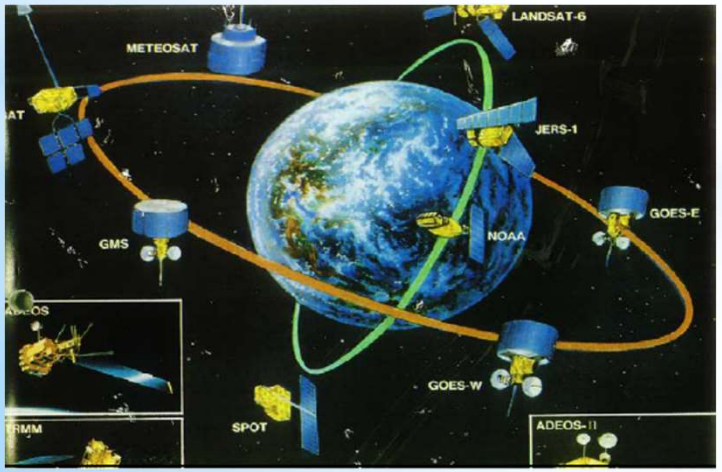
Introduction to Remote sensing and aplications



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D.Eng(RS&GIS)

*Contents

* Concept of Remote Sensing
* Overview of Remote Sensing Technology
* Application of Remote Sensing

*What is Remote Sensing ?

"Remote Sensing is defined as the science and technology by which *characteristics* of objects of interest can be identified without direct contact"

*Type of remote sensing

*Optical remote sensing

*High resolution (Quick bird, IKONOS, LANDSAT, SPOT, THEOS **(Thailand Earth Observation System)**)

*Moderate or Low resolution (Terra-MODIS,NOAA)

*Non Optical remote sensing (Microwave)

- Passive Sensor

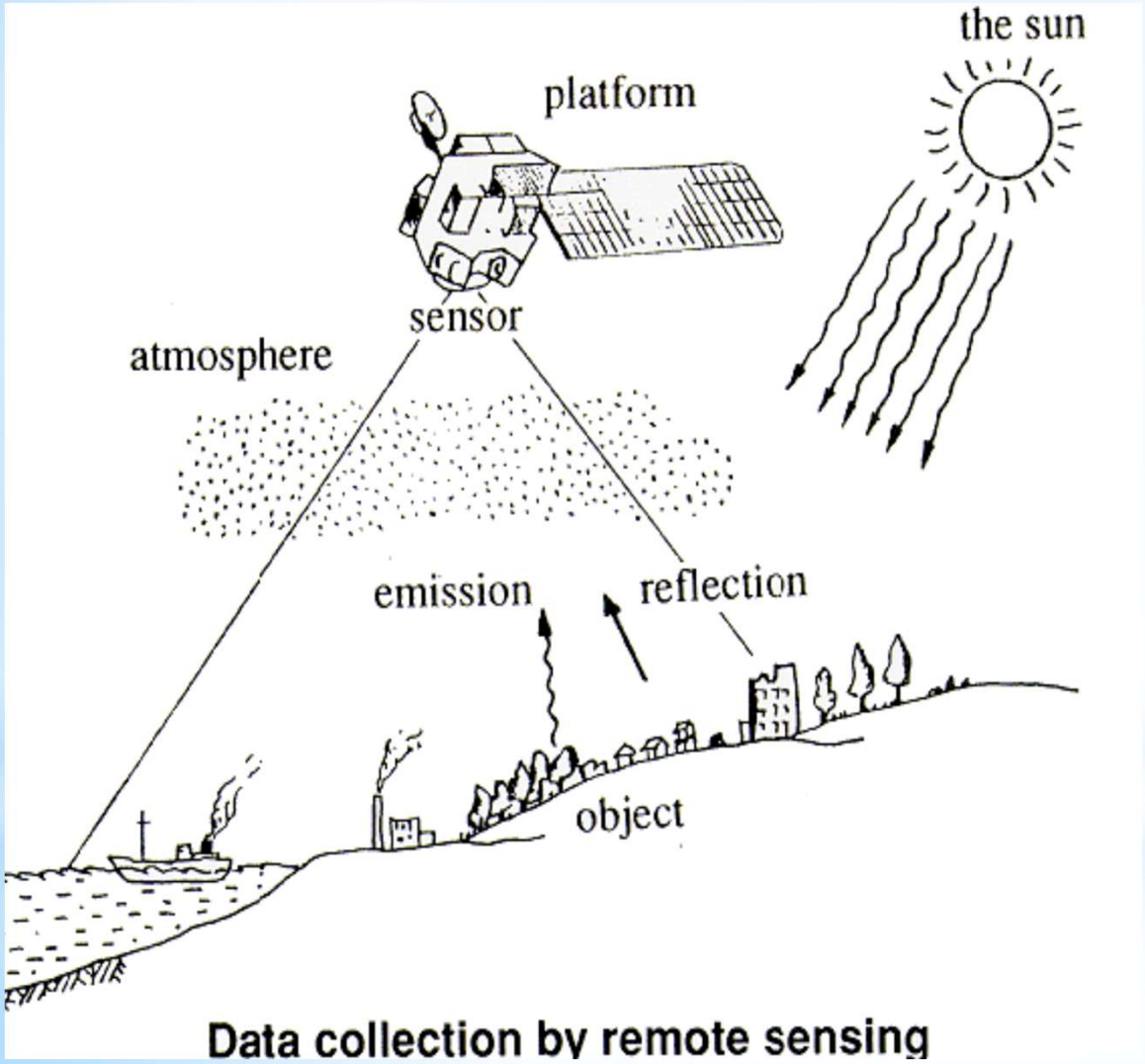
- Active Sensor

*Synthetic Aperture Radar (SAR)

*Real Aperture Radar (RAR)

*Synthetic Aperture Radar Interferometry (InSAR)

*Remote Sensing System



Data collection by remote sensing

Satellite Remote Sensing - Earth Observation
Broad Area

Quick,
180 kmx180km
30 sec
Repetitive

*Architecture of orbital system

*Low earth orbit (LEO)

➔ T<25 min , h<6,000 km

➔Earth sensing, some communication Human space flight

*Medium earth orbit (MEO)

➔225 min < T<24 hr. 6,000 km< h<36,000 km

➔some earth sensing, navigation (military)

*Geo-stationary orbit (GEO)

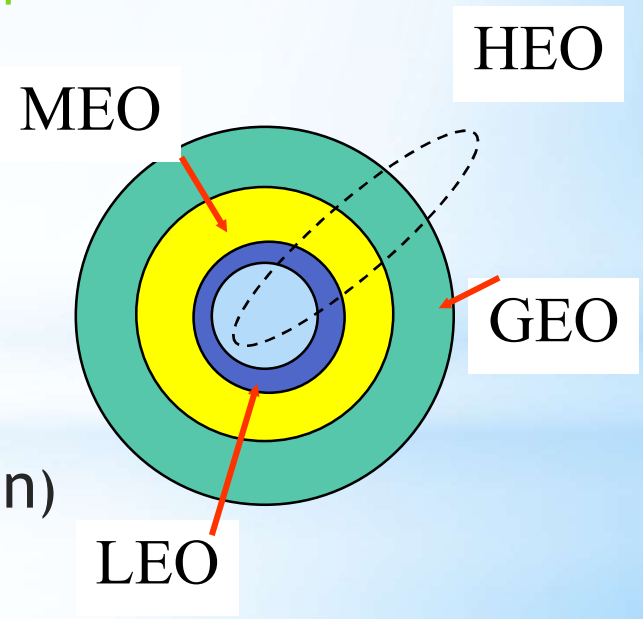
➔T=24 hr, h=36,000 km

➔geosynchronous, geostationary

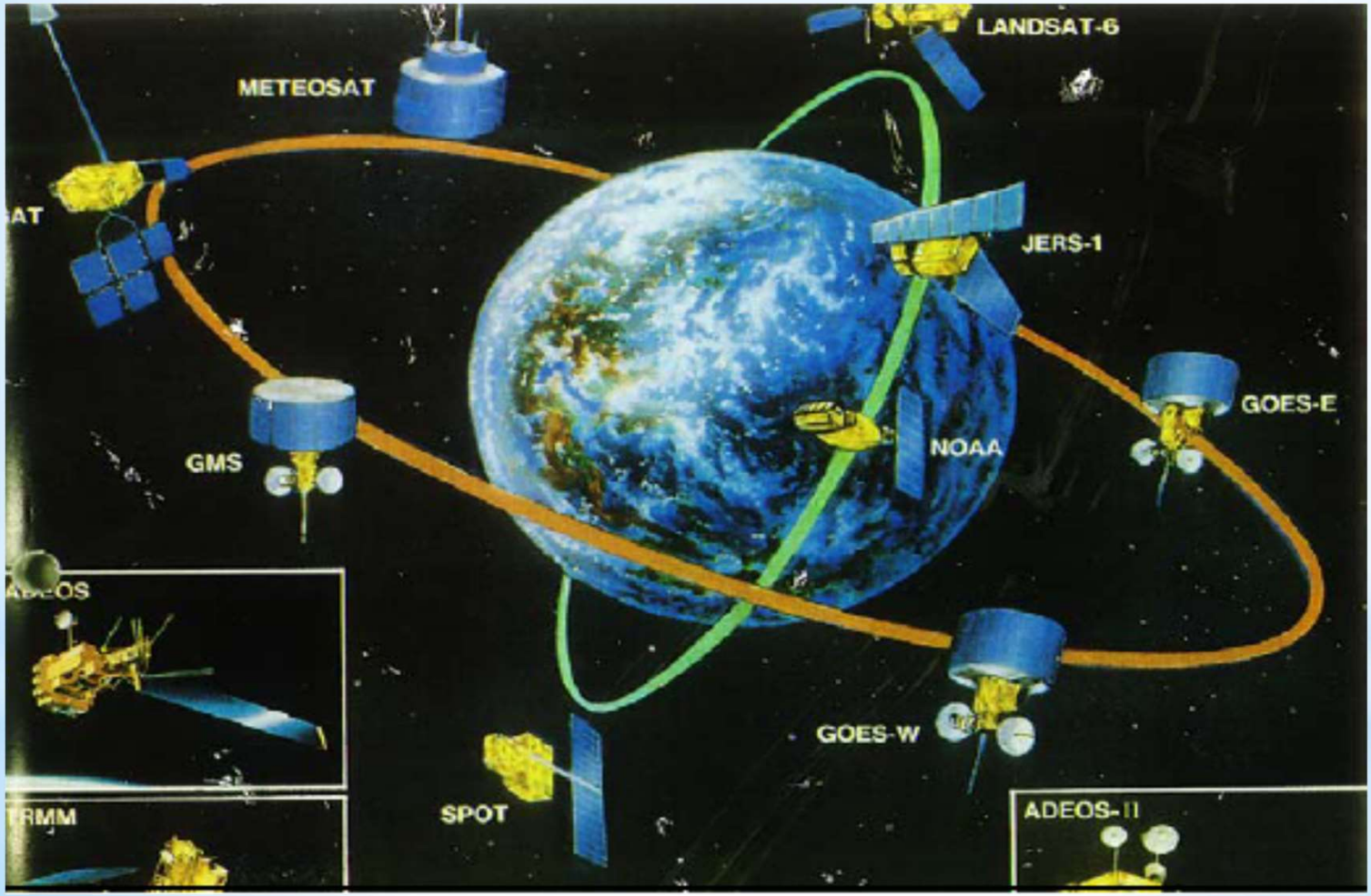
*Higher Earth orbit (HEO)

➔T>24 hr, h>36,000 km

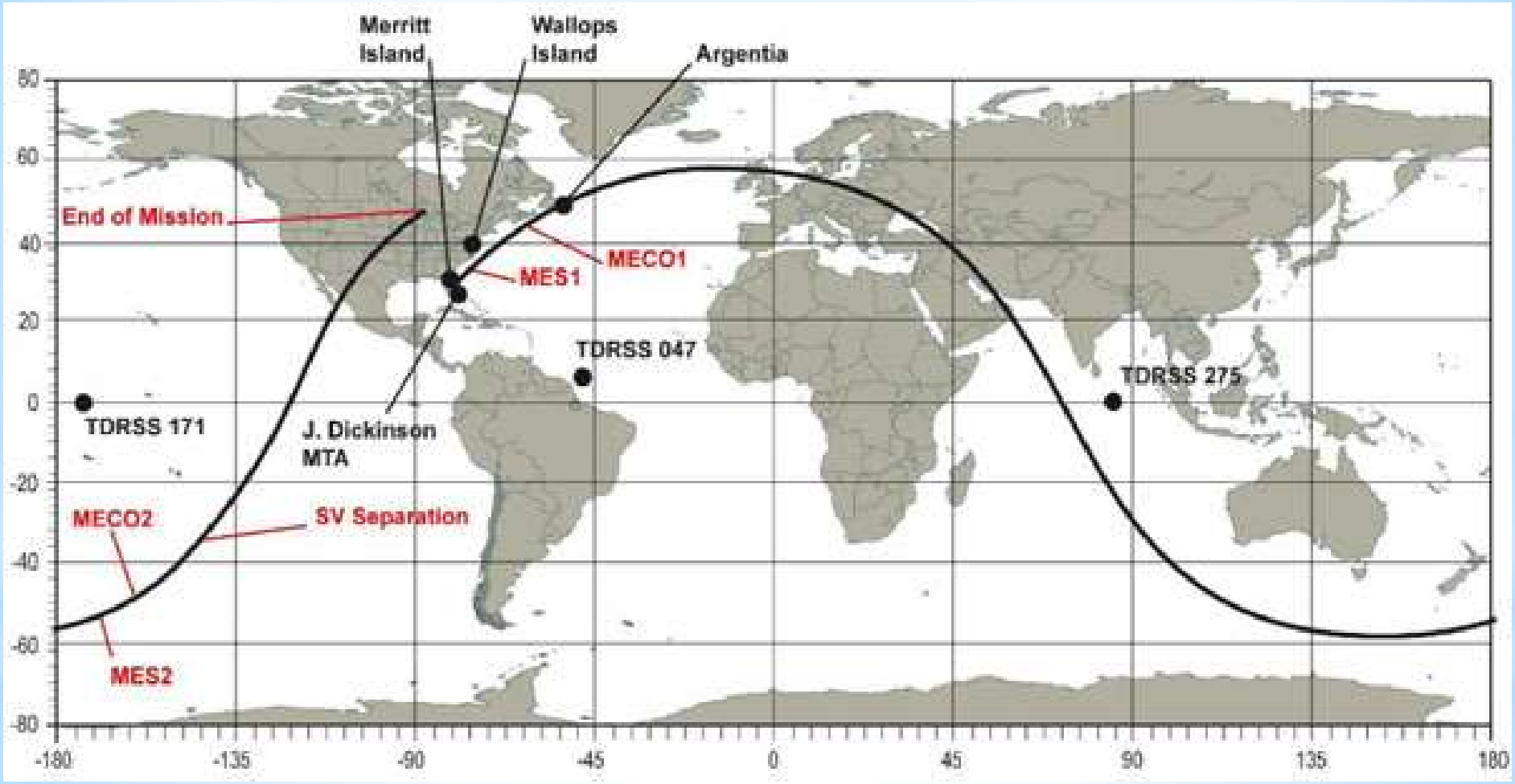
➔moninya orbit(military,comunication)



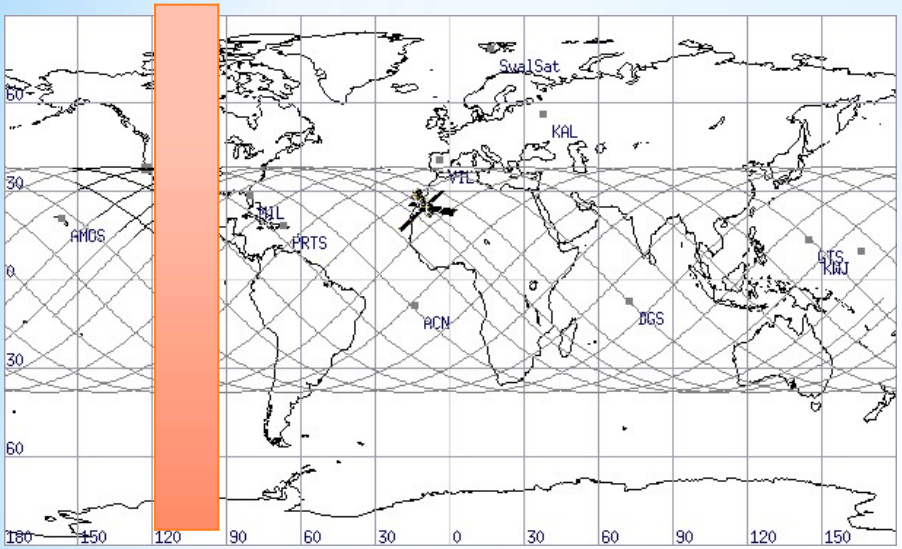
* Polar Orbit Satellite and Geostationary Satellite

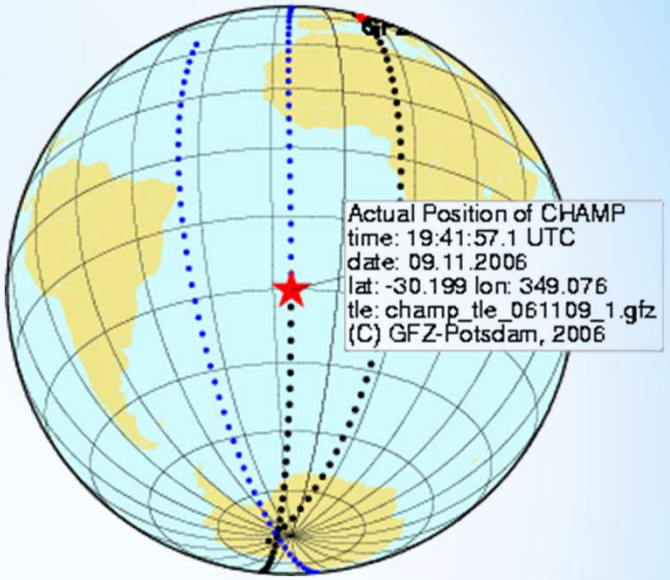


*Ground track

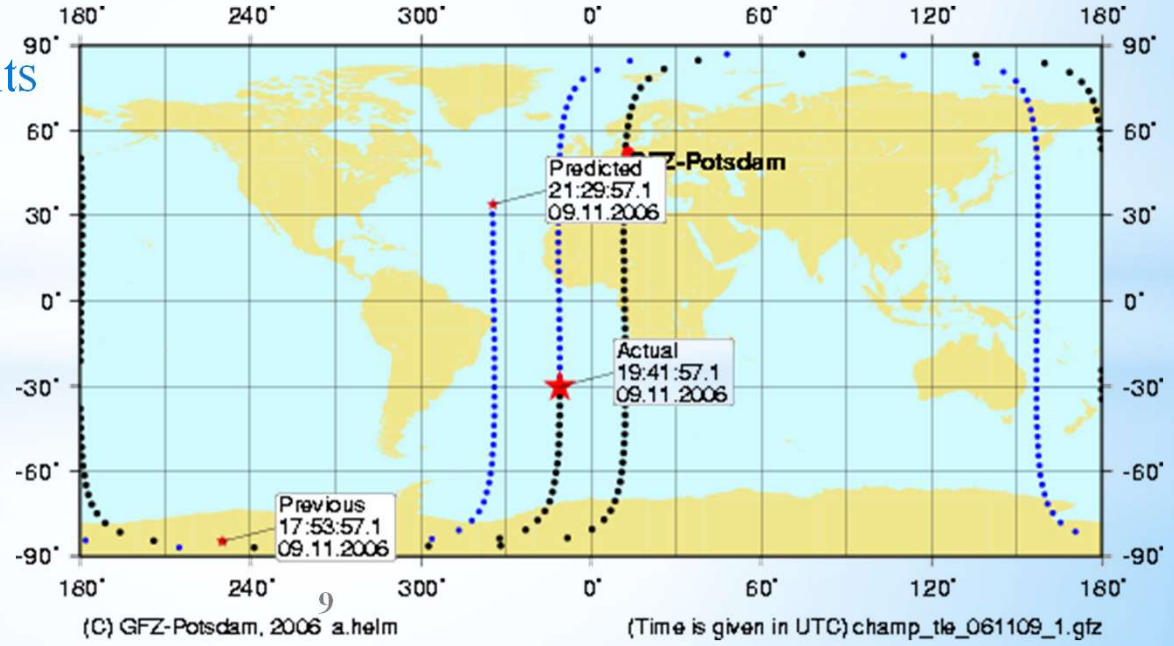


How height you can go?

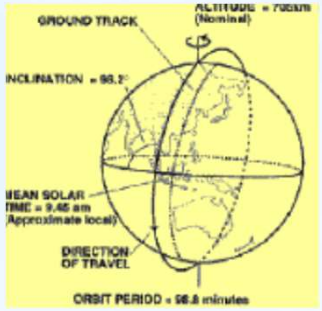


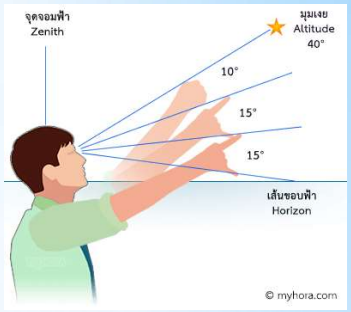


Ground Track for 16 Orbits

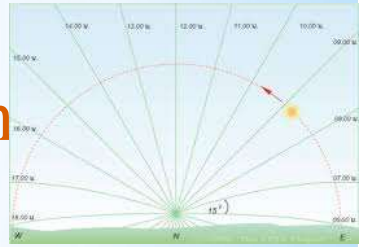


*Several Important Numbers

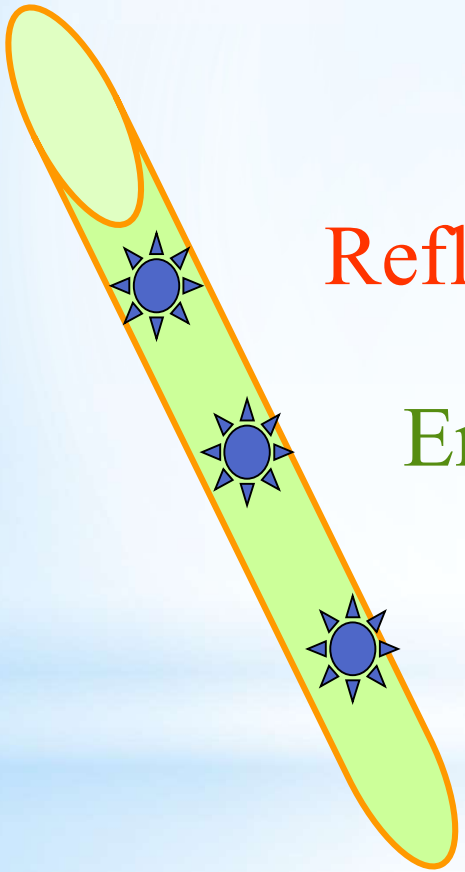




- Radius of Earth approx. 6,300km
  (a=6377, b=6356, Bessel)
- Altitude of Polar Orbit Satellite •300km - 900km
- Landsat 705km, JERS-1 568km, SPOT 822km,
  NOAA 833-870km
- Altitude of Geo-stationary Satellite 35,800km
- Speed of light 300,000km/sec
- Speed of Satellite (relative to the earth)
- 6.5km/sec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



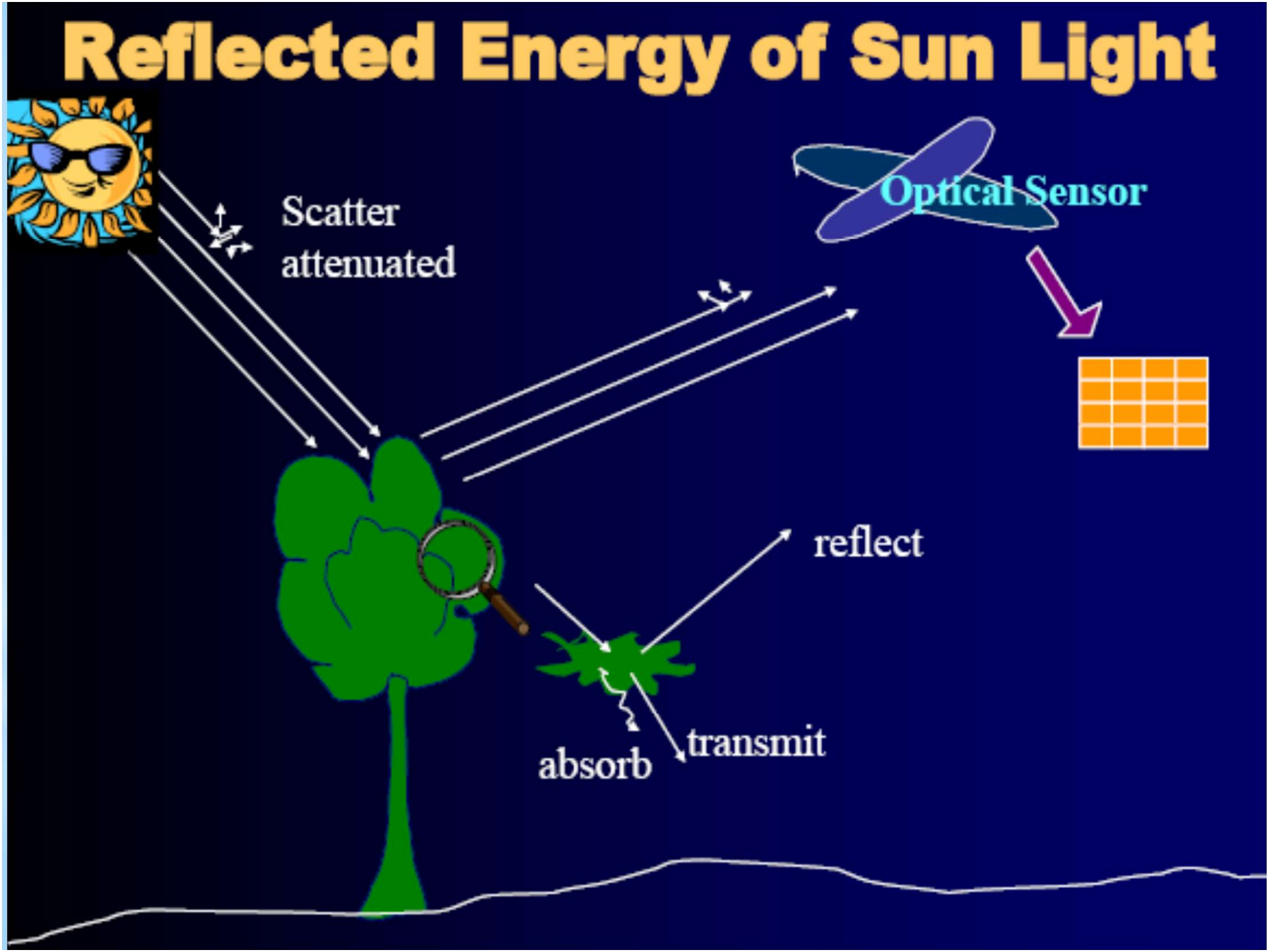
*What Does a Sensor Measure?



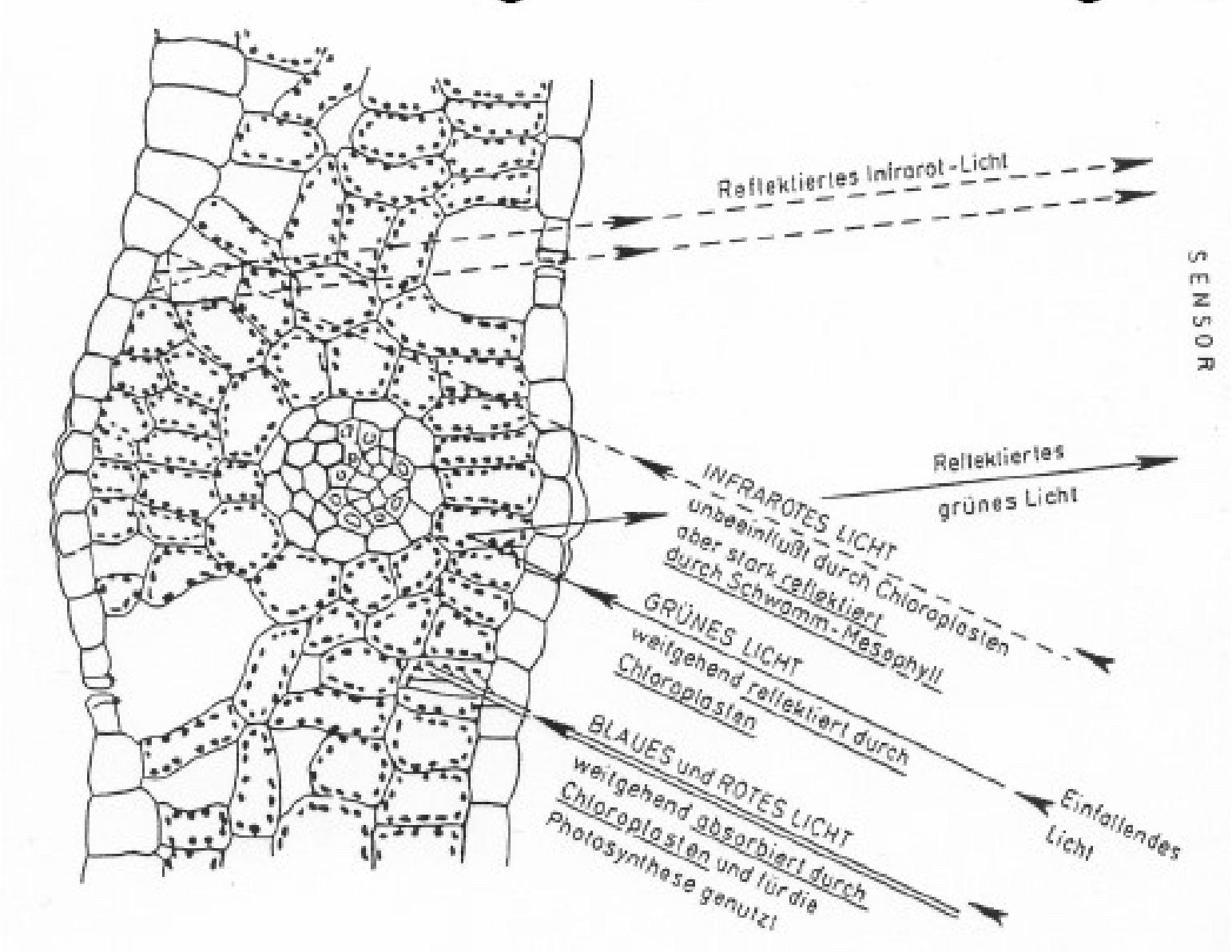
Reflected energy from the Earth

Emitted energy from the Earth

Scattered Energy from the Earth


Reflected Energy of Sun Light
Scatter
attenuated
Optical Sensor
reflect
absorb
transmit

Reflexionseigenschaften von Vegetation



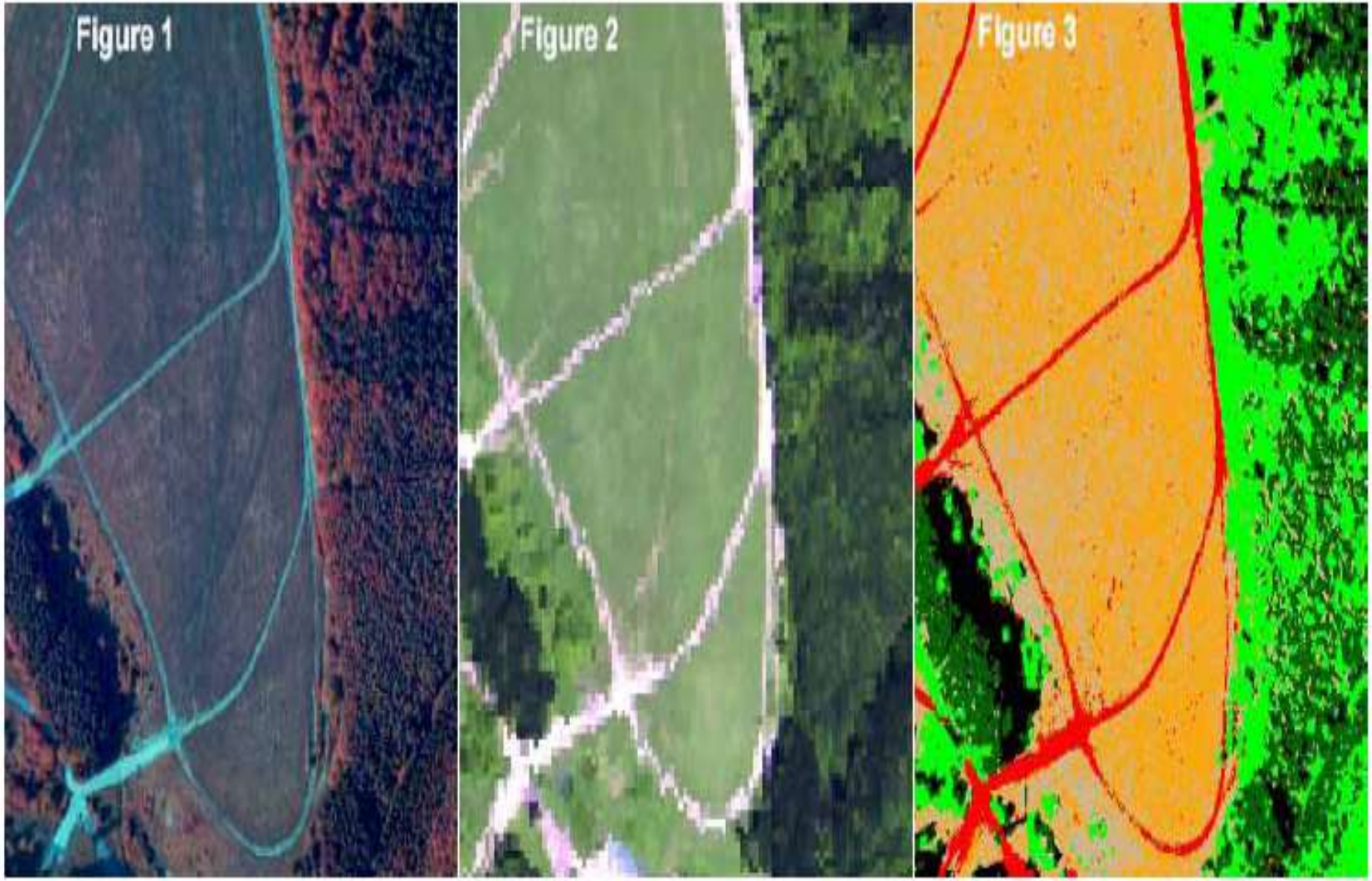
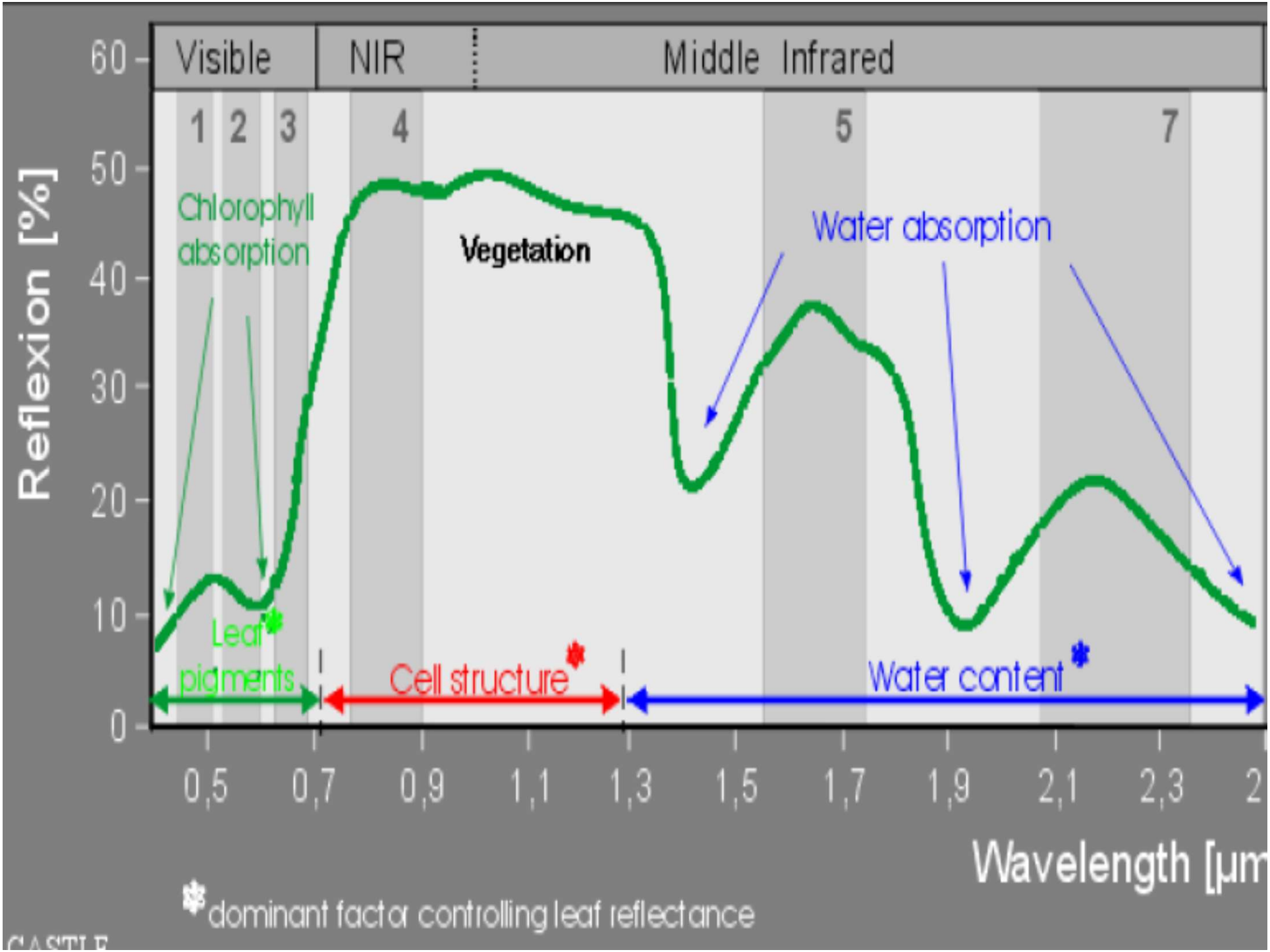


Figure 1
Figure 2
Figure 3


Visible
NIR
Middle Infrared
1
2
3
4
5
7
Reflexion [%]
60
50
40
30
20
10
0
Chlorophyll absorption
Vegetation
Water absorption
Leaf pigments
Cell structure
Water content
0,5
0,7
0,9
1,1
1,3
1,5
1,7
1,9
2,1
2,3
Wavelength [µm
dominant factor controlling leaf reflectance

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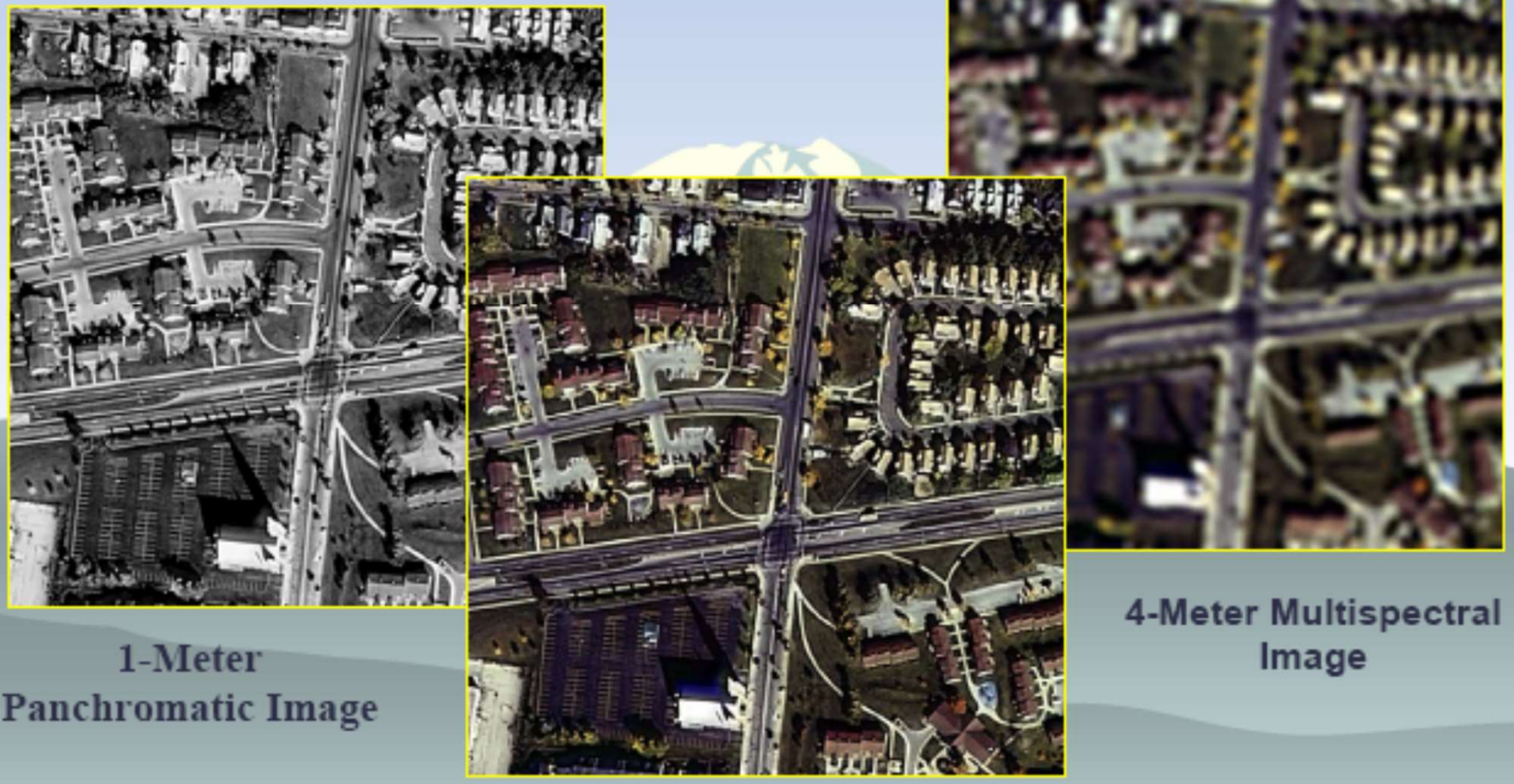
* Optical Remote sensing

Landsat 7 ETM+ Image around Lake Titicaca, Bolivia/Peru


QuickBird Imagery of Suvarnabhumi Airport and Vicinity
acquired on November 21, 2005
Bangkok-Chon Buri New Highway
Lad Krabang Rd.
On Nut Rd.
King Kaew Rd.
Bang Na - Trad
Highway
© DigitalGlobe/GISTDA_2005

Pan-sharpened imagery – Ikonos example



1-Meter
Panchromatic Image

4-Meter Multispectral
Image

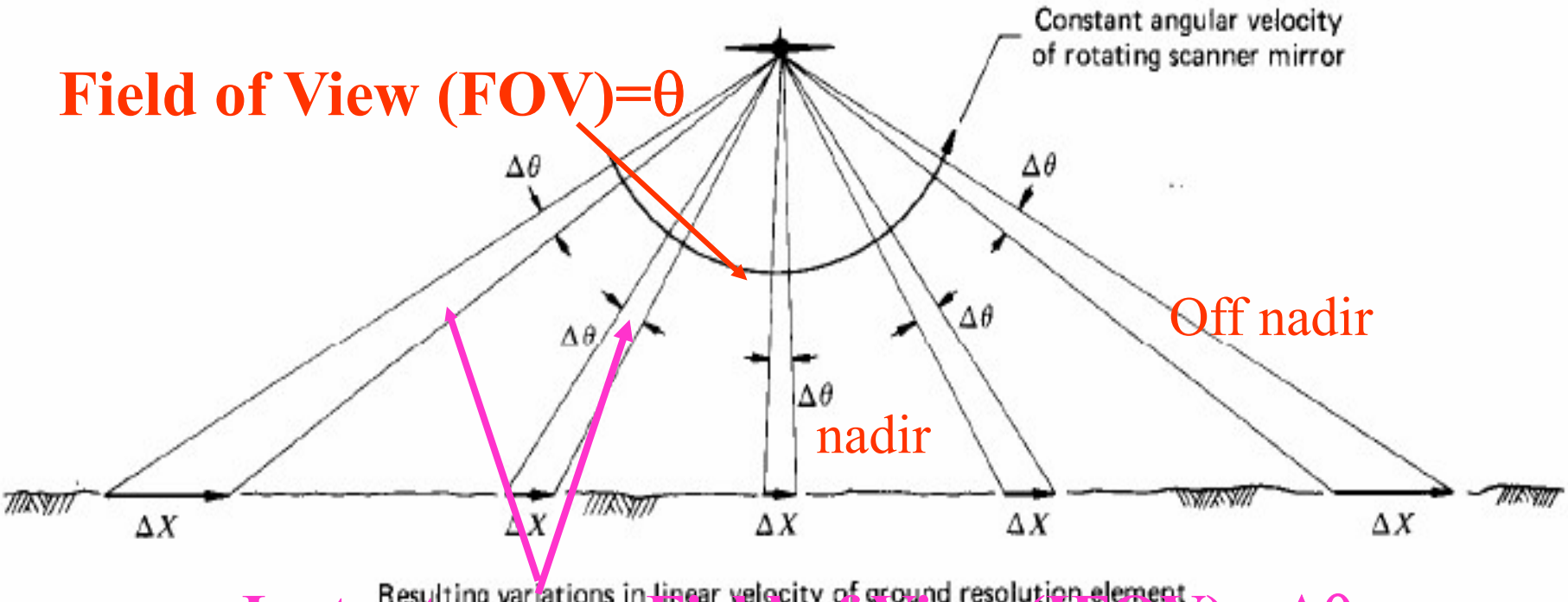
1-Meter Pan-Sharpened Image

*Microwave-RS (Non optical)

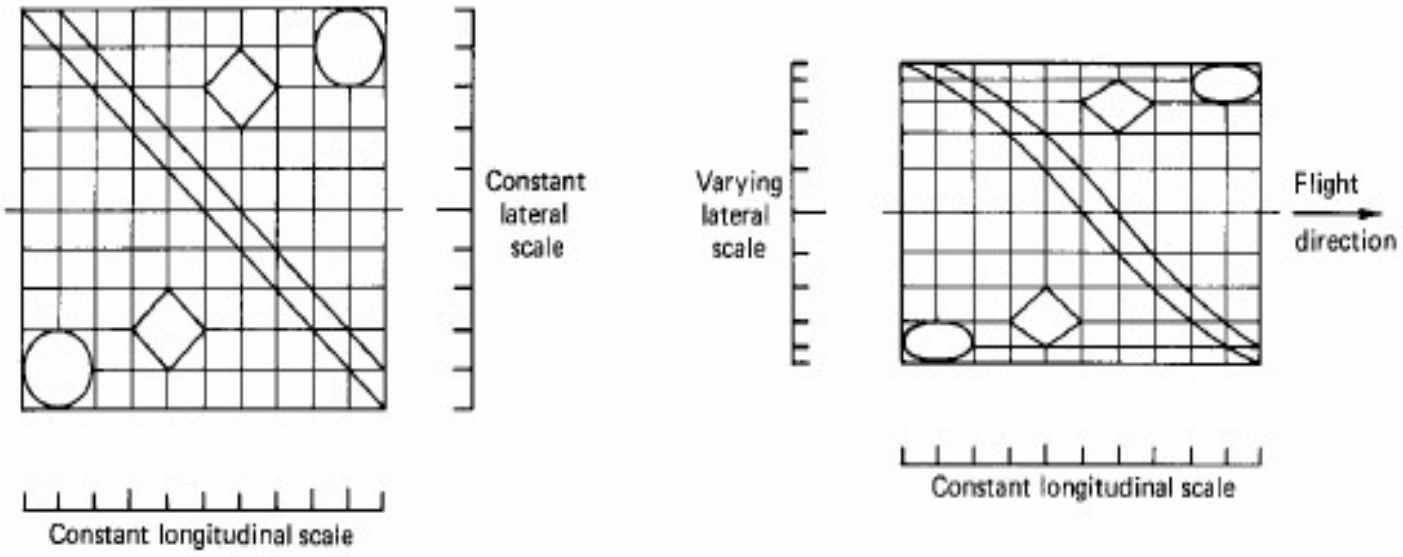
JERS1-OPS
(Optical sensor)

JERS1-sar
(active microwave sensor)

Field of View (FOV)=θ

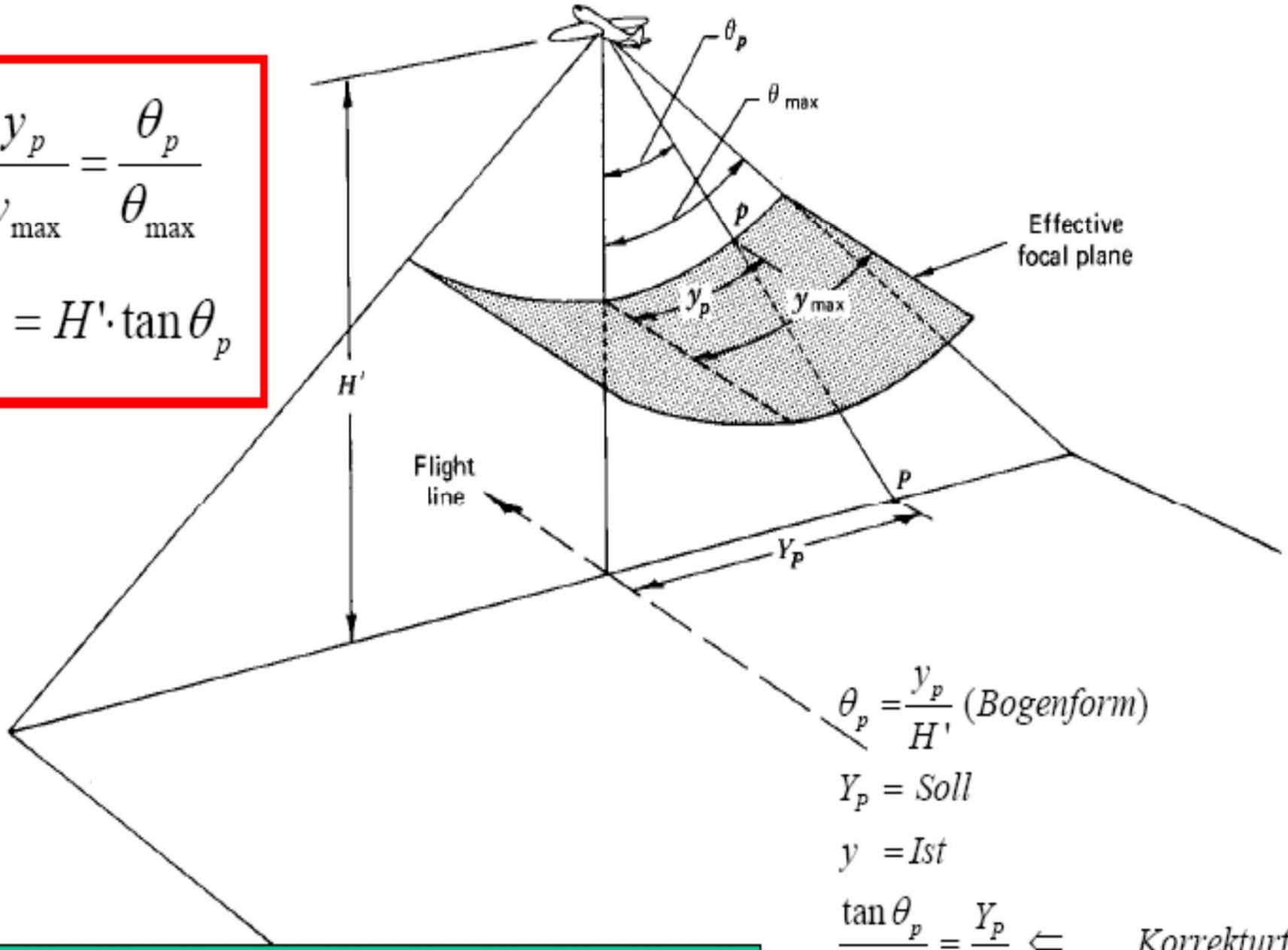


Instantaneous Field of View (IFOV)= Δθ= ω



$$\frac{y_p}{y_{max}} = \frac{\theta_p}{\theta_{max}}$$

$$Y_p = H' \cdot \tan\theta_p$$



$$\theta_p = \frac{y_p}{H'} \; (Bogenform)$$

$Y_p = Soll$

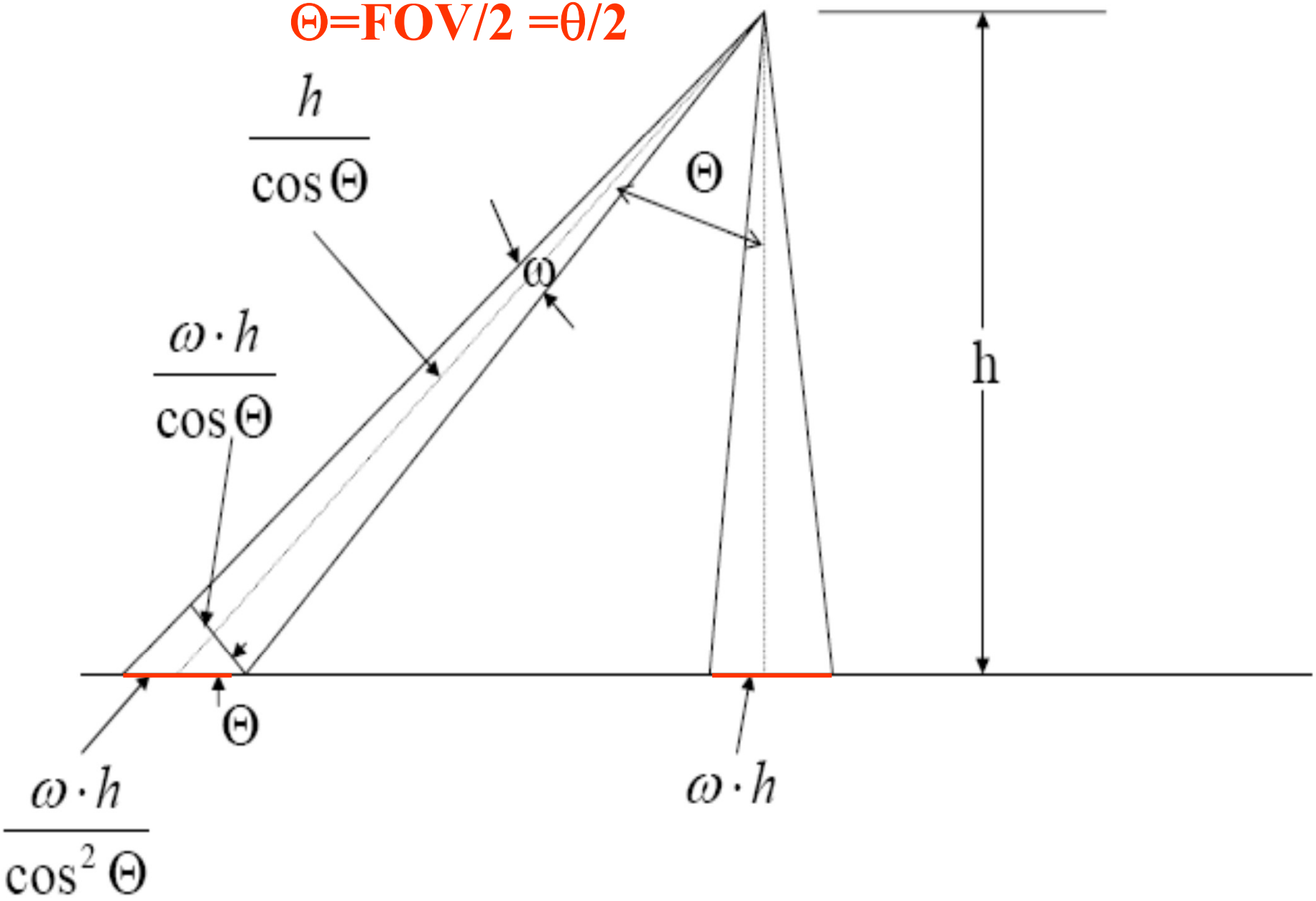
$y = Ist$

$$\frac{\tan\theta_p}{\theta_p} = \frac{Y_p}{y} \Leftarrow \quad Korrekturform$$

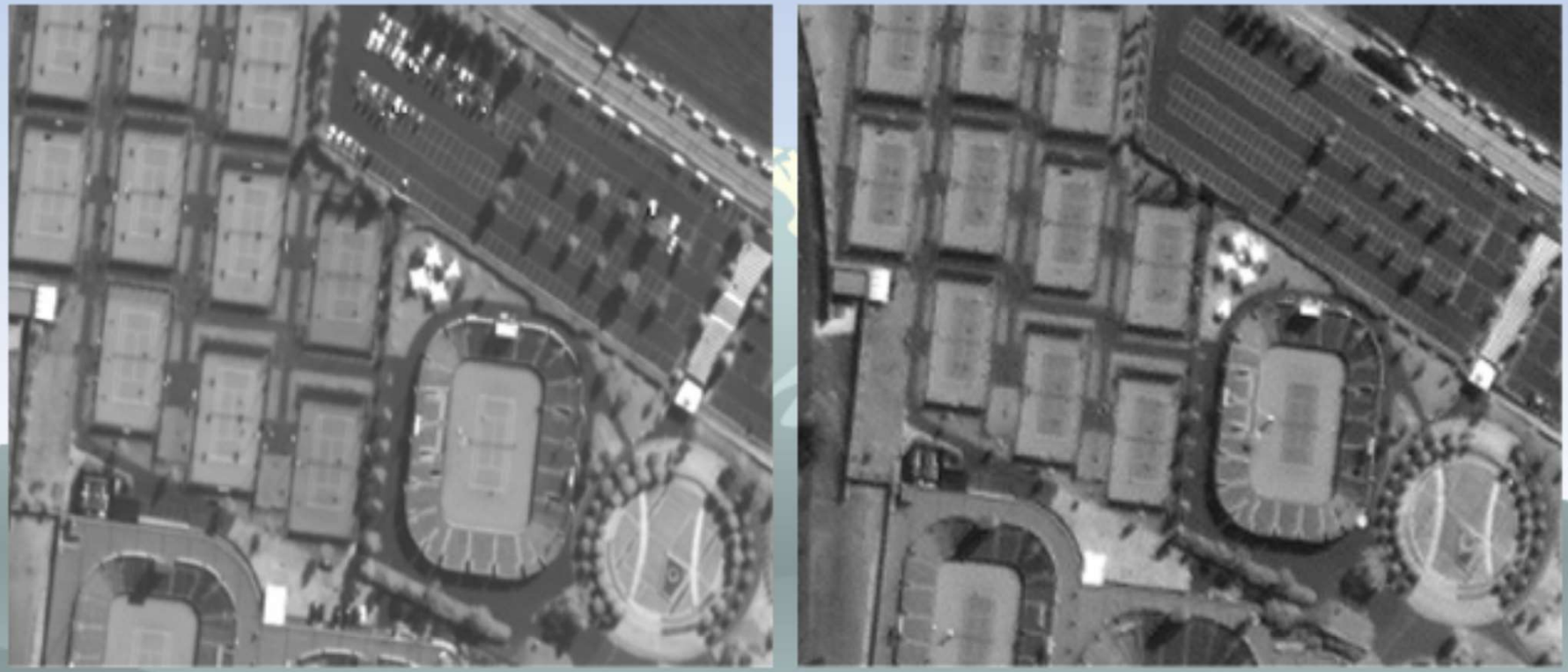
Panoramakorrektur

IFOV = $\Delta\theta = \omega$

Θ=FOV/2 =θ/2



Quickbird 70 cm pan (left) versus *Ikonos* 1m pan (right)



Tennis Centre, Melbourne

Comparison between IKONOS and Quickbird

Item	IKONOS	Quickbird
Focal Length	10m	9m
Altitude	680km	450km
No of pixel/l	13,800	27,500
FOV	0.93deg.	2.1deg.
Resolution	0.82m	0.61m
Coverage	11x11km	16.5x16.5km
•IFOV	1.206 μrad.	1.356 μrad.

*Example

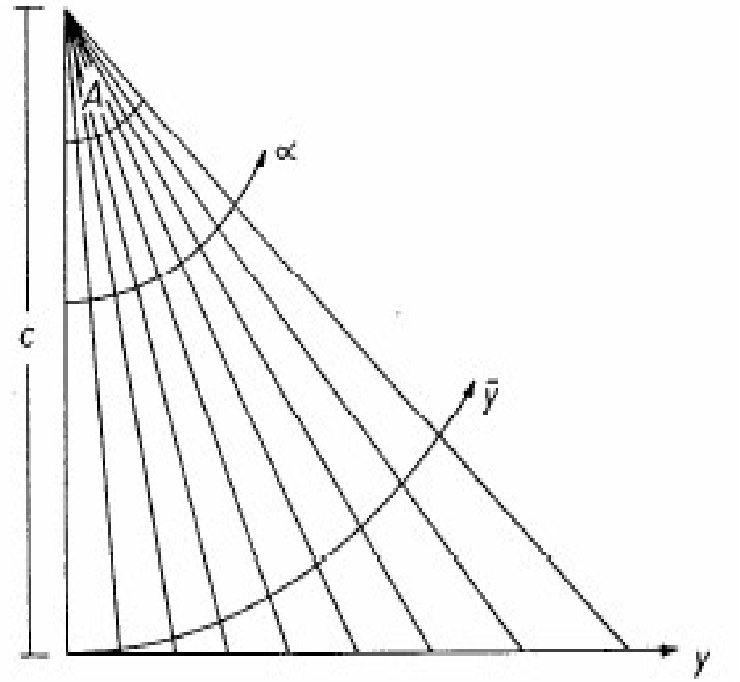
1. ถ้าต้องการถ่ายภาพให้ได้ความชัดถึง 10 cm (nadir). จะต้องให้ดาวเทียม quick bird ถ่ายภาพที่ระดับความสูงเท่าใด

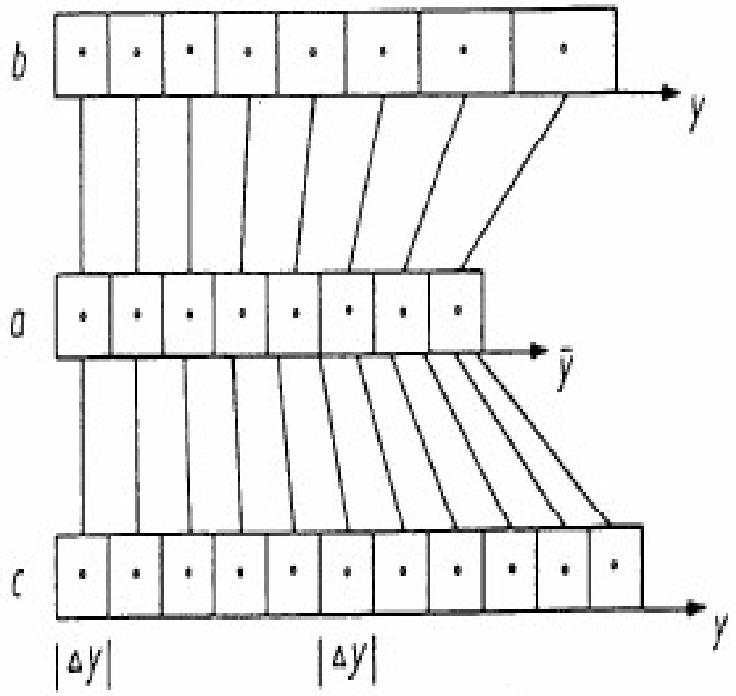
ถ้าปัจจุบัน sensor altitude = 450 km. Res.=0.60 m

2. ดาวเทียมดวงหนึ่งถ่ายได้ละเอียดที่ 80 cm (nadir). sensor อยู่สูงเท่าใดและบริเวณไกลสุด off nadir จะถ่ายภาพของวัตถุได้อย่างชัดที่สุดเมื่อวัตถุมีขนาดเท่าใด ถ้าปัจจุบัน IFOV=1.0 μrad. FOV =90 °

Ans. $h=0.8/1x10^{-6}=800,000$ m. = 800 km

Res' = $0.8 /\cos^2(90/2) = 1.6$ m.





Panoramaverzerrung

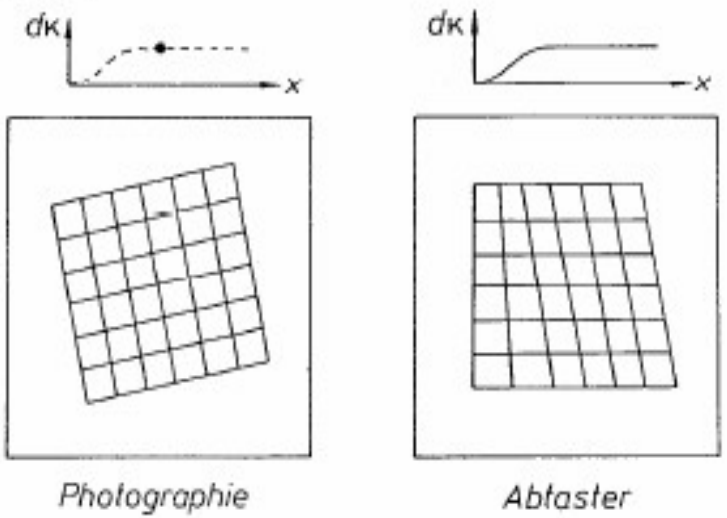
a) Originaldaten einer Halbzeile

b) panoramakorrigierte Daten mit Bildelementen ungleicher Größe

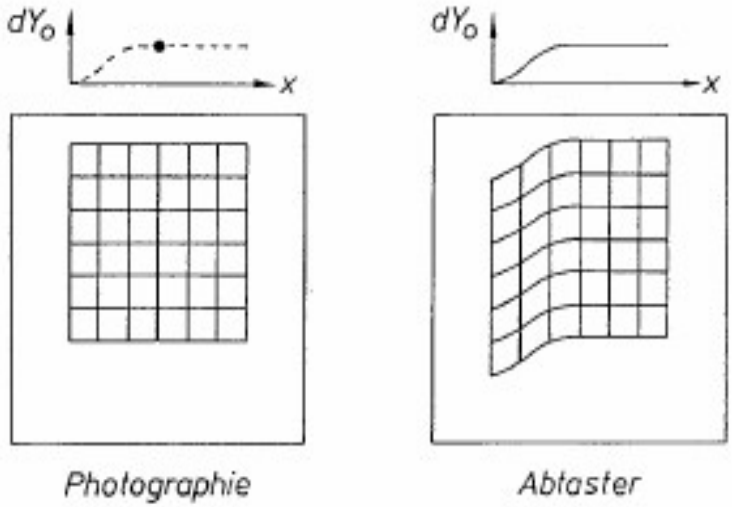
c) panoramakorrigierte Daten mit Bildelemeten gleicher Größe (interpoliert)

Parametrische Entzerrung (Forts.)

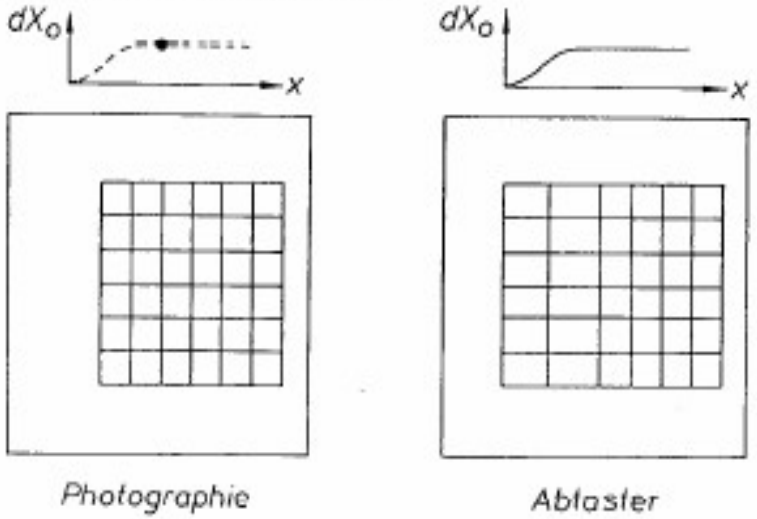
c) Kantung $d\kappa$



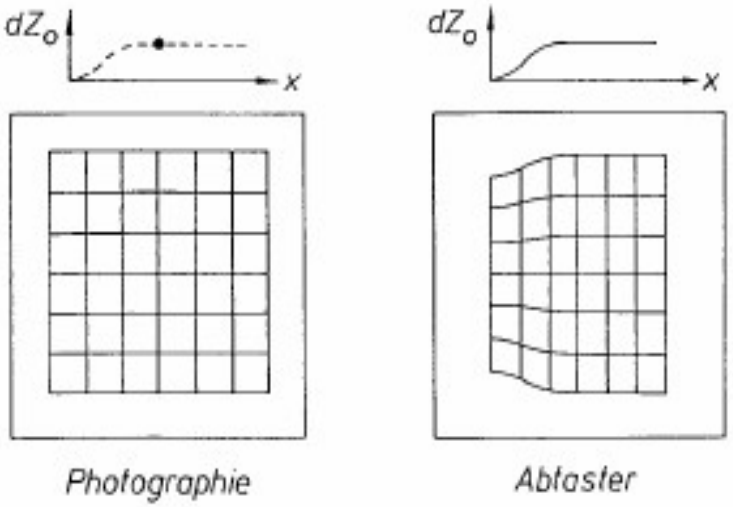
e) Kursabweichung dY_0



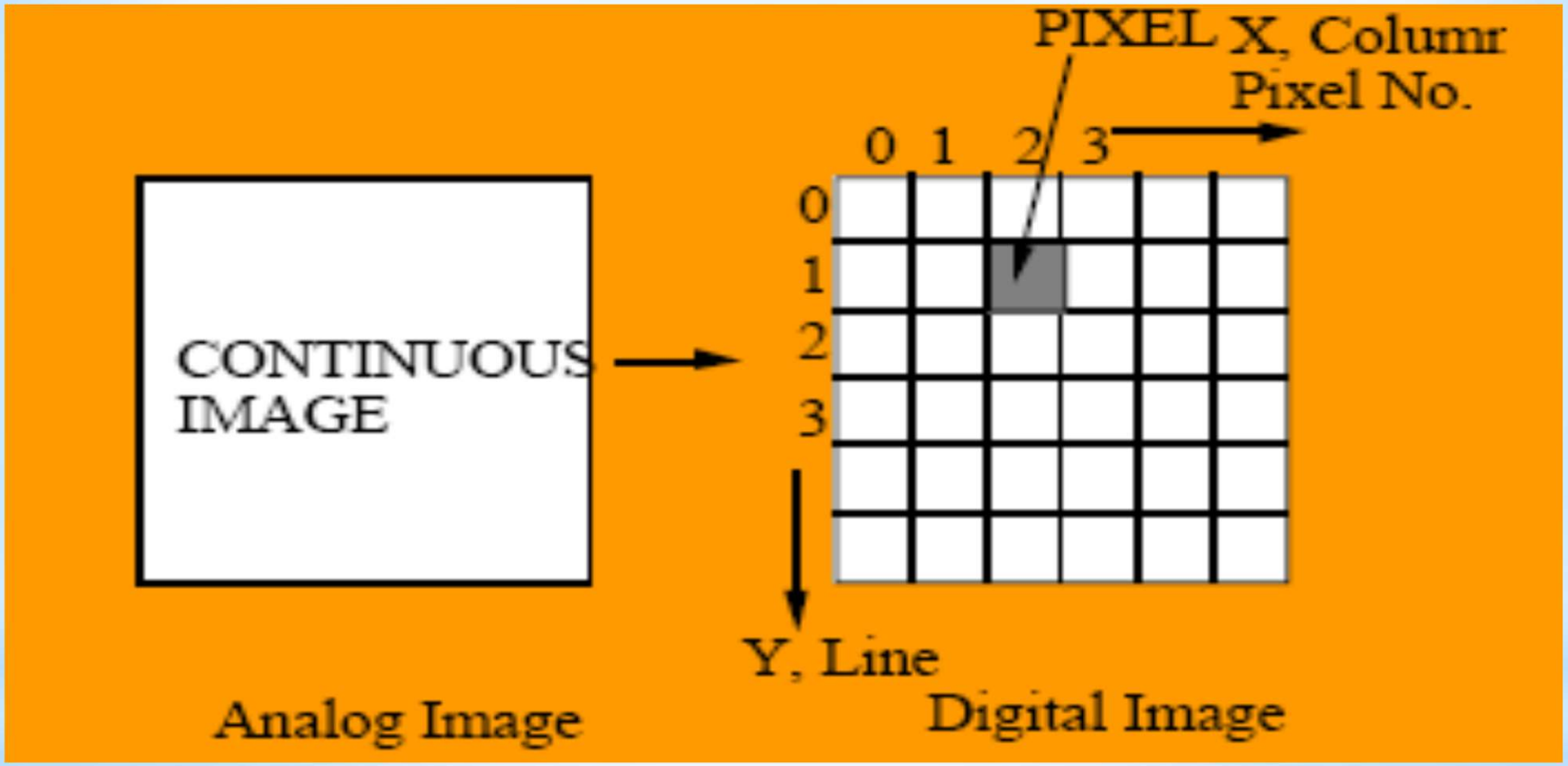
j) Translation dX_0 (Fluggeschwindigkeit)



f) Flughöhenänderung dZ_0

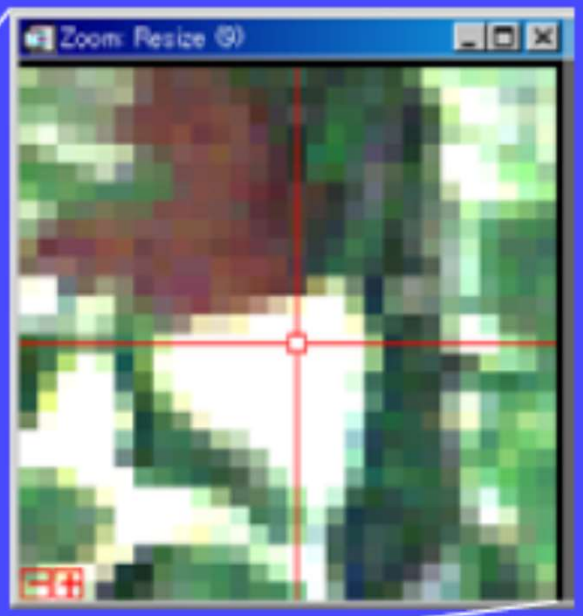


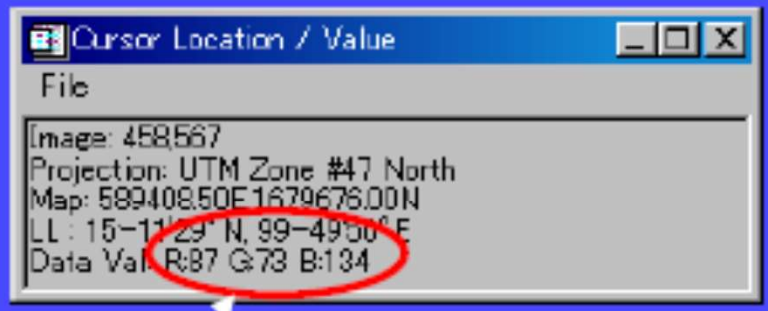
*Digital Image Data Pixel



Pixel (Picture Element) ,pixel has a value f(x,y)
x,y:integer, f: brightness in most case, integer

Pixel II

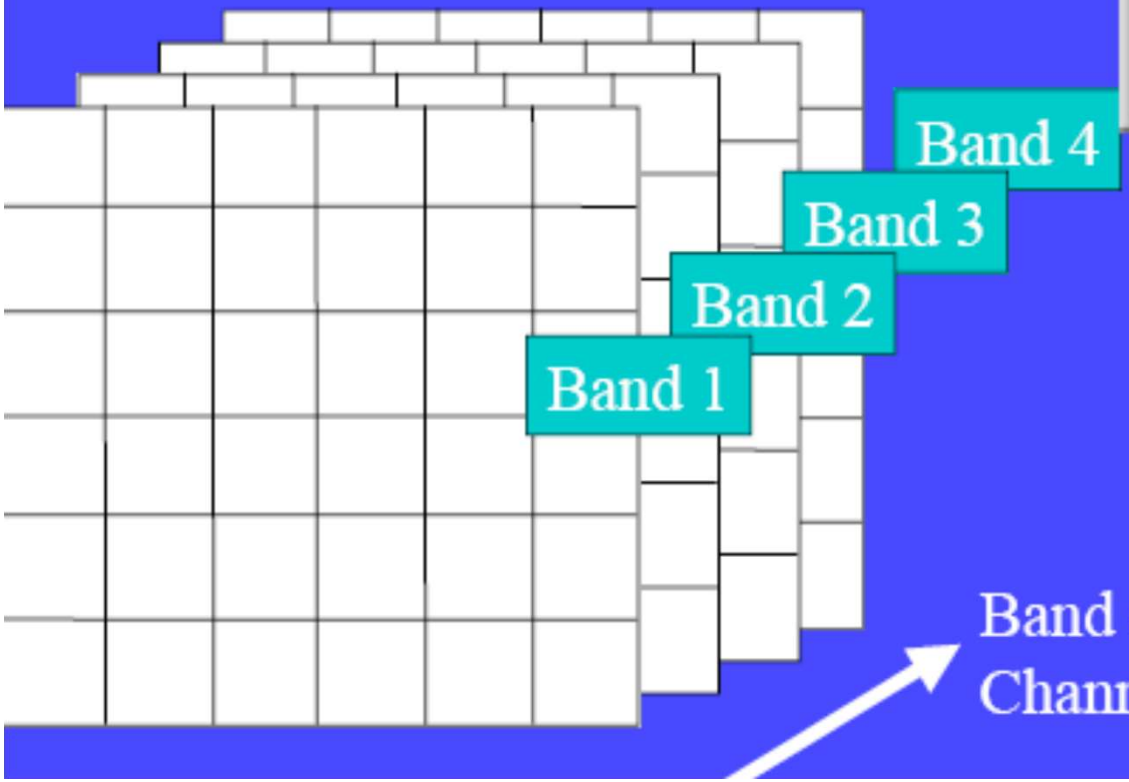




Pixel Value

Multi Channel Image

Color Image: 3 channel for R,G,B
Landsat TM 7 Channel



*Bit and Binary System

- The gray level of each pixel is recorded and stored as finite number of bits

- If there are k bits/pixel, total of 2^k gray levels over the range 0 to 2^k-1

- Example of 3 bits image

Bit2	Bit1	Bit0	Gray level	Bit2	Bit1	Bit0	Gray level
0	0	0	0	1	0	0	4
0	0	1	1	1	0	x	5
0	1	0	2	1	0	0	x
0	1	1	x	1	1	x	7

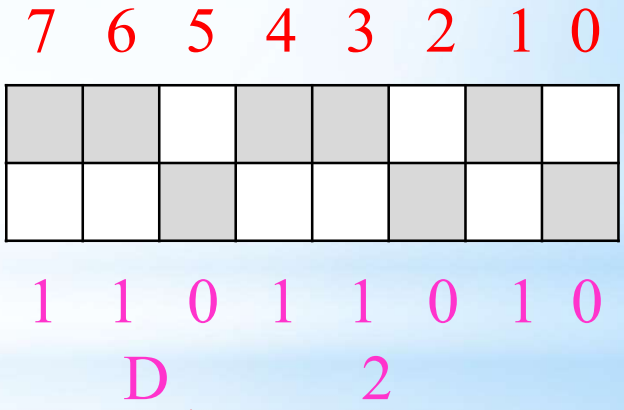
If k =8 , the group of bits is called “byte”.

*Binary system in computer memory

Pixel value is stored in limited space in a computer memory, 1 unit = 1 byte = 8 bits
8 bits has 28 =2x2x2x2x2x2x2x2 =256
Combinations of on/off at bits.

Thus k bits unsigned integer has 0 to 2^k-1 of data range.
8 bits(1 byte)/ pixel 0 to 255
16 bits(2 bytes)/pixel 0 to 65535

1 byte =8 bits



Binary system
Hexadecimal system
(0123456789ABCDEF)

1024 bytes = 1kB
1024 kB = 1MB
1024 MB =1GB
1024 GB =1TB

Image size in Bytes
1024 width x 1024 height x 7 bands/1 byte/pixel => 7 MB

*Reference:

Assoc.Prof.Dr.HONDA Kiyoshi, Lecture Note .School of Engineering and Technology ,AIT Thailand.

Suggested Web Sites:

- *Fundamentals of Remote Sensing, Canada Centre for Remote Sensing, Canada*
- AUSLIG (http://www.auslig.gov.au/)
- Space Imaging (http://www.spaceimage.com/)
- Australian Bureau of Meteorology (http://www.bom.gov.au/sat/intro/paper1intro.shtml)
- JPL Radar Site (http://www.jpl.nasa.gov/radar/sircxsar/)
- Australian geological Survey Organization (http://www.agso.gov.au/)

Thank you for your kind attention