Lesson B1

Intro remote sensing + electromagnetic spectrum

GEO1001.2020

Hugo Ledoux

Me

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- ~~BG.West.550~~ (🏠)
- Discord: hledoux#8017

Remote sensing (part B) == next 2 weeks

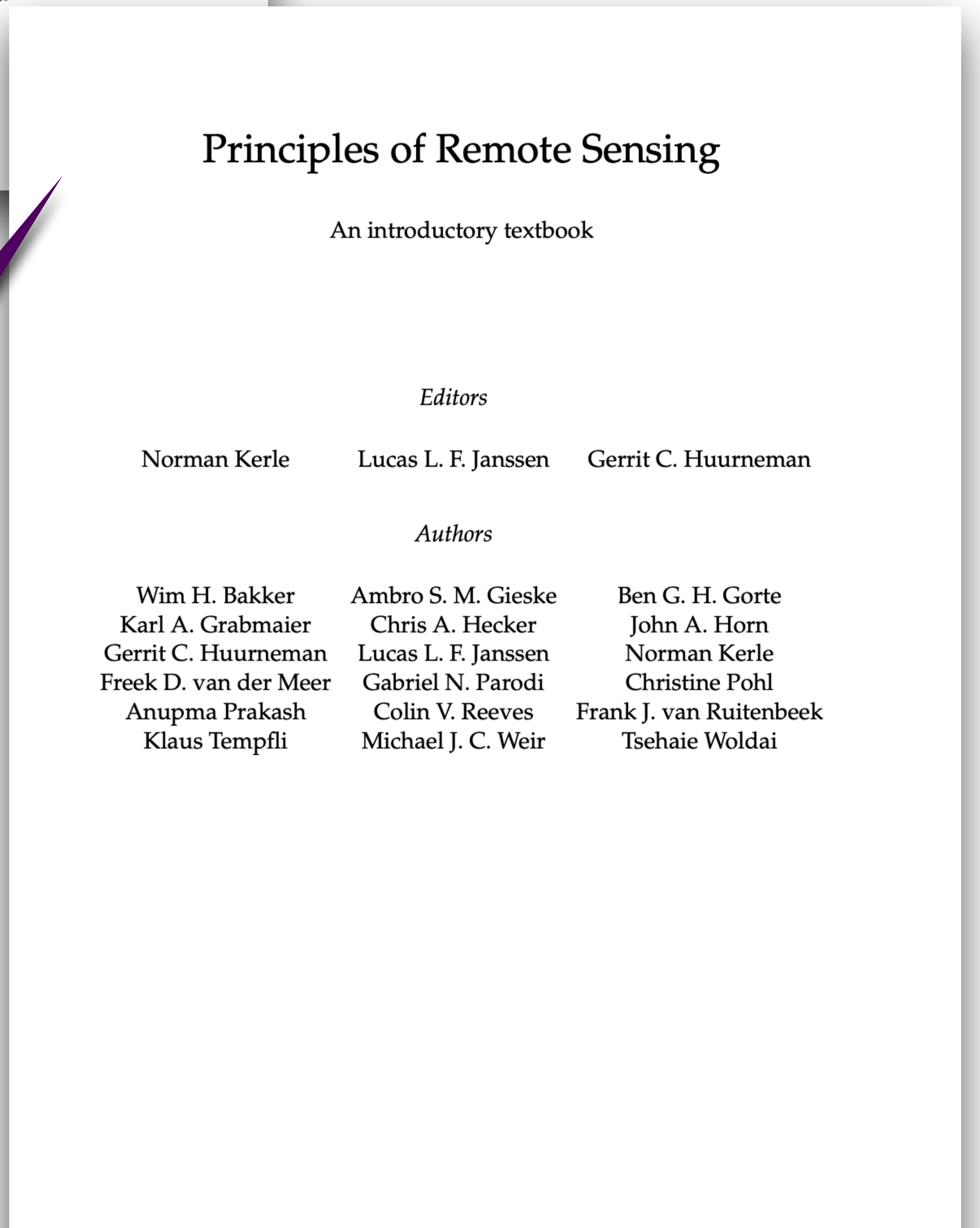
- **B1**: Intro remote sensing + electromagnetic spectrum
- **B2**: Basics of image processing + visualisation
- **B3**: Image classification

- **1 formative hw**: Calculating NDVI with Python
- **1 assignment (hw02)**: Classification of a Sentinel-2 image


PRINCIPLES OF

REMOTE SENSING

VERSION OF 23RD SEPTEMBER 2004


Principles of Remote Sensing

An introductory textbook

Editors

Norman Kerle   Lucas L. F. Janssen   Gerrit C. Huurneman

Authors

Wim H. Bakker, Karl A. Grabmaier, Gerrit C. Huurneman, Freek D. van der Meer, Anupma Prakash, Klaus Tempfli, Ambro S. M. Gieske, Chris A. Hecker, Lucas L. F. Janssen, Gabriel N. Parodi, Colin V. Reeves, Michael J. C. Weir, Ben G. H. Gorte, John A. Horn, Norman Kerle, Christine Pohl, Frank J. van Ruitenbeek, Tsehaie Woldai

We use the (free) ITC book about RS, the "cousin" of the GIS book of GEO1002

Setup coming 2 weeks

week	Tue 10:45	Wed 11:15	Fri 10:45	deadlines
1.1	[illegible]	[illegible]	[illegible] + help	
1.2	[illegible]	[illegible]	[illegible]	
1.3	[illegible]	help [illegible]	help hw01	hw01 ([illegible])
1.4	B1	B2	THURSDAY 10:45 + NDVI lab	
1.5	B3 + hw02	help	help	
1.6	[illegible]	help		hw02 (2020-10-06)
1.7	[illegible]	help	help	

this week Thursday instead of Friday

- lectures: https://www.twitch.tv/hgldx
- after lecture + help: Discord
- ask questions in Discord chat please

hw02

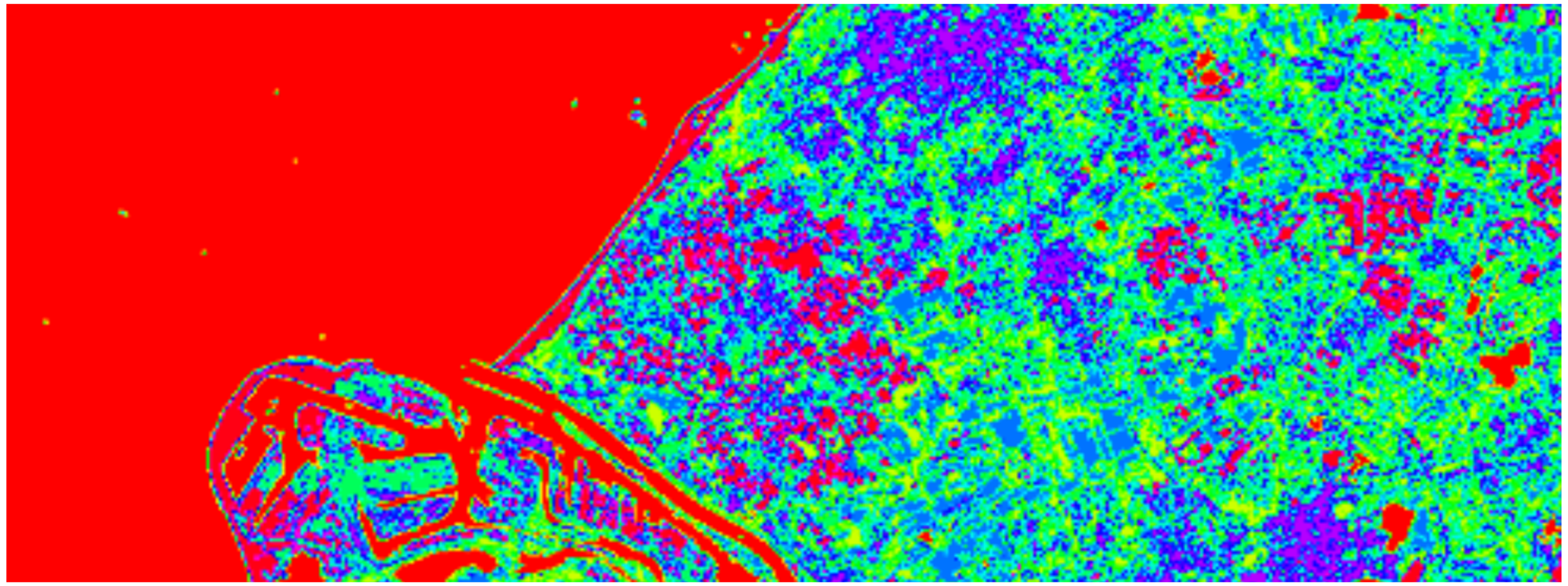
Assignment 02

Classification of a Sentinel-2 image

Deadline is **6 October 2020 at 10:00**.

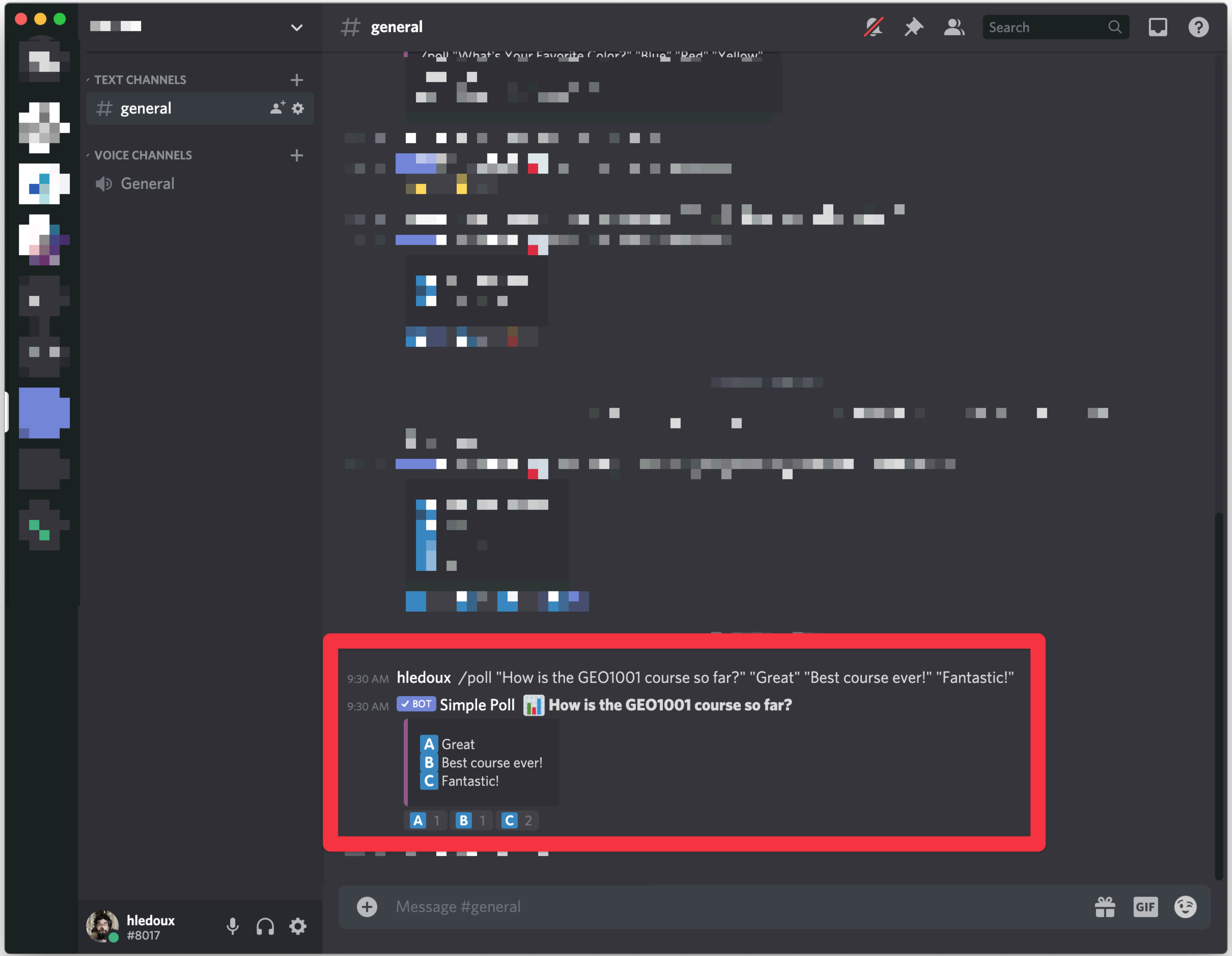
Late submission? 10% will be removed for each day that you are late.

This is an individual assignment.



- Soon online
- Python + Jupyter
- In a group of 2 (*modified after feedback)
- Deadline 2020-10-06 at 10:00

Discord polls: please answer on Discord #geo1001 channel



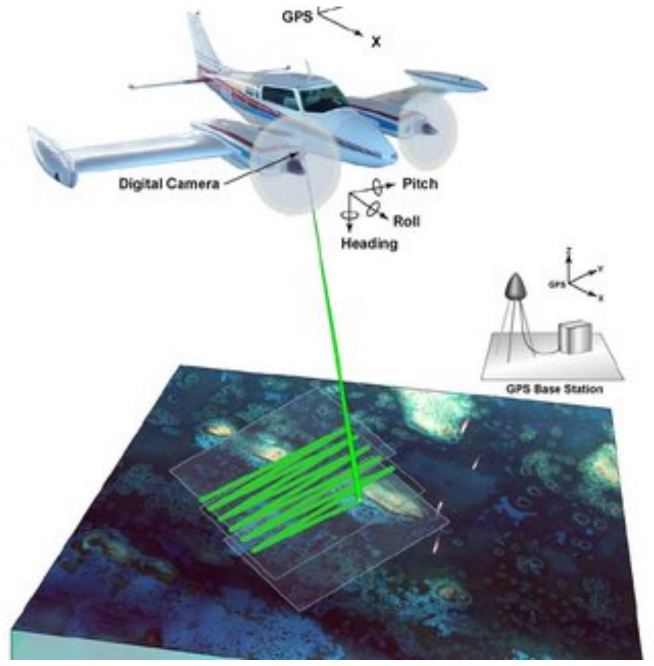
Remote Sensing

Remote sensing has several definitions

1. science of acquiring, processing and interpreting images that record the interaction between electromagnetic energy and matter
2. 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.
3. the instrumentation, techniques and methods to observe the Earth's surface at a distance and to interpret the images or numerical values obtained in order to acquire meaningful information of particular objects on Earth.

Different remote sensing technologies used in geomatics

lidar



↓

GEO1015

photogrammetry

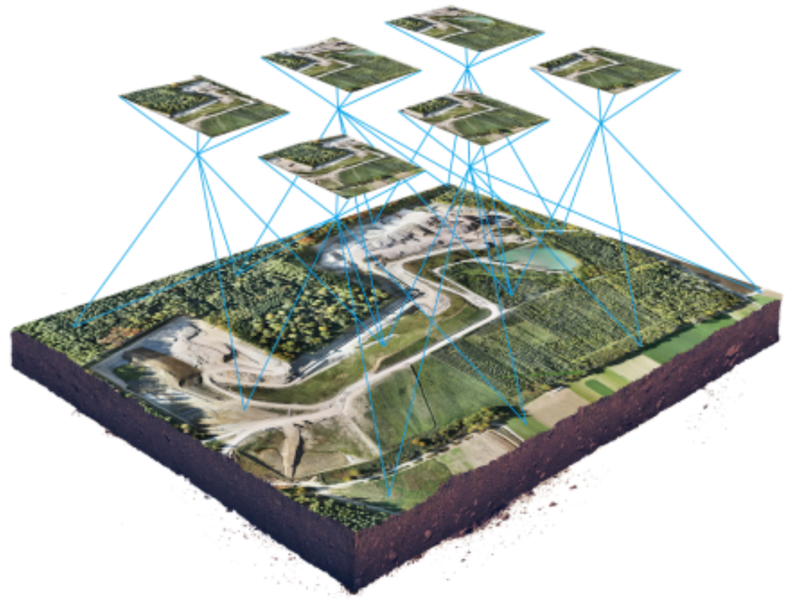


Image from https://wingtra.com

↓

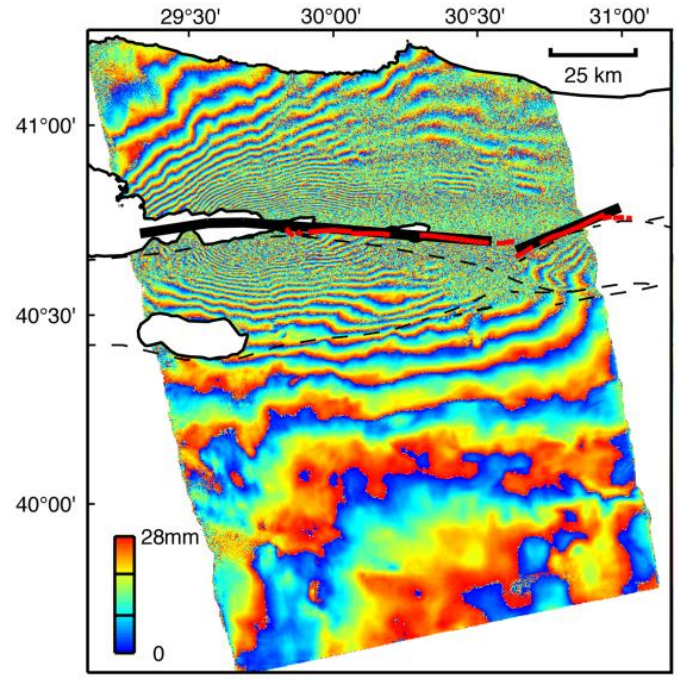
GEO1016

land surveying
(total station)

↓

nowhere!

InSAR



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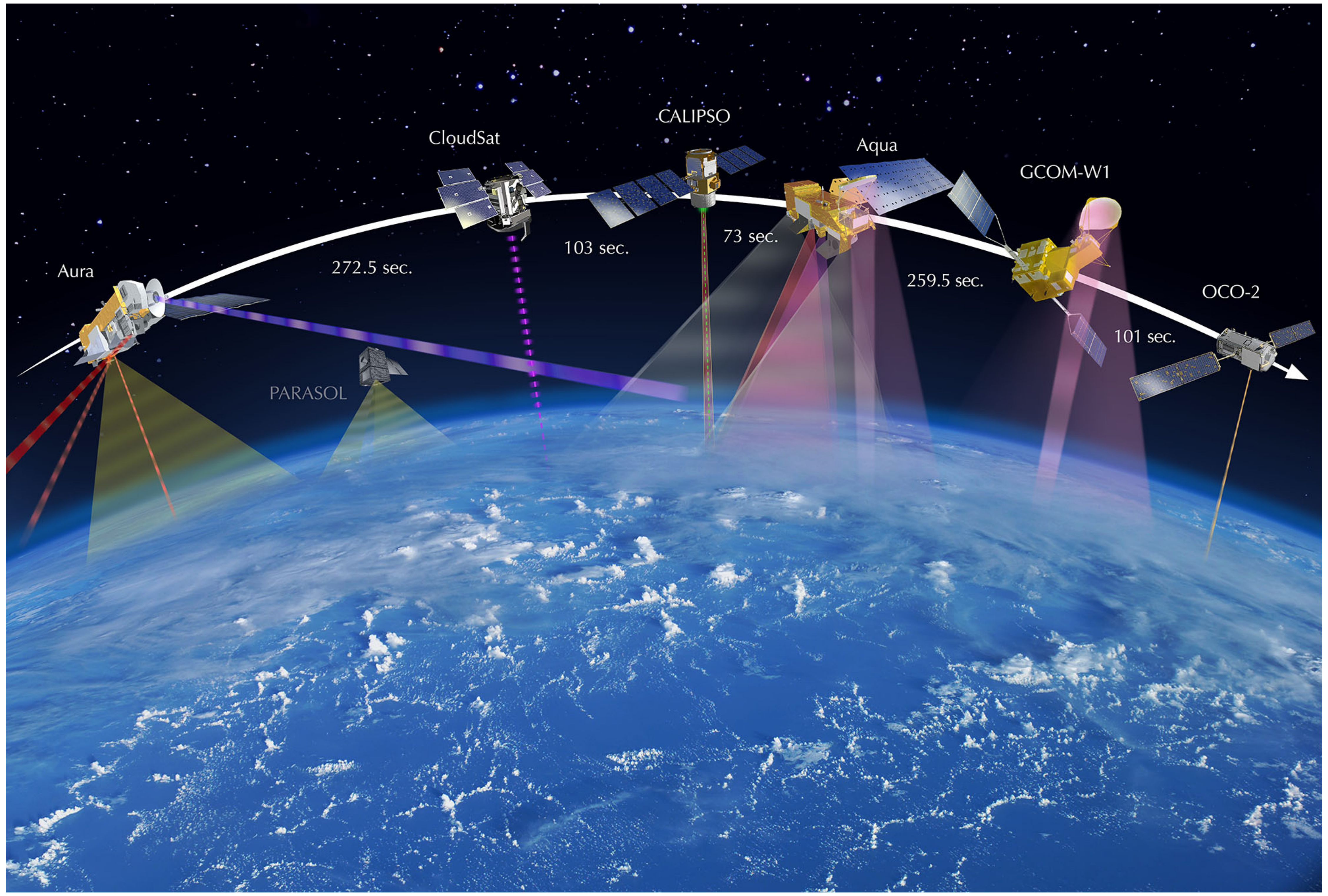
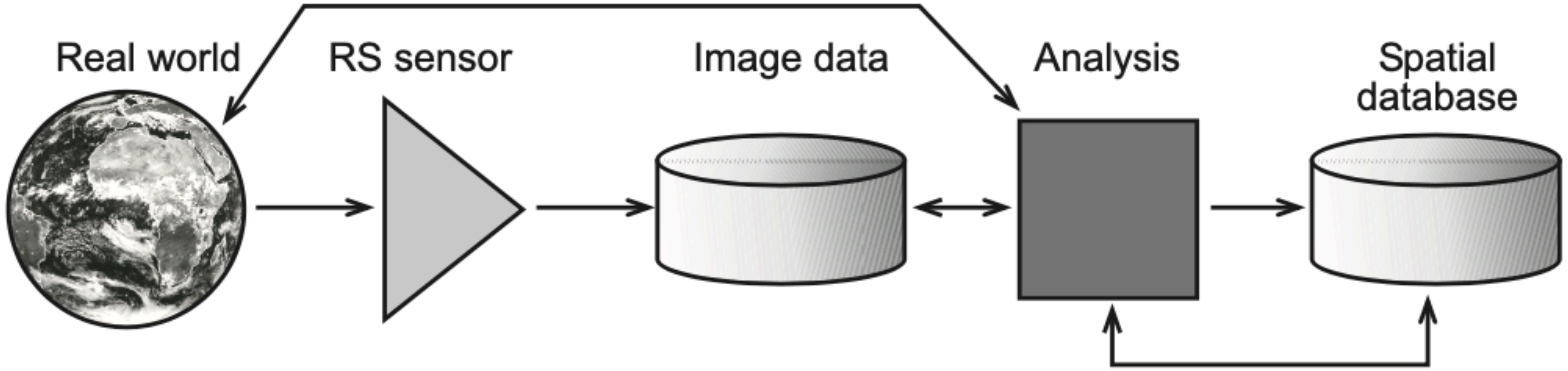
CIE4609

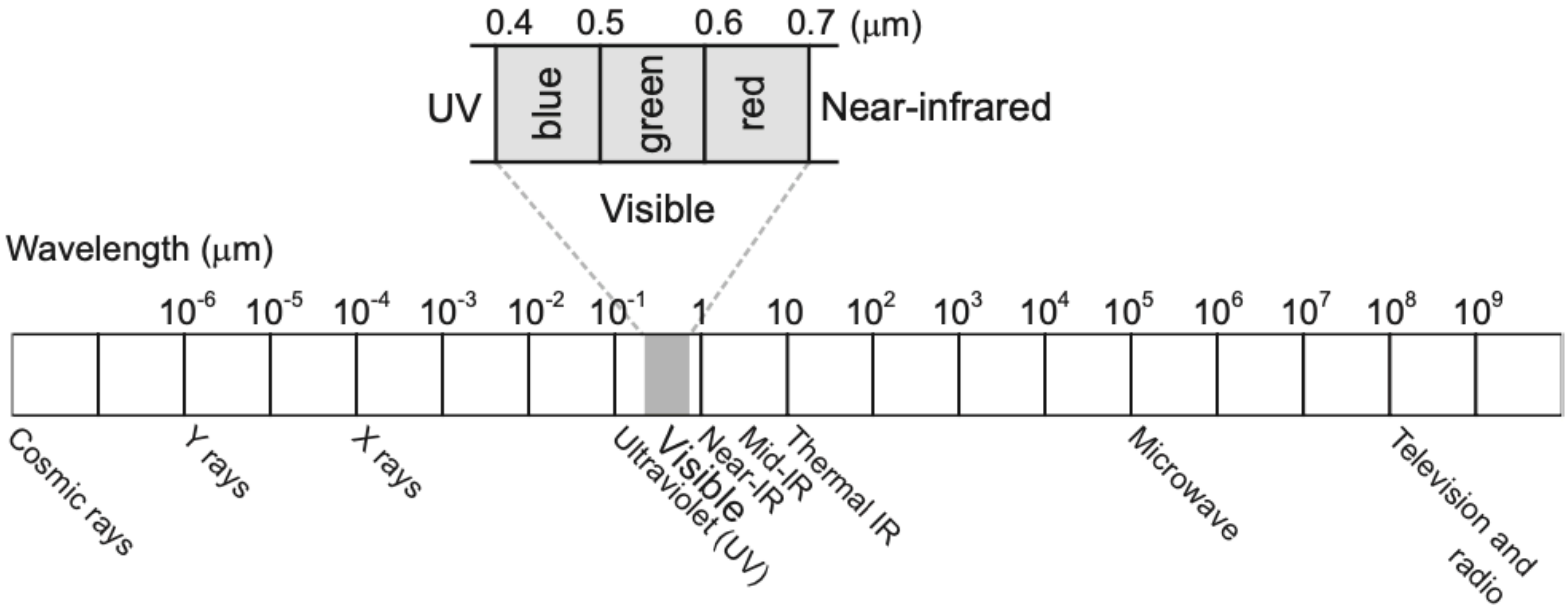
=> poll

We focus here on satellites that measure EM energy reflected by the Earth





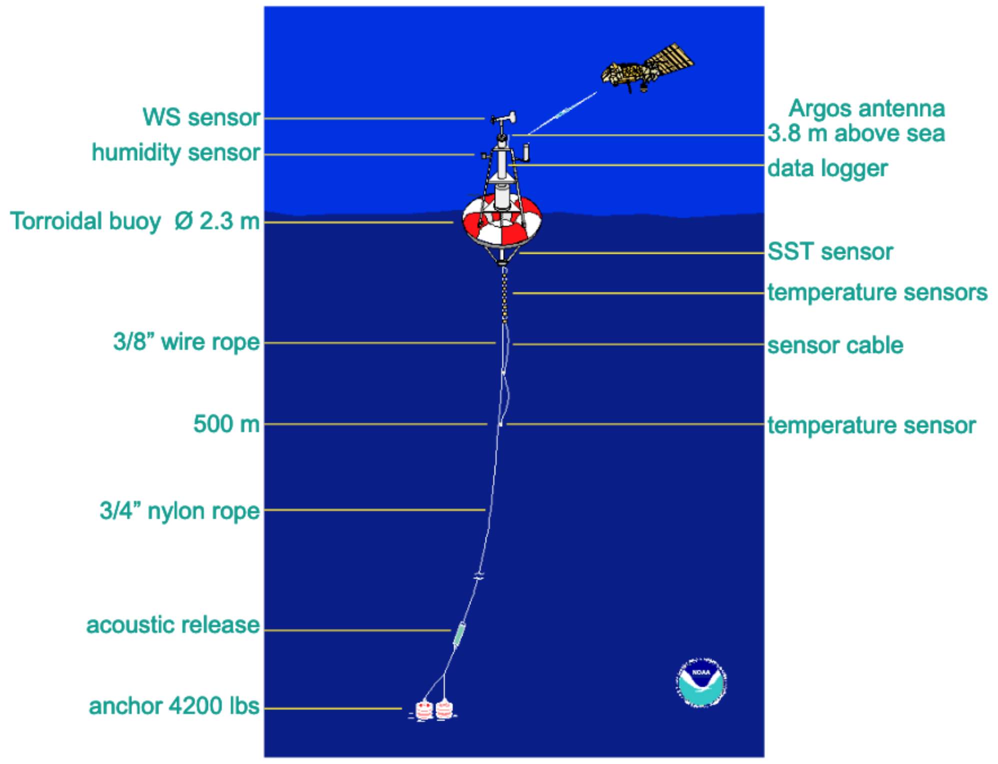
Electro-magnetic spectrum: we focus on visible and near-infrared regions

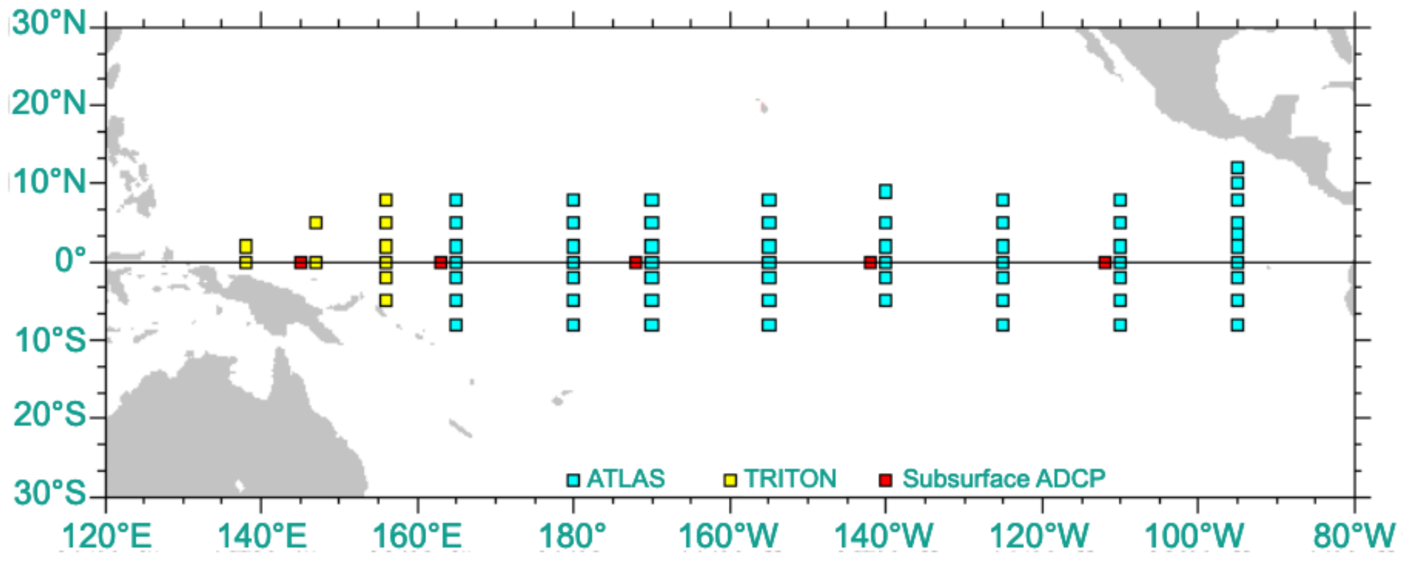


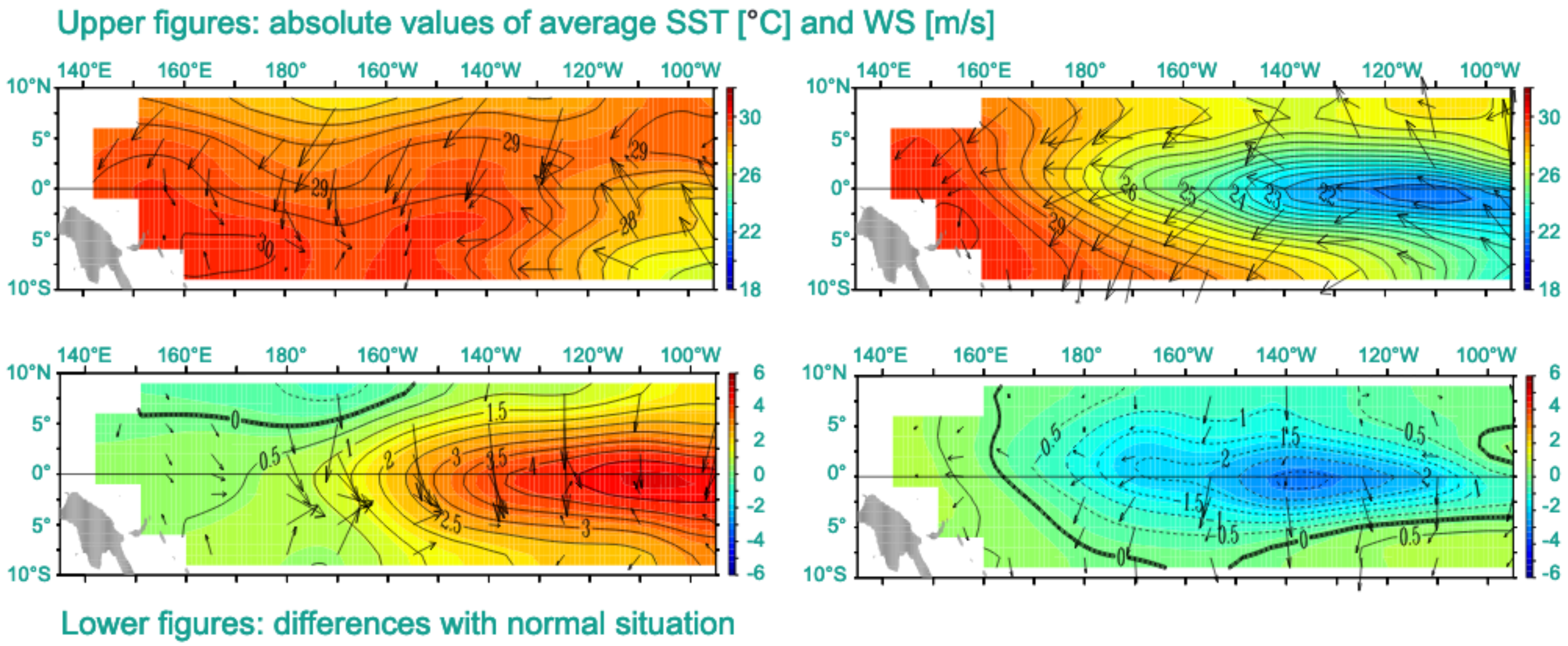
El Niño effect

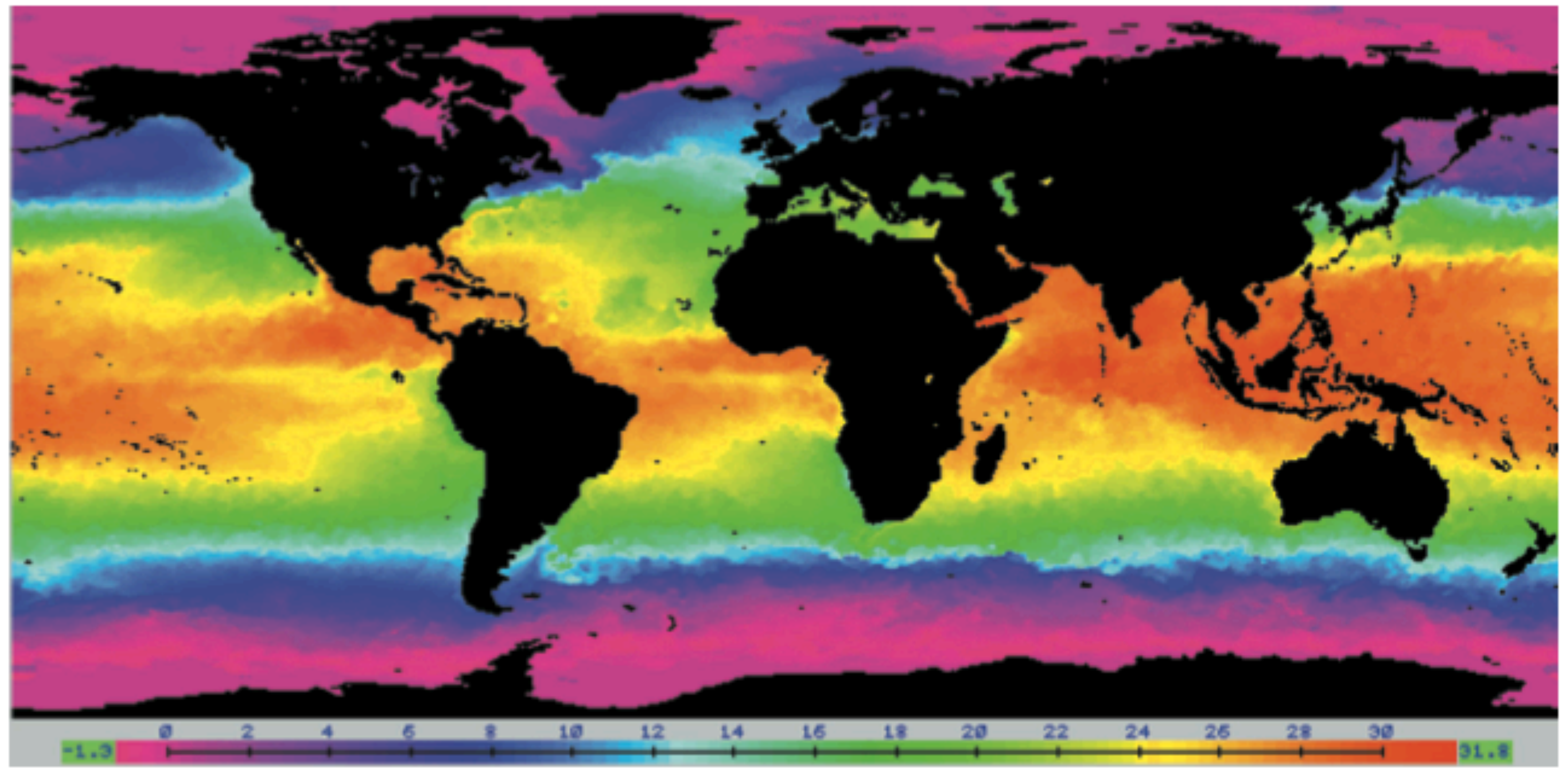
GEO1002

GEO1001









GEO1002: images (mostly) used for fields, here values have diff meaning

Raster representation of a field

GEO1002

In Figure 2.17, we illustrate how a raster represents a continuous field like elevation. Different shades of blue indicate different elevation values, with darker blues indicating higher elevations. The choice of a blue colour spectrum is only to make the illustration aesthetically pleasing; real elevation values are stored in the raster, so instead we could have printed a real number value in each cell. This would not have made the figure very legible, however.

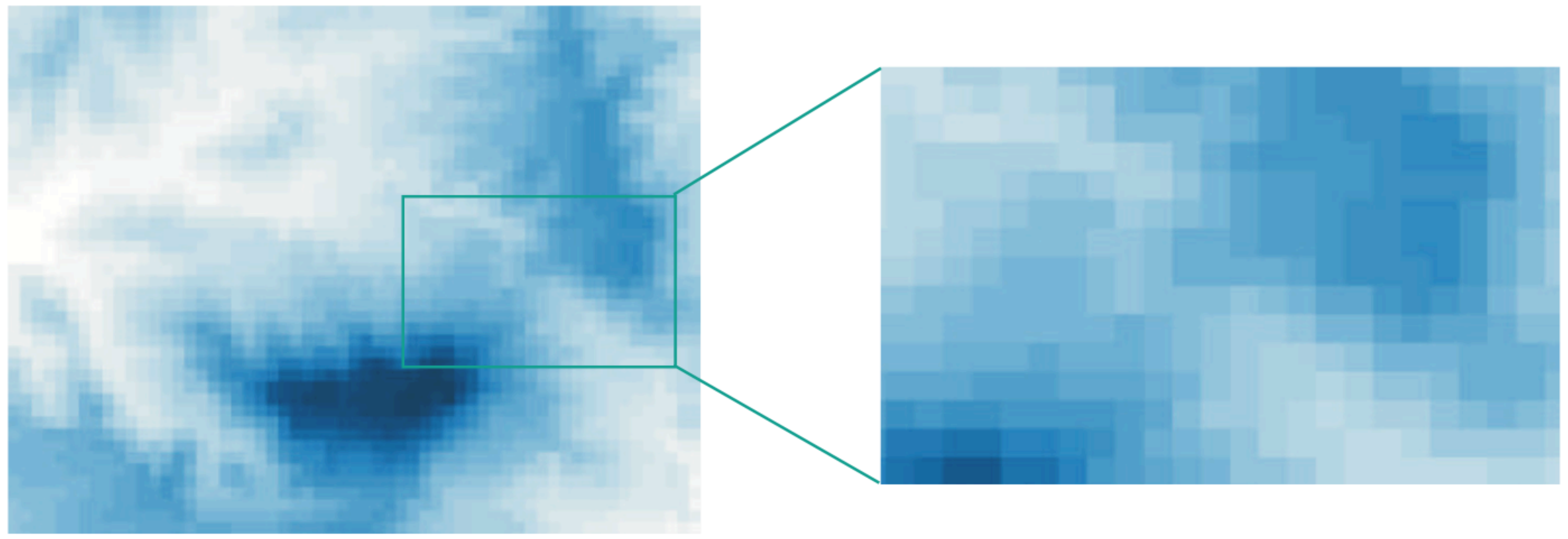


Figure 2.17: A raster representation (in part) of the elevation of the study area of Figure 2.2. Actual elevation values are indicated as shades of blue. The depicted area is the north-east flank of the mountain in the south-east of the study area. The right-hand side of the figure is a zoomed-in part of that of the left.

A raster can be thought of as a long list of field values: actually, there should be $m \times n$ such values. The list is preceded with some extra information, like a single georeference as the origin of the whole raster, a cell size indicator, the integer values for m and n, and a data type indicator for interpreting cell values. Rasters and quadtrees do not store the georeference of each cell, but infer it from the above information *about* the raster.

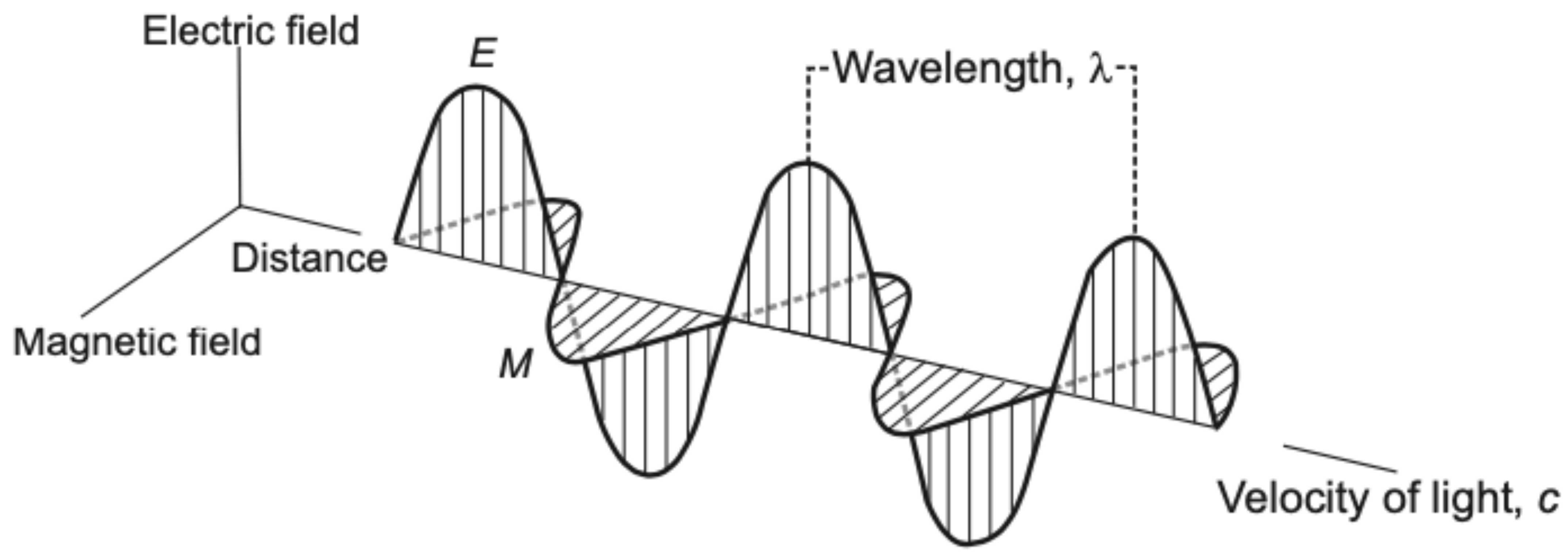
previous | next | back | exit | contents | index | glossary | web links | bibliography | about

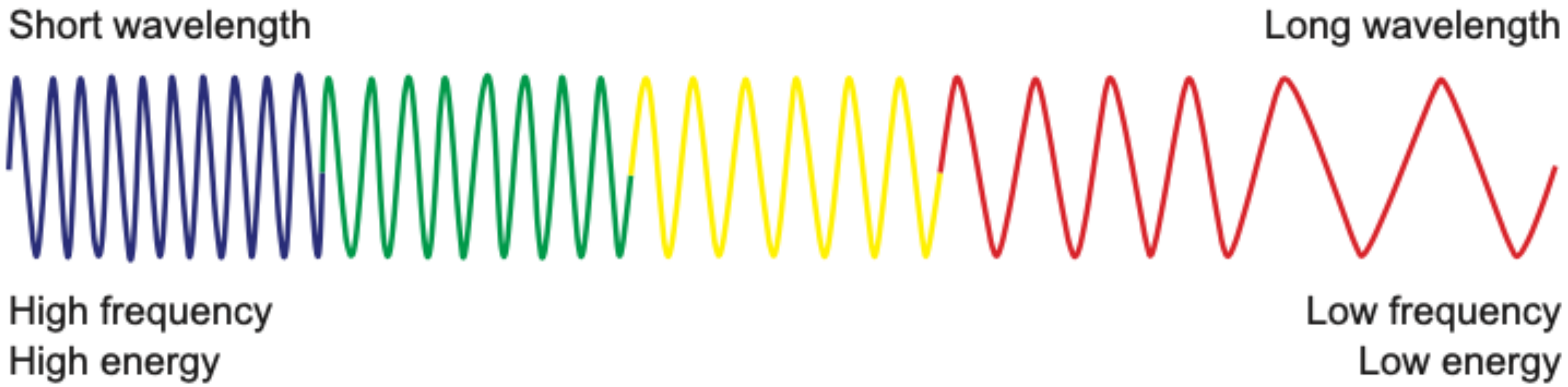

Mapping the Invisible: Introduction to Spectra...
Watch later
Share

Electro-magnetic (EM) energy

- RS relies on the measurement of EM energy
- Most important source of EM energy is the Sun
- Sun = light, heat, and UV-light
- Most RS sensors measure the reflected sunlight

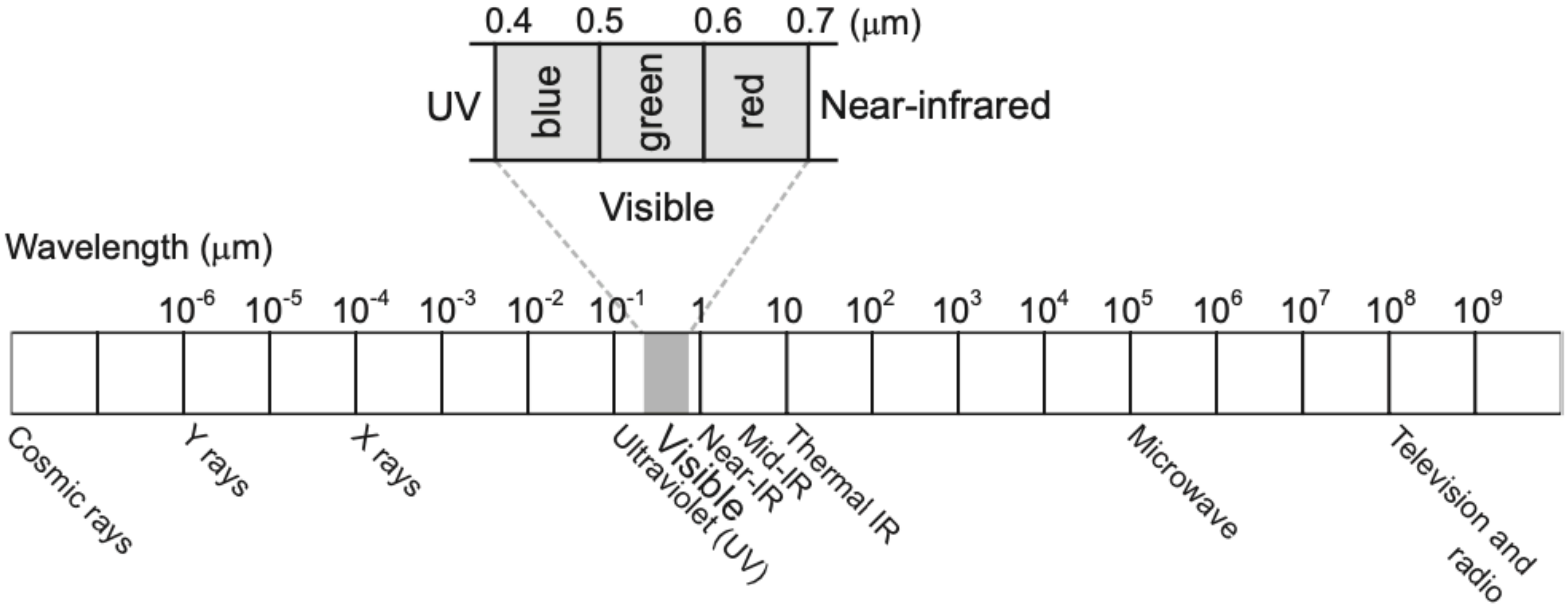
EM modelled with sine waves



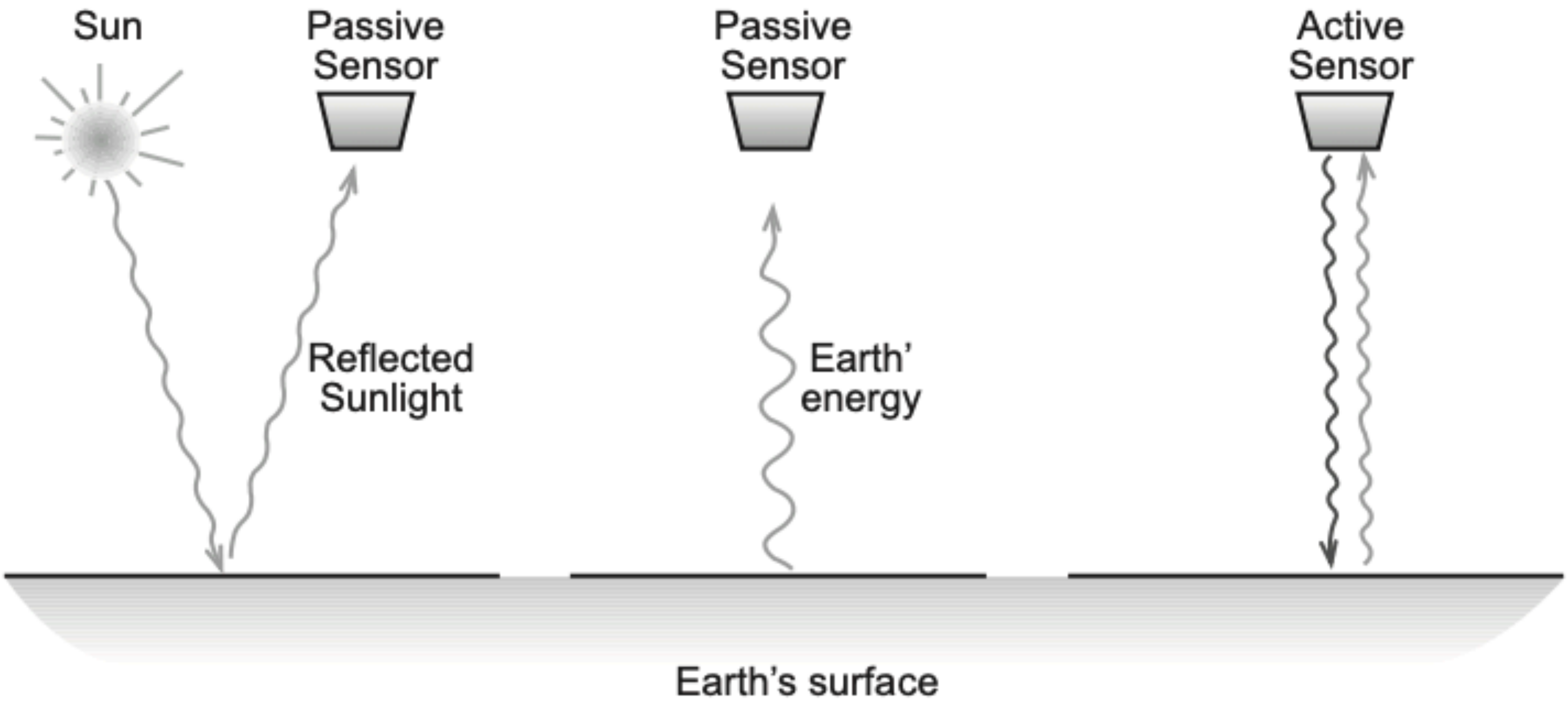


Electro-magnetic (EM) energy

- RS relies on the measurement of EM energy
- Most important source of EM energy is the Sun
- Sun = light, heat, and UV-light
- Most RS sensors measure the reflected sunlight
- All matter with a temperature >0K radiates EM of various wavelengths

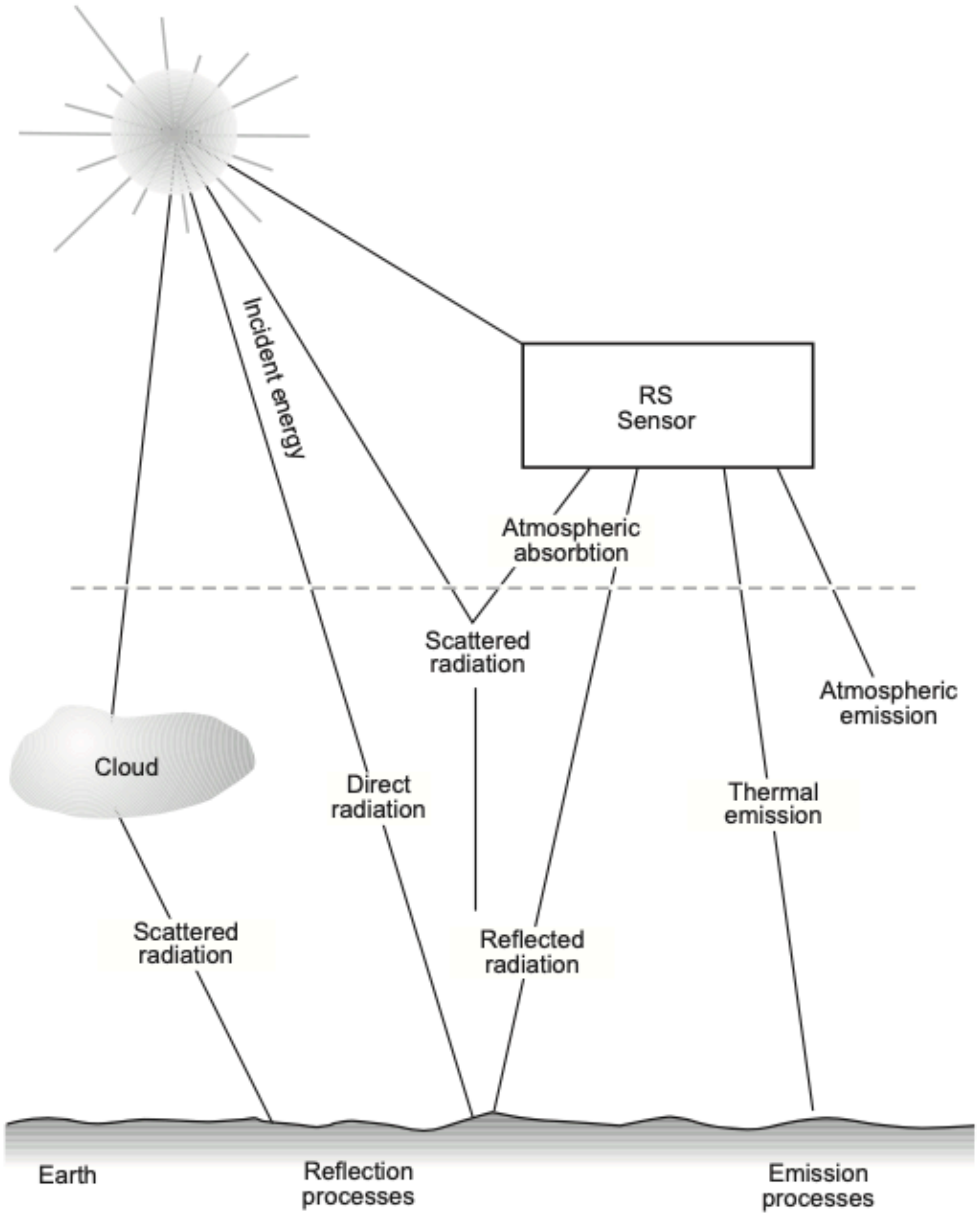


Sensors



Sun
Passive Sensor
Reflected Sunlight
Passive Sensor
Earth' energy
Active Sensor
Earth's surface

Energy interaction in the atmosphere



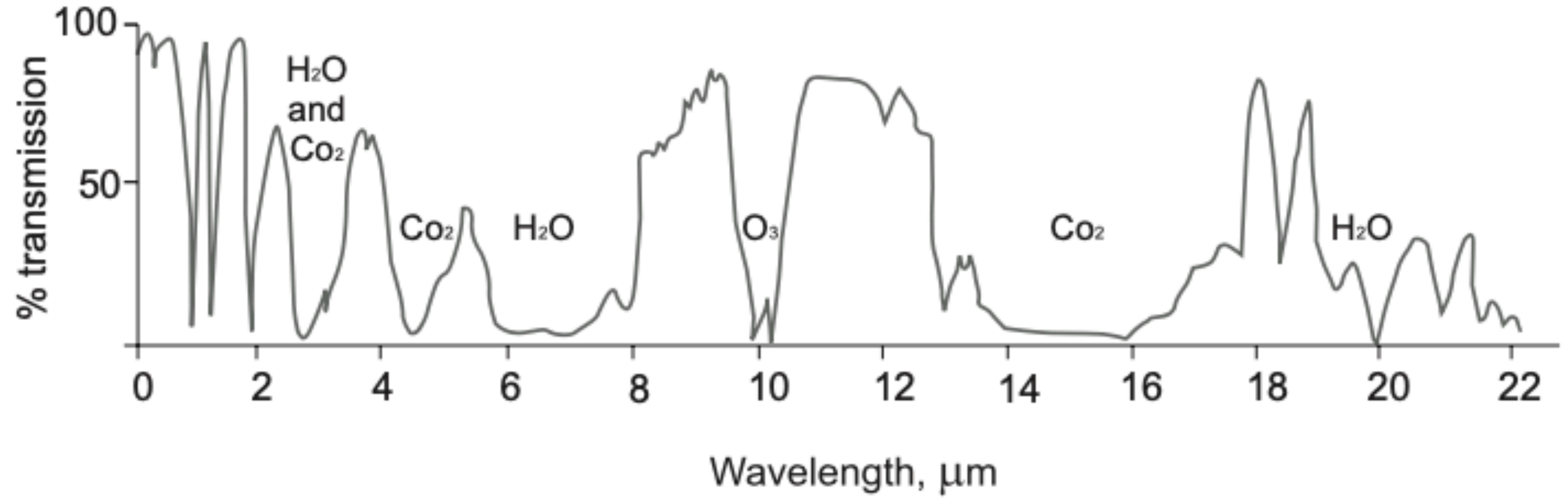


Figure 2.7: Atmospheric transmission expressed as percentage.

1. Absorption
2. Transmission
3. Scattering

Energy interaction in the atmosphere: scattering

Scattering occurs when the particles or gaseous molecules in the atmosphere case the EM waves to be redirected

Figure 2.9: Rayleigh scattering is caused by particles smaller than the wavelength and is maximal for small wavelengths.

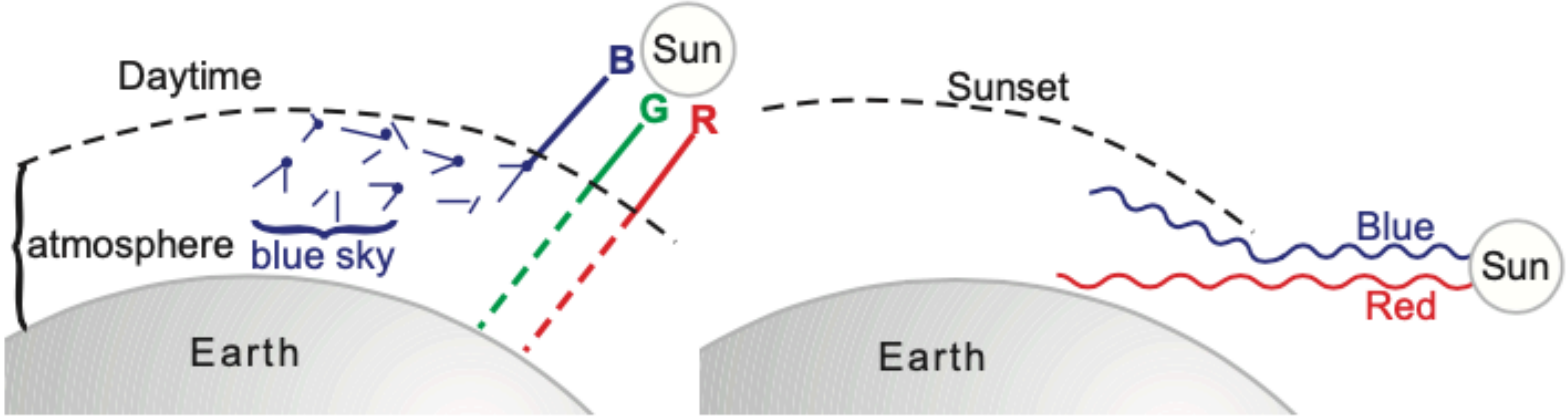
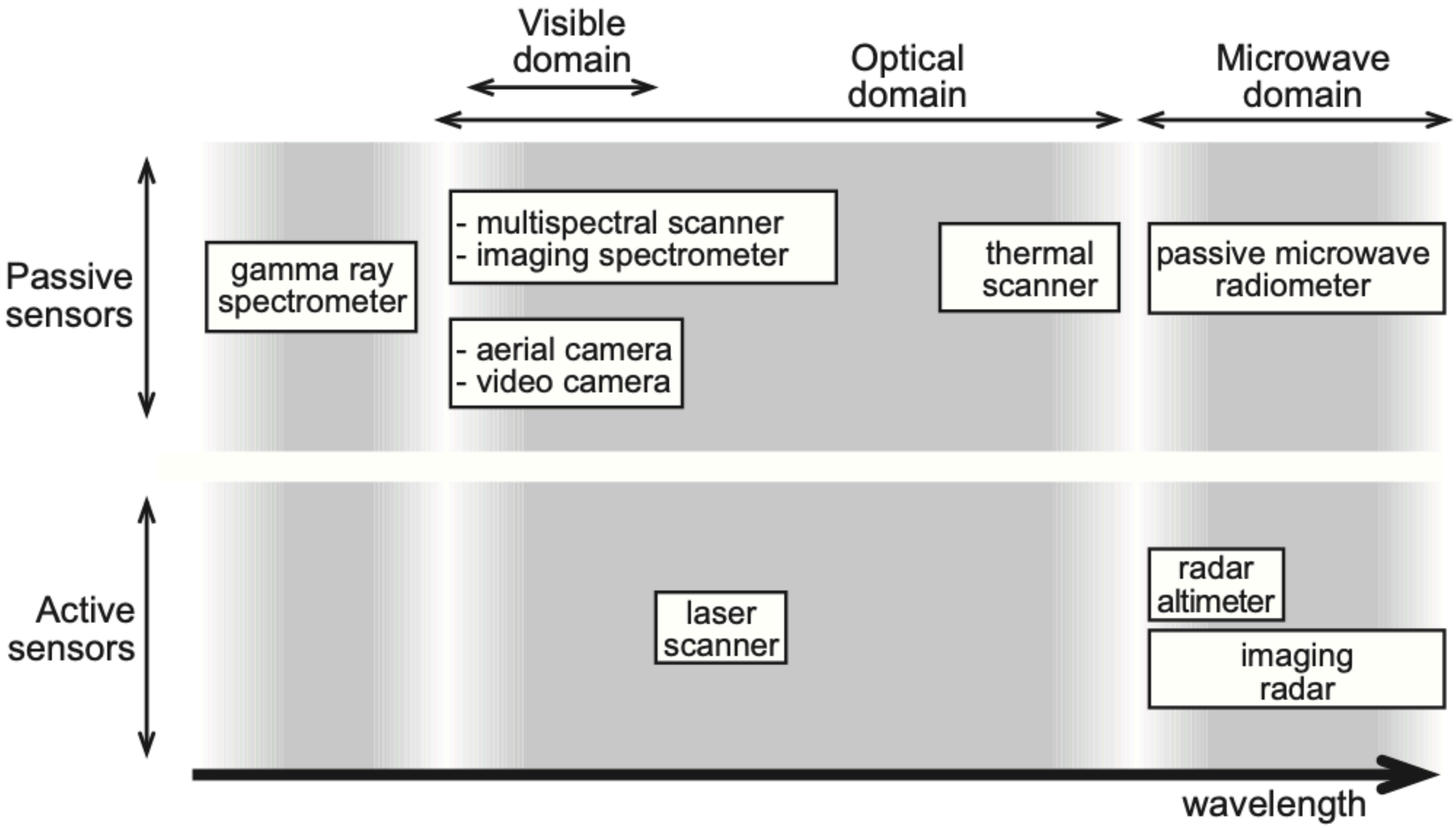


Figure 2.10: Rayleigh scattering causes us to perceive a blue sky during daytime and a red sky at sunset.

Sensors and platform

Watch out the book is not the newest, many new satellites exist!

Overview RS sensors

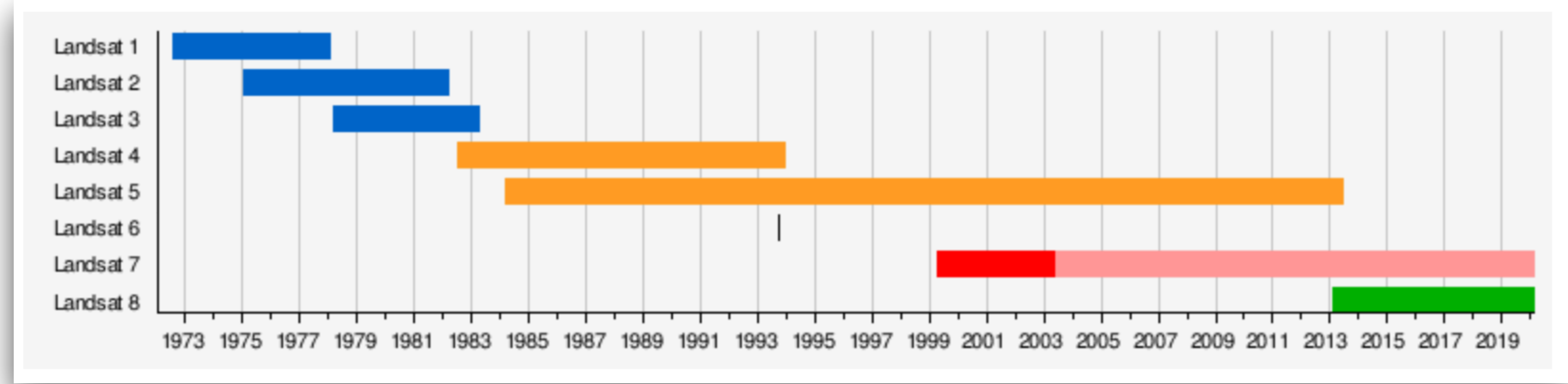


Overview RS sensors

Focus on those when reading Chapter 3:

- 3.2.1 — Multispectrum scanners
- 3.3.2 — Spaceborne remote sensing
- 3.4 — Image data characteristics

Landsat

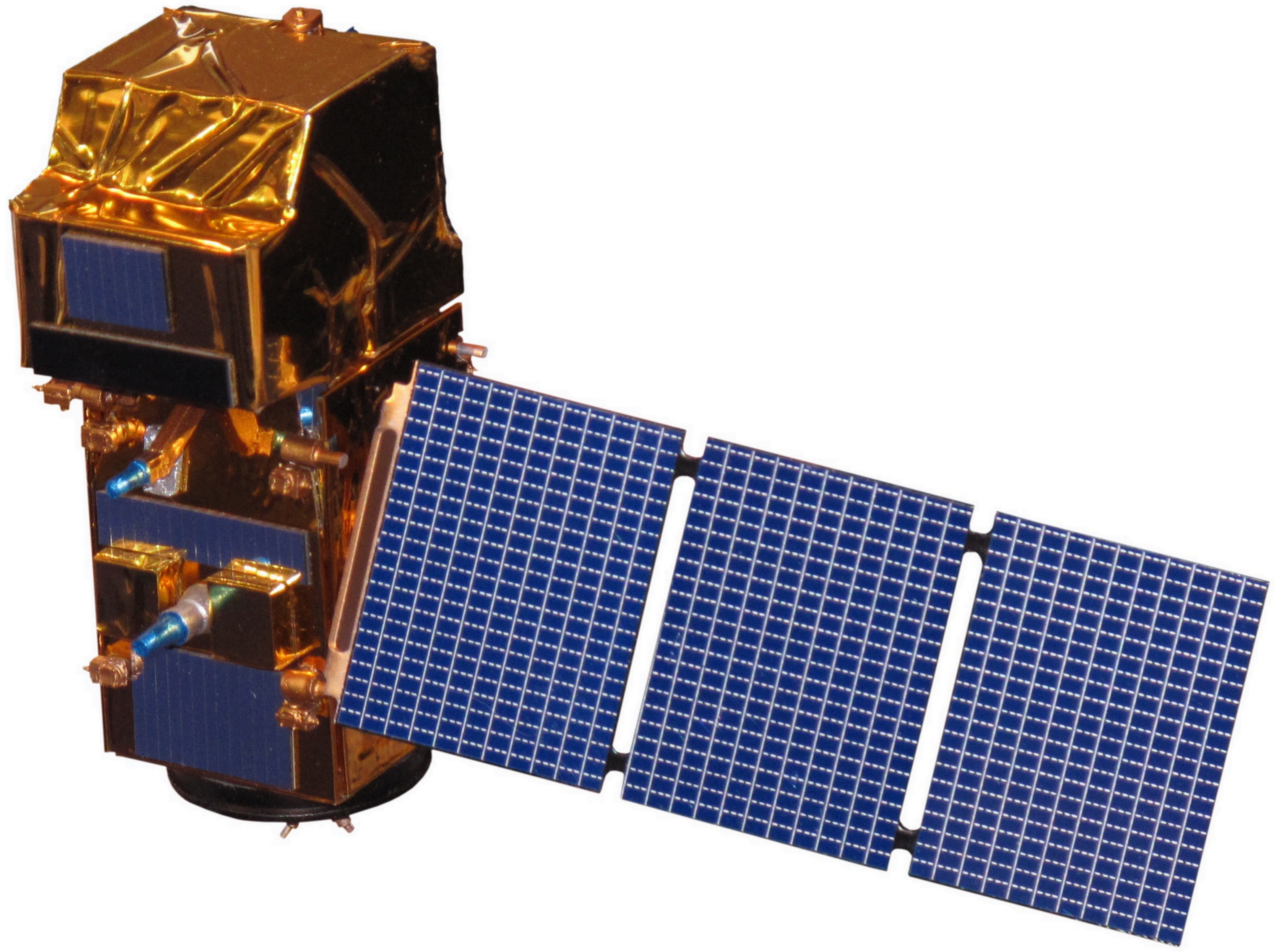


- Longest enterprise for acquisition of satellite imagery of Earth
- From NASA
- Book refers to Landsat-5, but we're at Landsat-8 (next year 9)
- 705km altitude
- 11 bands

Spectral Band	Wavelength	Resolution	Solar Irradiance
Band 1 - Coastal / Aerosol	0.433 – 0.453 µm	30 m	2031 W/(m^{2}µm)
Band 2 - Blue	0.450 – 0.515 µm	30 m	1925 W/(m^{2}µm)
Band 3 - Green	0.525 – 0.600 µm	30 m	1826 W/(m^{2}µm)
Band 4 - Red	0.630 – 0.680 µm	30 m	1574 W/(m^{2}µm)
Band 5 - Near Infrared	0.845 – 0.885 µm	30 m	955 W/(m^{2}µm)
Band 6 - Short Wavelength Infrared	1.560 – 1.660 µm	30 m	242 W/(m^{2}µm)
Band 7 - Short Wavelength Infrared	2.100 – 2.300 µm	30 m	82.5 W/(m^{2}µm)
Band 8 - Panchromatic	0.500 – 0.680 µm	15 m	1739 W/(m^{2}µm)
Band 9 - Cirrus	1.360 – 1.390 µm	30 m	361 W/(m^{2}µm)

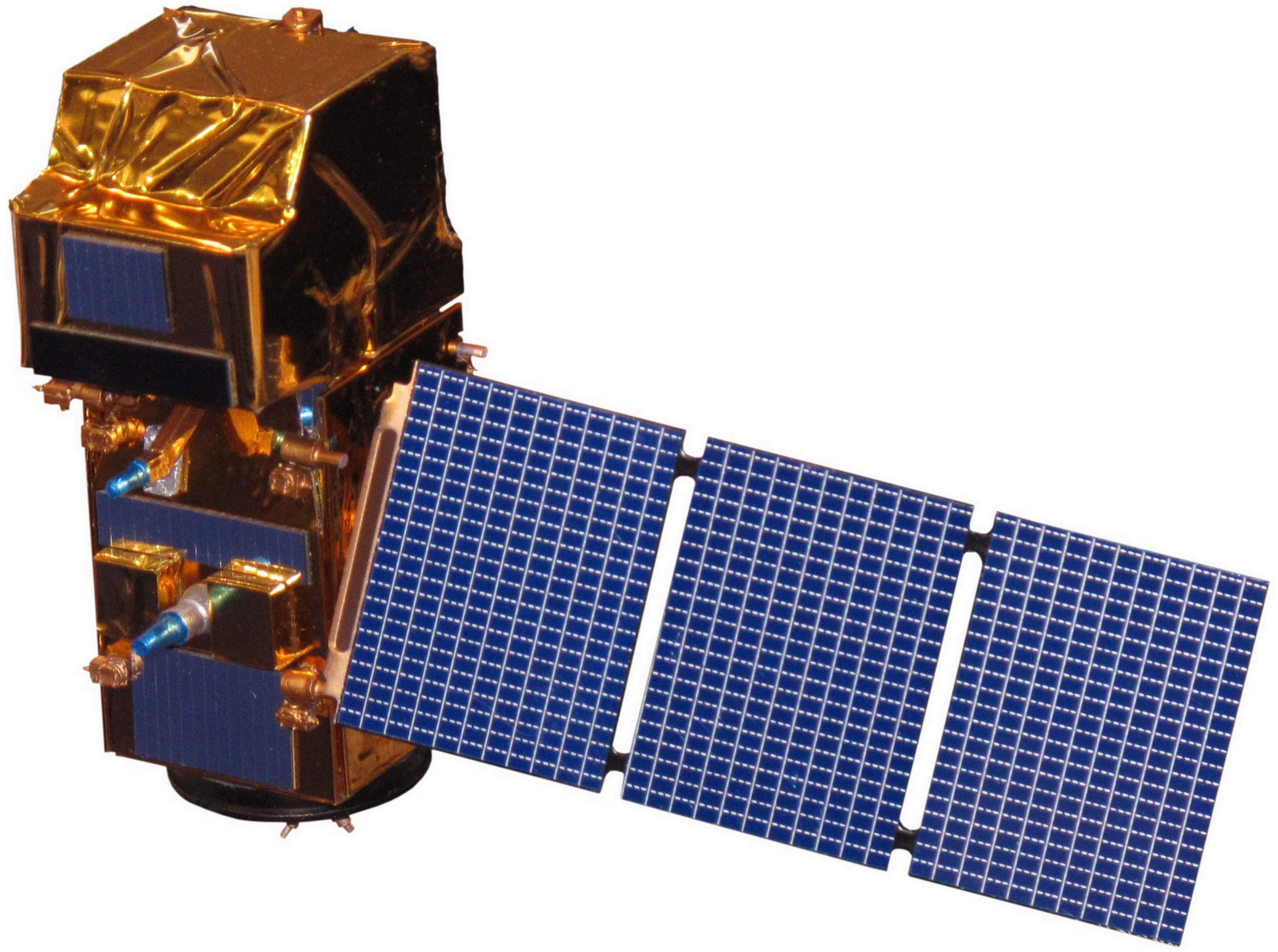
Spectral Band	Wavelength	Resolution
Band 10 - Long Wavelength Infrared	10.30 – 11.30 µm	100 m
Band 11 - Long Wavelength Infrared	11.50 – 12.50 µm	100 m

Sentinel



- EU project (ESA), under Copernicus (EU Earth observation program)
- Similar scope to Landsat
- https://en.wikipedia.org/wiki/Sentinel-2
- https://sentinels.copernicus.eu/web/sentinel/missions/sentinel-2/overview
- constellation of two polar-orbiting satellites
- wide swath width (290 km)
- high revisit time (10 days at the equator with one satellite, and 5 days with 2 satellites under cloud-free conditions which results in 2-3 days at mid-latitudes)
- The coverage limits are from between latitudes 56° south and 84° north.
- 786 km altitude

Sentinel



- Free and open data policy
- (you'll use one image of Delft for the hw02)
- Multi-spectral data with 13 bands in the visible, near infrared, and short wave infrared part of the spectrum

Spectral bands for the Sentinel-2 sensors[15]

Sentinel-2 bands	Sentinel-2A		Sentinel-2B		
	Central wavelength (nm)	Bandwidth (nm)	Central wavelength (nm)	Bandwidth (nm)	Spatial resolution (m)
Band 1 – Coastal aerosol	442.7	21	442.2	21	60
Band 2 – Blue	492.4	66	492.1	66	10
Band 3 – Green	559.8	36	559.0	36	10
Band 4 – Red	664.6	31	664.9	31	10
Band 5 – Vegetation red edge	704.1	15	703.8	16	20
Band 6 – Vegetation red edge	740.5	15	739.1	15	20
Band 7 – Vegetation red edge	782.8	20	779.7	20	20
Band 8 – NIR	832.8	106	832.9	106	10
Band 8A – Narrow NIR	864.7	21	864.0	22	20
Band 9 – Water vapour	945.1	20	943.2	21	60
Band 10 – SWIR – Cirrus	1373.5	31	1376.9	30	60
Band 11 – SWIR	1613.7	91	1610.4	94	20
Band 12 – SWIR	2202.4	175	2185.7	185	20

Formative assessment: calculate NDVI

NDVI | GEO1001.2020

localhost:4000/courses/geo1001/labs/ndvi/

GEO1001.2020 about news lessons homework help etc

Labs about NDVI

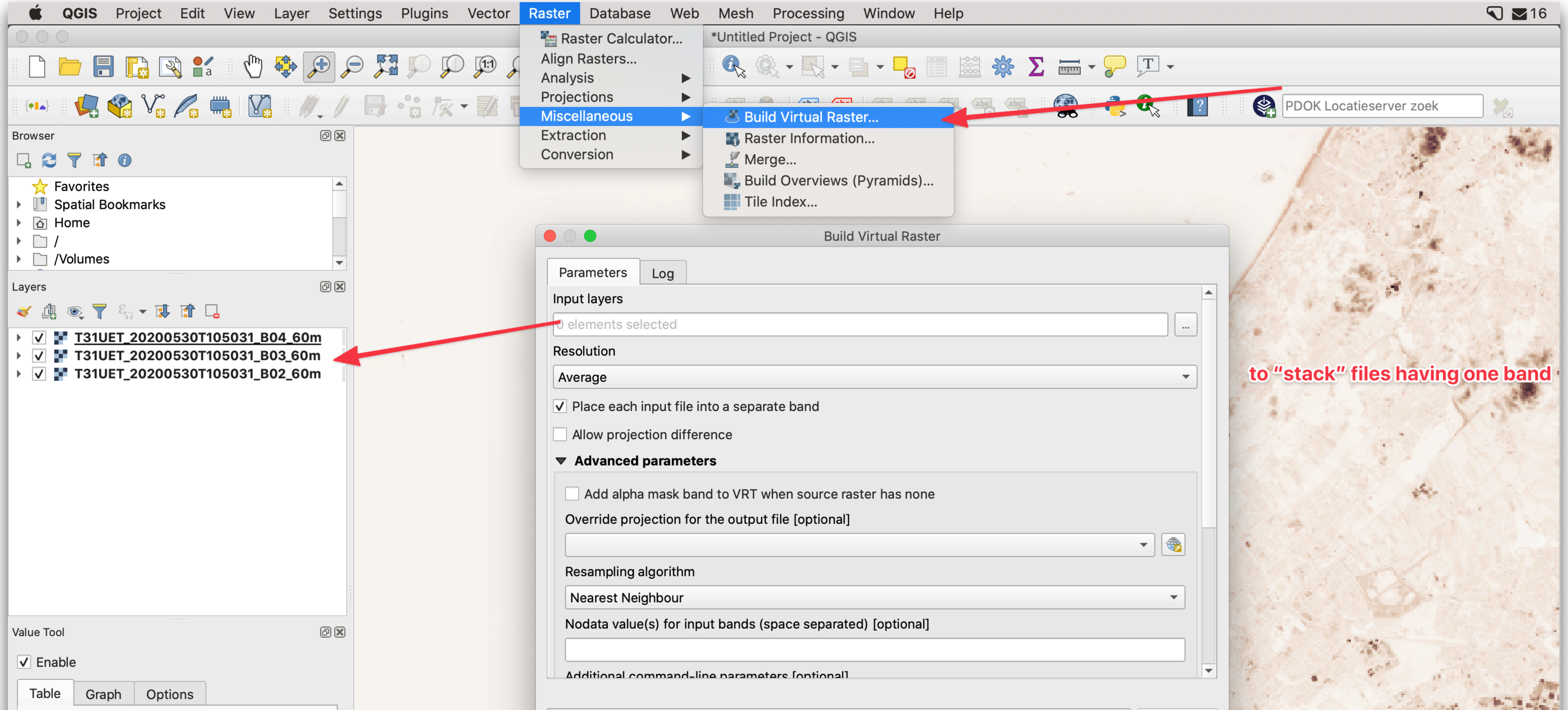
This is just a formative labs, there is no marks attached to it and it won't be marked.

It's a good idea to do it to get used to the data and to practise methods that will be useful for the hw02

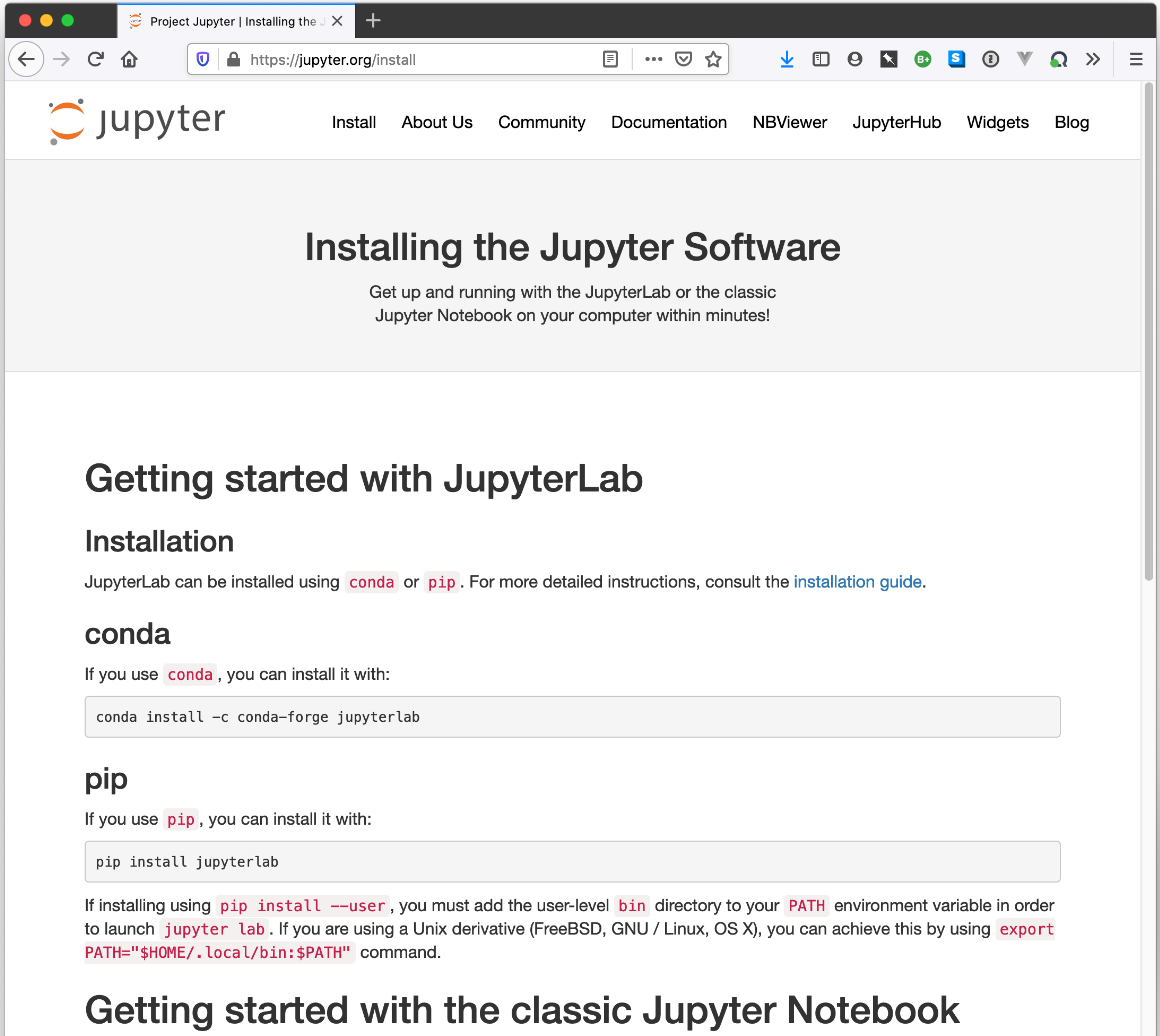
NDVI (normalized difference vegetation index)

- Simple indicator to assess whether pixels represent green vegetation
- By far most popular vegetation index

$$\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{Red})}{(\mathrm{NIR} + \mathrm{Red})}$$



Jupyter notebook


Project Jupyter | Installing the J
https://jupyter.org/install

jupyter

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Installing the Jupyter Software

Get up and running with the JupyterLab or the classic Jupyter Notebook on your computer within minutes!

Getting started with JupyterLab

Installation

JupyterLab can be installed using `conda` or `pip`. For more detailed instructions, consult the installation guide.

conda

If you use `conda`, you can install it with:

```
conda install -c conda-forge jupyterlab
```

pip

If you use `pip`, you can install it with:

```
pip install jupyterlab
```

If installing using `pip install --user`, you must add the user-level `bin` directory to your `PATH` environment variable in order to launch `jupyter lab`. If you are using a Unix derivative (FreeBSD, GNU / Linux, OS X), you can achieve this by using `export PATH="$HOME/.local/bin:$PATH"` command.

Getting started with the classic Jupyter Notebook

Markdown is used for text

```
$ pip install jupyterlab
$ pip install notebook
$ jupyter notebook
```

https://3d.bk.tudelft.nl/courses/geo1001/