Introduction to Remote sensing and aplications

Present by:

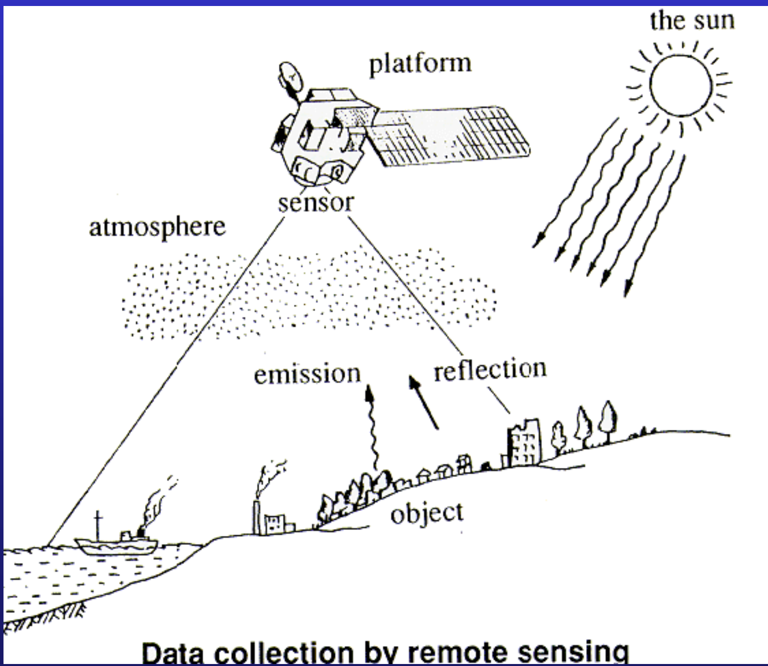
Weerayuth Suanpaga

อ.วีระยุทธ สวนผกา

Contents

- Concept of Remote Sensing
- Overview of Remote Sensing Technology
- Application of Remote Sensing

Remote Sensing System

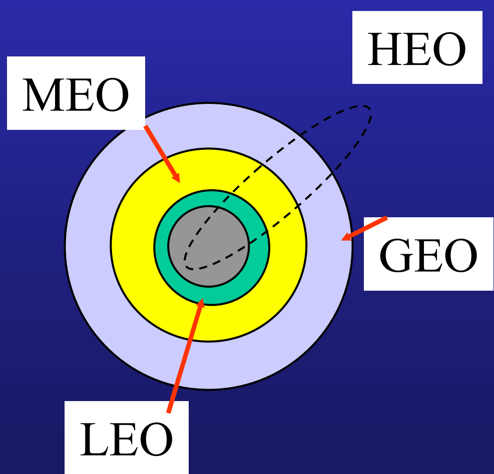


Satellite Remote Sensing - Earth Observation Broad Area

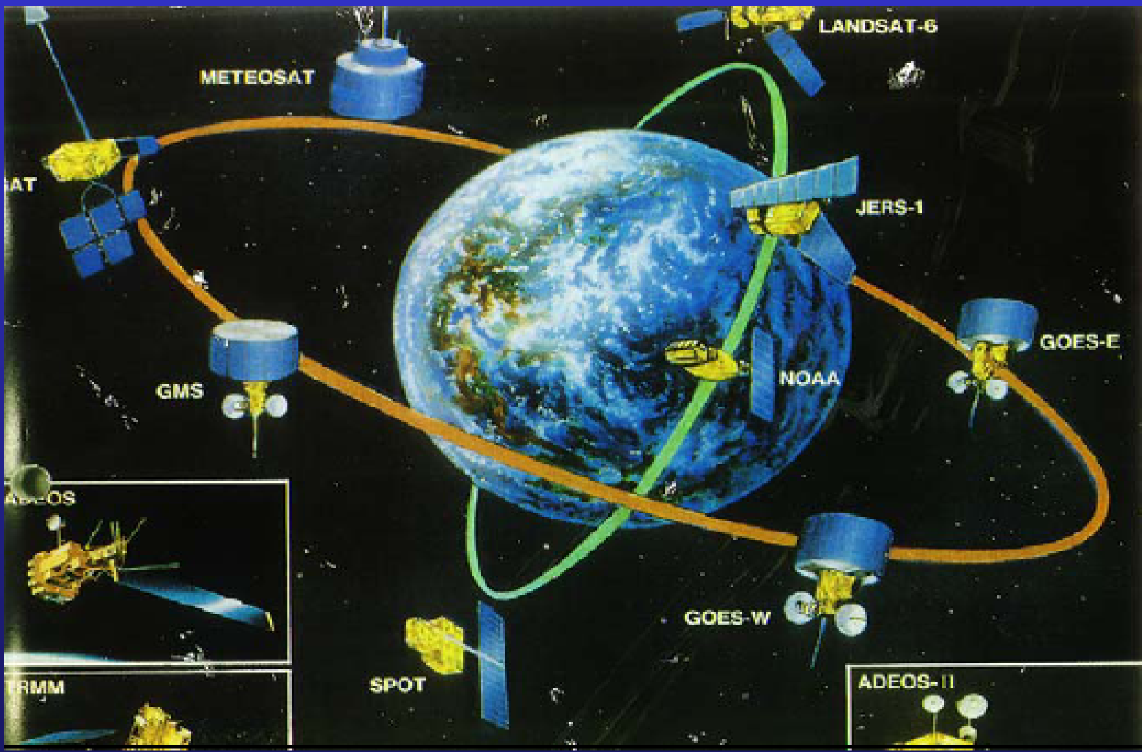
Quick,
180 kmx180km
30 sec
Repetitive

Architecture of orbital system

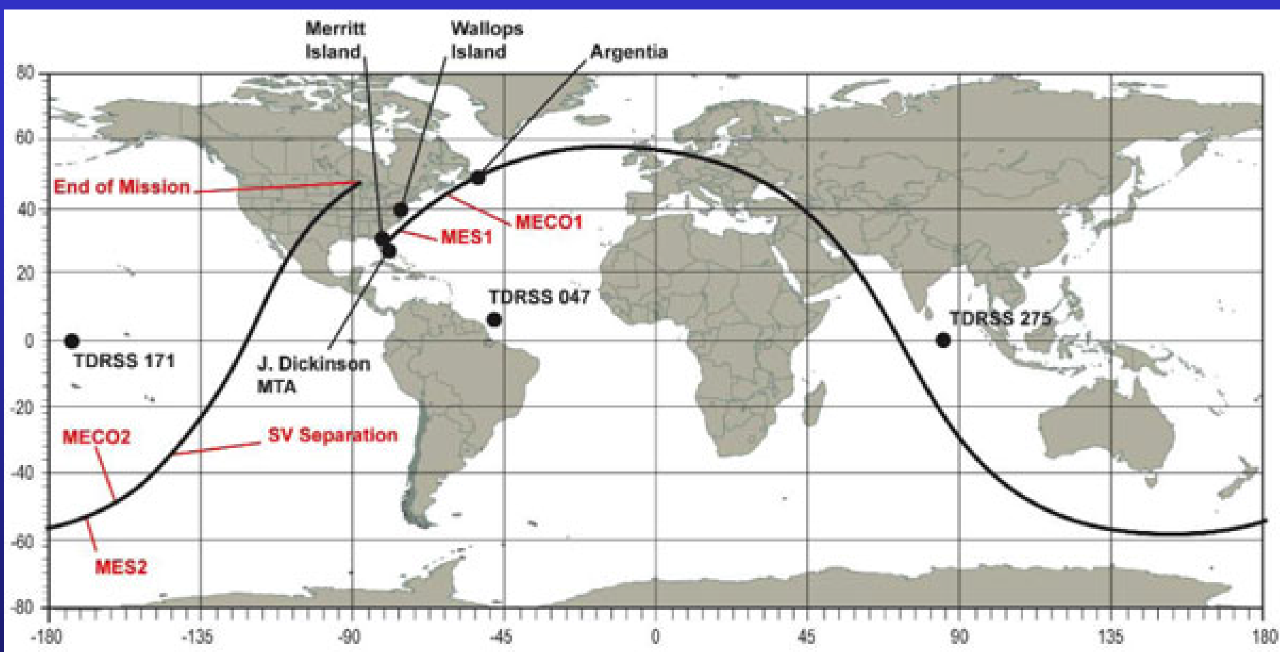
- Low earth orbit (LEO)
  ➔ T<25 min , h<6,000 km
  ➔Earth sensing, some communication Human space flight
- Medium earth orbit (MEO)
  ➔225 min < T<24 hr. 6,000 km< h<36,000 km
  ➔some earth sensing, navigation (military)
- **Geo-stationary orbit (GEO)**
  ➔T=24 hr, h=36,000 km
  ➔geosynchronous, geostationary
- Higher Earth orbit (HEO)
  ➔T>24 hr, h>36,000 km
  ➔moninya orbit(military,comunication)



Polar Orbit Satellite and Geostationary Satellite

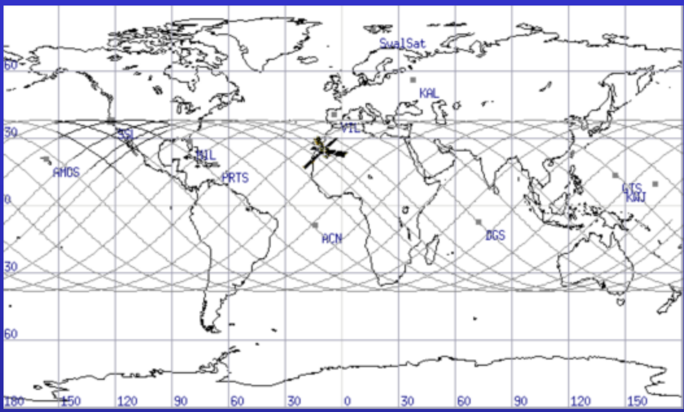


Ground track

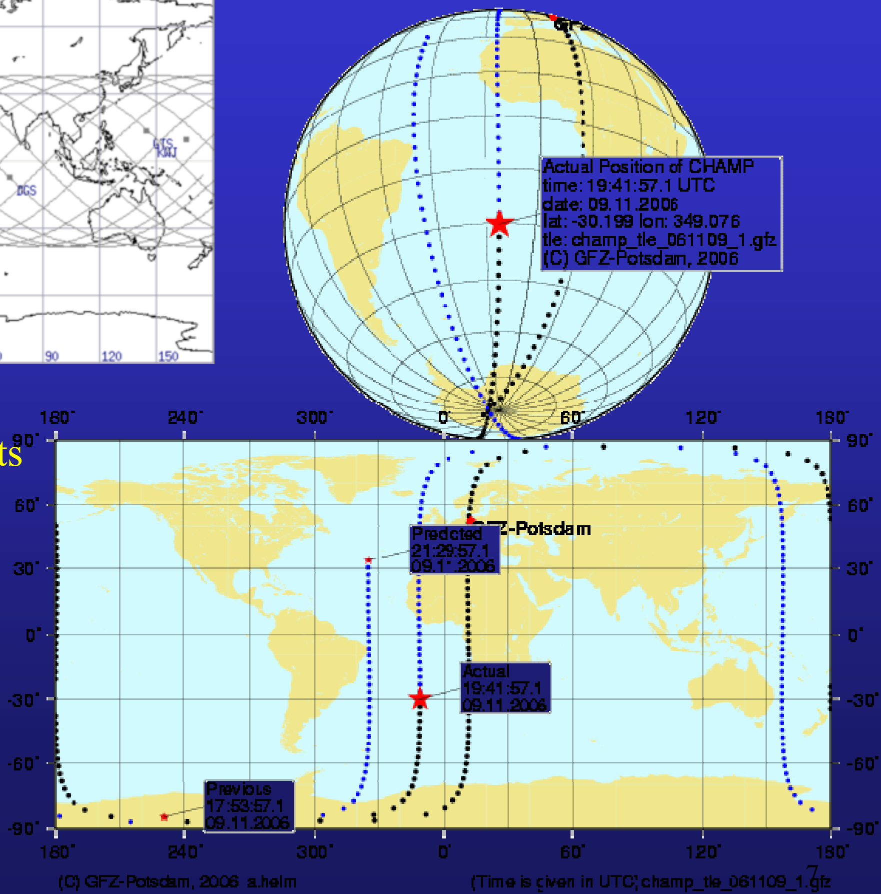


How height you can go?

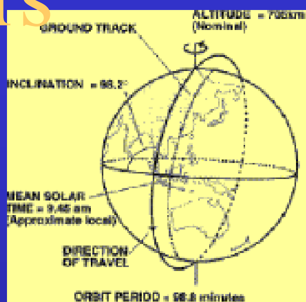
launch site



Ground Track for 16 Orbits

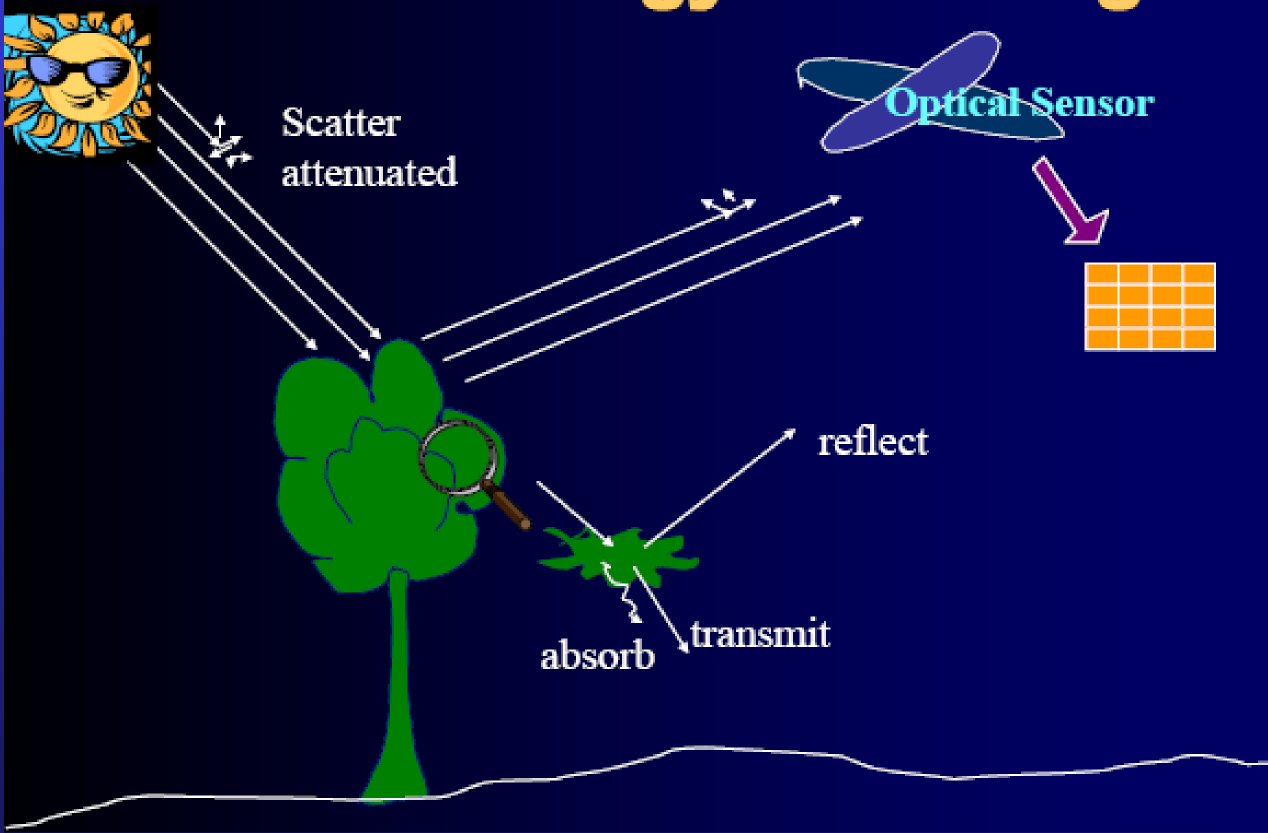


Several Important Numbers

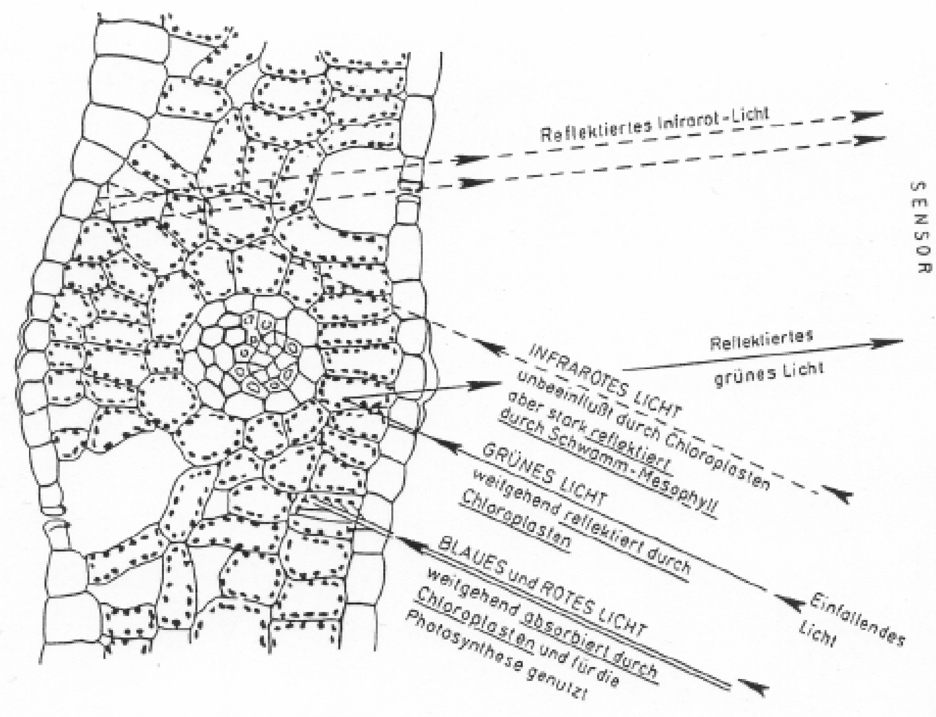


- •Radius of Earth approx. 6,300km
  (a=6377, b=6356, Bessel)
- •Altitude of Polar Orbit Satellite •300km - 900km
- •Landsat 705km, JERS-1 568km, SPOT 822km,
  NOAA 833-870km
- •Altitude of Geo-stationary Satellite 35,800km
- •Speed of light 300,000km/sec
- •Speed of Satellite (relative to the earth)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

Reflected Energy of Sun Light



Reflexionseigenschaften von Vegetation



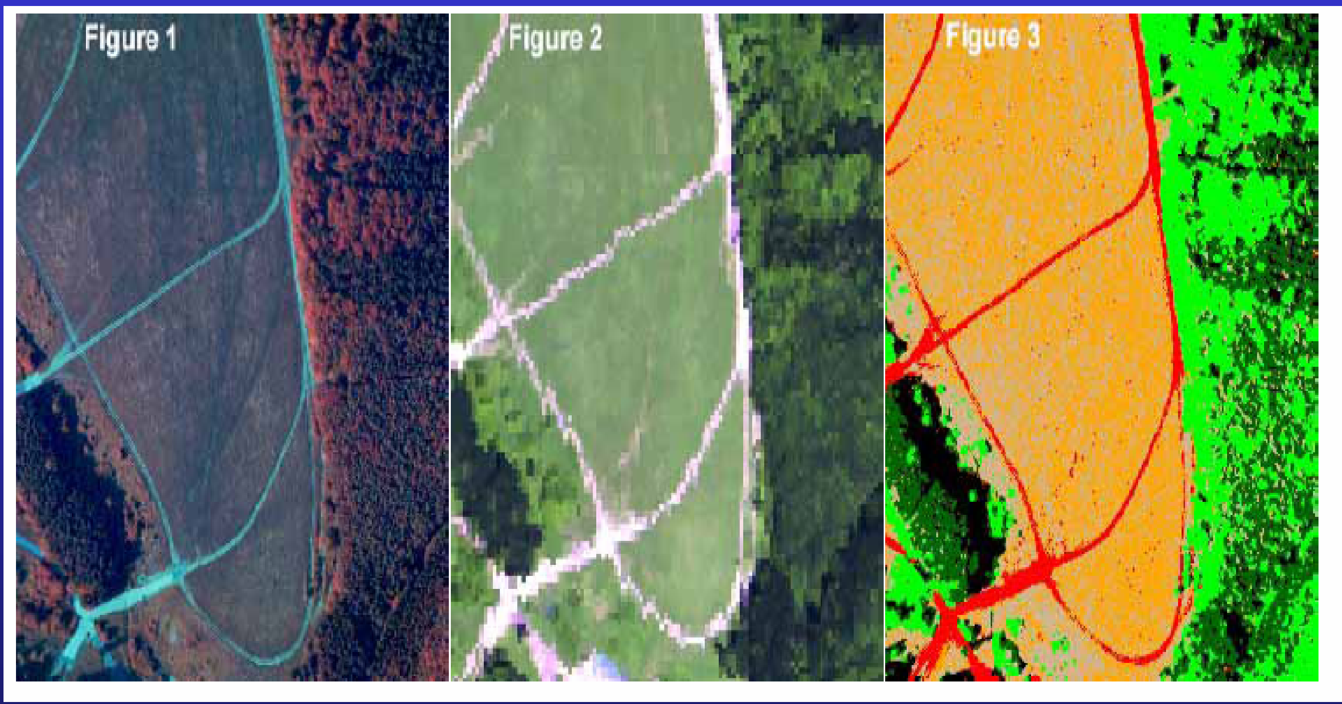
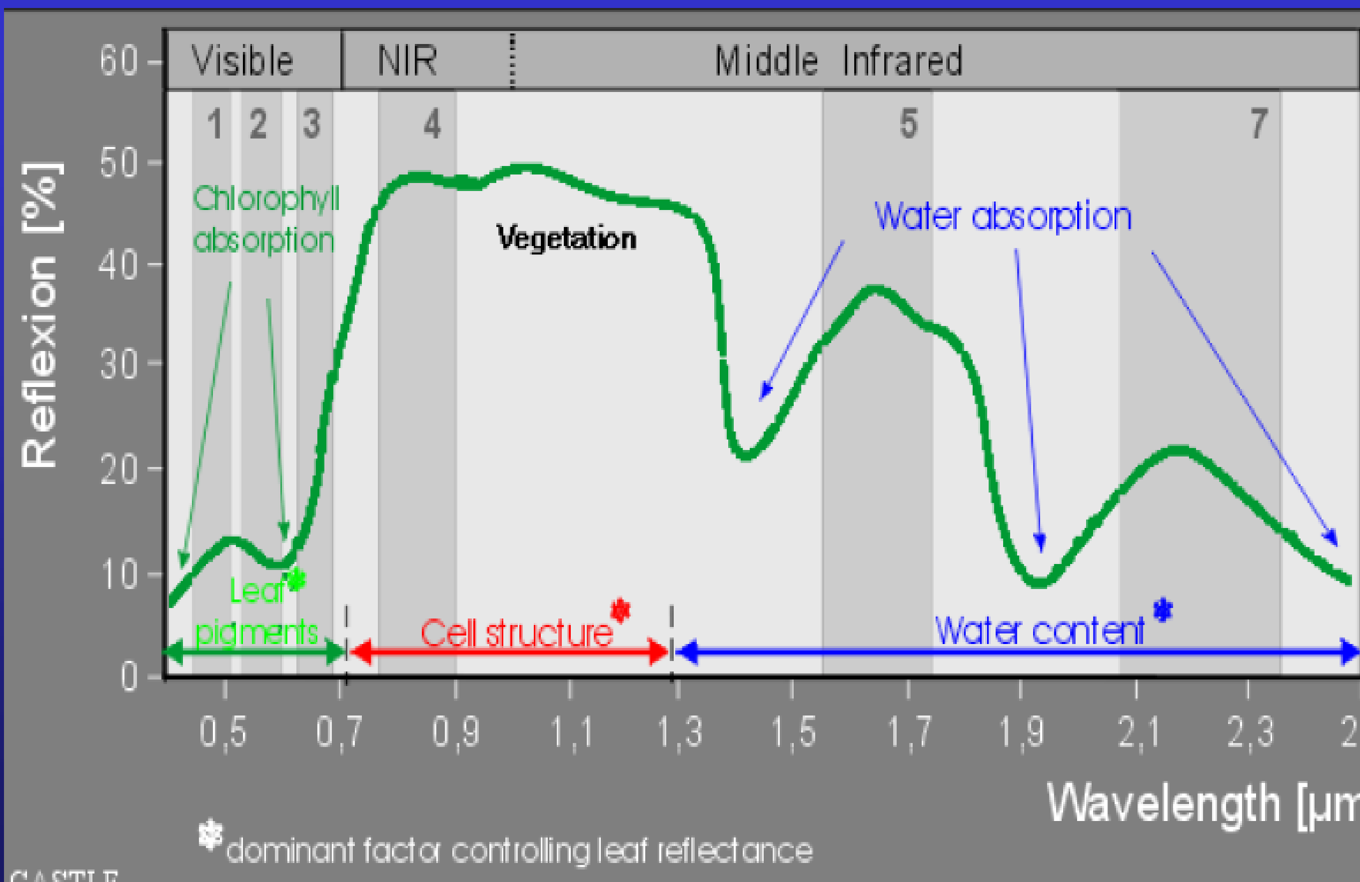


Figure 1
Figure 2
Figure 3

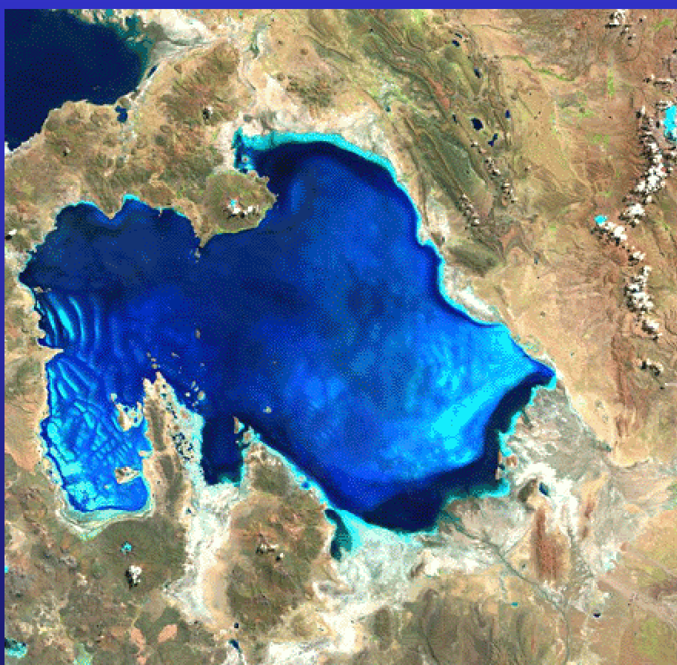

Visible
NIR
Middle Infrared
1
2
3
4
5
7
Chlorophyll absorption
Vegetation
Water absorption
Leaf pigments
Cell structure
Water content
Reflexion [%]
0
10
20
30
40
50
60
0,5
0,7
0,9
1,1
1,3
1,5
1,7
1,9
2,1
2,3
Wavelength [µm
dominant factor controlling leaf reflectance

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)

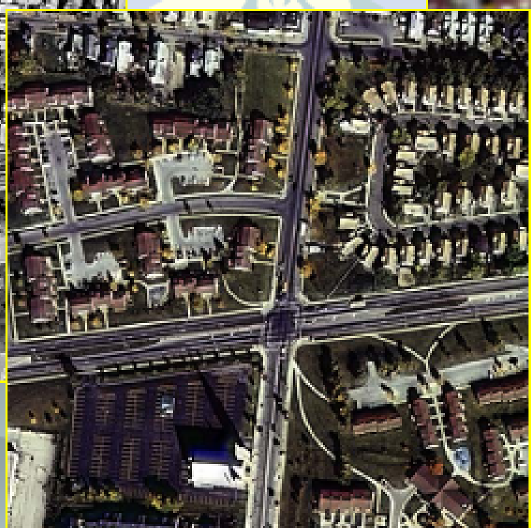
Optical Remote sensing



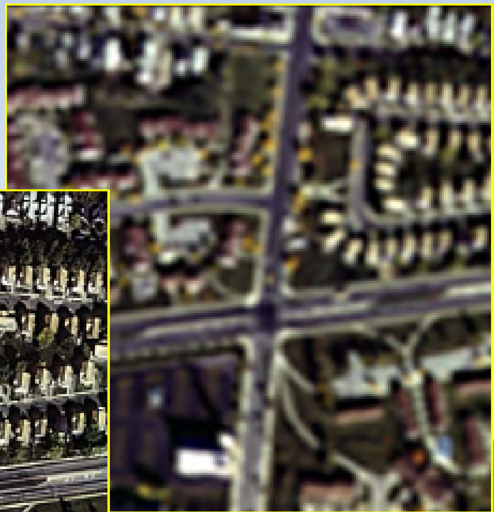
Landsat 7 ETM+ Image around Lake Titicaca, Bolivia/Peru

Pan-sharpened imagery – Ikonos example

1-Meter Panchromatic Image

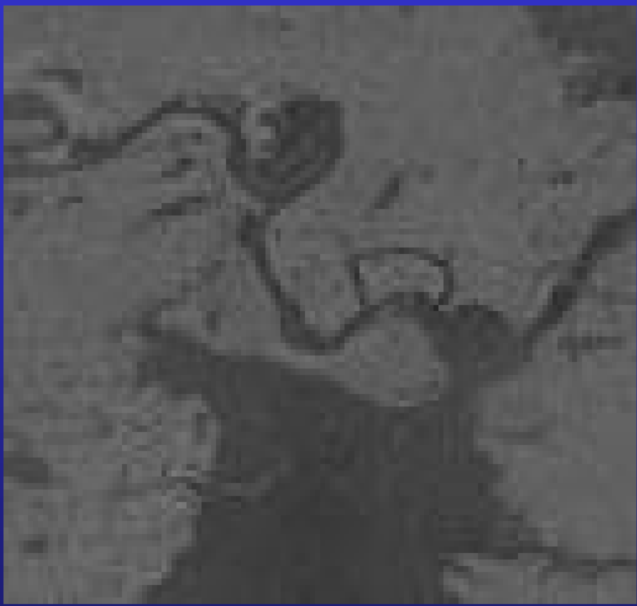


1-Meter Pan-Sharpened Image



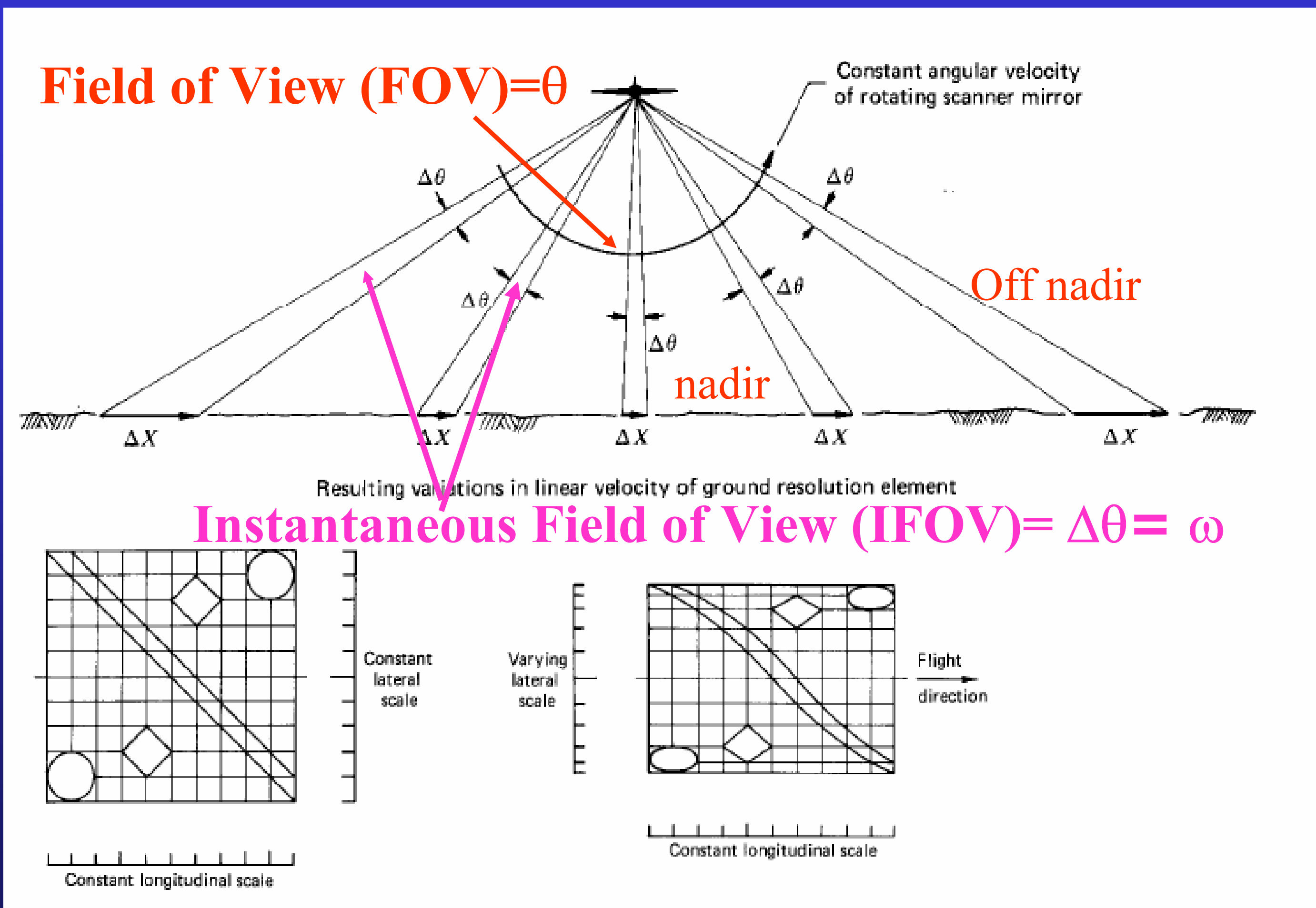
4-Meter Multispectral Image

Microwave-RS (Non optical)



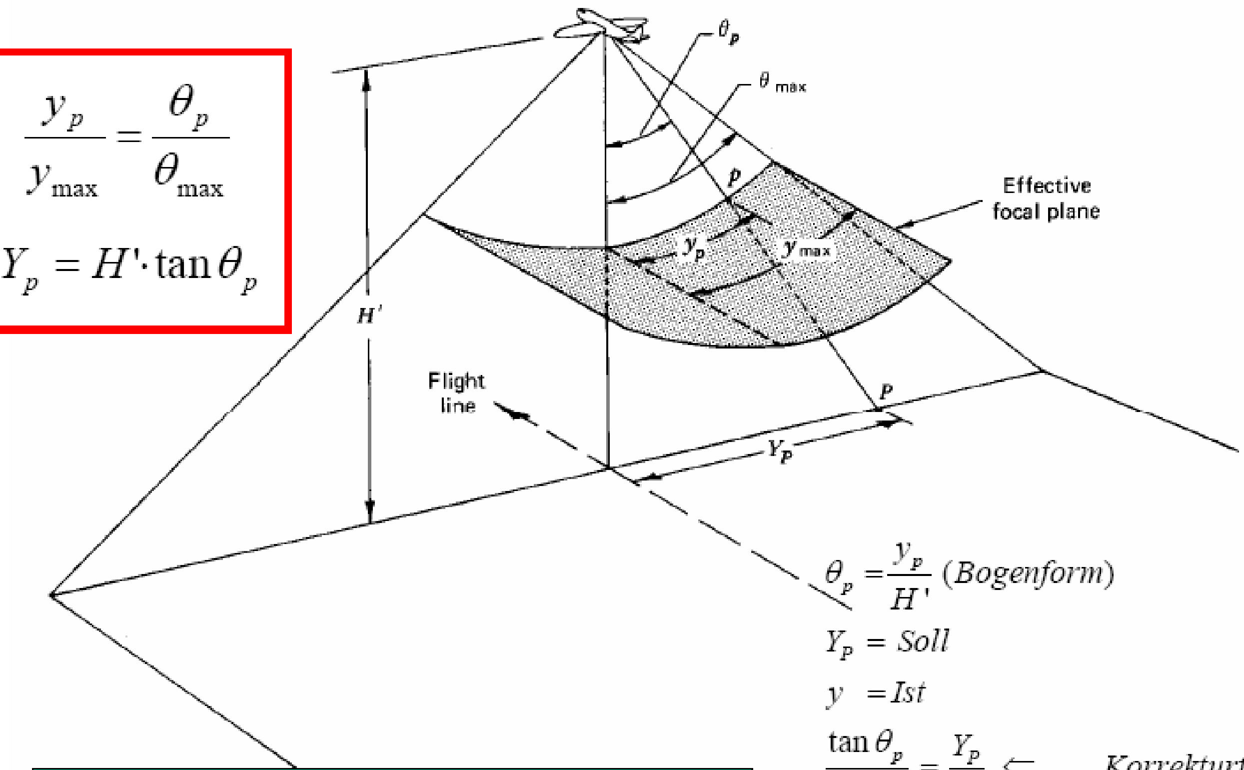
JERS1-OPS
(Optical sensor)

JERS1-sar
(active microwave sensor)



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

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



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

Y_P = Soll

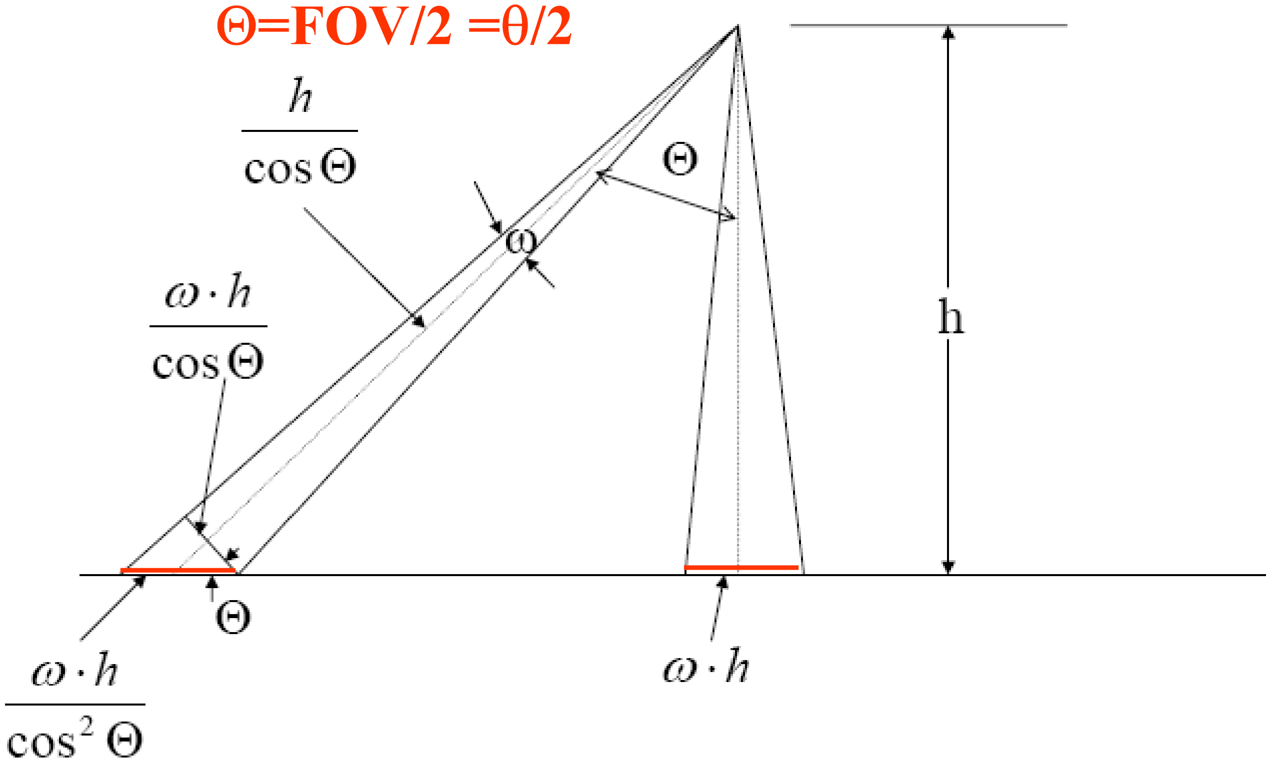
y = Ist

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

Panoramakorrektur

IFOV = Δθ= ω

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

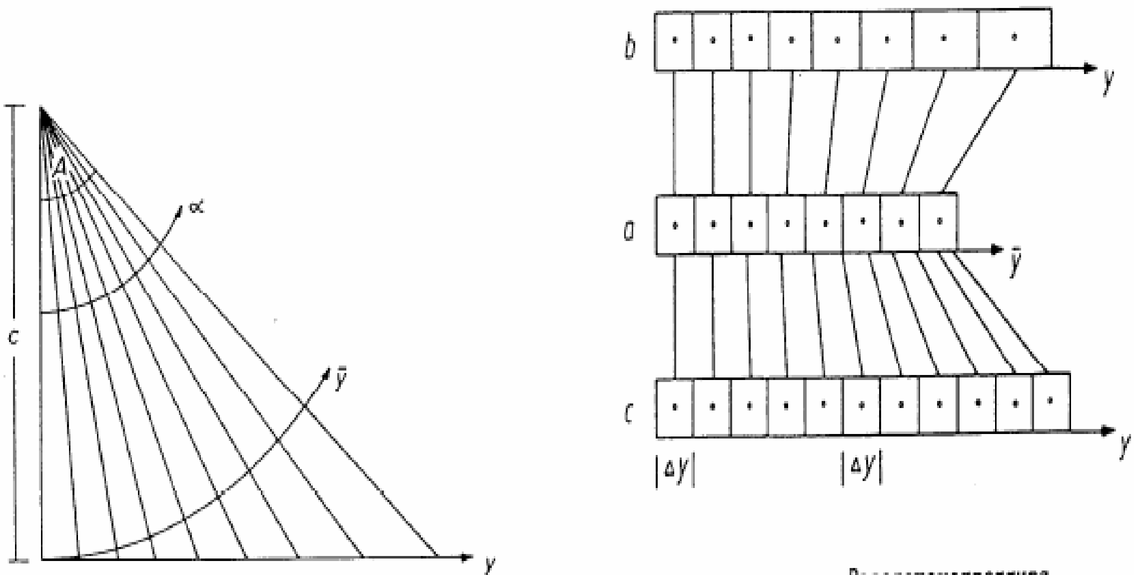
ถ้าปัจจุบัน sensor altitude = 450 km. Res.=0.60 m

Ans. 75 km impossible.

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

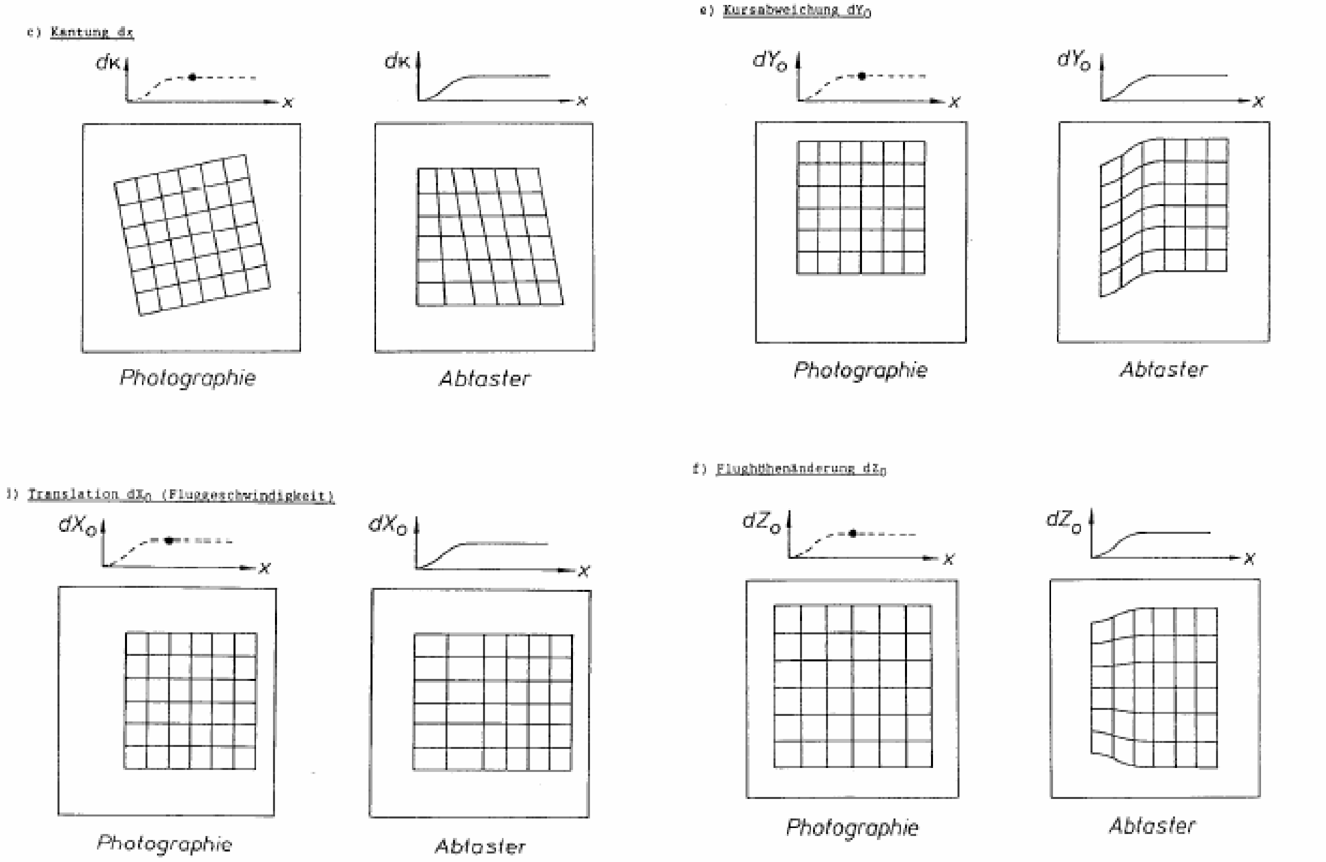
Ans. $h=0.8/1\times10^{-6}=800{,}000$ m. = 800 km

Res’ = $0.8/\cos^2(90/2) = 1.6$ m.



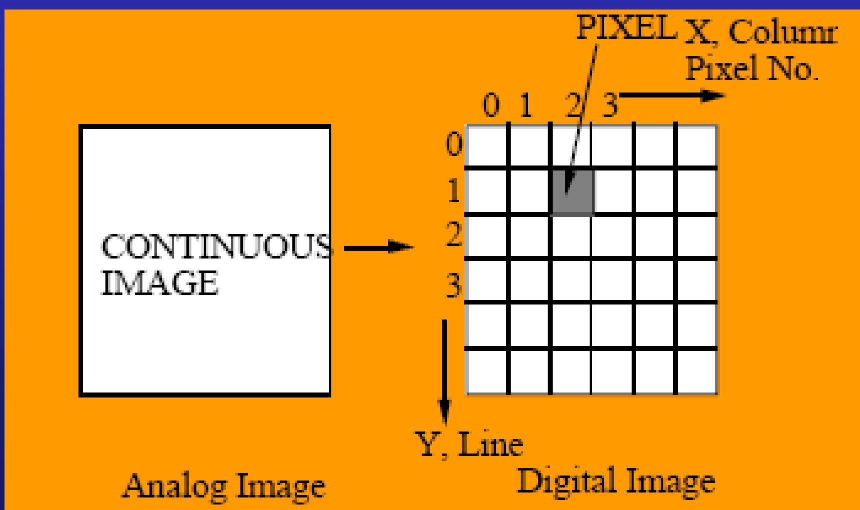
Panoramaverzerrung
a) Originaldaten einer Halbzeile
b) panoramakorrigierte Daten mit Bildelementen ungleicher Größe
c) panoramakorrigierte Daten mit Bildelemeten gleicher Größe (interpoliert)

Parametrische Entzerrung (Forts.)

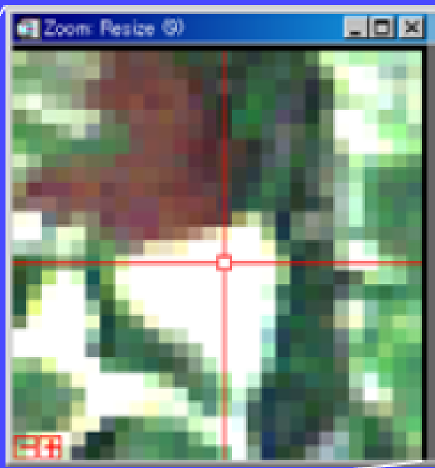


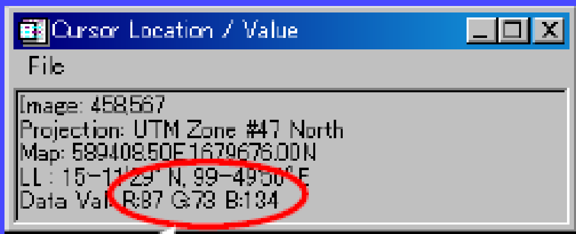
Digital Image Data Pixel

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



Pixel II

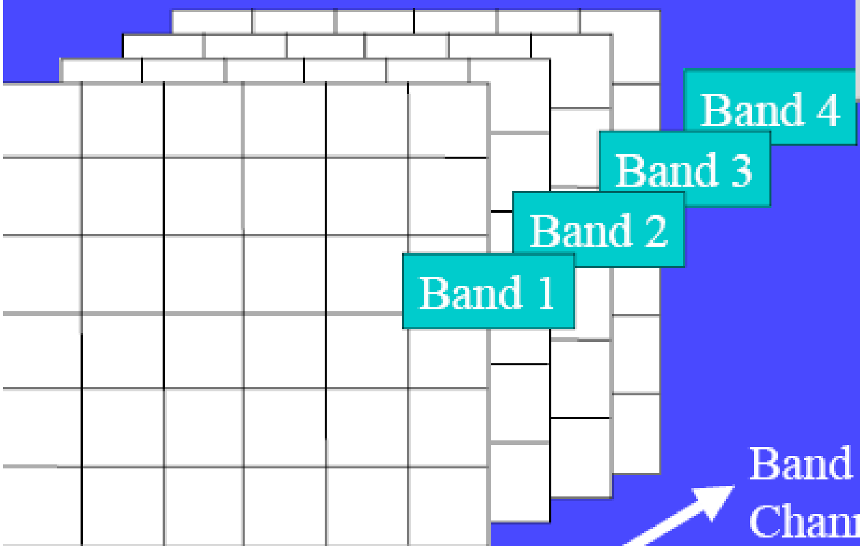




Pixel Value

Multi Channel Image

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



Band or Channel

Bit and Binary System

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

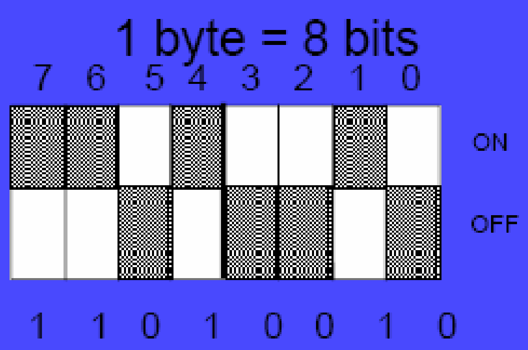
If there are k bits/pixel, total of 2^k gray levels over the range 0 to $2^k - 1$

Exmaple of 3 bits image

bit map			graylevel	bitmap			graylevel
bit2	bit1	bit0		bit2	bit1	bit0	
0	0	0	0	1	0	0	4
0	0	1	1	1	0	1	5
0	1	0	2	1	1	0	6
0	1	1	3	1	1	1	7

if k equals 8, the group of bits is called byte.

Binary System in Computer Memory



D 2

13x16+2 = 210

binary system
hexadecimal system
(0123456789ABCDEF)
decimal system

Pixel value is stored in limited space in a computer memory. 1unit = 1byte = 8bits

8 bits has 2^8=2*2*2*2*2*2*2*2 = 256 combinations of on/off at bits.

Thus k bits unsigned integer has 0 to 2^k-1 of data range.

8bits (1byte) / pixel 0 -> 255

16 bits (2bytes)/pixel 0-> 65535

1024 bytes = 1KB
1024 KB = 1MB
1024 MB = 1GB

Image Size in Bytes

1024 width *1024 height *7 bands / 1 byte/pixel -> 7MM

Reference:

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

Suggested Web Sites:

- 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/)

END