



SAR basics for land

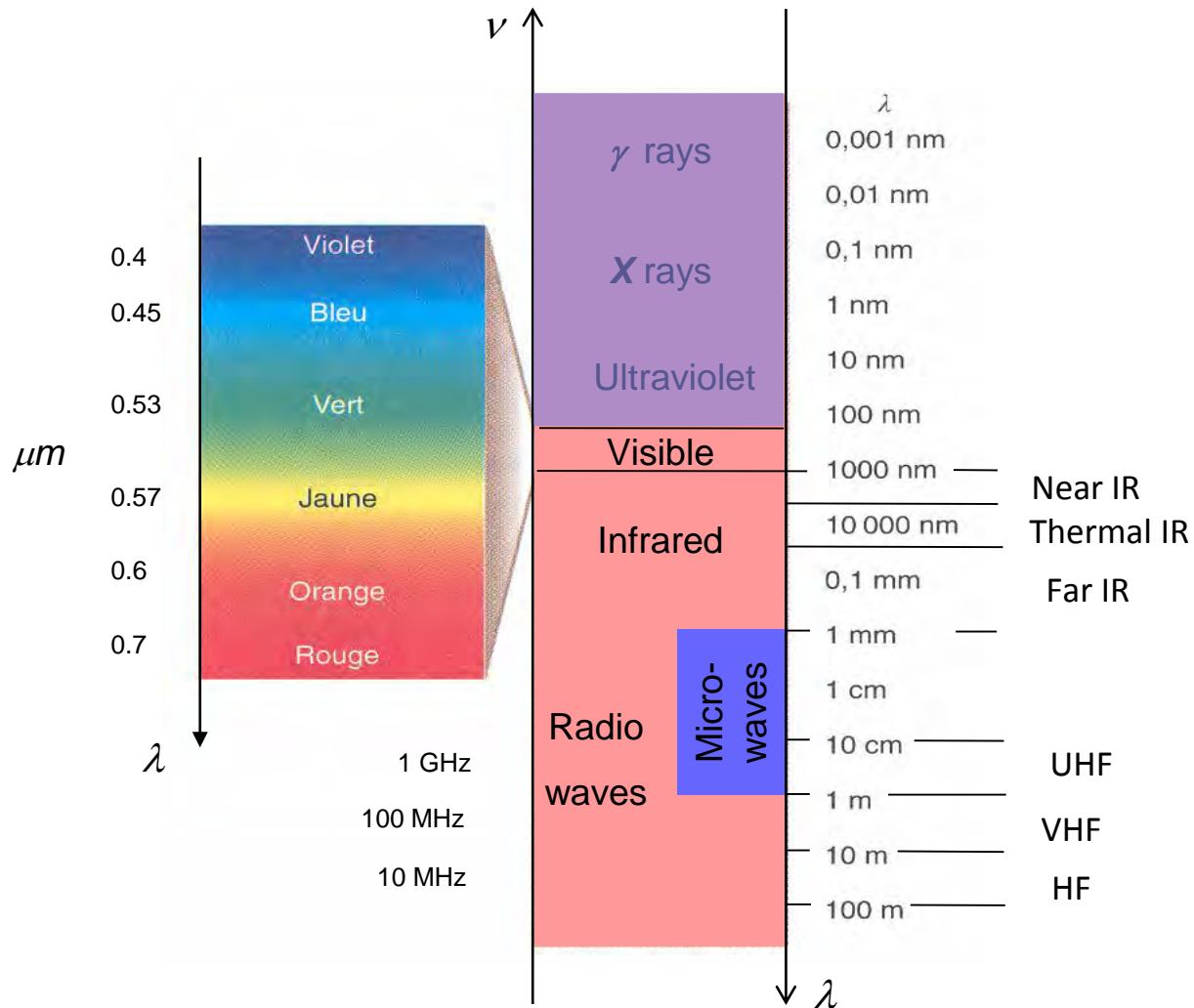
12th ESA Training Course on Earth Observation

Riga, 28th June 2022

Pierre-Louis Frison

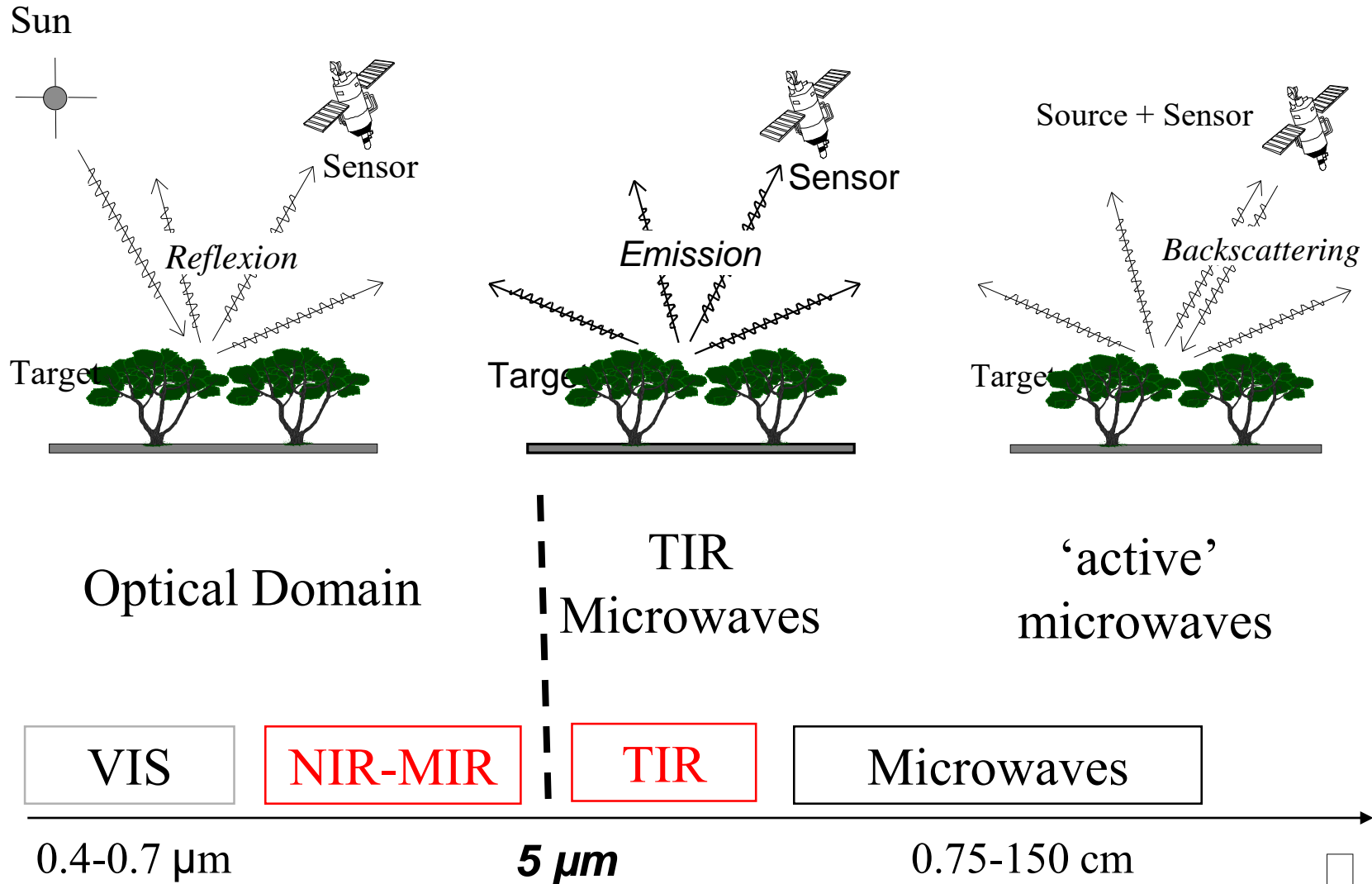
pierre-louis.frison@univ-eiffel.fr

Electromagnetic spectrum



From Seguin & Villeneuve,
Astronomie et Astrophysique

Observation modes



Radar Fundamentals

RADAR: **R**adio **D**etection **A**nd **R**anging

Emission of emw
Reception backscattered echoes



Road RADAR

(© US police)



US Army



Imaging RADAR PALSAR

(© NASDA)

Vegetation classification with SAR data

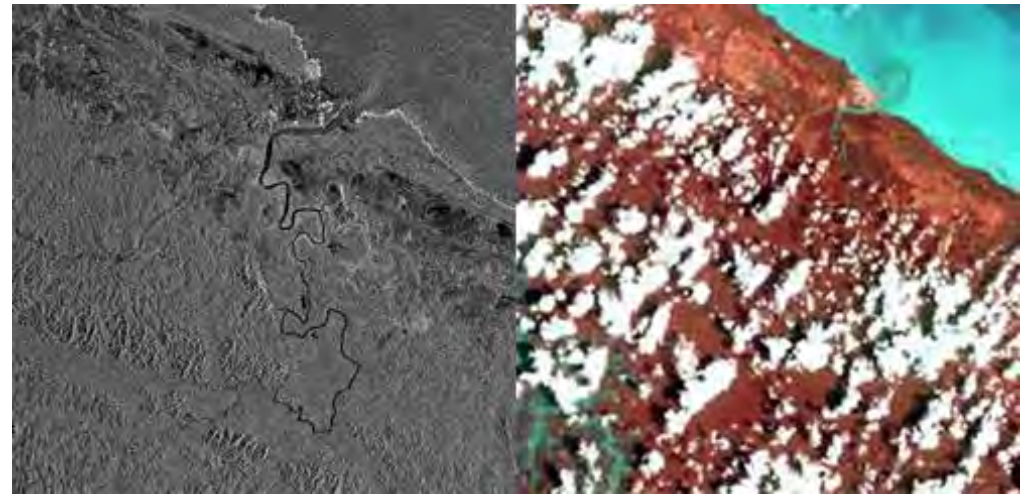
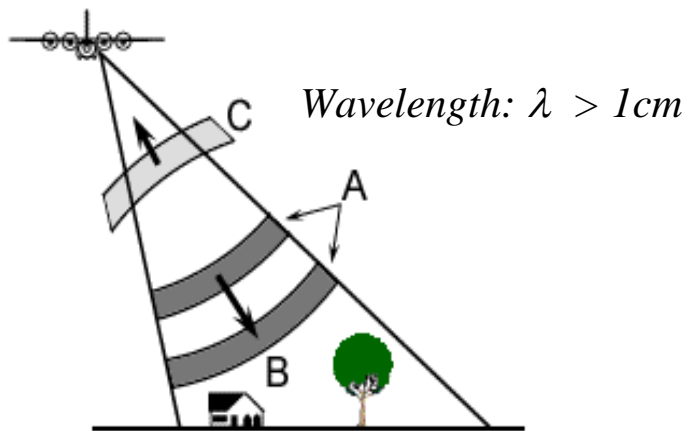
Radar, ERS

Optical, SPOT

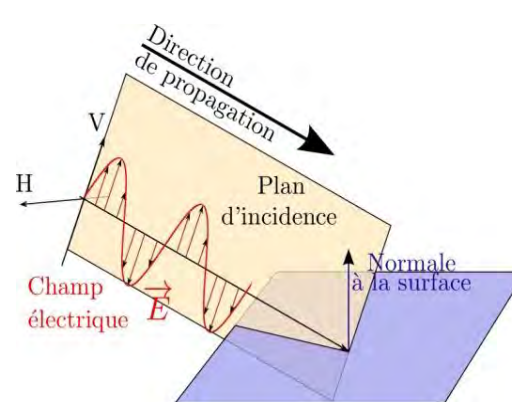
Spaceborne Remote Sensing

Optical since 70's

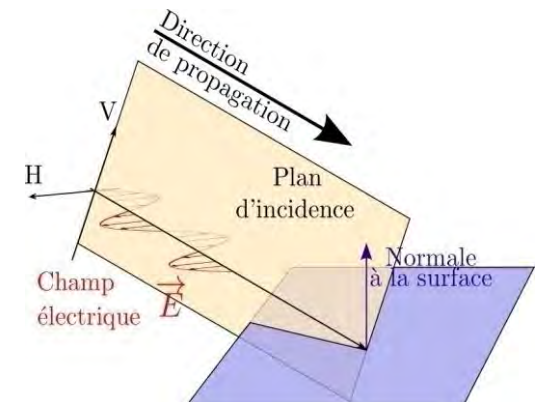
Radar since 1991



Insensitive to clouds and atmosphere
+
day / night acquisitions



V Polarisation



H Polarisation

Different polarizations

Source: Centre canadien de télédétection

Radar particularly suitable for heavily cloudy areas

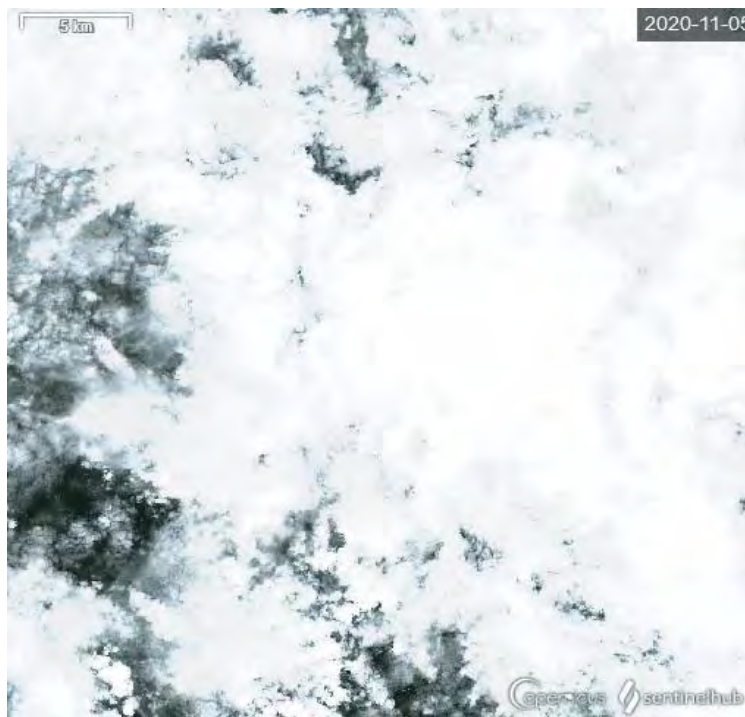
☞ *Not sensitive to cloud cover ($\lambda > 2\text{ cm}$)*

Radar



Sentinel-1

Optical

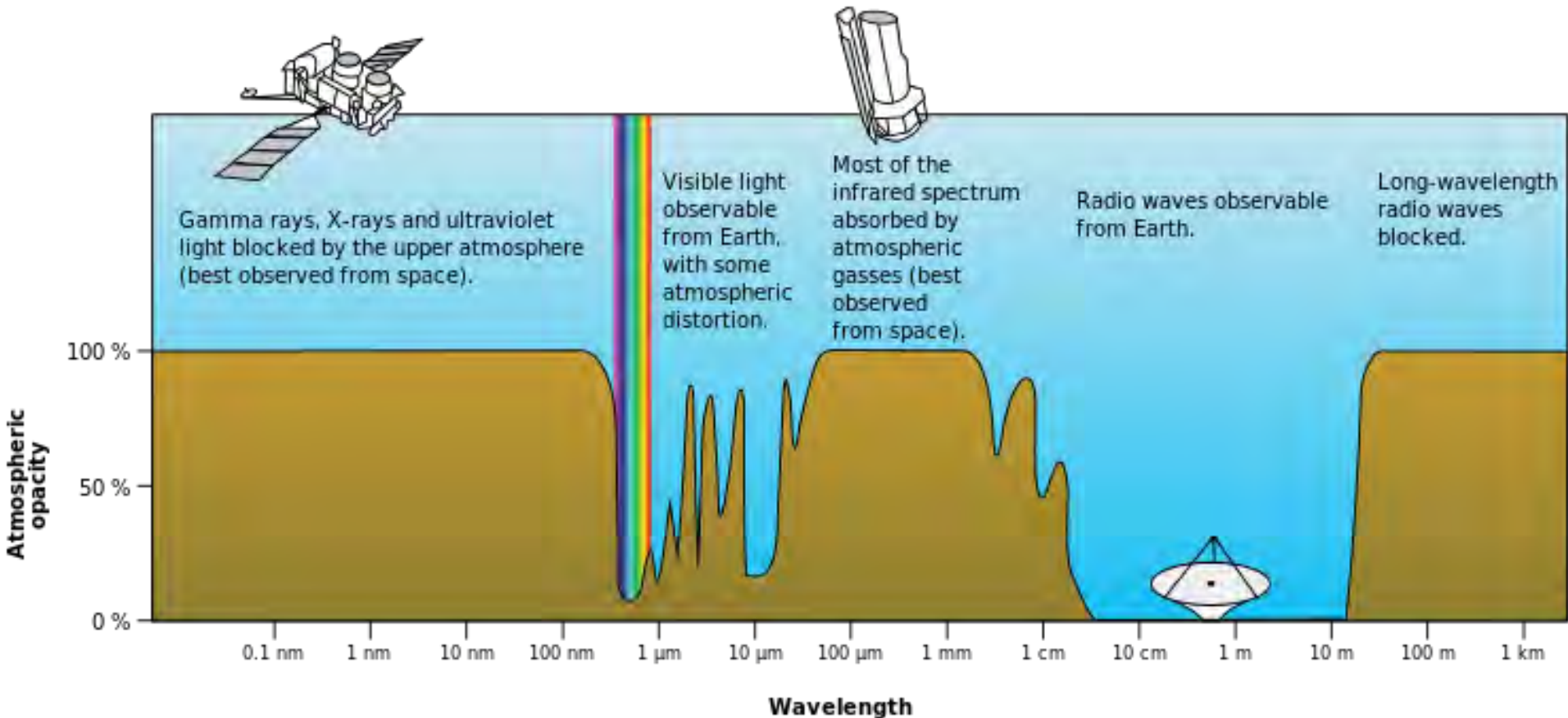


Sentinel-2



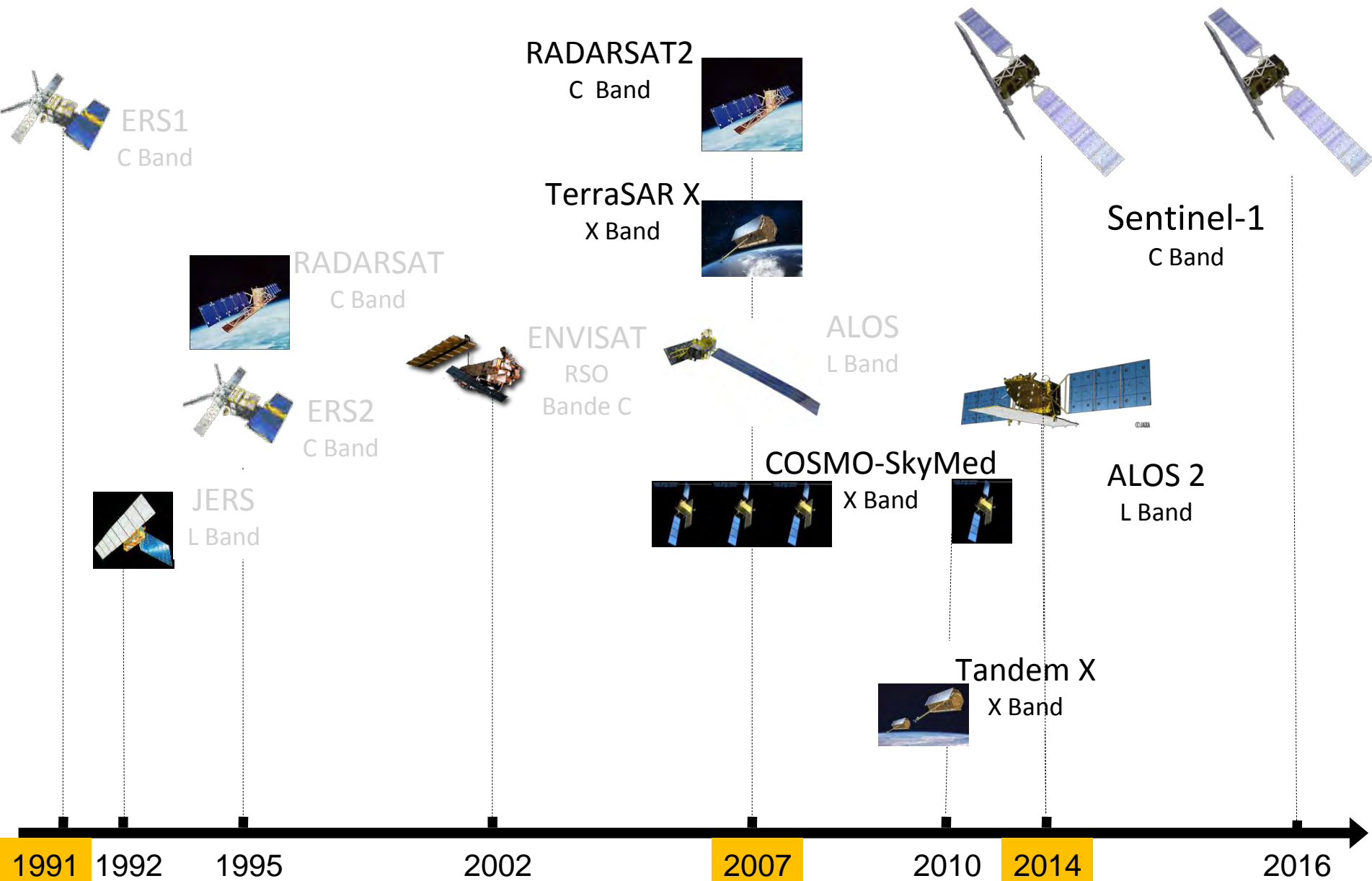
Frequency - wavelength

Radar: all weather acquisition



Source: Wikipedia

SPACEBORNE SAR SENSORS

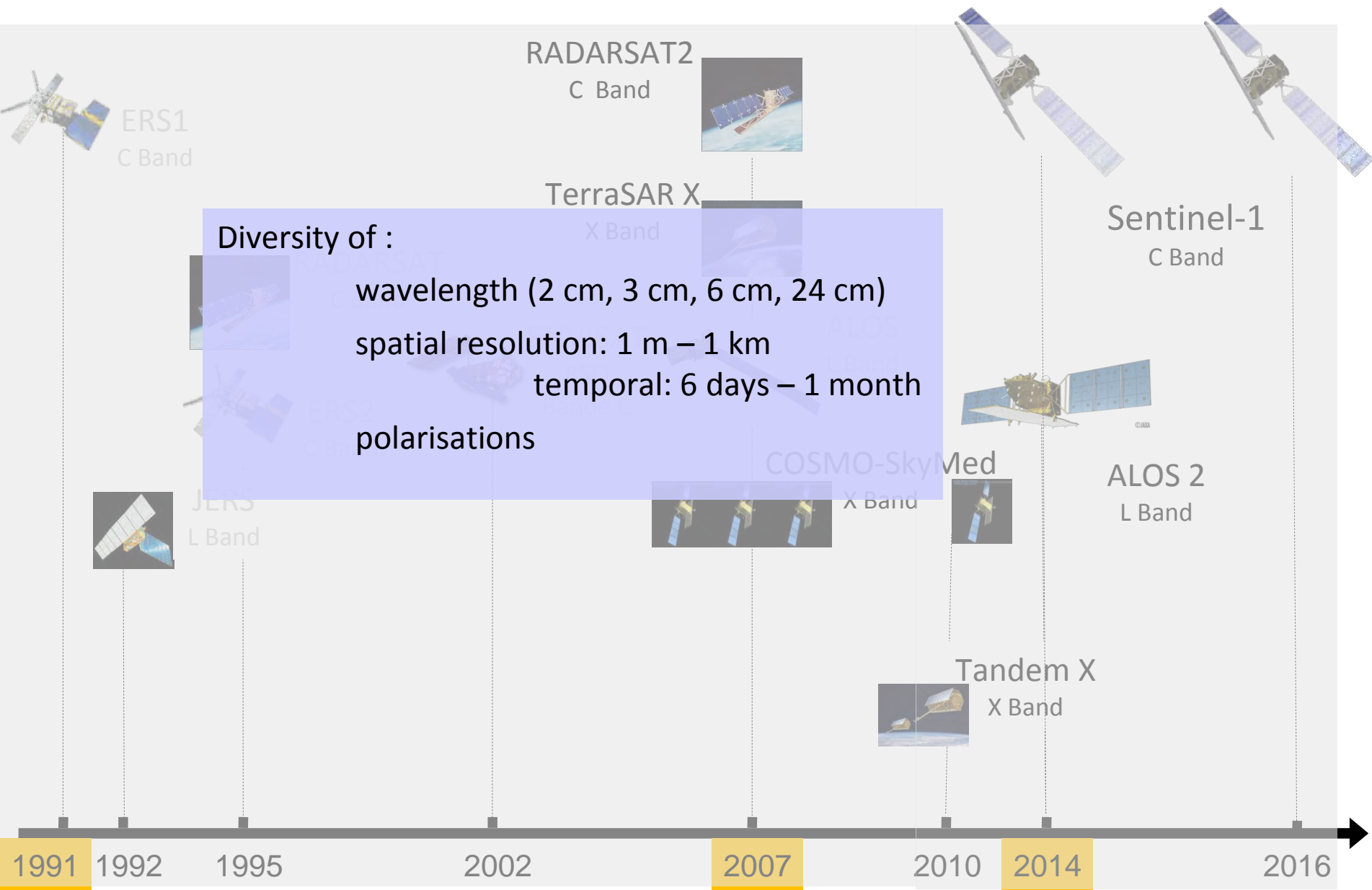


Frequency – Wavelength

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

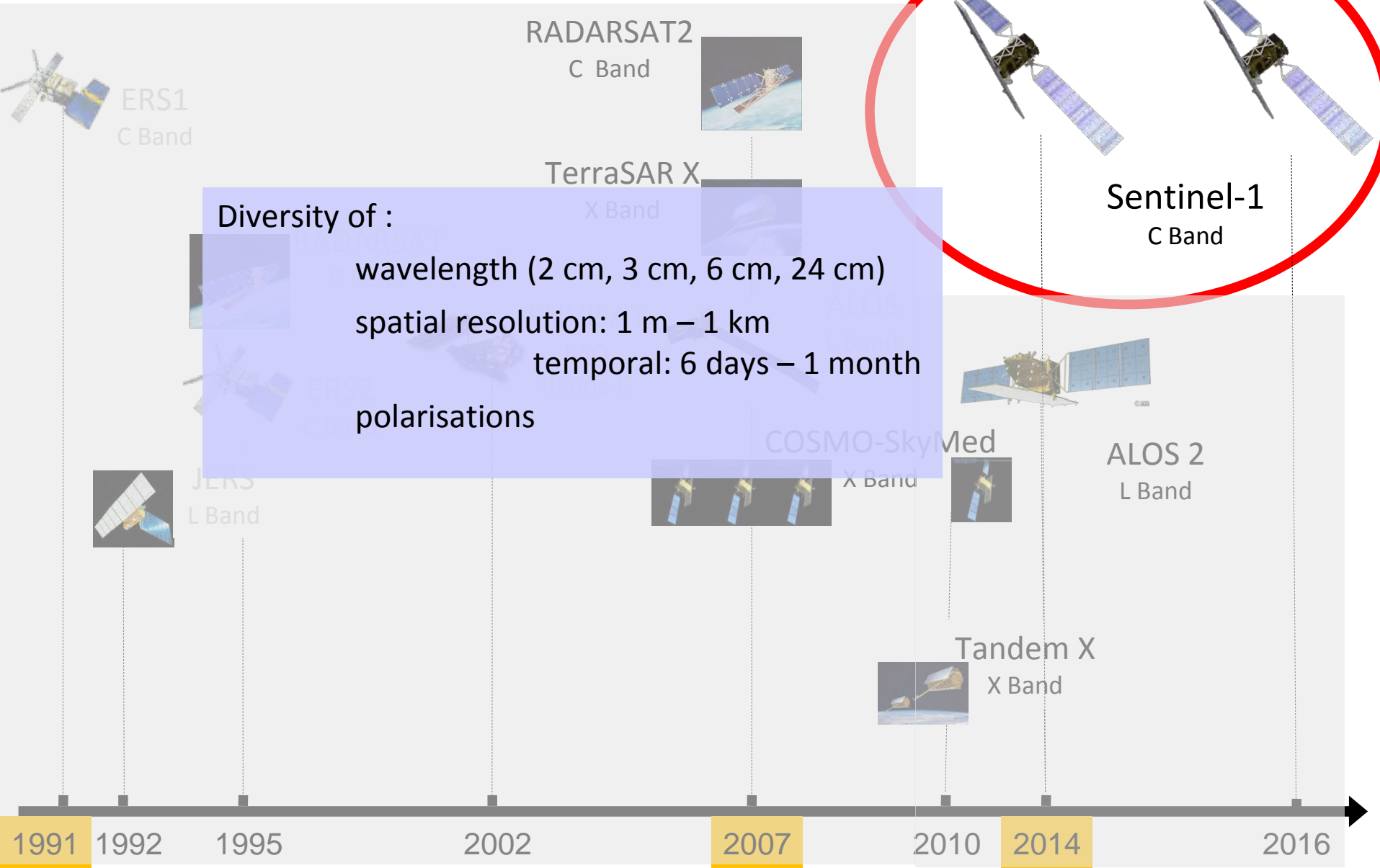
Band	Wavelength λ (cm)	Frequency f
<i>X</i>	~ 3 cm	~ 10 GHz
<i>C</i>	~ 6 cm	~ 5 GHz
<i>L</i>	~ 25 cm	~ 1,2 GHz
<i>P</i>	~ 70 cm	~ 400 MHz

SPACEBORNE SAR SENSORS



SPACEBORNE SAR SENSORS

COPERNICUS

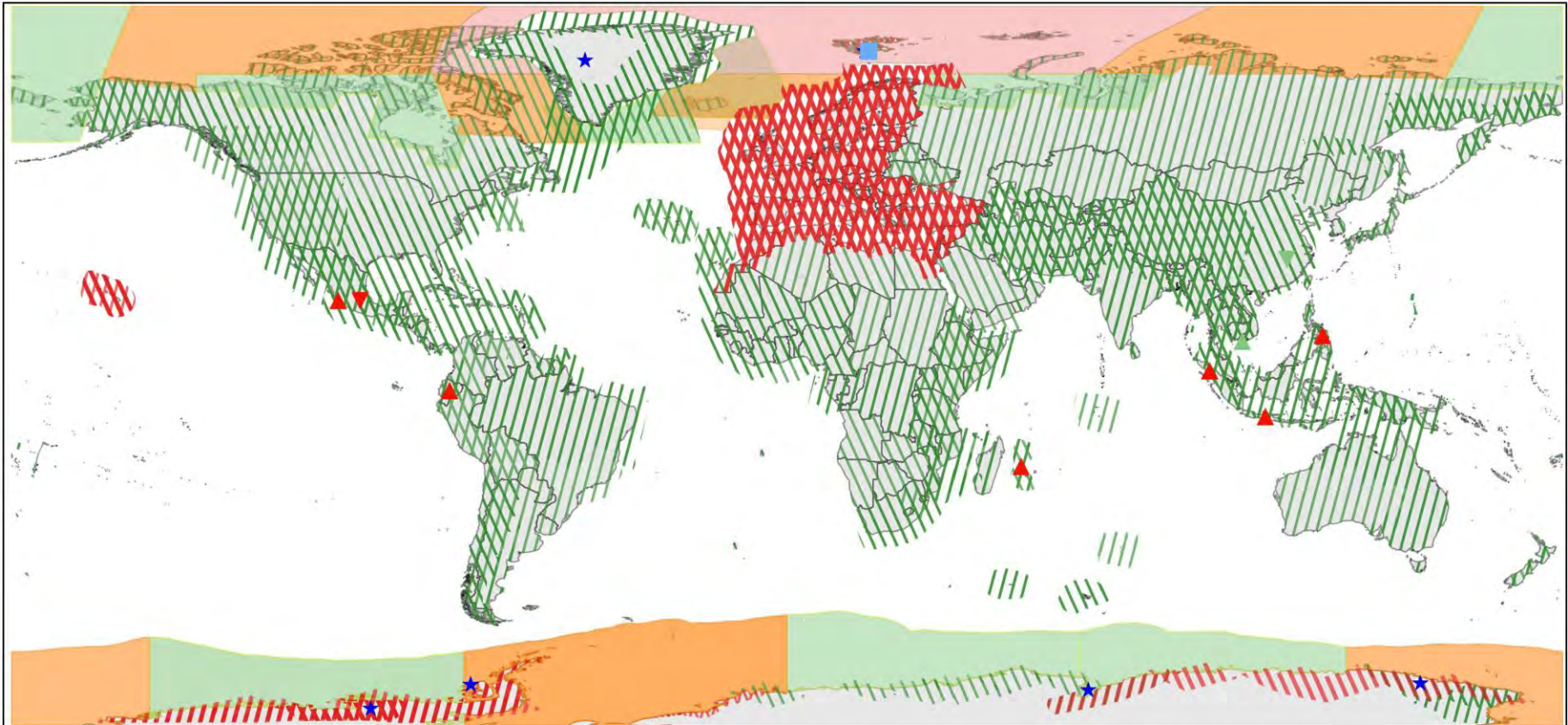


SPACEBORNE SAR SENSORS

Sentinel-1 Constellation Observation Scenario: Revisit & Coverage Frequency



validity start: 02/2018



PASS

ASCENDING
DESCENDING

REVISIT

6 days
12 days
12 days

FREQUENCY *

12 days
12 days
12 days

COVERAGE

1 days
1-3 days
2-4 days

FREQUENCY **

1 days
1-3 days
2-4 days

REFERENCE DATA SITES (6d repeat)

▲ Highly active volcanism
▼ Fast subsidence
▲ Short growth cycle, intensive agriculture
▼ Fast changing wetlands
★ Fast moving outlet glaciers
■ Permafrost & glaciers

* coverage ensured from same, repetitive relative orbits
** coverage not considering repetitiveness of relative orbits

SAR data: summary

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

