ANÁLISIS GEOESPACIAL

Intro a Sensores Remotos & SIG

Prof. Edier Aristizábal

UNIVERSIDAD NACIONAL DE COLOMBIA

SEDE MEDELLÍN

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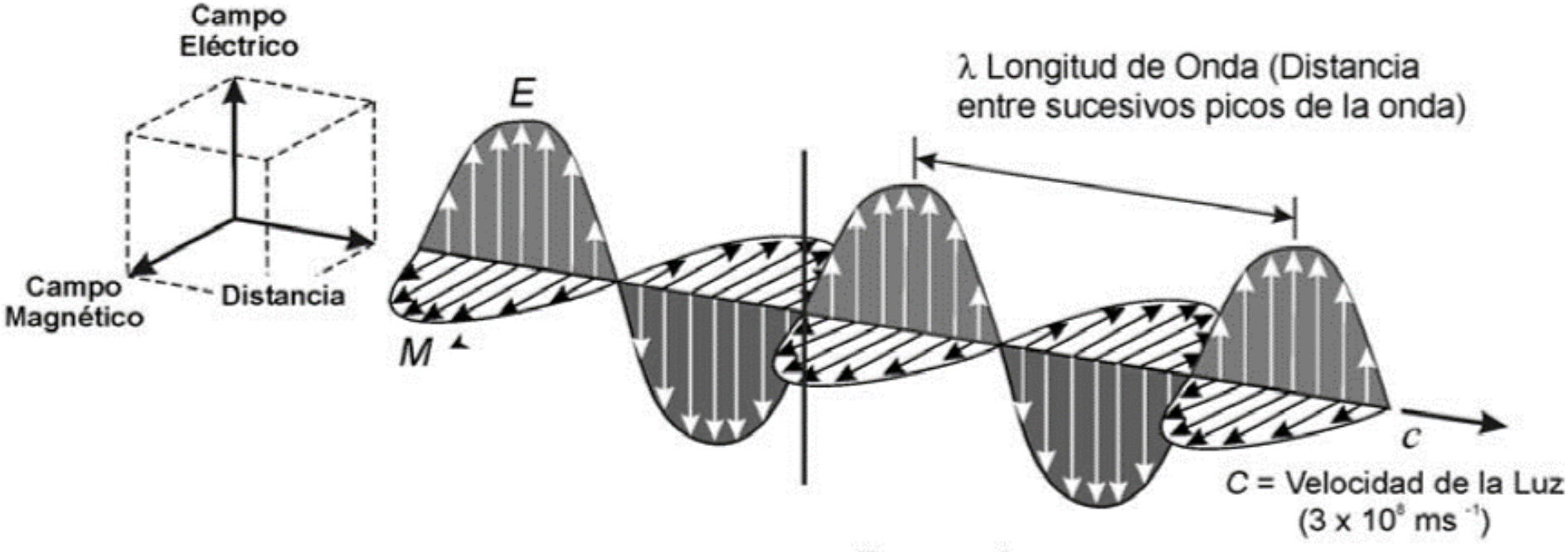
Definición

Los Sensores Remotos (teledetección) es el arte, ciencia y tecnología de observar un objeto, escena o fenómeno por técnicas basadas en instrumentos. El término remoto se refiere a la observación realizada a una distancia sin contacto físico con el objeto de interés. La energía puede ser radiaciones electromagnética, campos de fuerza o energía acústica.

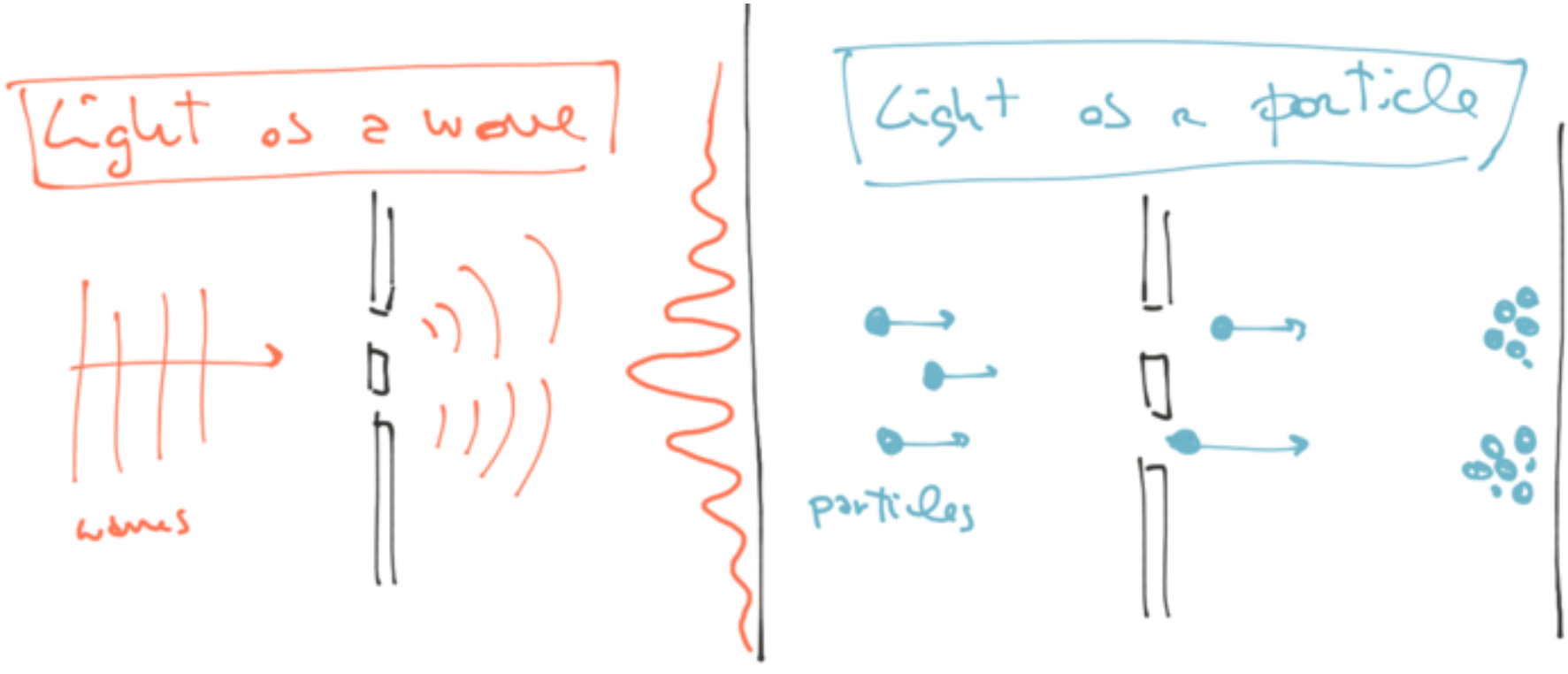
Radiación electromagnética



ν = Frecuencia
(Número de ciclos por segundo
pasando por un punto fijo)

Componentes del *REM*:
onda eléctrica Senoidal (E)
onda magnética senoidal (M) - ortogonal a (E)
(E) y (M) son perpendiculares a la dirección de propagación

$C = \nu\lambda$


Light as a wave
waves
Light as a particle
particles

$E = h \cdot f$ where E = photon energy (Joules)

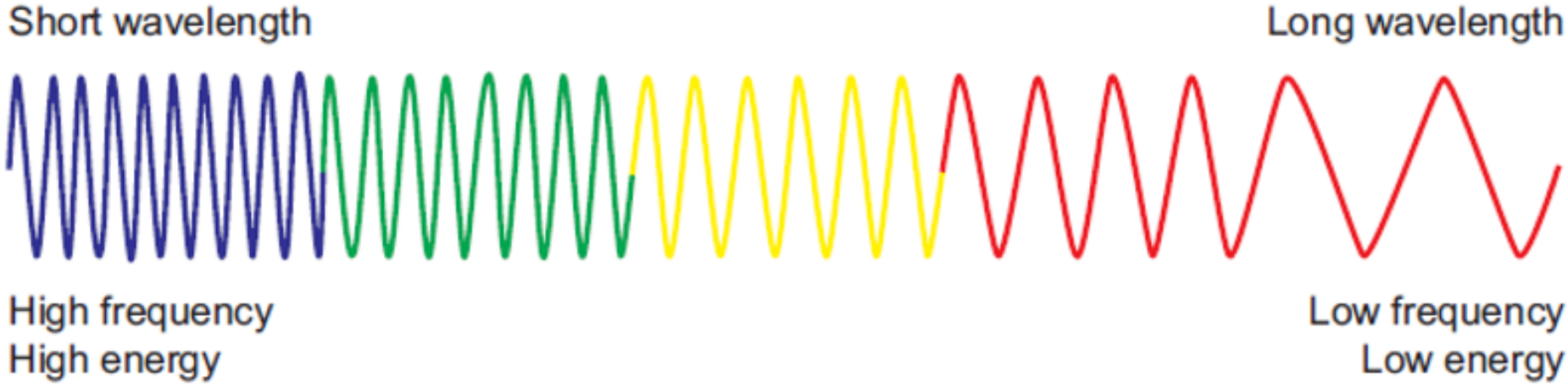
OR f = frequency (Hz)

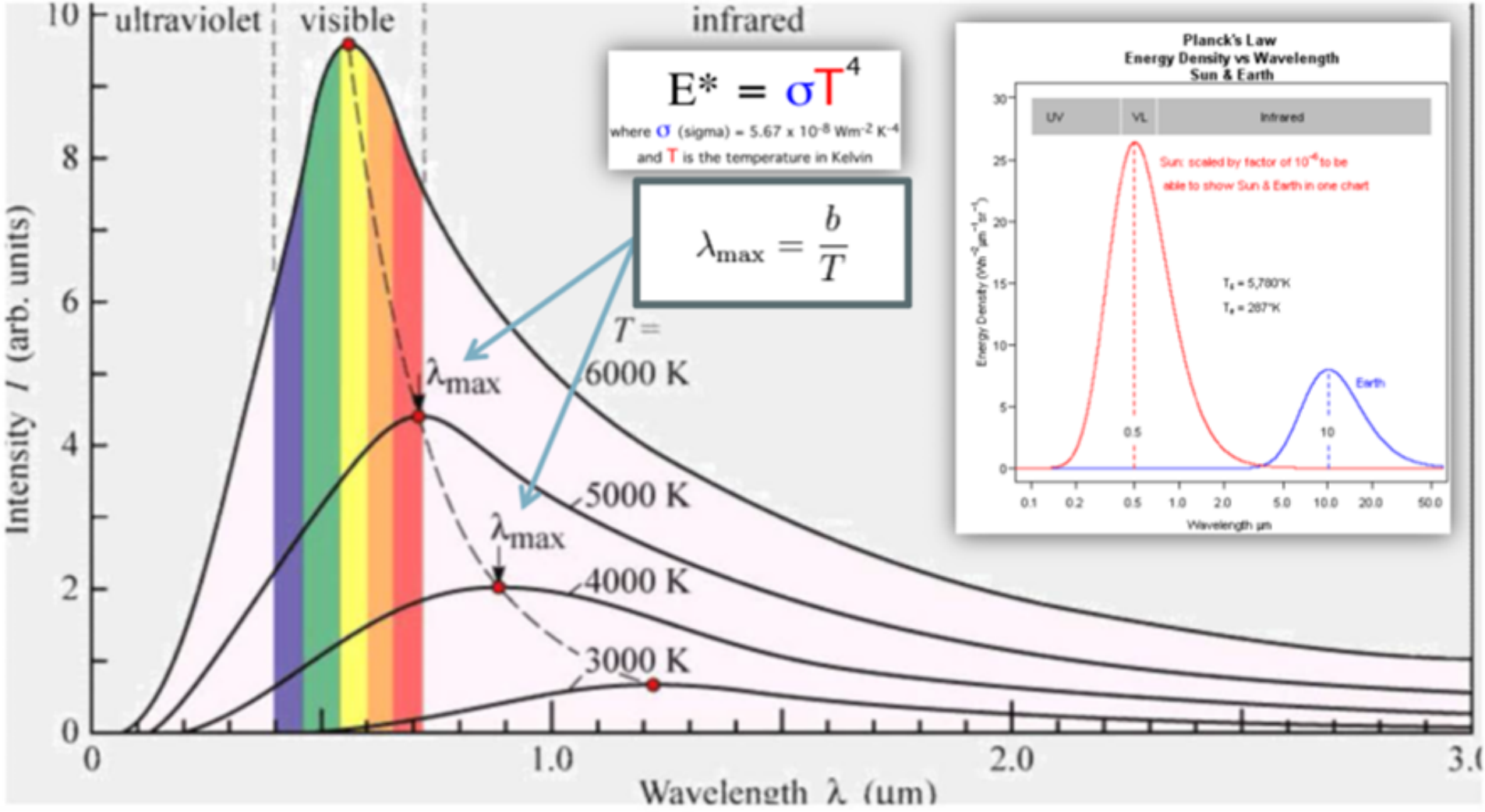
$$E = \frac{h \cdot c}{\lambda}$$

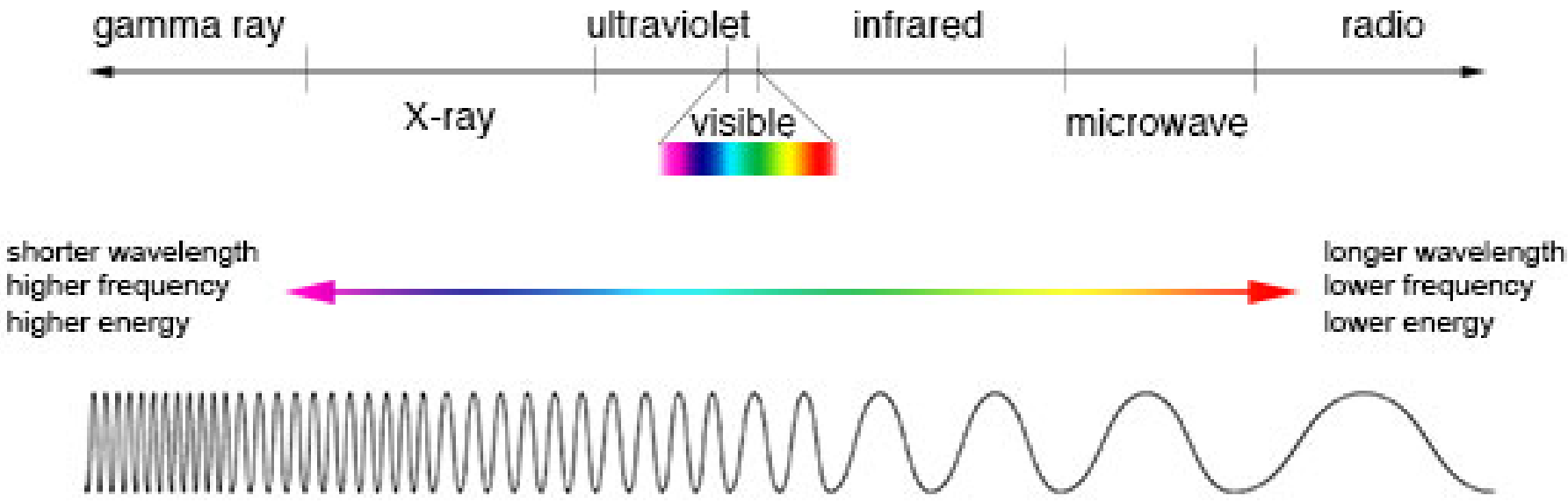
h = Planck's constant (6.63×10^{-34} j.s)

c = velocity of light (3.00×10^{8} m/s)

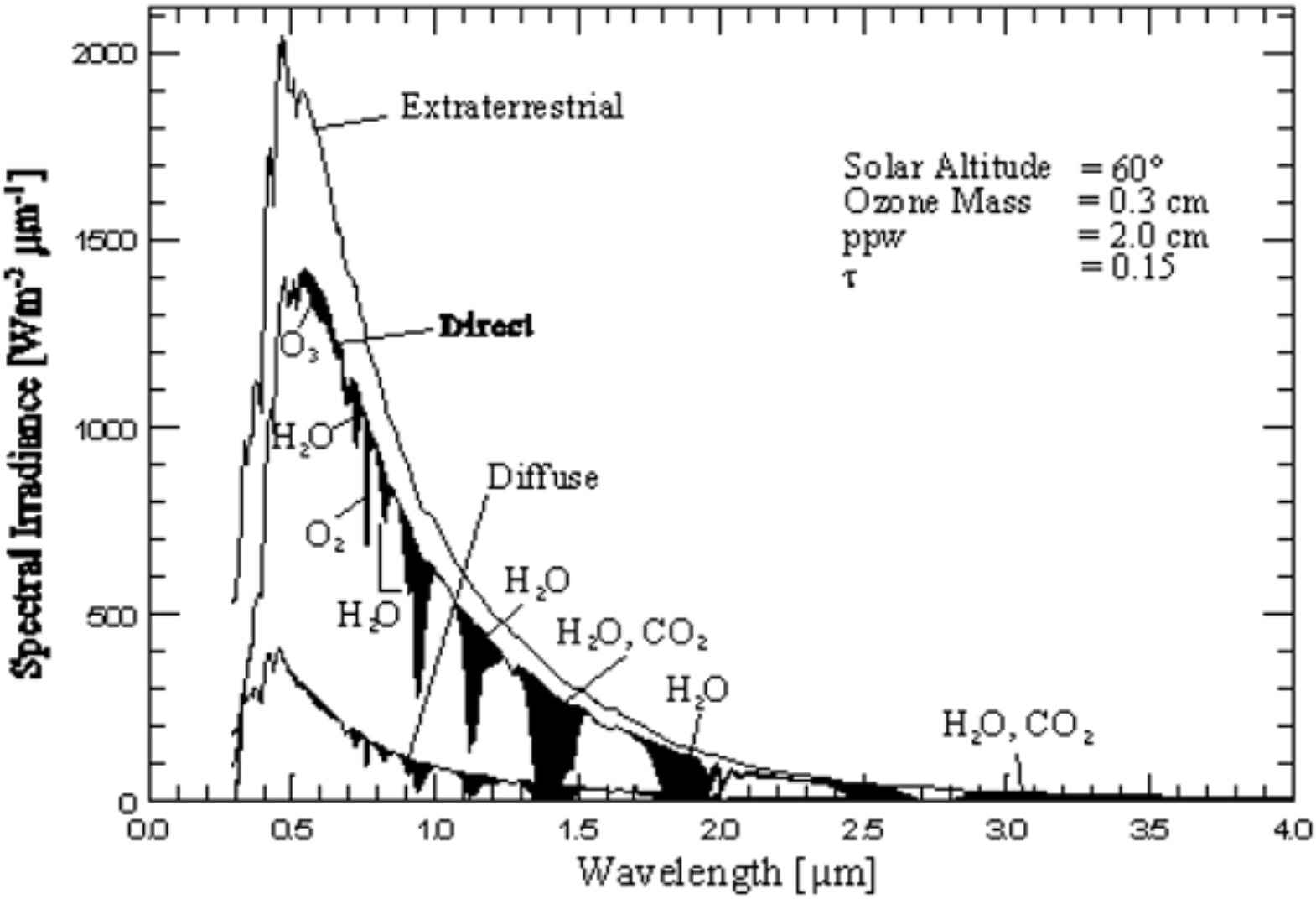
λ = wavelength (m)

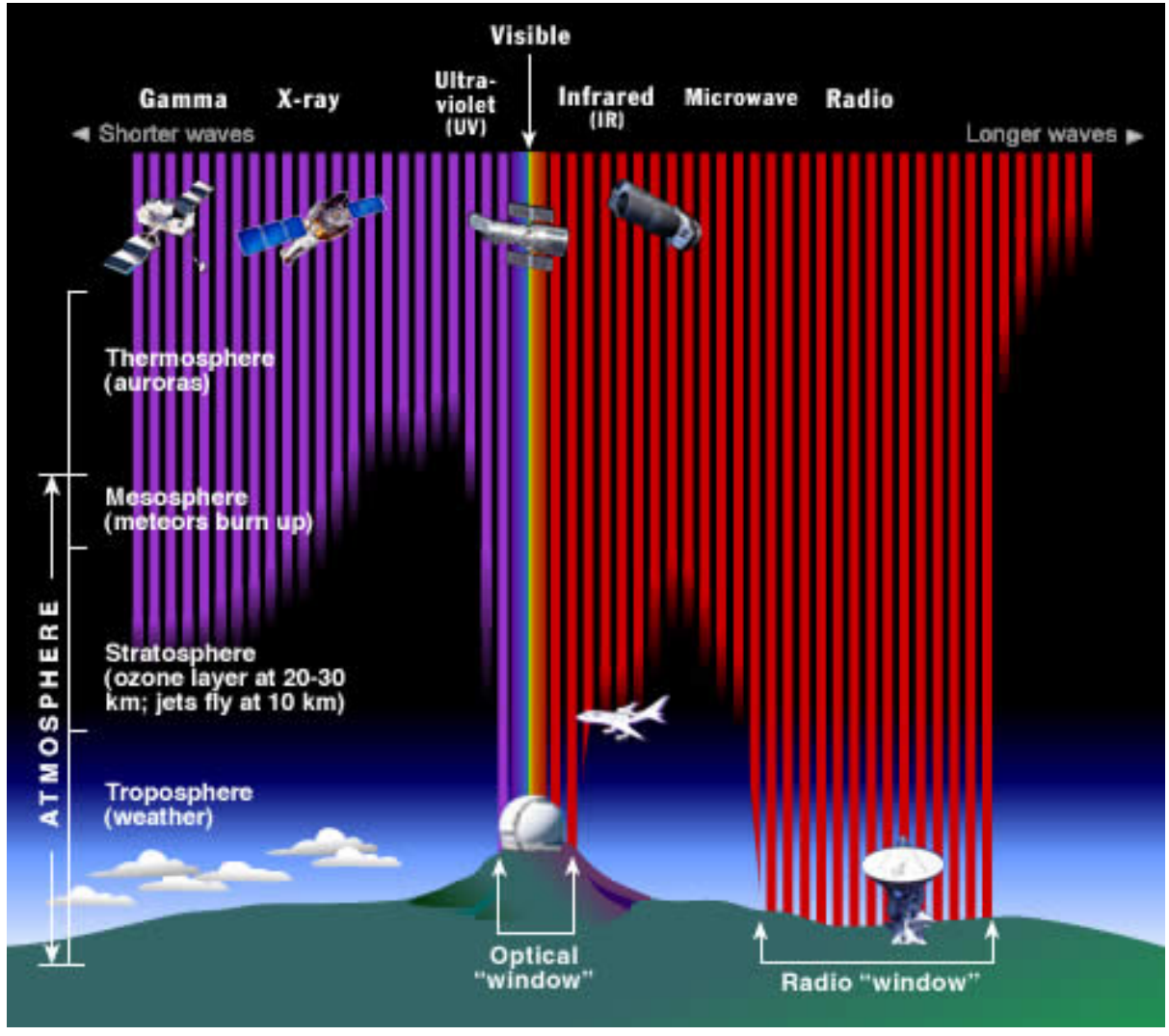

Short wavelength
Long wavelength
High frequency
High energy
Low frequency
Low energy

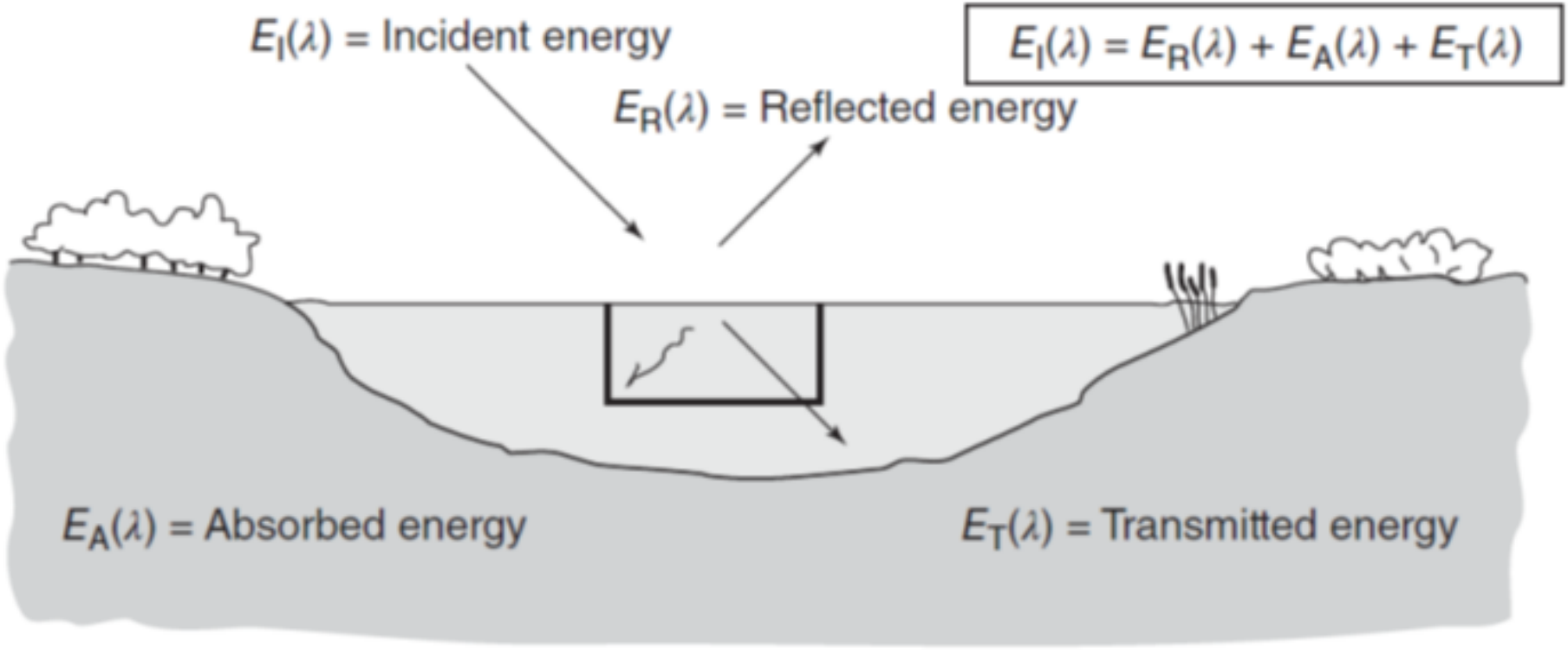

ultraviolet
visible
infrared
$E^* = \sigma T^4$
where σ (sigma) = 5.67 x 10⁻⁸ Wm⁻² K⁻⁴
and T is the temperature in Kelvin
$\lambda_{max} = \frac{b}{T}$
T =
6000 K
5000 K
4000 K
3000 K
λmax
λmax
Intensity I (arb. units)
Wavelength λ (um)
0
1.0
2.0
3.0
Planck's Law
Energy Density vs Wavelength
Sun & Earth
UV
VL
Infrared
Sun: scaled by factor of 10⁻⁶ to be able to show Sun & Earth in one chart
T☉ = 5,780°K
T⊕ = 287°K
Earth
0.5
10
Energy Density (Wb⁻²μm⁻¹sr⁻¹)
Wavelength μm

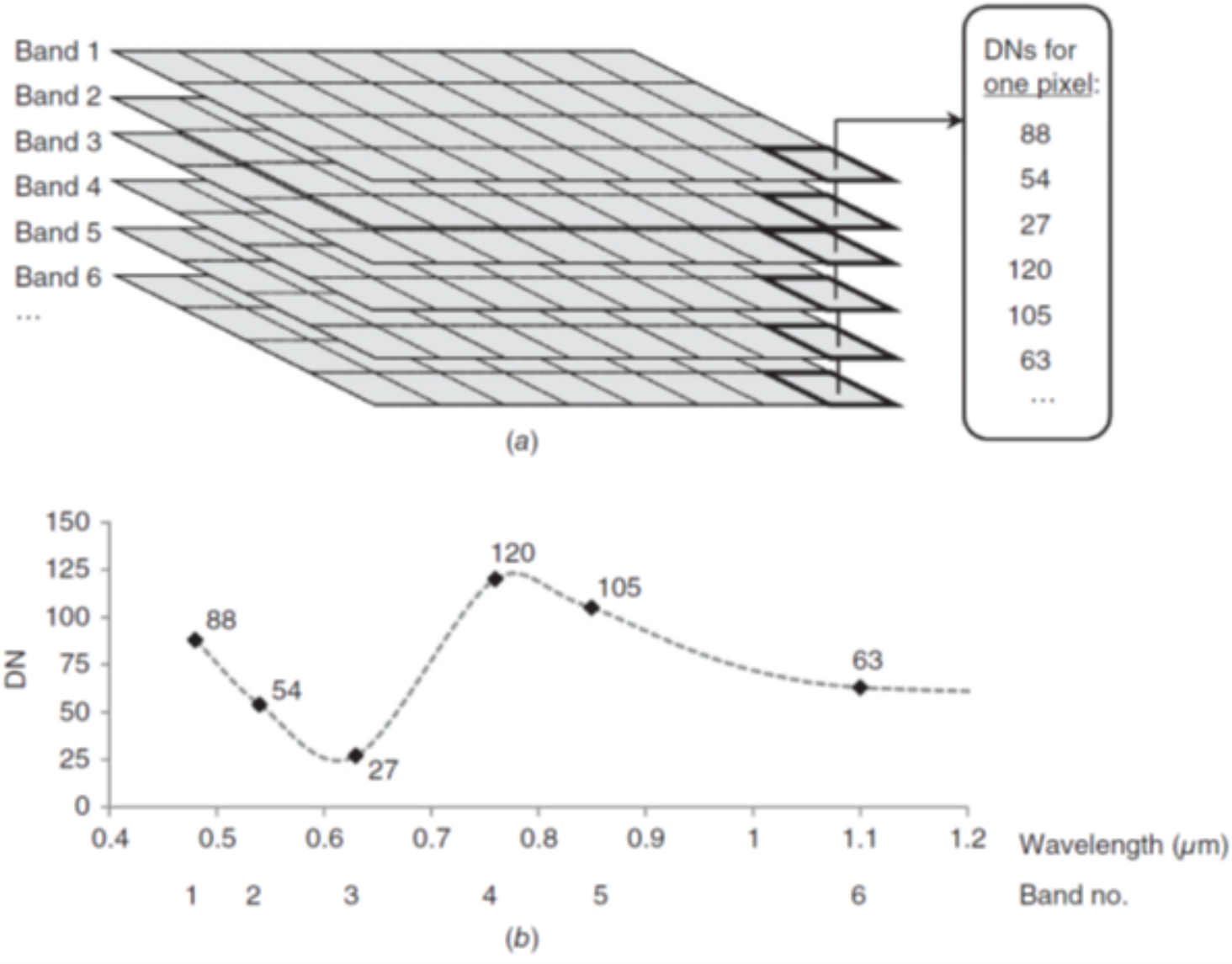

gamma ray
X-ray
ultraviolet
visible
infrared
microwave
radio
shorter wavelength
higher frequency
higher energy
longer wavelength
lower frequency
lower energy

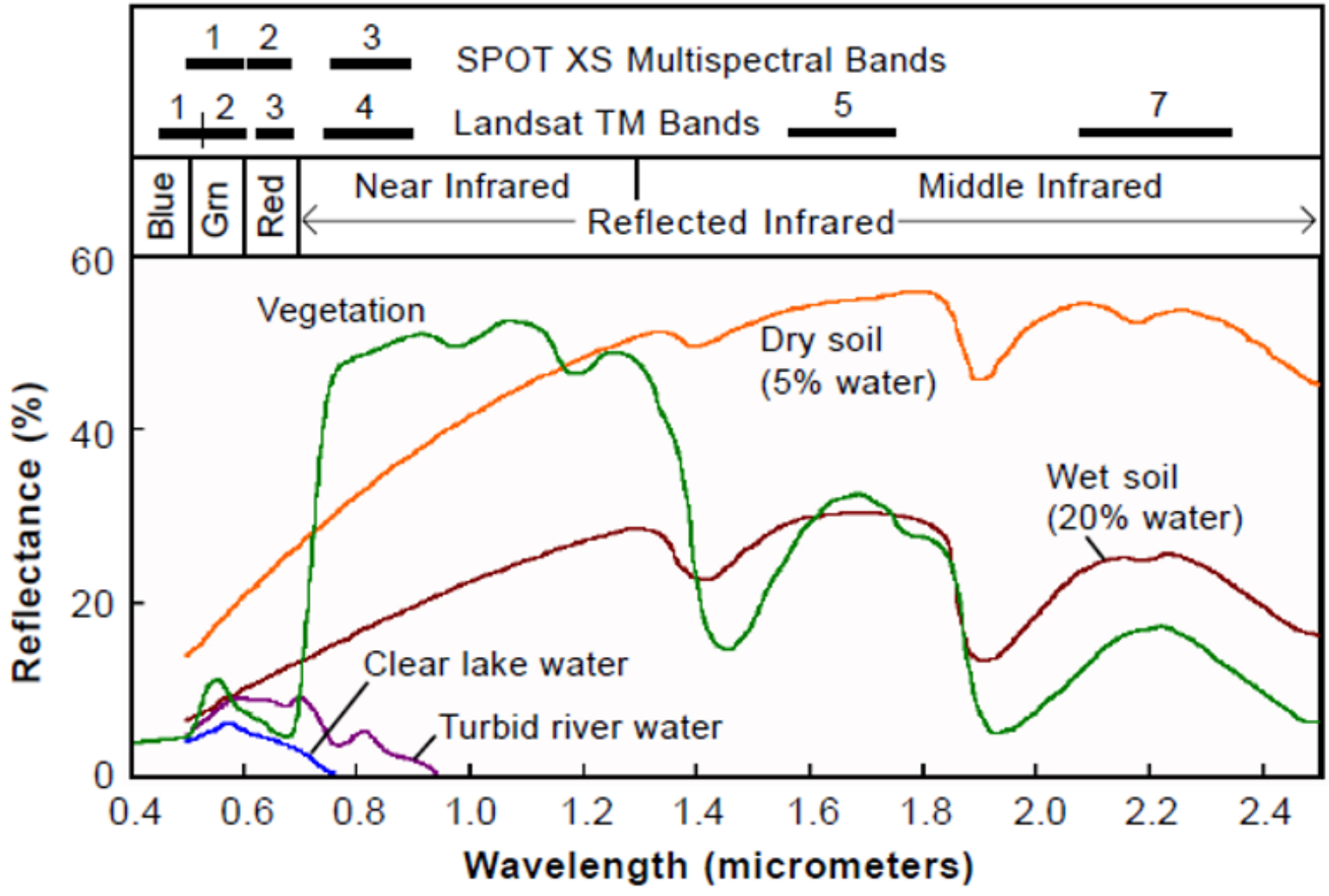
Interacción con la atmósfera & Objeto


Spectral Irradiance [Wm⁻² μm⁻¹]
2000
1500
1000
500
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Wavelength [μm]
Extraterrestrial
Direct
Diffuse
O₃
H₂O
O₂
H₂O
H₂O
H₂O, CO₂
H₂O
H₂O, CO₂
Solar Altitude = 60°
Ozone Mass = 0.3 cm
ppw = 2.0 cm
τ = 0.15

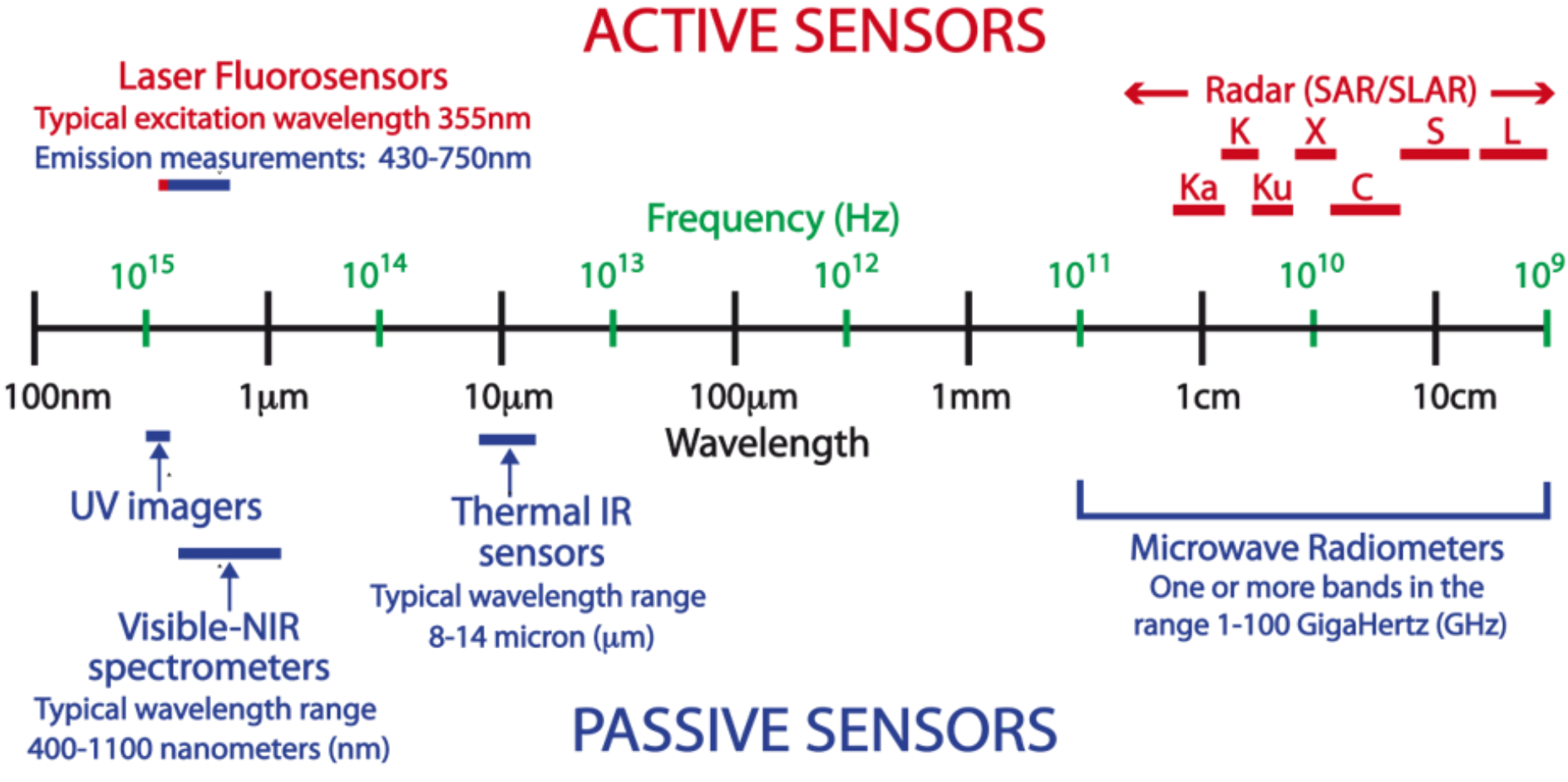

Visible
Gamma
X-ray
Ultra-violet (UV)
Infrared (IR)
Microwave
Radio
Shorter waves
Longer waves
Thermosphere (auroras)
Mesosphere (meteors burn up)
Stratosphere (ozone layer at 20-30 km; jets fly at 10 km)
Troposphere (weather)
ATMOSPHERE
Optical "window"
Radio "window"


$E_I(\lambda)$ = Incident energy
$E_I(\lambda) = E_R(\lambda) + E_A(\lambda) + E_T(\lambda)$
$E_R(\lambda)$ = Reflected energy
$E_A(\lambda)$ = Absorbed energy
$E_T(\lambda)$ = Transmitted energy

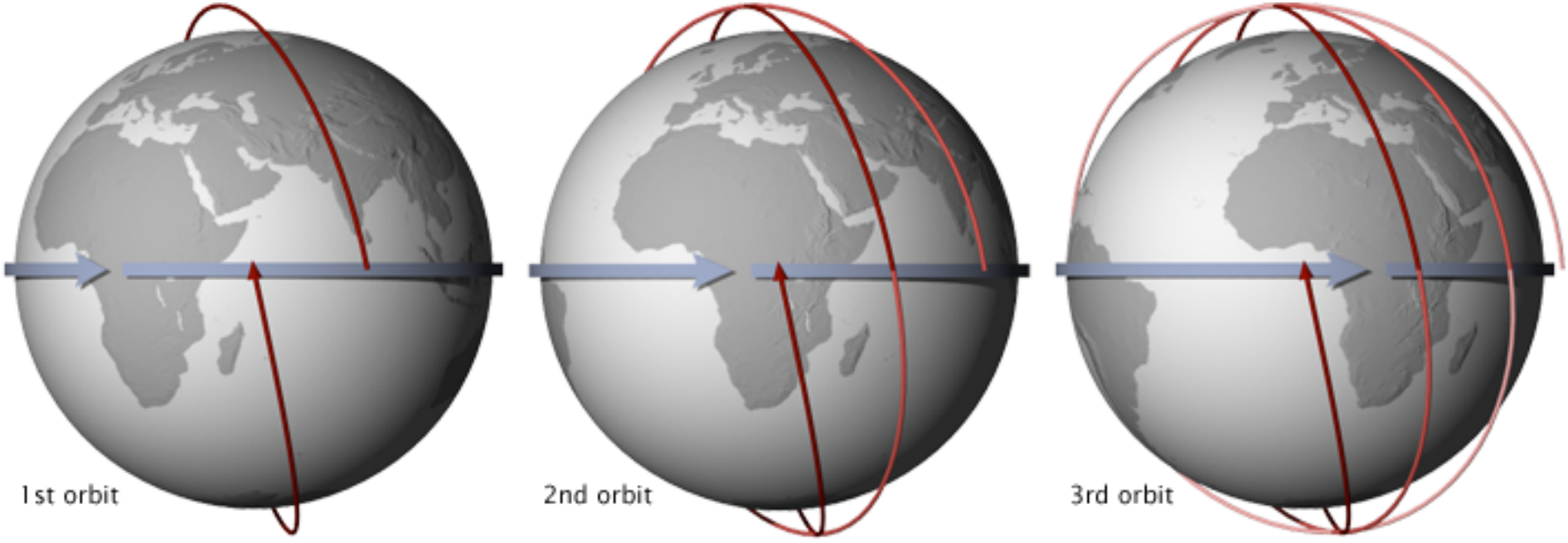

Band 1
Band 2
Band 3
Band 4
Band 5
Band 6
...
DNs for one pixel:
88
54
27
120
105
63
...
(a)
150
125
100
75
50
25
0
DN
88
54
27
120
105
63
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
Wavelength (μm)
1
2
3
4
5
6
Band no.
(b)


1 2 3
SPOT XS Multispectral Bands
1 2 3 4
Landsat TM Bands
5
7
Blue
Grn
Red
Near Infrared
Reflected Infrared
Middle Infrared
Vegetation
Dry soil
(5% water)
Wet soil
(20% water)
Clear lake water
Turbid river water
Reflectance (%)
60
40
20
0
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
Wavelength (micrometers)

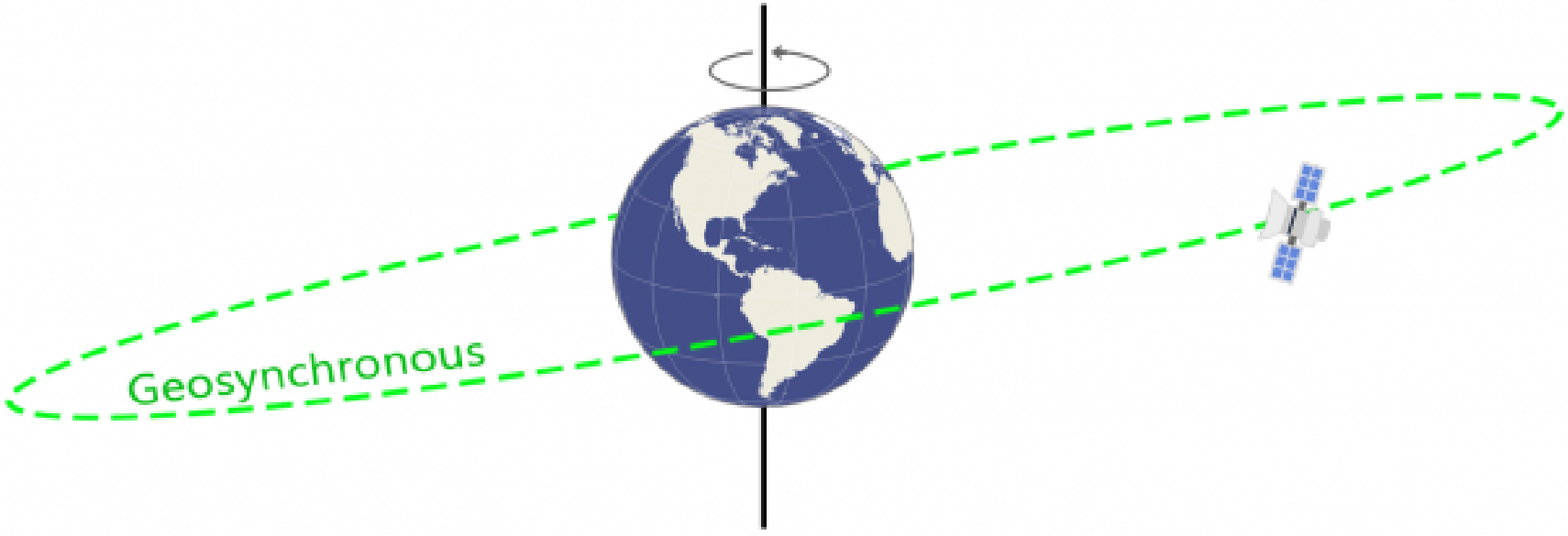
Plataformas & Sensores

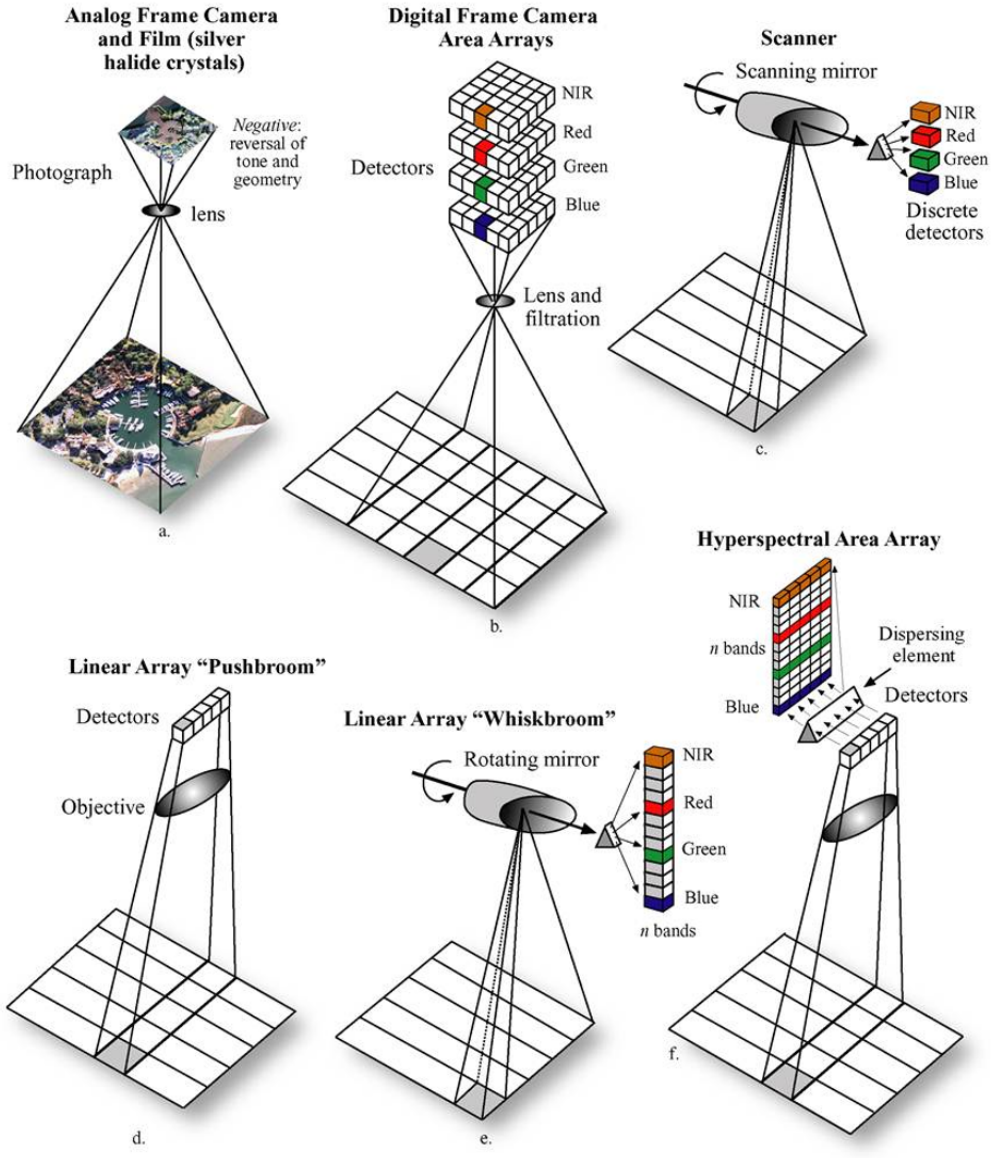


Polares & Heliosincrónicas

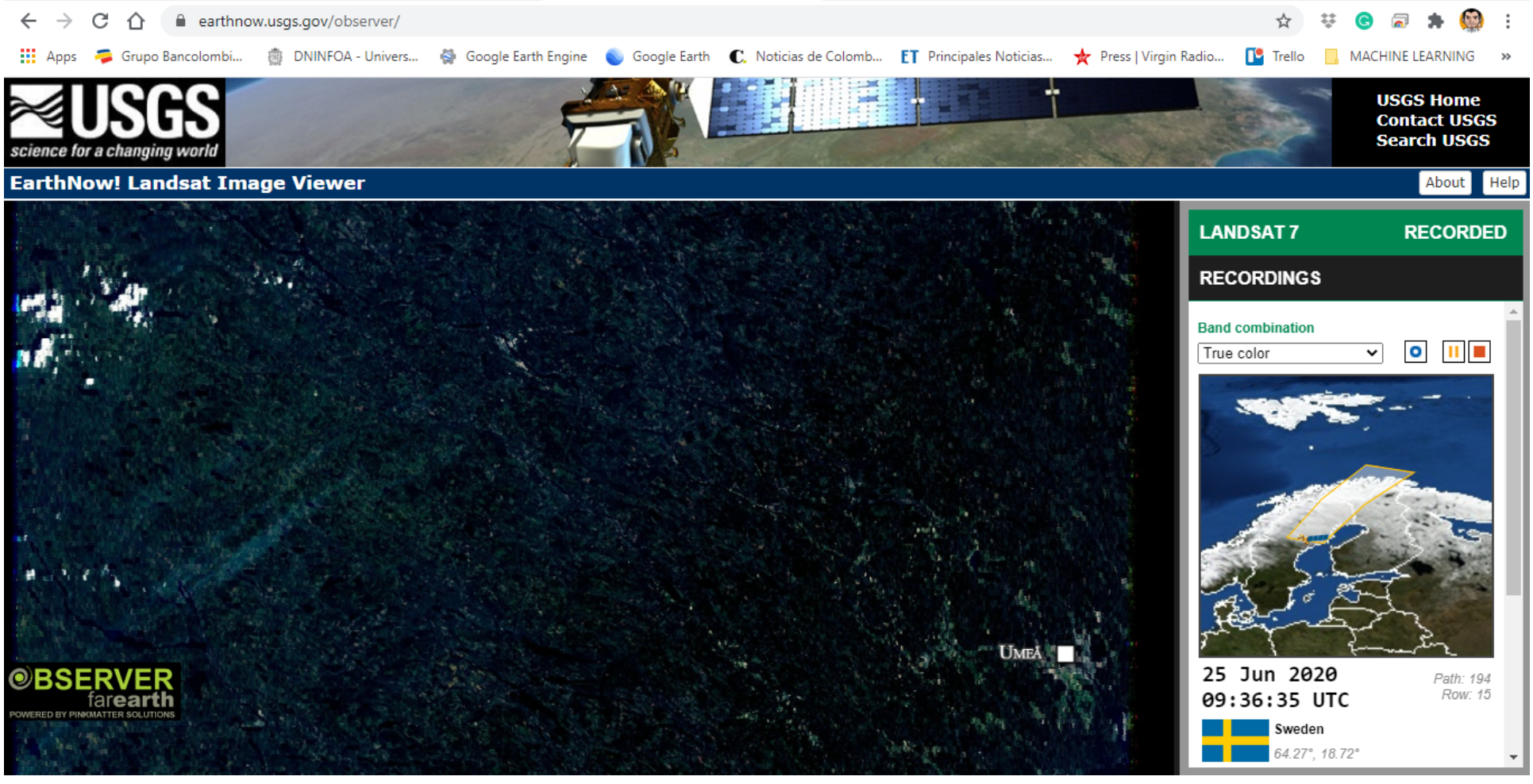


Geosincrónica & Geoestacionaria



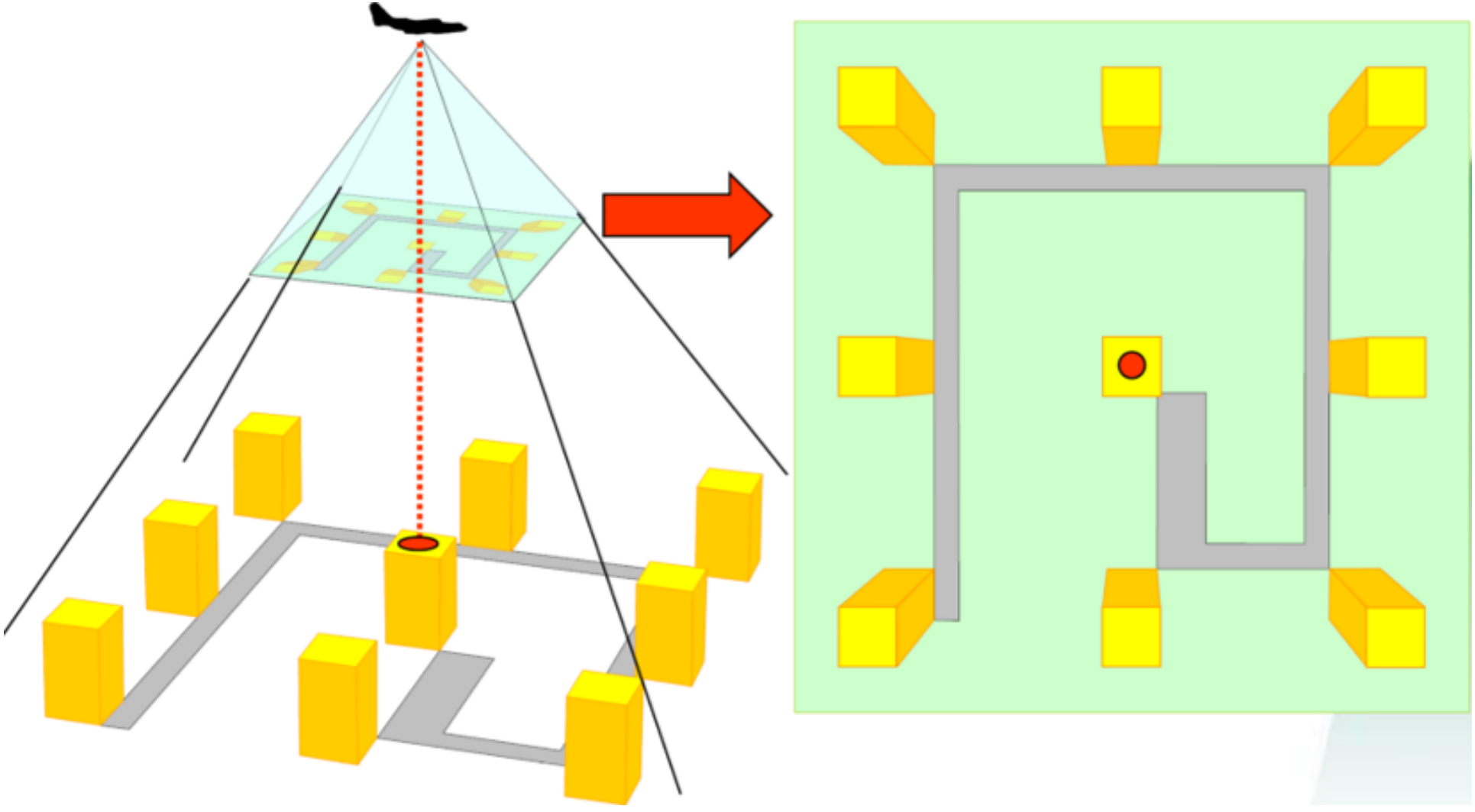

Analog Frame Camera and Film (silver halide crystals)
Photograph
Negative: reversal of tone and geometry
lens
a.
Digital Frame Camera Area Arrays
Detectors
NIR
Red
Green
Blue
Lens and filtration
b.
Scanner
Scanning mirror
NIR
Red
Green
Blue
Discrete detectors
c.
Hyperspectral Area Array
NIR
n bands
Blue
Dispersing element
Detectors
f.
Linear Array "Pushbroom"
Detectors
Objective
d.
Linear Array "Whiskbroom"
Rotating mirror
NIR
Red
Green
Blue
n bands
e.

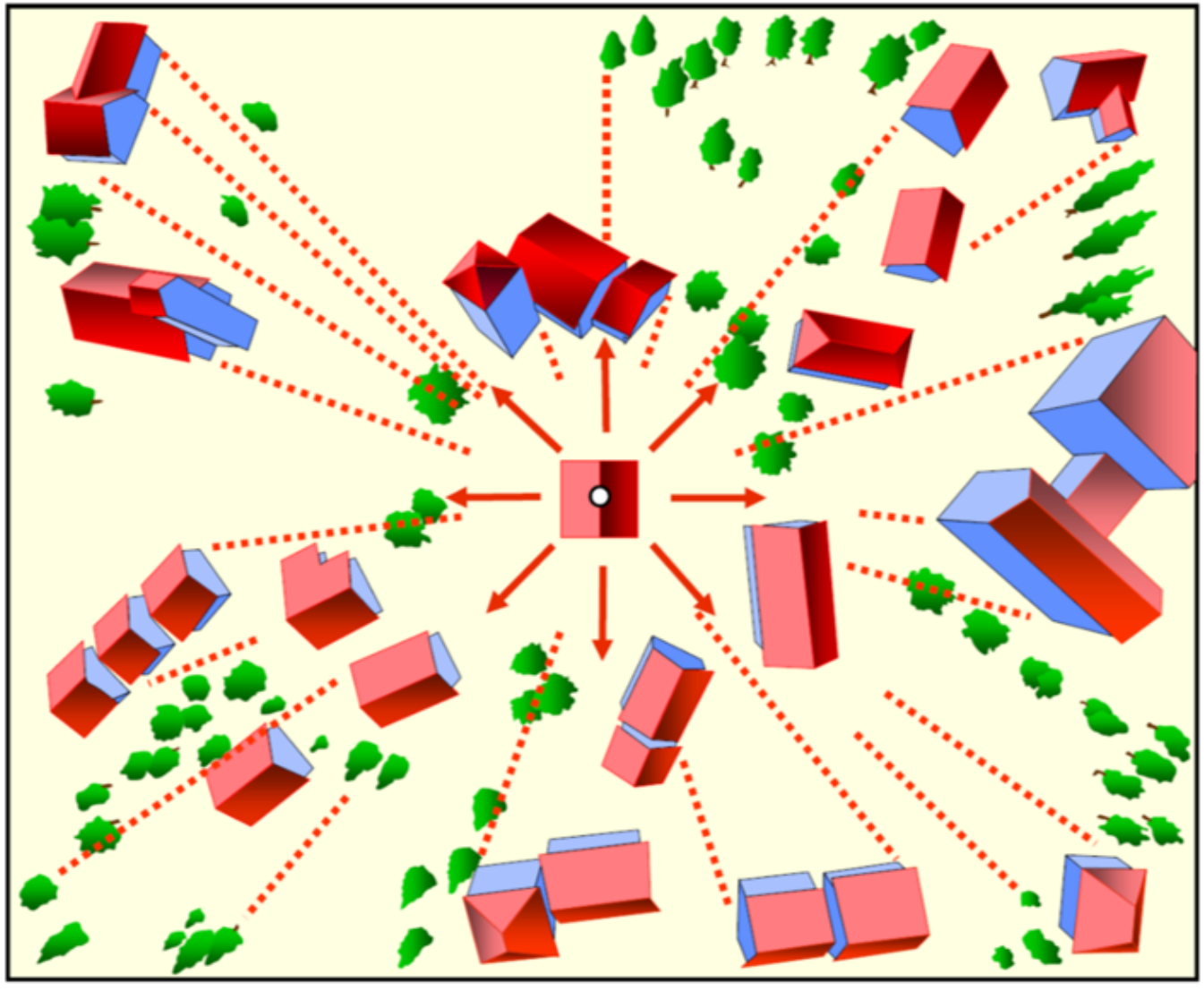
Earthnow

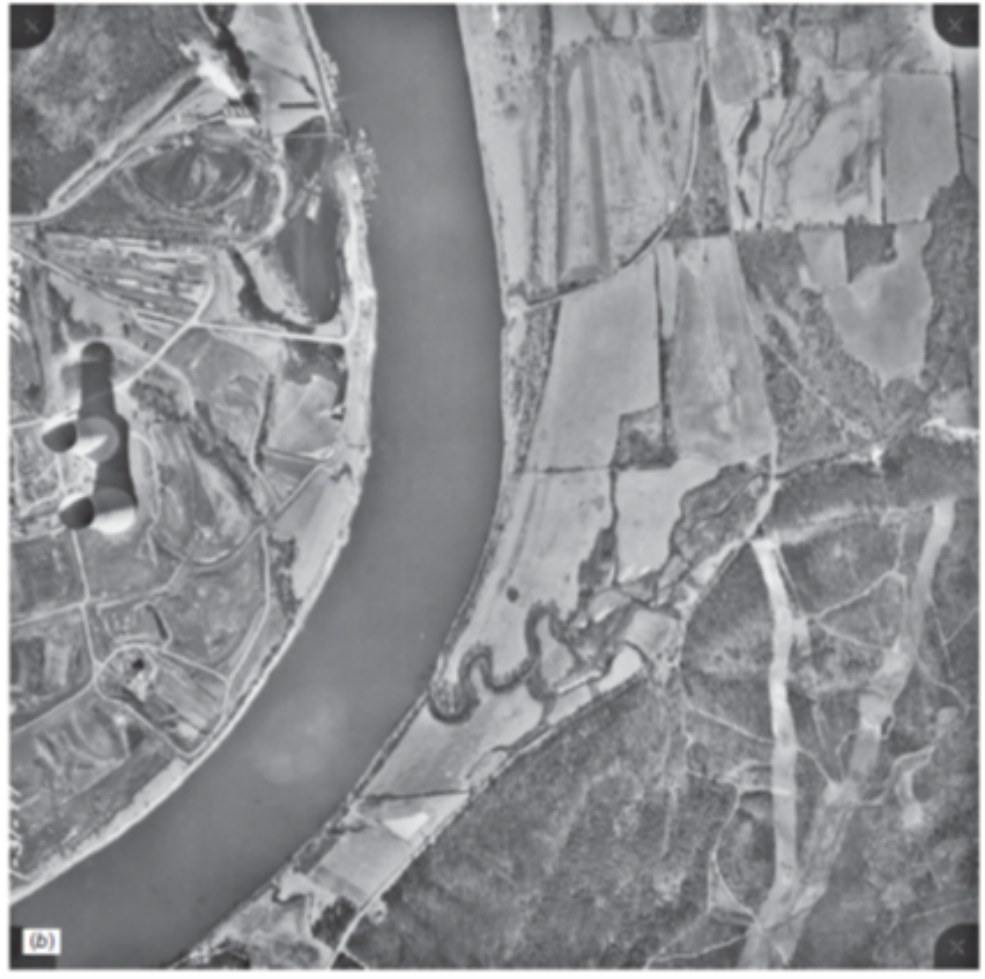

earthnow.usgs.gov/observer/
Apps
Grupo Bancolombi...
DNINFOA - Univers...
Google Earth Engine
Google Earth
Noticias de Colomb...
Principales Noticias...
Press | Virgin Radio...
Trello
MACHINE LEARNING
USGS
science for a changing world
USGS Home
Contact USGS
Search USGS
EarthNow! Landsat Image Viewer
About
Help
UMEÅ
OBSERVER
farearth
POWERED BY PINKMATTER SOLUTIONS
LANDSAT 7
RECORDED
RECORDINGS
Band combination
True color
25 Jun 2020
09:36:35 UTC
Path: 194
Row: 15
Sweden
64.27°, 18.72°

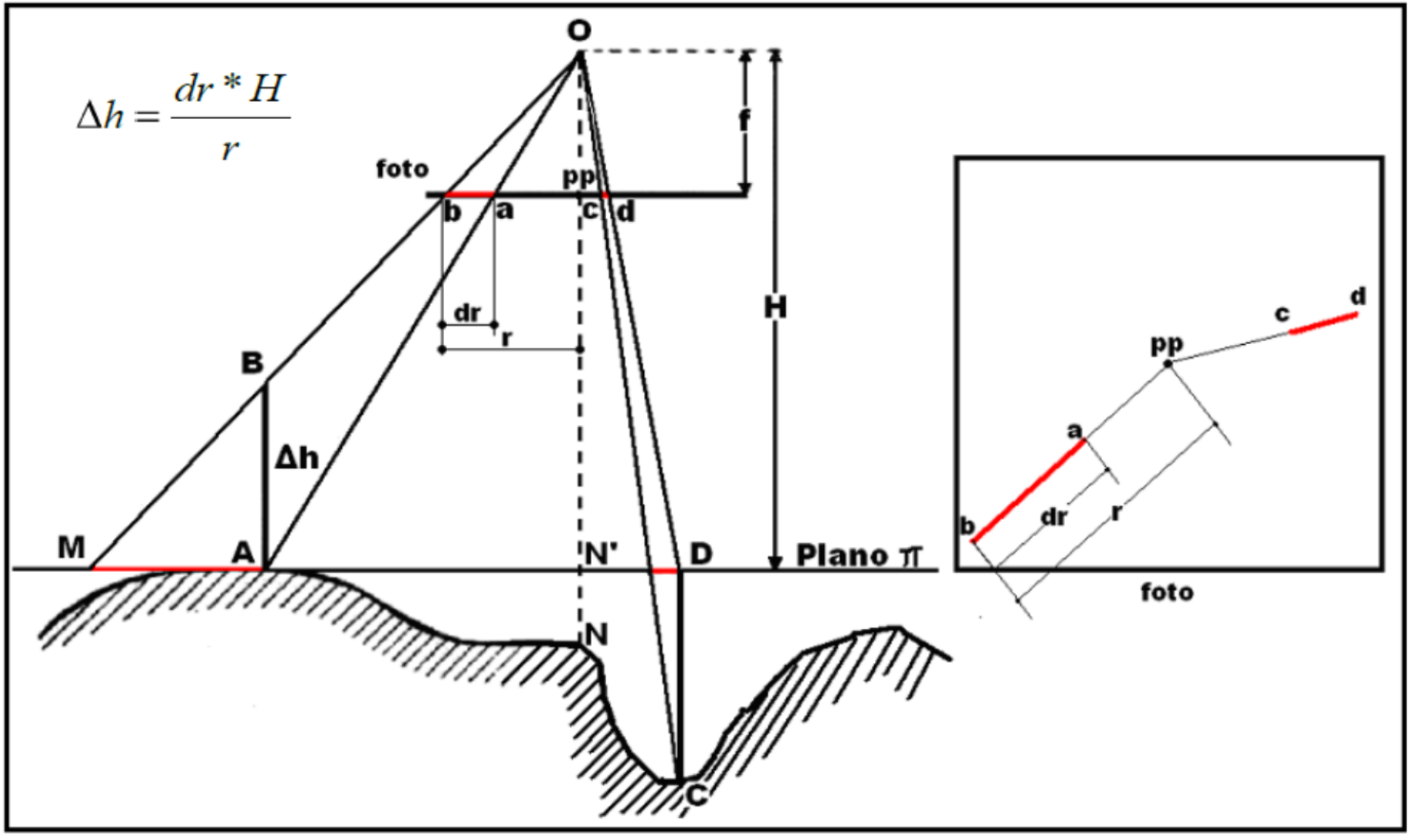
Fotogrametría


a'
Negative
b'






(b)

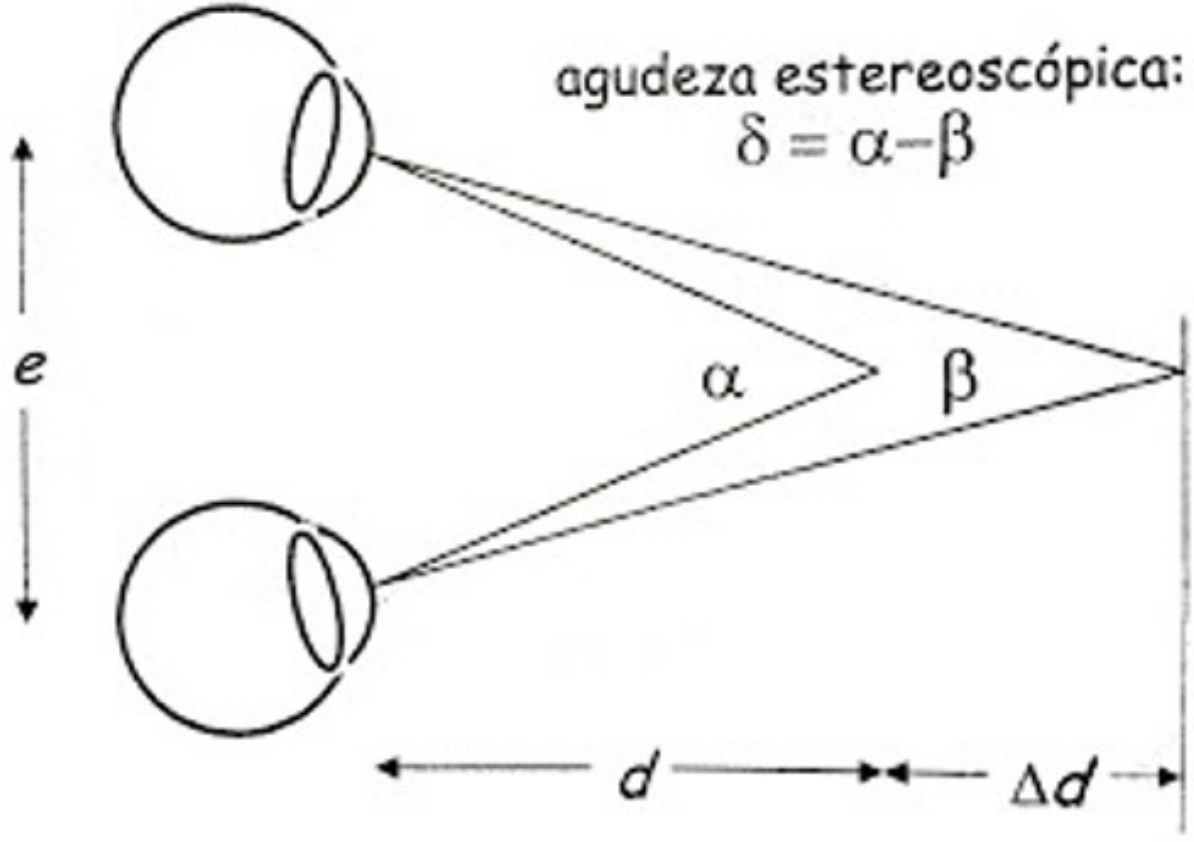

$\Delta h = \frac{dr * H}{r}$
O
f
foto
pp
b
a
c
d
dr
r
H
B
Δh
M
A
N'
D
Plano π
N
C
pp
c
d
a
b
dr
r
foto

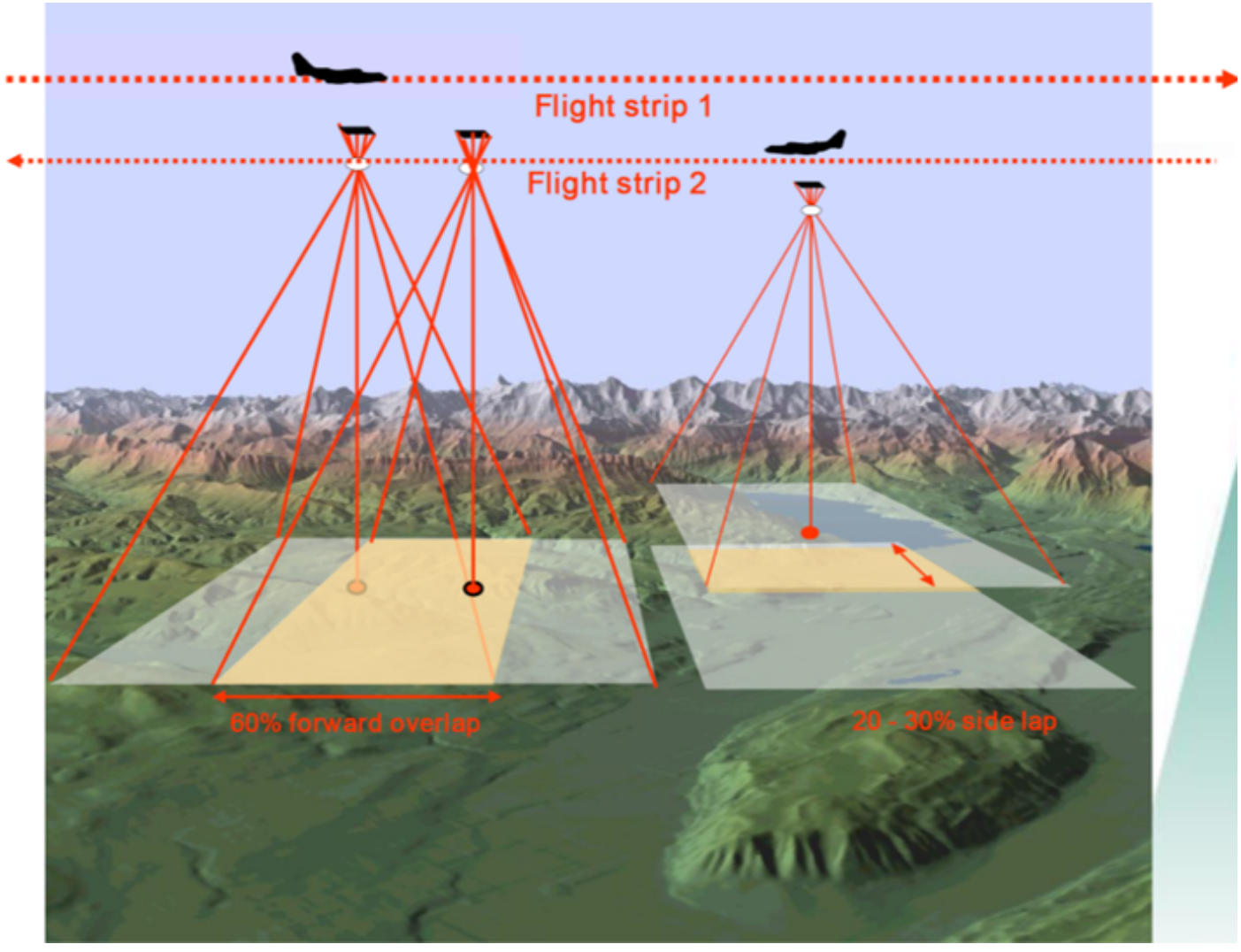
Paralaje

Los ojos convergen en el pulgar.
El fondo se ve doble

Los ojos convergen en el fondo.
El pulgar se ve doble

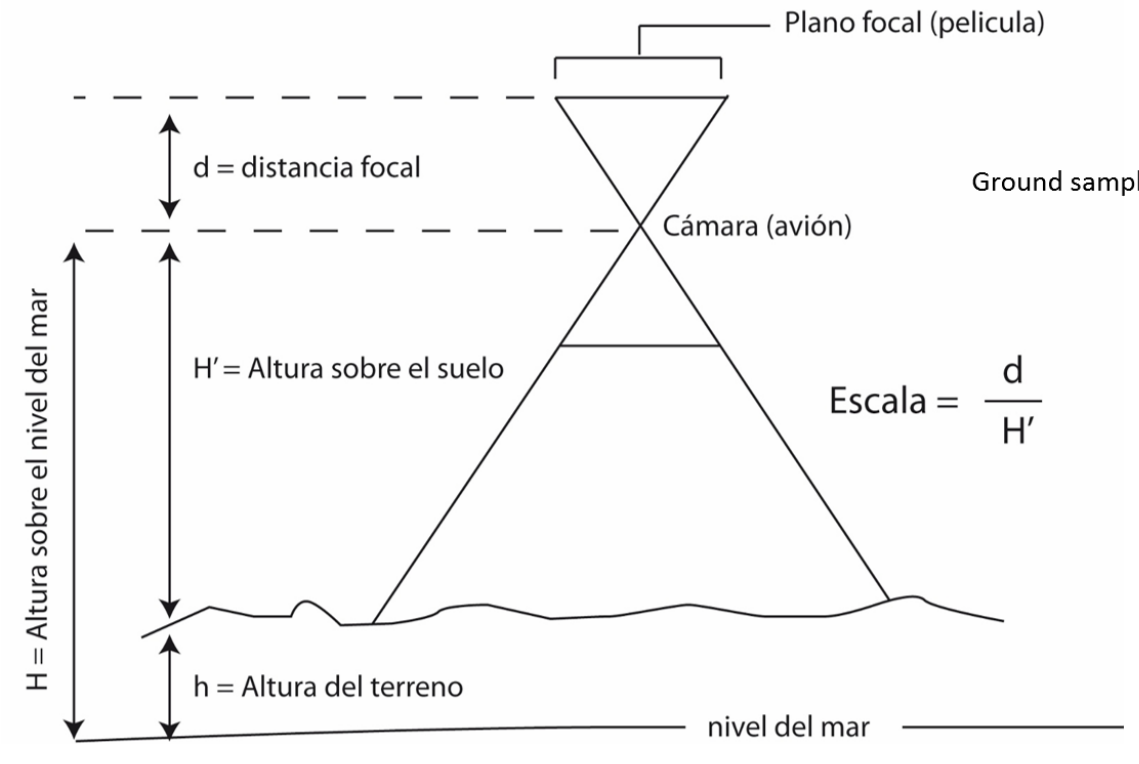
$$\delta \approx \frac{e\,\Delta d}{d^2} \text{ (en radianes).}$$




Flight strip 1
Flight strip 2
60% forward overlap
20 - 30% side lap

Resolución

Escala



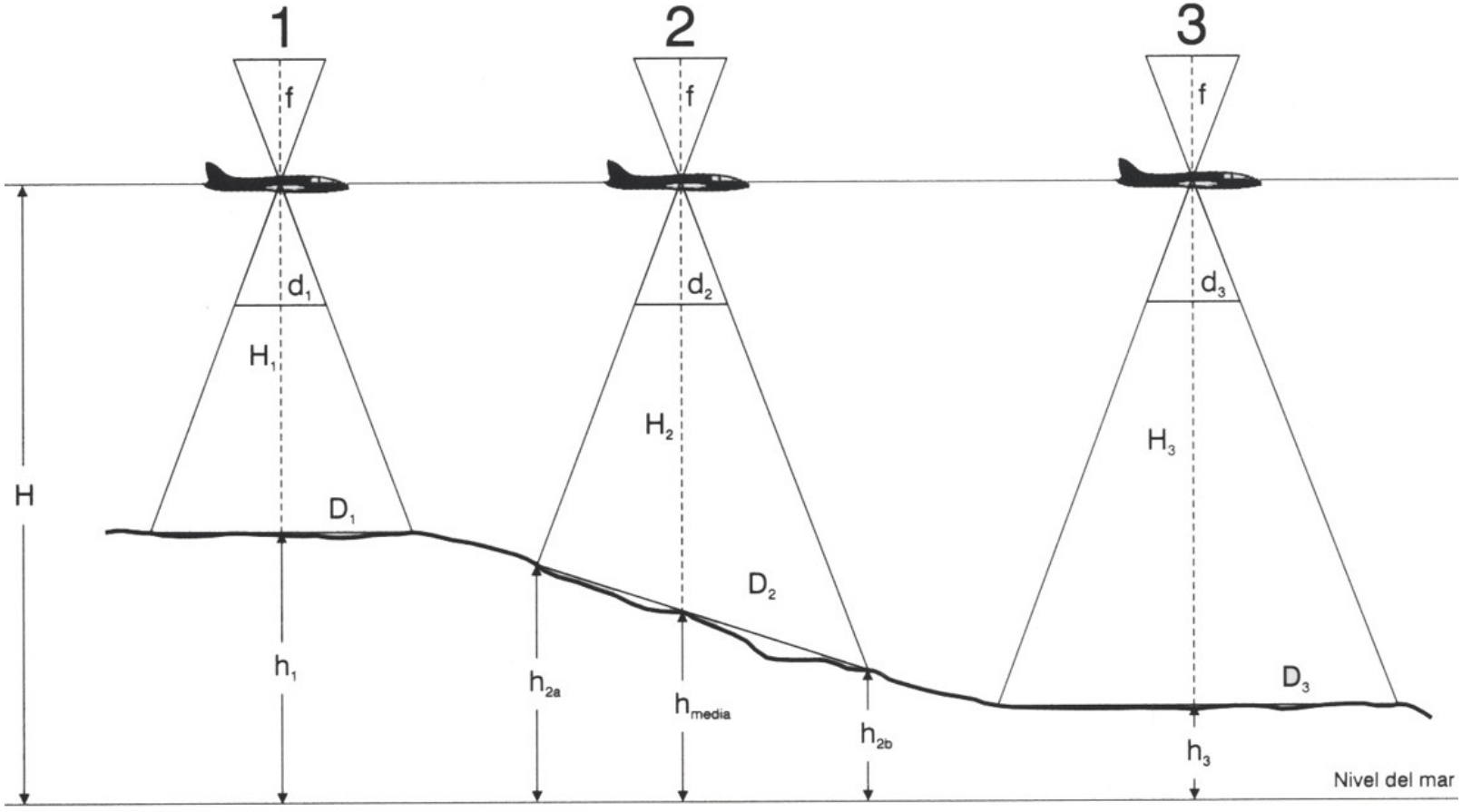
Ground sample distance (GSD)

Instantaneous field of view (IFOV)

$$\frac{O}{Z} = \frac{i}{f}$$

$$\frac{i}{O} = \frac{Z}{f}$$

O = longitud del objeto observado
Z = distancia entre el objeto y el sensor
i = Dimensión lineal del pixel
F= distancia focal

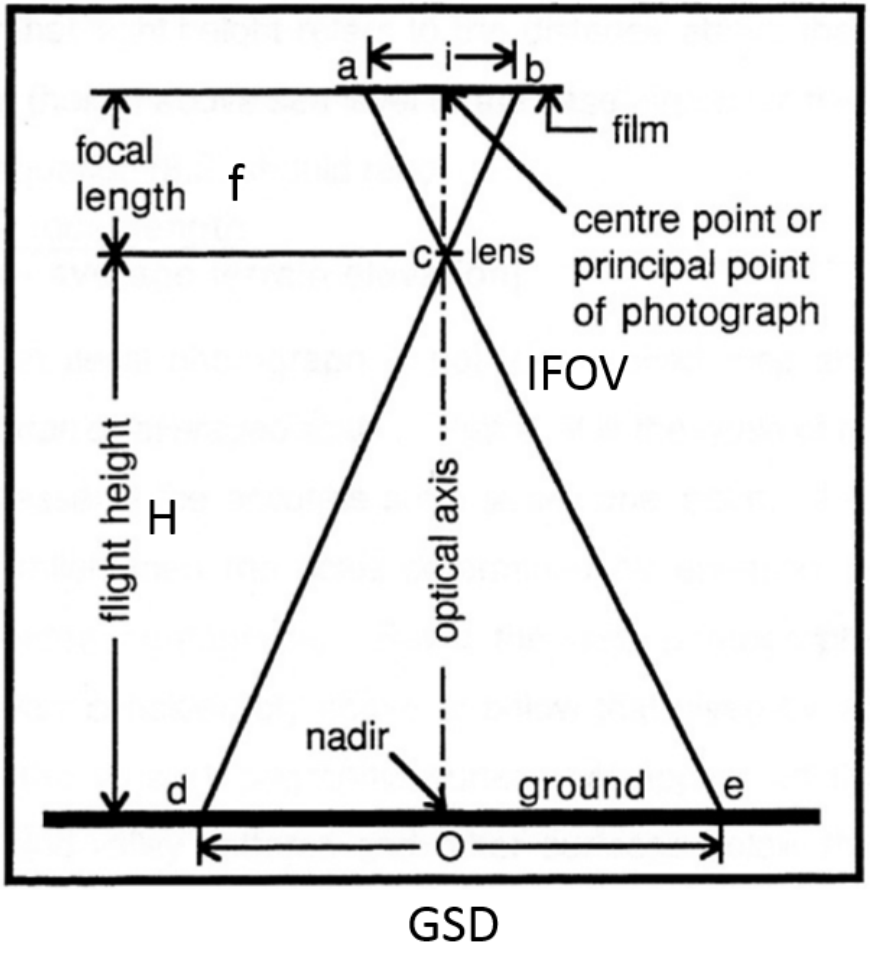


$E_1 = 1 / [(H-h_1)/f]$ $E_2 = 1 / [(H-h_{media})/f]$ $E_3 = 1 / [(H-h_3)/f]$

Escalas grandes (1/10.000)

Escalas pequeñas (1:50.000)

Resolución espacial



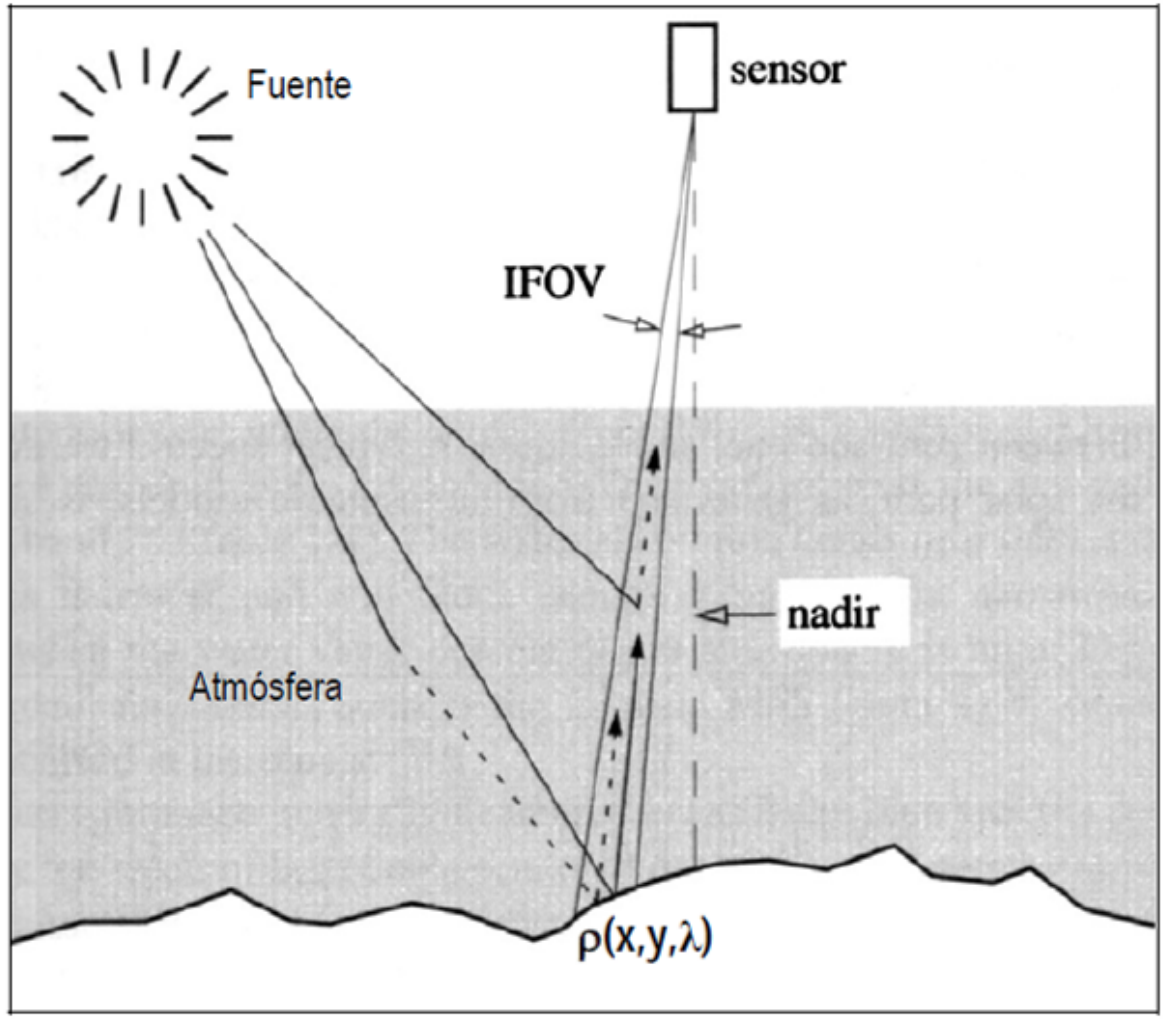
GSD

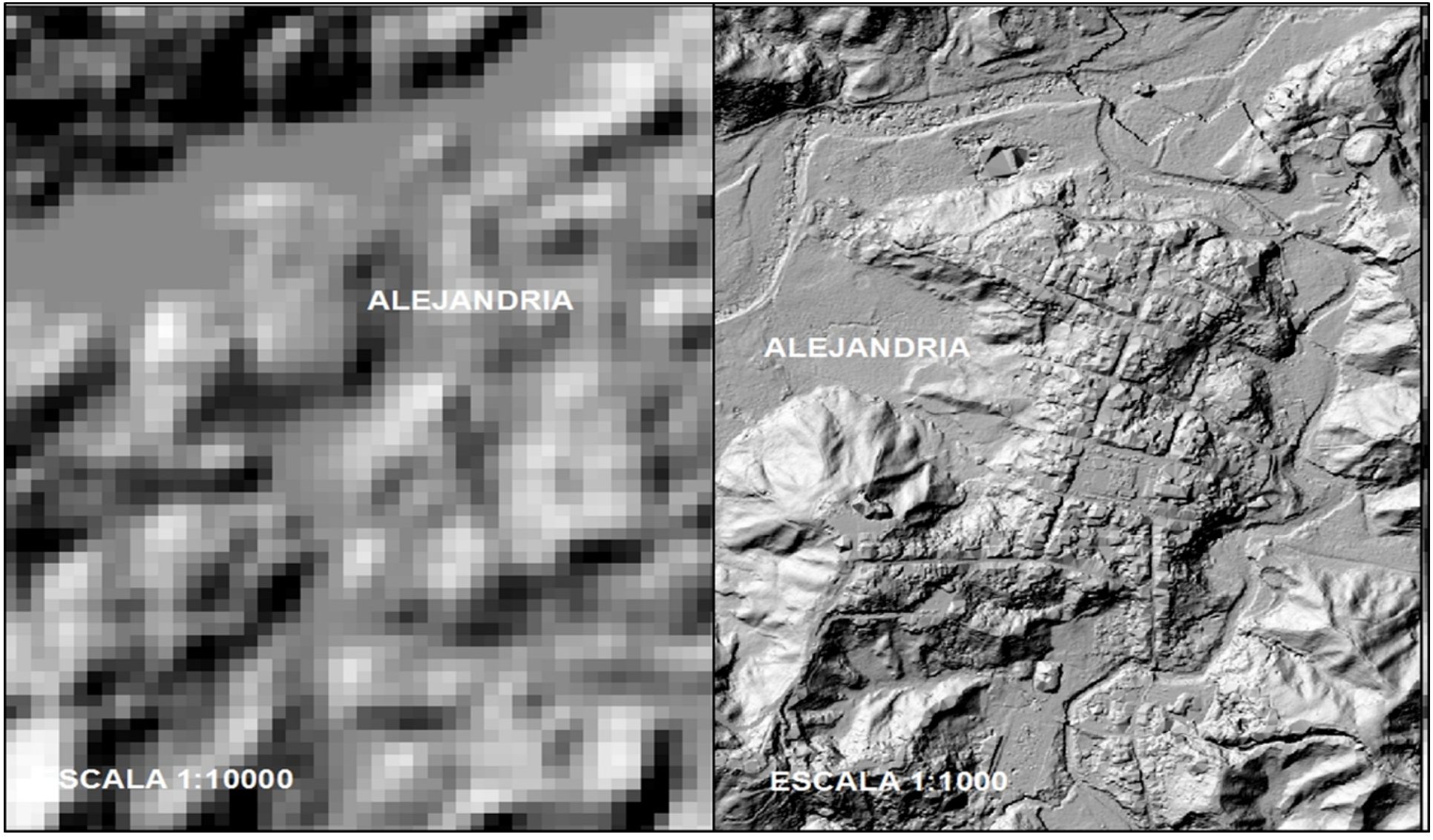
Instantaneous field of view (IFOV)

$$\frac{O}{H} = \frac{i}{f}$$

$$\frac{1}{escala} = \frac{i}{O} = \frac{CCD}{GSD} = \frac{f}{H}$$

O = Longitud del objeto observado
H = Distancia entre el objeto y el sensor
i = Dimensión lineal del pixel
f = distancia focal
CCD = Tamaño del detector
GSD = Ground sample Distance

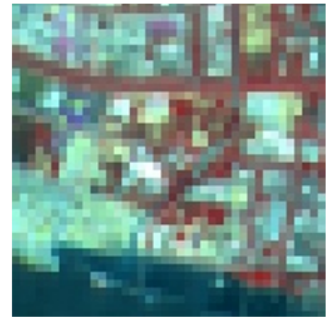

Fuente
sensor
IFOV
nadir
Atmósfera
ρ(x,y,λ)


ALEJANDRIA
ESCALA 1:10000
ALEJANDRIA
ESCALA 1:1000

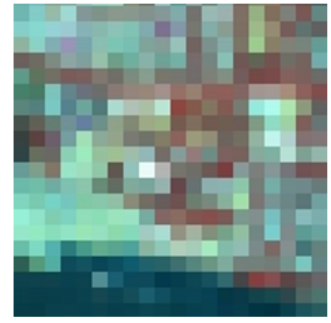
Remuestreo “*up*”

Rs=Px=10m
160x160 px

Rs=10m, Px=20m
80x80 px

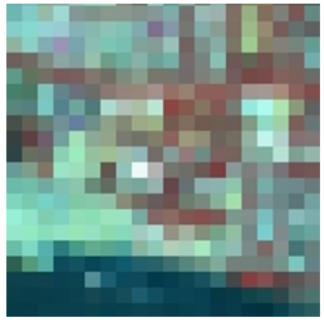


Rs=10m, Px=40m
40x40 px

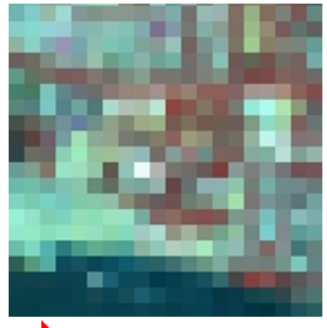


Rs=10m, Px=80m
20x20 px

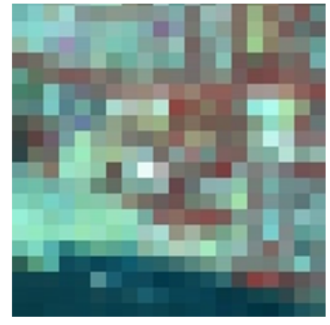
Rs=Px=80m
20x20 px



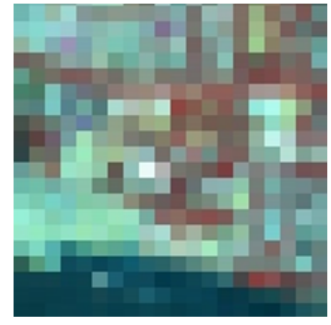
Rs=80m, Px=40m
40x40 px



Rs=80m, Px=20m
40x40 px



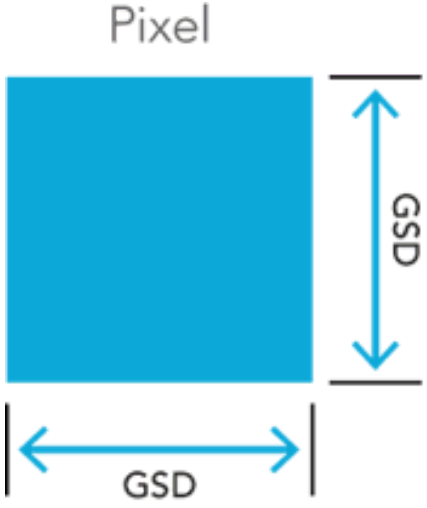
Rs=80m, Px=10m
160x160 px



Full resolution

Remuestreo “*down*”

El procesamiento de imágenes está interesado no solamente en la **Detección**: discernir discretamente los objetos, sino también en **Reconocer:** determinar que tipo de objeto es, y en la **Identificación:** identificar el objeto específicamente.



Área Mínima Cartografiable

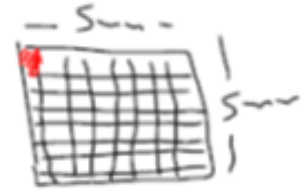
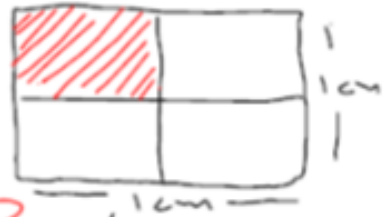
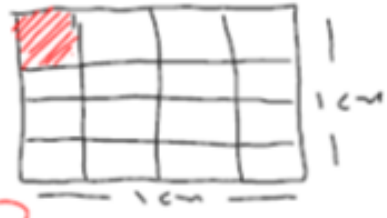
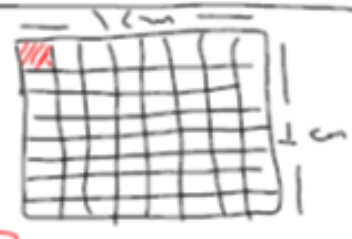
Cuadro 1. Área mínima cartografiable para diferentes escalas (Salitchev 1979)

Escala	1 cm igual a		1 mm igual a		Área mínima cartografiable (4 x 4 mm)	
	m	km	m	km	m^2	km^2
1:500	5	0.005	0.5	0.0005	4	0.000004
1:1,000	10	0.01	1	0.001	16	0.000016
1:2,000	20	0.02	2	0.002	64	0.000064
1:5,000	50	0.05	5	0.005	400	0.0004
1:10,000	100	0.1	10	0.01	1,600	0.0016
1:20,000	200	0.2	20	0.02	6,400	0.0064
1:25,000	250	0.25	25	0.025	10,000	0.01
1:50,000	500	0.5	50	0.05	40,000	0.04
1:100,000	1,000	1	100	0.1	160,000	0.16
1:250,000	2,500	2.5	250	0.25	1,000,000	1
1:500,000	5,000	5	500	0.5	4,000,000	4
1:1,000,000	10,000	10	1000	1	16,000,000	16
1:6,000,000	60,000	60	6000	6	576,000,000	576

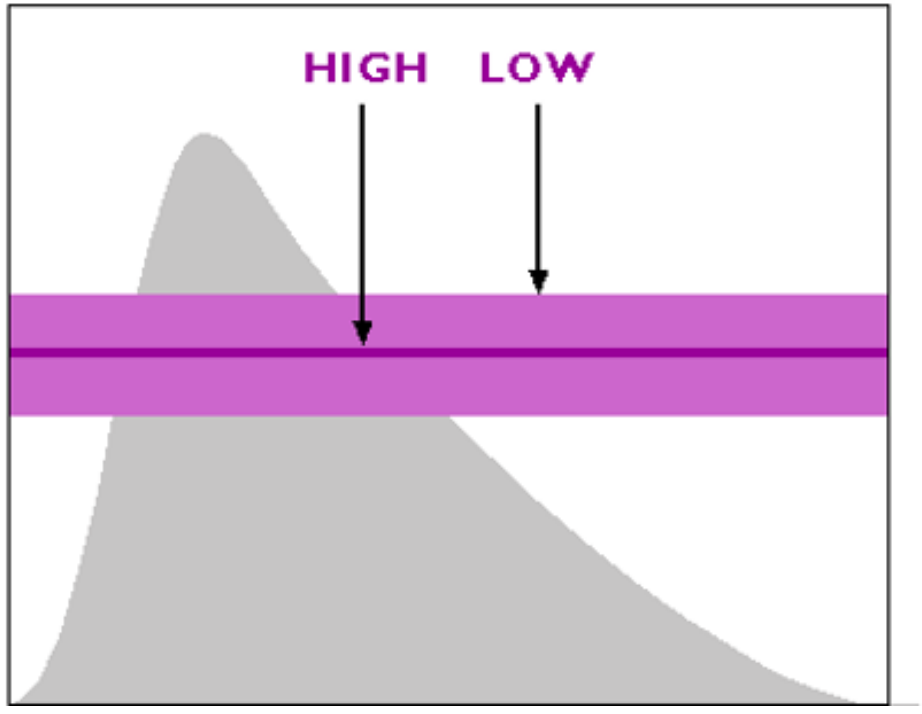
Regla de Waldo Tobler (1967) --> The rule is: divide the denominator of the map scale by 1,000 toget the detectable size in meters. The resolution is one half of this amount.

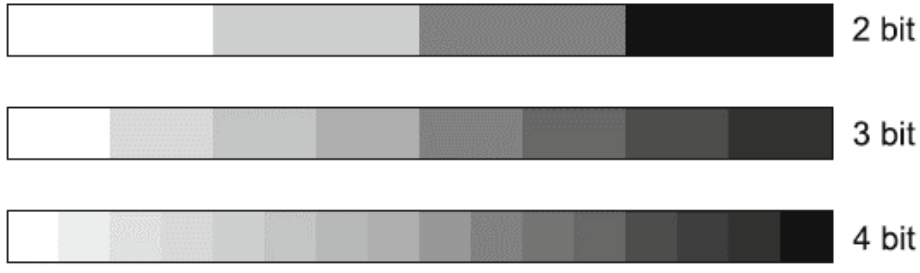
Map Scale = Raster resolution (in meters) * 2 * 1000

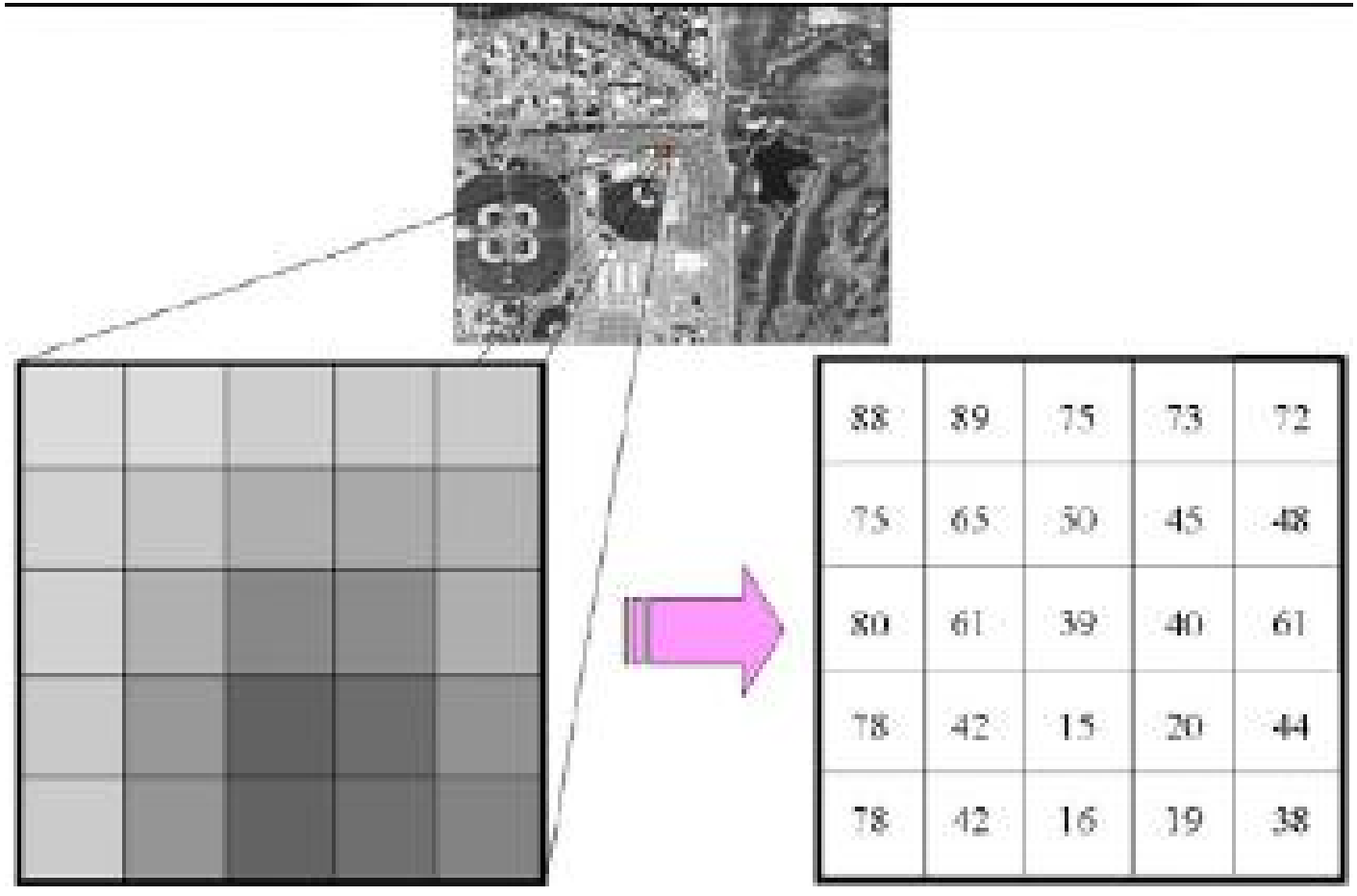
Map scale	Detectable size (in meters)	Raster resolution (in meters)
1:1,000	1	0.5
1:5,000	5	2.5
1:10,000	10	5
1:50,000	50	25
1:100,000	100	50
1:250,000	250	125
1:500,000	500	250
1:1,000,000	1,000	500

	4 Px (2×2)	16 Px (4×4)	64 Px (8×8)
4 mm	 Px = 2 mm	 Px = 1 mm	 Px = 0,5 mm
5 mm	 Px = 2,5 mm	 Px = 1,25 mm	 Px = 0,625 mm
10 mm (1 cm)	 Px = 5 mm	 Px = 2,5 mm	 Px = 1,25 mm

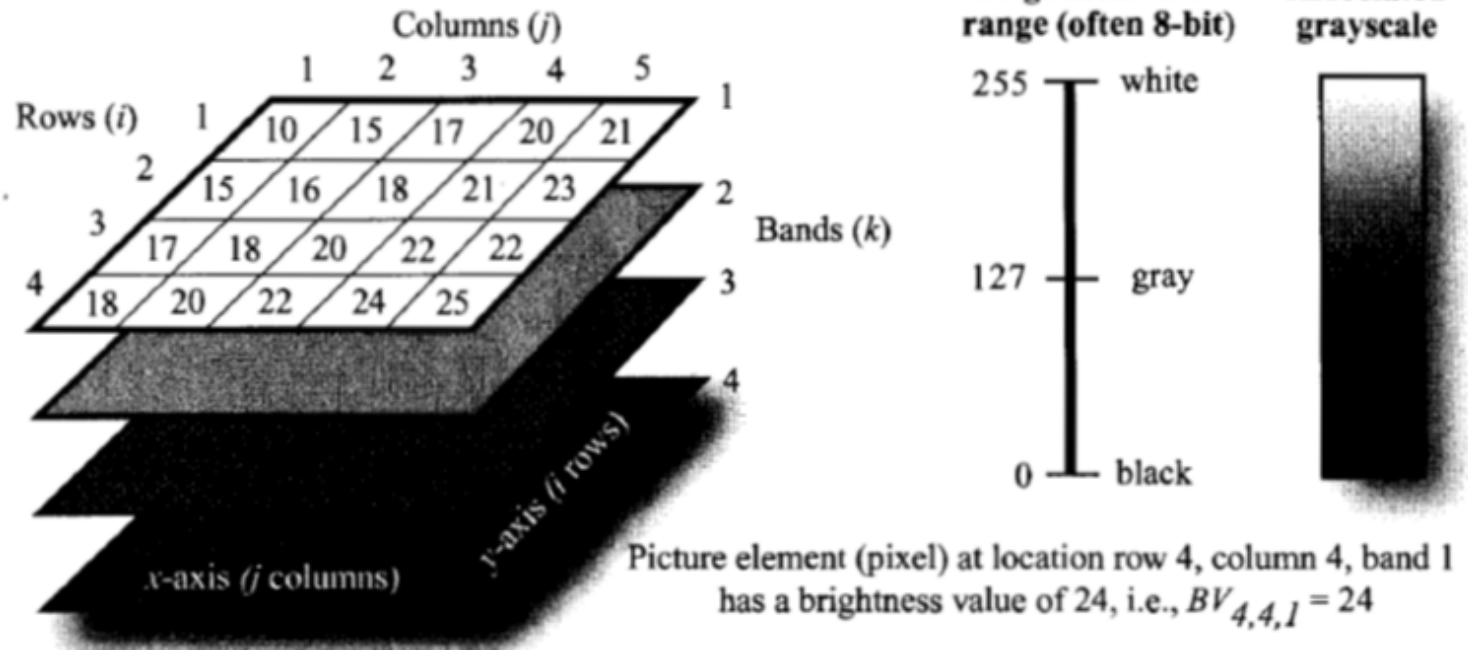
Radiometric Resolution



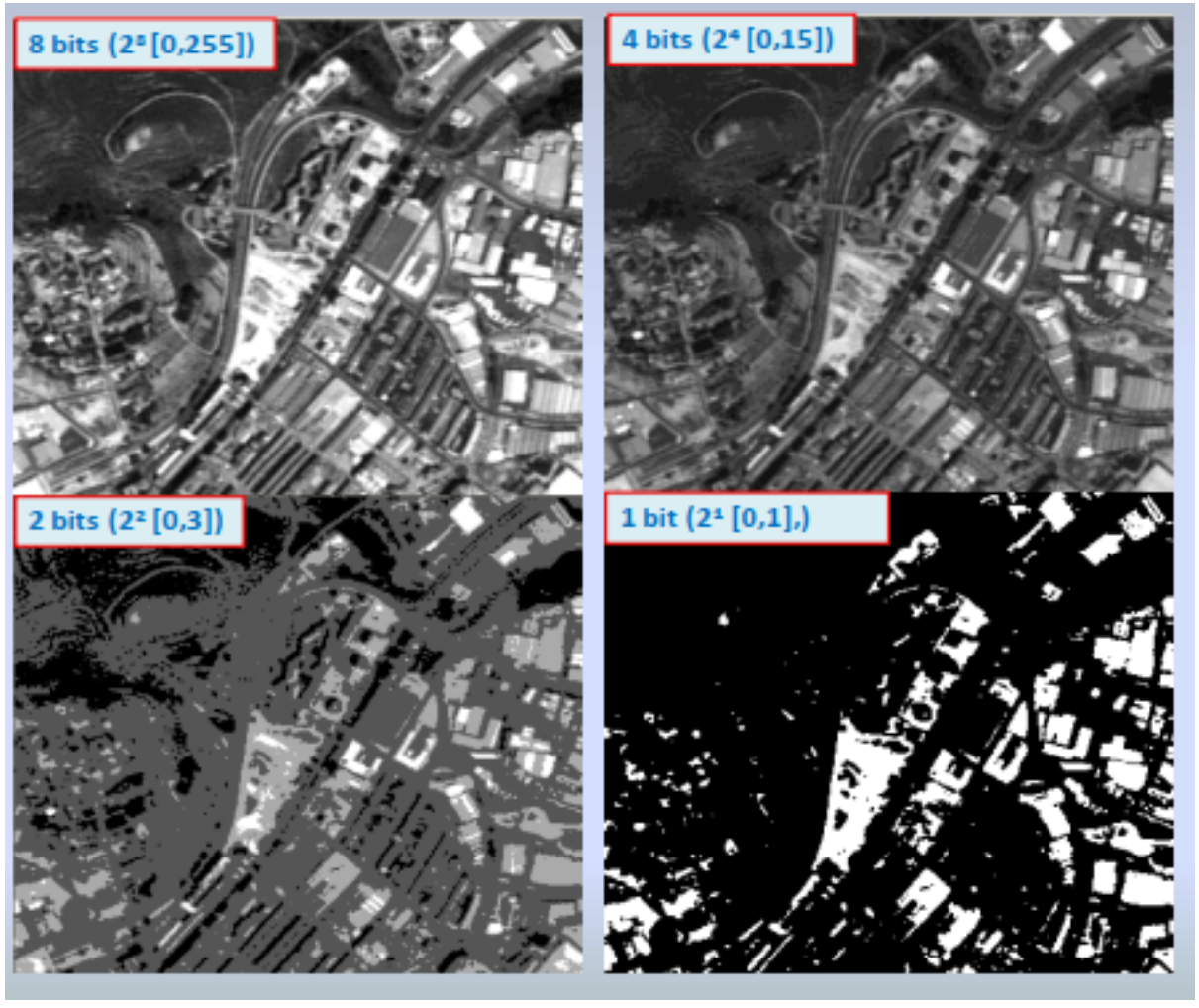



88 89 75 73 72
75 65 50 45 48
80 61 39 40 61
78 42 15 20 44
78 42 16 19 38

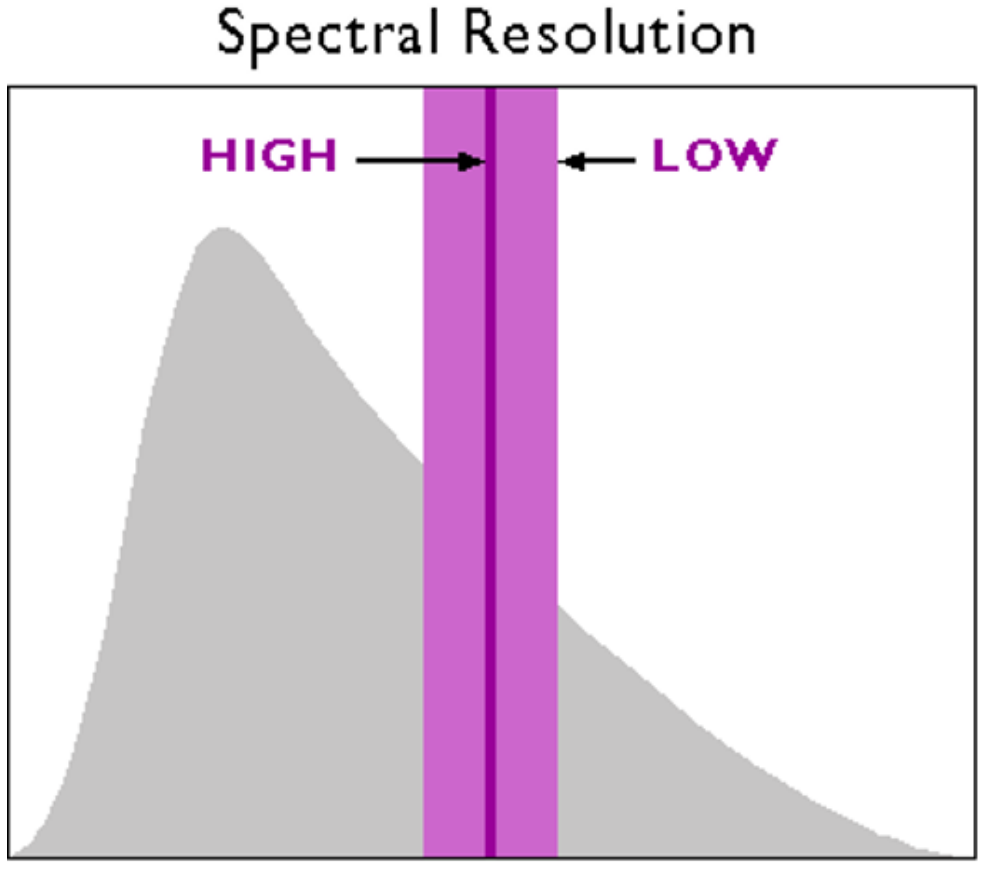
Digital Image Terminology



Picture element (pixel) at location row 4, column 4, band 1 has a brightness value of 24, i.e., $BV_{4,4,1} = 24$


8 bits (2⁸ [0,255])
4 bits (2⁴ [0,15])
2 bits (2² [0,3])
1 bit (2¹ [0,1],)

Resolución espectral

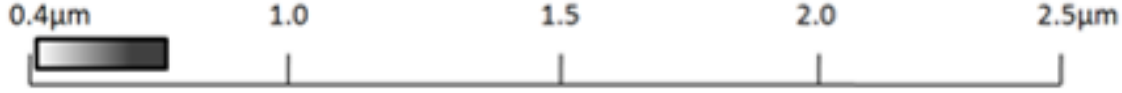



Panchromatic
Natural Color
False Color Infrared

Spectral Resolution of Different Sensors

Panchromatic Sensor

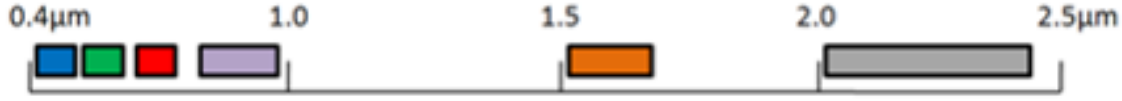
(single-channel detector sensitive to radiation within a broad wavelength range)



B&W Aerial Photos

Multispectral Sensor

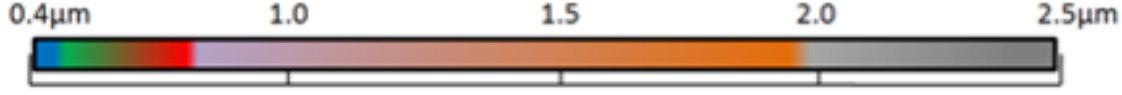
(2 to ~15 channels chosen at discrete wavelengths along the optical spectrum)



RGB Imagery
Landsat
WorldView-2
NAIP

Hyperspectral Sensor

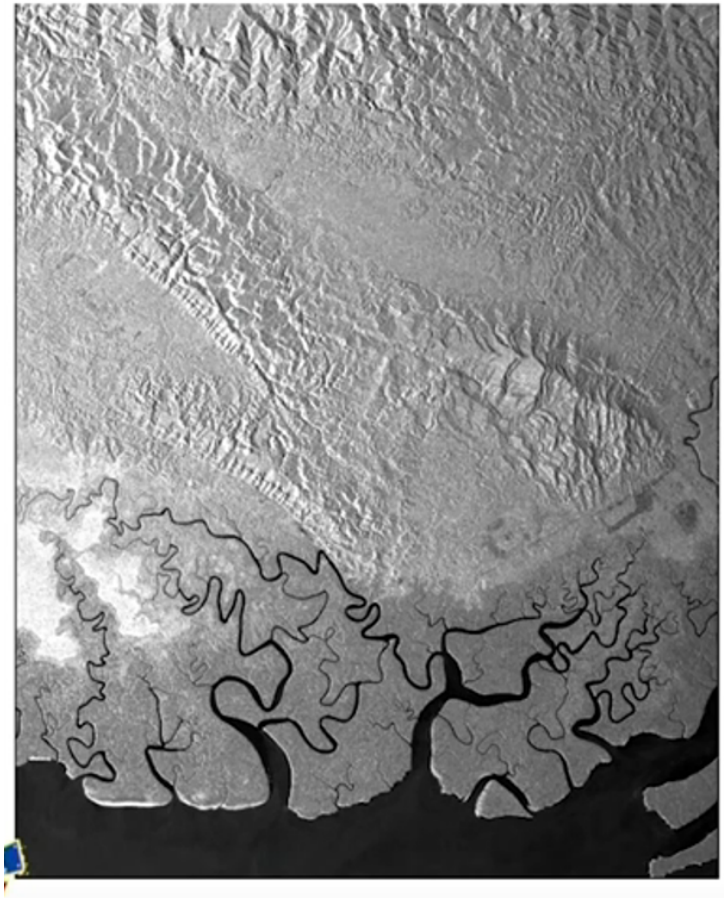
(hundreds of channels provide a near continuous reading of the optical spectrum)



AVIRIS

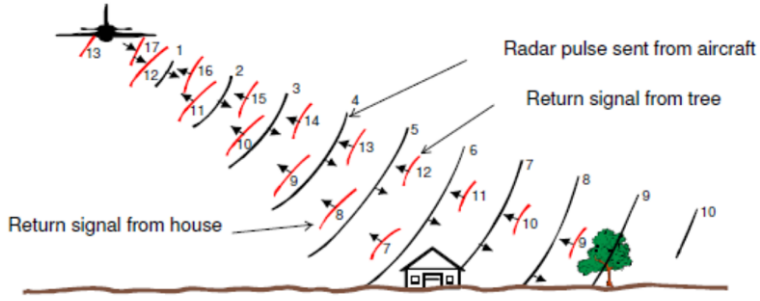
Sensores de Antena

Radar

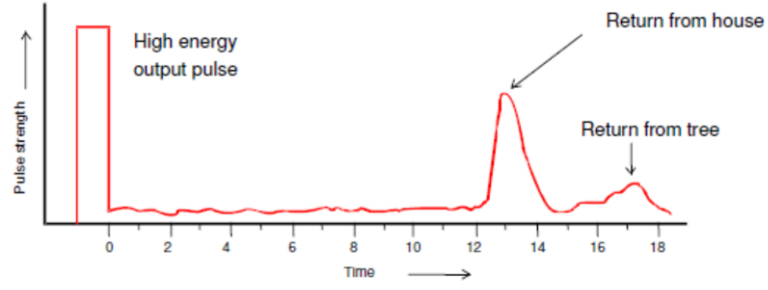


Óptico

Radar—Sensor de rango y radio detección que provee su propia fuente de energía electromagnética. Emite radiación de microondas en una serie de pulsos desde una antena. Cuando la energía alcanza su objetivo parte de la energía se reflejada hacia el sensor. Esta radiación es detectada, medida y se estima el tiempo de viaje.



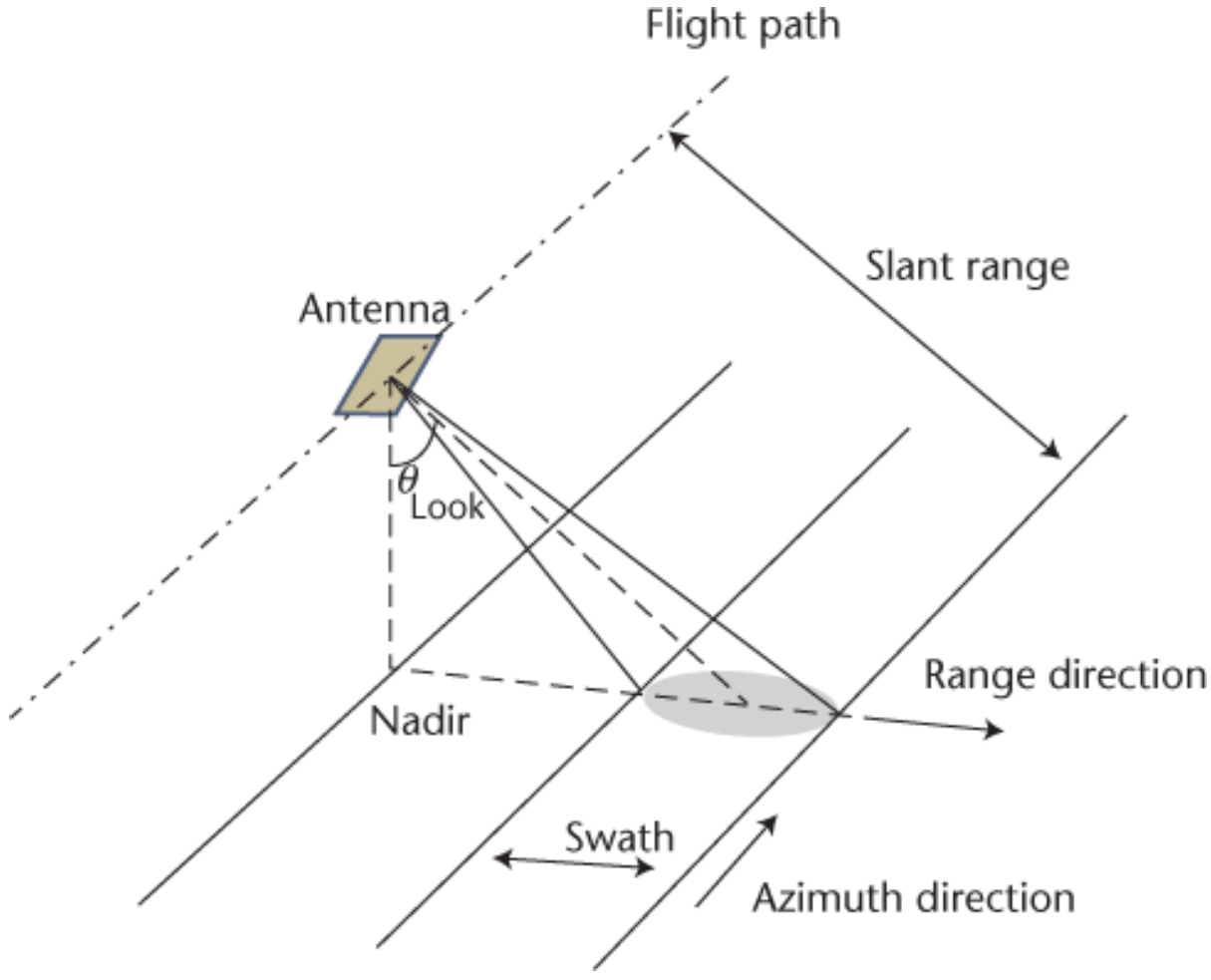
(a) Propagation of one radar pulse (indicating the wavefront location at time intervals 1-17)

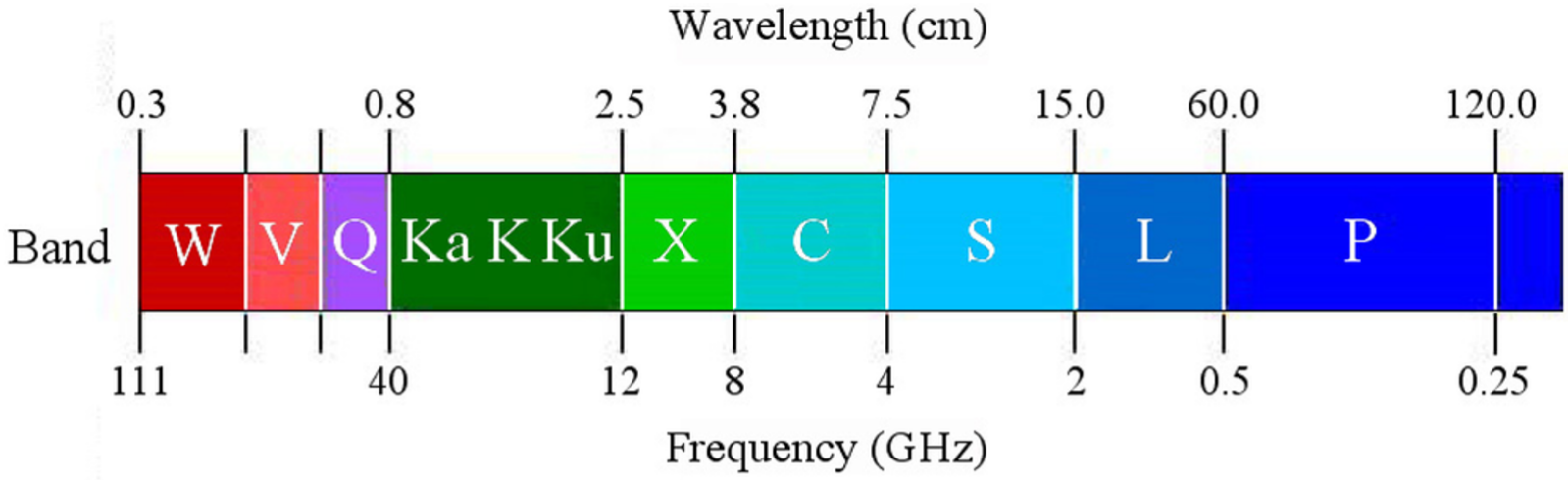


(b) Resulting antenna return

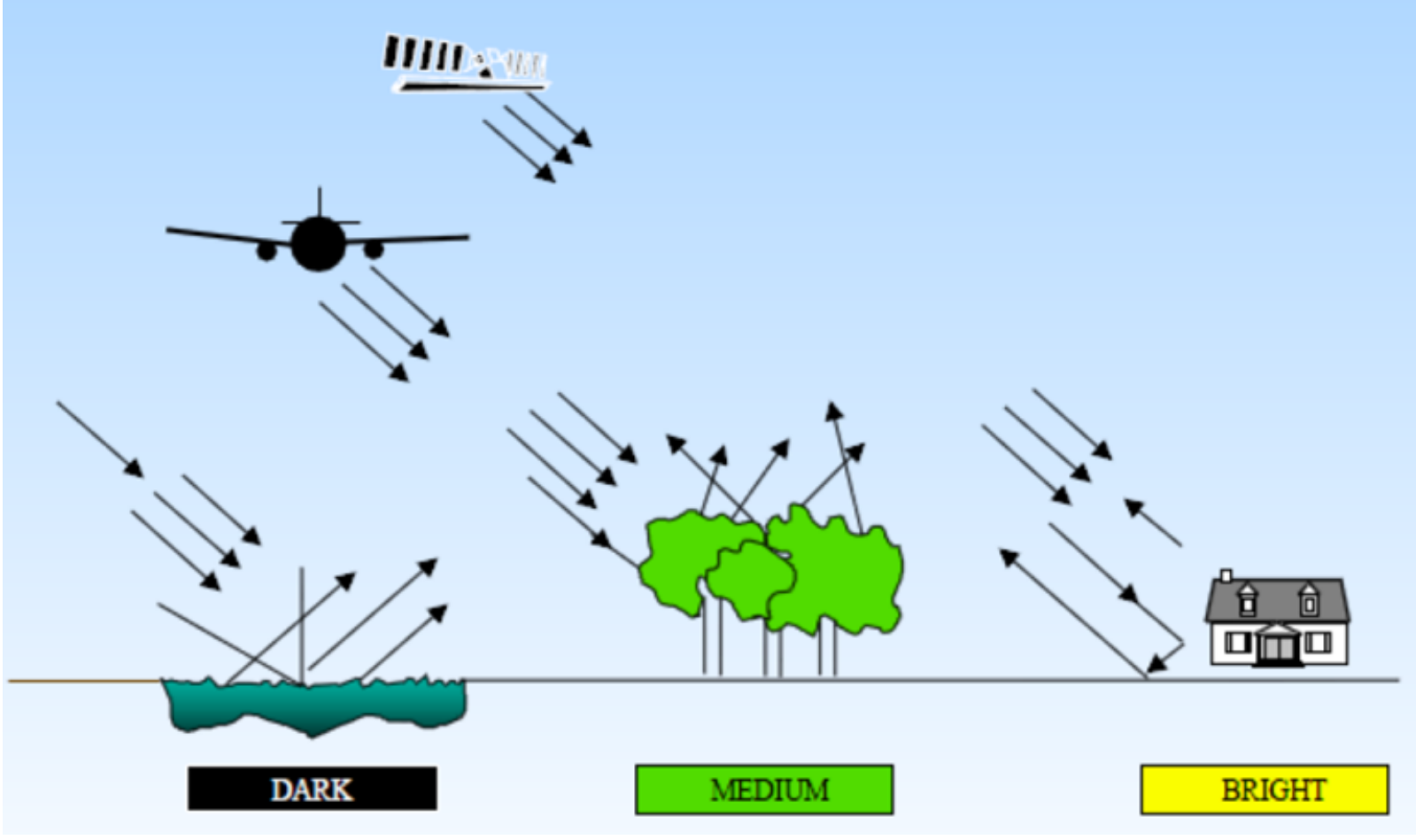
$$\overline{SR} = \frac{ct}{2}$$

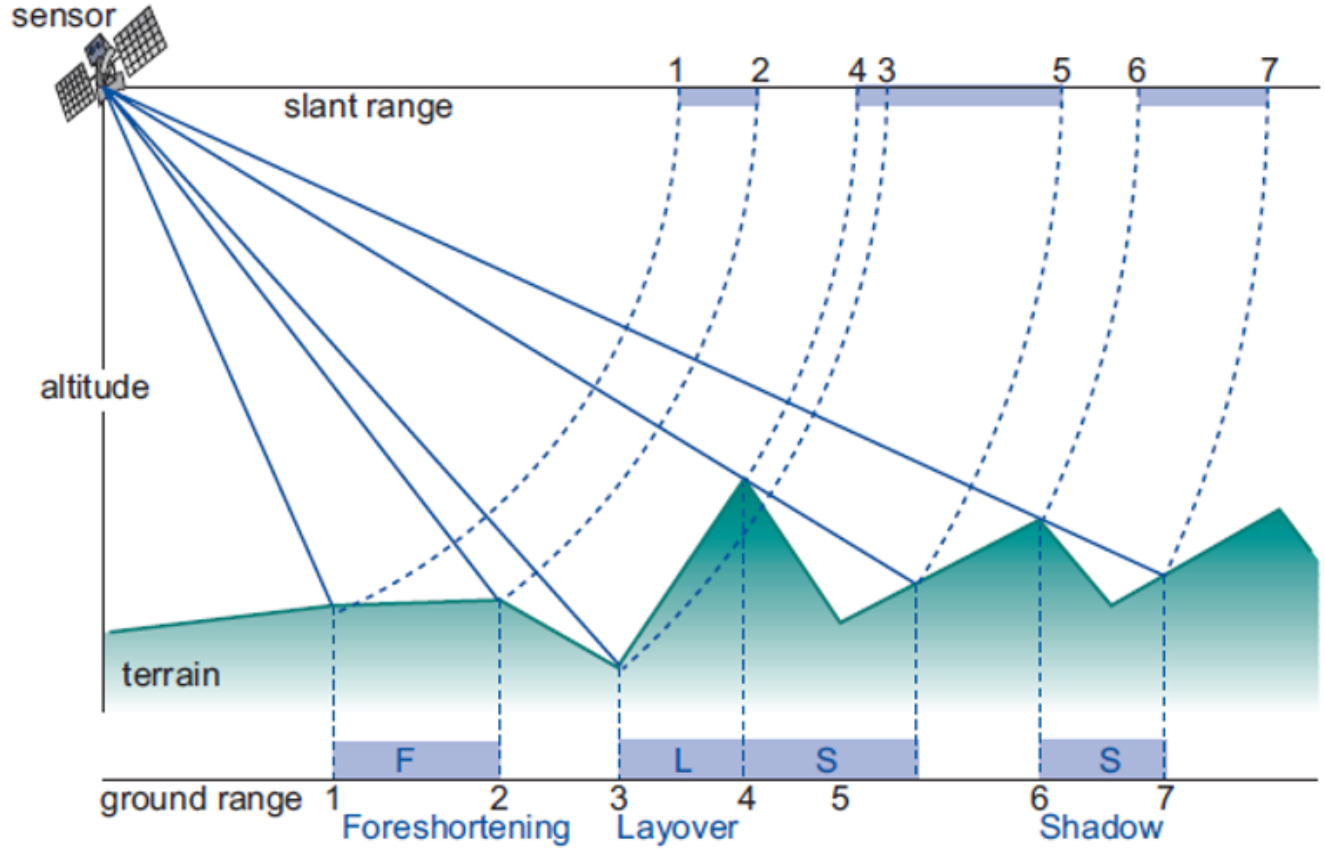
$\overline{SR}$ = slant range (direct distance between transmitter and object)
c = speed of light (3×10^8 m/sec)
t = time between pulse transmission and echo reception

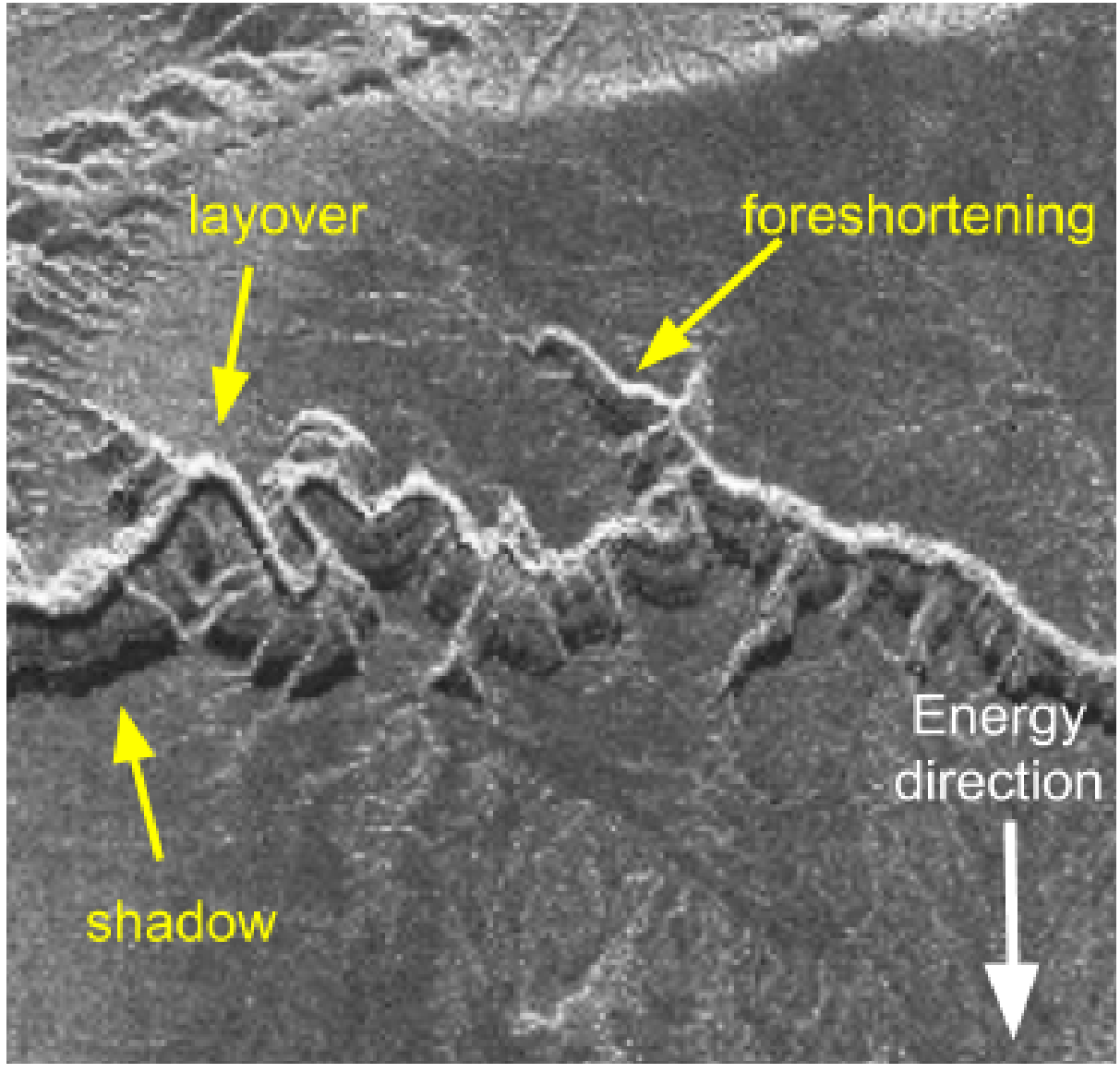

Flight path
Slant range
Antenna
θ
Look
Nadir
Range direction
Swath
Azimuth direction



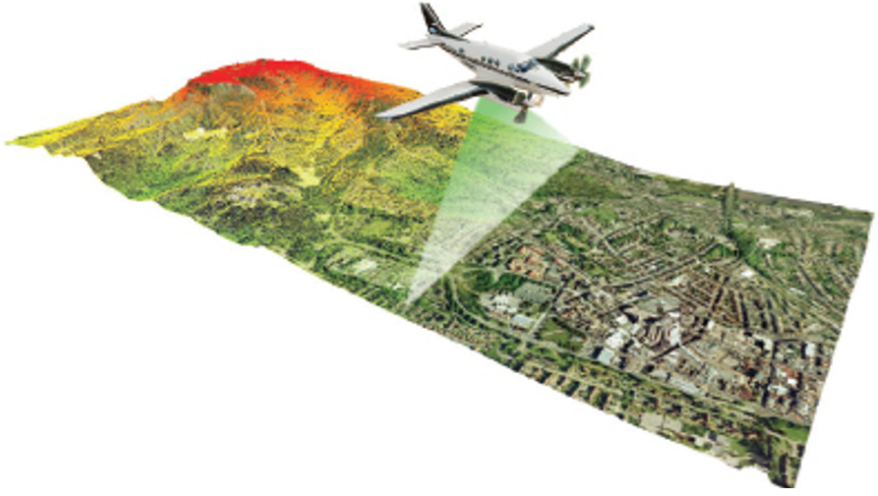
Band	Wavelength (cm)	Frequency (GHz)
K	0.83–2.75	36.0–10.8
X	2.75–5.21	10.9–5.74
C	5.22–7.14	5.75–4.20
S	7.15–19.74	4.21–1.54
L	19.75–76.9	1.55–0.39
P	>76.9	<0.39


DARK
MEDIUM
BRIGHT

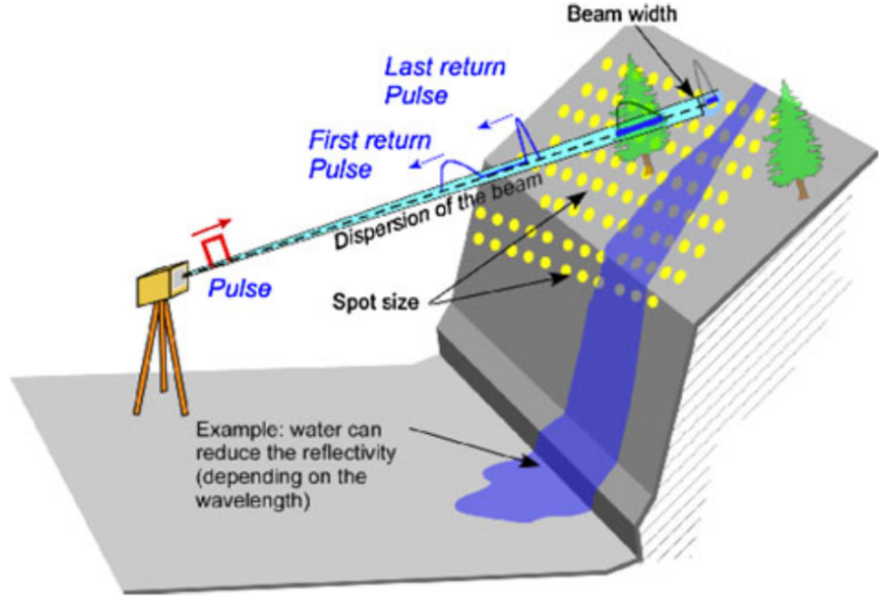

sensor
slant range
1 2 4 3 5 6 7
altitude
terrain
F
L
S
S
ground range 1 2 3 4 5 6 7
Foreshortening
Layover
Shadow


layover
foreshortening
Energy
direction
shadow

LIDAR



Airborne-based sensors



Ground-based sensors

Fuente: http://learn.arcgis.com/en/arcgis-imagery-book/chapter4/

Longitud de onda: 55-1,700 nm

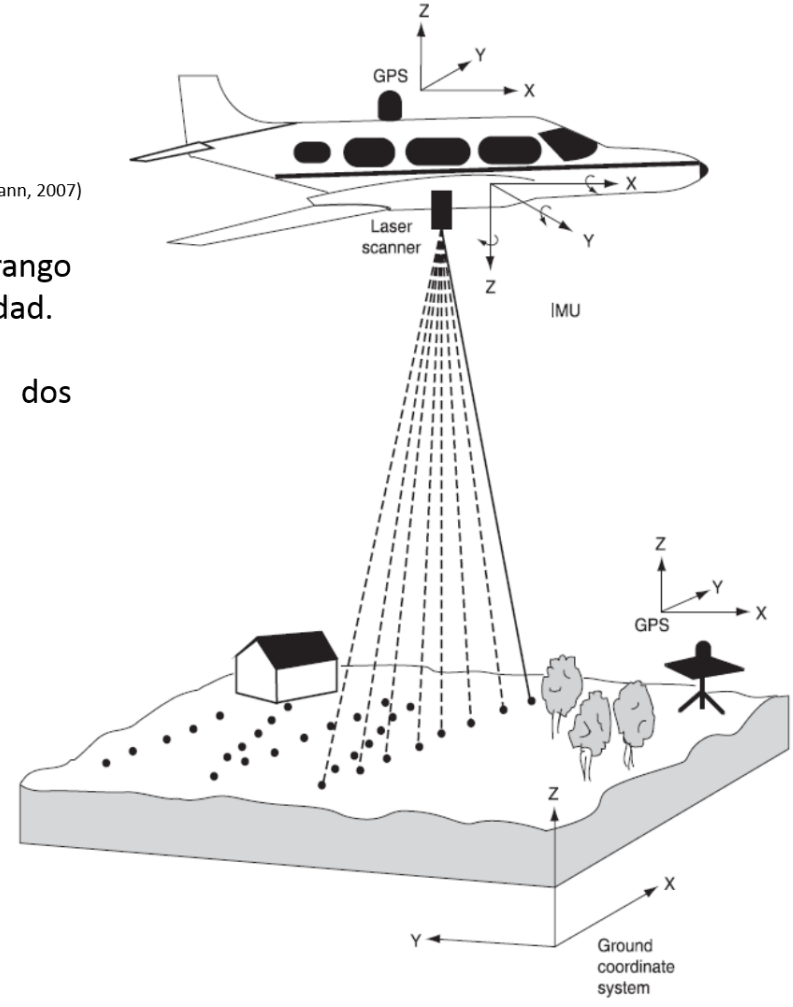
Precisión típica: +/- 1.5 cm → 800m-1000m (Manetti & Steinmann, 2007)

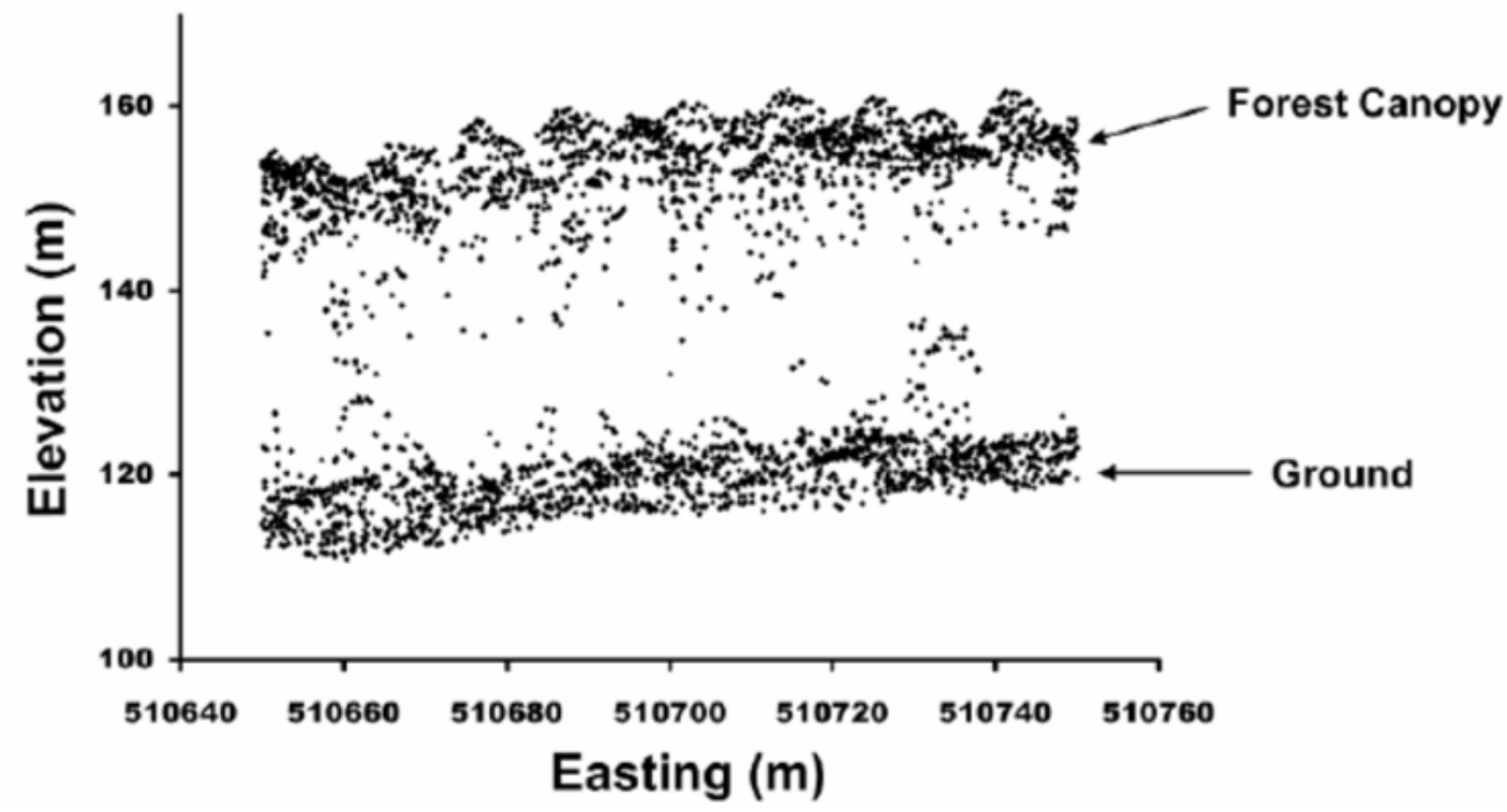
Resolución de rango: es la habilidad del buscador de rango en diferenciar dos objetos en la misma línea de visibilidad.

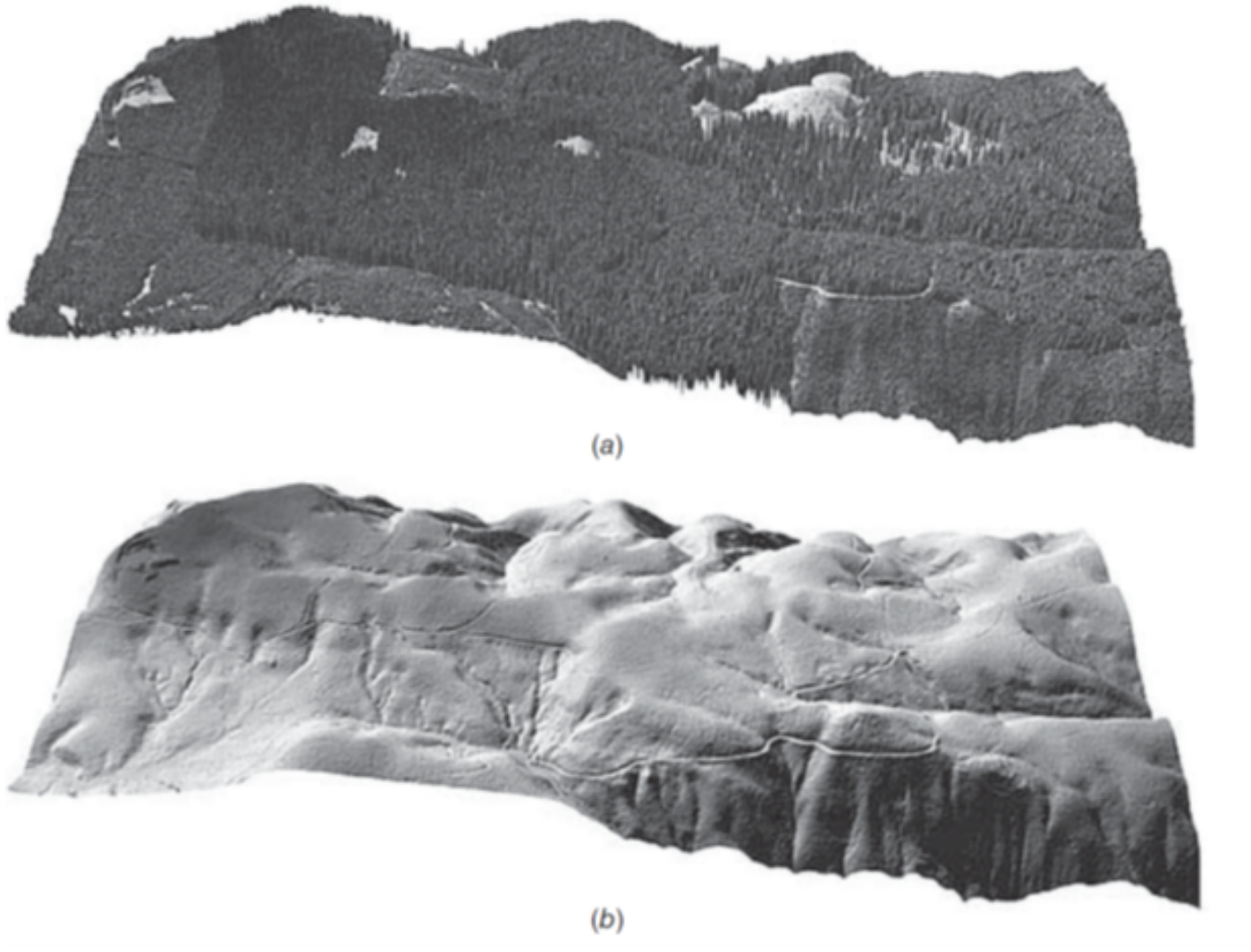
Resolución angular: es la habilidad en diferenciar dos objetos en líneas de visibilidad adyacentes.

Densidad de puntos:

ALS: 0,5 – 100 pts/m2
TLS: 50-10,000 pts/m2




Forest Canopy
Ground
Elevation (m)
160
140
120
100
510640
510660
510680
510700
510720
510740
510760
Easting (m)

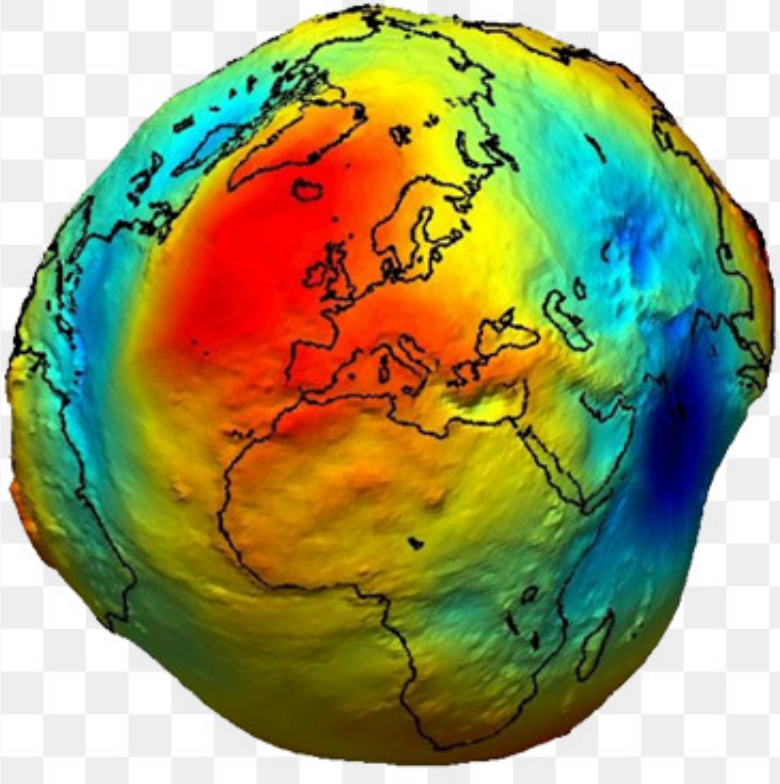


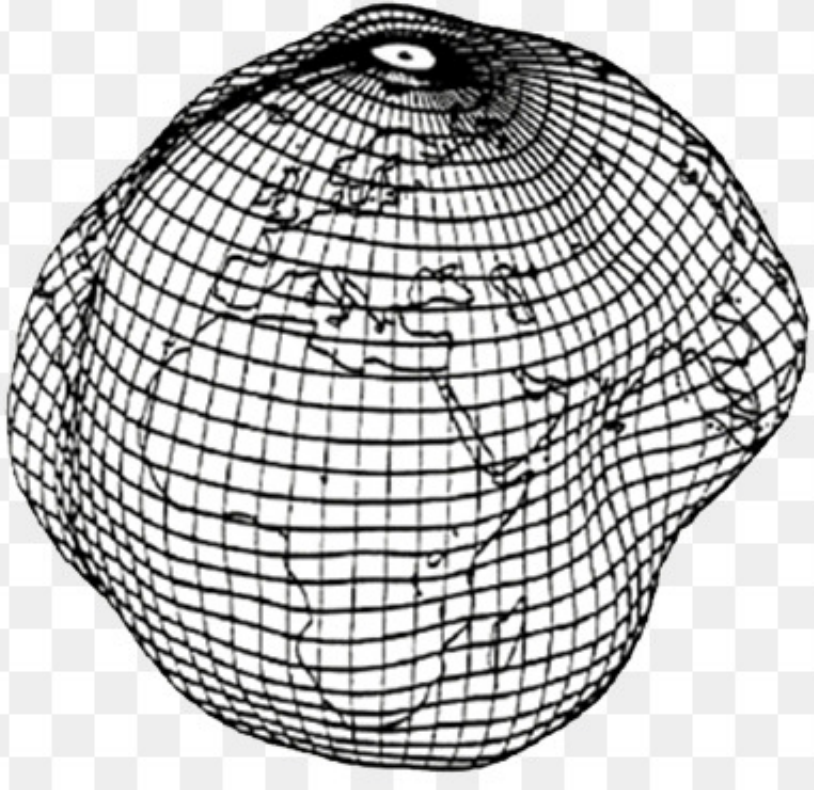
(*a*)

(*b*)

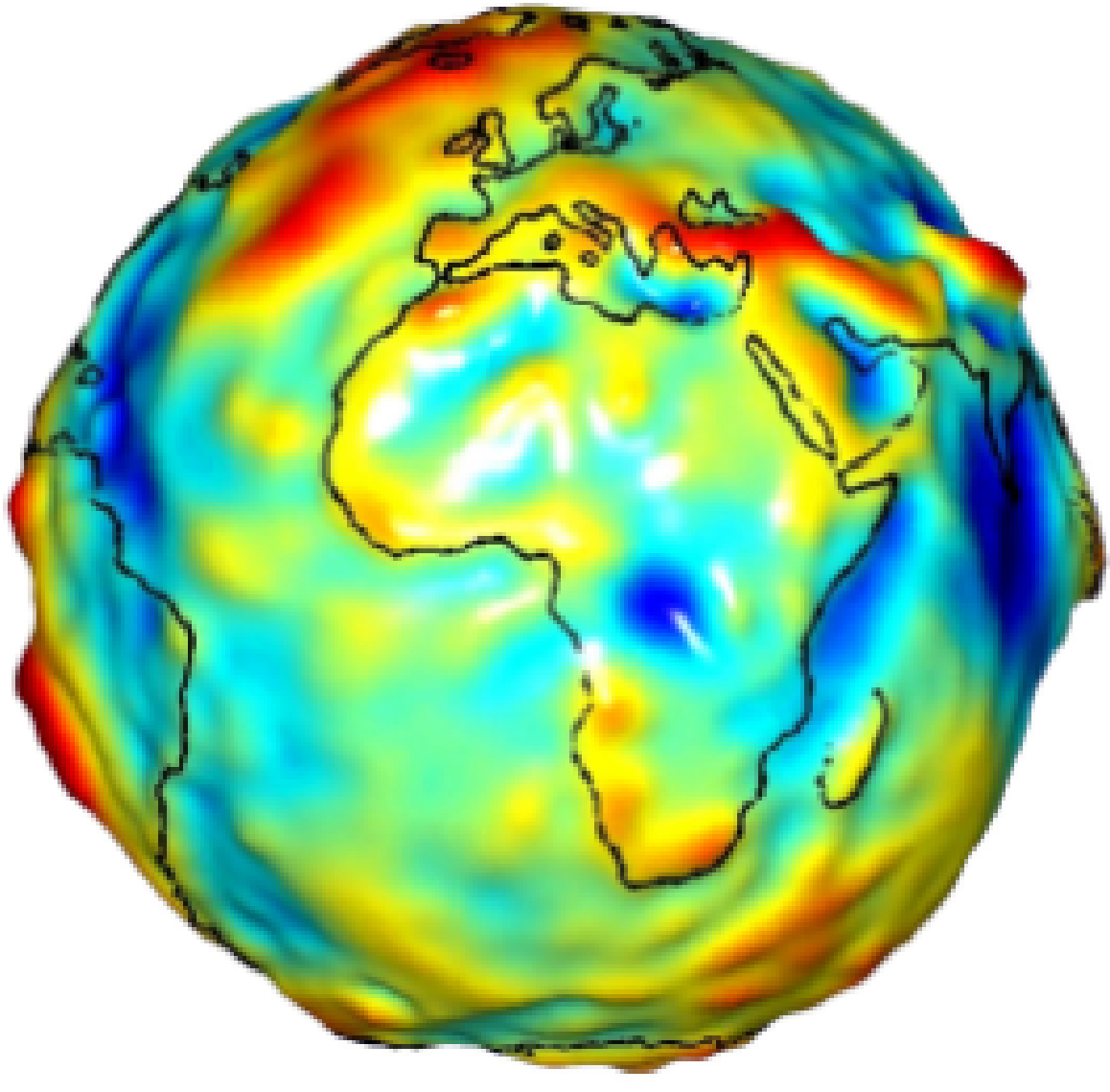
CRS

The Earth

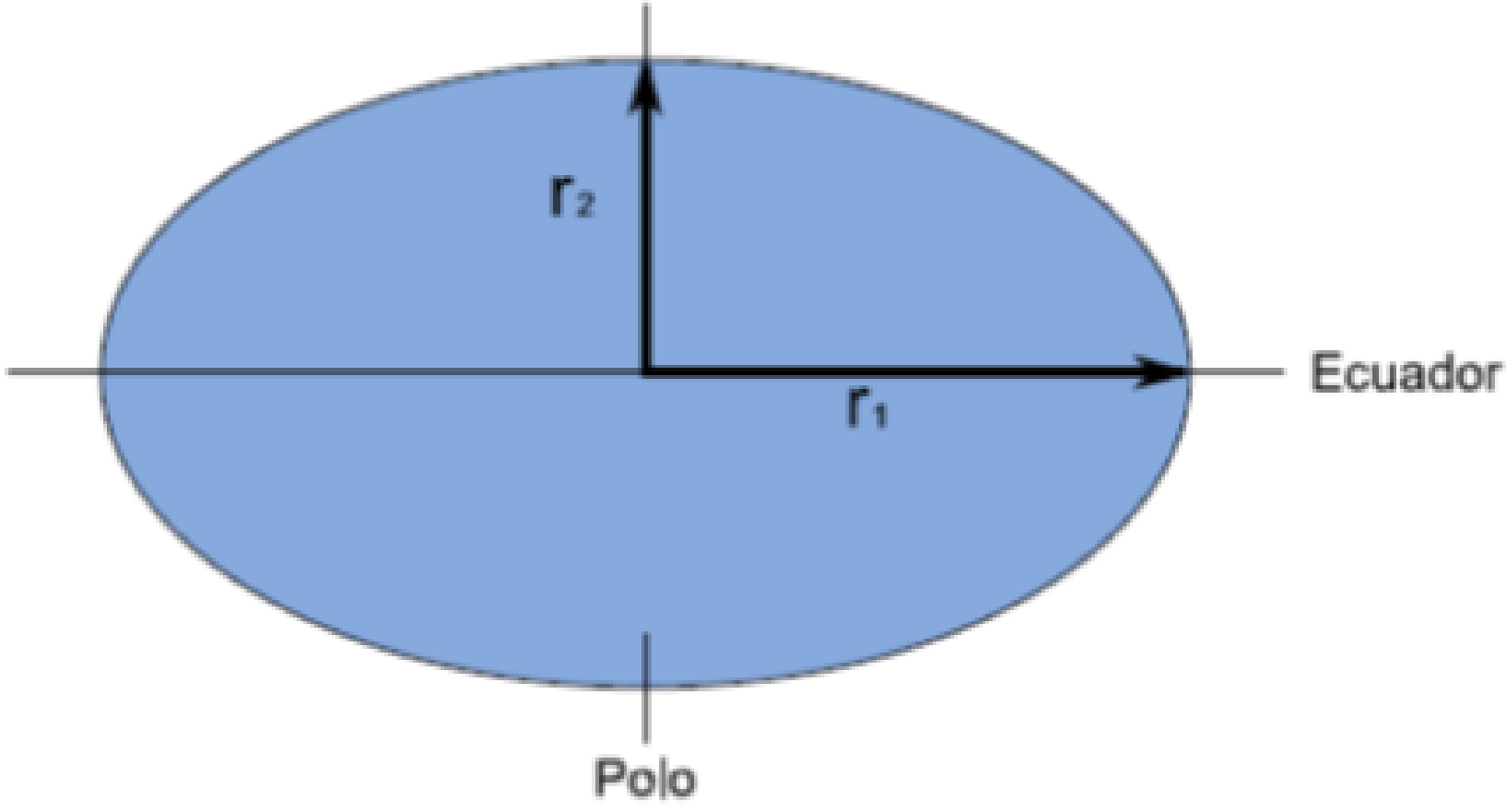


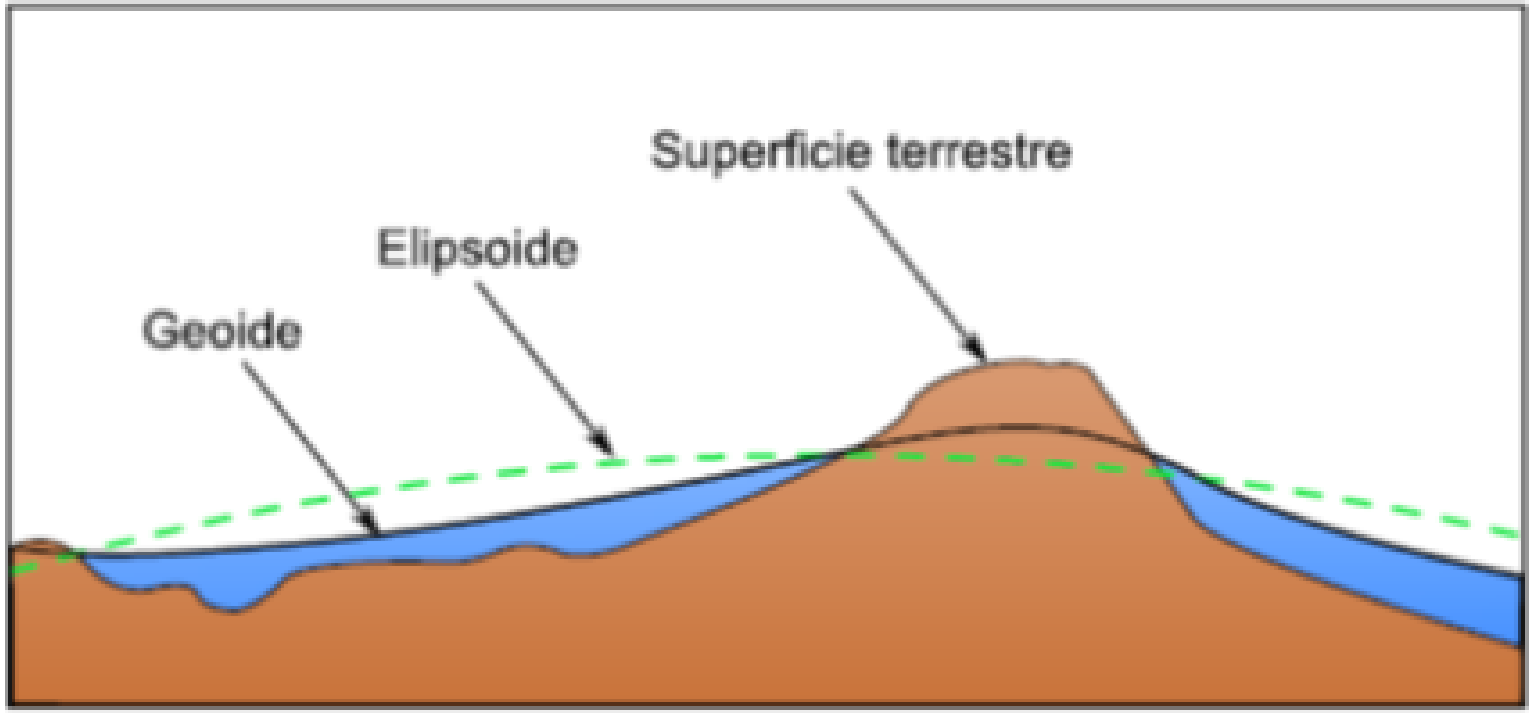


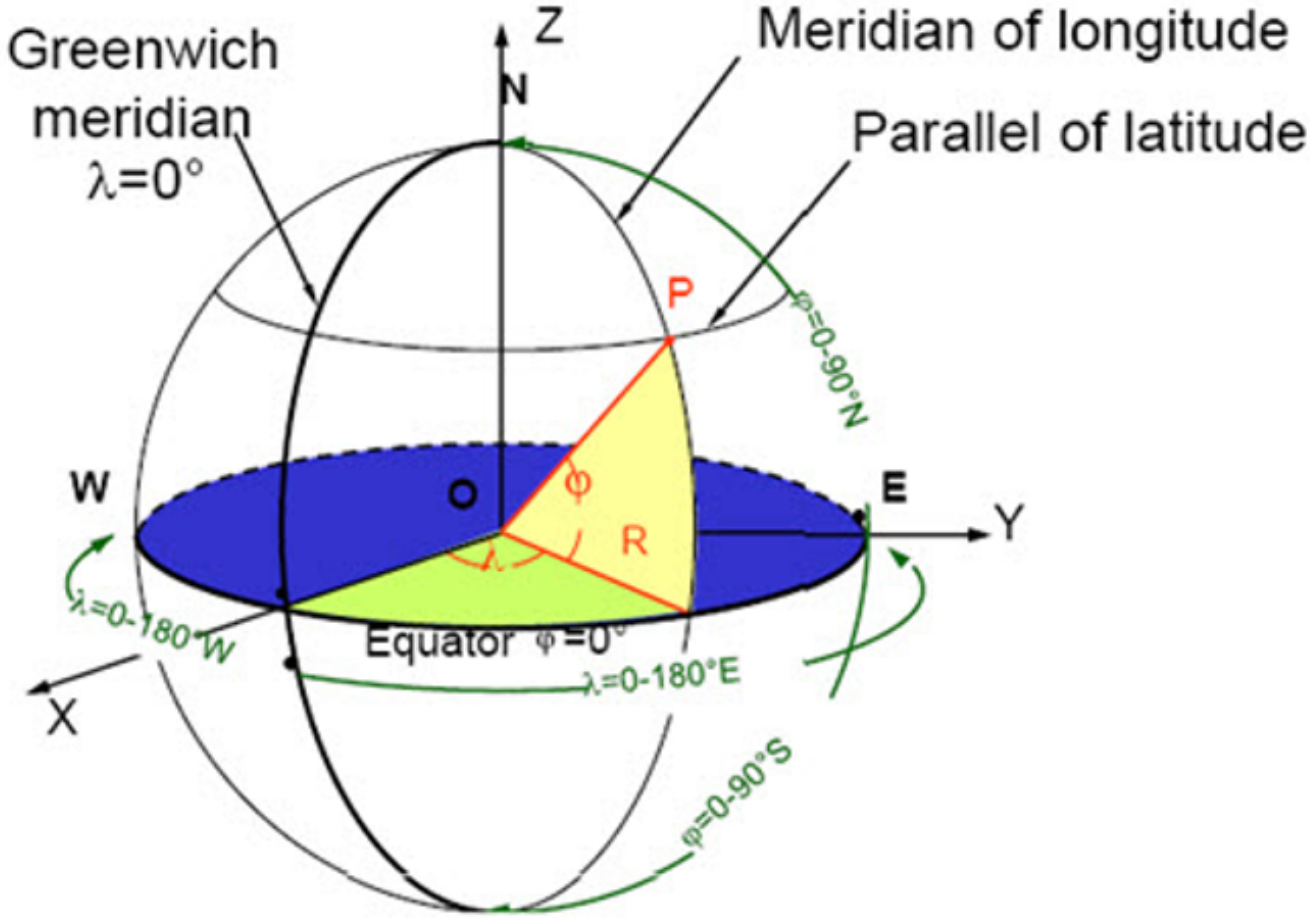
Geoide



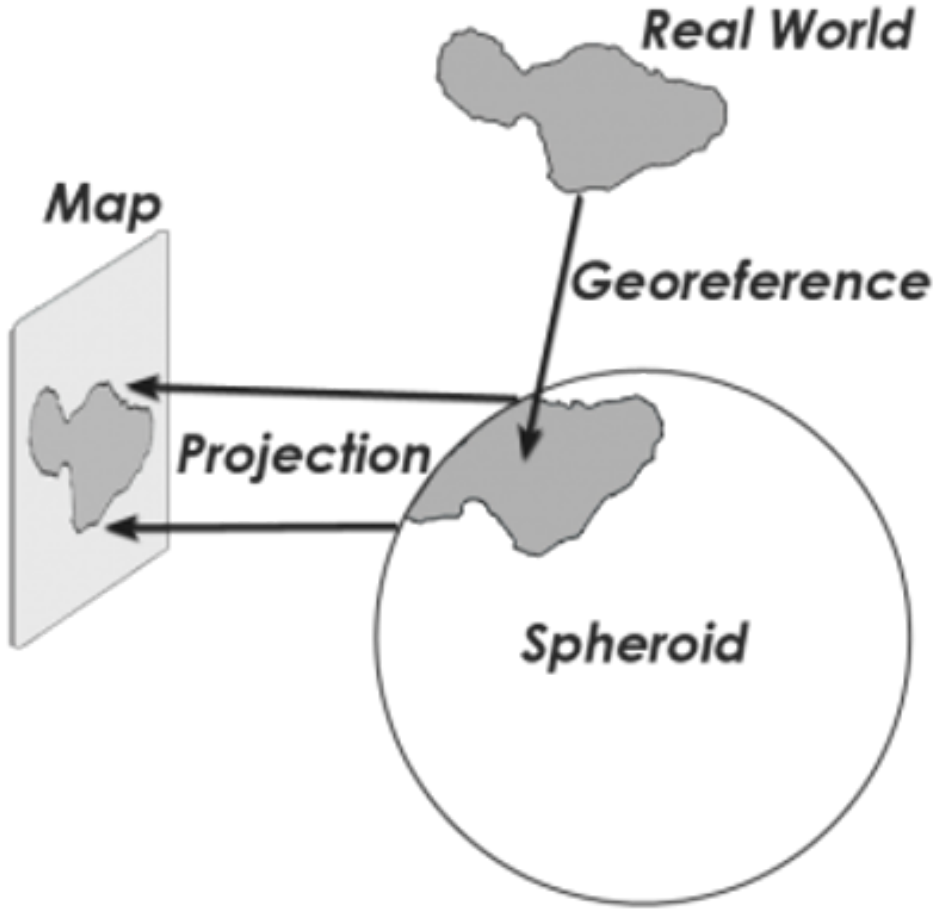
Elipsoide

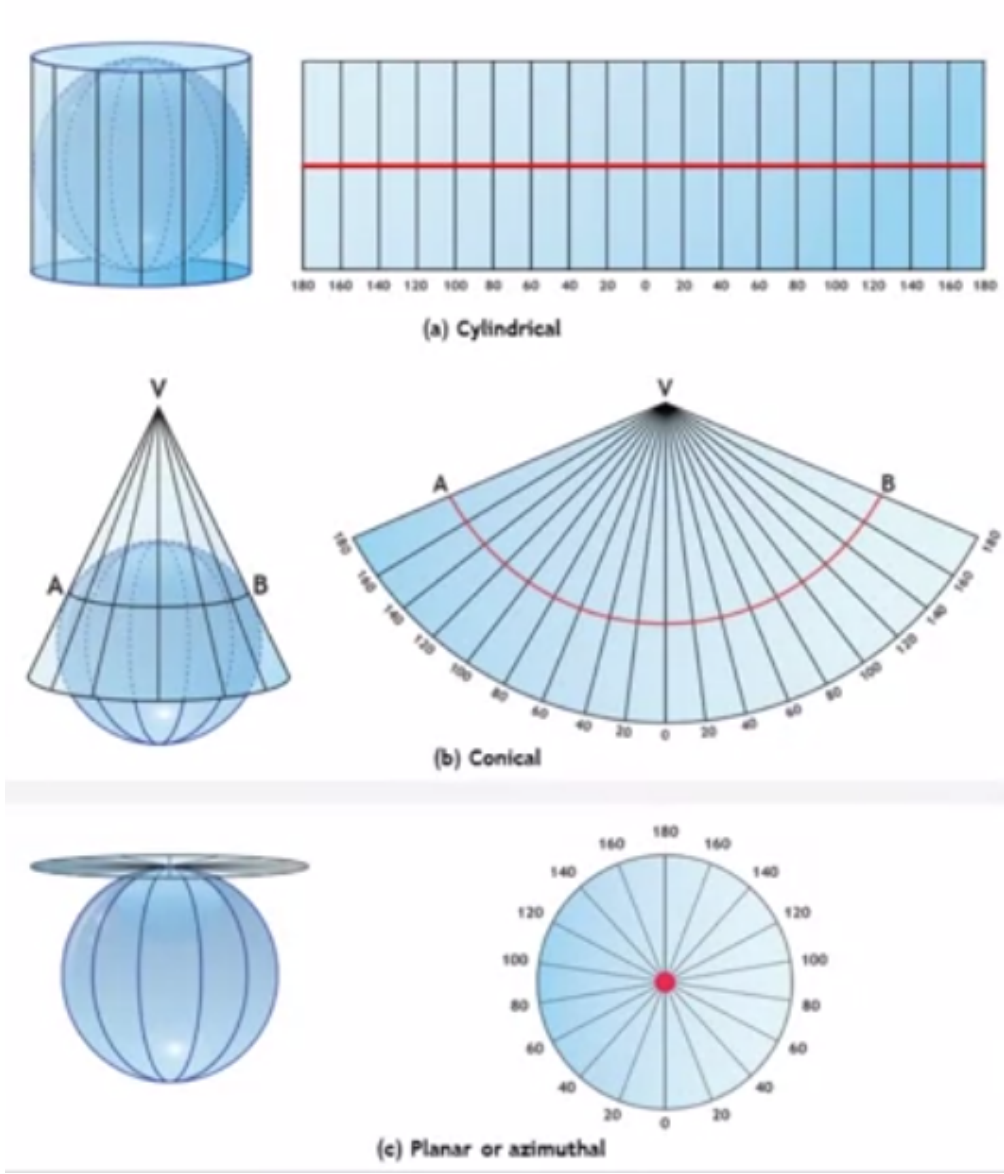



Superficie terrestre
Elipsoide
Geoide

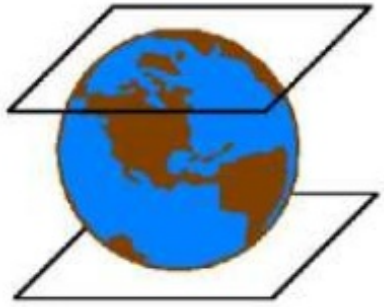

Greenwich
meridian
λ=0°
Z
N
Meridian of longitude
Parallel of latitude
P
φ=0-90°N
W
O
φ
R
E
Y
λ
λ=0-180°W
Equator φ=0°
λ=0-180°E
X
φ=0-90°S

Proyección a Coordenadas Planas



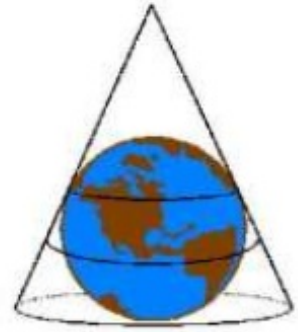

180 160 140 120 100 80 60 40 20 0 20 40 60 80 100 120 140 160 180
(a) Cylindrical
V
A
B
V
A
B
(b) Conical
180
160
160
140
140
120
120
100
100
80
80
60
60
40
40
20
20
0
(c) Planar or azimuthal

Según figura



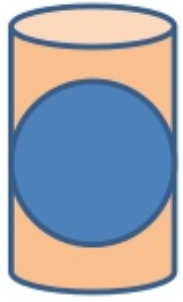
Azimutal

Cilíndrica

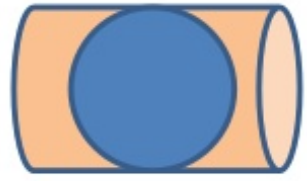


Cónica

Según posición



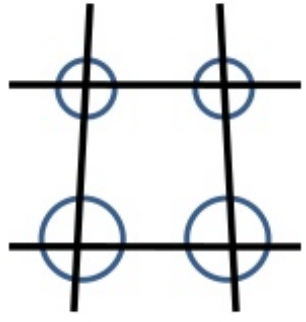
Normal



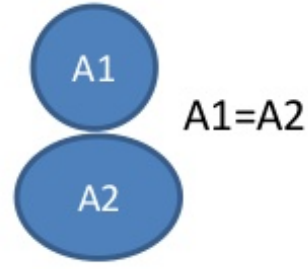
Transversal

Oblicua

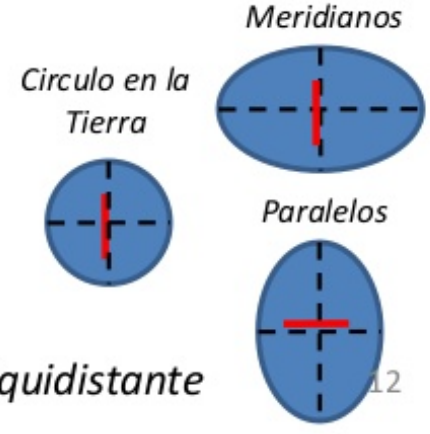
Según deformación



Conforme

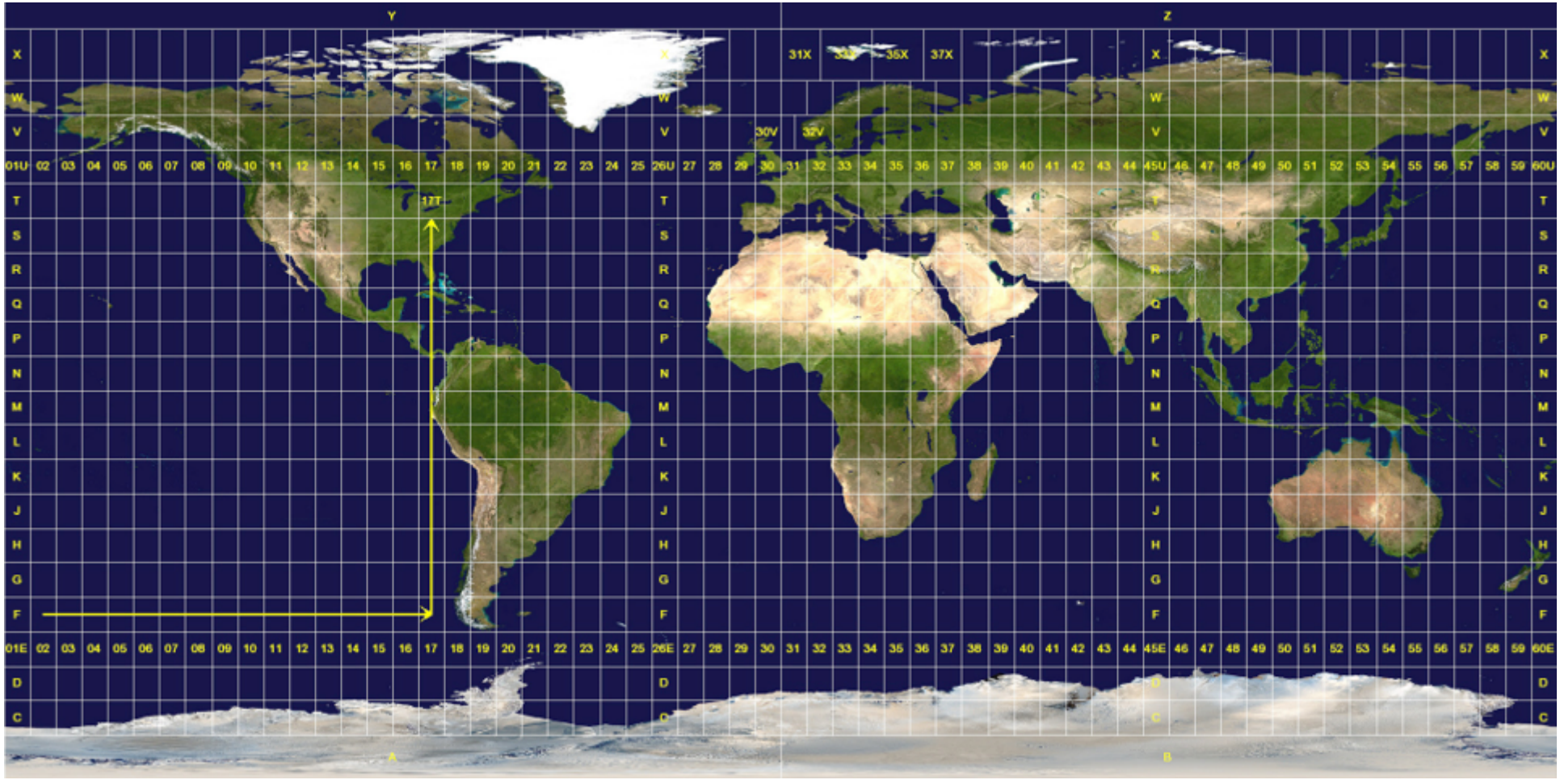


Equivalente



Equidistante

Universal Transversal Mercator (UTM)



Spatial Reference System Identifie

Home | Upload Your Own | List user-contributed references | List all references

Previous: EPSG:25829: ETRS89 / UTM zone 29N | Next: EPSG:25831: ETRS89 / UTM zone 31N

EPSG:25830

ETRS89 / UTM zone 30N (Google it)

- **WGS84 Bounds**: -6.0000, 34.7500, 0.0000, 62.3300
- **Projected Bounds**: 225370.7346, 3849419.9580, 774629.2654, 6914547.3835
- **Scope**: Large and medium scale topographic mapping and engineering survey.
- **Last Revised**: Oct. 19, 2000
- **Area**: Europe - 6°W to 0°W and ETRS89 by country

2:48:28am

- Well Known Text as HTML
- Human-Readable OGC WKT
- Proj4
- OGC WKT
- JSON
- GML
- ESRI WKT
- .PRJ File
- USGS
- MapServer Mapfile | Python
- Mapnik XML | Python
- GeoServer
- PostGIS spatial_ref_sys INSERT statement
- Proj4js format

Input Coordinates: -3, 48.54 Output Coordinates: 500000, 5376321.814613

The True Size of...