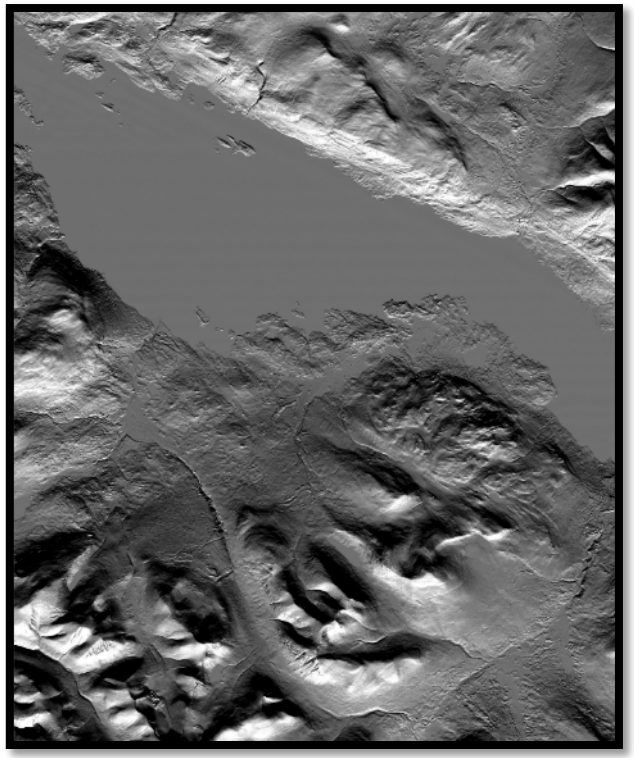
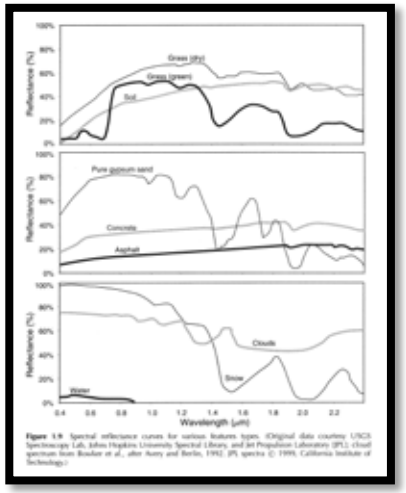
UNIVERSITY OF GOTHENBURG

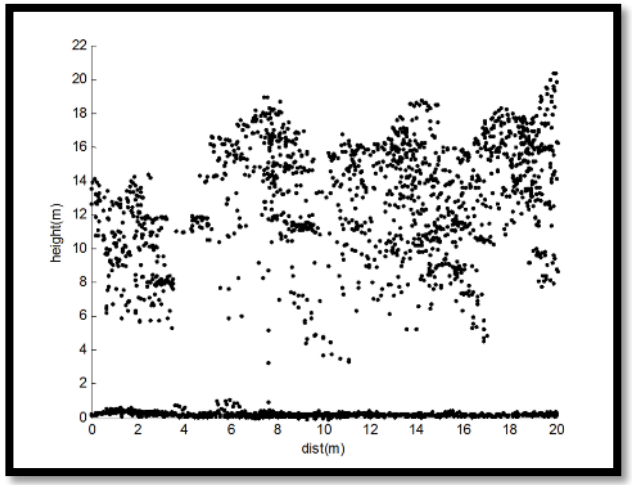
Remote Sensing and GIS

GV2300

Lecture: Introduction to Remote Sensing







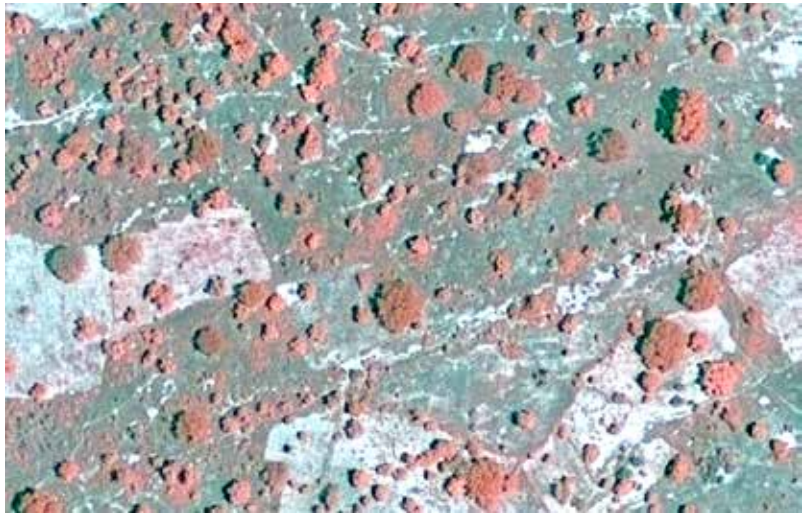
Overview

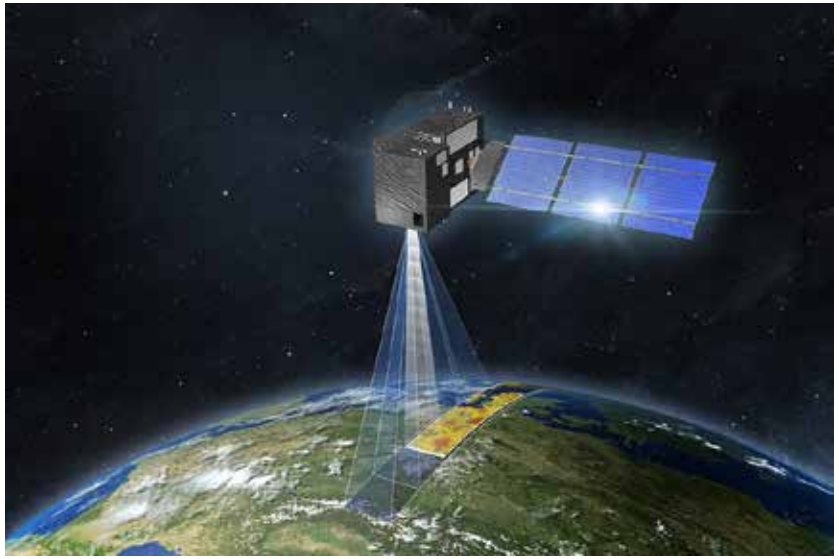
- Remote sensing definition
- Remote sensing framework
- Remote sensing data types

Definition of Remote Sensing

“Remote sensing is the practice of deriving information about the Earth’s land and water surfaces using images acquired from an overhead perspective, using electromagnetic radiation in one or more regions of the electromagnetic spectrum, reflected or emitted from the Earth’s surface.”

-Cambell, Wynne & Thomas, 2022. Introduction to Remote Sensing. Guilford Publications

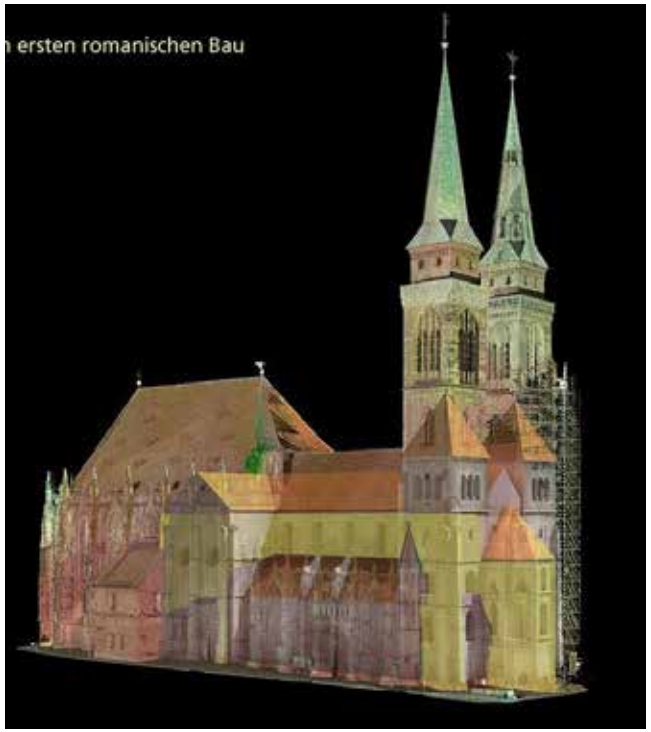


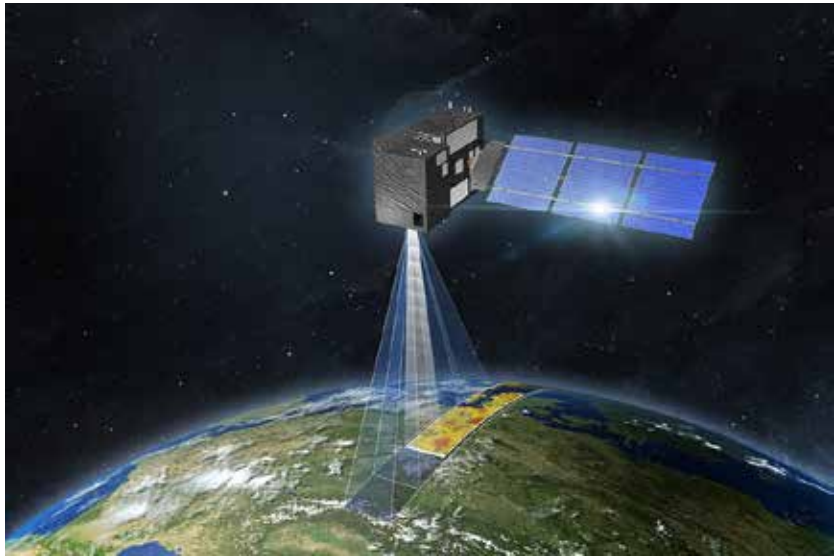


Definition of Remote Sensing

"Remote sensing is the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area or phenomenon under investigation."

- Lillesand, Kiefer and Chipman, "Remote Sensing and Image Interpretation", Wiley Press



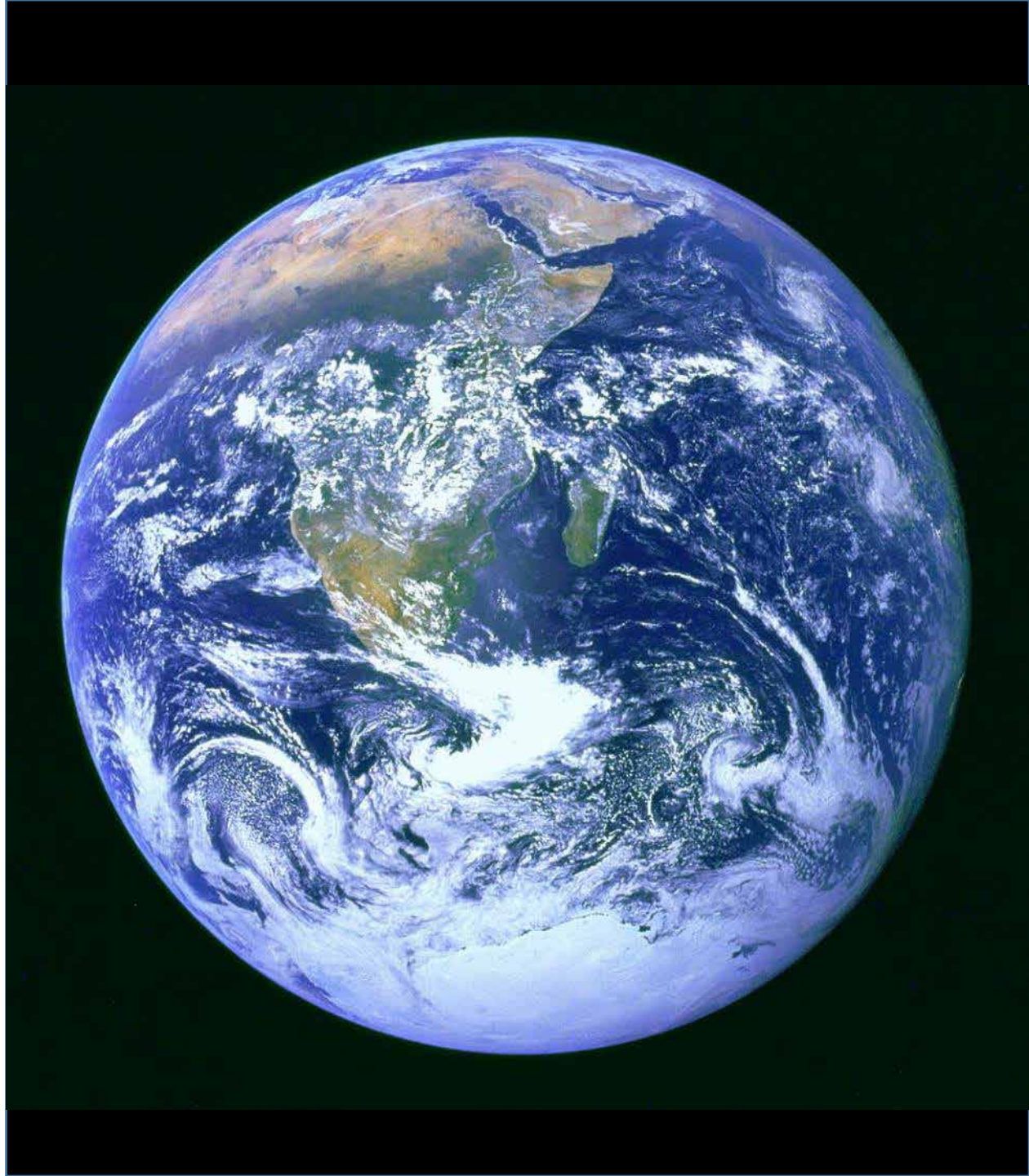


Earth Observation (EO)

A subdiscipline in remote sensing

Earth observation is the gathering of information about planet Earth's physical, chemical and biological systems via remote sensing technologies, usually involving satellites carrying imaging devices.

Earth observation is used to monitor and assess the status of, and changes in, the natural and manmade environment.



Close-range remote sensing

A subdiscipline in remote sensing

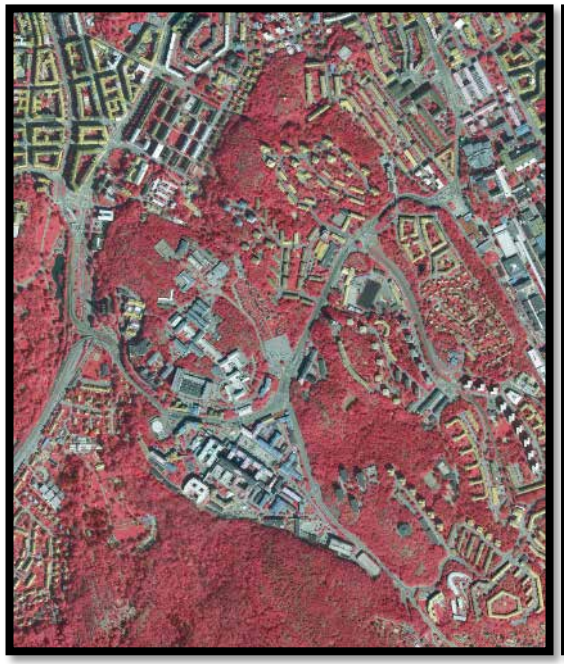
Use of sensors to collect information about objects without coming into contact with them, done so at close distances (< 200 m)

Why use remote sensing?

- A cost-effective way to get information
- Large area coverage
- Coverage of remote areas that are hard to get to
- Better and new information can be obtained
  (as compared to traditional data collection methods)
- Objective analysis of digital data is possible
- You can get repeated images over time

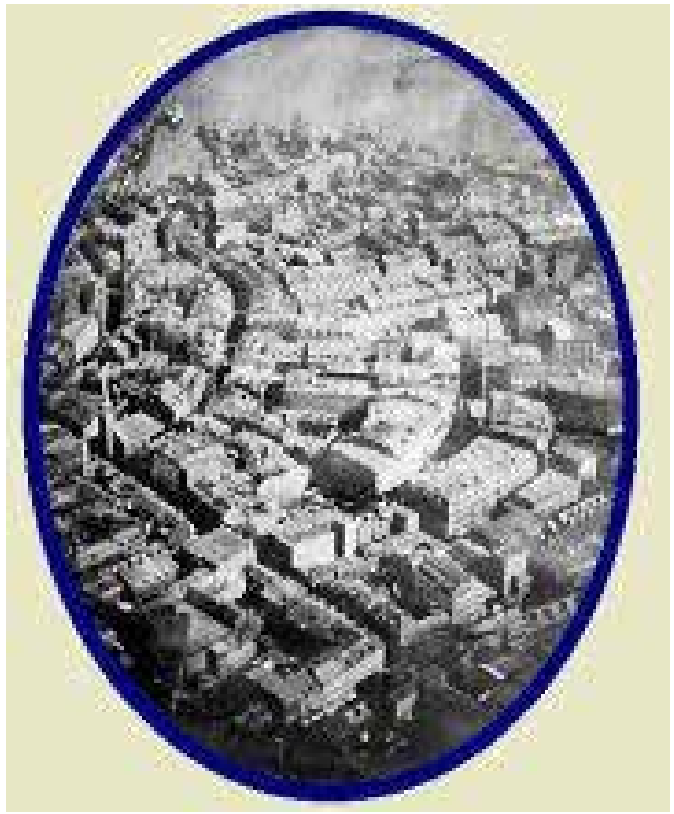
From Ljungbergs compendium, Chapter 1

Why use remote sensing?



History of remote sensing

Aerial photography began with cameras from balloons and kites
1858 – G.F. Tournachon, also known as ”Nadar” took photographs over Paris

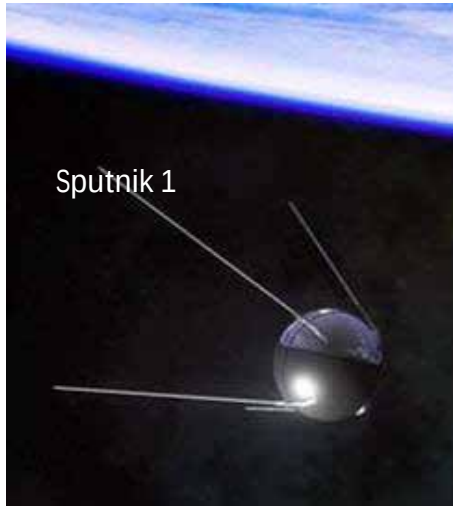


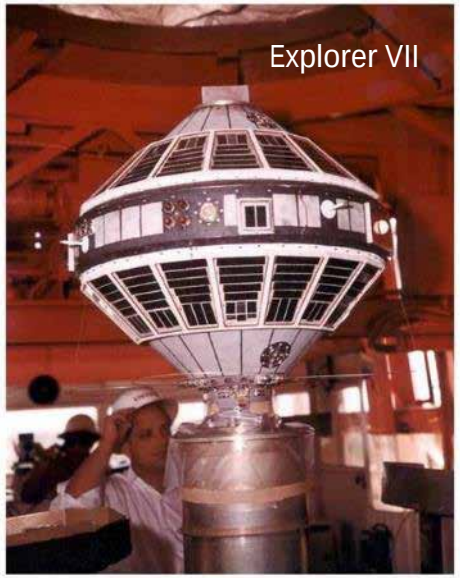
History of remote sensing

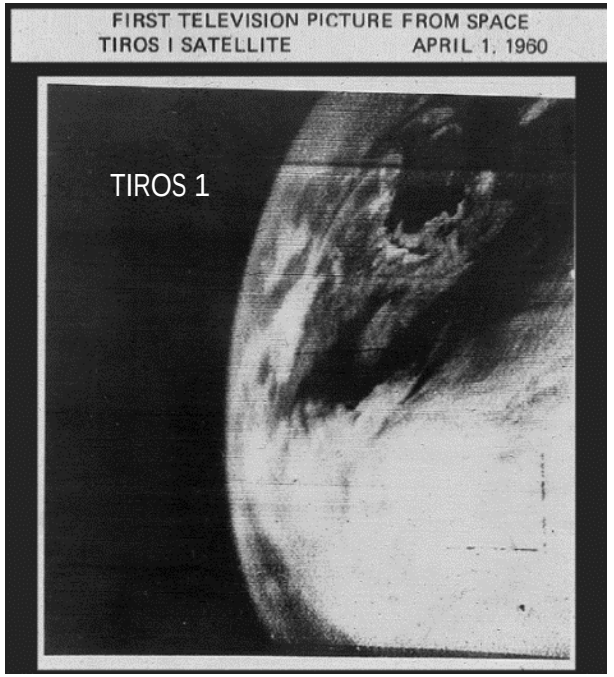
World War I and II was behind many uses and developments of aerial photography
In fact, many innovations in remote sensing have been started for military reasons

History of satellite remote sensing

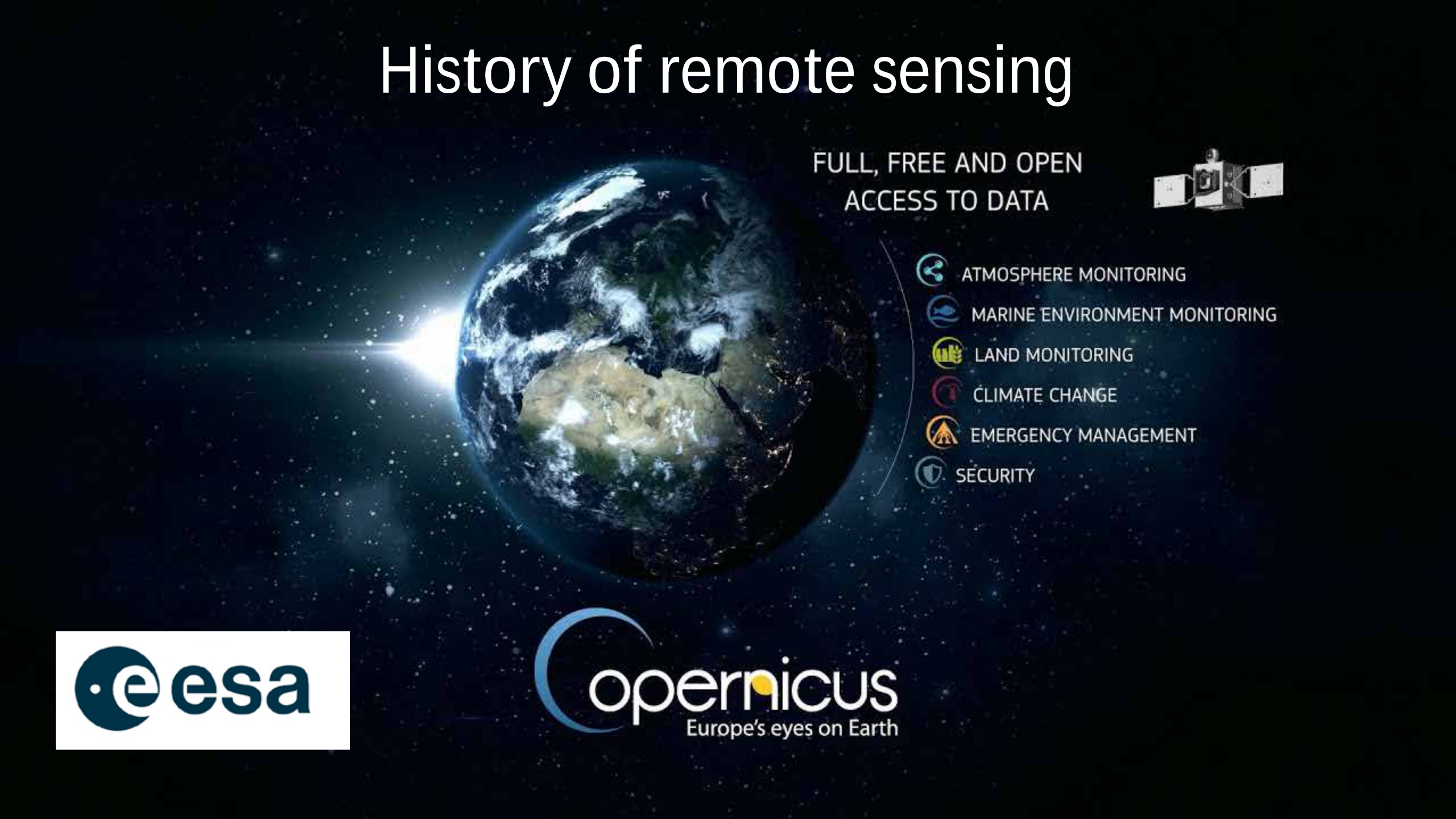
- Sputnik 1 was the first earth-orbiting artificial satellite (no sensor onboard), launched 1957.
- Explorer VII took the first picture from space, Purpose was to measure Earth's radiation. August 1959.
- Tiros-1 Purpose was to observe clouds for meteorology. Started taking pictures 1960.
- Corona / Argon – reconnaisance satellites were operating mainly in the 1960s.
- Landsat 1 (ERTS-1) was the first satellite whose purpose was to observe land and natural resources on Earth. Launched 1972







History of remote sensing



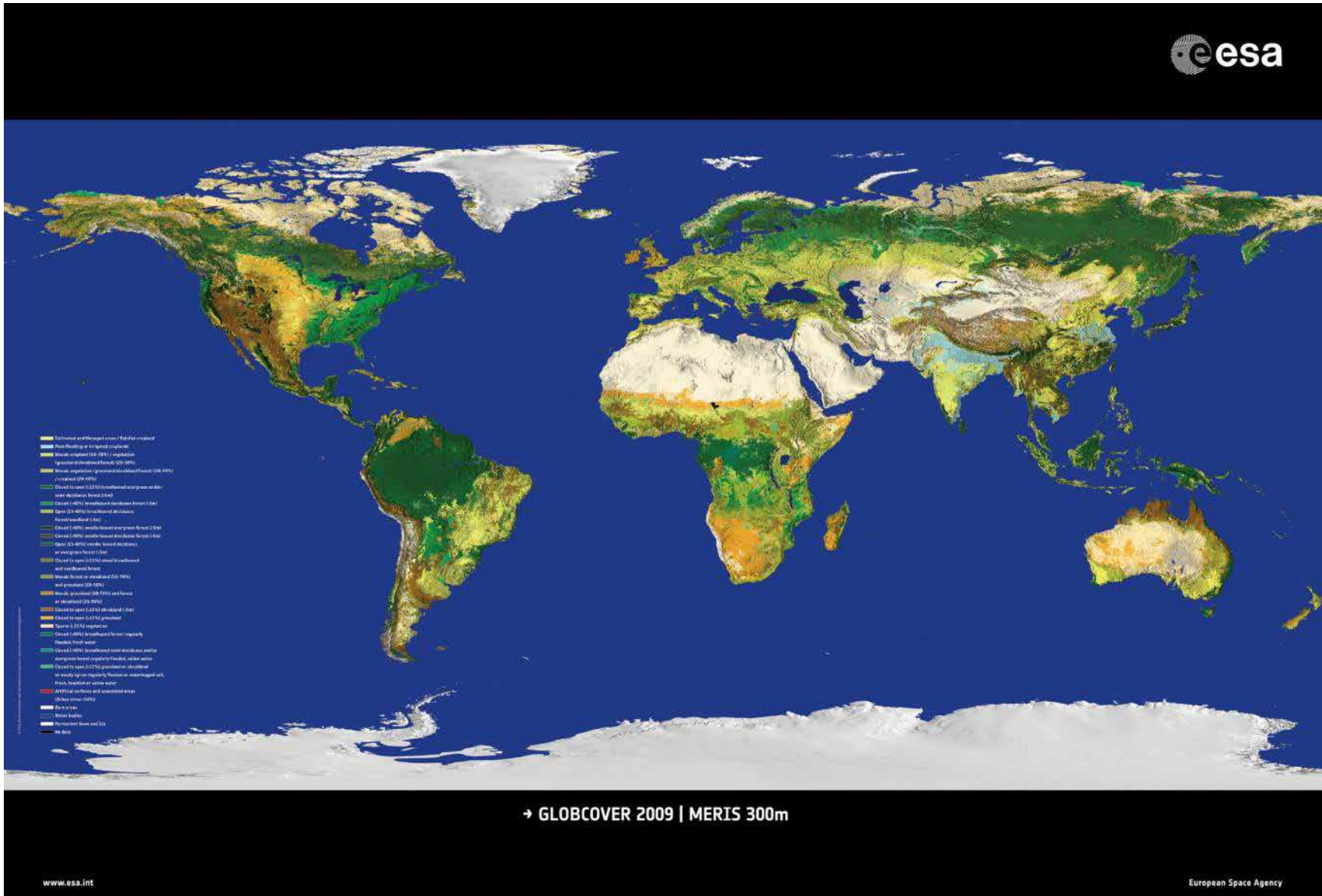
Current trends in remote sensing

Remote sensing is in an exciting and expansive phase!!

- More frequent data
- More high resolution data
- More global data
- More cloud-based processing
- Using Artificial Intelligence to process data
- There are more users and applications than ever before

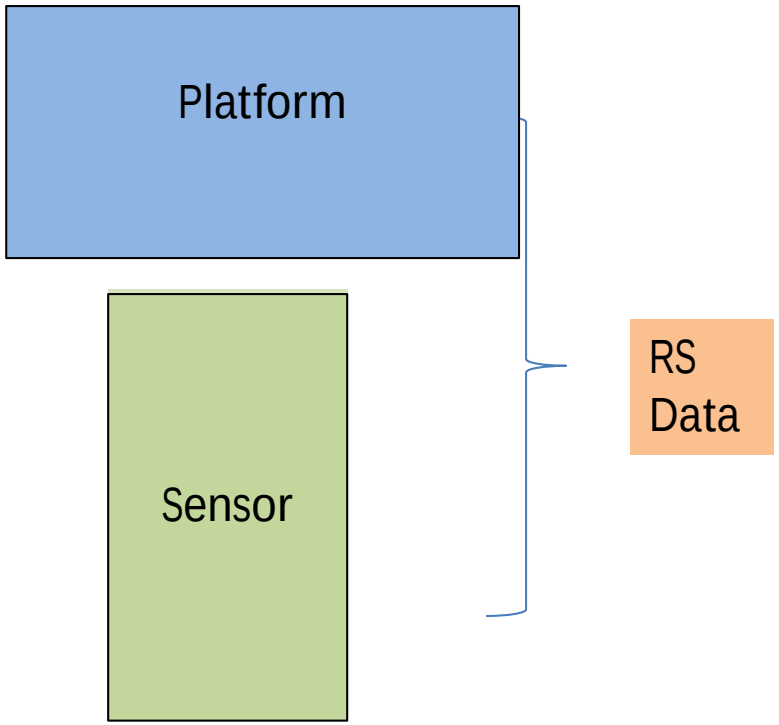
Applications of remote sensing

- Biosphere
  - Vegetation type
  - Vegetation health
  - Phenology
- Geosphere
  - Sub-surface moisture
  - Earthquake faults
  - Minerals at surface
- Hydrosphere
  - Algae blooms
  - Oil spills
  - Water level, flooding
  - Sea ice
- Cryosphere
  - Glacial ice velocity
  - Permafrost
- Atmosphere
  - Cloud cover
  - Wind speed
- … many more



Introduction to remote sensing

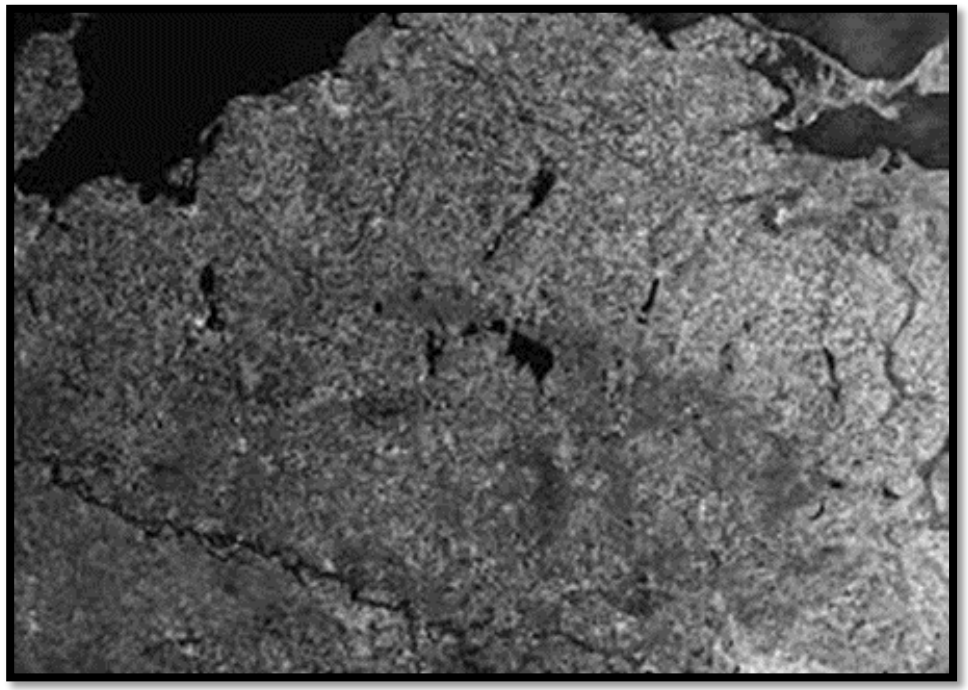
Framework for elements in Remote Sensing



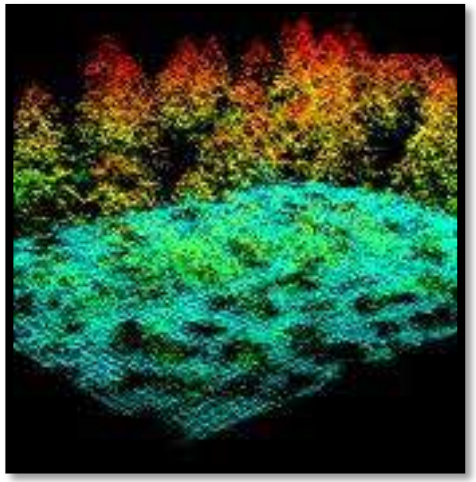
Typical division of sensors

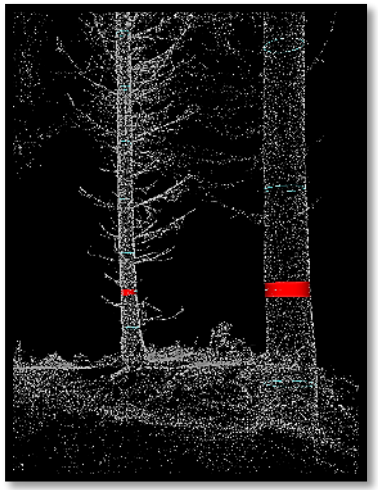
(Electro-) Optical

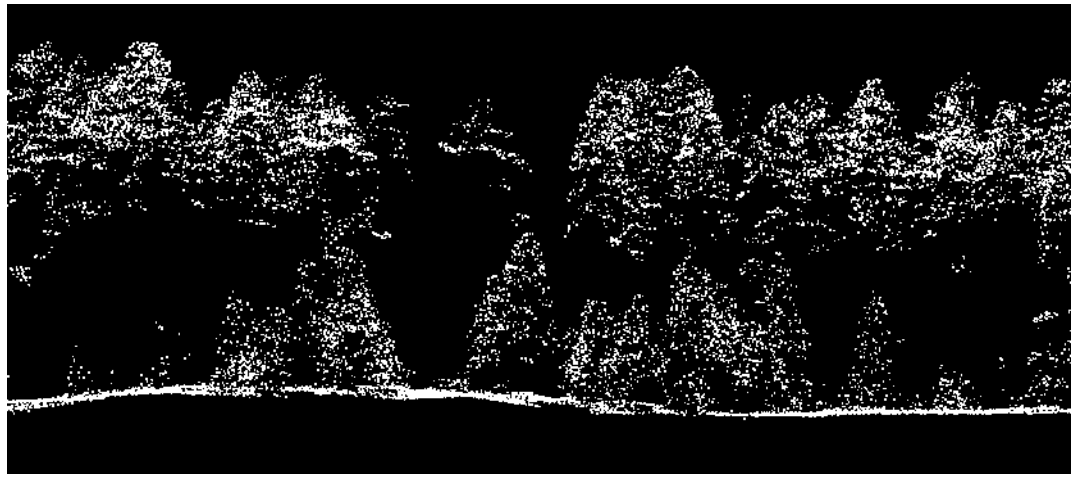
RADAR



LiDAR







A typical division of platforms

Satellite

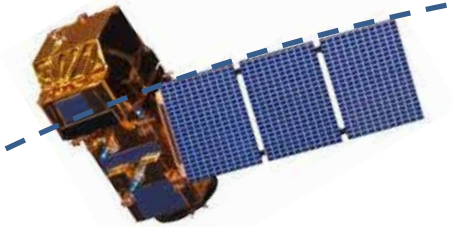
Airborne

Drone/Uncrewed Aerial Vehicle

Terrestrial

Spaceborne satellites

Ca 800 km



Airborne platforms (airplanes often up to 5 km)

Introduction to remote sensing

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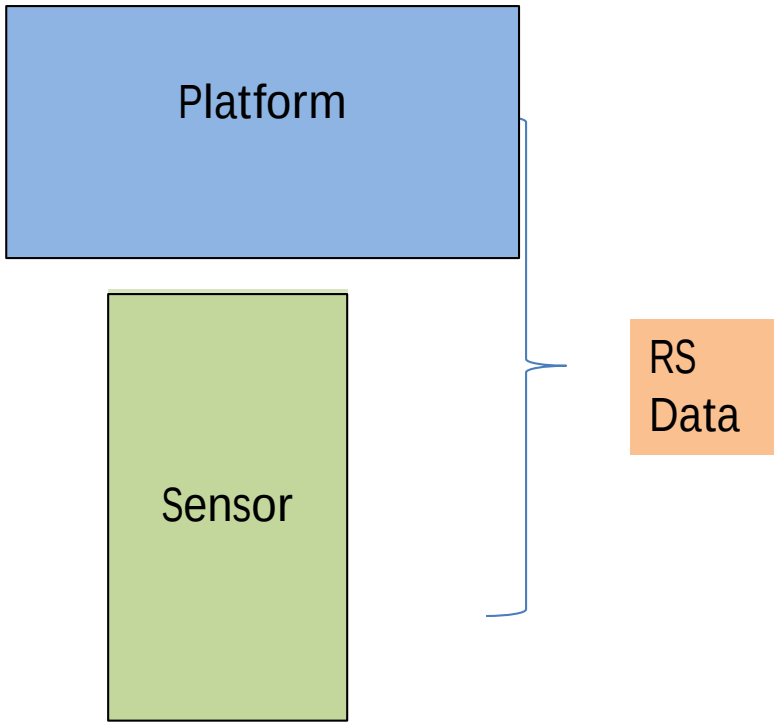
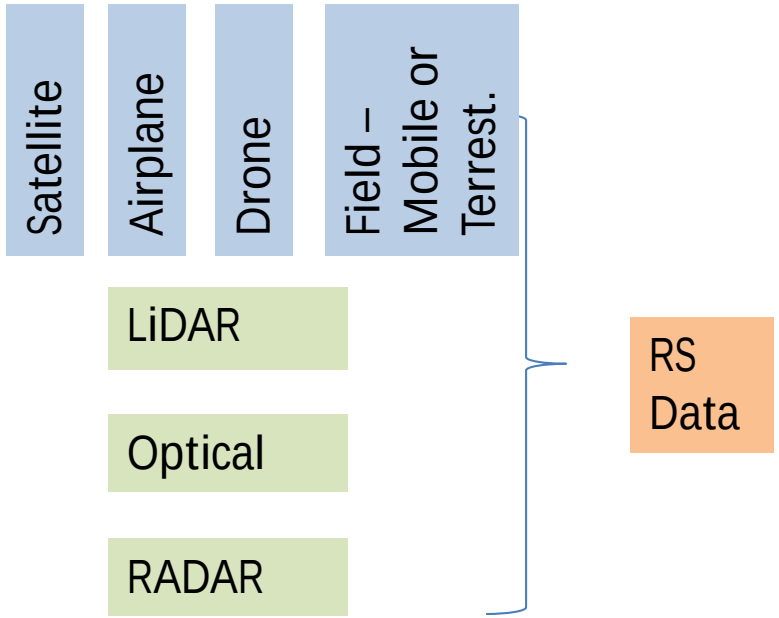


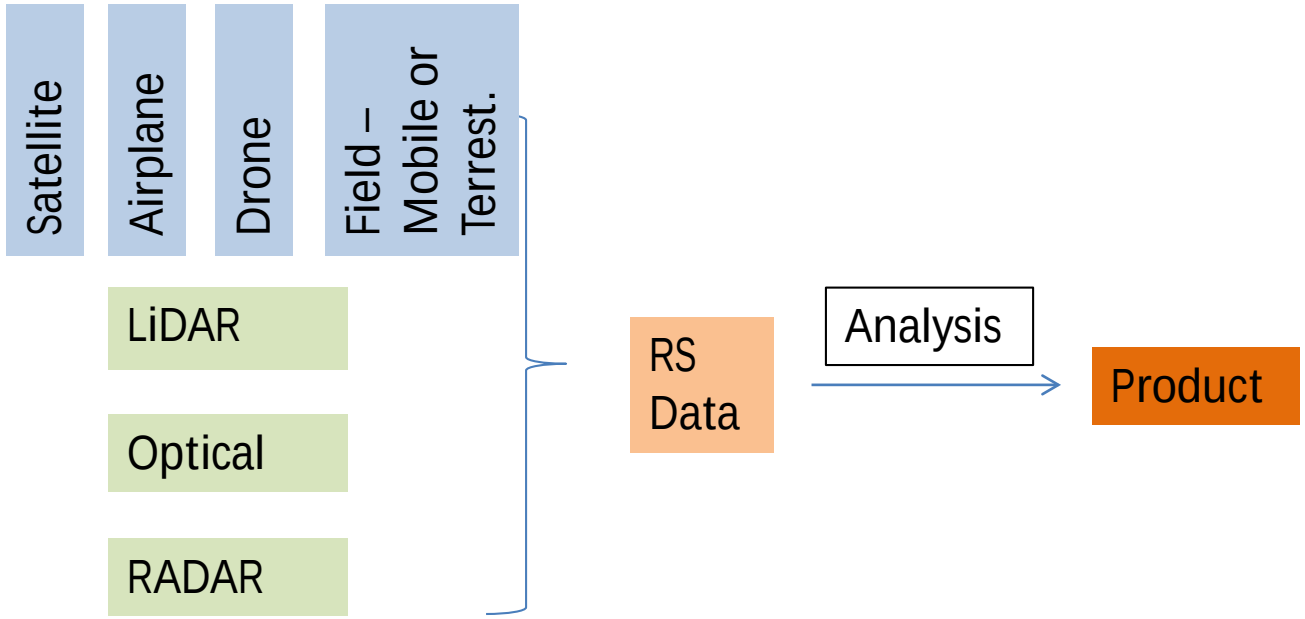
Introduction to remote sensing

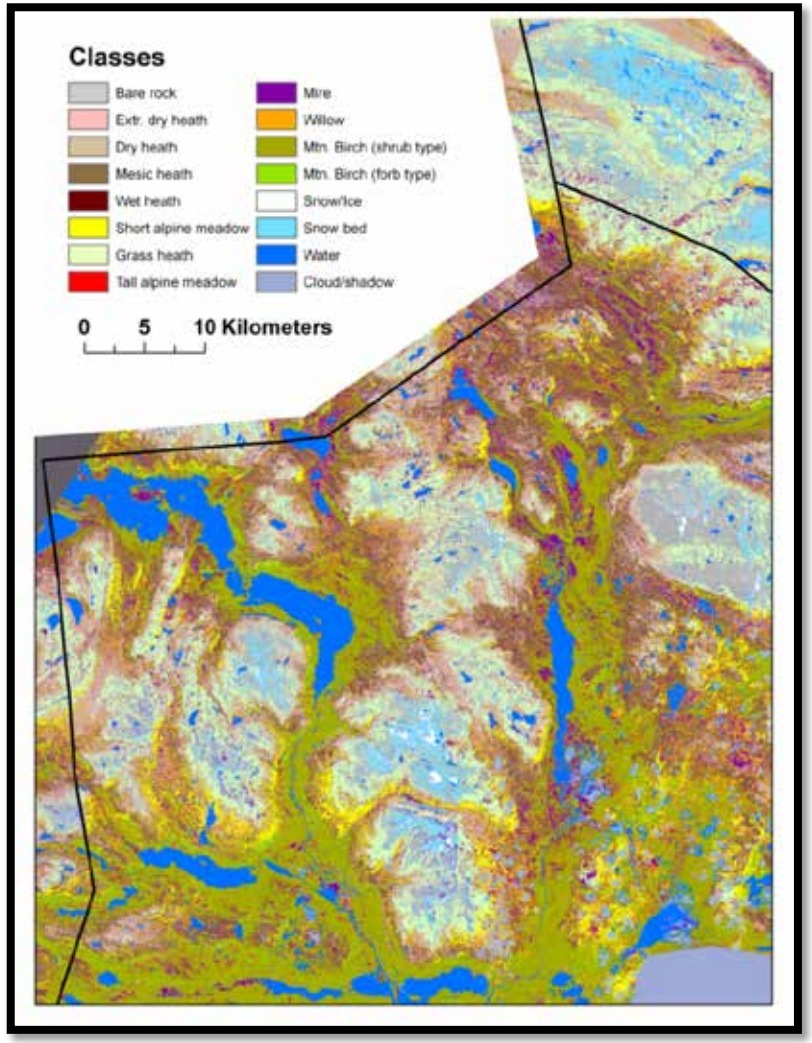
Framework for elements in Remote Sensing



Introduction to remote sensing

Framework for elements in Remote Sensing





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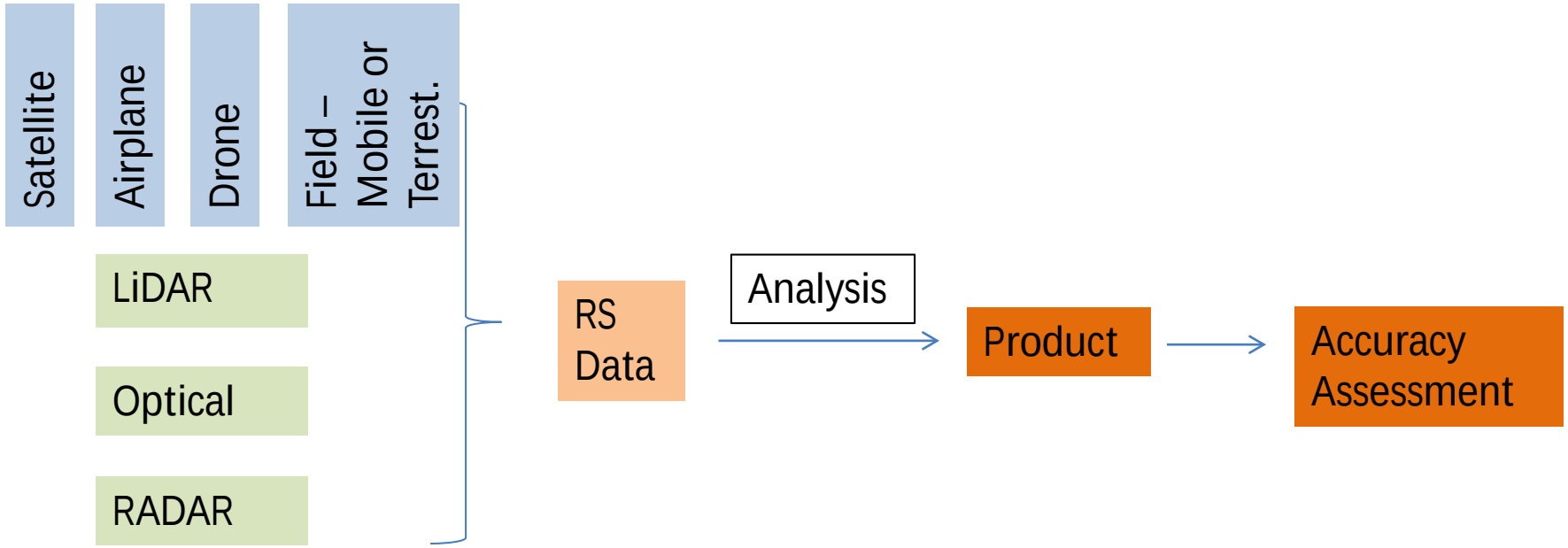


Active vs Passive Sensors

Active sensors

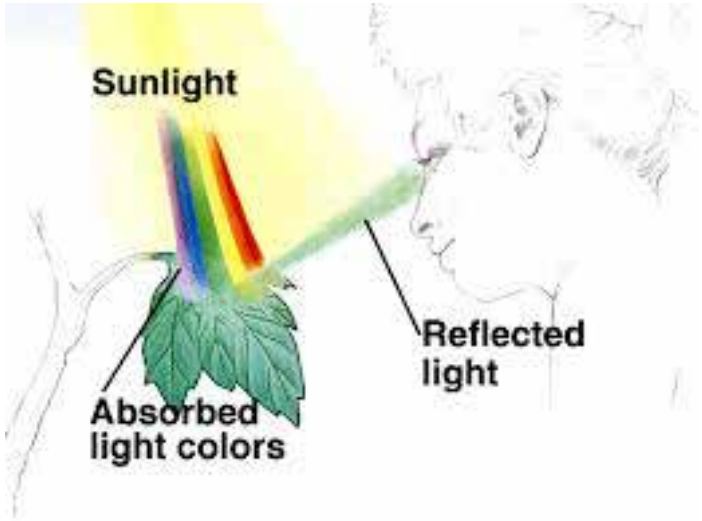
Send out their own energy source and record the returned energy

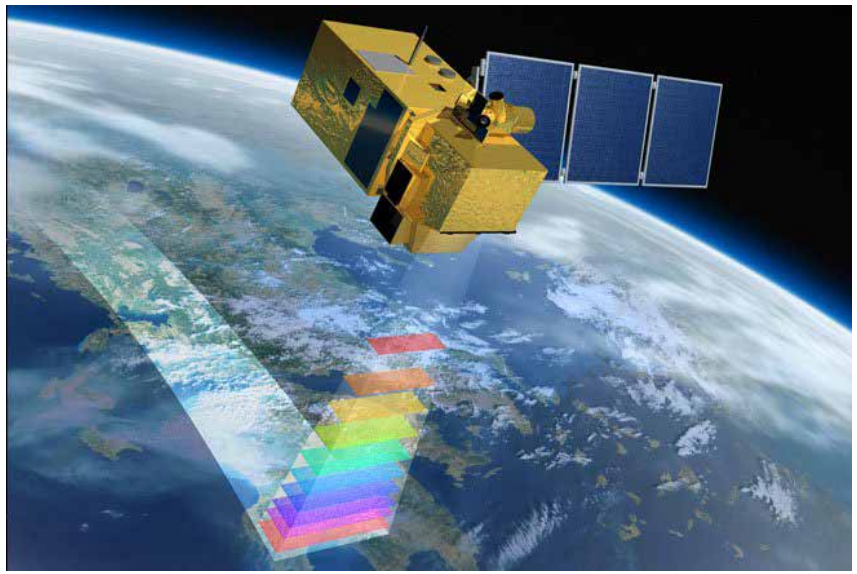
Passive sensors

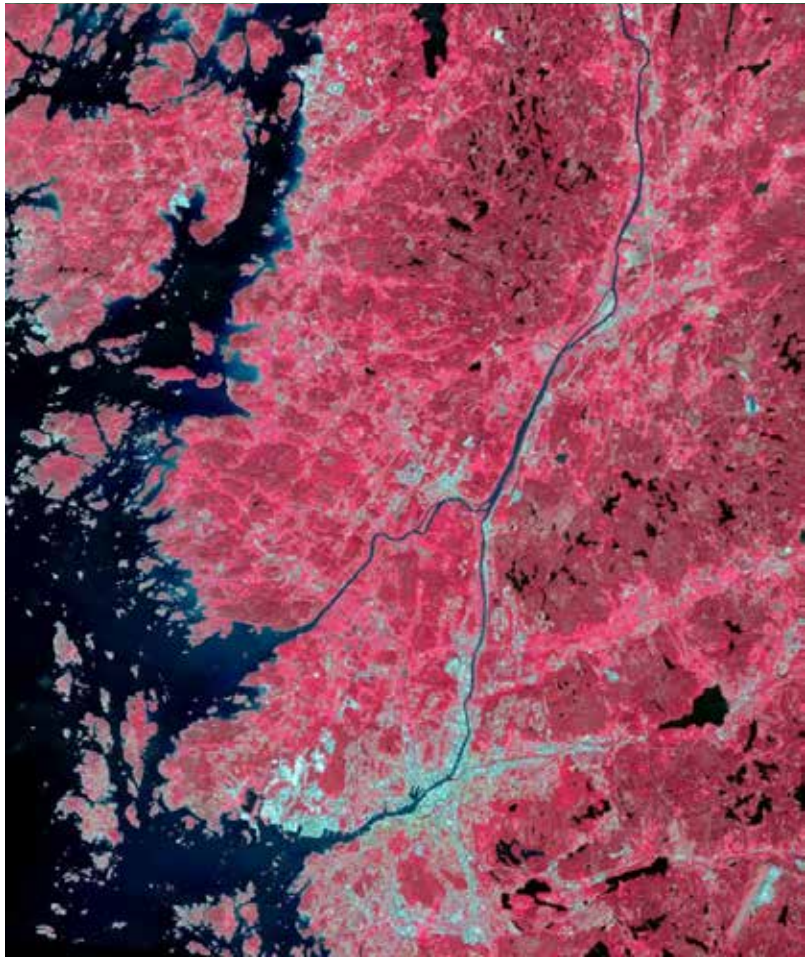
Record energy as reflected from the sun or emitted by the object

Optical sensors

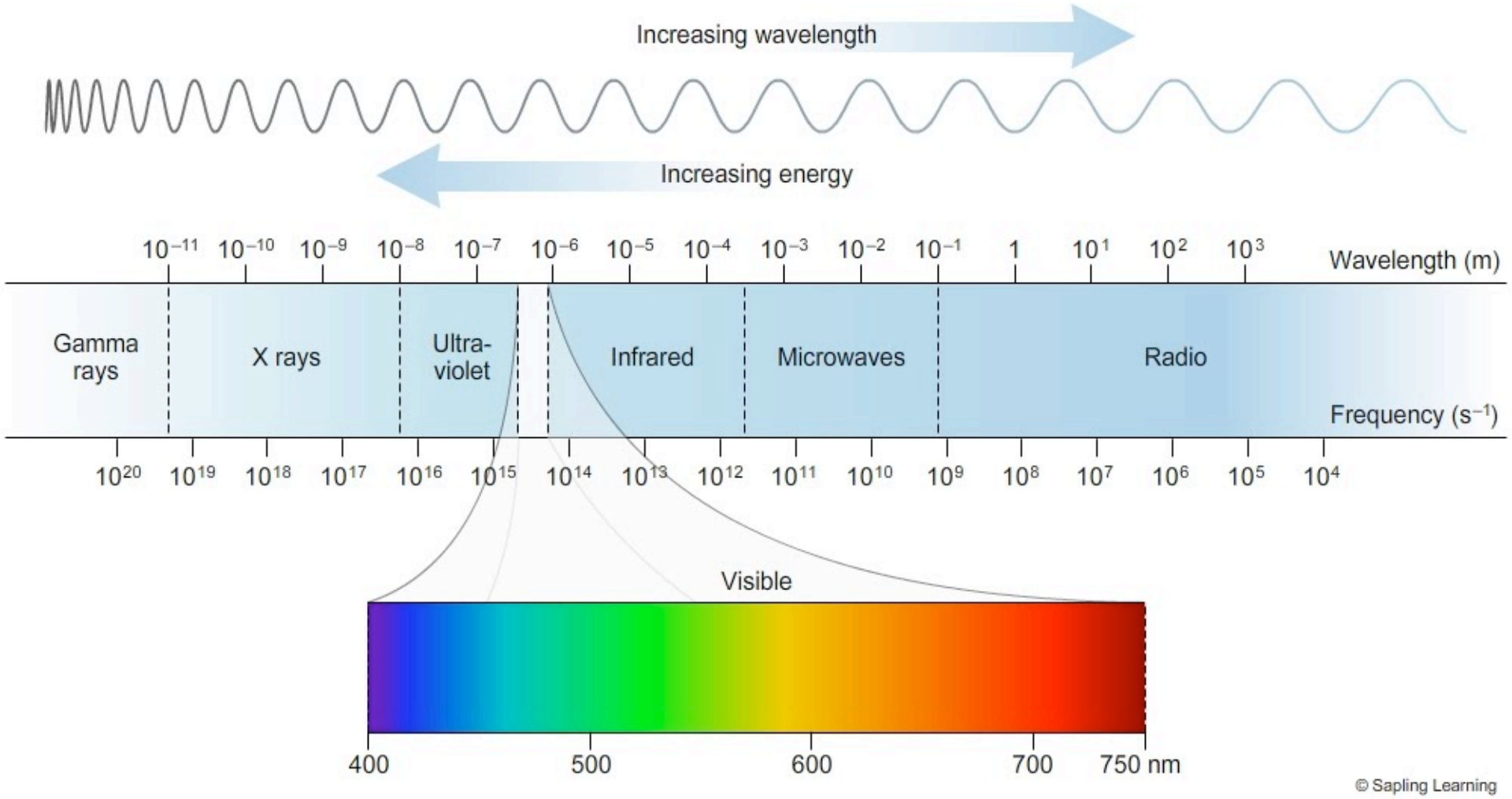
Electro-Optical or just “optical”



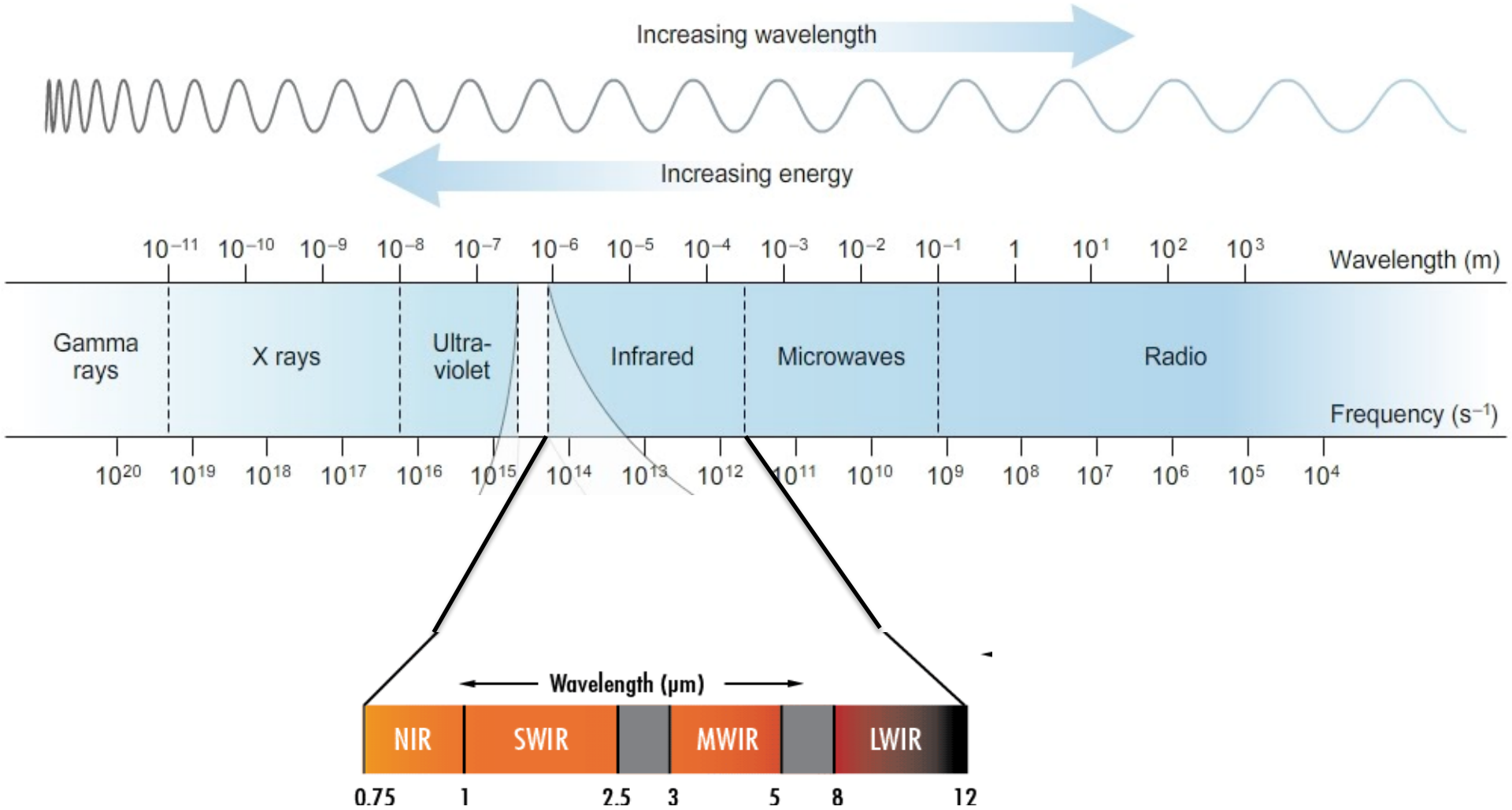




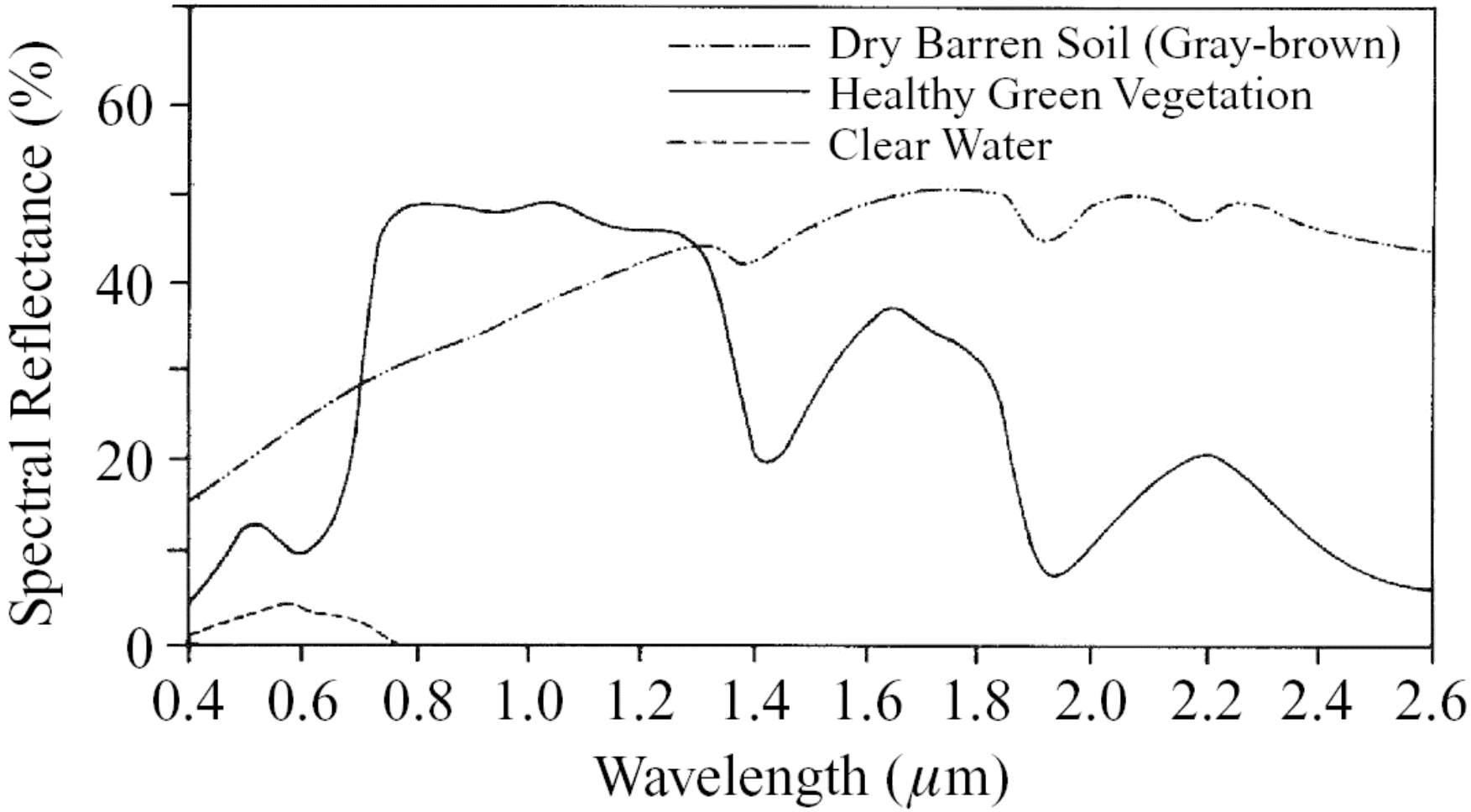
Electromagnetic spectrum



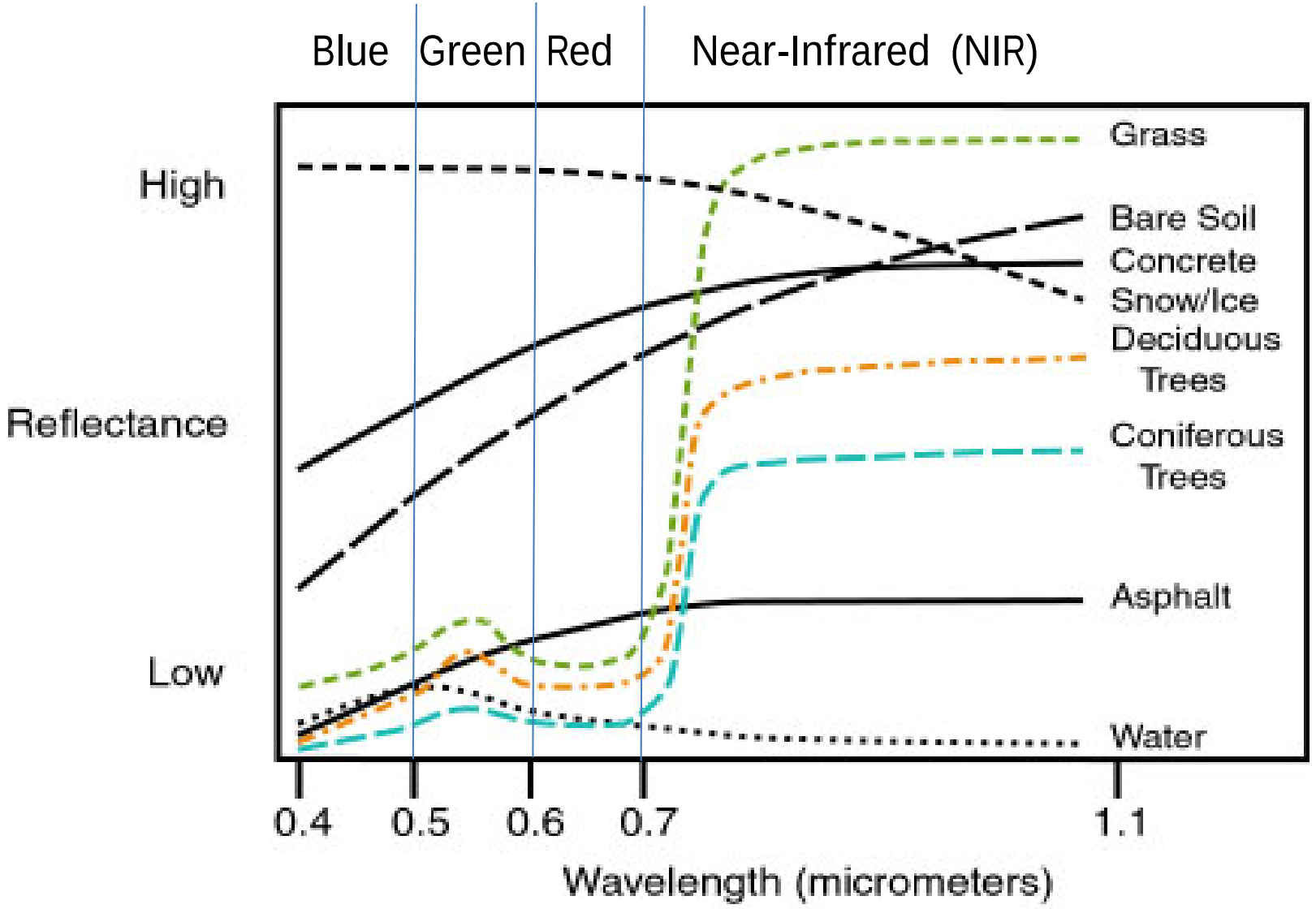
Electromagnetic spectrum



Spectral reflectance curves or "Spectral Signatures"



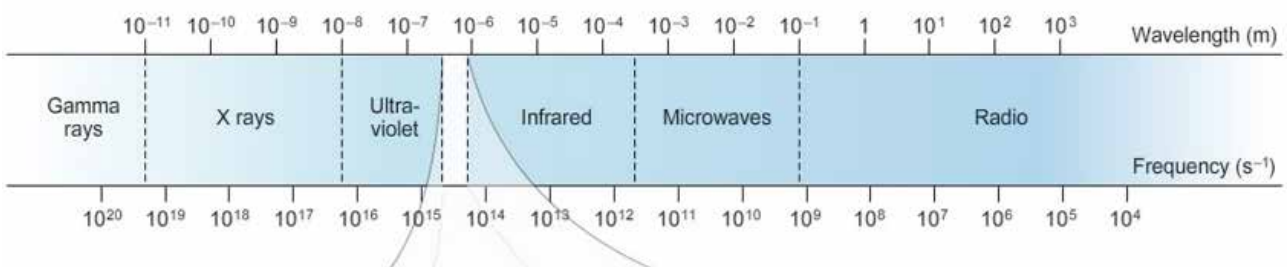
Spectral reflectance curves or "Spectral Signatures"



Typical wavelengths recorded with Electro-Optical sensors

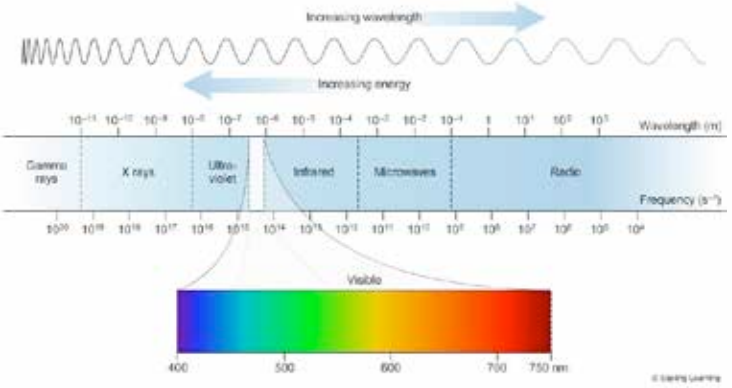
Nominal wavelength	Approximate Wavelength (µm)	Actual Wavelength (µm)	Application
Blue	0.4 – 0.5	0.45-0.495	Good for water body penetration and detection of haze
Green	0.5 - 0.6	0.495-0.57	Good for green reflectance peak of vegetation, therefore for vegetation identification and to detect vigor
Red	0.6 - 0.7	0.62-0.75	Is in a chlorophyll absorption region, therefore aids in vegetation identification
Red-Edge			Between the red and NIR region, useful for vegetation identification and to detect vigor
Near Infrared (NIR)	0.7 - 1.3*	0.78-1.3	Sensitive to leaf structure at smaller scale, and due to its high reflectance by plants, can be used for vegetation identification and to detect vigor
Short-wave IR (SWIR)	1.3* - 3.0	1.3-3.0	Also called Mid-IR. Indicates vegetation and soil moisture content. Sensitive to shadowing. Useful in mineral and rock discrimination.

*May be 1.4 in some sources

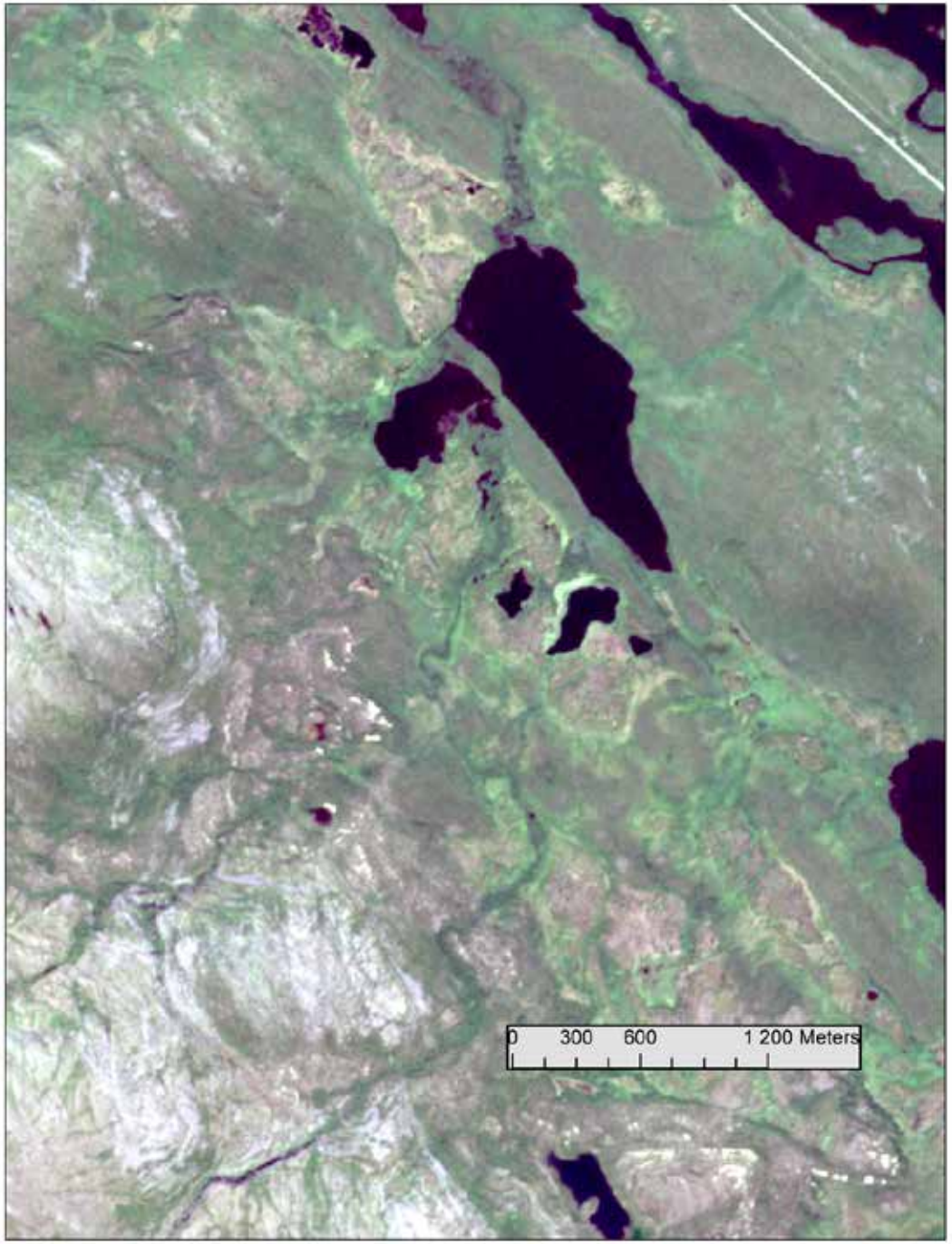


True Color

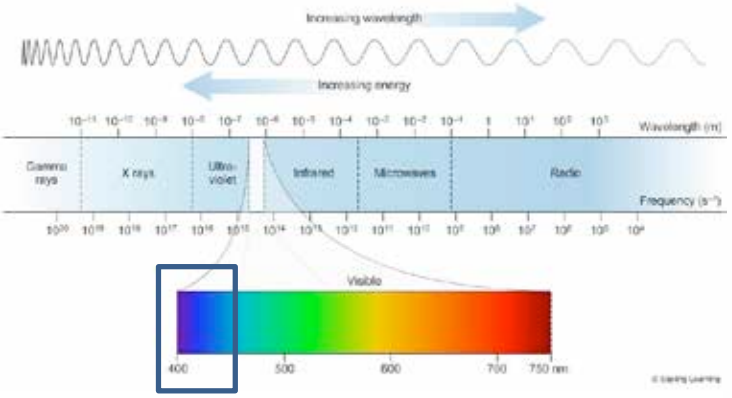
Red
Green
Blue

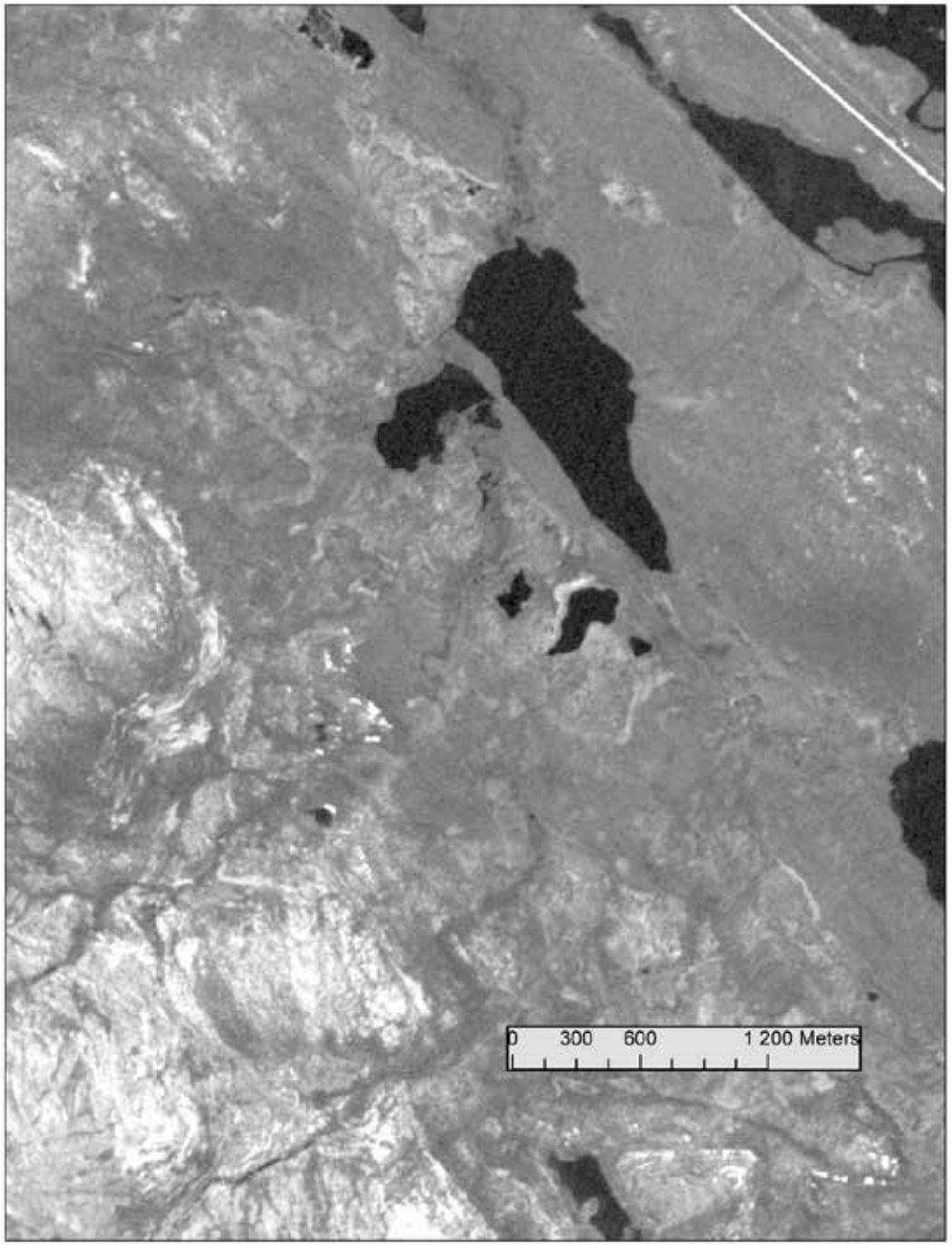


Visible part of spectrum

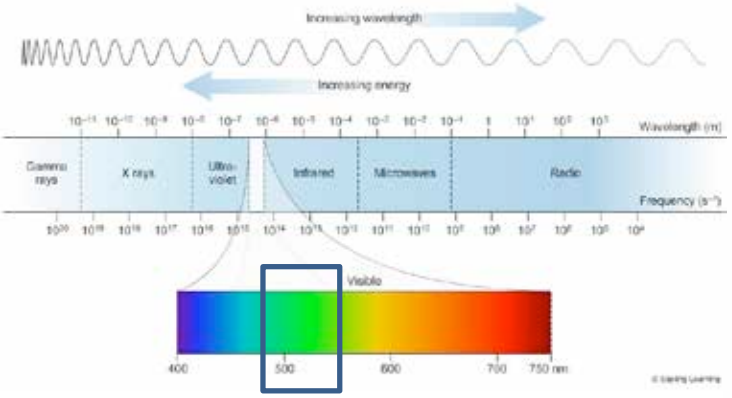


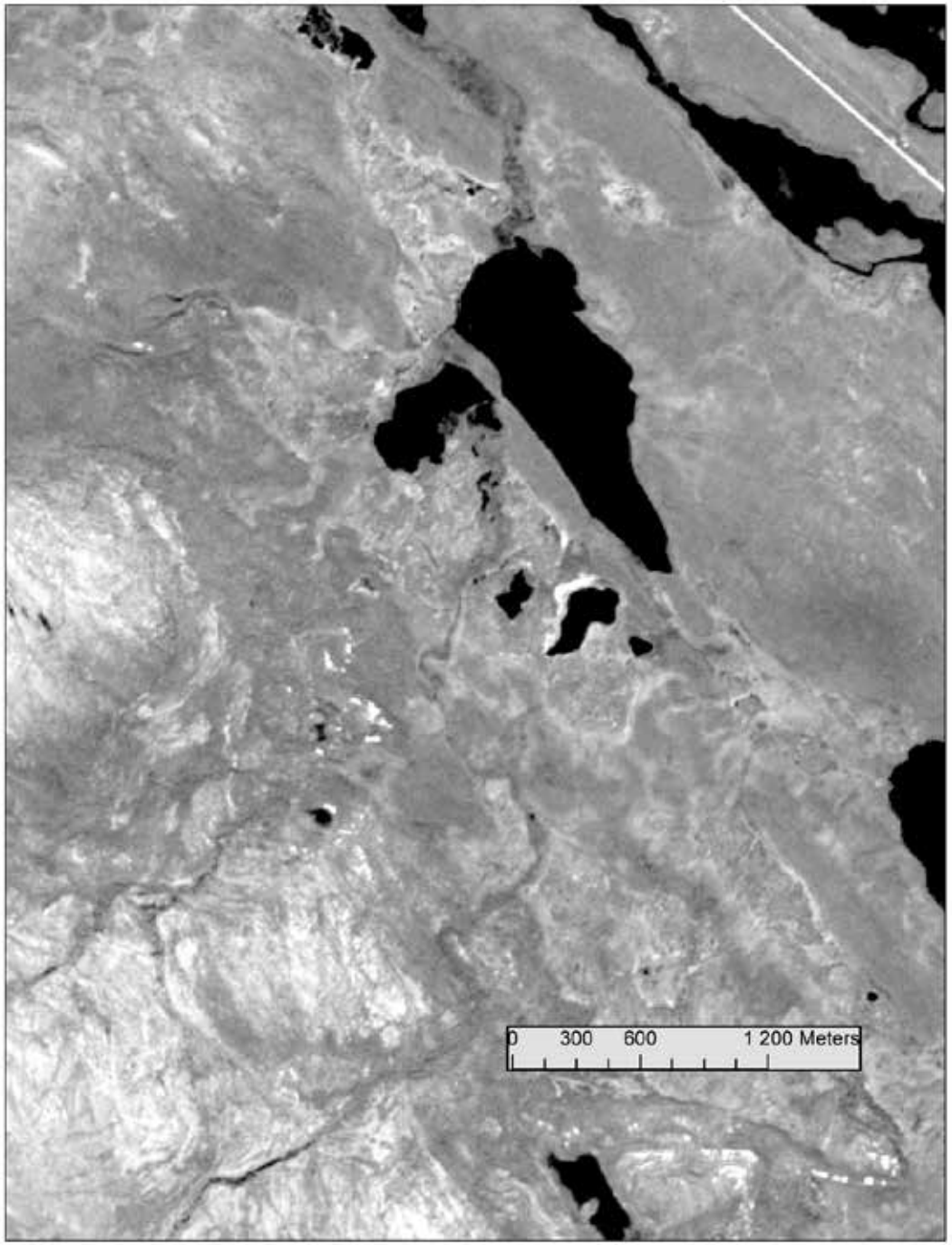
This raster layer has data on reflectance from Blue wavelength



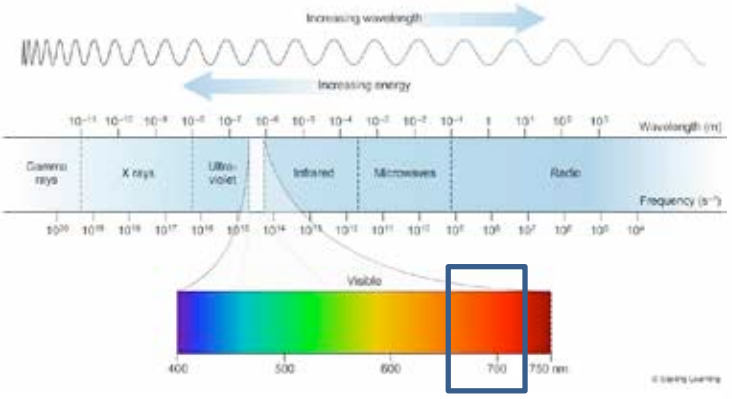


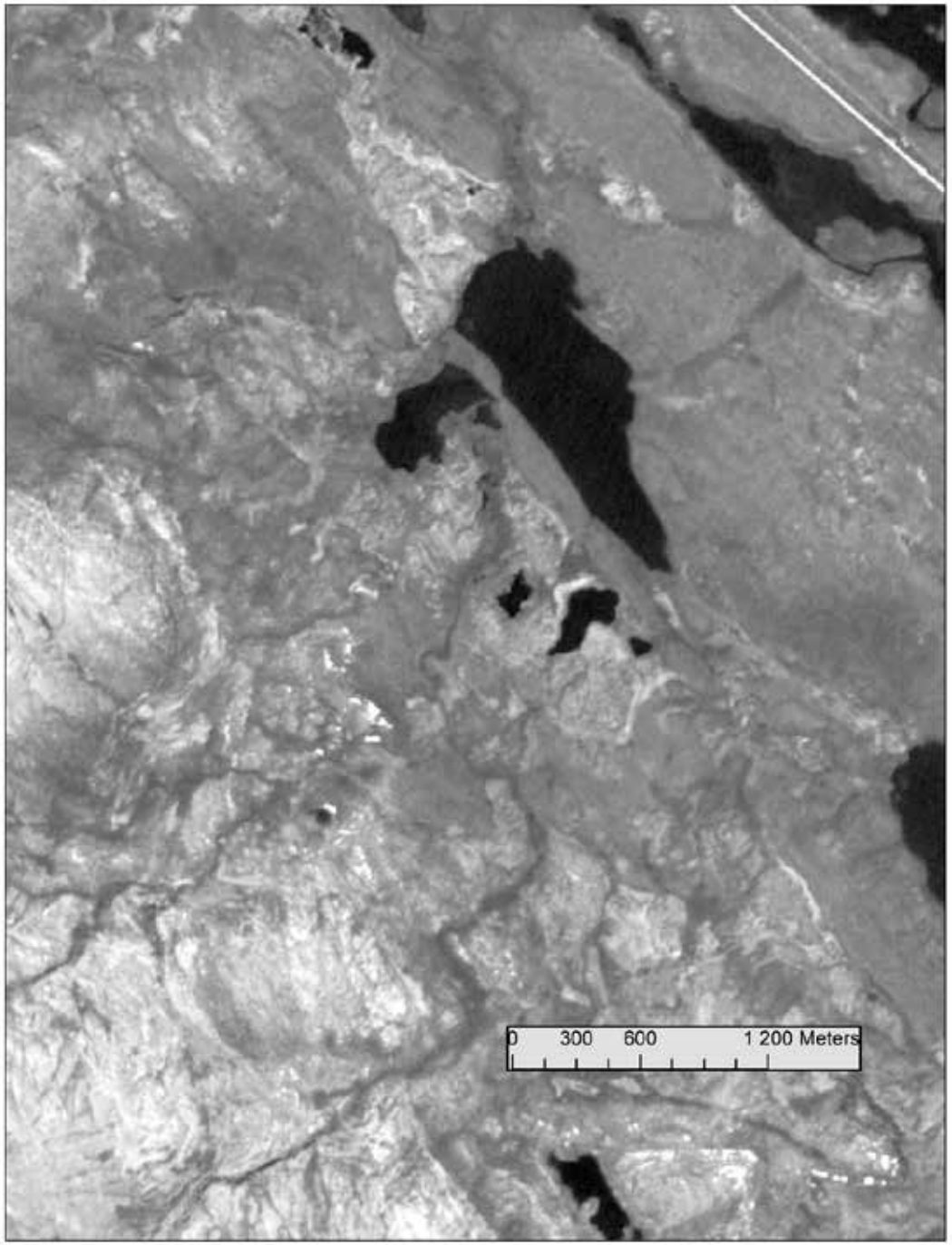
This raster layer has data on reflectance from Green wavelength



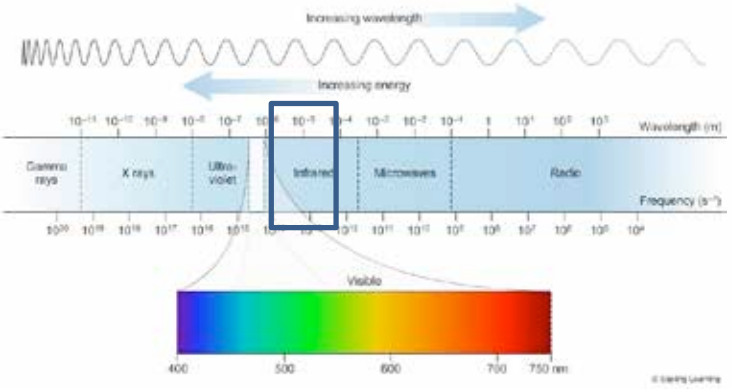


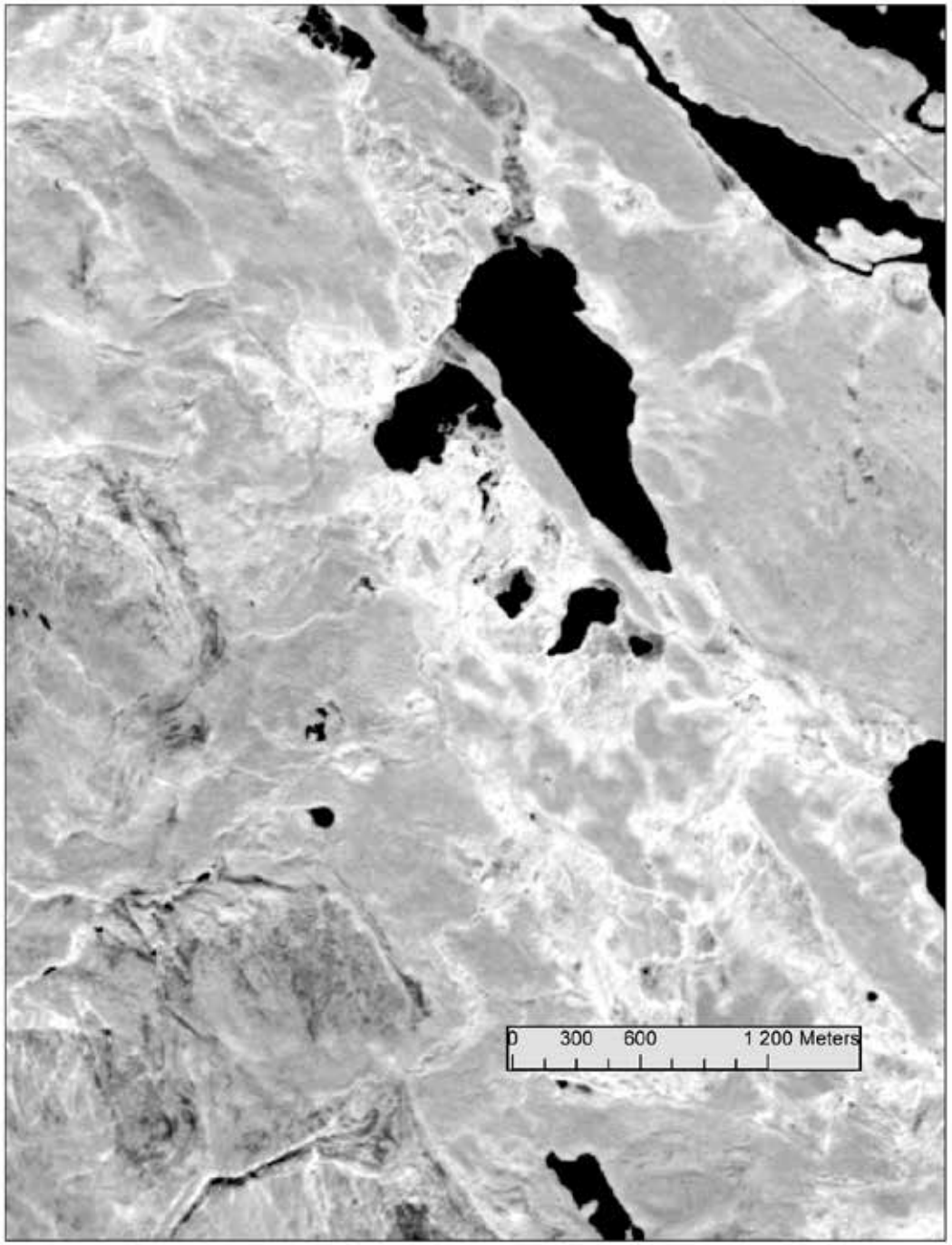
This raster layer has data on reflectance from Red wavelength





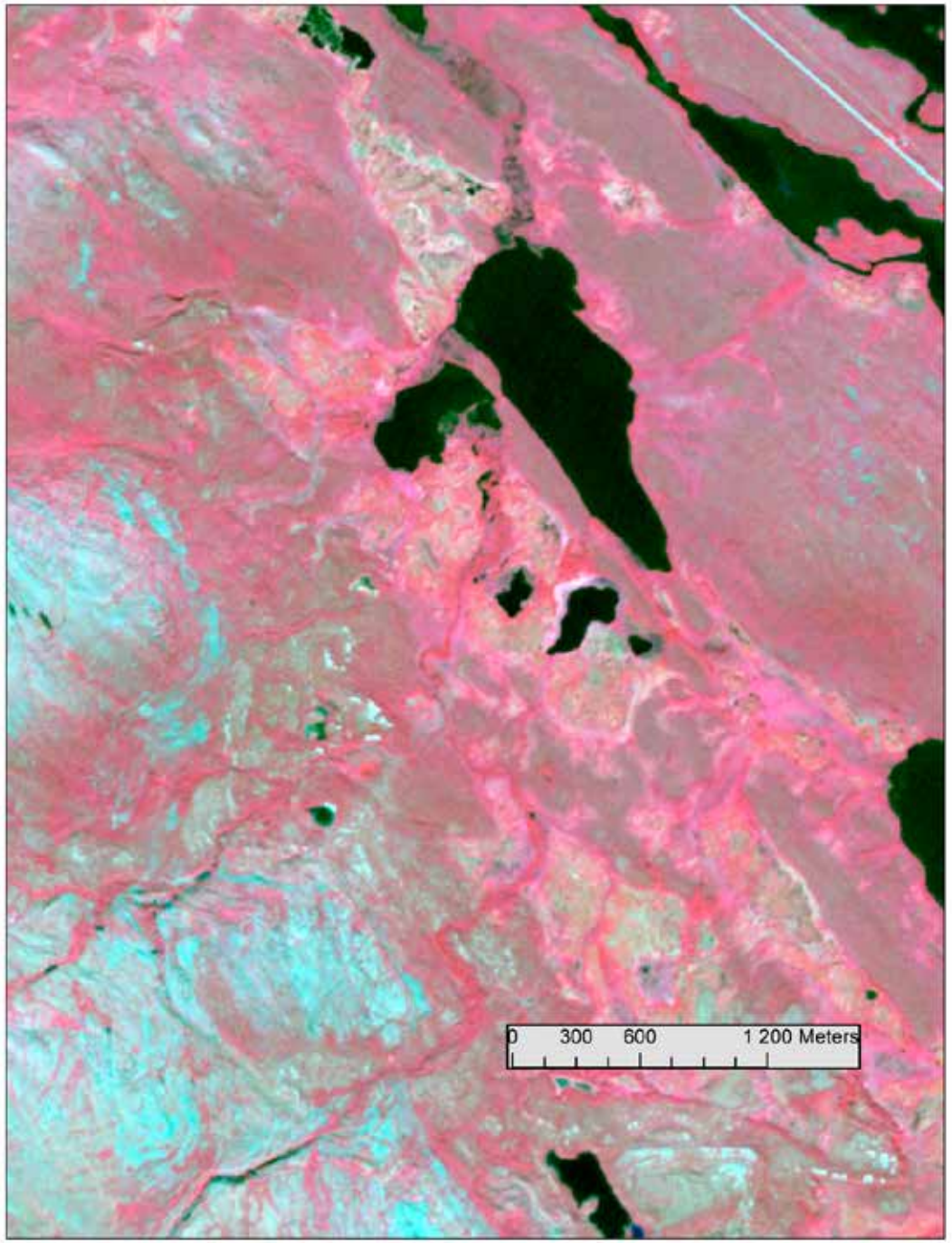
This raster layer has data on reflectance from Near-infrared wavelength





False Color

Near-Infrared
Red
Green

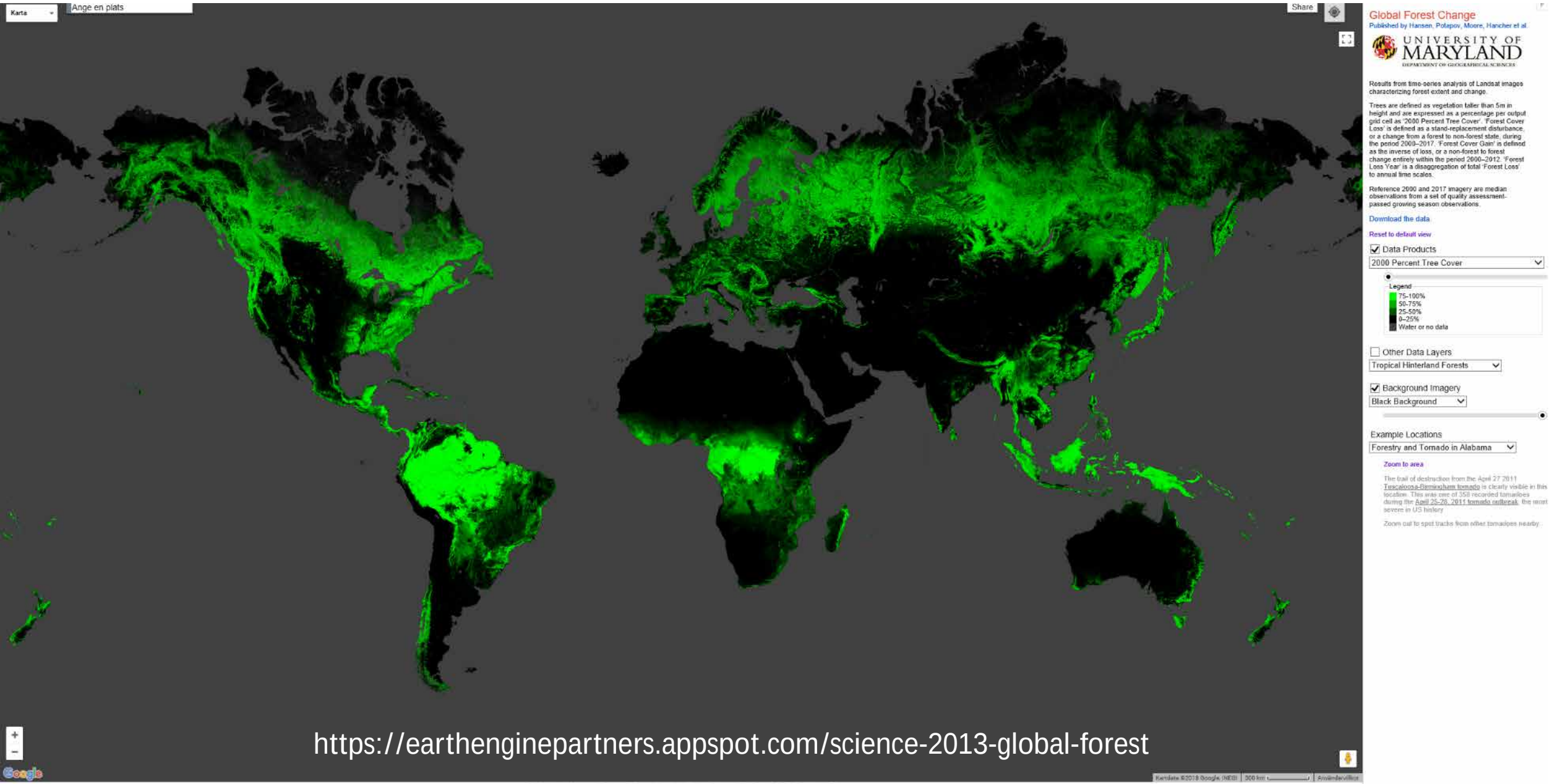


Optical sensors

What are optical data useful for?

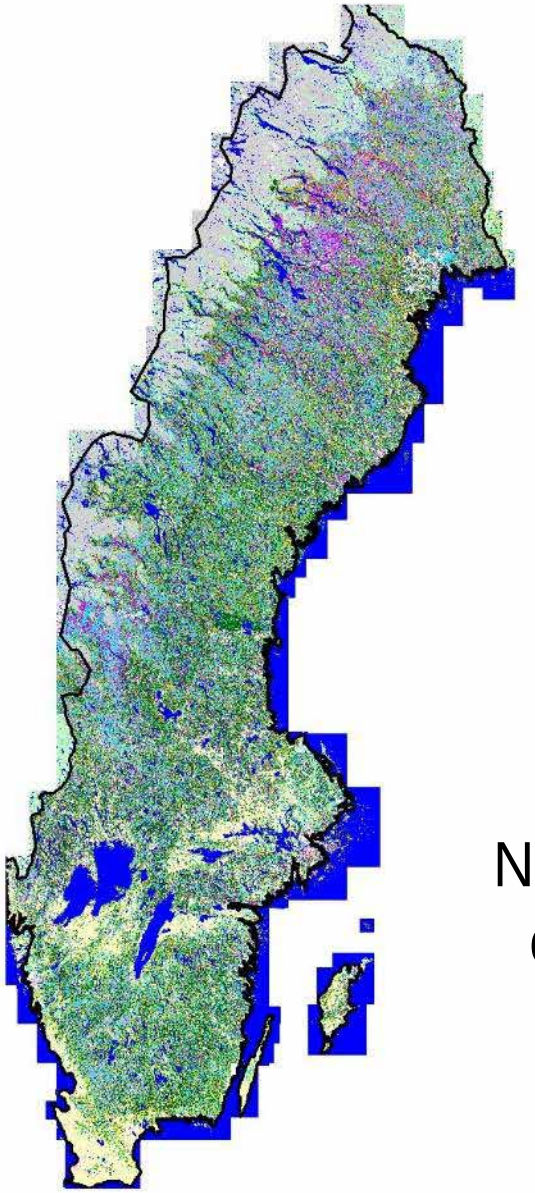
- Map vegetation type and percent cover
- Indicate vegetation health and biomass
- Quantify photosynthetic activity
- Presence of snow and ice
- Changes in water bodies
- ... and much more

Percent tree cover

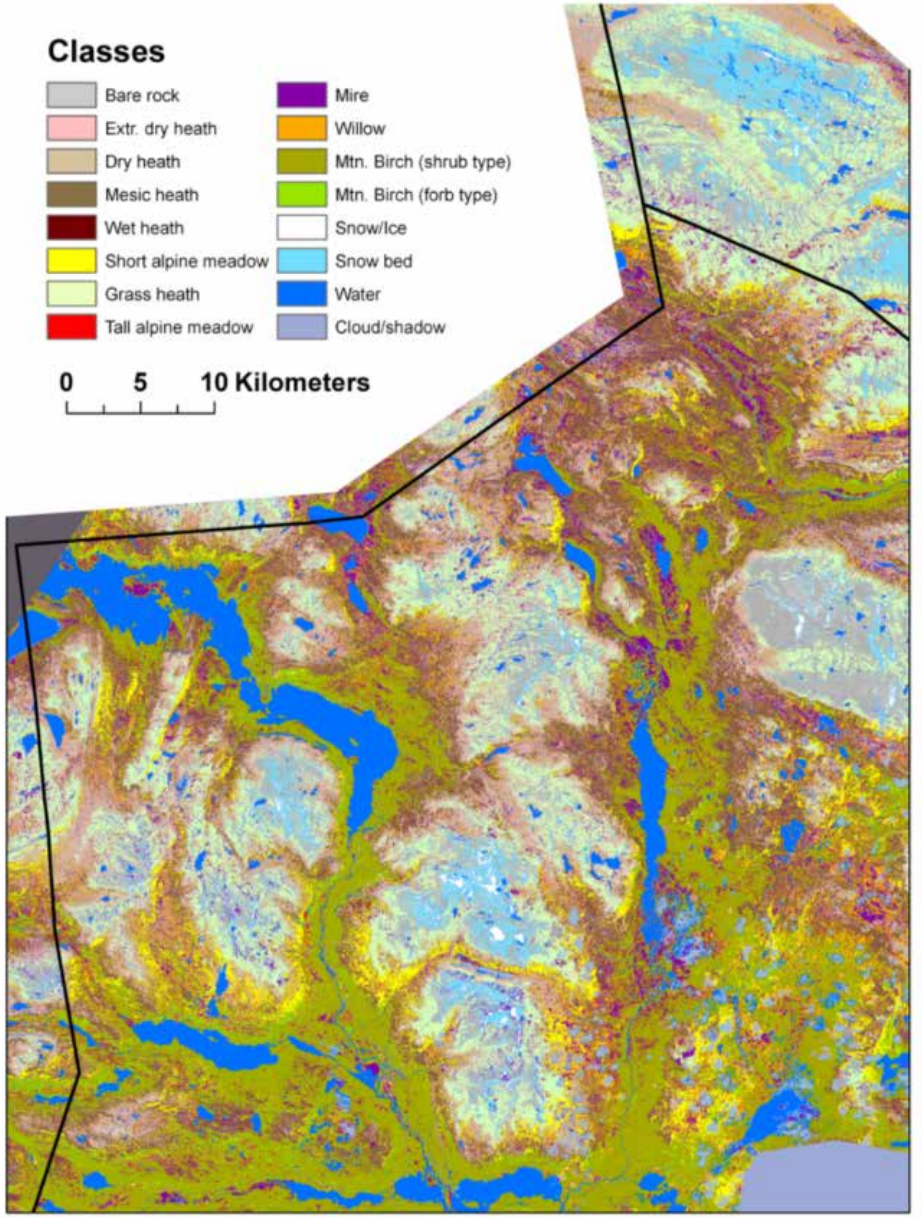


https://earthenginepartners.appspot.com/science-2013-global-forest

Vegetation, Land cover and Land use



National land cover data
(NMD)



Definition - Land cover and land use

Land cover – the actual material that covers the Earth's surface

- Land cover can be determined by analyzing satellite data.

Land use – what the Earth's surface is used for

- Land use is much more difficult to be determined from satellite data.

Land cover and land use

Land cover and land use

Land cover and land use

Next lecture – 6 Dec

Further Introduction and Optical satellites

Accessing data – Online – watch before Exercise 1 for best effect!

Lecture – 7 Dec

Data display and interpretation – Online – watch before Exercise 2 for best effect!


Questions?