SAR basics for land surfaces

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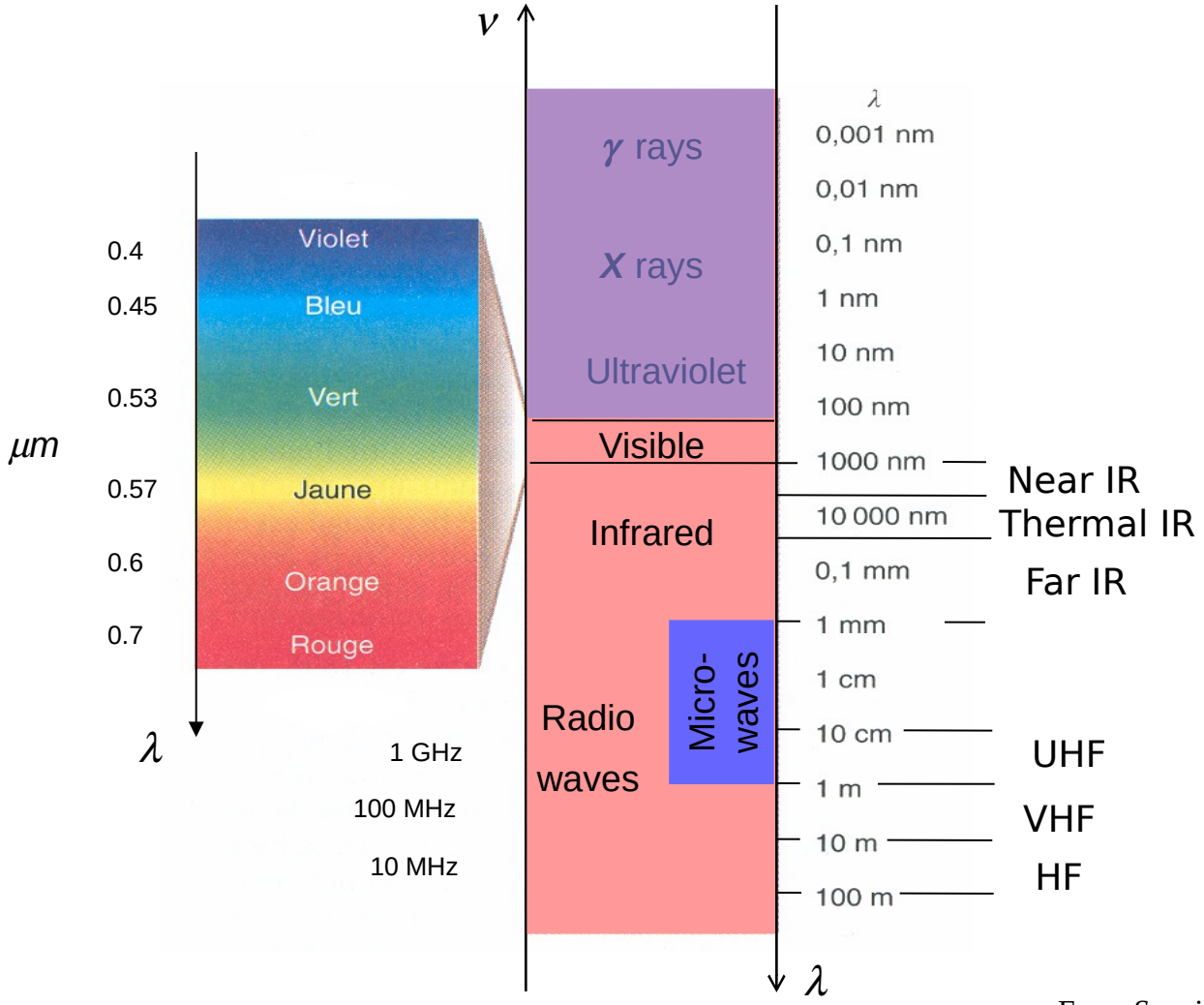
Laboratoire des Sciences et Technologies de l'Information Géographique

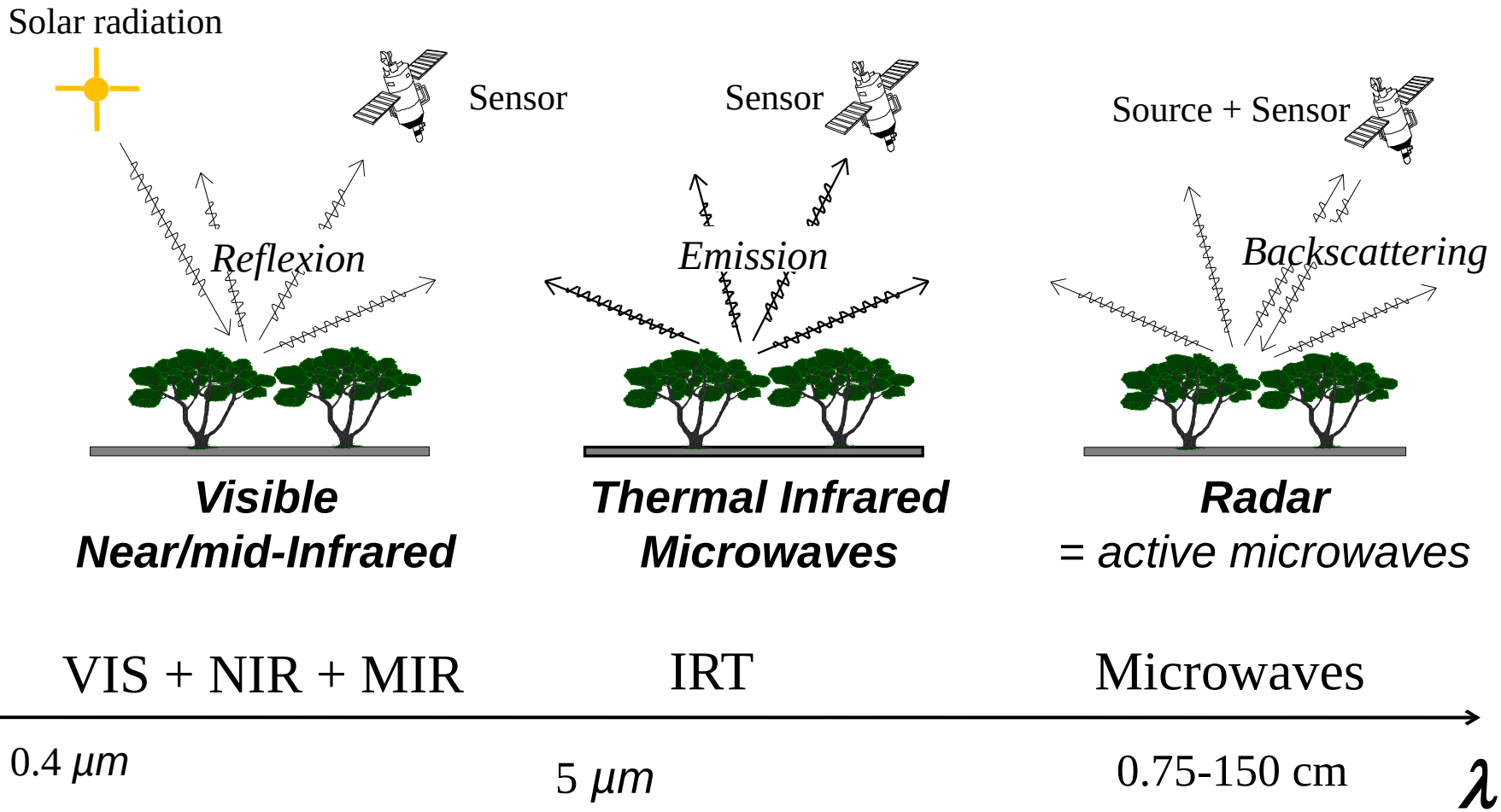
Electromagnetic spectrum



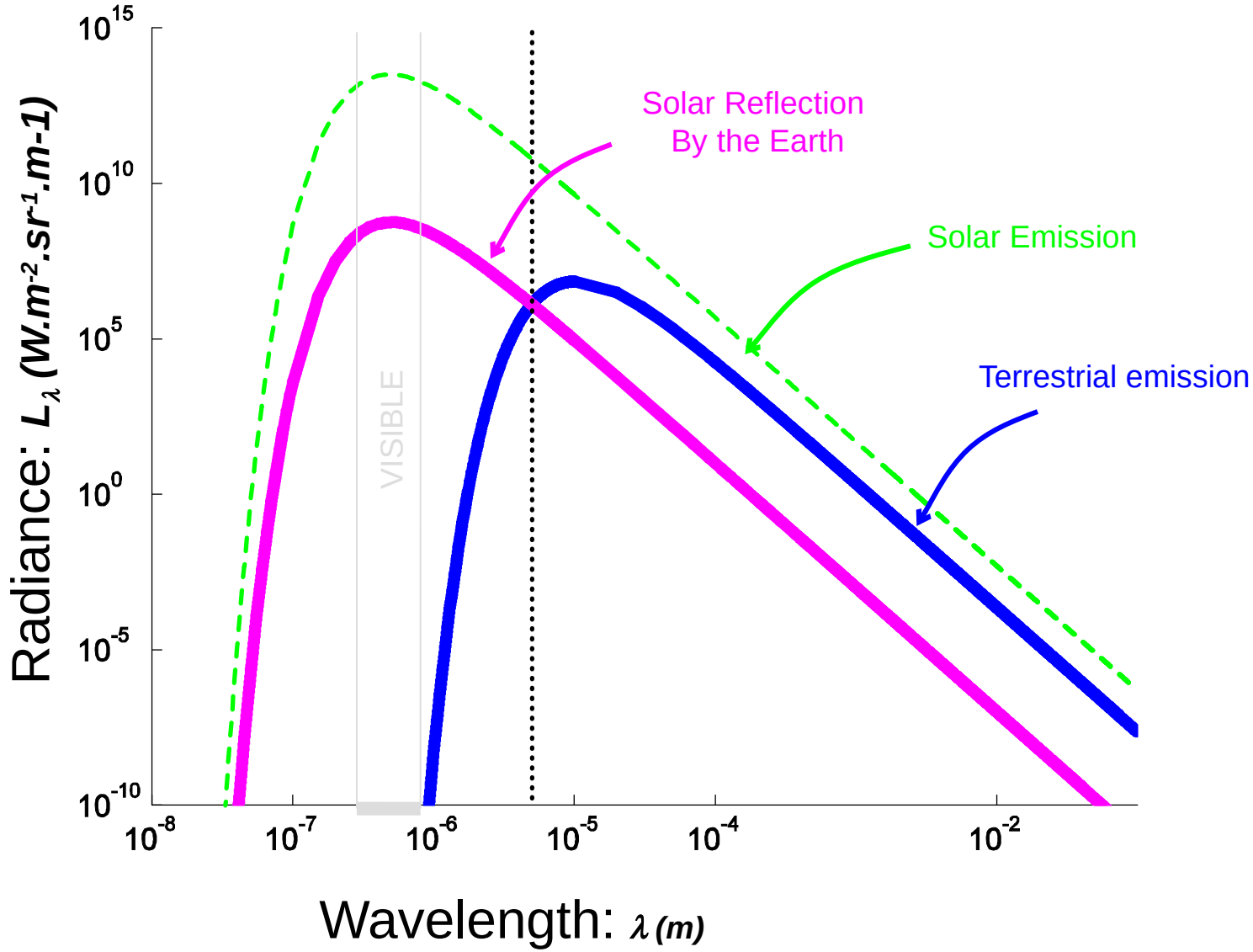
From *Seguin & Villeneuve, Astromnomie et Astrophysique*

Radar Fundamentals

Remote Sensing observations mode



The electromagnetic radiation Coming from the Earth



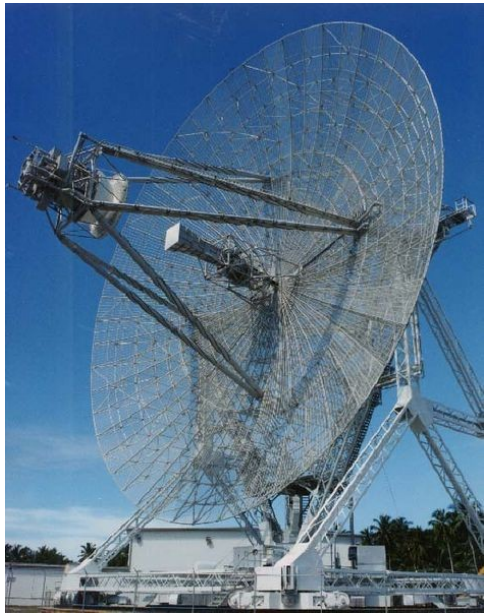
Radar Fundamentals

RADAR:

RAdio **D**etection **A**nd **R**anging

Emition of emw

Reception backscattered echoes



US Army

Road RADAR (© US police)

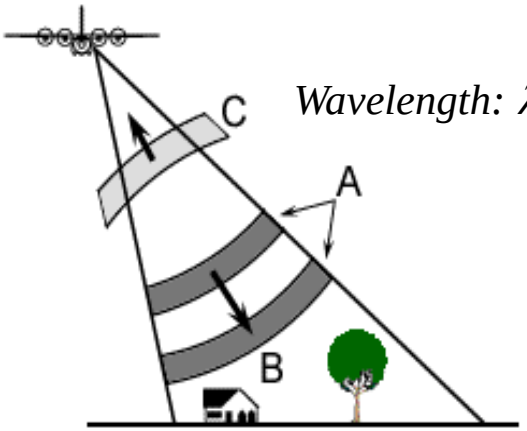
Imaging RADAR PALSAR (© NASDA)

Vegetation classification with SAR data

Spaceborne Remote Sensing

Optical since 70's

Radar since 1991

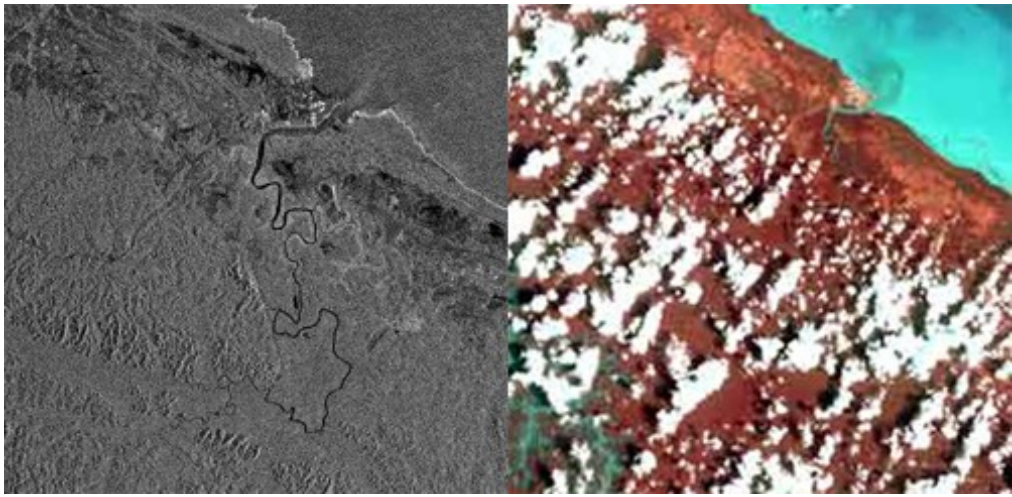


Wavelength: λ > 1cm

Source: Centre canadien de télédétection

Radar, ERS

Optical, SPOT

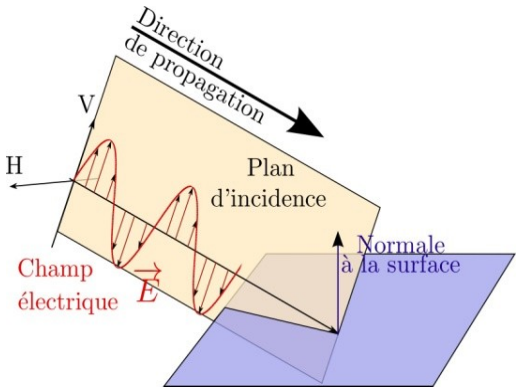


Insensitive to clouds and atmosphere

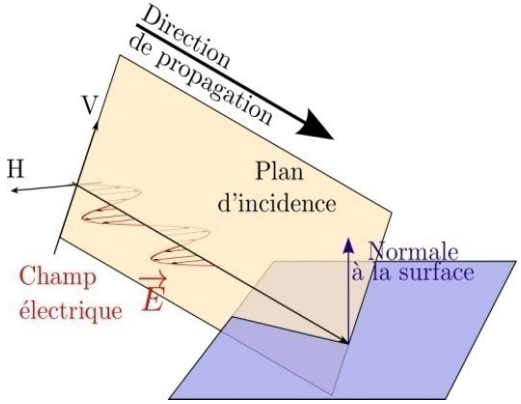
+

day / night acquisitions

Different polarizations



V Polarisation

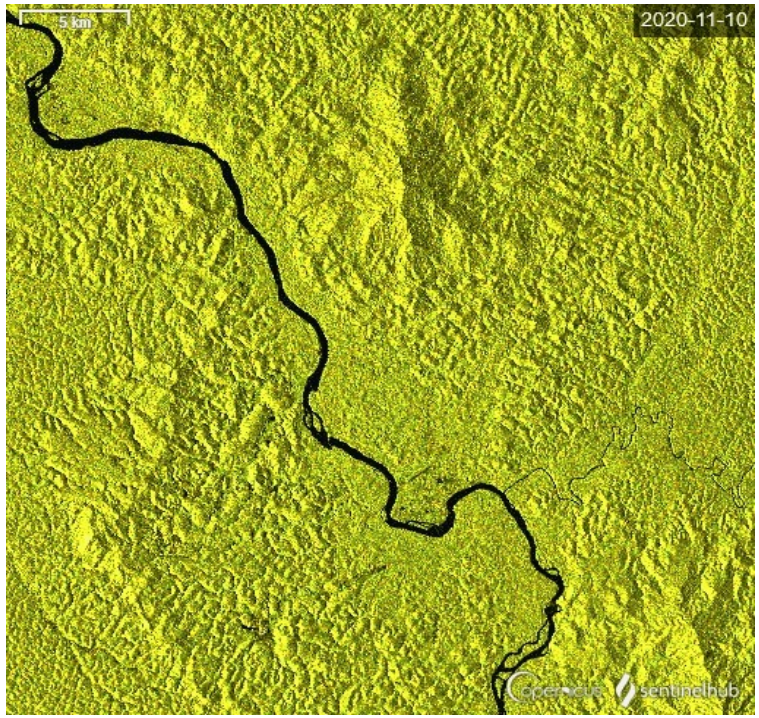


H Polarisation

Radar particularly suitable for heavily cloudy areas

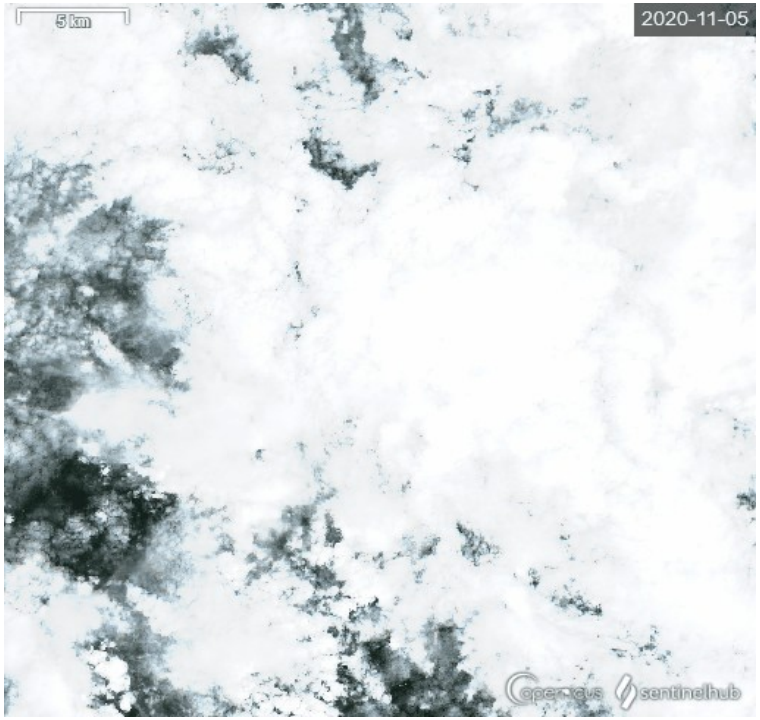
- ***Not sensitive to cloud cover ($\lambda > 2$ cm)***

Radar

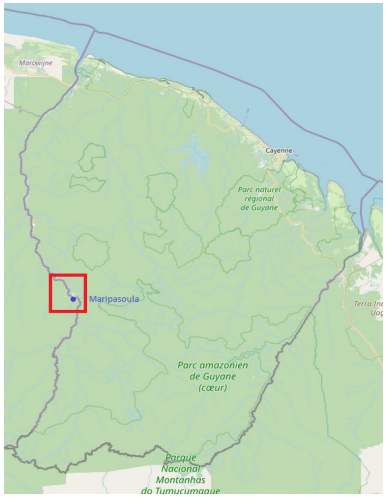


Sentinel-1

Optical

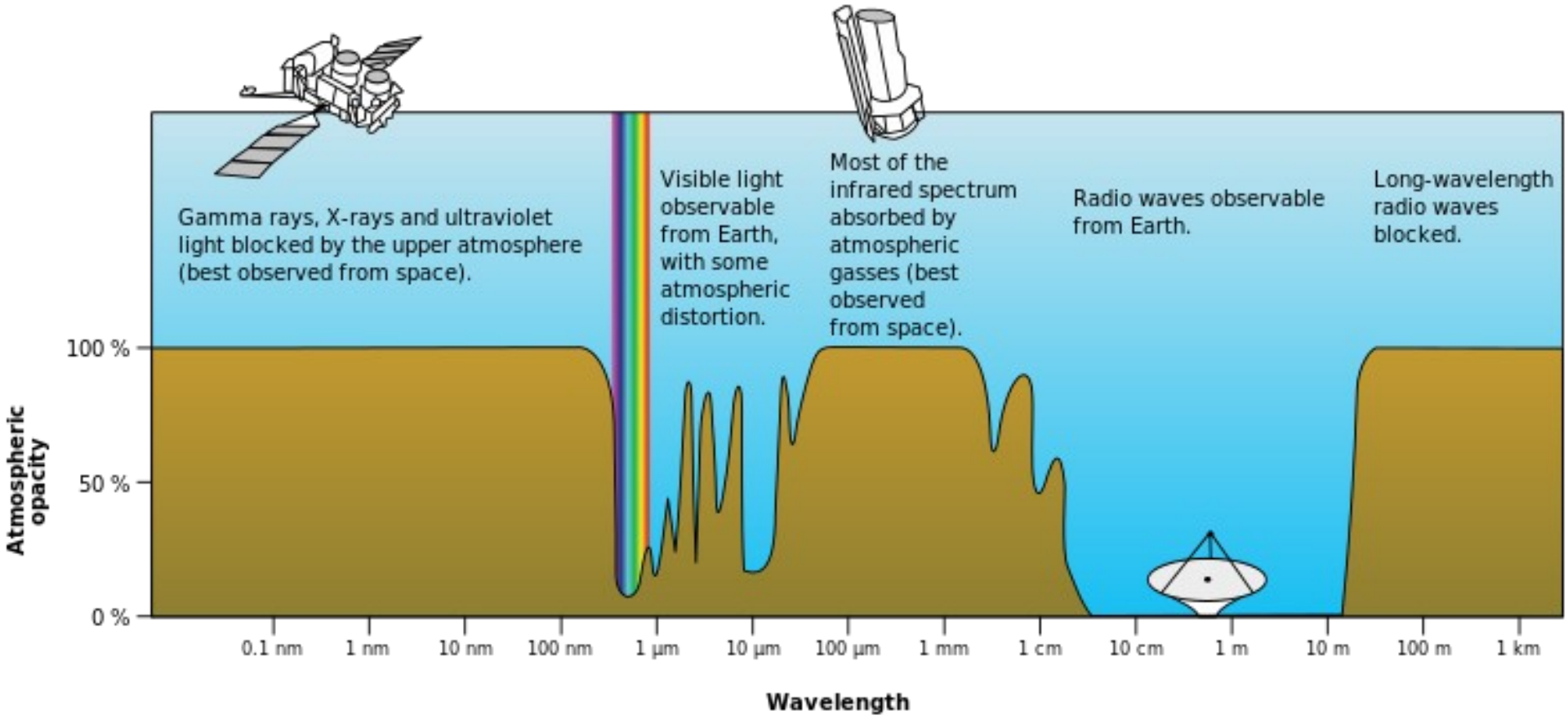


Sentinel-2



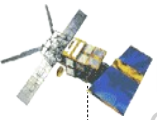
Frequency - wavelength

Radar: all weather acquisition



Source: Wikipedia

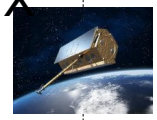
SPACEBORNE SAR SENSORS



ERS1
C Band

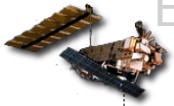
RADARSAT2
C Band

TerraSAR X
X Band



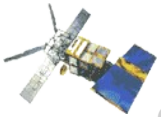
Sentinel
-1
C Band

RADARSAT
C Band

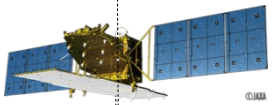


ENVISAT
RSO
Bande C

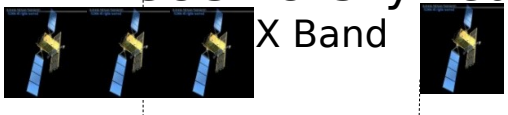
ALOS
L Band



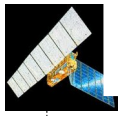
ERS2
C Band



COSMO-SkyMed
X Band

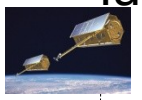


ALOS
2
L Band



JERS
L Band

Tandem X
X Band



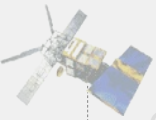
1991 1992 1995 2002 2007 2010 2014 2016

Frequency – Wavelength

$$f = \frac{c}{\lambda}$$

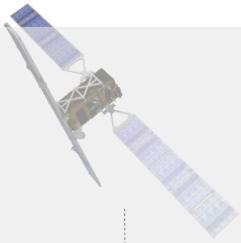
Band	Wavelength λ (cm)	Frequency ***f***
X	**~ 3 cm**	**~ 10 GHz**
C	**~ 6 cm**	**~ 5 GHz**
L	**~ 25 cm**	**~ 1,2 GHz**
P	**~ 70 cm**	**~ 400 MHz**

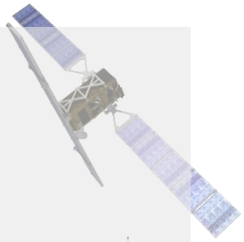
SPACEBORNE SAR SENSORS



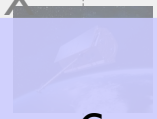
ERS1
C Band

RADARSAT2
C Band





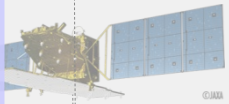
TerraSAR X
X Band



Sentinel
-1
C Band

Diversity of :

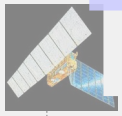
- wavelength (2 cm, 3 cm, 6 cm, 24 cm)
- spatial resolution: 1 m – 1 km
- temporal: 6 days – 1 month
- polarisations



COSMO-SkyMed
X Band

ALOS
2
L Band

JERS
L Band

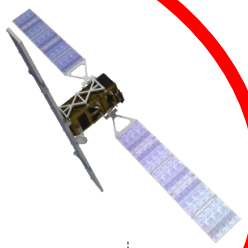


Tandem X
X Band

1991 1992 1995 2002 2007 2010 2014 2016

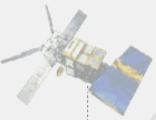
SPACEBORNE SAR SENSORS

COPERNICUS



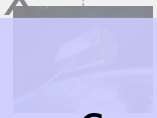
Sentinel
-1
C Band

RADARSAT2
C Band



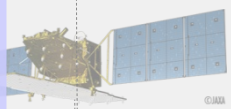
ERS1
C Band

TerraSAR X
X Band



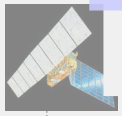
RADARSAT
C Band

ALOS
L Band



COSMO-SkyMed
X Band

JERS
L Band



ALOS
2
L Band

Tandem X
X Band

Diversity of :

- wavelength (2 cm, 3 cm, 6 cm, 24 cm)
- spatial resolution: 1 m – 1 km
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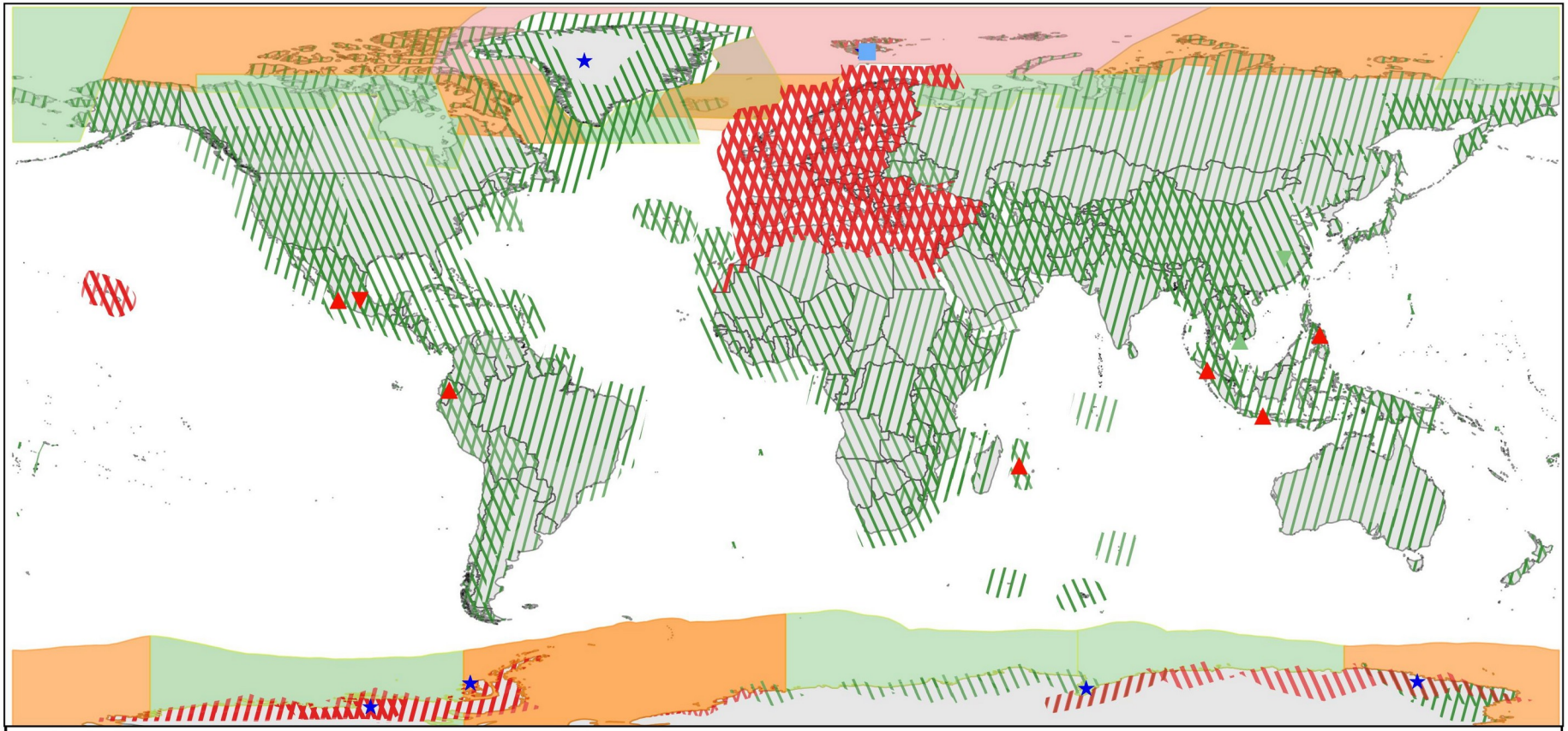
1991 1992 1995 2002 2007 2010 2014 2016

SPACEBORNE SAR SENSORS

Sentinel-1 Constellation Observation Scenario: Revisit & Coverage Frequency

sentinel-1

validity start: 02/2018



SAR data: summary

Name	*Acquisition period*	*Band Frequency*	*Polarization mode*	*Spatial resolution (m)*	*Revisit time (days)*	*Scene cover (km)*
ERS-1 / 2	91 - 11	C	VV	20	35	185x185
JERS	92 - 98	L	HH	20	44	75 x 75
Radarsat	95 – 13	C	HH	10-100	24	35 x 500
ASAR	01-13	C	1 or 2 pol. HH/HV/VV	30-1000	few -35	100x500
PALSAR	07-11	L	Polarimetric HH/HV/VV	10-100	few-24	100-500
Radarsat-2	2007 -	C	Polarimetric HH/HV/VV	1-15	5 to 10	NA
TerraSAR-X	2007 -	X	1 or 2 pol. HH/HV/VV	1-20	few-11	5-100
Cosmo-Skymed	2007 -	X	1 or 2 pol HH/HV/VV	1-100	12 h	10-200
SAOCOM	2015	L	Polarimetric HH/HV/VV	7-100	few-16	60-320
Sentinel 1	2015	C	1 or 2 pol HH/HV/VV	5 - 100m	few-12	80-400
ALOS-2	2015	L	Polarimetric HH/HV/VV	3-100	few-14	25-350

OUTLINE

I. Radar imaging - Spatial resolution
II. Polarization - Polarimetry
III. Radar response sensitivity
IV. Relief effects
V. Speckle and Filtering