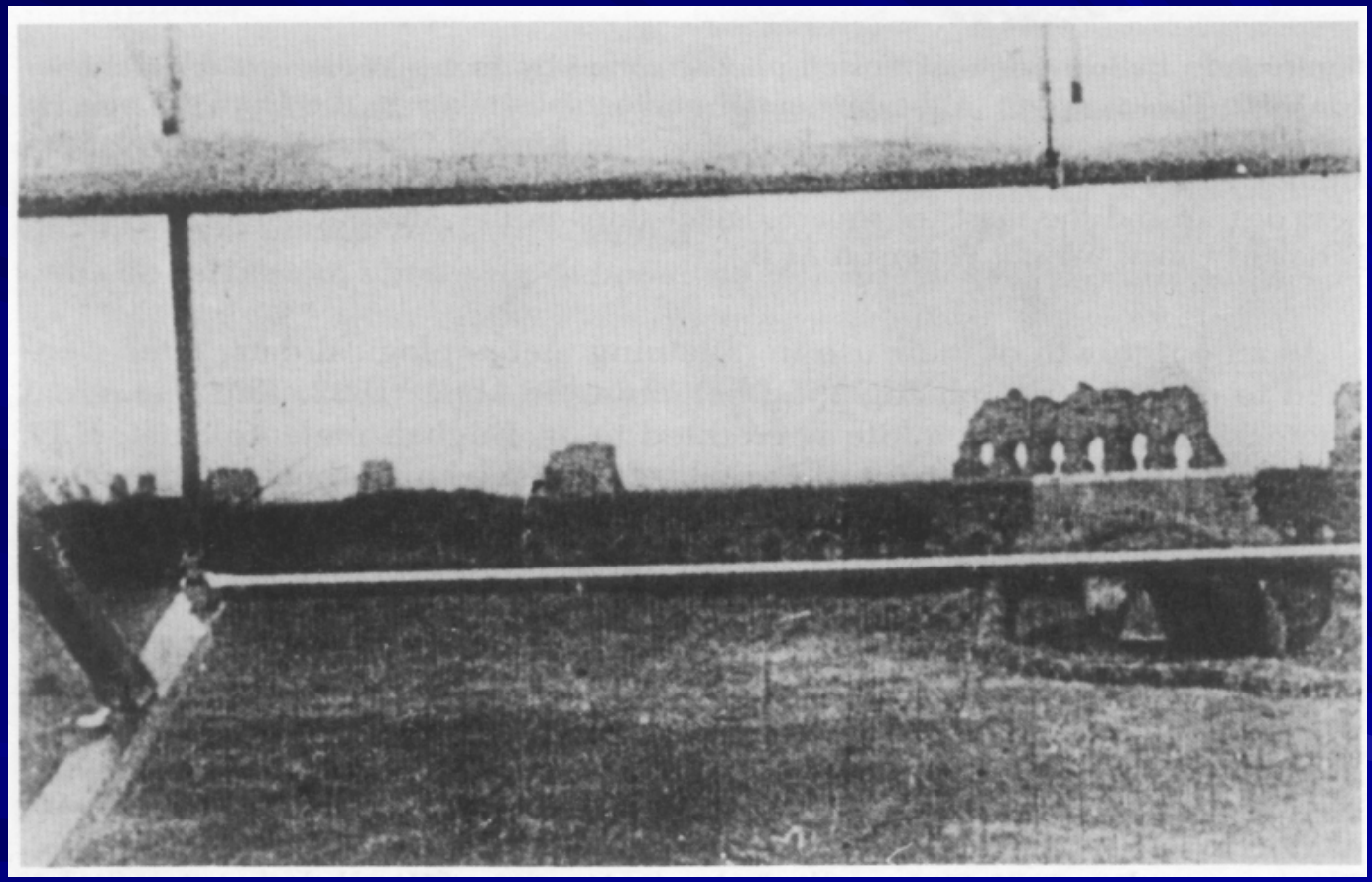


Several Important Numbers



- Radius of Earth
  - approx. 6,300km (a=6377, b=6356, Bessel)
- Altitude of Polar Orbit Satellite
  - 300km - 900km
  - Landsat 705km, JERS-1 568km, SPOT 822km, NOAA 833-870km
- Altitude of Geo-stationary Satellite
  - 35,800km
- Speed of light
  - 300,000km/sec
- Speed of Satellite (relative to the earth)
  - 6.5km/sec = 23,400km/hour, Jet Passenger Aircraft 900km/h

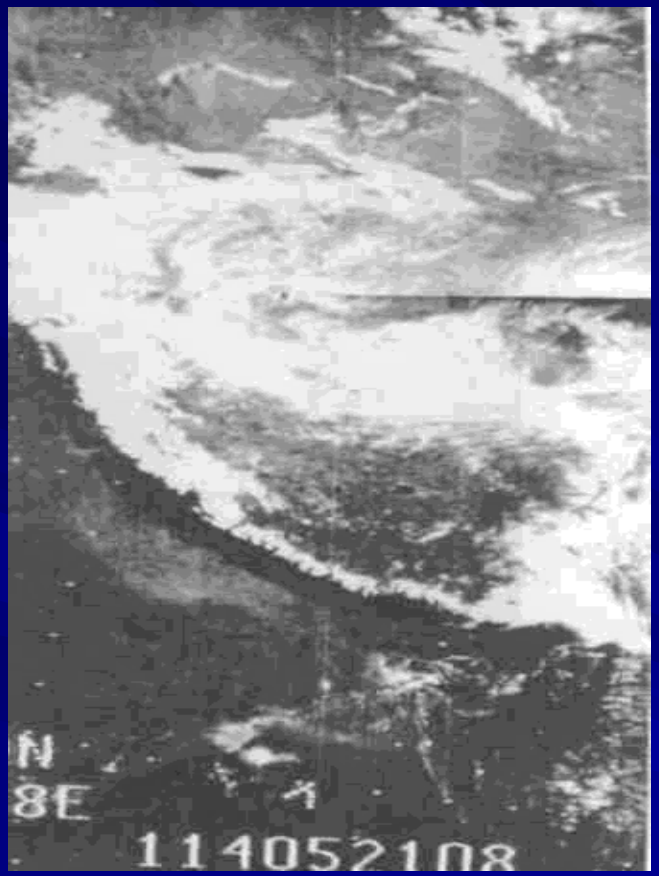
First Aerial Photograph from Airplan



Italy 24-04-1909 (Oblique view of walls of Centocelli Italy, by Wibur Wright)

EARLY PICTURES FROM SPACE

Saudi Arabia



Eastern India, Bangladesh & Himalayas (20N, 88E)

Gulf of California and Southern California

Military Use of RS

Military Use of RS

Land Uses

Newfoundland , *Canada*
Landsat Composite Image

Flood Mapping

satellite image of St. Louis on **July 4, 1988**, during normal river levels.

St. Louis on **July 18, 1993**, during the height of the flooding.

Significance of RS

- Environment
- Hydrology
- Developers and Planners
- Oil / Gas Industry
- Forestry
- Agriculture
- Geology
- Military

Cost Effective

Time Effective

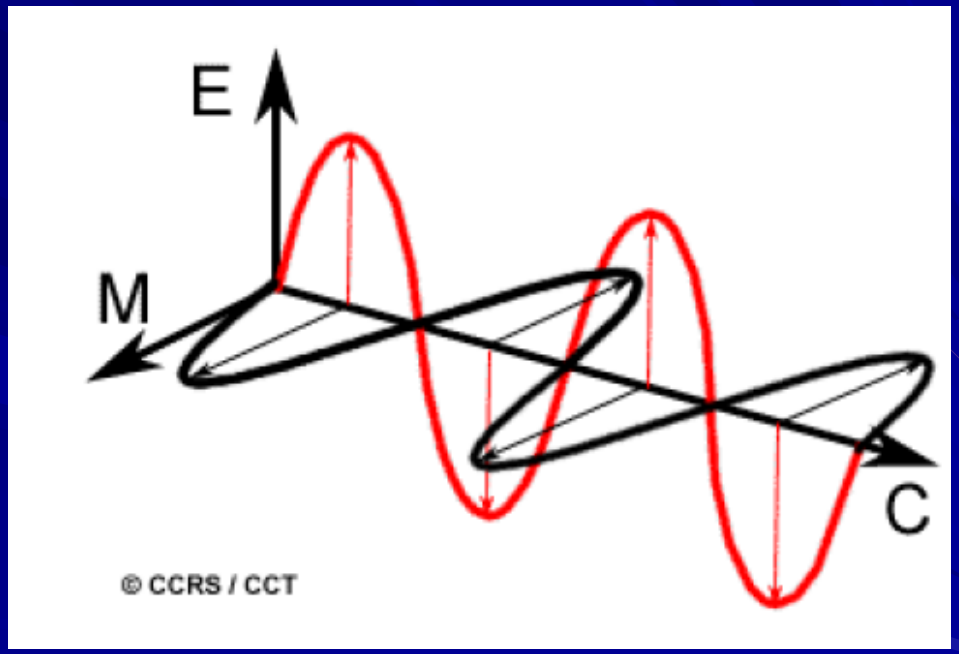
Technological Assisted Remote Sensing

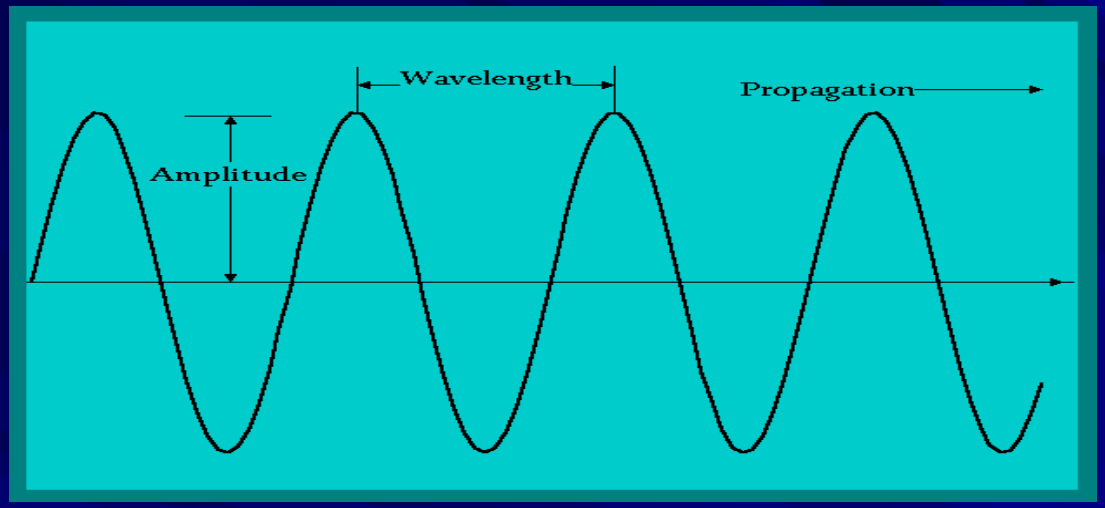
- Force Field
  - (Gravitational and Magnetic)

    NASA's Gravity Recovery and Climate Experiment (GRACE)
- Acoustical Energy
  - For Sonar Survey, ADCP (Acoustic Doppler Current Profiler)
- Electromagnetic Energy
  - Pass through free space
  - Pass through atmosphere
  - Variety in Behaviour
  - Can be exploited in different ways

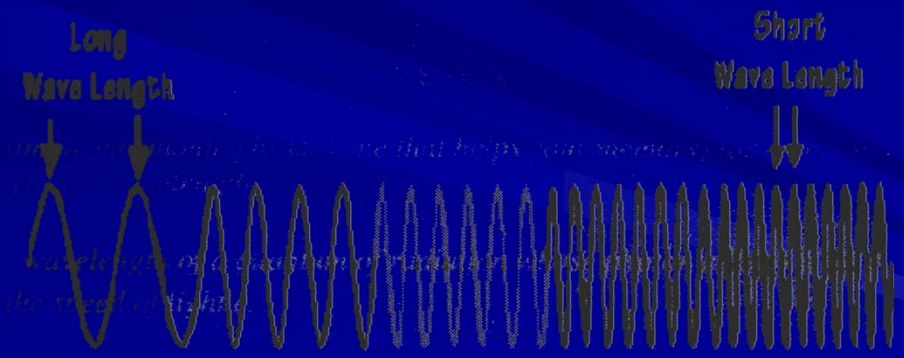
Theoretical Concepts

- What is ElectroMagnetic Energy?
- Theories of EM
  - WAVE Model
    - Wave Length
    - Frequency
    - Speed
  - Particle Model
    - Photon or Quanta
    - Photon Energy α Frequency





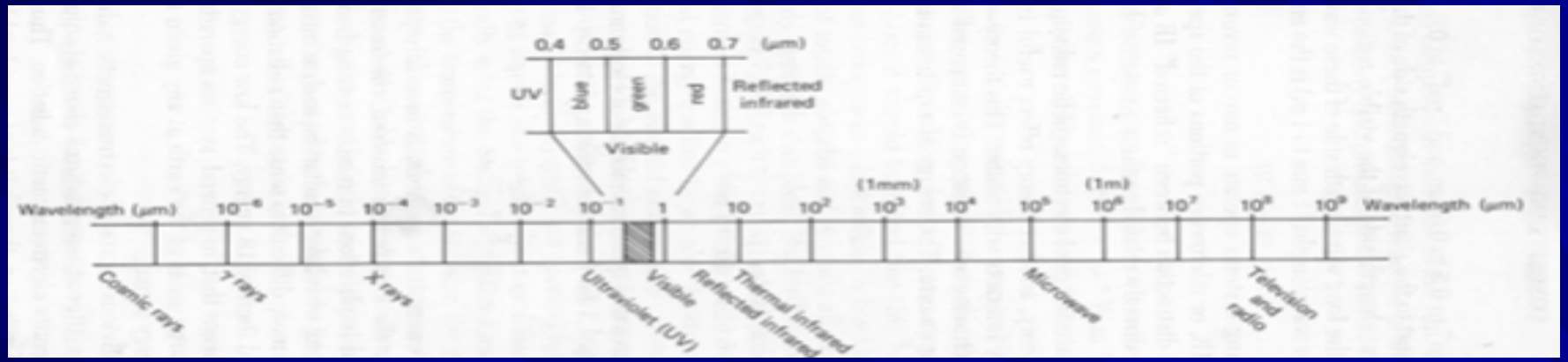
Frequency
Wavelength
Transmission direction
Amplitude
Plane of polarization

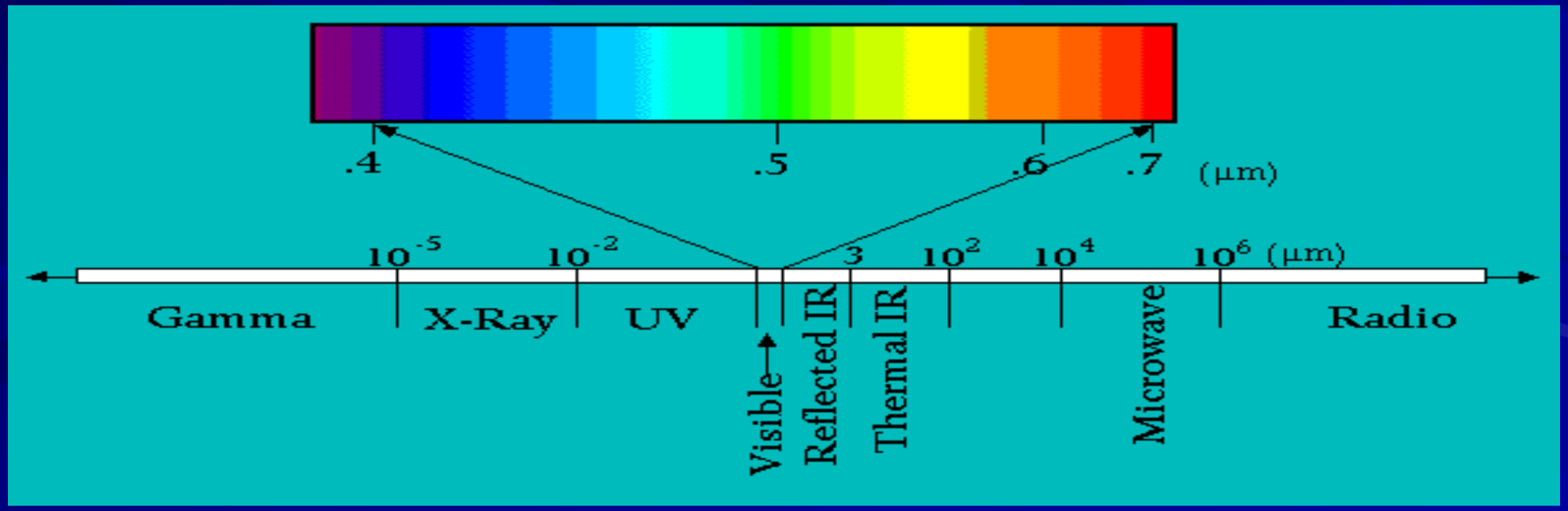


Low Frequency,
Low Energy

High Frequency,
High Energy

EM Spectrum


0.4
0.5
0.6
0.7
(μm)
UV
blue
green
red
Reflected infrared
Visible
Wavelength (μm)
(1mm)
(1m)
Wavelength (μm)
Cosmic rays
γ rays
X rays
Ultraviolet (UV)
Visible
Reflected infrared
Thermal infrared
Microwave
Television and radio


.4
.5
.6
.7
(μm)
10-5
10-2
3
10²
10⁴
10⁶ (μm)
Gamma
X-Ray
UV
Visible
Reflected IR
Thermal IR
Microwave
Radio

Speed of EM Wave

$$c = f \lambda$$

c = Speed of Light
= 3×10^{8} m/Sec

Energy of a Particle

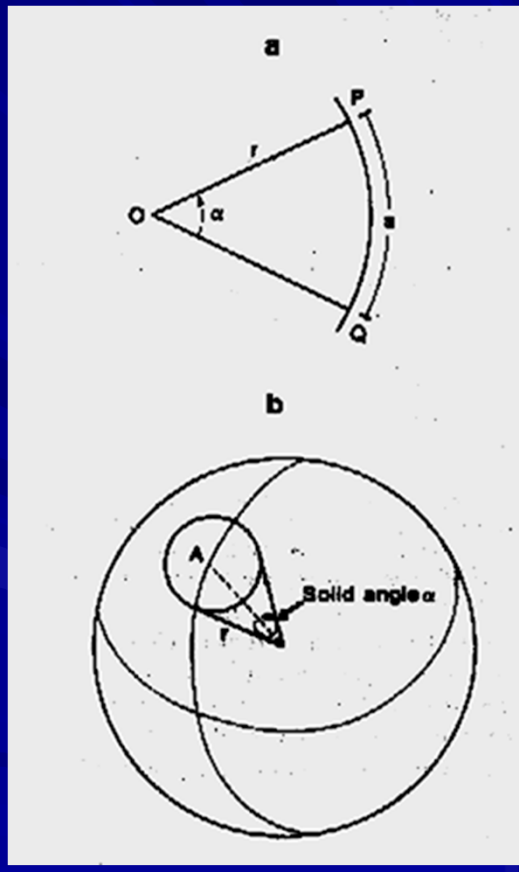
$$E = h f$$

h = Planck's Constant
= 6.626×10^{-34} Joule Sec

$$E = h c / \lambda$$

EM Radiation & its Characteristics

- Energy
- Radiant Energy (E)
- Flux of Energy (Φ)
  (similar to Power)
- Radiant Flux Density W (Φ/area)
  - Irradiance (incoming)
  - Radiant Exitance (outgoing)
- Radiance (L) (Φ area^{-1} st^{-1})
- Spectral Radiance W_λ (L / λ)



Concepts of Radiations

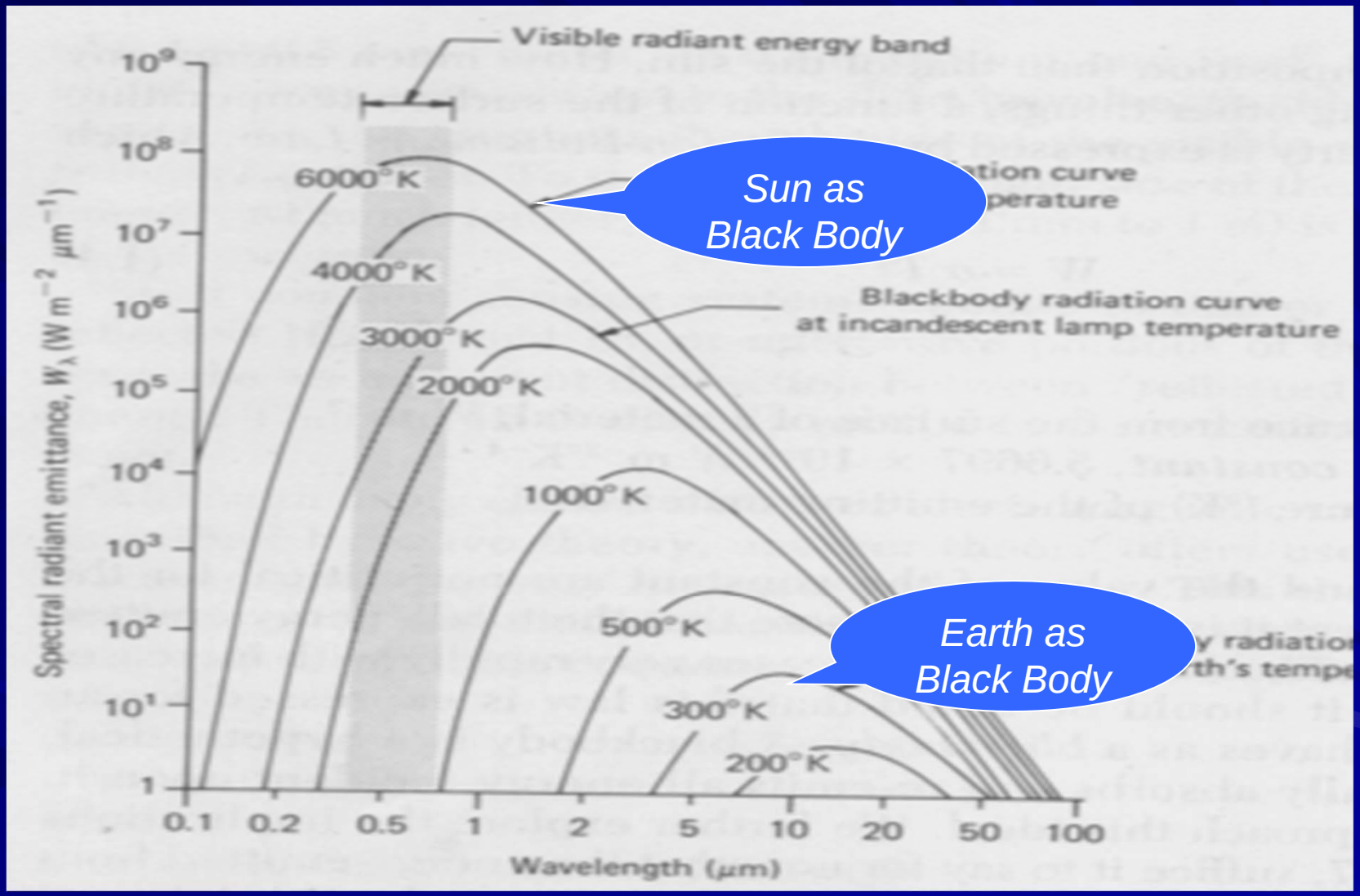
- Black Body ?

  (perfect absorber, perfect radiator)

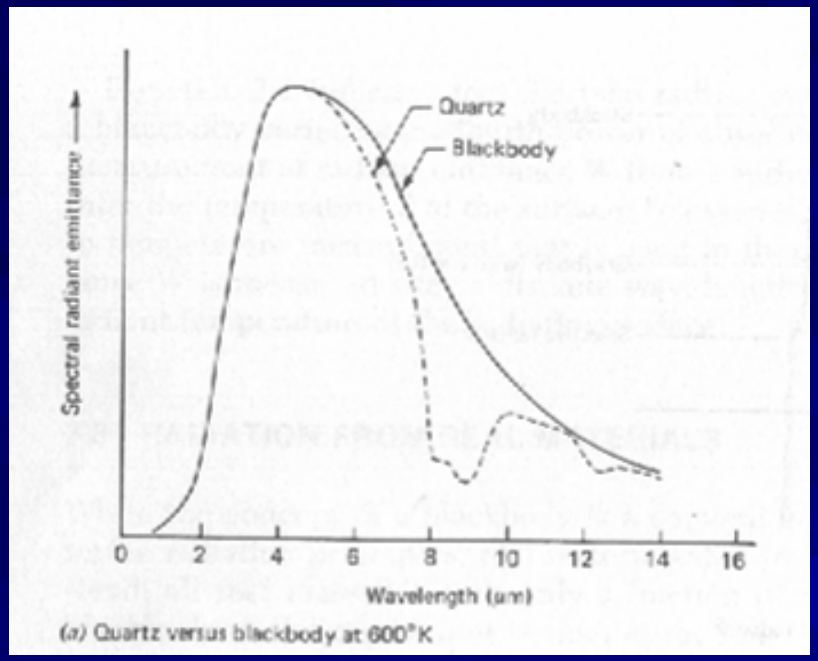
  An object that absorbs all the radiations incident upon it, and emits maximum amount of radiation at all temperatures.

- Gray Bodies (Constant Emissivity)
- Selected Radiator (Variable Emissivity)
- White Body (perfect Reflector)

Black Bodies Emission

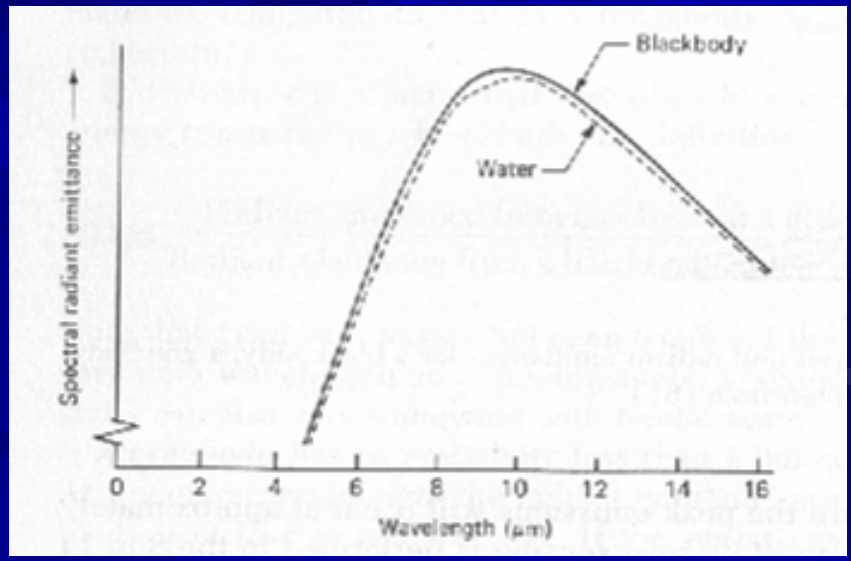


Emittance from Real Bodies

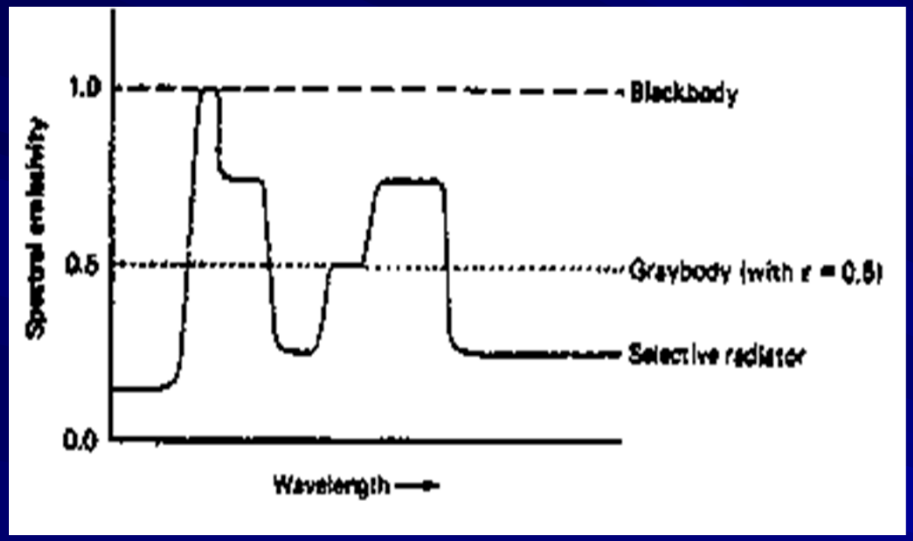


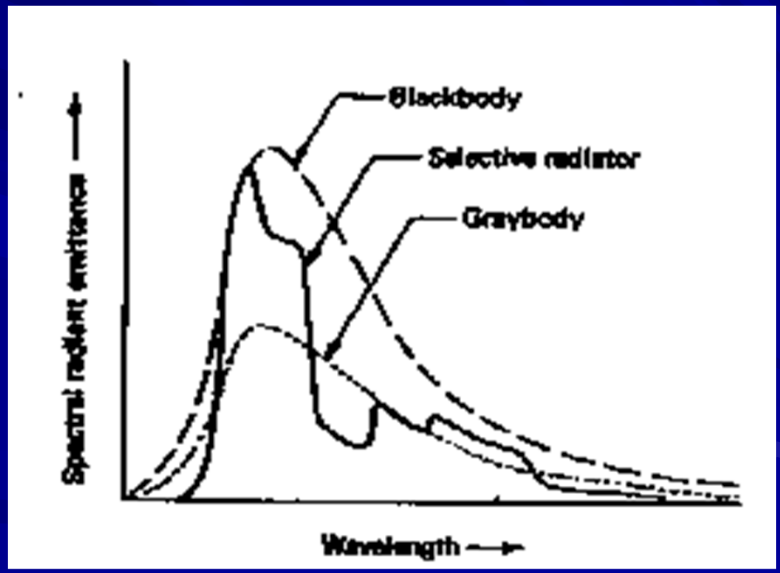
QUARTZ

WATER



Real Bodies Emission: Difference between Gray bodies and Selective radiators





Basic Laws for Emission -1

- Stefan's Law (Stefan Boltzmann's Law)

$$W = \sigma T^4$$

W = total radiant exitance watts / m^2

σ = Stefan Constant = 5.6697 x10^{-8} W m^{-2} $^oK^{-4}$

- Wien Displacement Law

$$\lambda_m = A / T$$

A = 2898 μm ^oK

T = abs. Temp. ^oK

Basic Laws for Emission -2

- Planck's Law

$$W_\lambda = c_1 \lambda^{-5} \left[\frac{1}{e^{c_2 / \lambda T} - 1} \right]$$

W_λ = Spectral radiance emmitance watts / m^2 / m

c_1 = 3.742E-16 W m^{-2}

c_2 = 1.4388E-2 m K^o

Thanks

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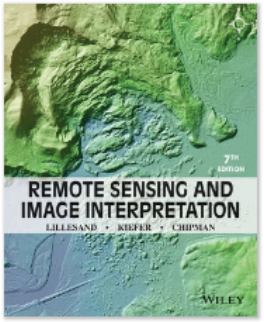

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TEXTBOOK

Remote Sensing and Image Interpretation, 7th Edition

Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman
March 2015, ©2015

Wiley E-Text £30.83 / €37.00	Remote Sensing and Image Interpretation, 7th Edition	ADD TO CART	ISBN : 978-1-118-91947-7
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For Instructors | For Students

Description

Remote Sensing and Image Interpretation, 7th Edition is designed to be primarily used in two ways: as a textbook in the introductory courses in remote sensing and image interpretation, and as a reference for the burgeoning number of practitioners who use geospatial information and analysis in their work. Because of the wide range of academic and professional settings in which this book might be used, we have made the discussion "discipline neutral." In short, anyone involved in geospatial data acquisition and analysis should find this book to be a valuable text and reference.

Instructors

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Typical Emissivity Values

Material	Temperature (°C) of Sample Analyzed	Emissivity (ϵ)[a]
Human skin	32	0.98
Distilled water	20	0.96
Ice	−10	0.96
Carbon (candle soot)	20	0.95
Wet Soil	20	0.95
Glass	20	0.94
Paint (average of 16 colors)	100	0.94
Brick	20	0.93
Dry soil	20	0.92
Concrete	20	0.92
Plaster	20	0.91
Sand	20	0.90
Wood	20	0.90
Snow	−10	0.85
Anodized aluminum	100	0.55
Buffed stainless steel	20	0.16
Highly polished gold	100	0.02

HI-511 APPLICATION OF RS & GIS IN CIVIL ENGINEERING (2 + 2)

- Remote Sensing: Introduction and significance, Principles, Spectral Signatures, Spectral range in Remote Sensing, Types of Remote Sensing (Passive and active), Spectrum of Solar radiation.
- Optical Remote Sensing: Principles, Sensors and data processing,
- Sensor Performances: Spatial characteristics (Resolution, Coverage), Spectral Characteristics (Range, resolutions, number of bands), Radiometric Characteristics (dynamic range, Quantizing level), Temporal Resolution. Platforms (Satellite systems, Aircraft, Space Shuttle and others), Imaging System (Camera, push broom scanner, whisk broom scanner, Resolving Power and Spatial Performances, Dispersing Systems (filter, dispersing element, spectrometer, prism, grating.
- Microwave Remote Sensing: Principles, Sensors and data processing. Image Processing: Introduction to Image Processing (e.g. WinASIAN) software, Data Analysis, Image Enhancement, Classification. Applications.

- Geographic Information System (GIS): Introduction, Basic data operations and data structures for GIS: Concept and theories of Database, Representation of Geo-objects, Basic data structure and data operations, Advanced data models/structures.
- Introduction of GIS software (ArcGIS/ArcView/ArcInfo), Data input and transformation.
- Spatial query and analysis: Spatial query and related data structures, Spatial Operations and analysis,
- Practice Sessions: Data generation for Hydrological Modeling: Filling DEM, Flow direction map, Flow accumulation map, Catchment boundaries, River network generation, Slope etc grids.