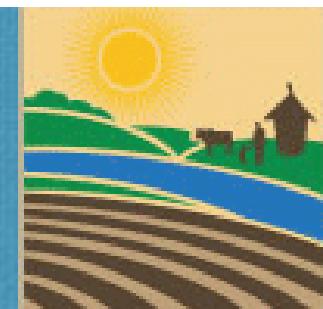


A (very) brief introduction to Remote Sensing: From satellites to maps!



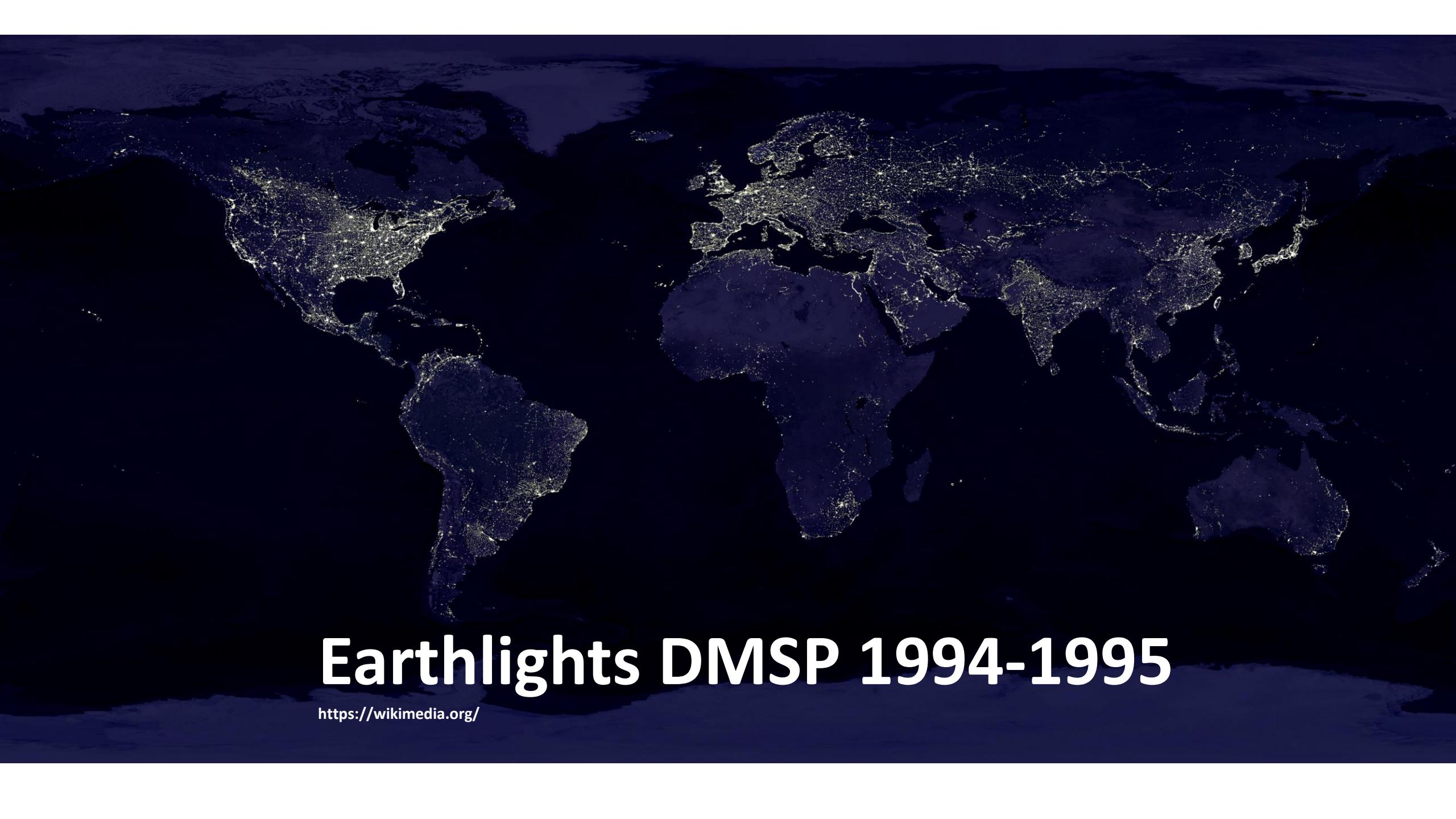
FEED THE FUTURE

The U.S. Government's Global Hunger and Food Security Initiative



FEED THE FUTURE
INNOVATION LAB

Collaborative Research on
Sustainable Intensification



Earthlights DMSP 1994-1995

<https://wikimedia.org/>

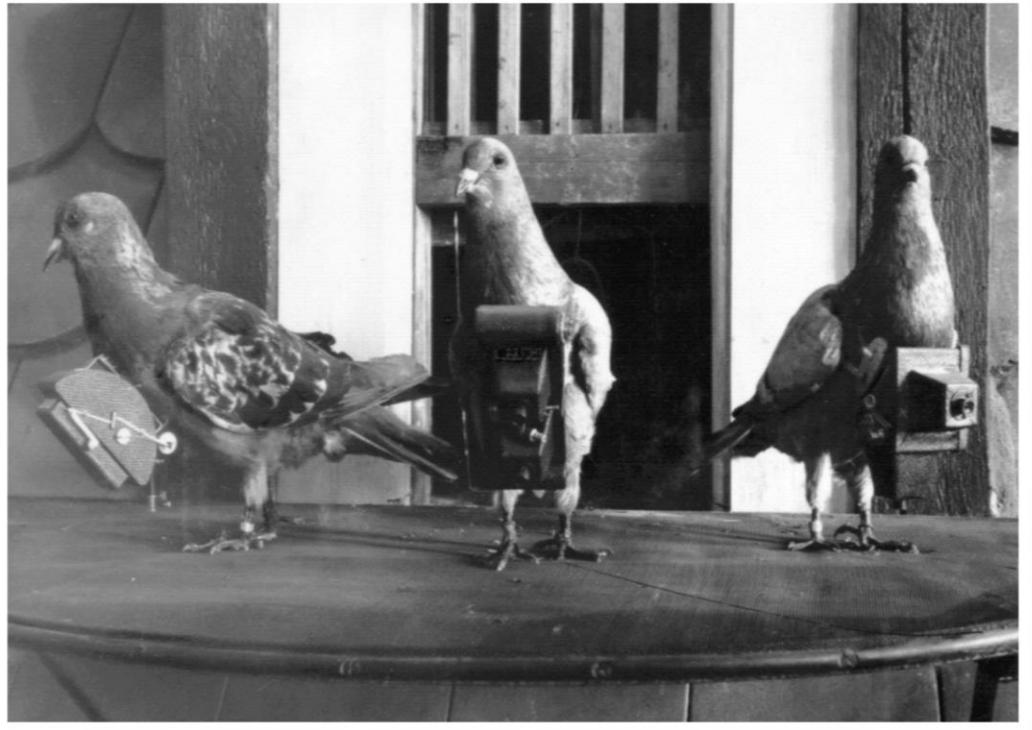
Early days of Remote Sensing



The first known aerial photograph was obtained by Gaspard Felix Tournachon (Nadar) from a tethered balloon 1,700-ft. above Paris, France in 1858. This is an oblique photograph obtained from the *Hippodrome* Balloon using a multiband camera



Intrepid tethered during the Civil War battle of Fair Oaks on June 1, 1862
(copyright Smithsonian Institution, Washington, D.C.).



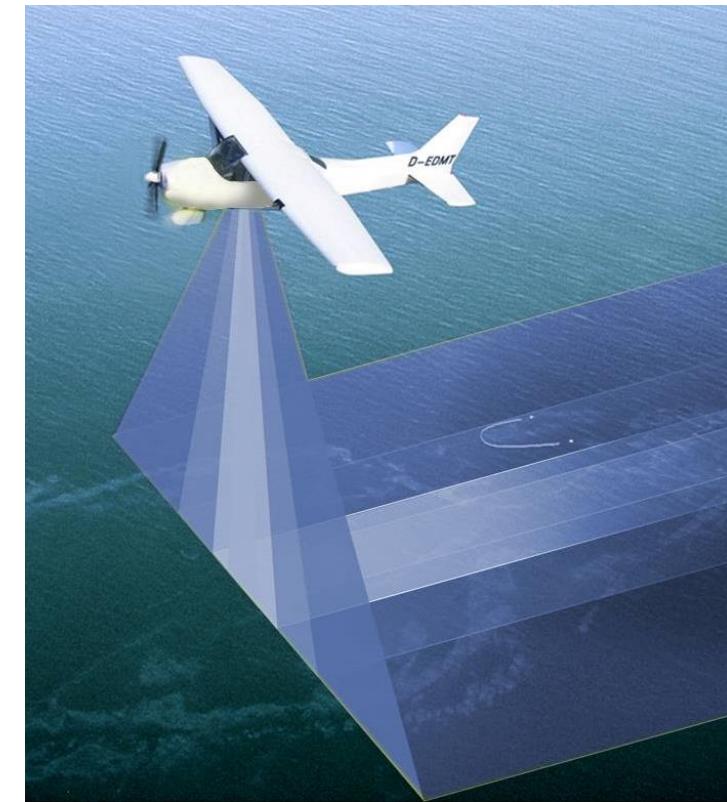
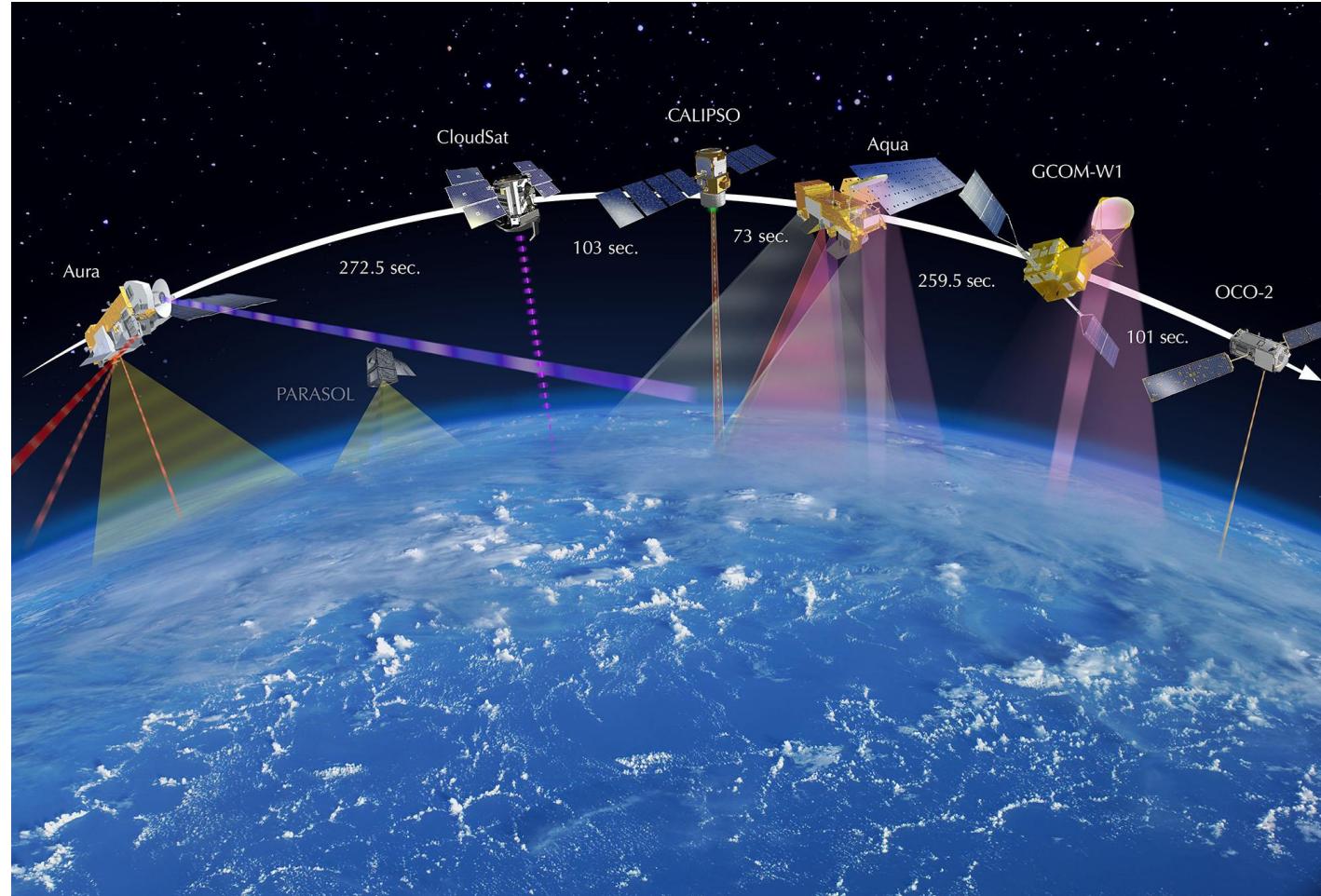
In 1903, Julius Neubronner patented a breast-mounted camera for carrier pigeons that weighed only 70 grams. A squadron of pigeons is equipped with light-weight 70-mm aerial cameras.



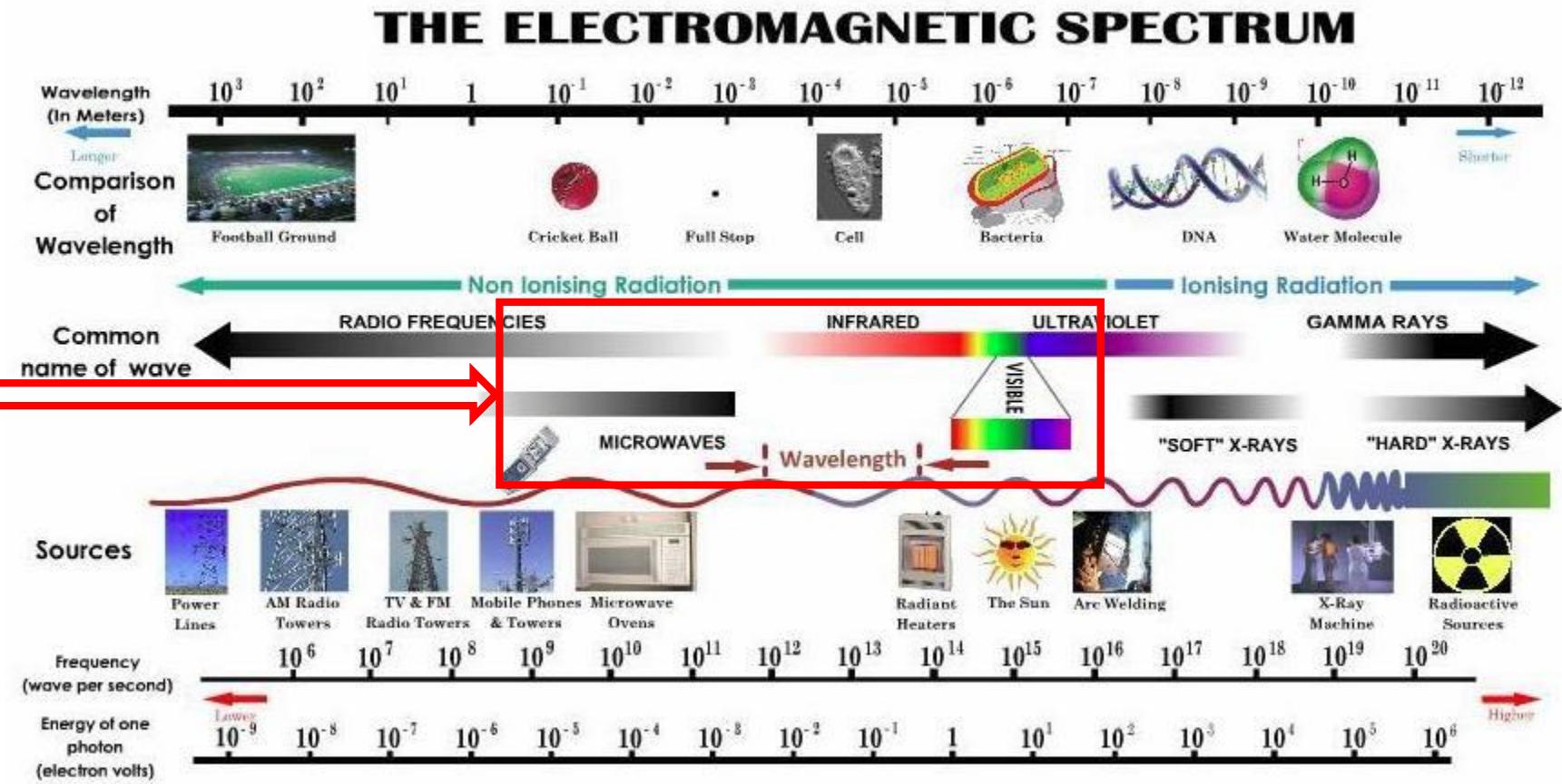
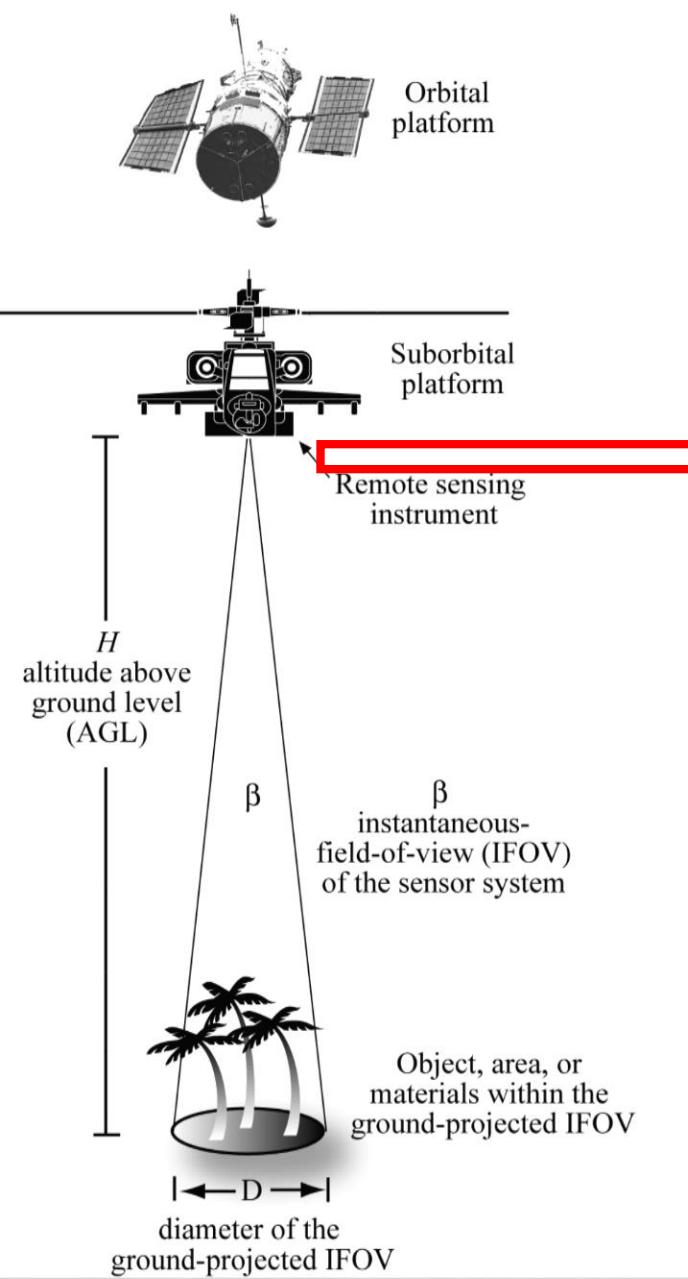
Pilot and aerial photographer with a Graflex aerial reconnaissance camera in 1918 (copyright Smithsonian Institution, Washington, D.C.).

Force B-17 Flying Fortress over Berlin, Germany in World War II. Aerial photographs show bombs from the unseen B-17 crashing through the port horizontal stabilizer (copyright Smithsonian Institution, Washington, D.C.).

Modern Remote Sensing Platforms

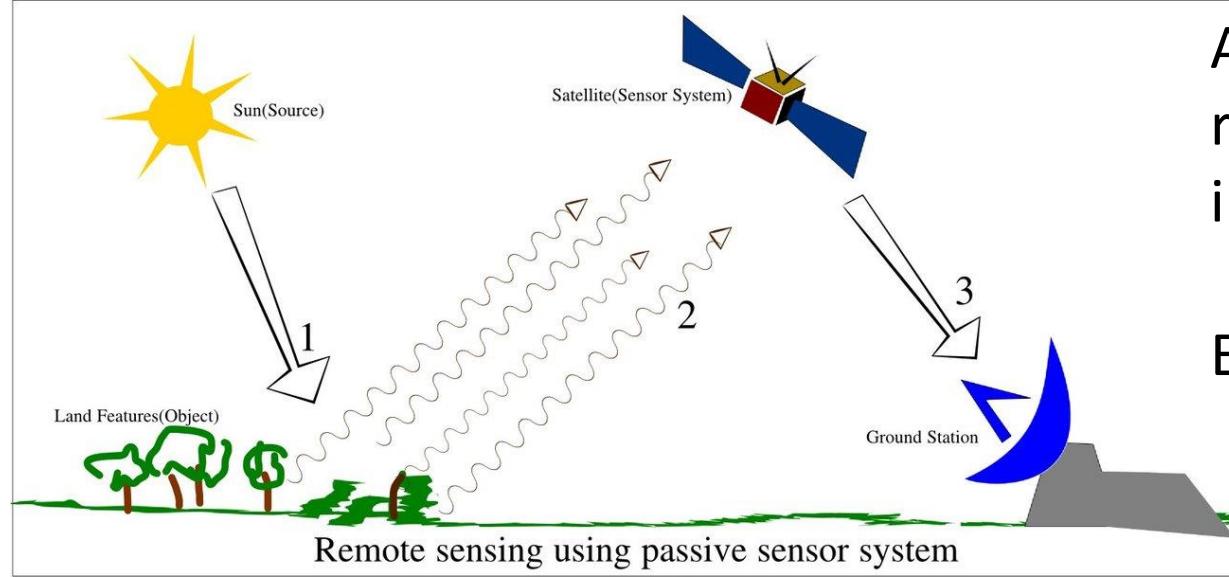


How it works?



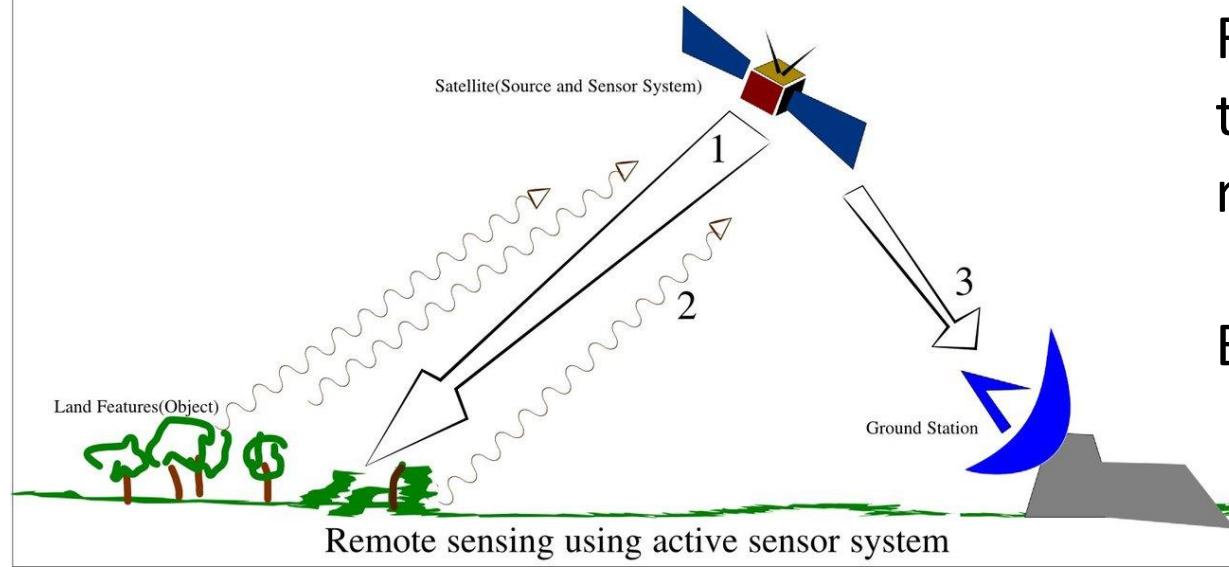
<http://www.nasa.gov/>

How it senses?



All sensors in operating in visible wavelength regions captures on reflected solar irradiance; also thermal sensors

Example: Landsat, MODIS, QuickBird



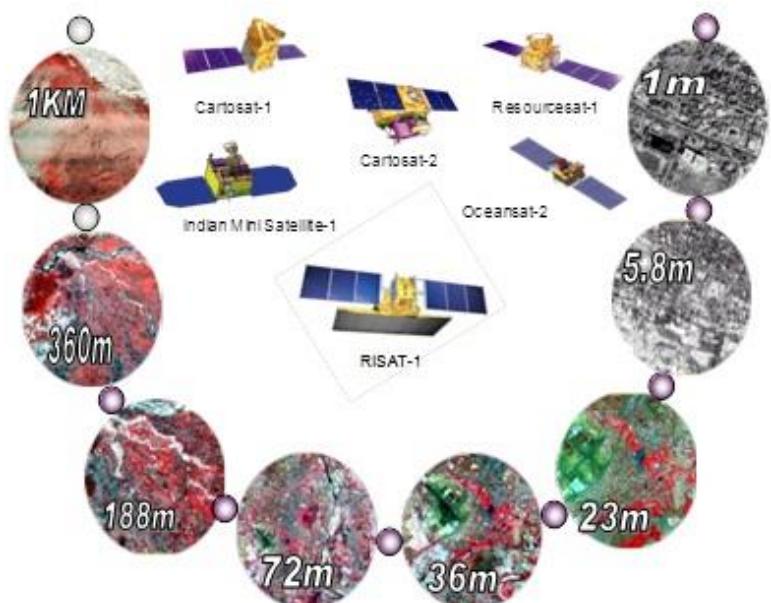
Radars, LiDAR instruments measuring signals transmitted by the sensor that were reflected

Example: Radarsat, SMAP

Common camera can be both active (bright sunny day) and passive (dark room with flash)!!!

Satellites and what they measure?

$$L = f(\lambda, s_{x,y,z}, t, \theta, P, \Omega)$$



$s_{x,y,z}$ = x , y , z location of the picture element and its size (x , y)

t = temporal information, i.e., when and how often the information was acquired

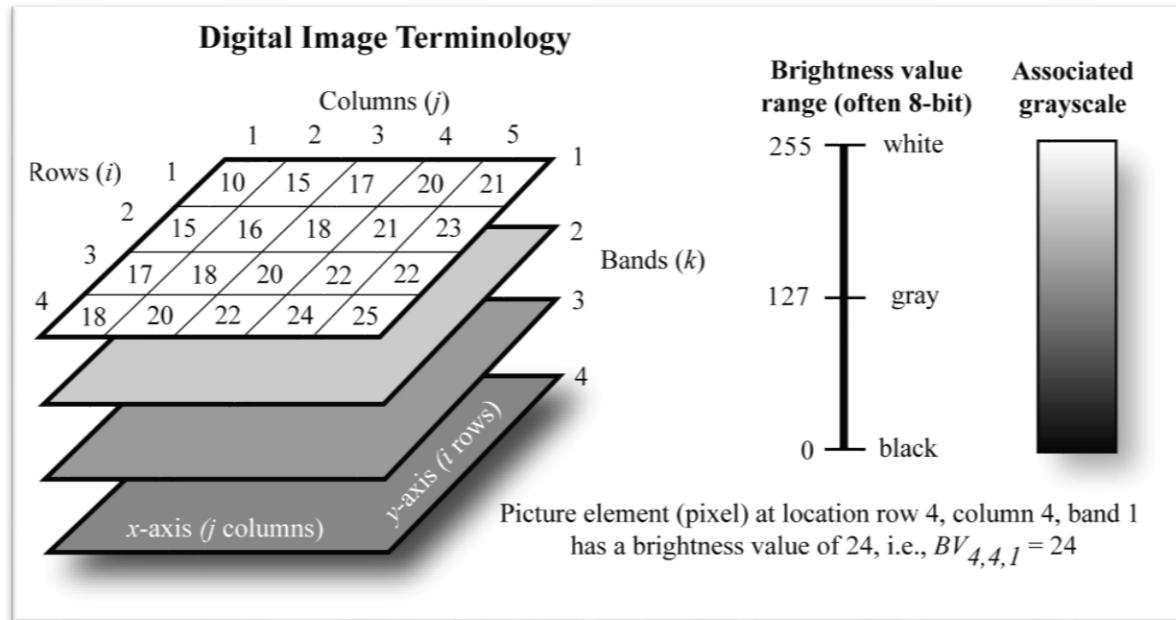
θ = set of angles that describe the geometric relationships among the radiation source (e.g., the Sun), the terrain target of interest (e.g., a corn field), and the remote sensing system

P = polarization of back-scattered energy recorded by the sensor

Ω = radiometric resolution (precision) at which the data (e.g., reflected, emitted, or back-scattered radiation) are recorded by the remote sensing system.

Remote sensing image: It's all about 'pixels'

Representing Earth Surface features as Digital Numbers (DN)



“what's in a pixel?”...Resolution!

Multispectral Image

near-infrared
(750 – 900 nm)

red band
(640 – 690 nm)

green band
(525 – 605 nm)

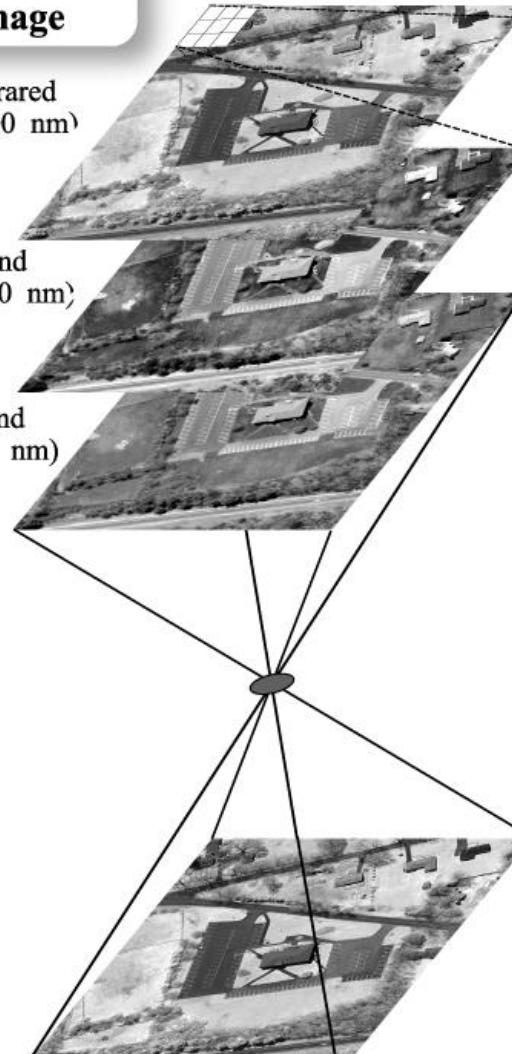


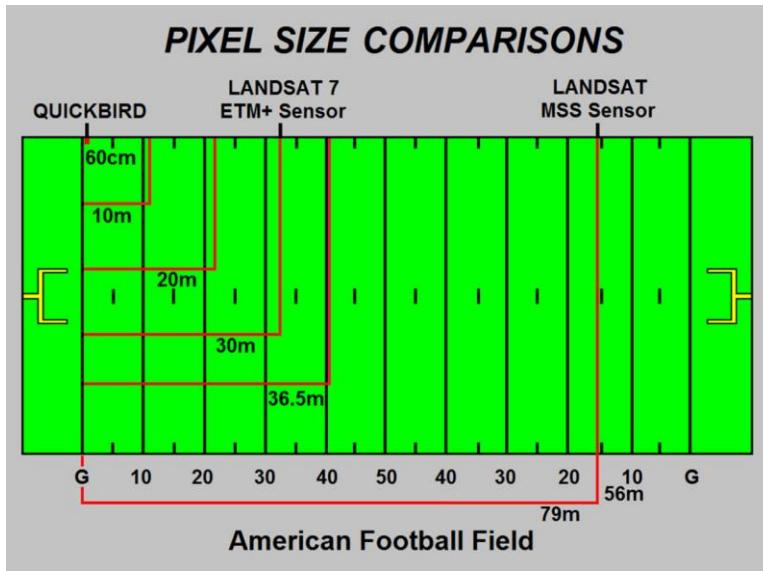
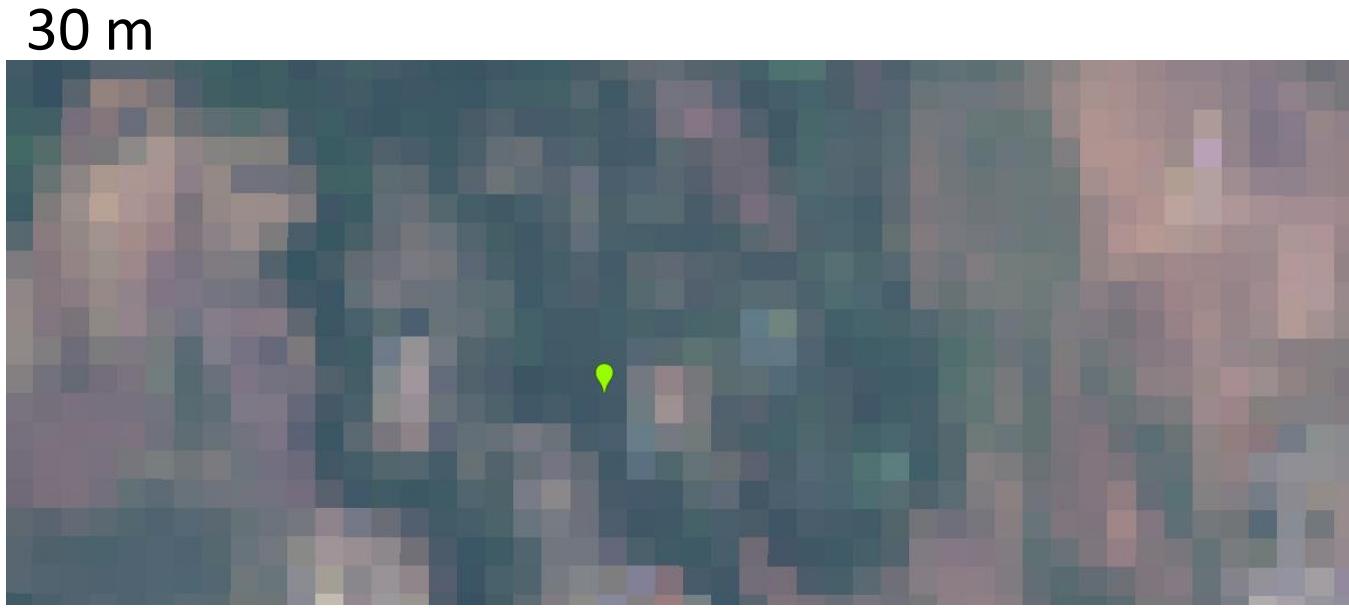
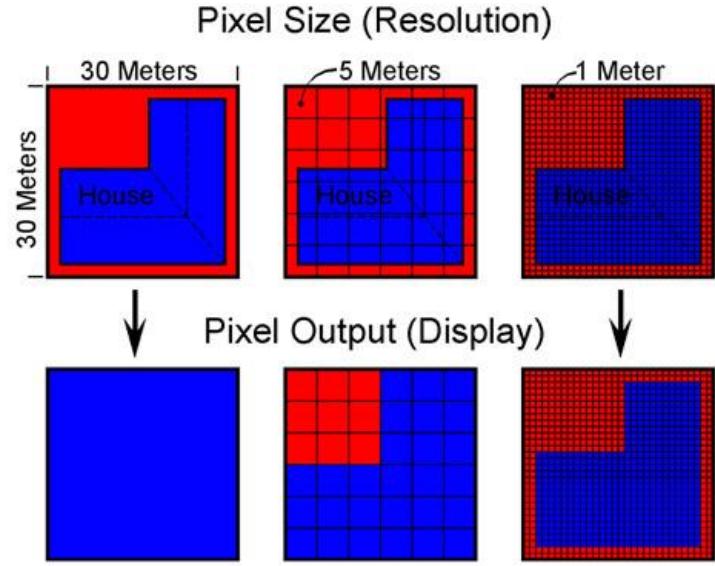
Image Matrix Notation

10	10	10	12	Band 1
10	50	82	80	Band 2
12	80	80	44	Band 3
45	55	60	45	
45	60	60	42	
40	55	62	42	
42	60	65	1,1 1,2 1,3	
2,1	2,2	2,3		
3,1	3,2	3,3		Row i
				Column j

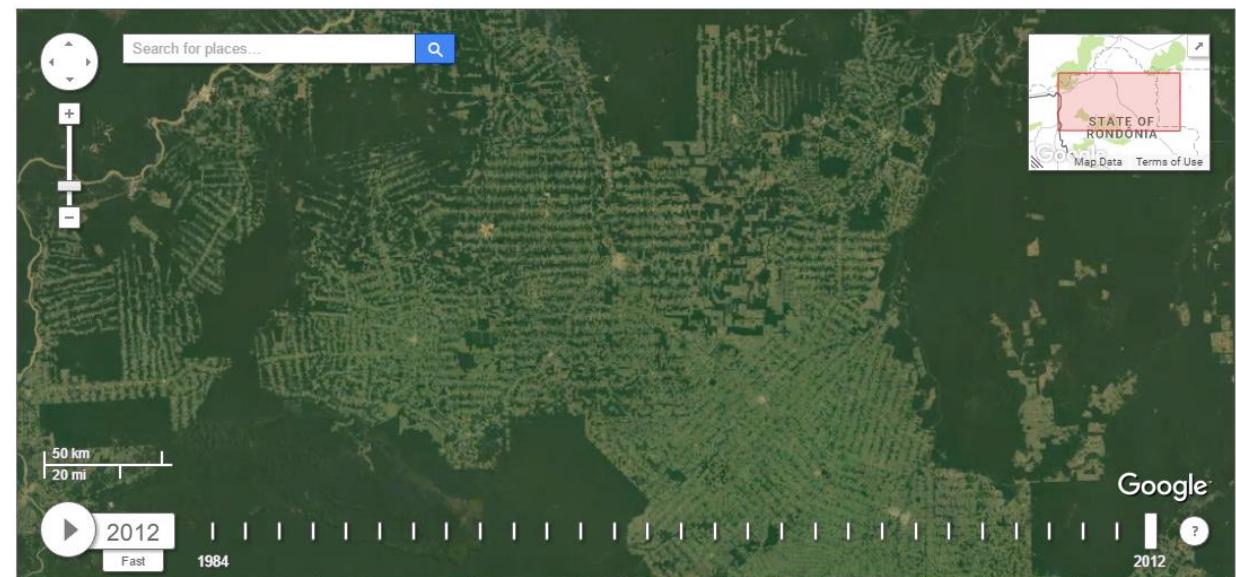
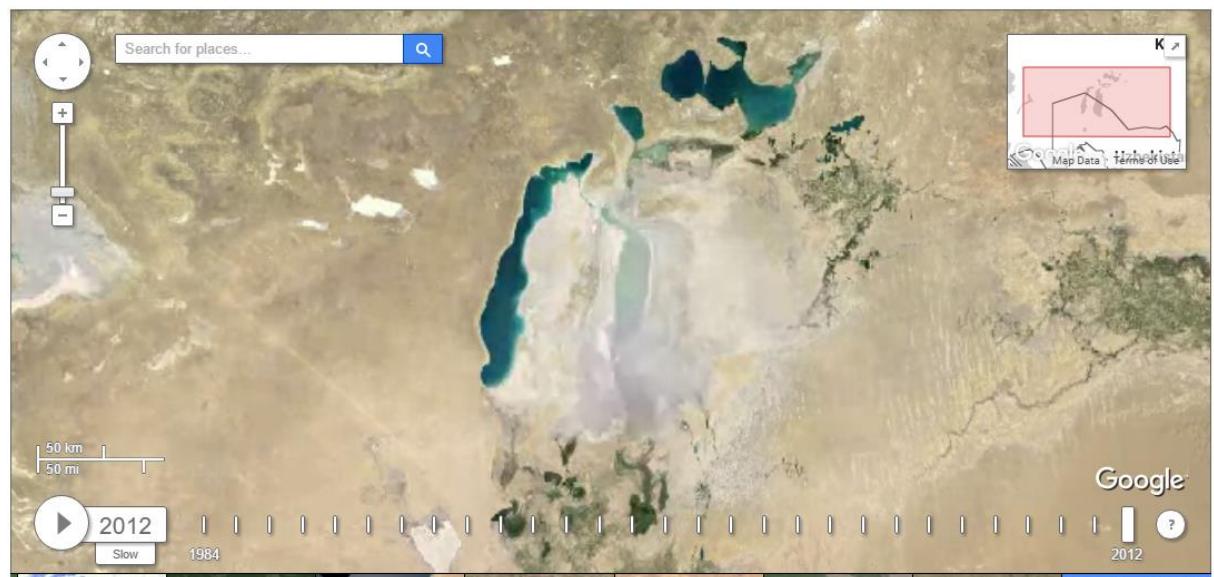
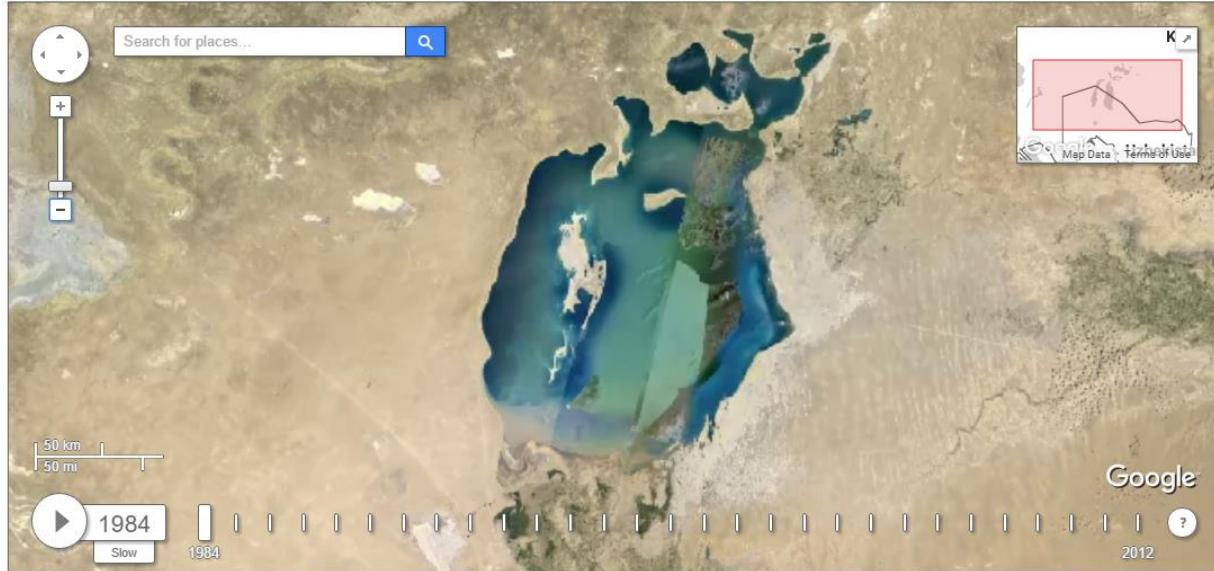
8-bit Image Data

255 = white
127 = gray
0 = black

Spatial resolution



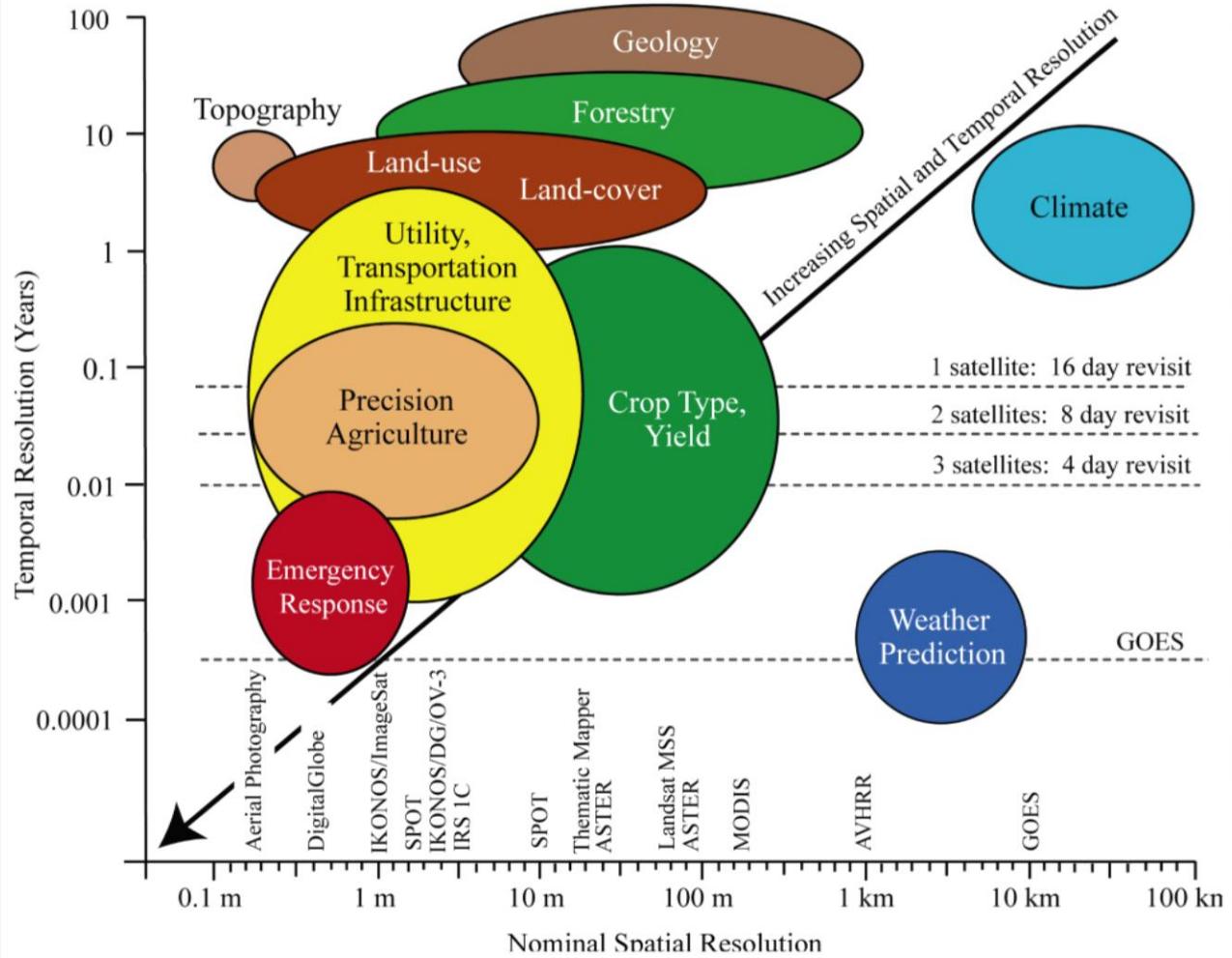
Temporal resolution



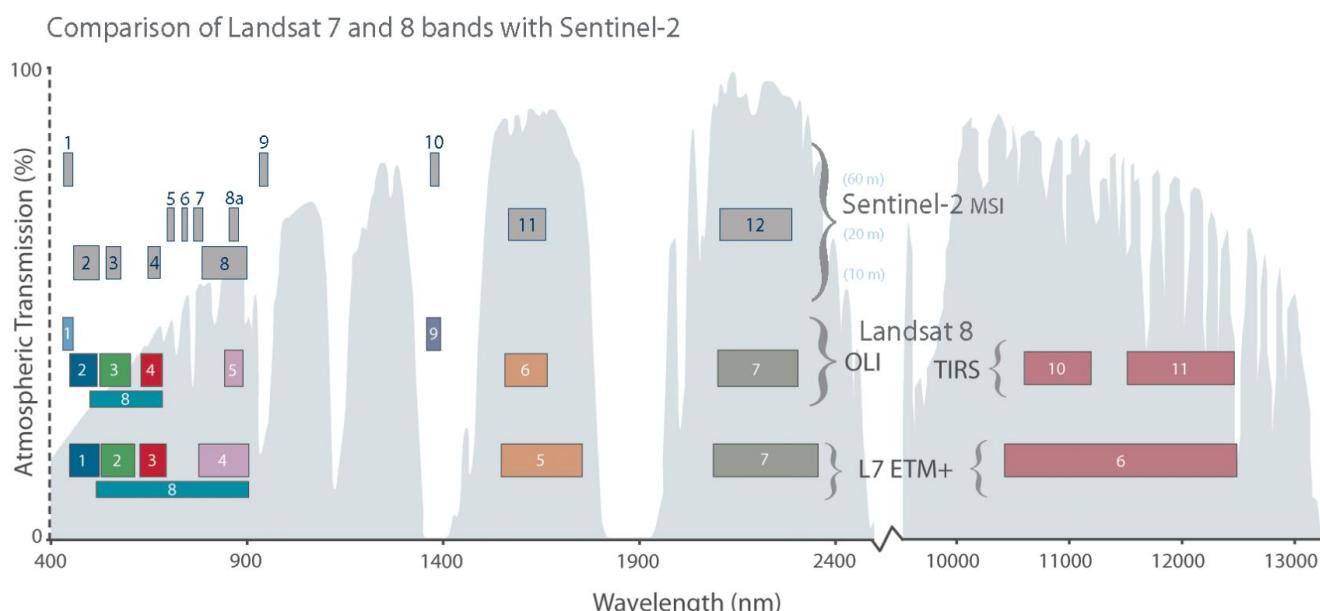
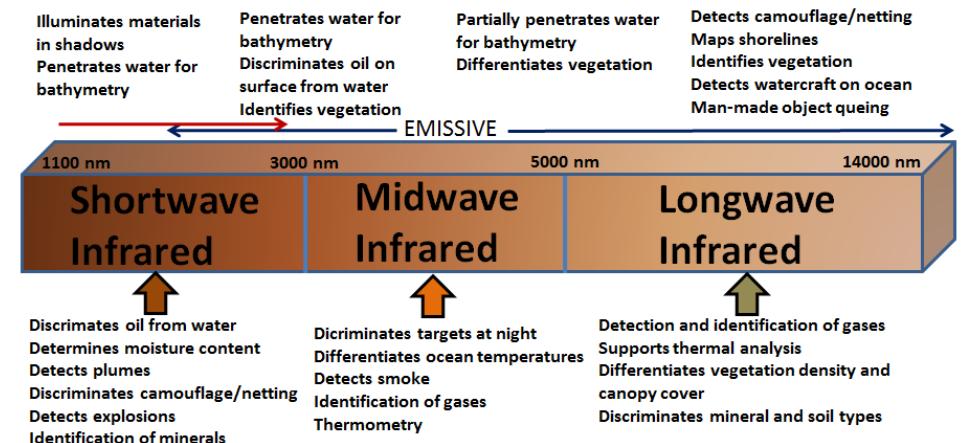
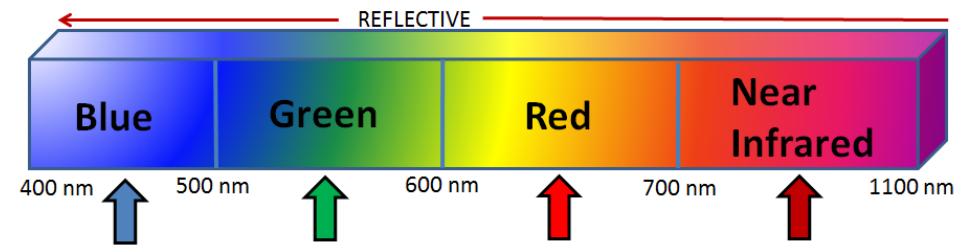
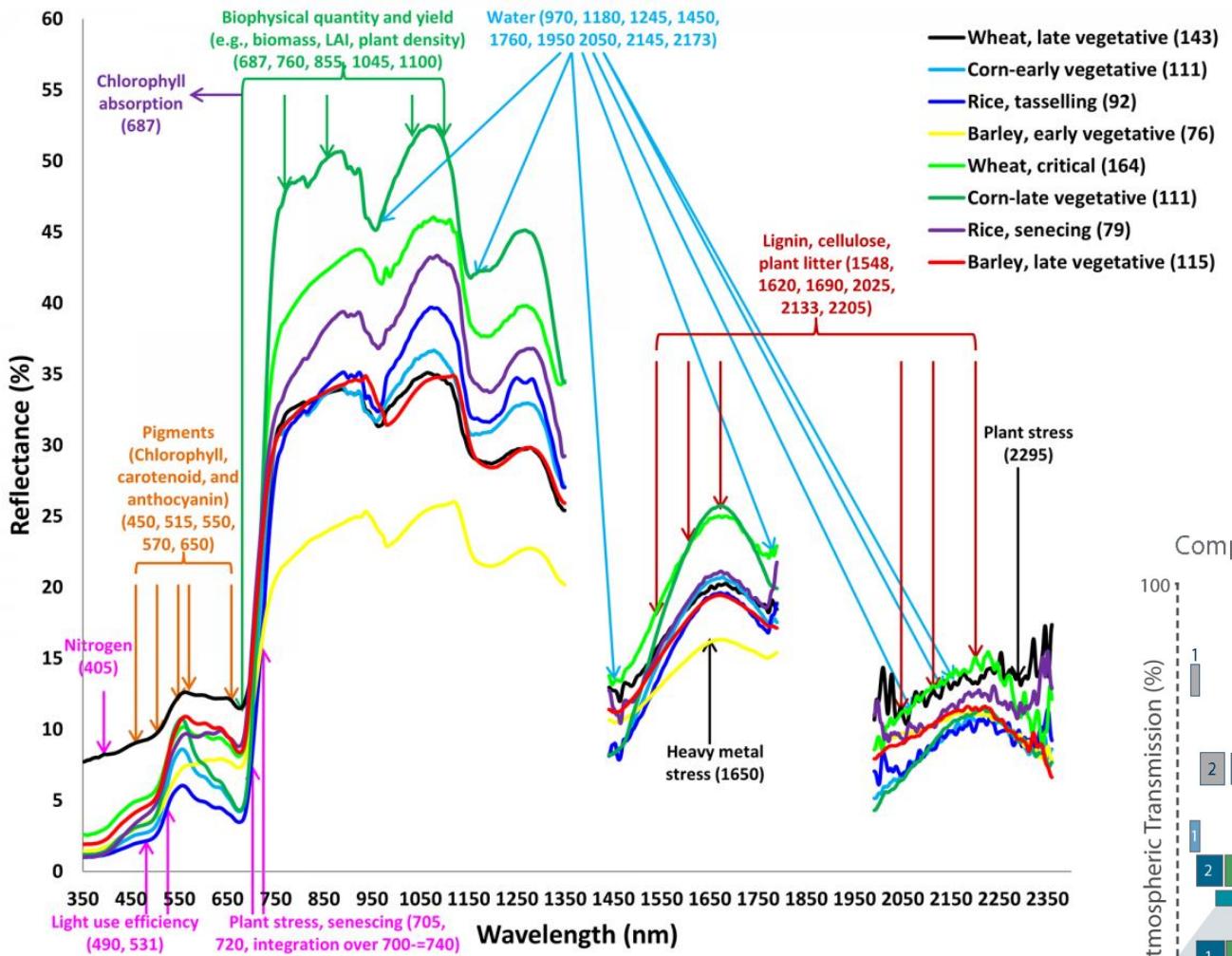
<https://earthengine.google.com/timelapse/#v=45.06583,59.48403,6.045,latLng&t=2.85>

<https://earthengine.google.com/timelapse/#v=-10.0348,-63.006,7.34,latLng&t=2.90>

Spatial and Temporal Resolution for Selected Applications



Spectral resolution



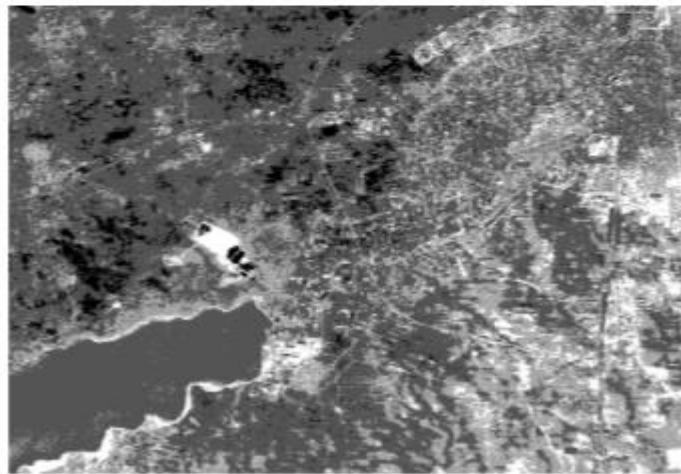
Radiometric resolution



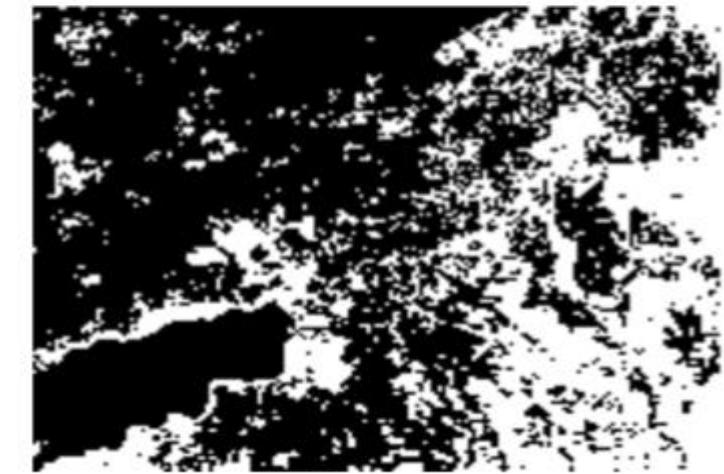
16 Values (4 bit)



8 Values (3 bit)



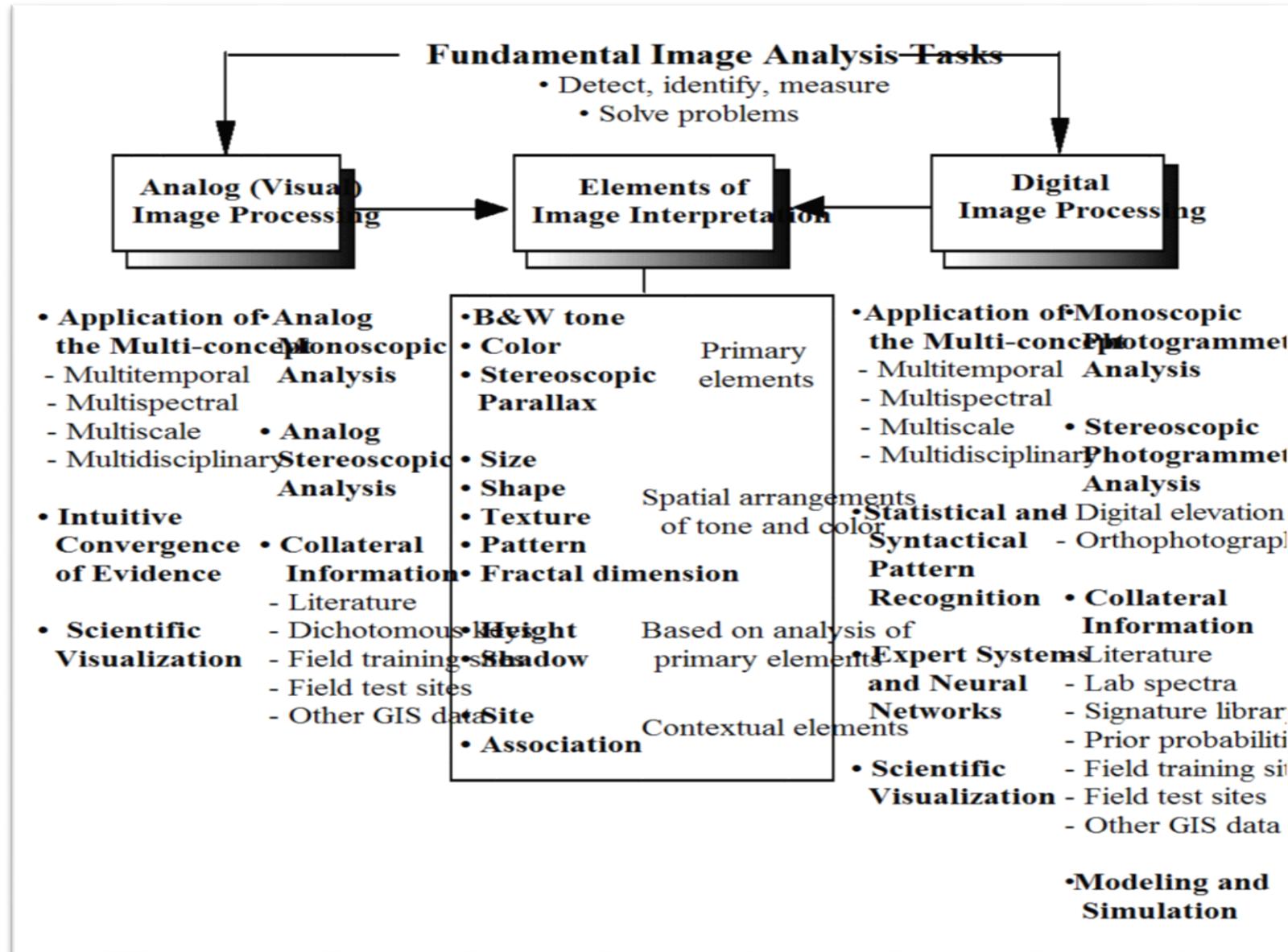
4 Values (2 bit)



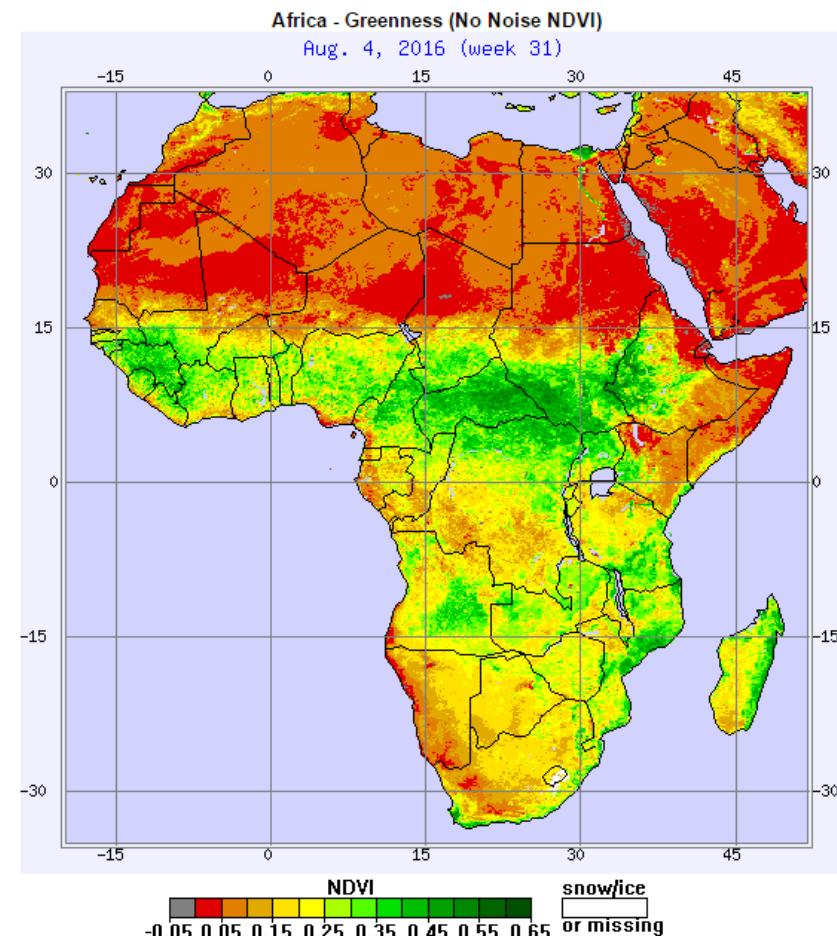
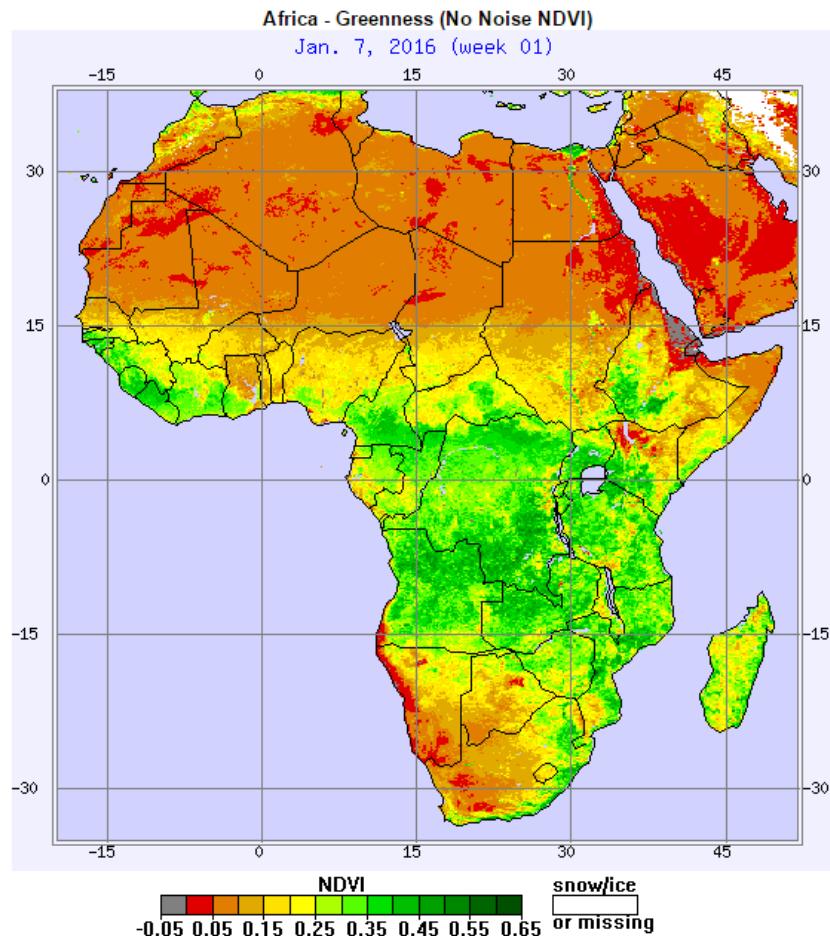
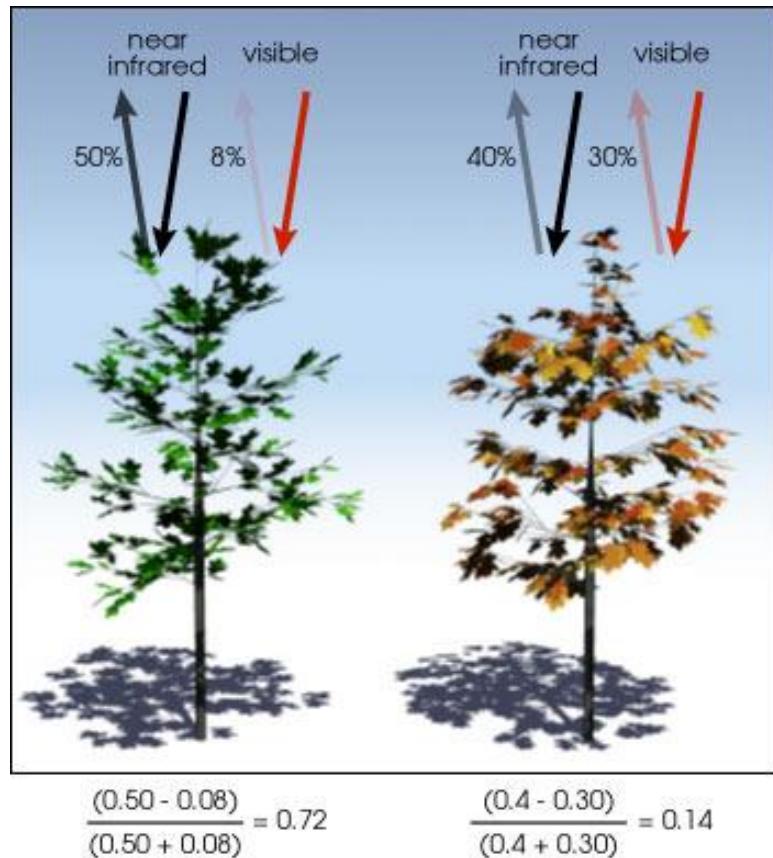
2 Values (1 bit)

Wikimedia.org

Processing remote sensing image



Example of image enhancement: NDVI

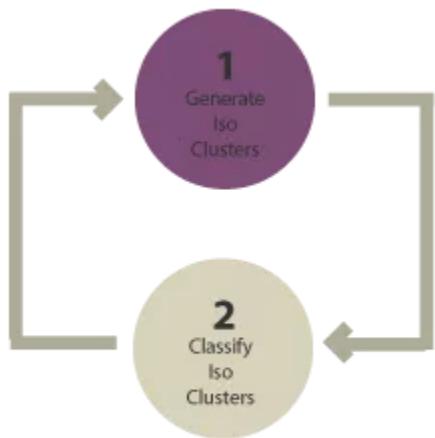


Thematic information extraction: Pattern recognition/ Classification

- Supervised or unsupervised learning;
- Assign each pixel to a particular class or cluster

Unsupervised Classification Steps:

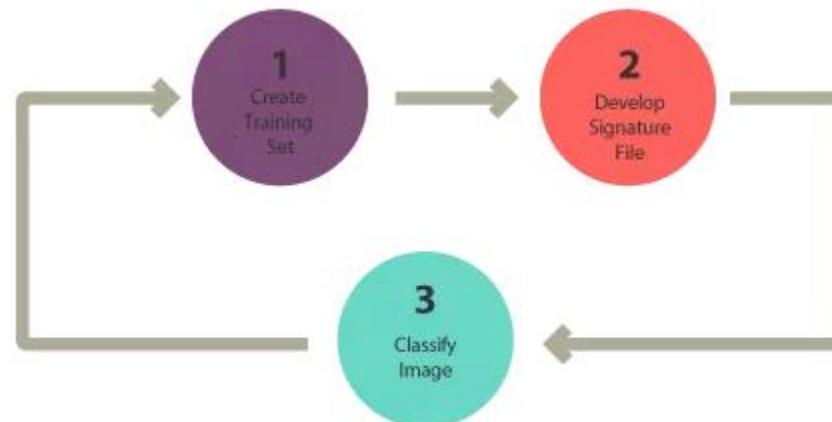
- Generate clusters
- Assign classes



Unsupervised Classification Diagram

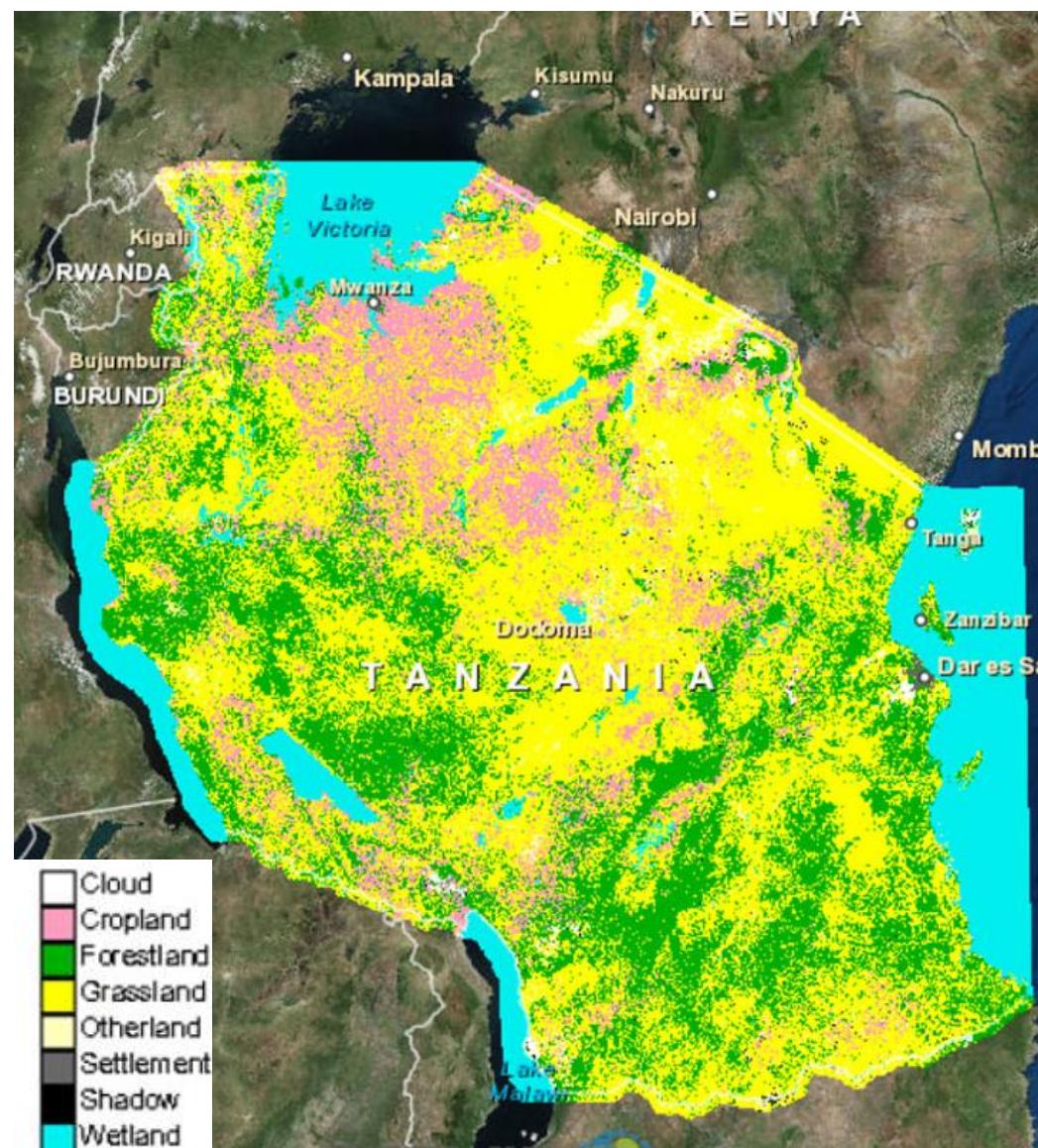
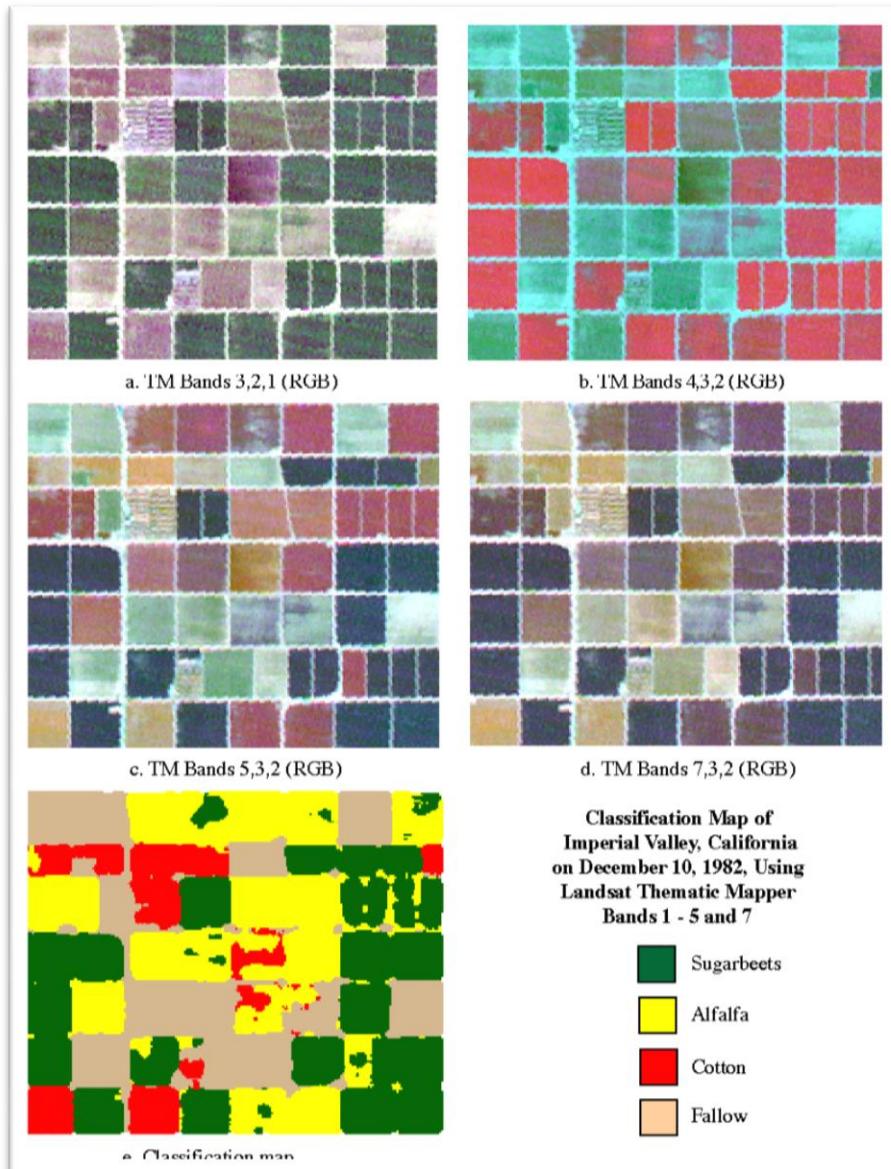
Supervised Classification Steps:

- Select training areas
- Generate signature file
- Classify



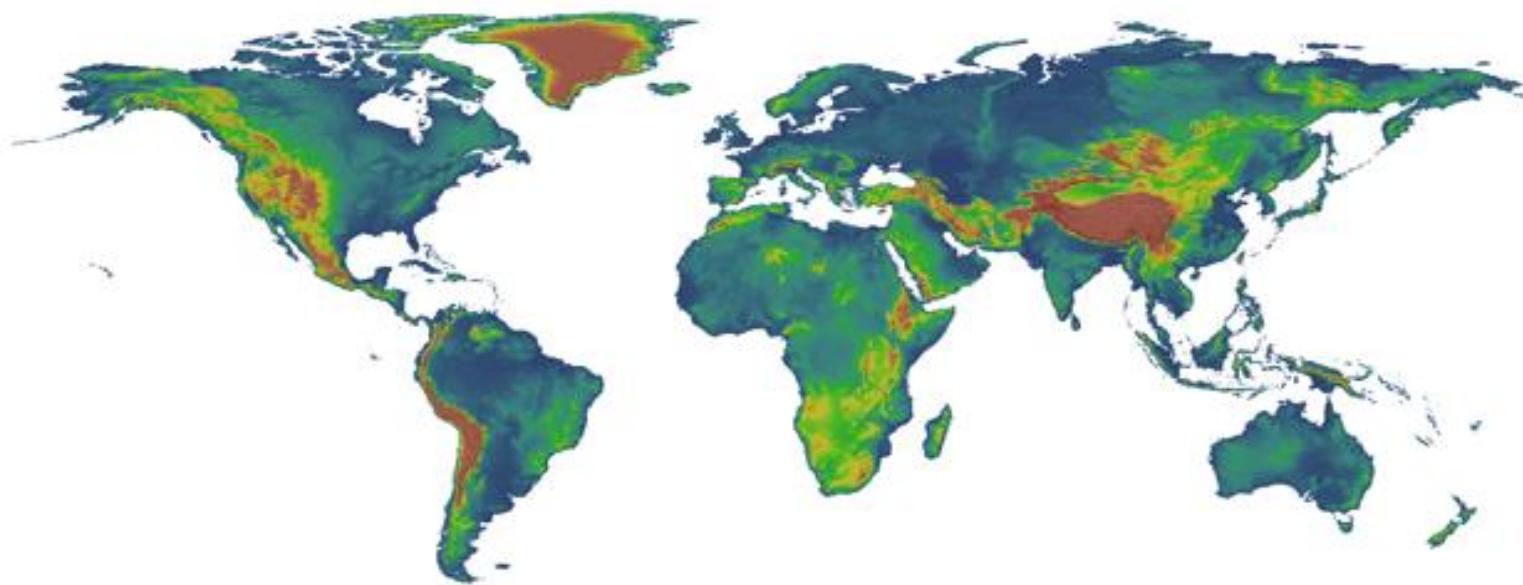
Supervised Classification Diagram

Example of image classification

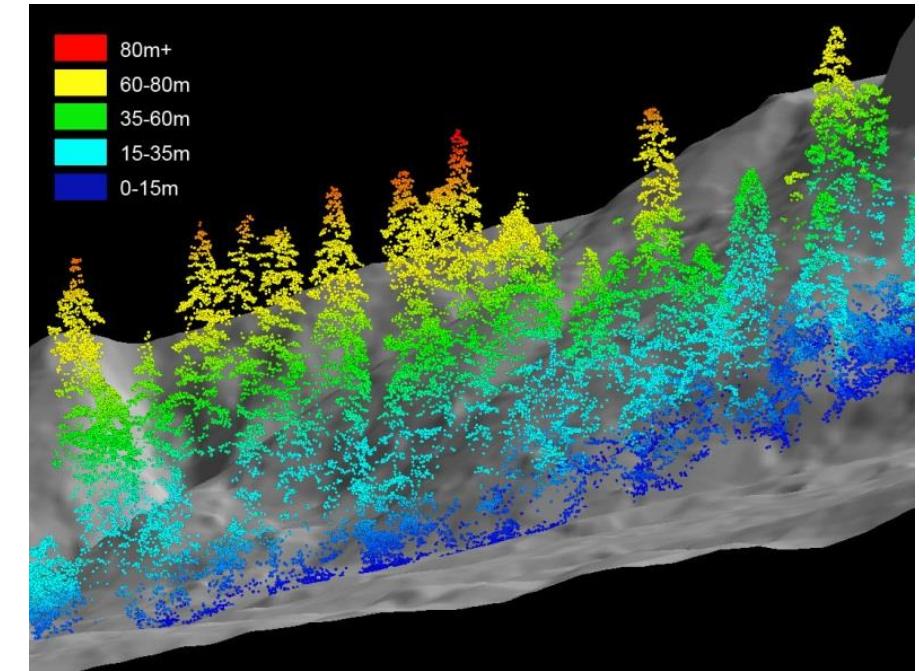


3-dimensional remote sensing

ASTER/SRTM derived global elevation



LiDAR derived canopy heights



Relationships of Remote Sensing with other n'-spatial sciences

Remote Sensing

Definition:

"the art, science, and technology of obtaining reliable information about physical environment, process of recording and interpreting the digital representations of patterns derived from noncontact sensing."

