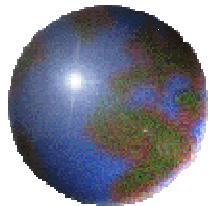




Remote sensing



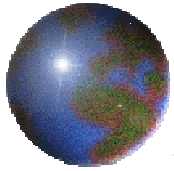
introduction

Karel Martínek

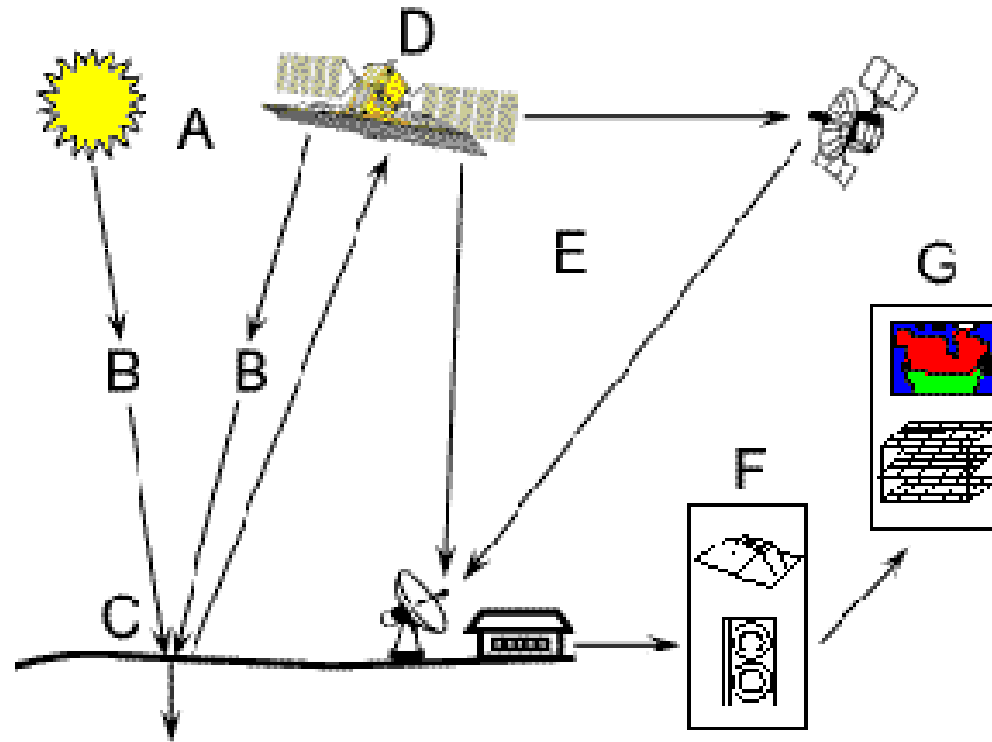
karel.martinek@natur.cuni.cz

karel.martinek@geology.cz

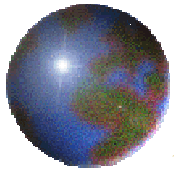
electromagnetic radiation, sensing, images



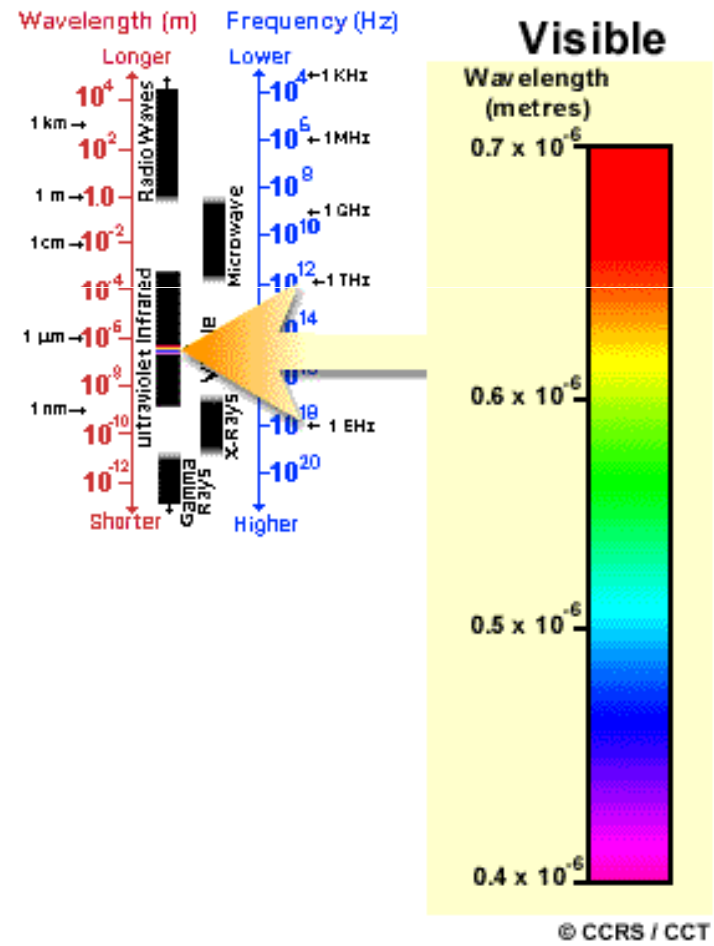
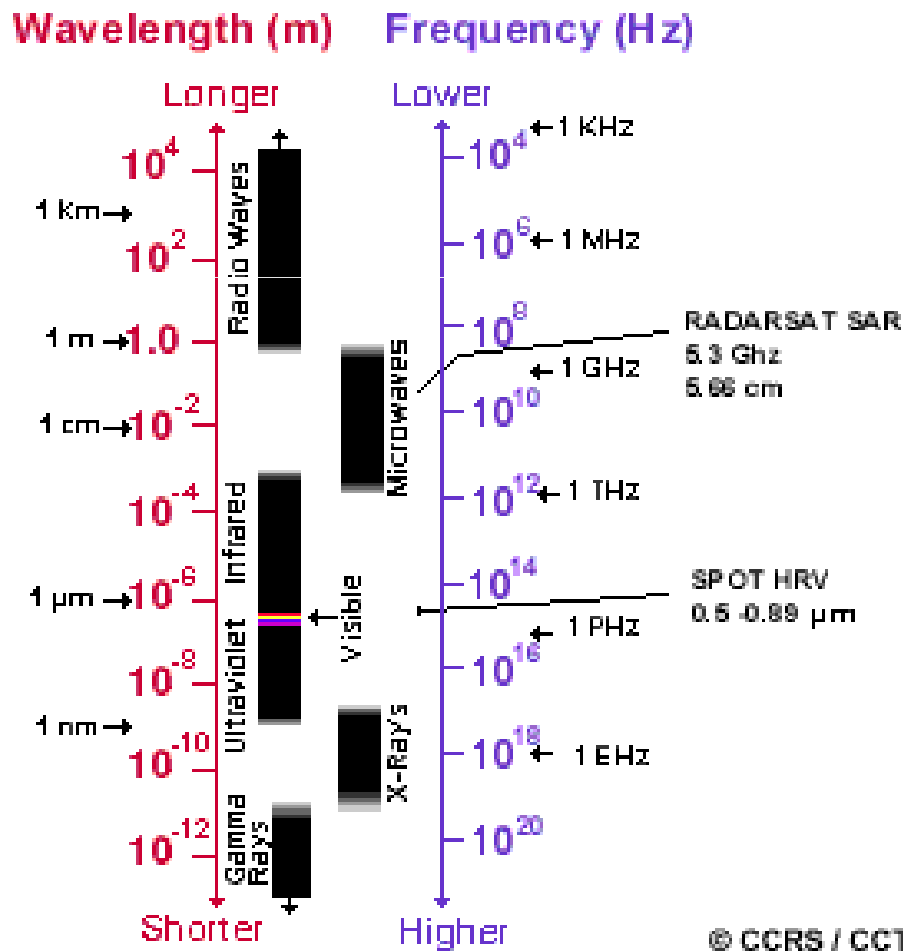
Remote sensing

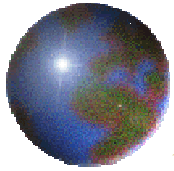


© CCRS / CCT

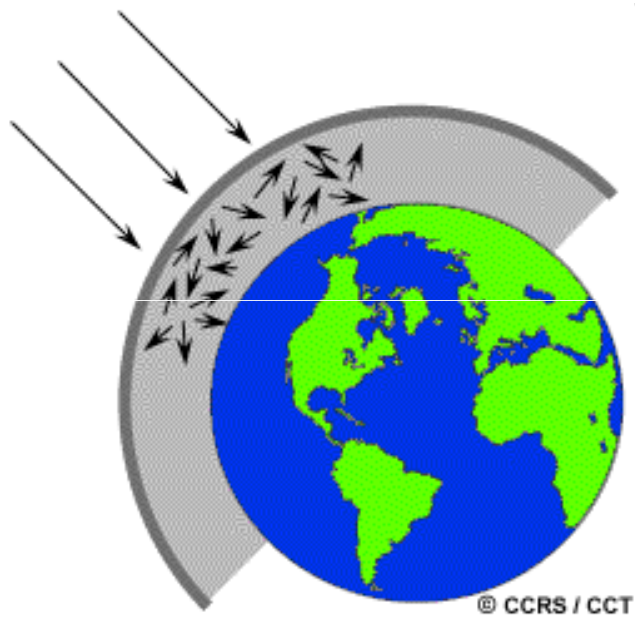


electromagnetic radiation





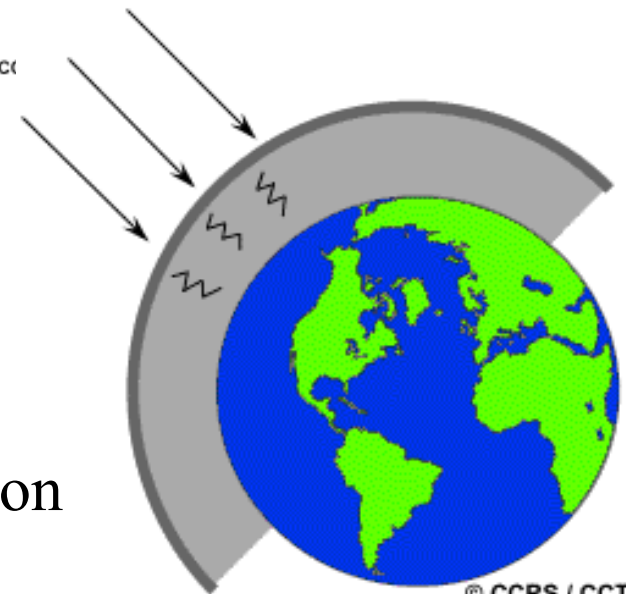
interactions with the atmosphere



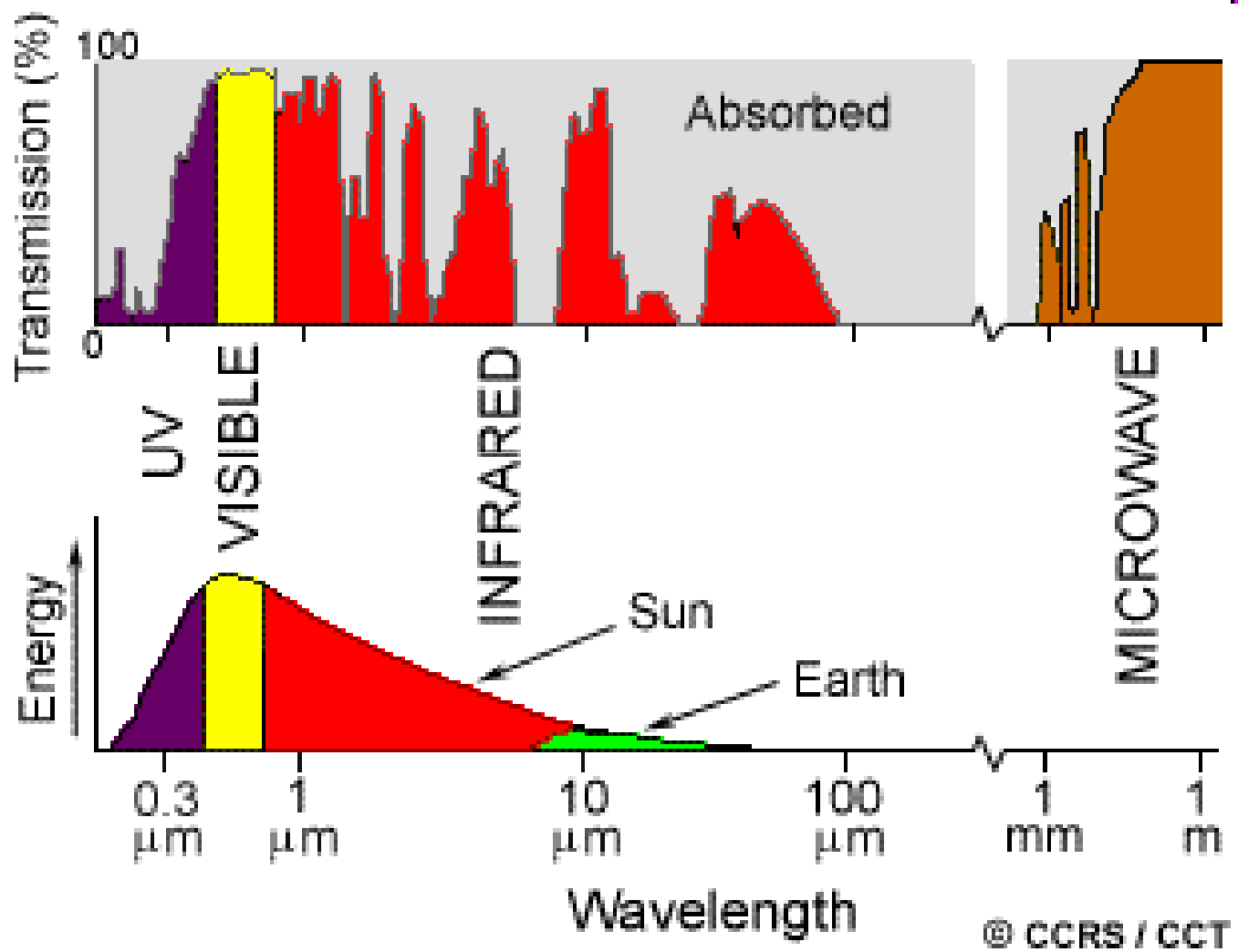
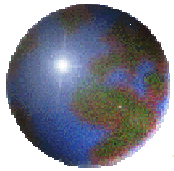
scattering

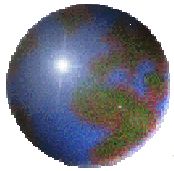


absorption

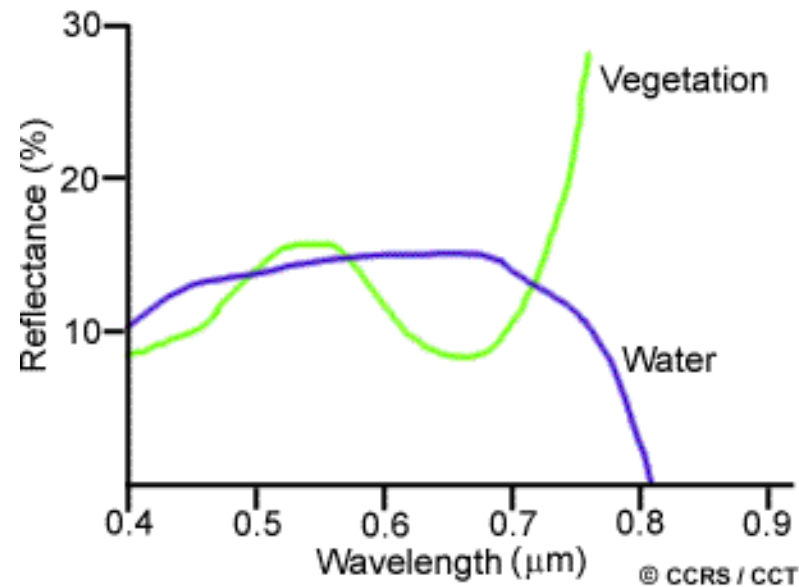
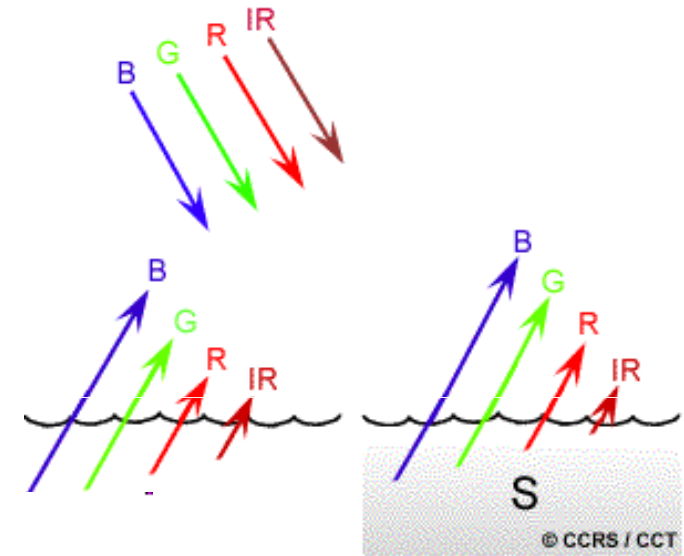
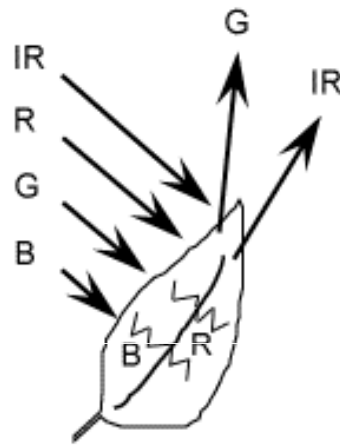
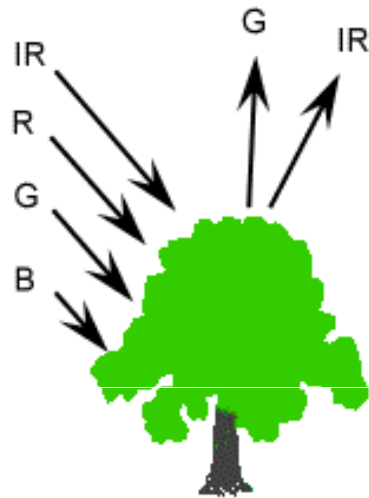


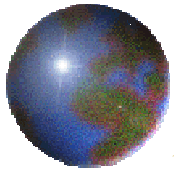
© CCRS / CCT



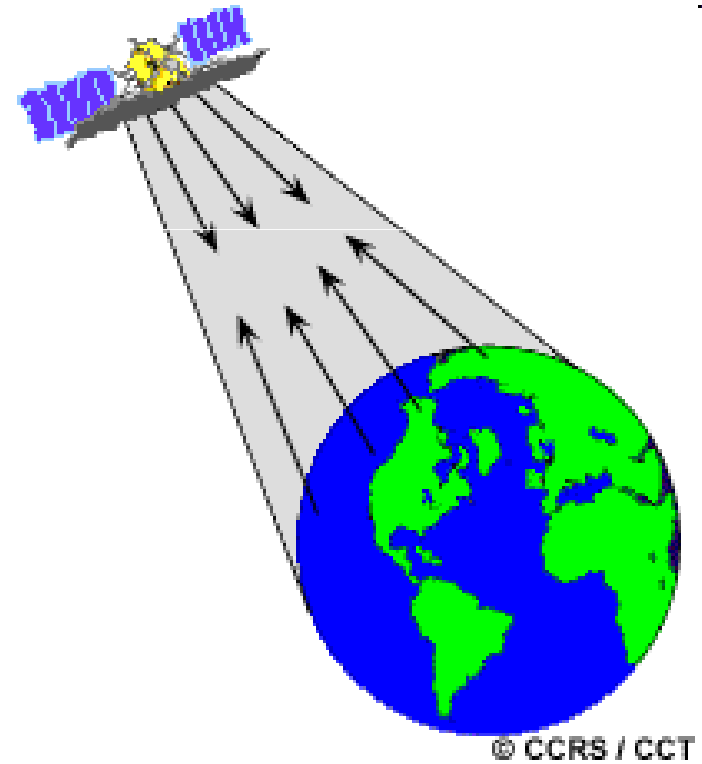
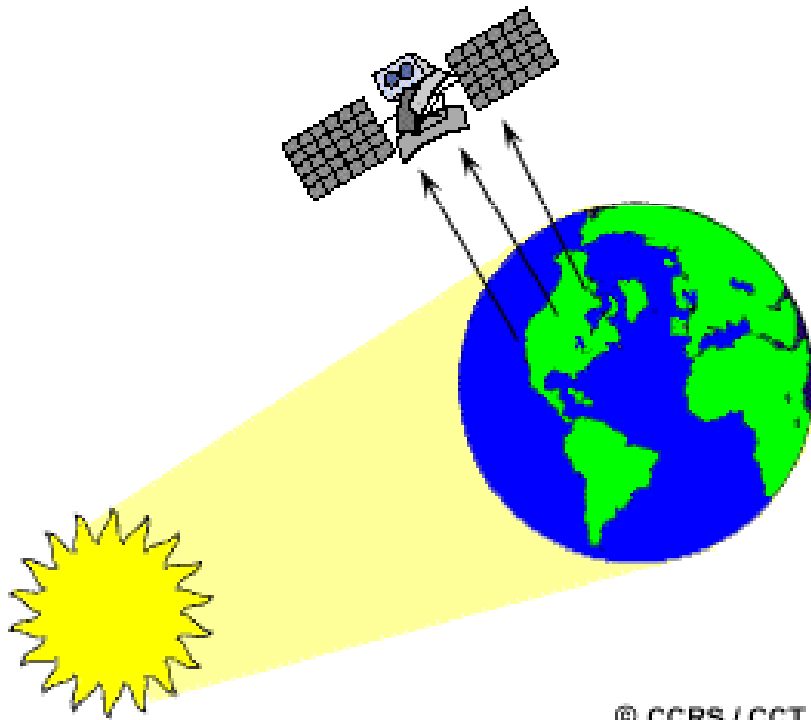


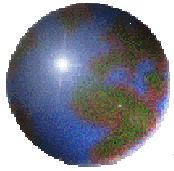
interactions with Earth surface materials





passive vs. active sensors

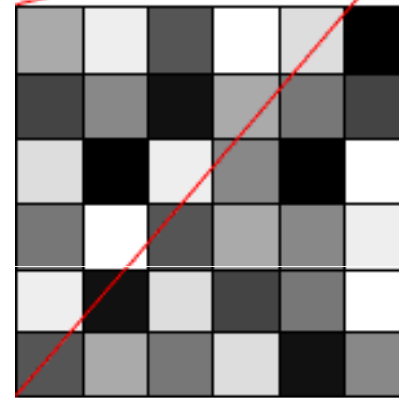




images



© CCRS / CCT



170	238	85	255	221	0
68	136	17	170	119	68
221	0	238	136	0	255
119	255	85	170	136	238
238	17	221	68	119	255
85	170	119	221	17	136



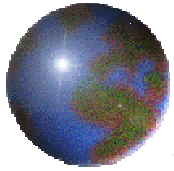
raster image

pixel/cell

DN digital number

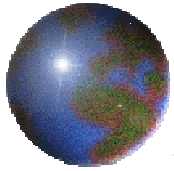
(pixel value)

panchromatic vs colour image



sensors



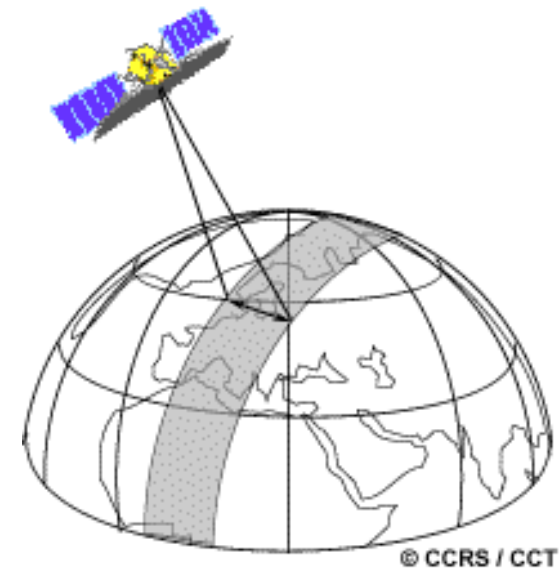
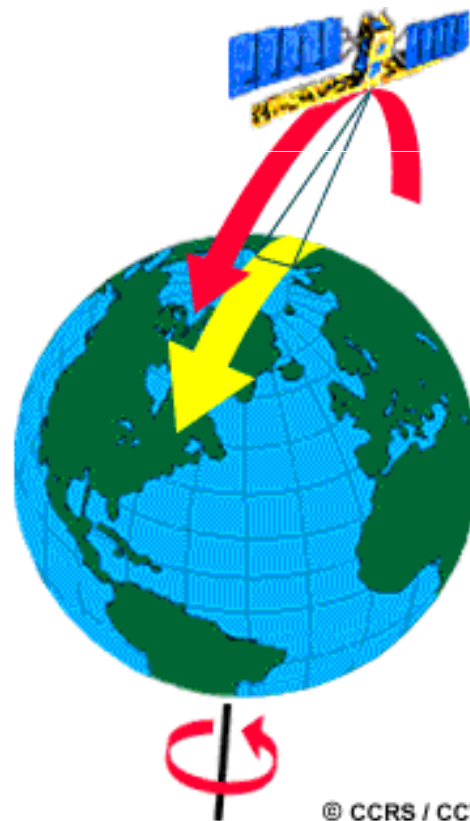
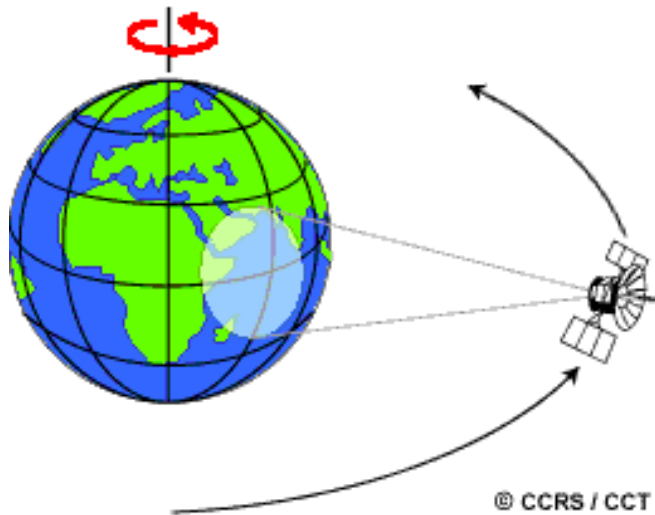


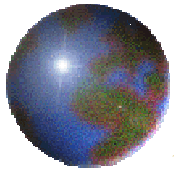
satellite characteristics

near polar orbit

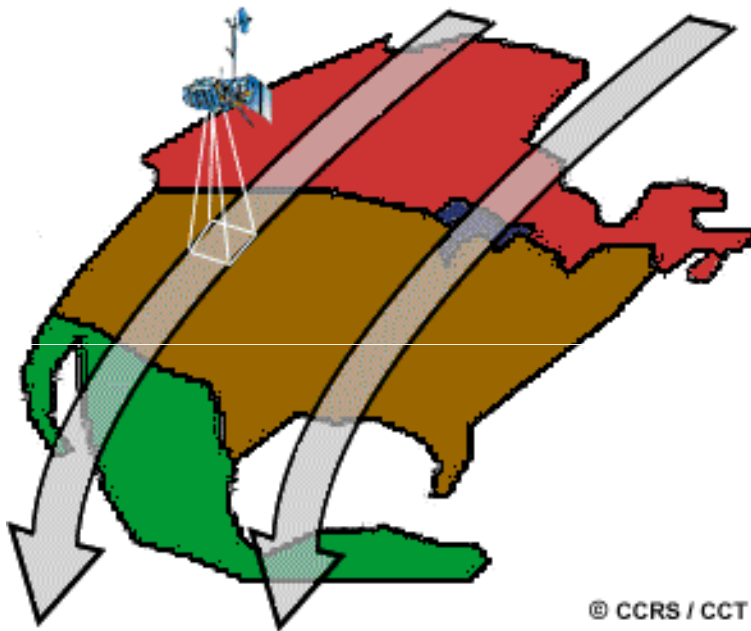
swath

geostationary

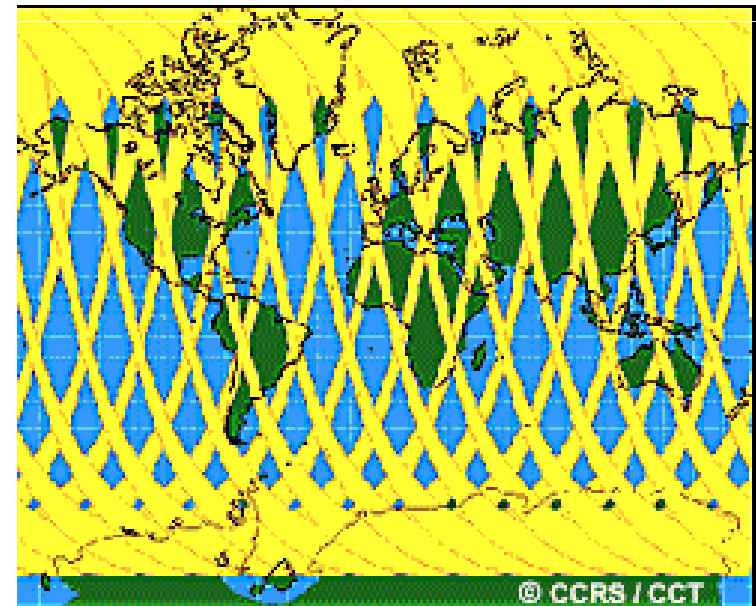


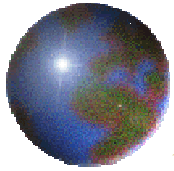


nadir point



revisit period





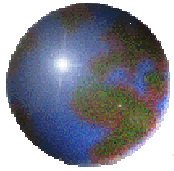
spatial resolution (pixel size)



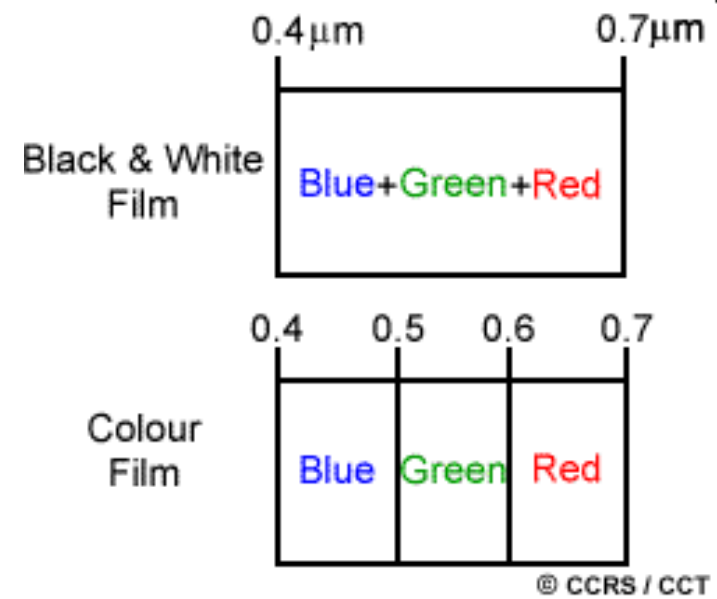
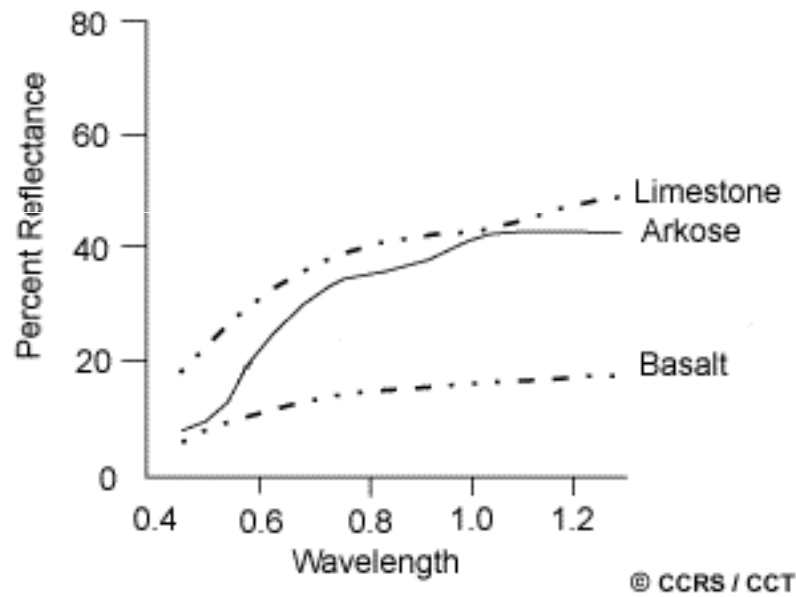
low resolution =
= large pixel size

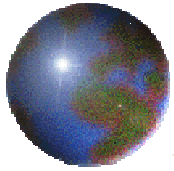


high resolution =
= small pixel size



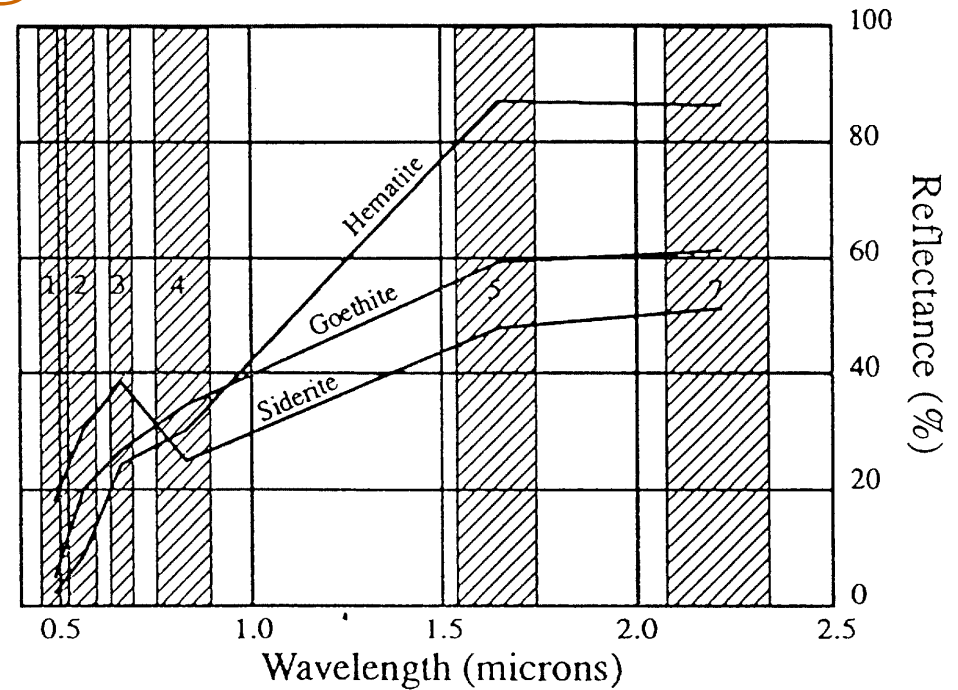
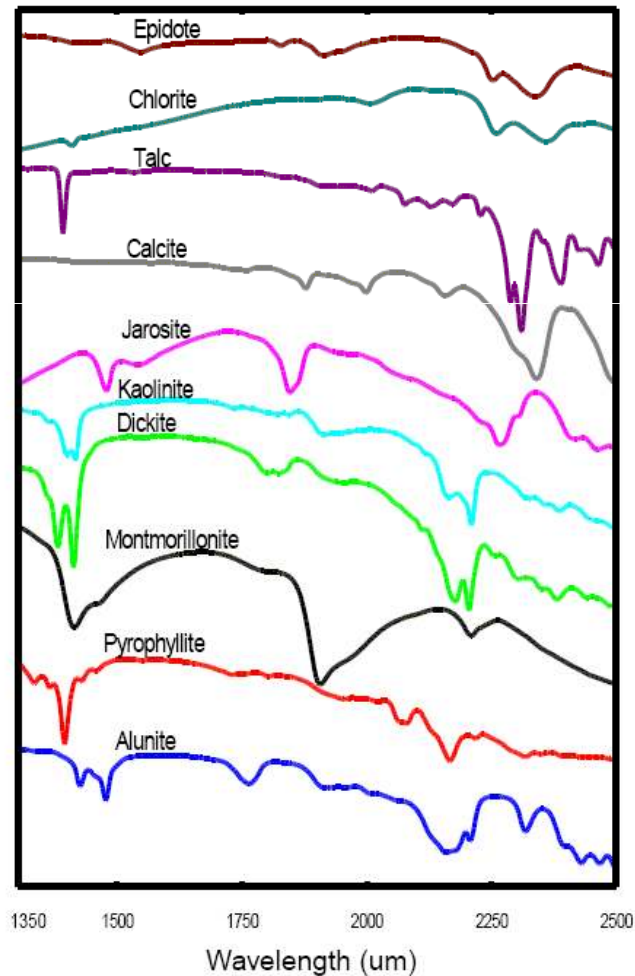
spectral resolution

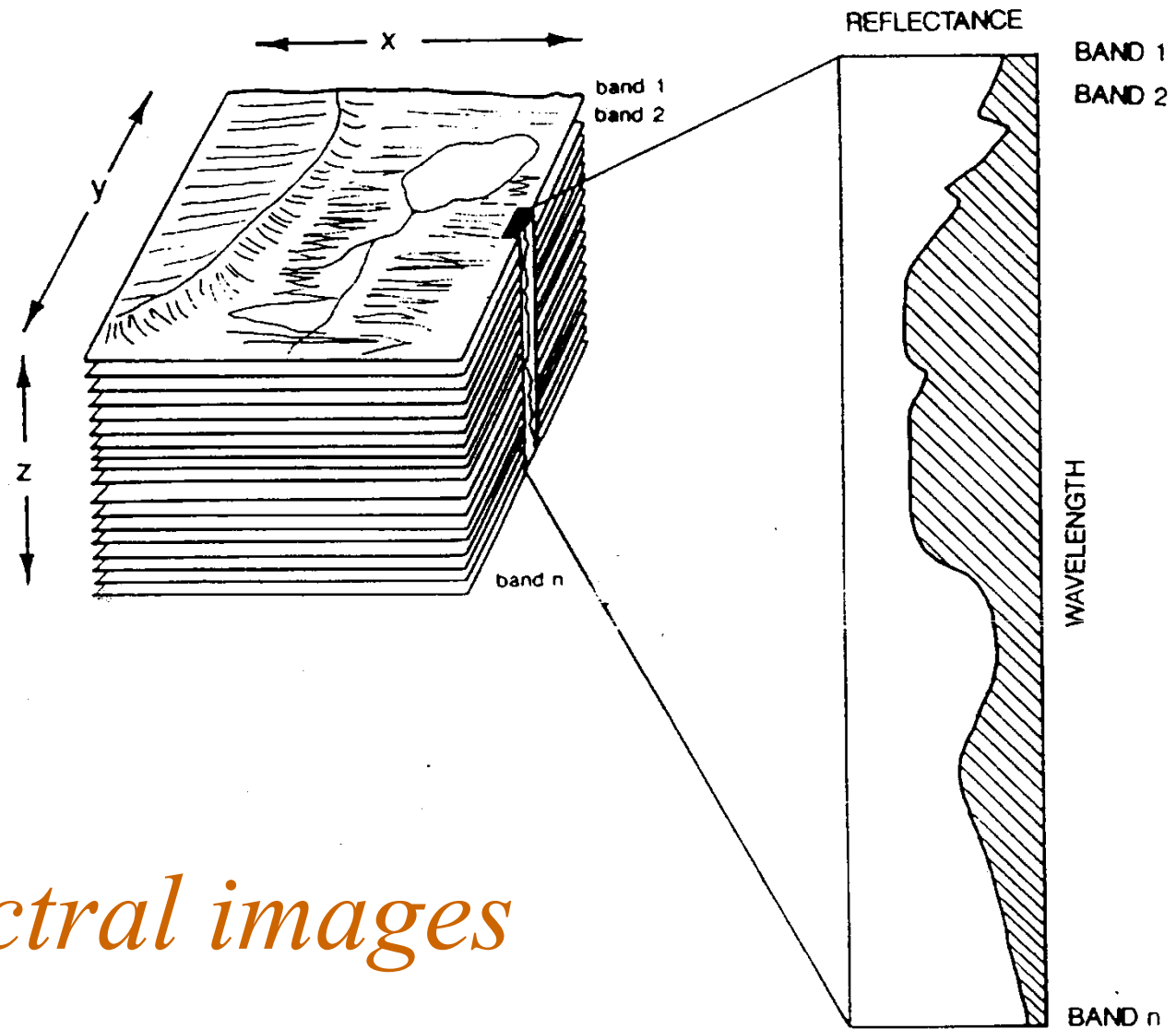
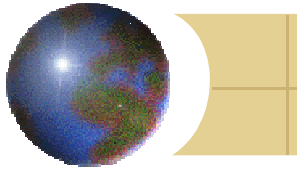




multispectral images - Landsat

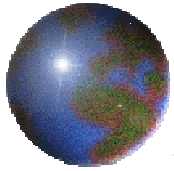
Examples of Minerals with SWIR Absorption Bands (1.3 - 2.5um)





hyperspectral images

Figure 6.6 Diagram of a hyperspectral image cube consisting of "n" layers of images in "n" wavelengths. One may extract a reflectance curve for any given pixel in the image.

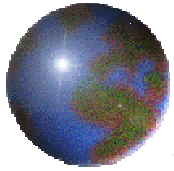


radiometric resolution

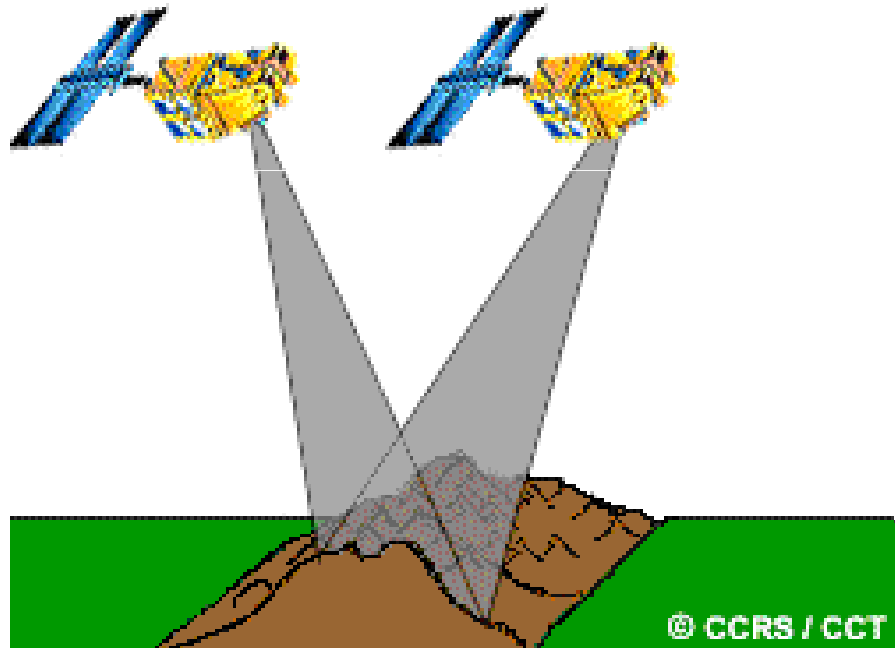
2-bit

vs. 16-bit image

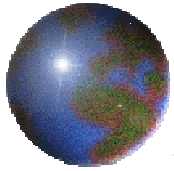




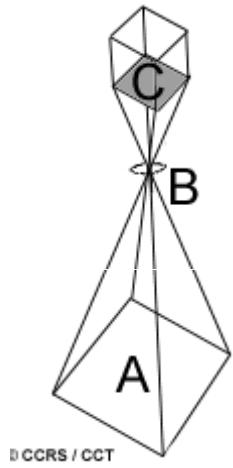
revisit period



change analysis
geohazards



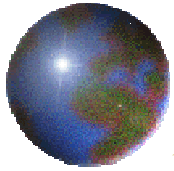
airborne imaging



true color

vs. infrared image

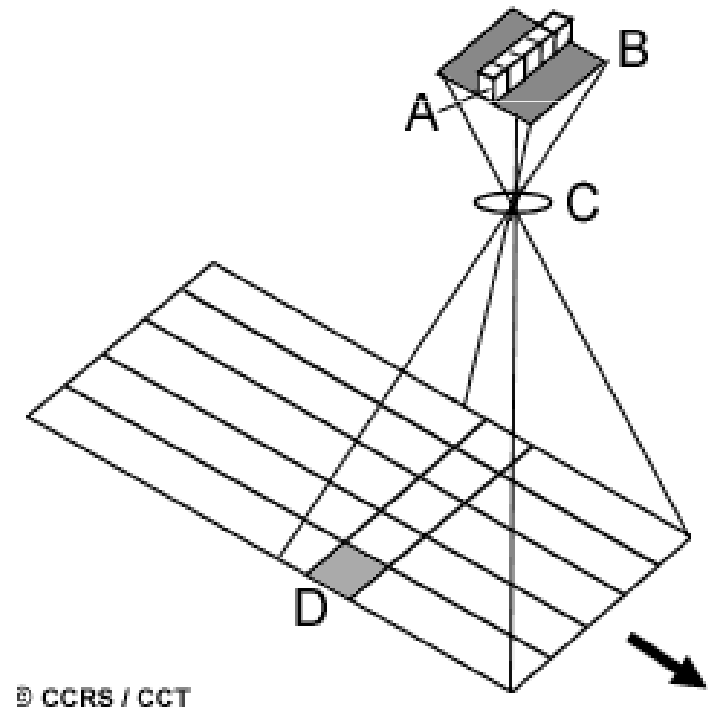
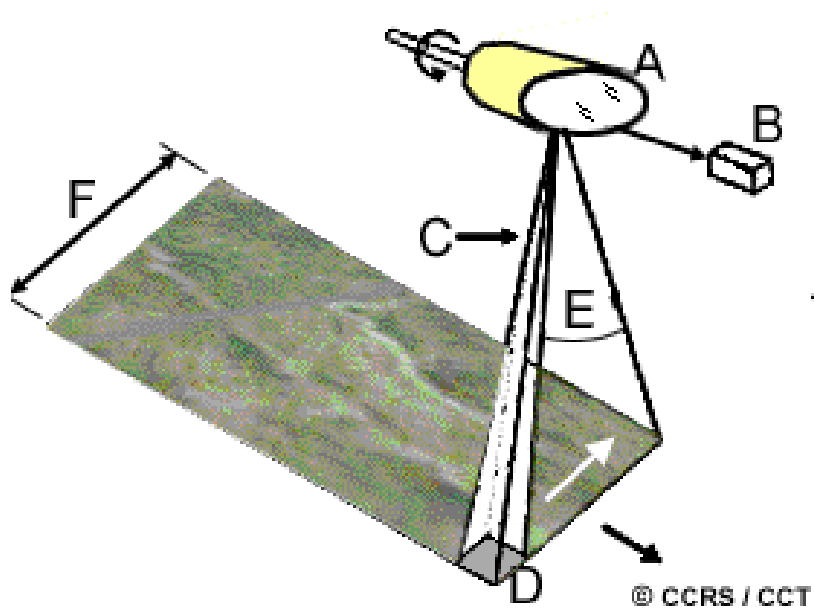
high spatial resolution, distortion of image

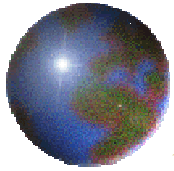


optical satellite sensors (~ 0,4 – 2,5 microns)

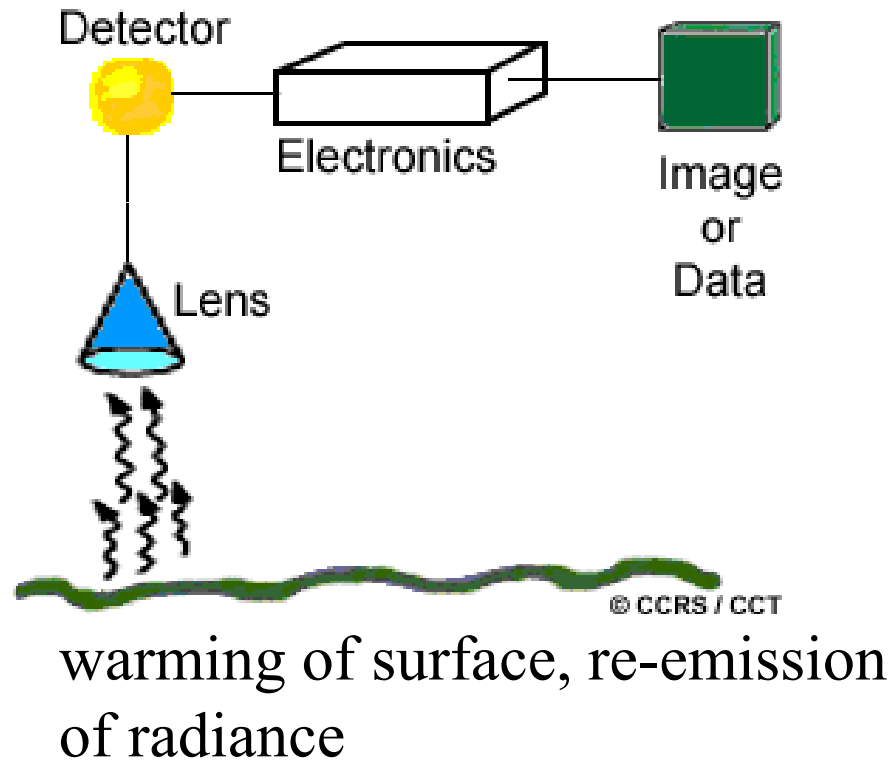
along-track scanners

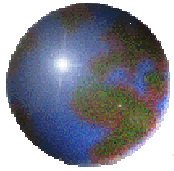
across-track scanners





thermal sensing (~ 10 microns)



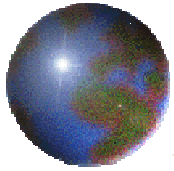


Landsat (Land observation satellite)

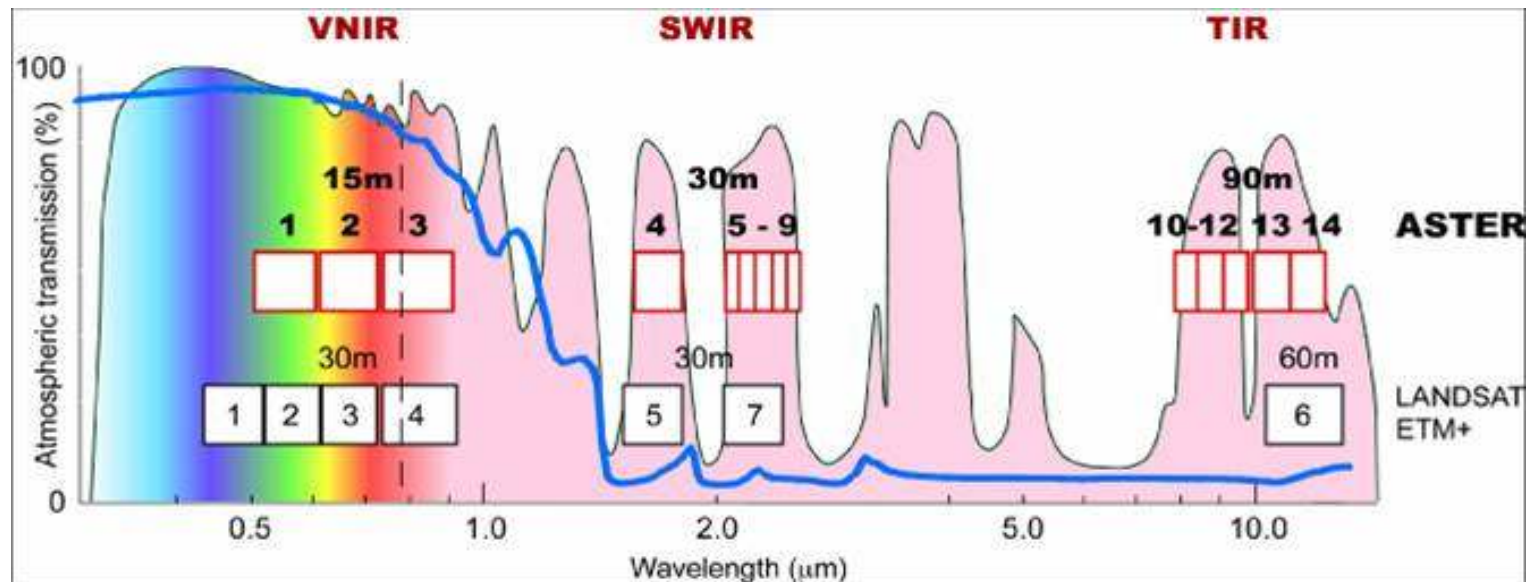
MSS – multispectral scanner

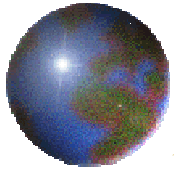
MSS Bands

Channel		Wavelength Range (μm)
Landsat 1,2,3	Landsat 4,5	
MSS 4	MSS 1	0.5 - 0.6 (green)
MSS 5	MSS 2	0.6 - 0.7 (red)
MSS 6	MSS 3	0.7 - 0.8 (near infrared)
MSS 7	MSS 4	0.8 - 1.1 (near infrared)



- Landsat 7 ETM+, 7 spectral bands between 0.5 and 12.5 μm , NASA
- ASTER, 14 spectral bands between 0.5 and 11.7 μm , NASA

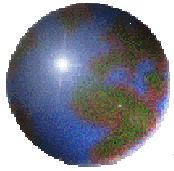




Landsat (Land observation satellite)

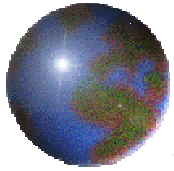
TM – thematic mapper; ETM – enhanced thematic mapper

Channel	Wavelength Range (μm)	Application
TM 1	0.45 - 0.52 (blue)	soil/vegetation discrimination; bathymetry/coastal mapping; cultural/urban feature identification
TM 2	0.52 - 0.60 (green)	green vegetation mapping (measures reflectance peak); cultural/urban feature identification
TM 3	0.63 - 0.69 (red)	vegetated vs. non-vegetated and plant species discrimination (plant chlorophyll absorption); cultural/urban feature identification



Landsat (Land observation satellite)

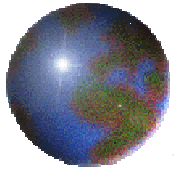
TM 4	0.76 - 0.90 (near IR)	identification of plant/vegetation types, health, and biomass content; water body delineation; soil moisture
TM 5	1.55 - 1.75 (short wave IR)	sensitive to moisture in soil and vegetation; discriminating snow and cloud-covered areas
TM 6	10.4 - 12.5 (thermal IR)	vegetation stress and soil moisture discrimination related to thermal radiation; thermal mapping (urban, water)
TM 7	2.08 - 2.35 (short wave IR)	discrimination of mineral and rock types; sensitive to vegetation moisture content



SPOT (Système Pour l'Observation de la Terre)

HRV Mode Spectral Ranges

Mode/Band	Wavelength Range (μm)
Panchromatic (PLA)	0.51 - 0.73 (blue-green-red)
Multispectral (MLA)	
Band 1	0.50 - 0.59 (green)
Band 2	0.61 - 0.68 (red)
Band 3	0.79 - 0.89 (near infrared)

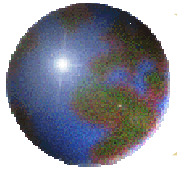


IRS - Indian Remote Sensing

IRS Sensors

LISS-II

Sensor	Wavelength Range (μm)	Spatial Resolution	Swath Width	Revisit Period (at equator)
PAN	0.5 - 0.75	5.8 m	70 km	24 days
Green	0.52 - 0.59	23 m	142 km	24 days
Red	0.62 - 0.68	23 m	142 km	24 days
Near IR	0.77 - 0.86	23 m	142 km	24 days
Shortwave IR	1.55 - 1.70	70 m	148 km	24 days
WiFS				
Red	0.62 - 0.68	188 m	774 km	5 days
Near IR	0.77 - 0.86	188 m	774 km	5 days



high spatial resolution satellites (metres – dm)

QuickBird

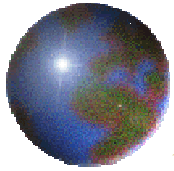
WorldView

IKONOS

Orbview

Formosat-2

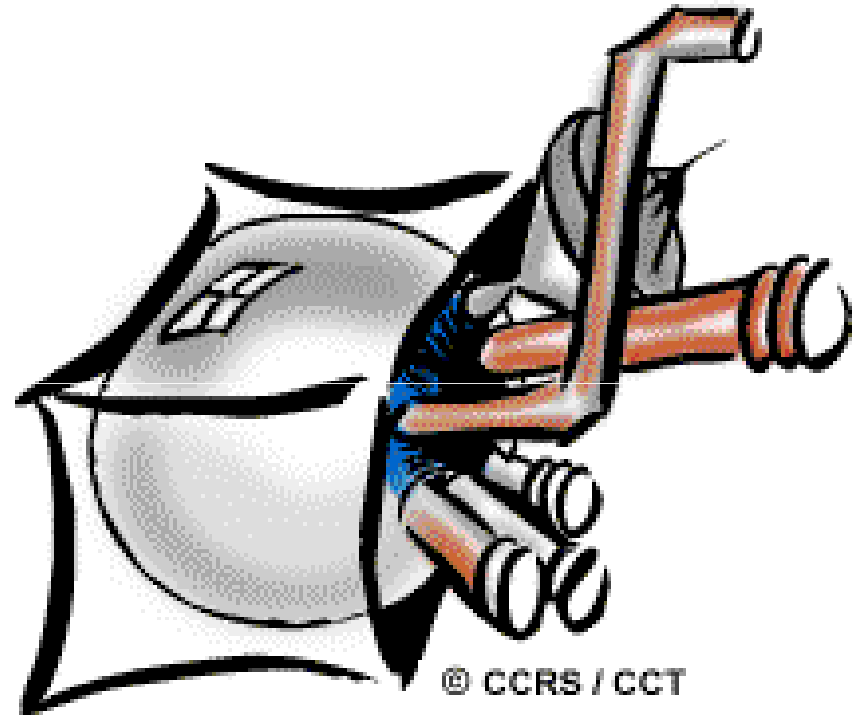
Pleiádes



meteorological sensors

ocean

other



video

Lidar (LIght Detection And Ranging, cm resolution)

Radar (RAdio Detection And Ranging)

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