Remote Sensing

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University of Naples Federico II

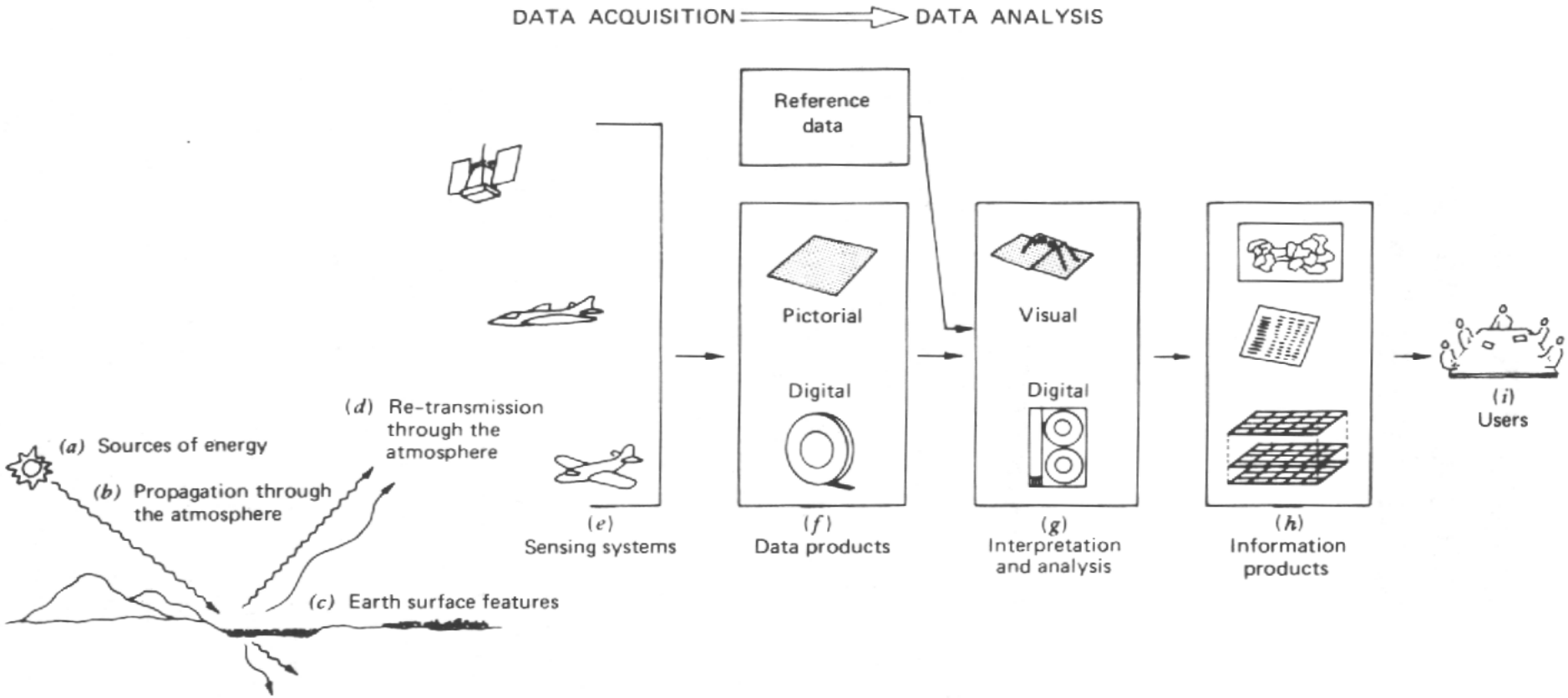
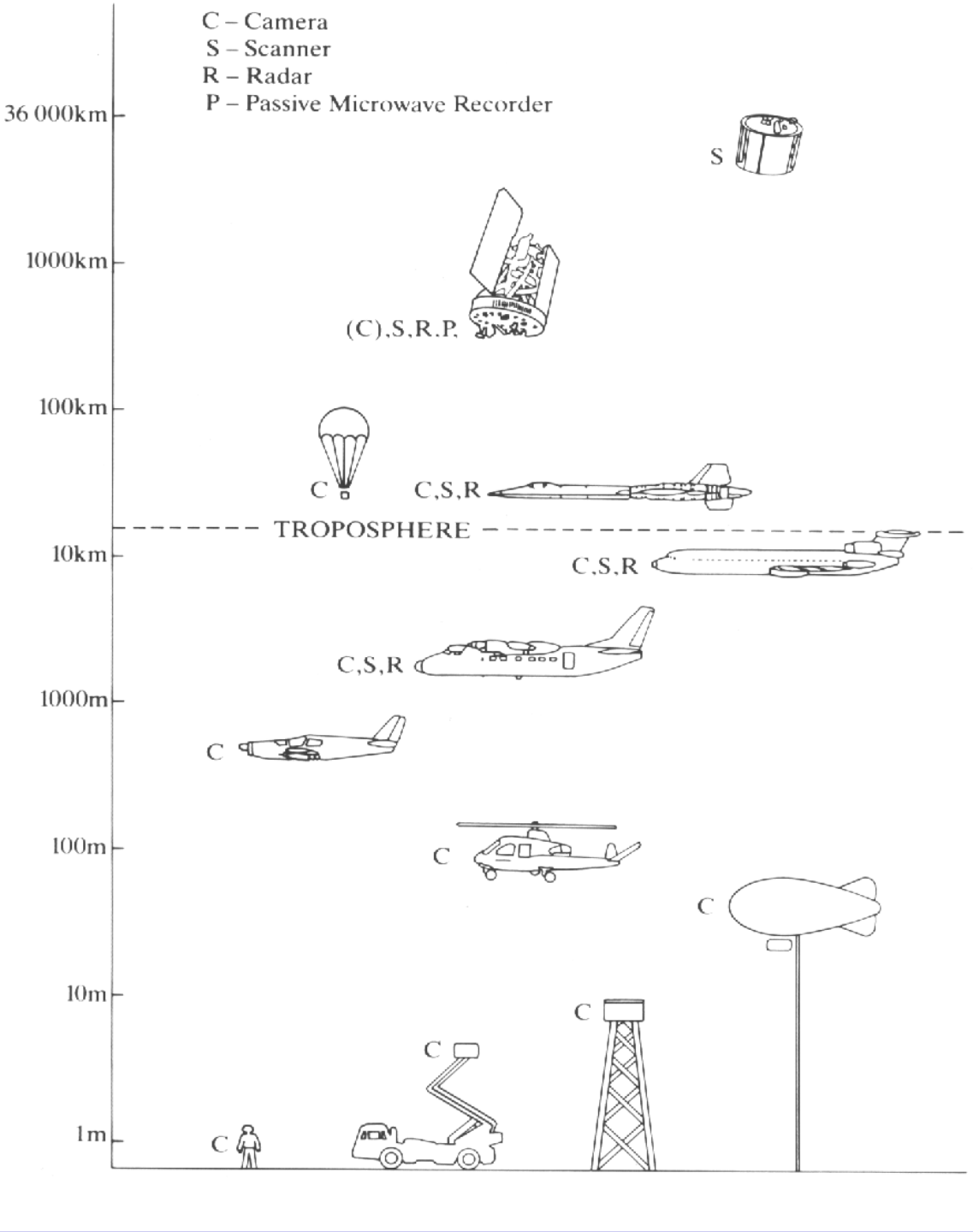
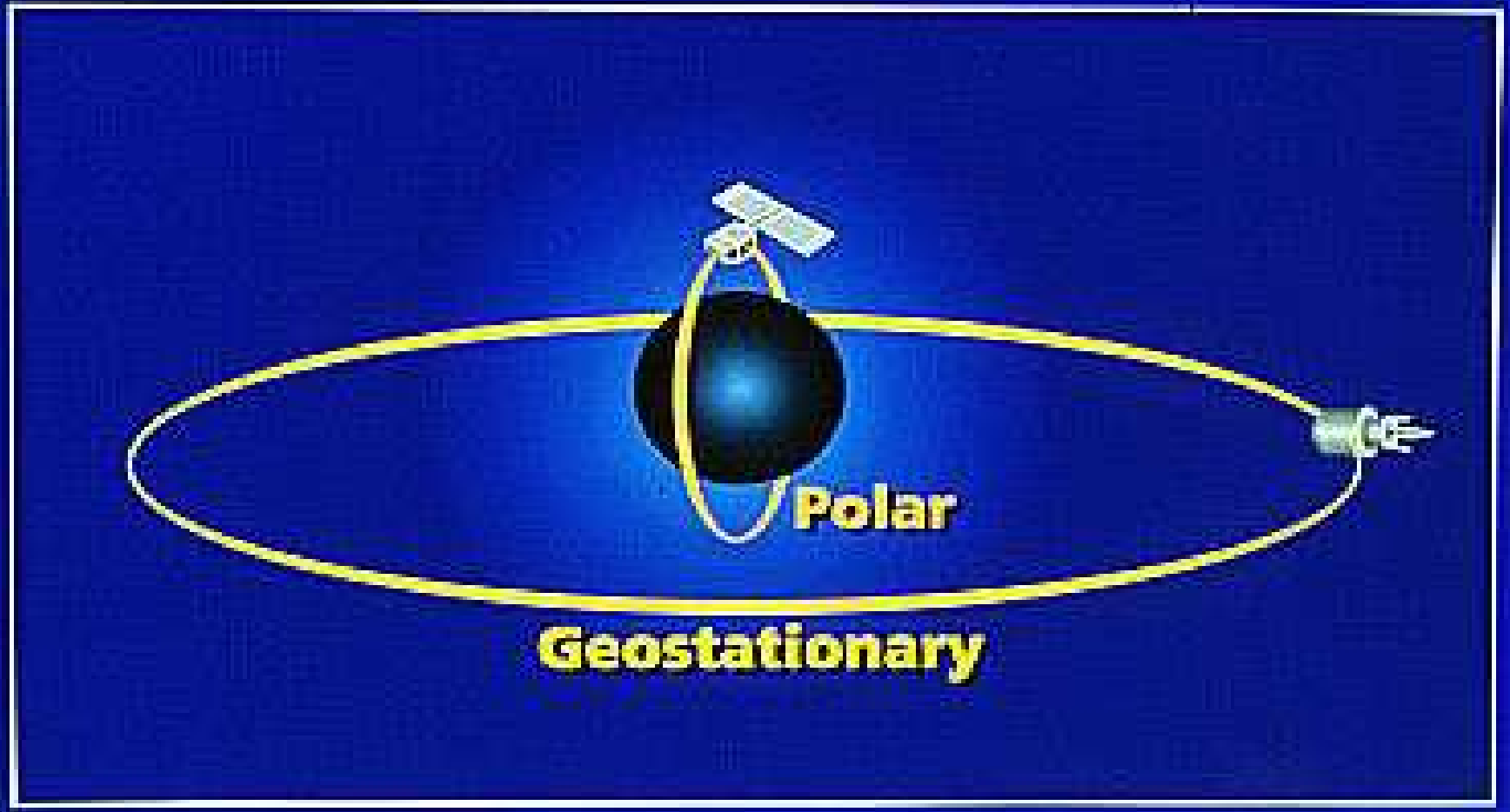


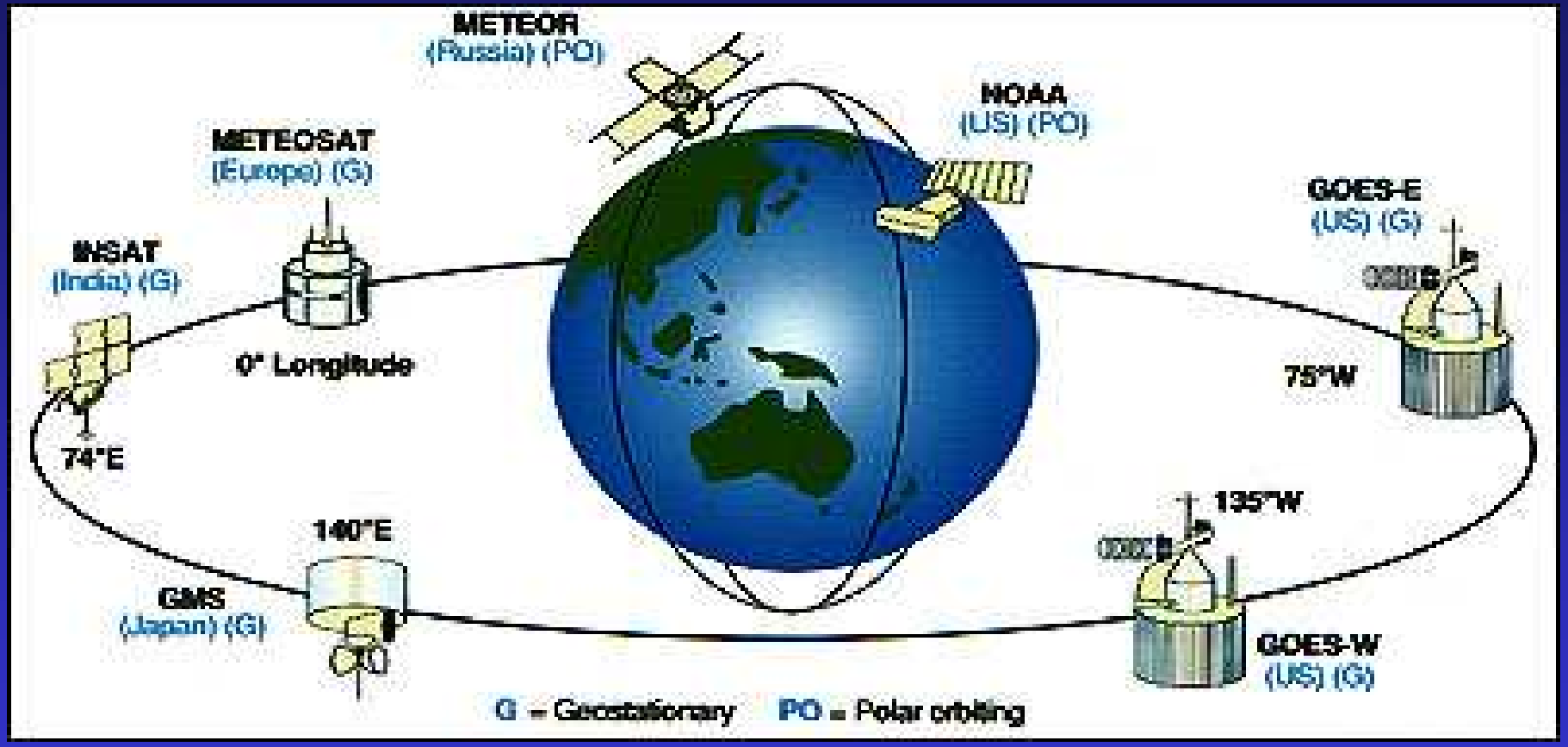
FIGURE 1.1 Electromagnetic remote sensing of earth resources.

Earth Observation platforms



Orbits




METEOR
(Russia) (PO)
NOAA
(US) (PO)
METEOSAT
(Europe) (G)
INSAT
(India) (G)
0° Longitude
GOES-E
(US) (G)
75°W
74°E
135°W
140°E
GMS
(Japan) (G)
GOES-W
(US) (G)
G = Geostationary
PO = Polar orbiting

Sun-synchronous polar orbit

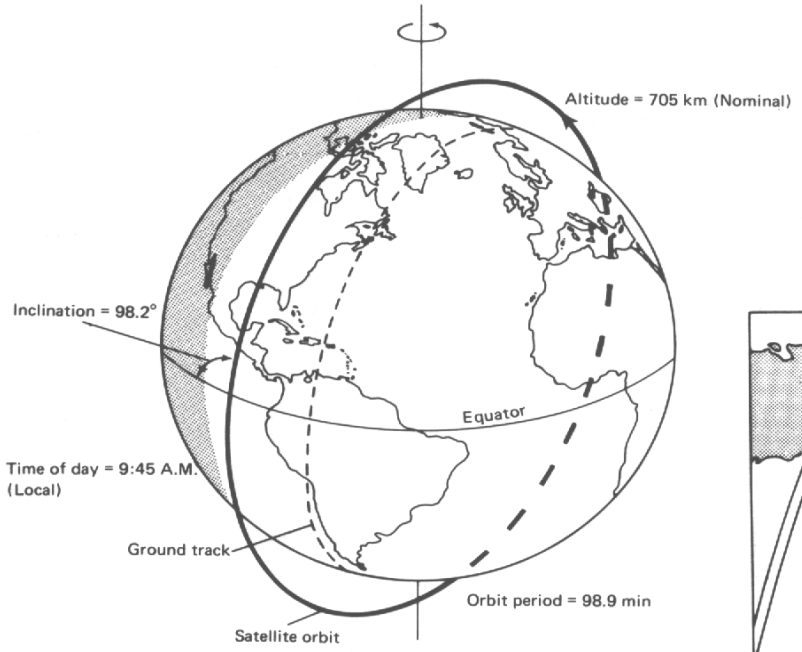


FIGURE 9.19 Sun-synchronous orbit of Landsat-4 and -5. (Adapted from diagram.)

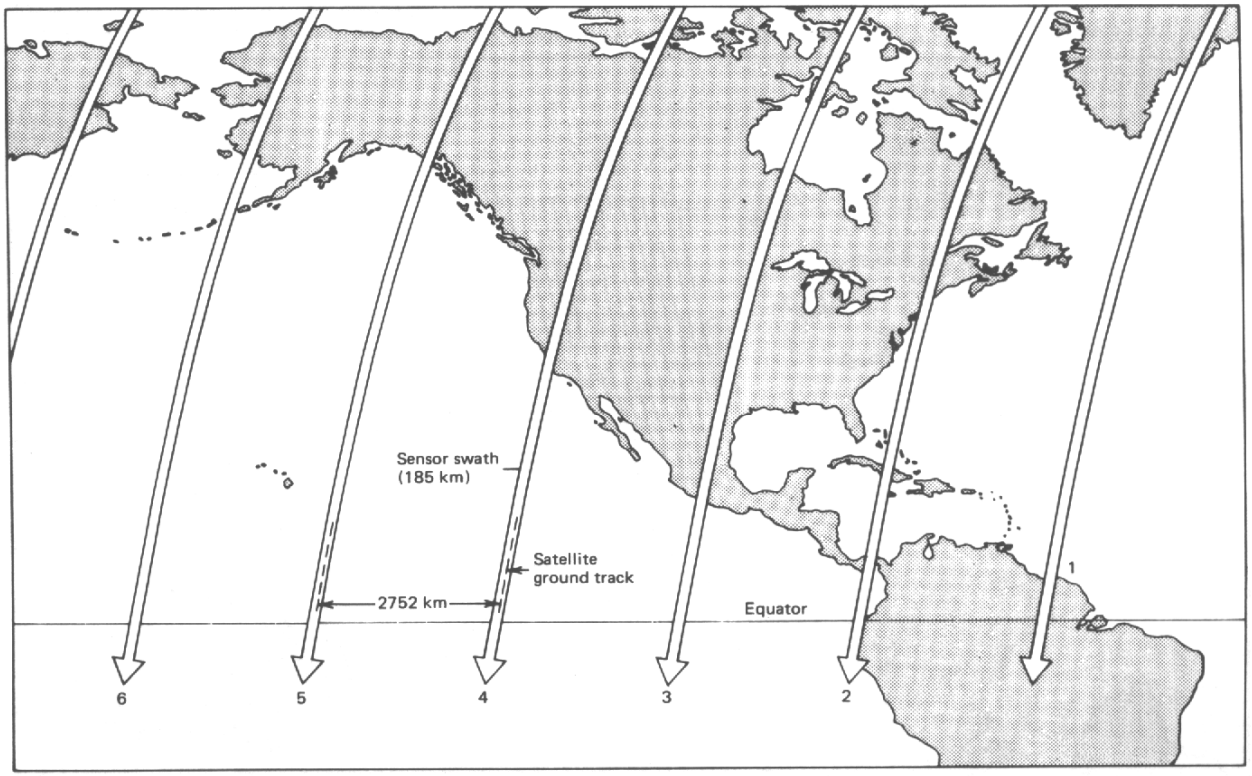


FIGURE 9.20 Spacing between adjacent Landsat-4 or -5 orbit tracks at the equator. The earth revolves 2752 km to the east at the equator between passes. (Adapted from NASA diagram.)

Sun-synchronous polar orbit

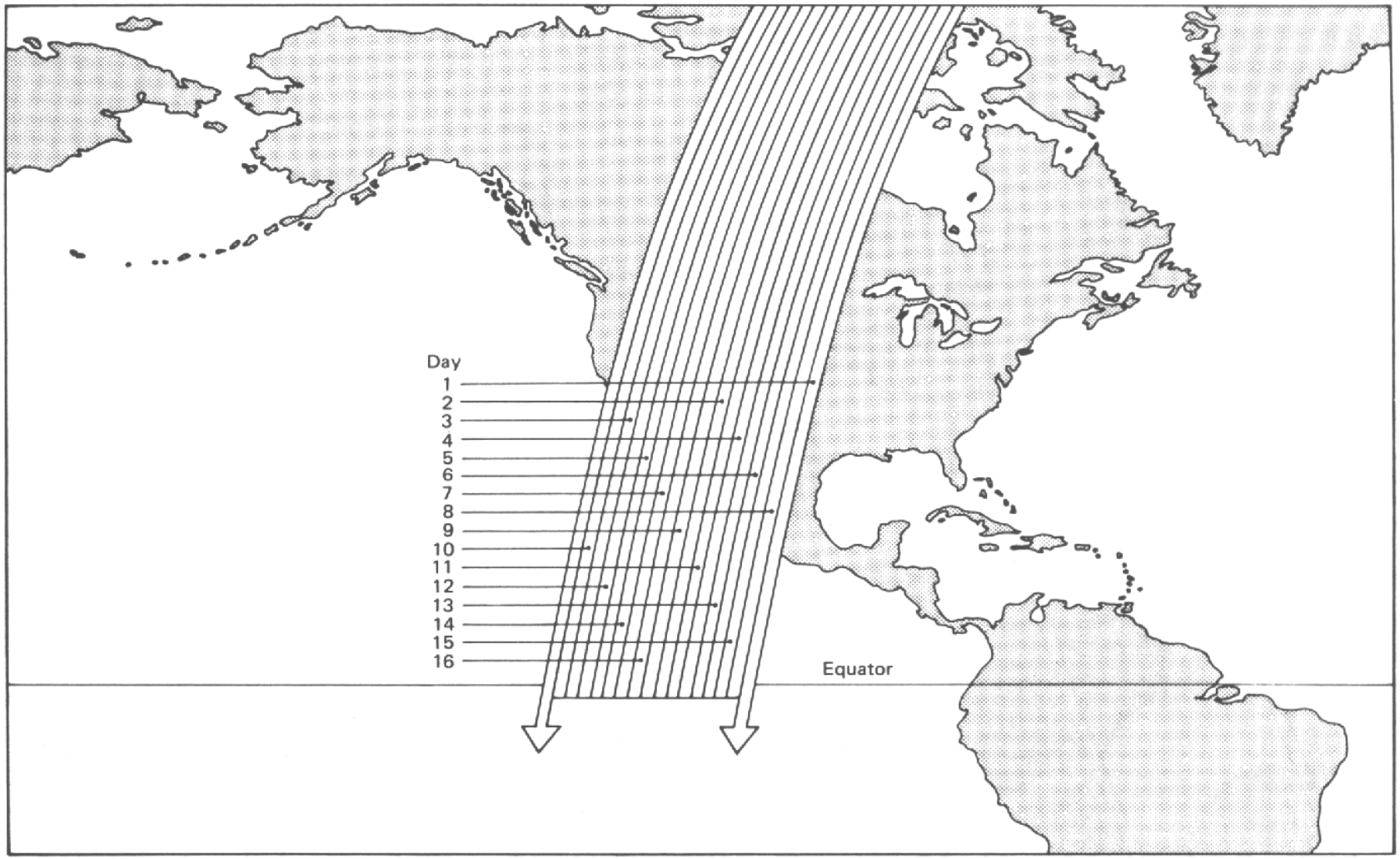
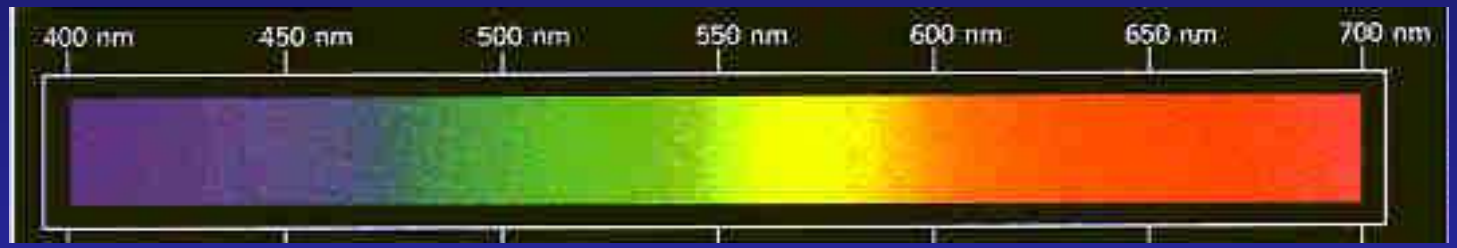
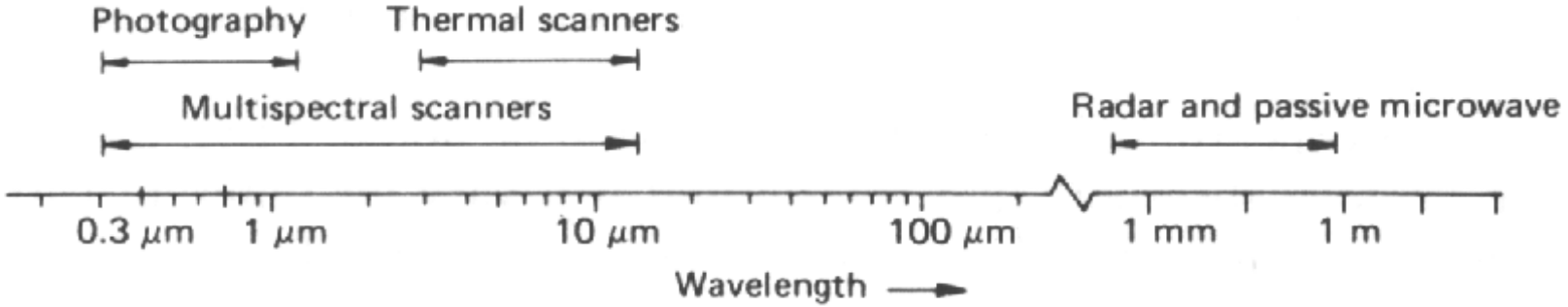


FIGURE 9.21 Timing of adjacent Landsat-4 or -5 coverage tracks. Adjacent swaths are imaged 7 days apart. (Adapted from NASA diagram.)

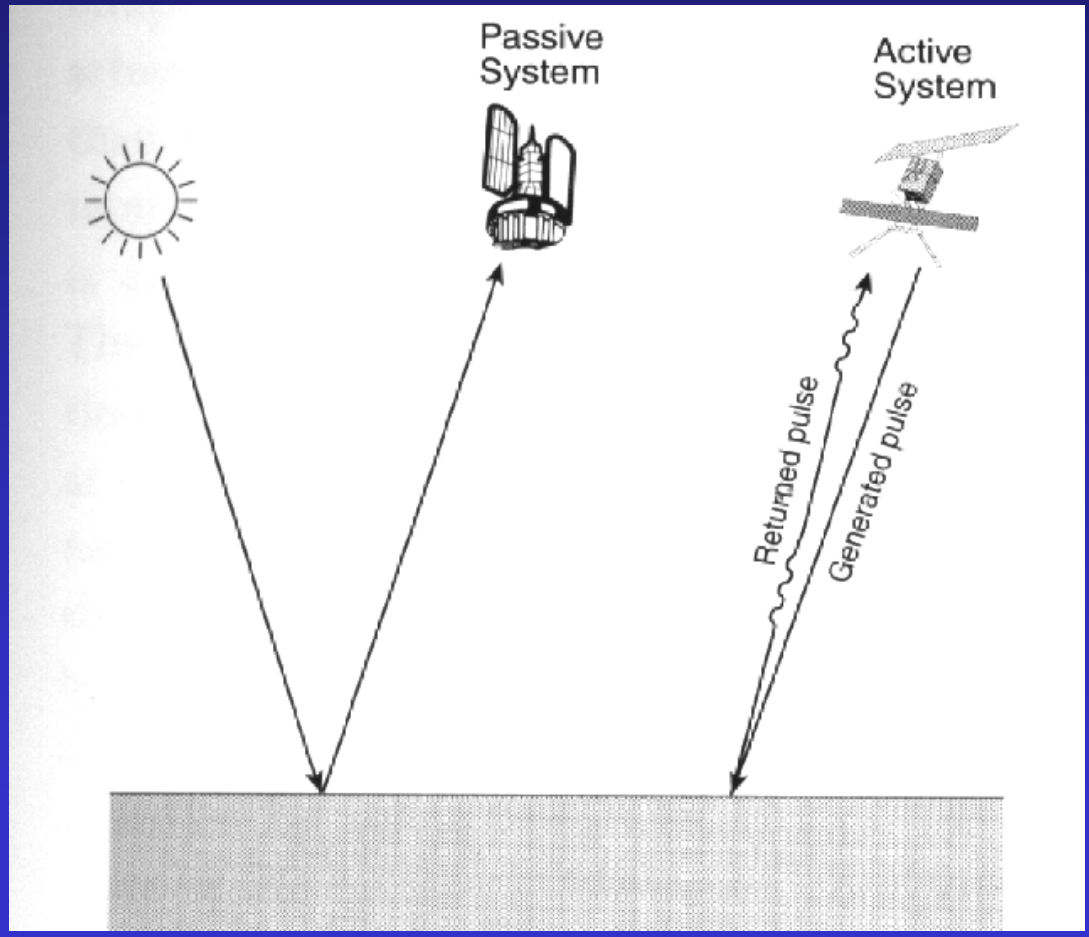
Electromagnetic radiation

Visible spectrum is only 0.3 nm wide

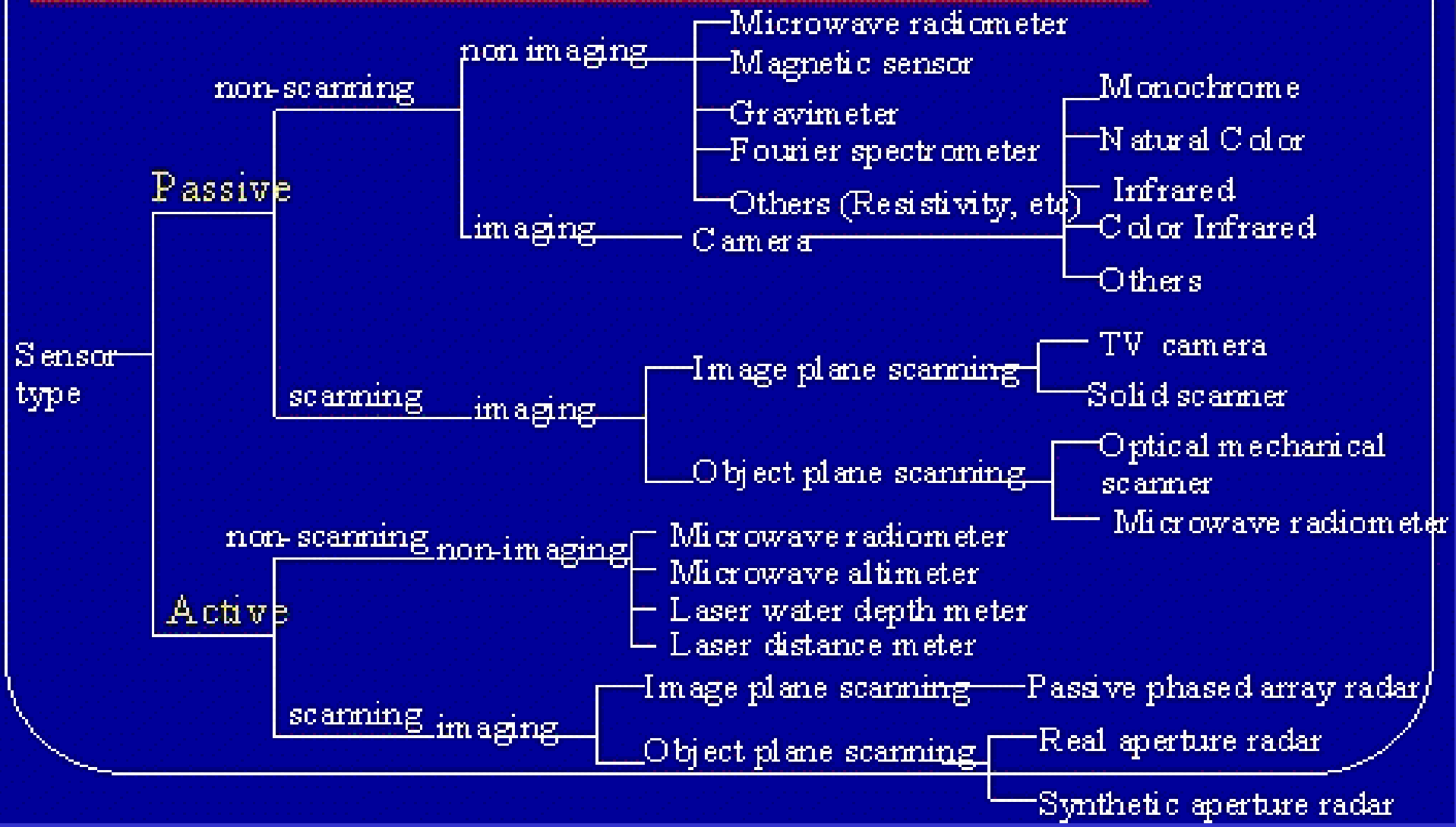




Sensor types



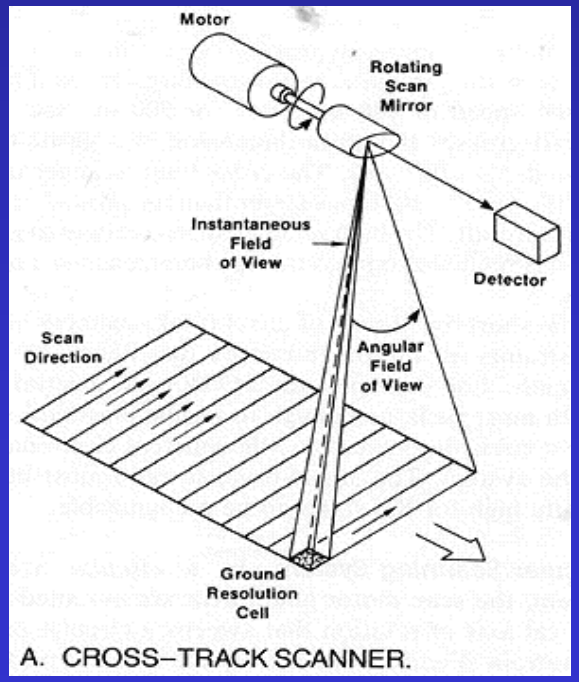
There are many remote sensors

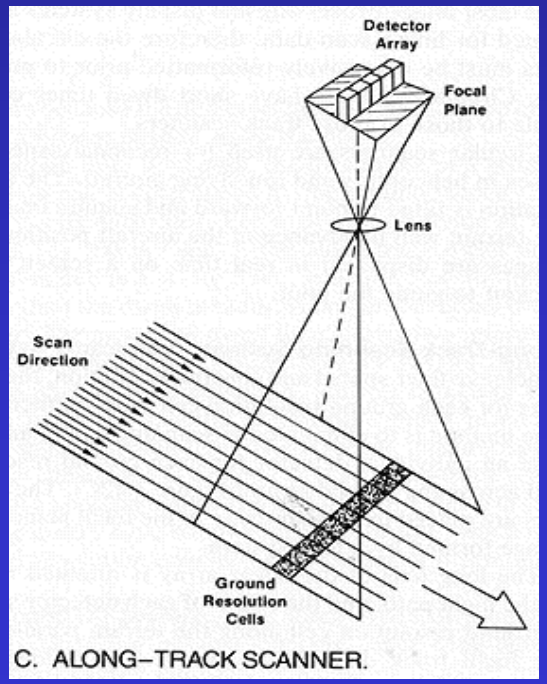


Passive optical systems

- multispectral scanners
- imaging sensors

Whiskbroom
(Landsat)

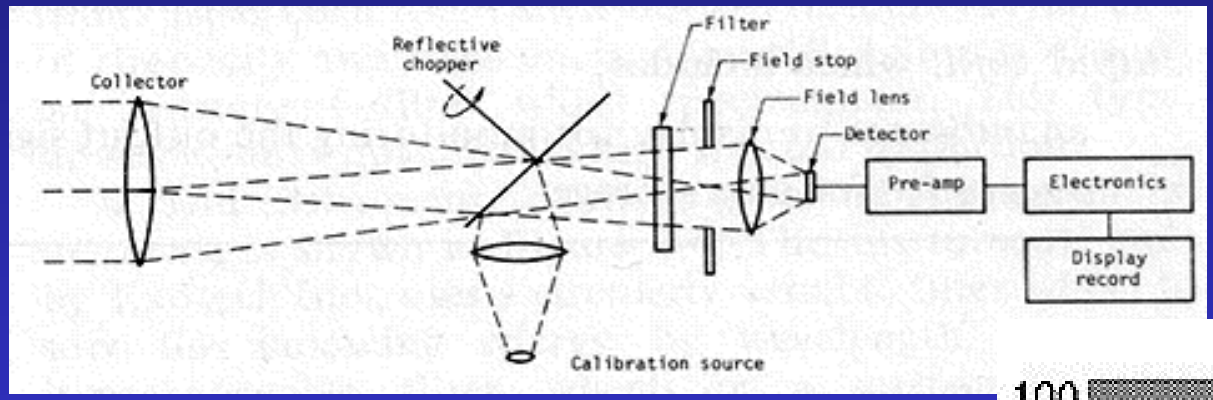


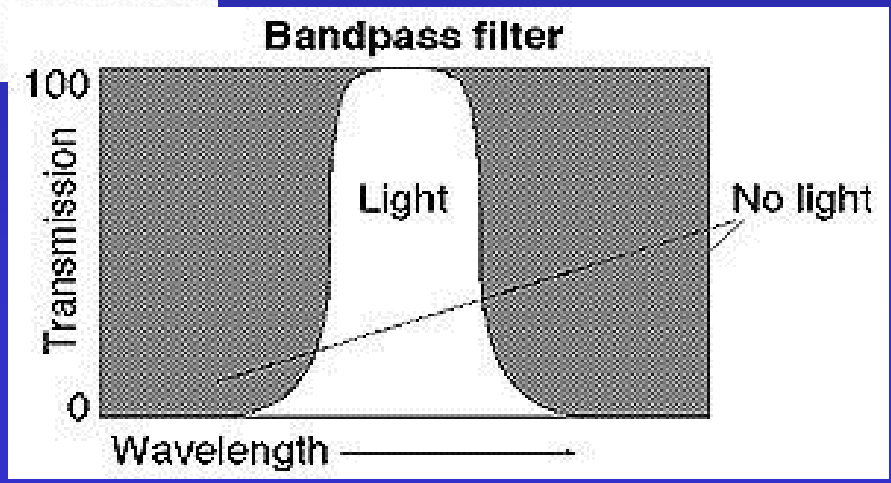


Pushbroom
(SPOT)

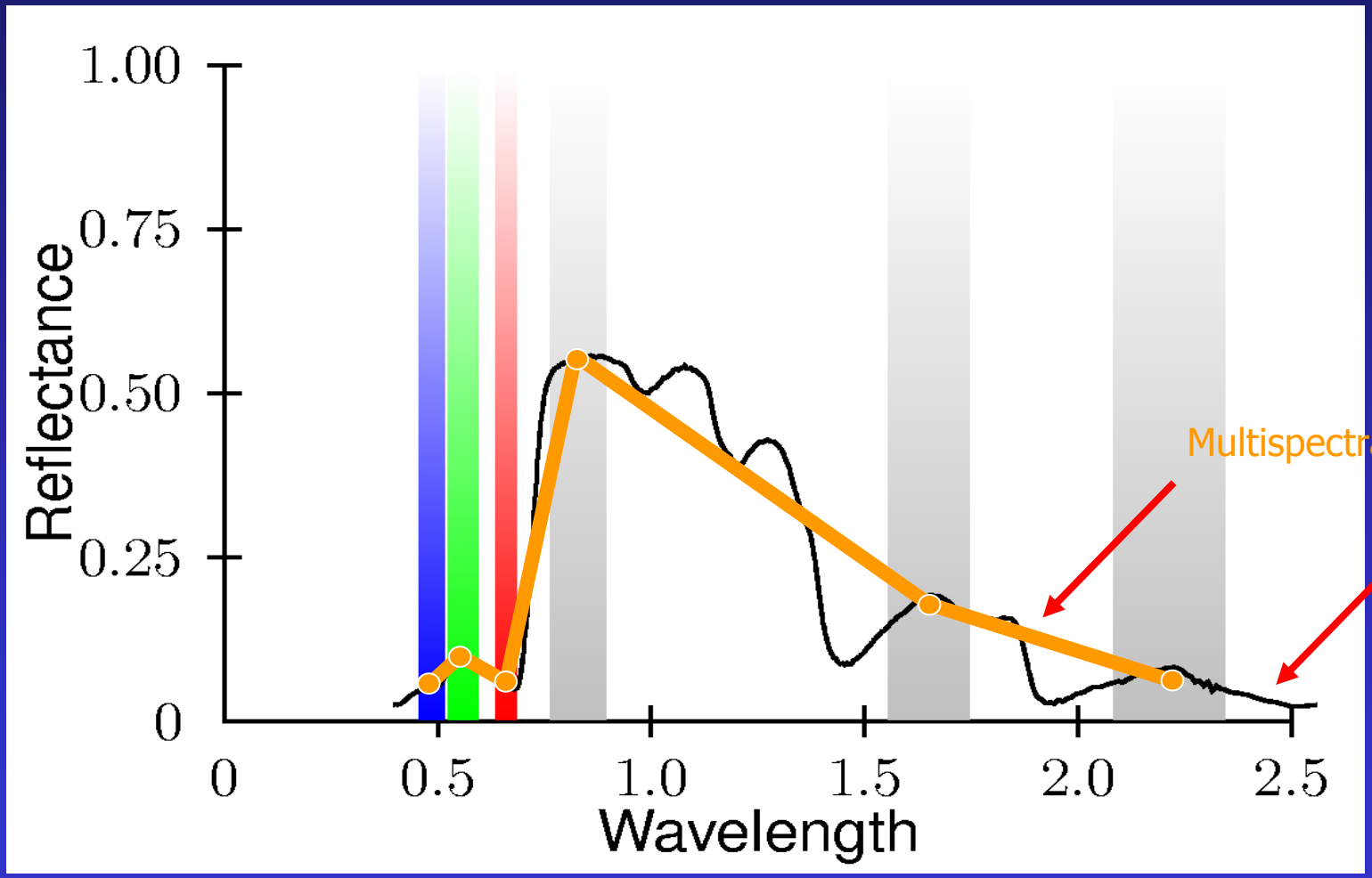
Passive optical systems

- multispectral ?

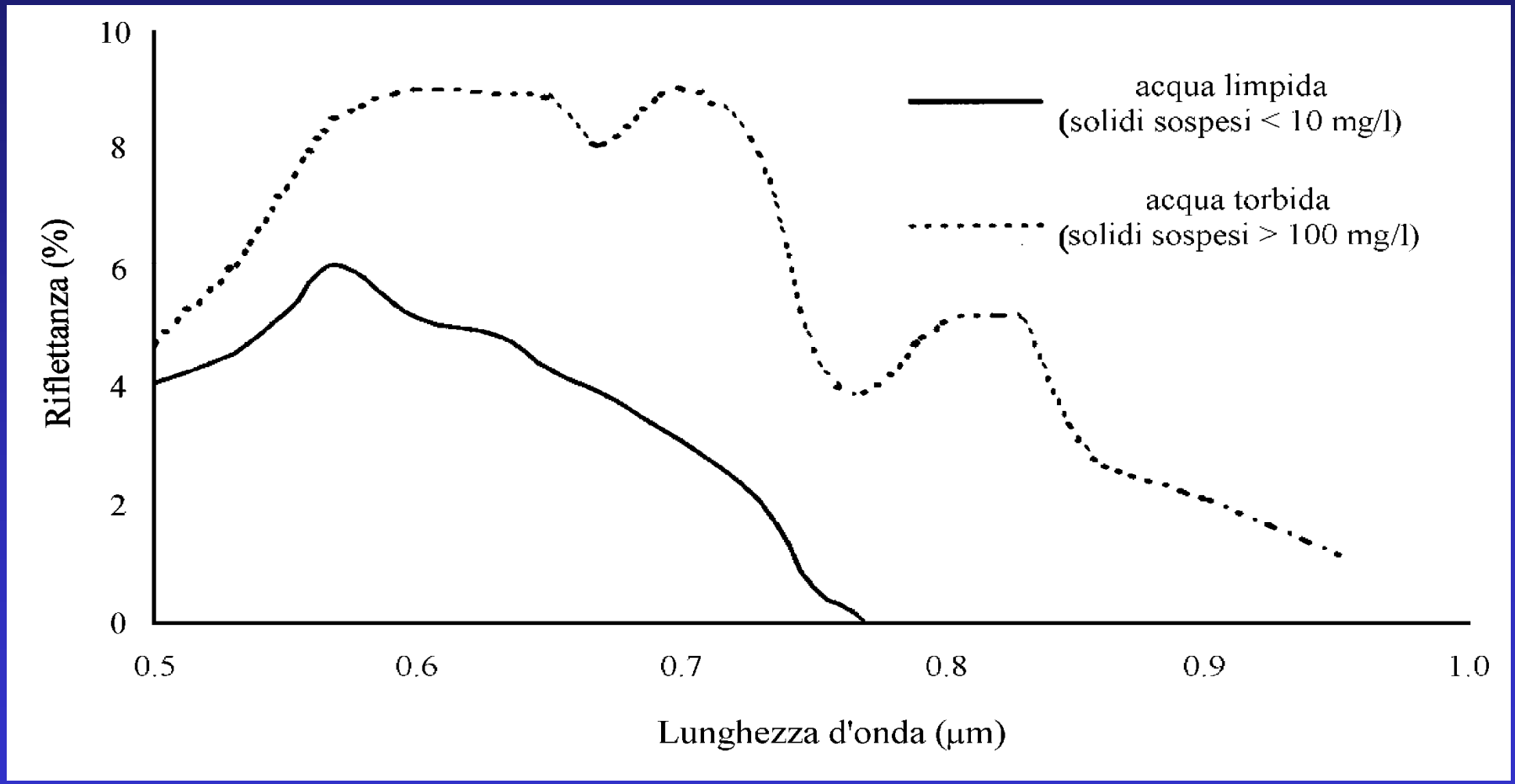




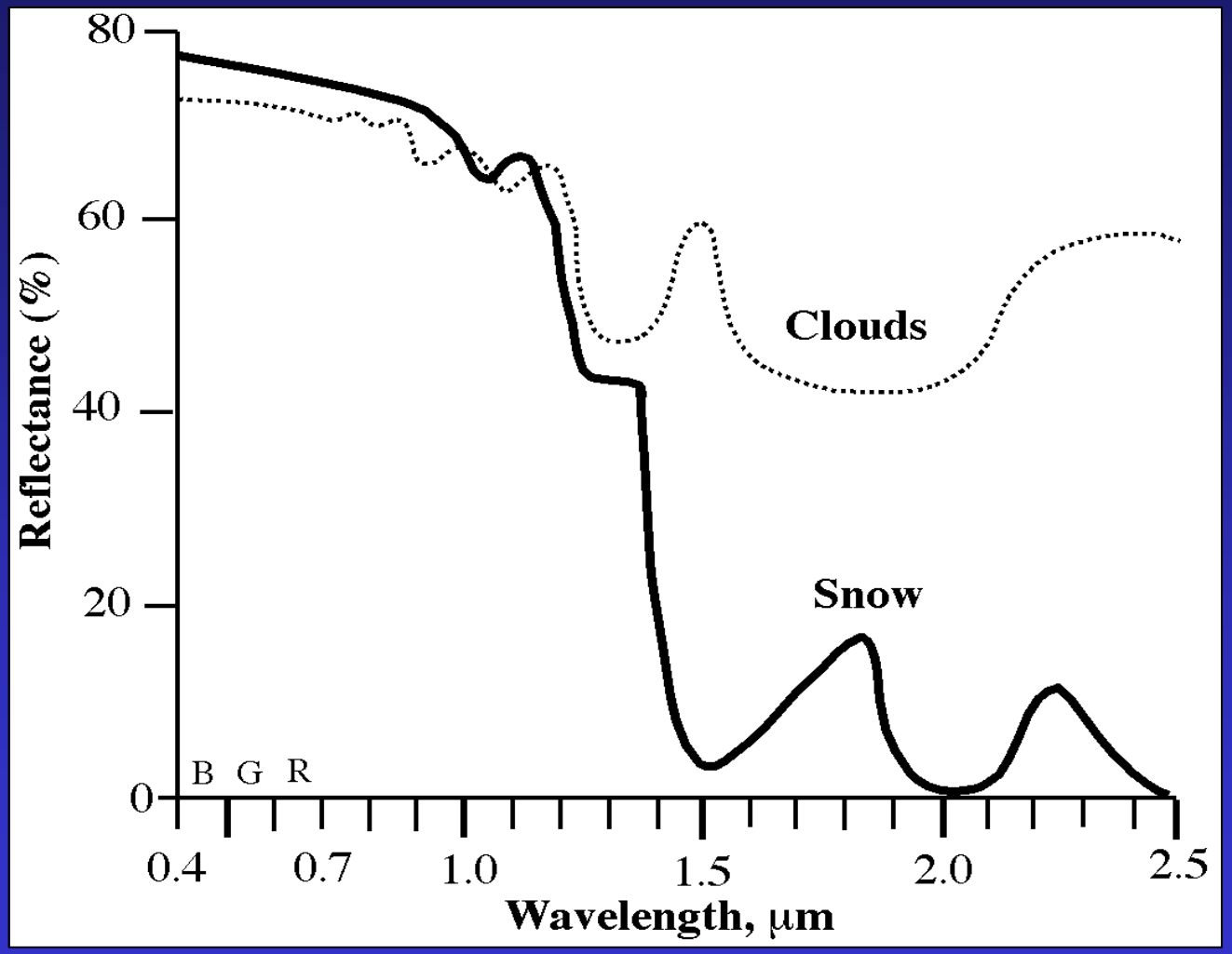
Surface reflectance



Water bodies - reflectance



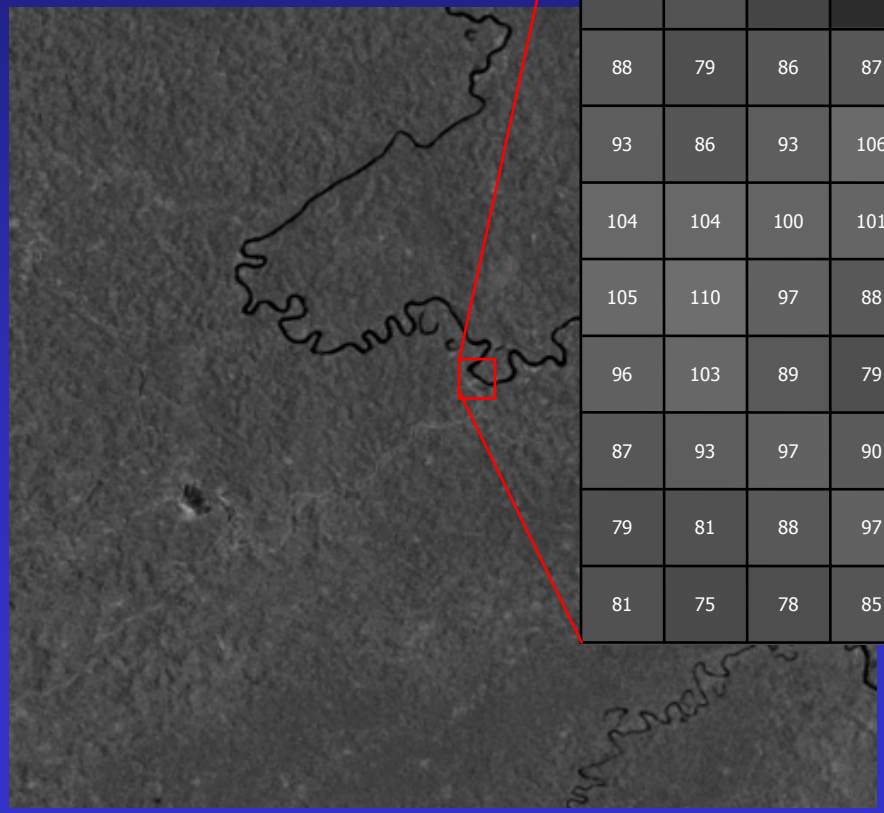
Snow & Clouds



Jensen, 2000

What is a digital image ?

Digital Number (DN)

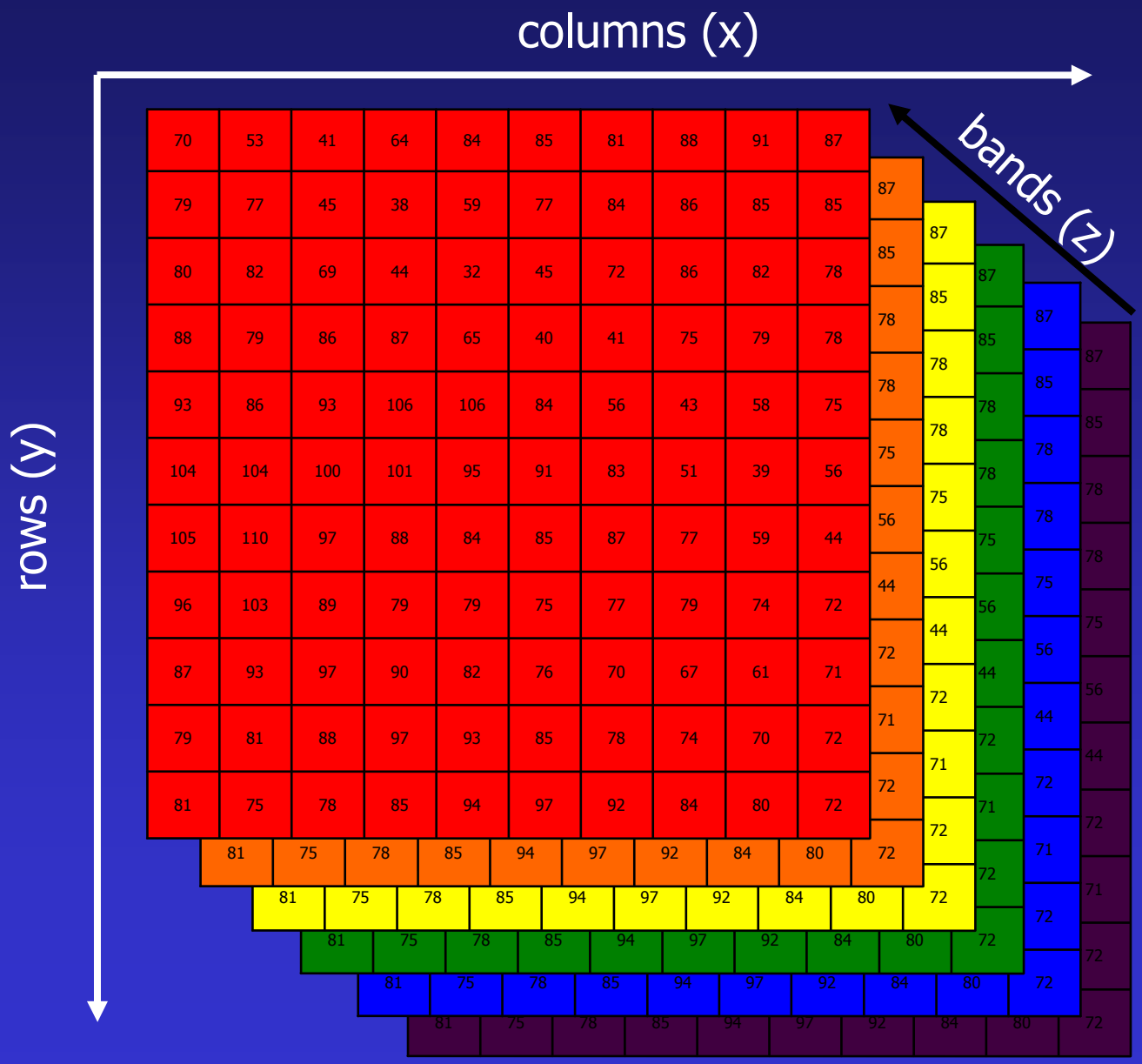


70	53	41	64	84	85	81	88	91	87
79	77	45	38	59	77	84	86	85	85
80	82	69	44	32	45	72	86	82	78
88	79	86	87	65	40	41	75	79	78
93	86	93	106	106	84	56	43	58	75
104	104	100	101	95	91	83	51	39	56
105	110	97	88	84	85	87	77	59	44
96	103	89	79	79	75	77	79	74	72
87	93	97	90	82	76	70	67	61	71
79	81	88	97	93	85	78	74	70	72
81	75	78	85	94	97	92	84	80	72

Digital numbers (DNs) 0 - 255; 0 - 511; 0 - 1023, etc. Binary ranges 2^8=256; 2^9=512; 2^{10}=1024.

Cosa vede il computer…

A multispectral image



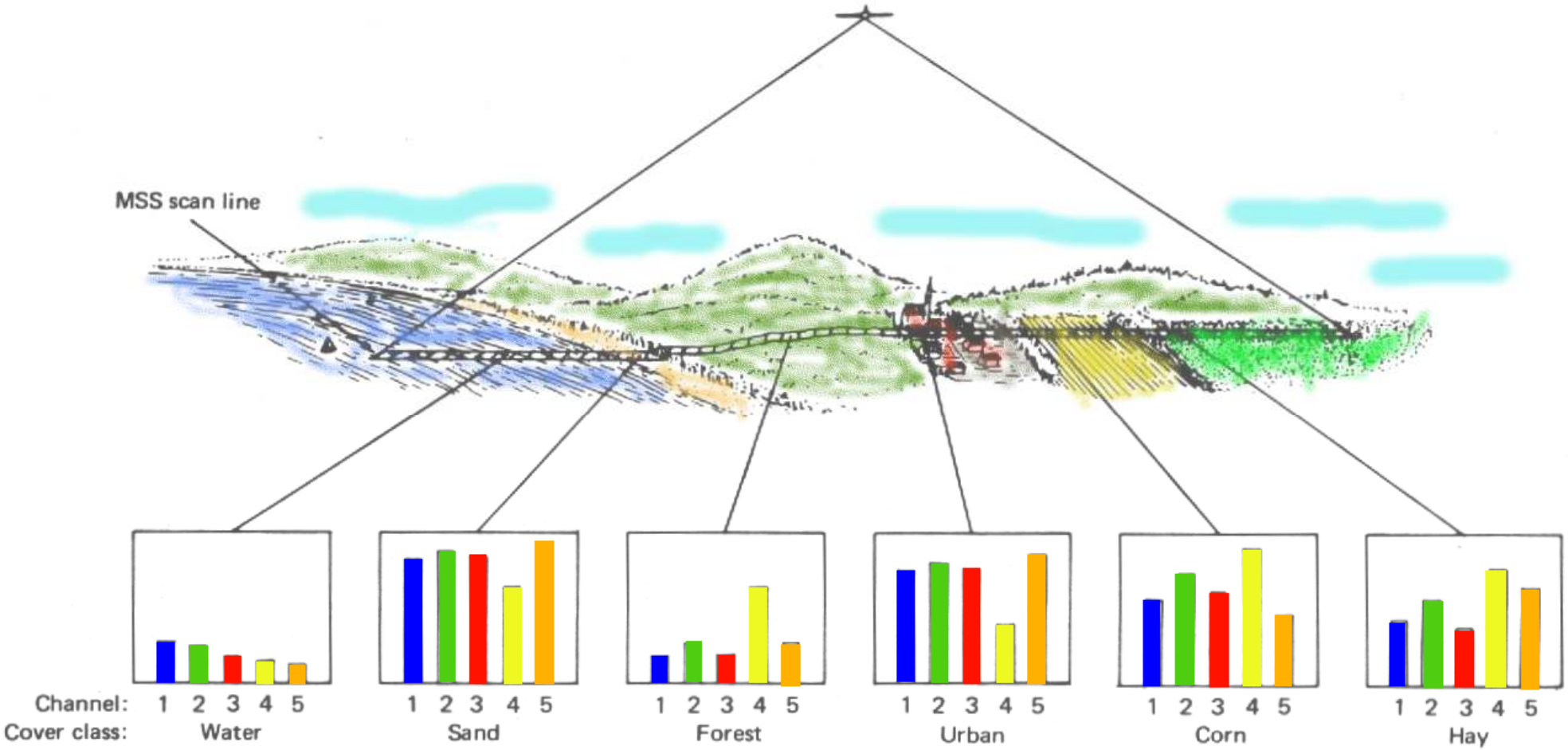
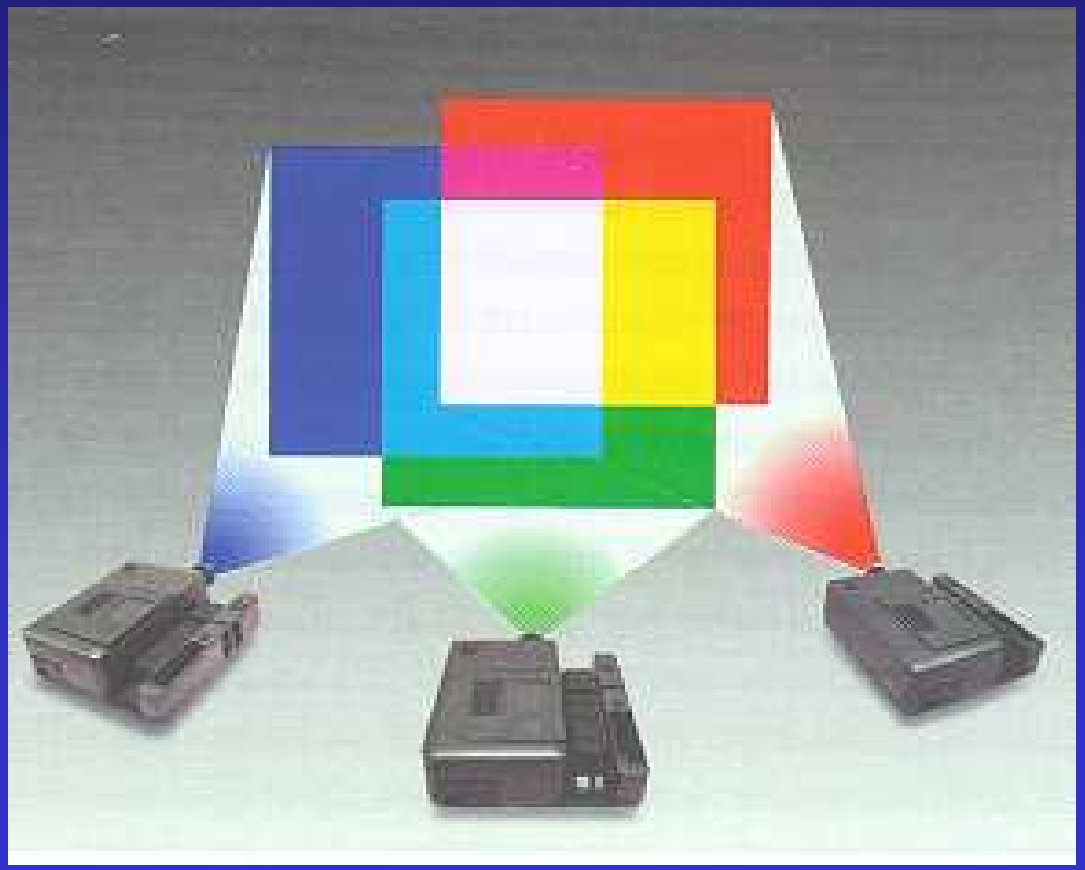
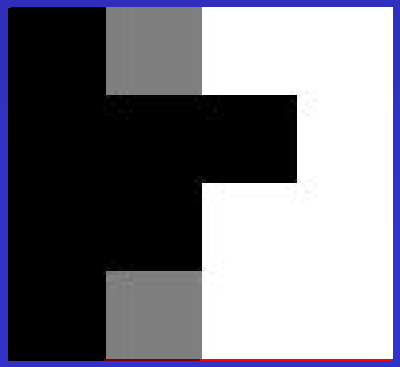


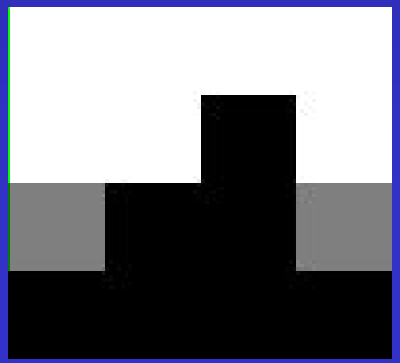
FIGURE 10.36 Selected MSS measurements made along one scan line. Channels cover the following spectral bands: 1—blue, 2—green; 3—red, 4—near-infrared, 5—thermal infrared.

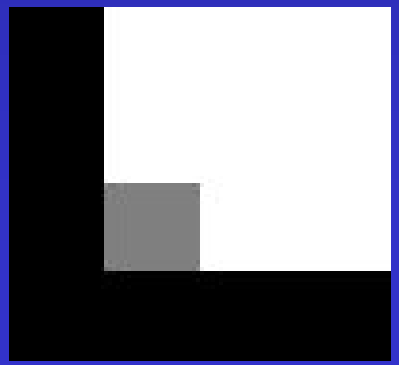
Synthetic color vision



R = 0 G = 255 B = 0	R = 127 G = 255 B = 255		
R = 0 G = 255 B = 0	R = 0 G = 255 B = 255	R = 0 G = 0 B = 255	
R = 0 G = 127 B = 0	R = 0 G = 0 B = 127	R = 255 G = 0 B = 255	R = 255 G = 127 B = 255
R = 0 G = 0 B = 0	R = 127 G = 0 B = 0	R = 255 G = 0 B = 0	R = 255 G = 0 B = 0



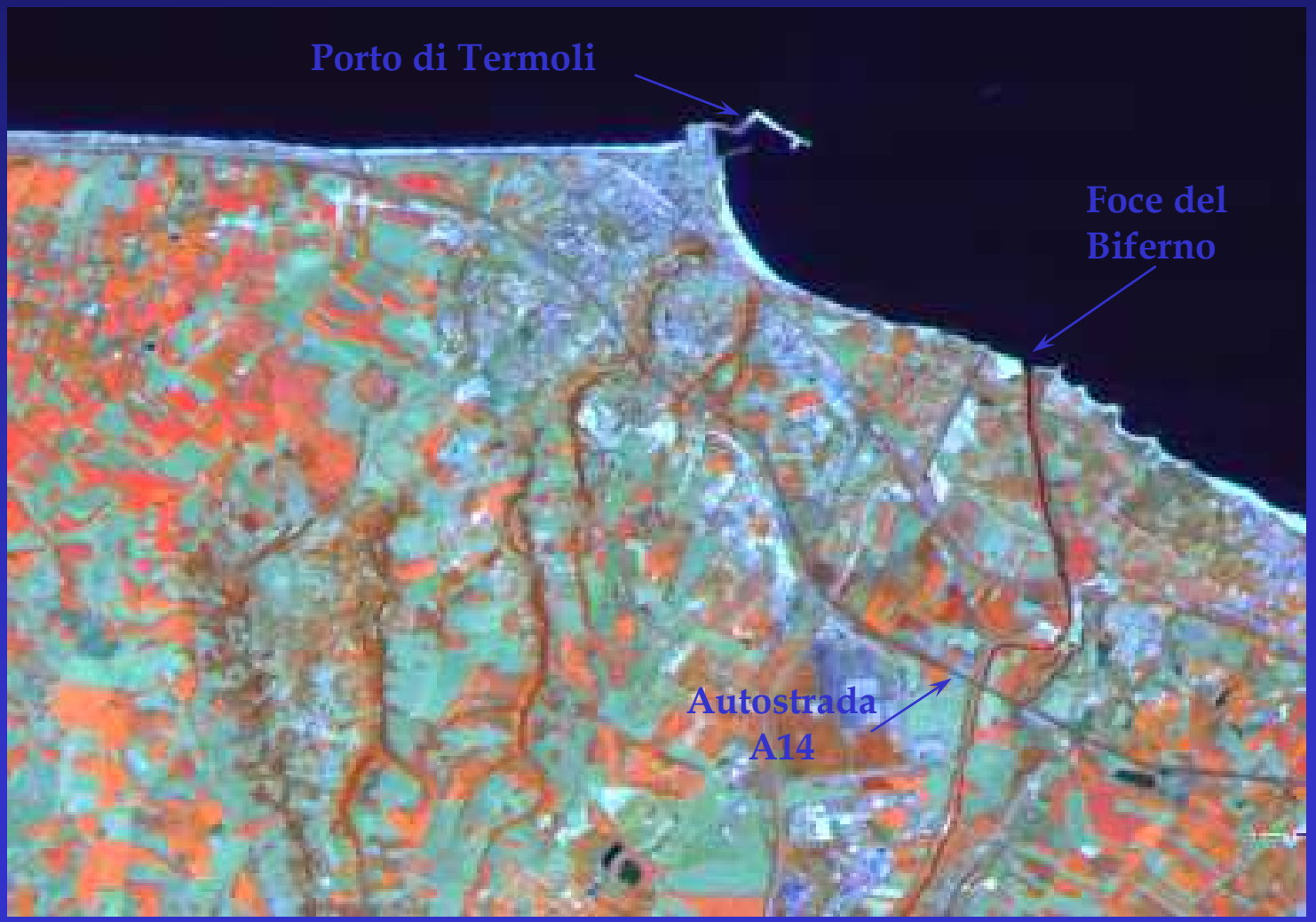




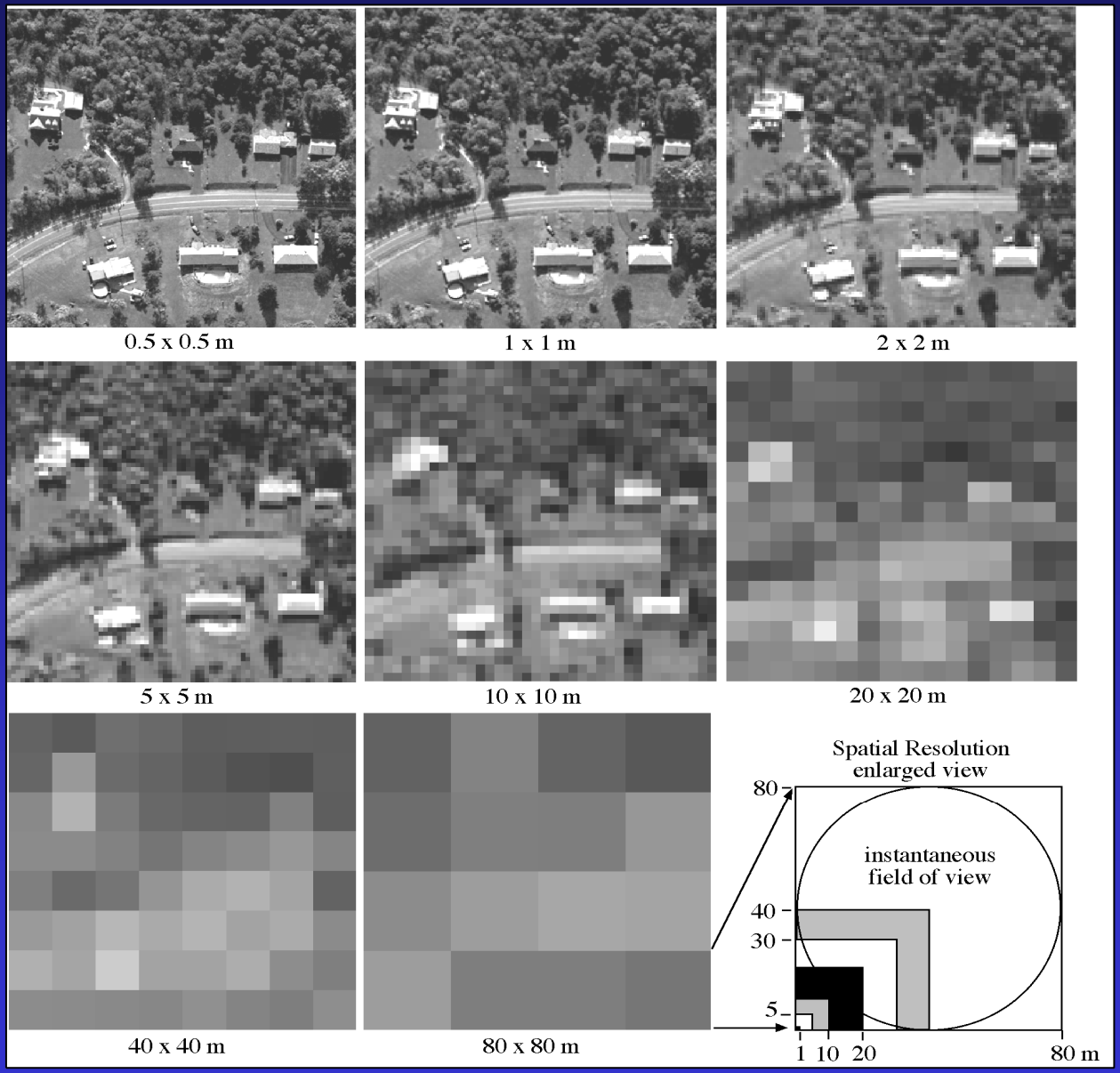
vegetazione

suolo nudo

Il Molise visto dal satellite Landsat 5; immagini a falsi colori
(Rosso= TM 3; Verde=TM4; Blu= TM5)



Spatial resolution



Landsat 7 ETM+ => 30 m

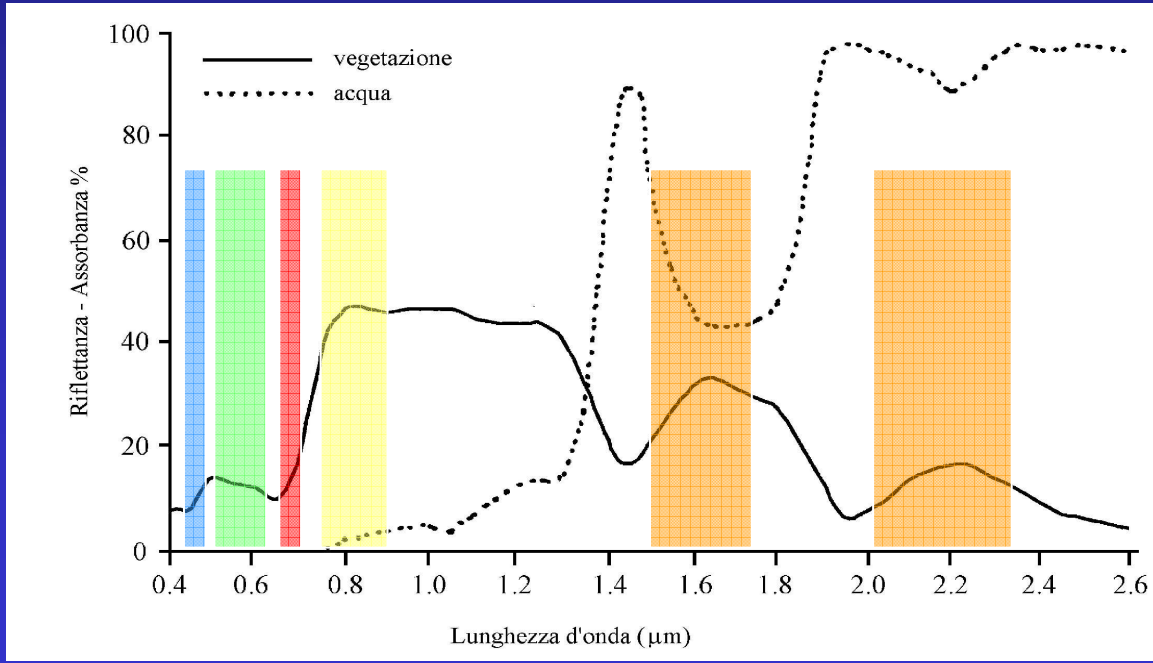
SPOT5 => 10 m

Quick Bird => 2,8 m

Landsat ETM+

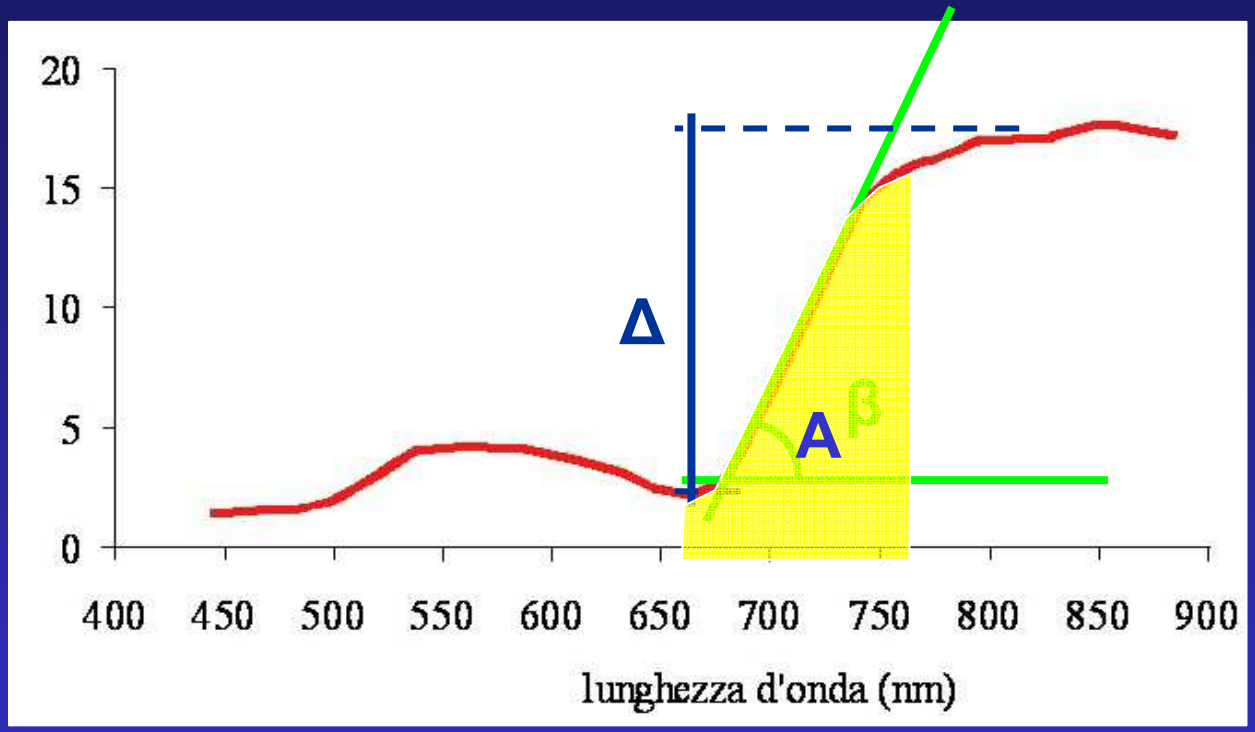
Temporal resolution: 16 gg.

Swath: 185 km



Spatial resolution	Bands
15 m	520 – 900 nm
30 m	450 – 515 nm 525 – 605 nm 630 – 690 nm 750 – 900 nm 1.55 – 1.75 µm 2.09 – 2.35 µm
60 m	10.4 – 12.5 µm

Vegetation indexes



NDVI (Normalized Difference Vegetation Index)

$$NDVI = \frac{\rho_{nir} - \rho_r}{\rho_{nir} + \rho_r}$$

NDVI and vegetation growth