

Radar Observing System for Europe at L-band (ROSE-L)

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ROSE-L Mission Advisory Group

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Copernicus 1.0 – The Present

S-1



High Resolution Radar

A



3 Apr. 2014

B



25 Apr. 2016

C

2022

D

> 2024

S-2



High Resolution Optical

A



23 Jun. 2015

B



6 Mar. 2017

C

2023

D

> 2025

S-3



Medium Resolution Optical & Altimetry

A



16 Feb. 2016

B



25 Apr. 2018

C

2023

D

> 2025

S-4



Atmospheric Chemistry (GEO)

A

2021

B

2027

S-5P



Atmospheric Chemistry (LEO)

A



13 Oct. 2017

S-5



Atmospheric Chemistry (LEO)

A

2021

B

2027

C

> 2027

S-6



Altimetry

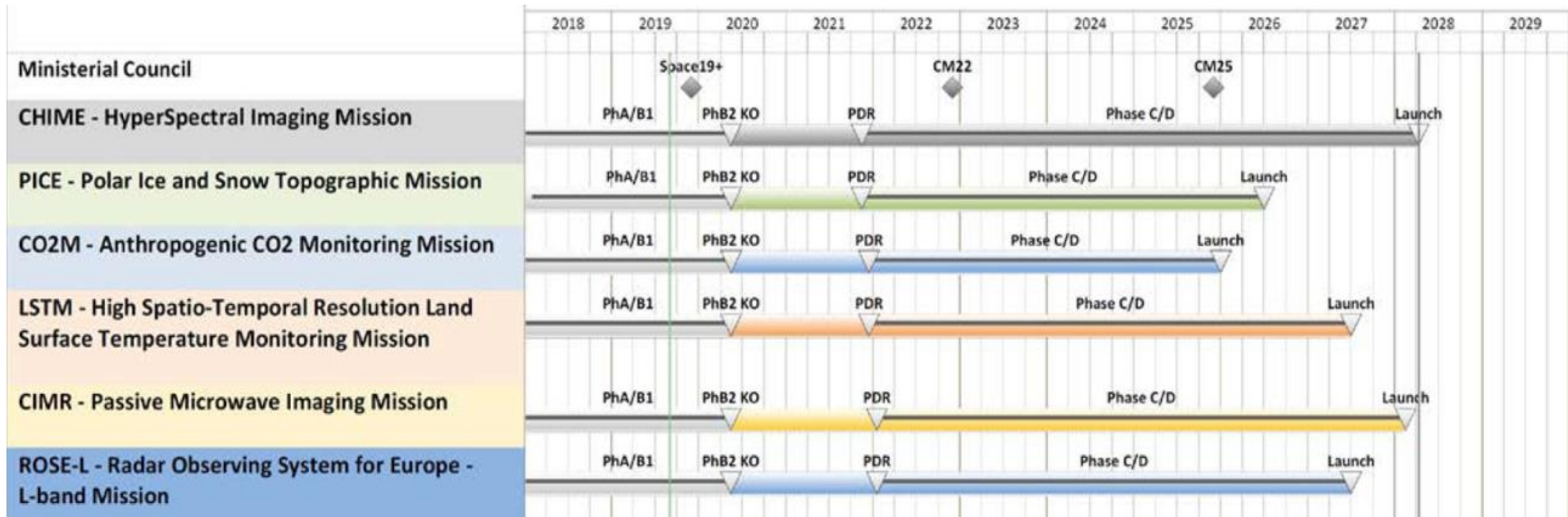
A

2020

B

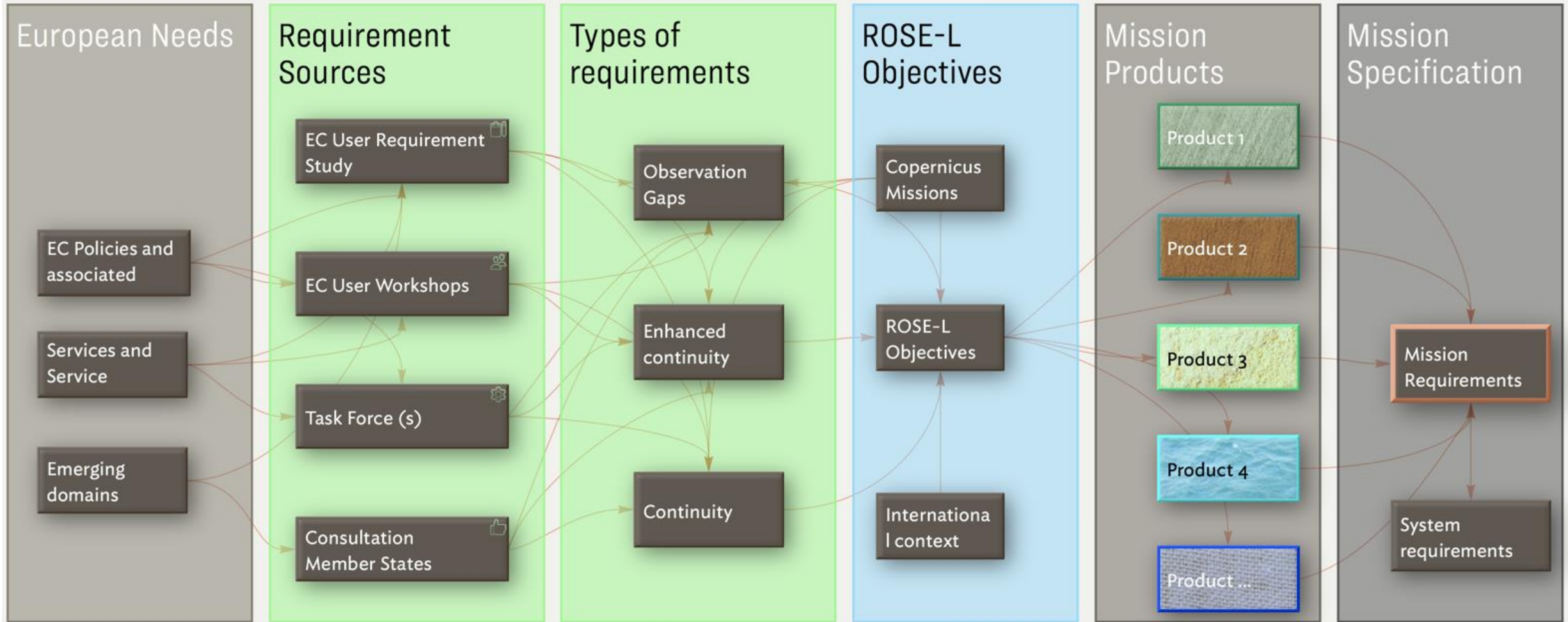
2025

- 4 Next Generation Missions (S1 NG, S2 NG, S3 OPT NG, S3 TOPO NG)
- 6 High Priority Candidate Missions (HPCMs)
- Invitation to Tender for Phase BCDE1 for all 6 HPCMs issued as of Nov 1st 2019



- Mission objectives related to Copernicus service needs (***NEXTSPACE-SC3*** study with EC Copernicus Service evolution documents, workshops), EC policies and Emerging Domains
- Address important ***measurement gaps*** from space
 - leverage unique information provided the longer L-band wavelength (23cm vs 5cm for C-band)
 - new information addresses gaps multiple applications and Copernicus services
- Support ***enhanced continuity*** of current Copernicus observations e.g improved accuracy, product quality, temporal and spatial resolution
 - Enable joint use of L-band SAR with Sentinel-1 at C-band to enhance information and improve revisit

Derivation of mission requirements



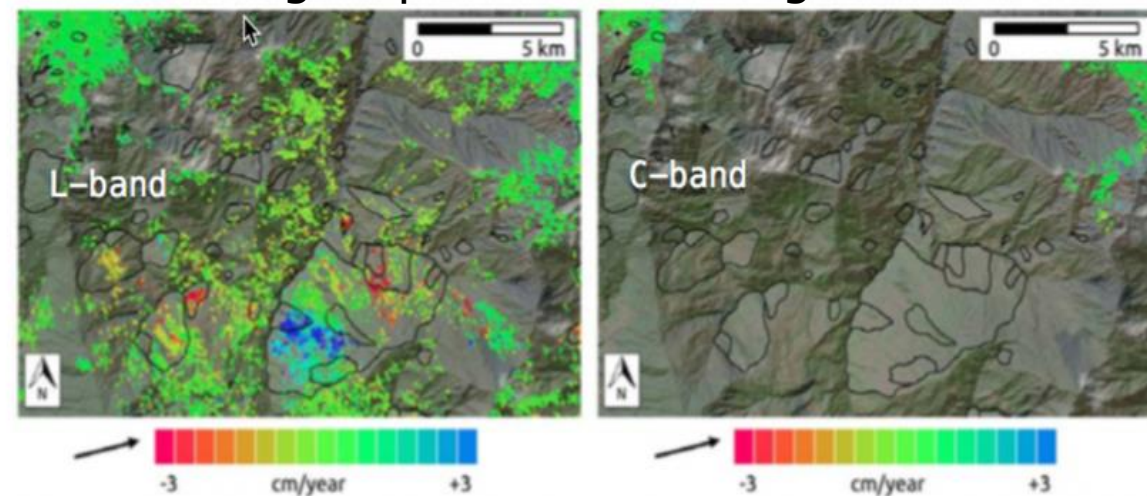
Fill measurement gaps from existing Sentinels, leveraging unique all-weather information provided at L-band:

- Ground motion information under vegetation
- Enhanced high-resolution sea ice information
- High resolution soil moisture information over land
- Enhanced Land use, Land use change, forestry and agriculture products
- Inundation/flooding below vegetation
- Improved Maritime Monitoring

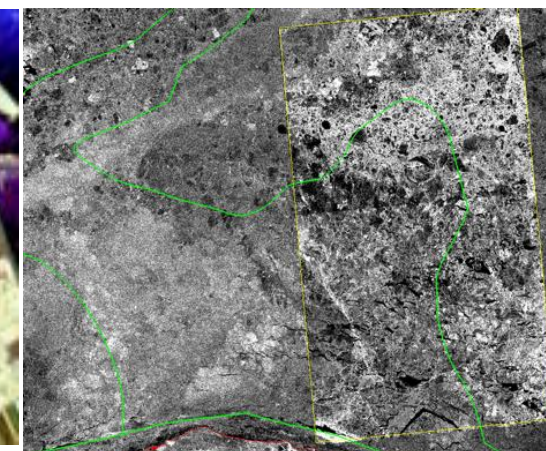
Enhanced continuity of current Copernicus SAR observations e.g. improved accuracy, product quality, resolution

- Enhanced revisit
- Enhanced information content through combination of L- and C-band (Sentinel-1)

Measuring displacement in vegetated areas



Temporal variations in Soil moisture



Enhanced sea ice mapping

Justification and Uniqueness:

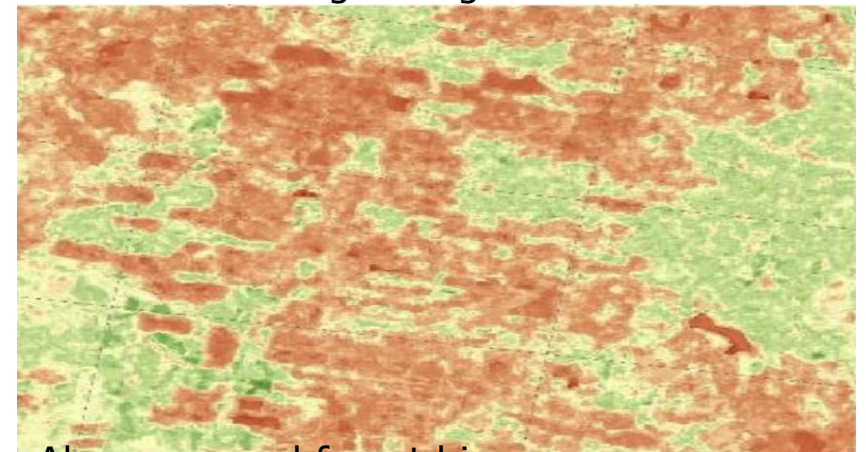
- High-resolution monitoring of changes in global forest carbon stocks and their spatial distribution
- High-resolution soil moisture information to support improved management of water use
- Enhanced weather-independent land cover and crop information
- Address cross-cutting information needs in Copernicus services (CLMS) and EU Policies (REDD+, EU Forest Strategy, EU 2020 Biodiversity strategy...)

Key Information products:

- Forest Biomass
- Forest Area (Forest/Non-forest) and Area change
- Land cover and Land Cover Change
- Irrigation Events
- Soil moisture
- Crop Type and Status

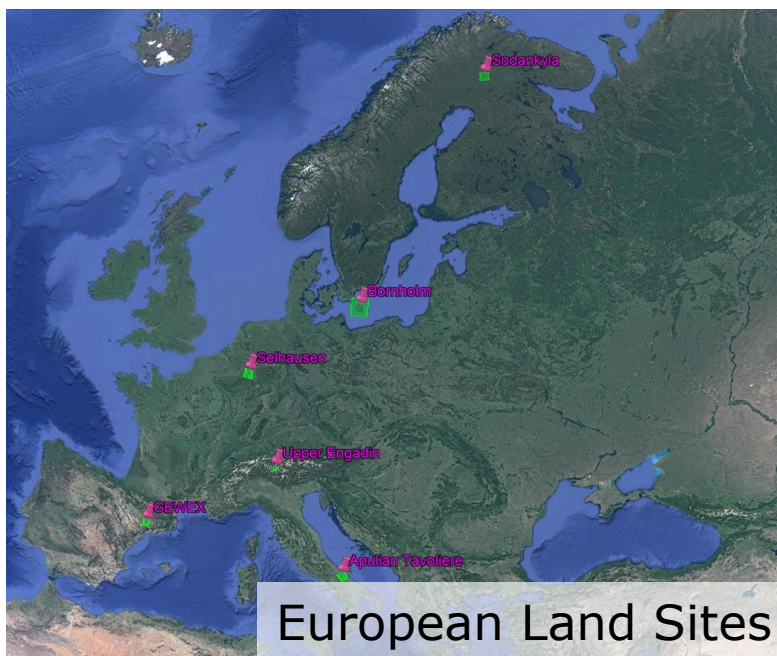


L-band SAR image of agricultural area

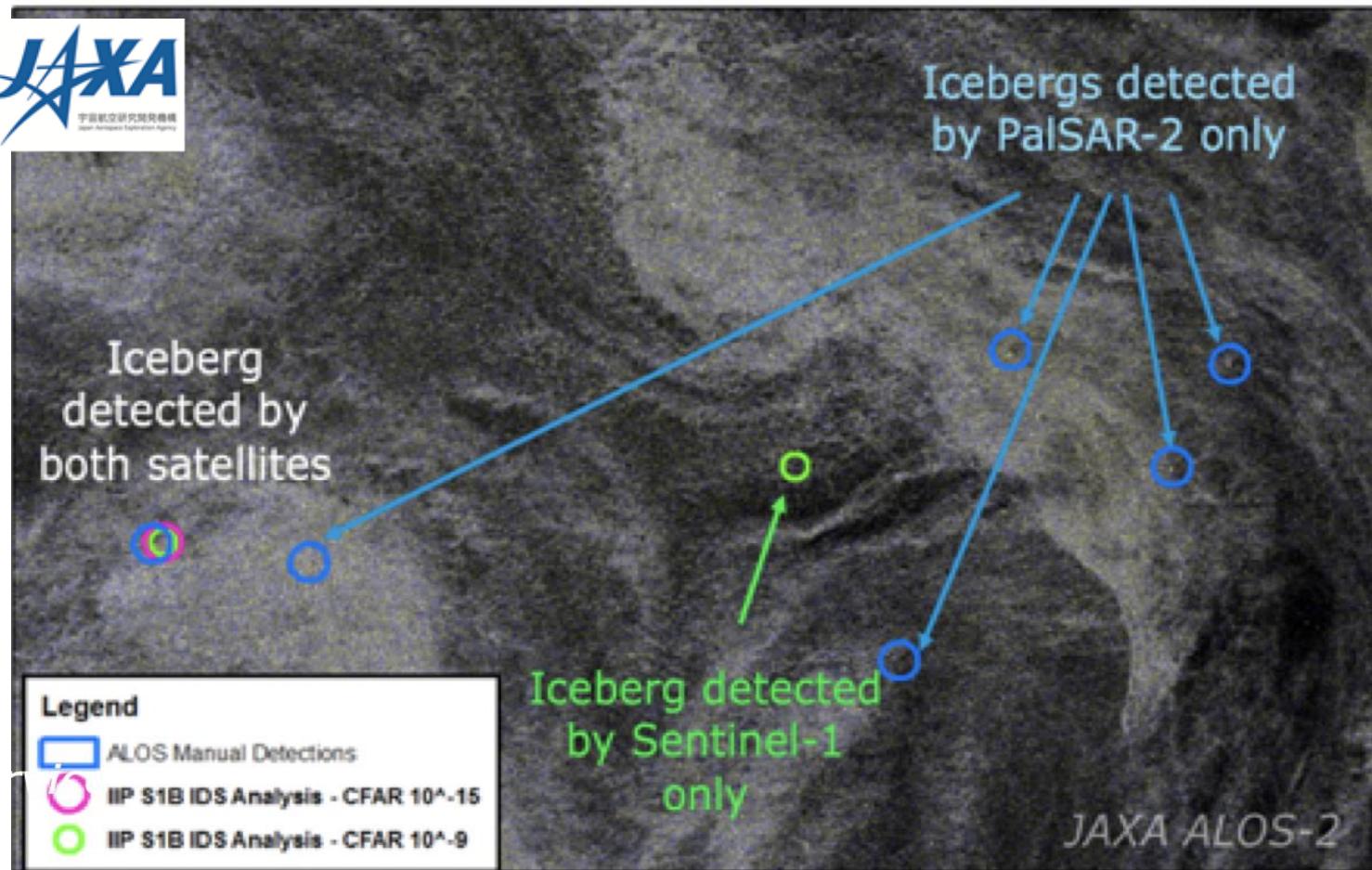


Above-ground forest biomass
(Stelmaszczuk-Górska et al., 2018)

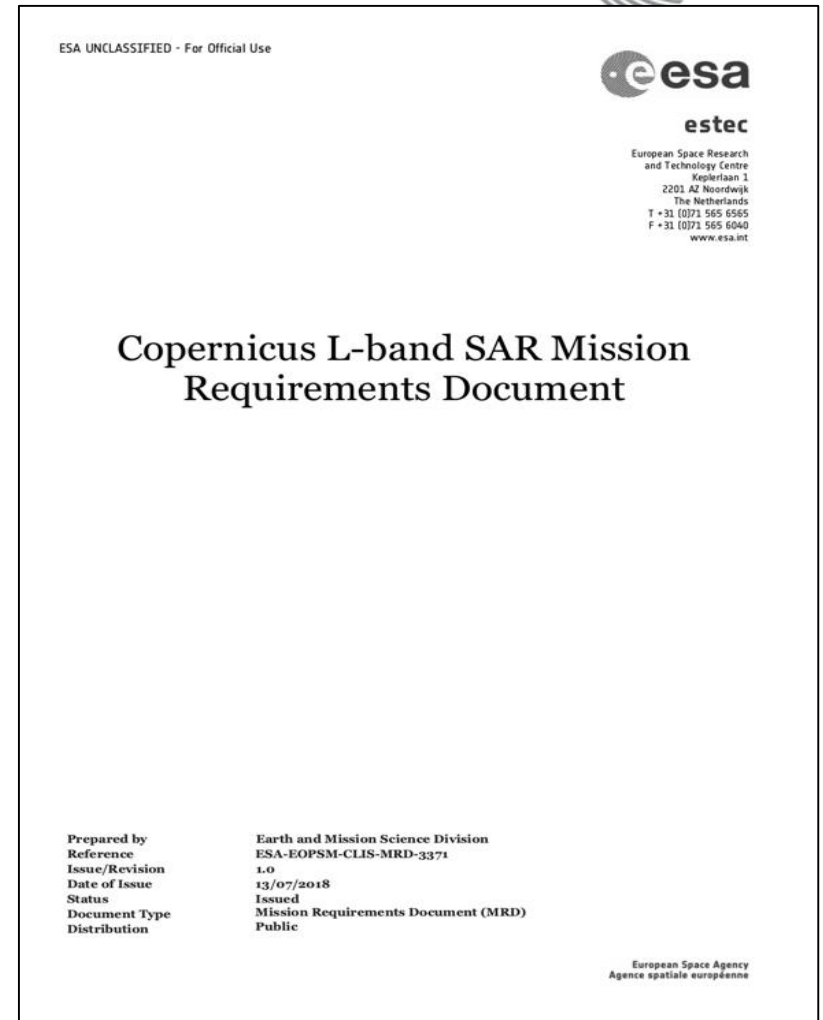
- ESA-JAXA agreement to coordinate PaISAR and Sentinel-1 acquisitions over limited number of test sites



ALOS WBD - HH/HV - RGB COMPOSITE
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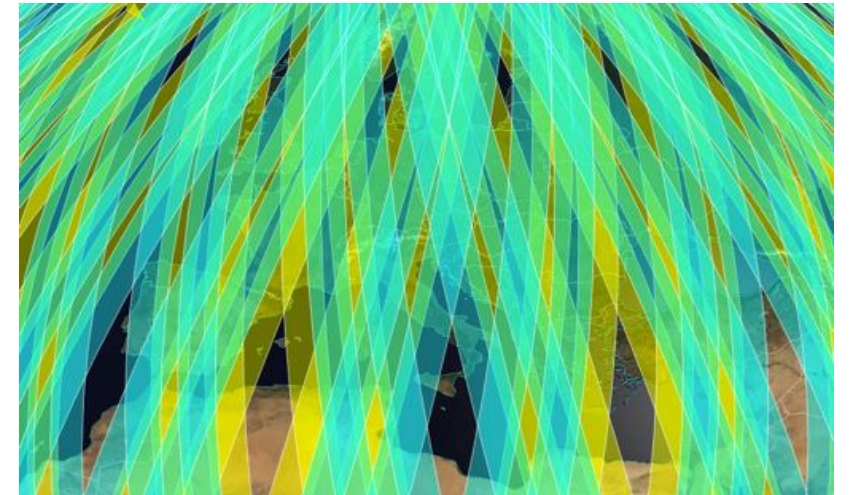


- Stringent revisit requirements to meet needs of specific products e.g. soil moisture
 - 6 days (Equator)
 - 3 days (Europe)
 - 1 day (Arctic)
- Sentinel-1 orbit & coverage to maximise synergy
- Minimise number of instrument modes
 - Design a “preferred mode” meeting known user requirements
 - Enable consistent long-term time-series over Europe and World
 - Avoid conflicting requests from users which interrupt time series

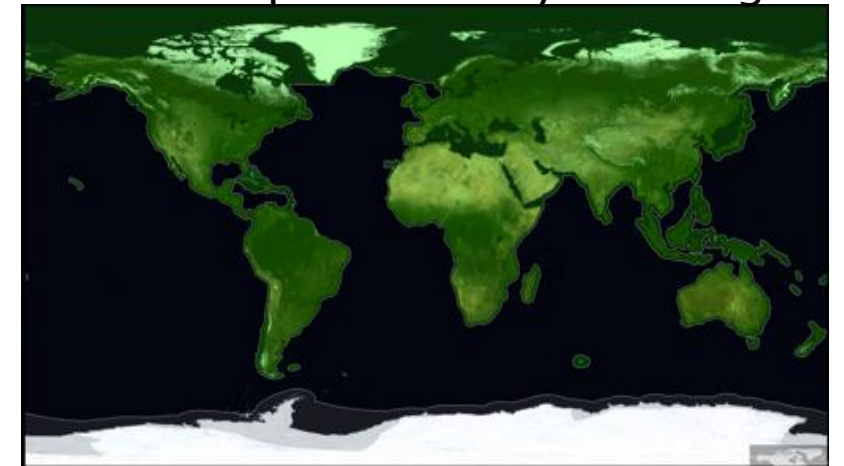


**MRD v2.0 currently public document:
<https://tinyurl.com/v825efb>**

- Polarisation diversity to maximise information content and robustness of information extraction (dual-pol and full-polarimetry)
- High-resolution e.g. 50m2 per resolution cell for enhanced continuity
- Radiometric stability 0.5dB to ensure consistent and repeatable geophysical retrievals
- Interferometry to monitor surface deformation and motion
- Stringent data latency requirements: 10min over Europe, 200min
- AIS-onboard to support Maritime Monitoring
- Wave-mode to operate over oceans and open seas

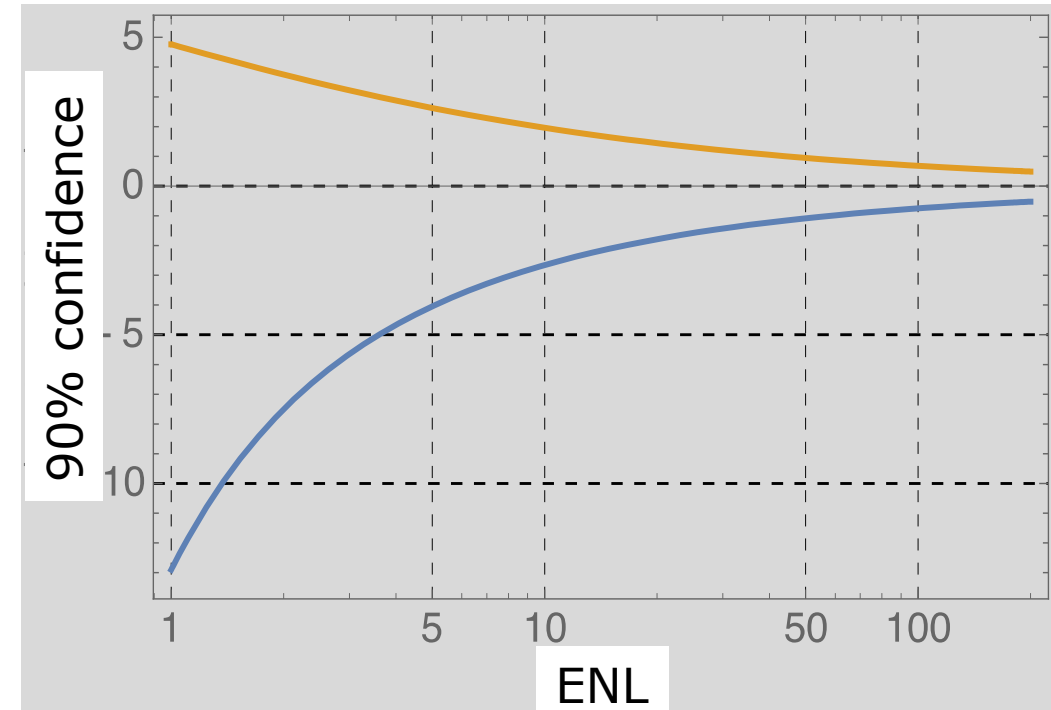


Europe: one-day coverage



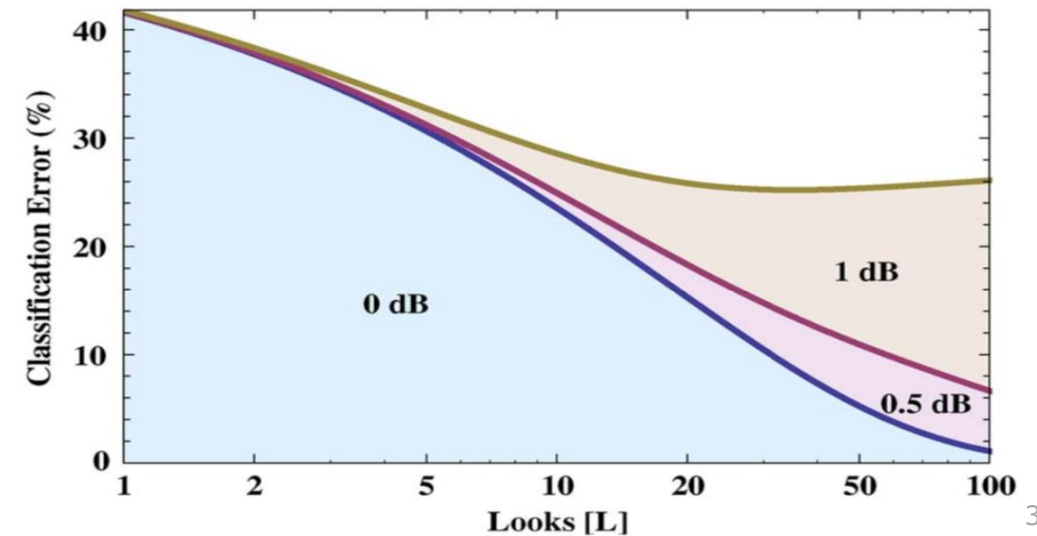
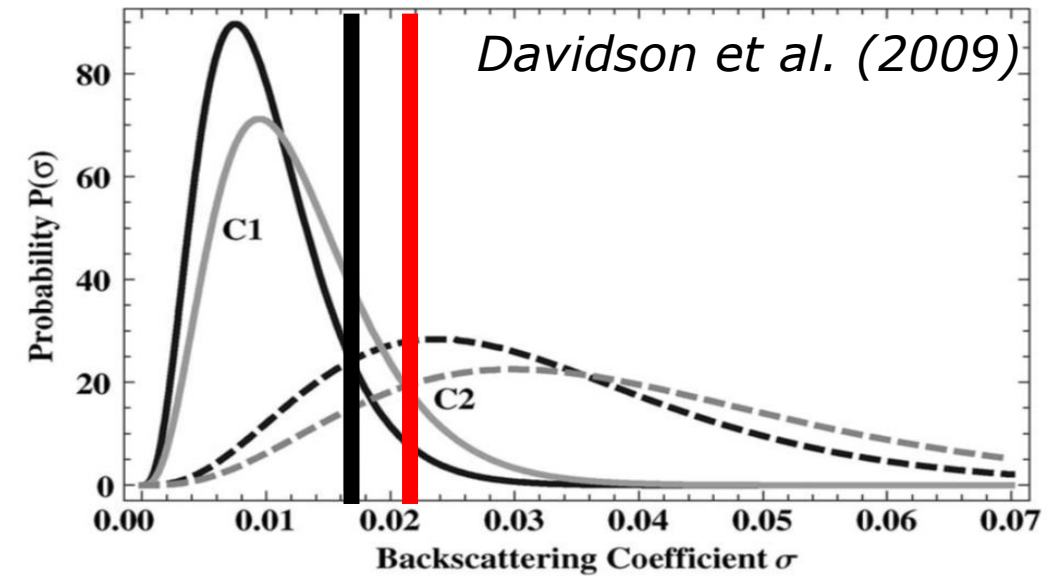
Mission Sizing Mask

- Resolution is an important mission design parameter
- Two aspects need to be considered in defining resolution requirements for SAR missions:
 1. the desired resolution for the information product
 2. the acceptable uncertainty in radar image product
- Careful analyses and interpretation of user requirements (in general as high as possible)
 - European forests (0.25 – 0.5 Ha)
 - Agriculture, land cover and soil moisture at field scale (0.1 – 0.5 Ha)
- Choose resolution of 50m²/res cell for baseline dual-pol mode



ENL = 50 or 1dB uncertainty at 0.25Ha
 ENL = 100 or 0.6 dB uncertainty at 0.5 Ha

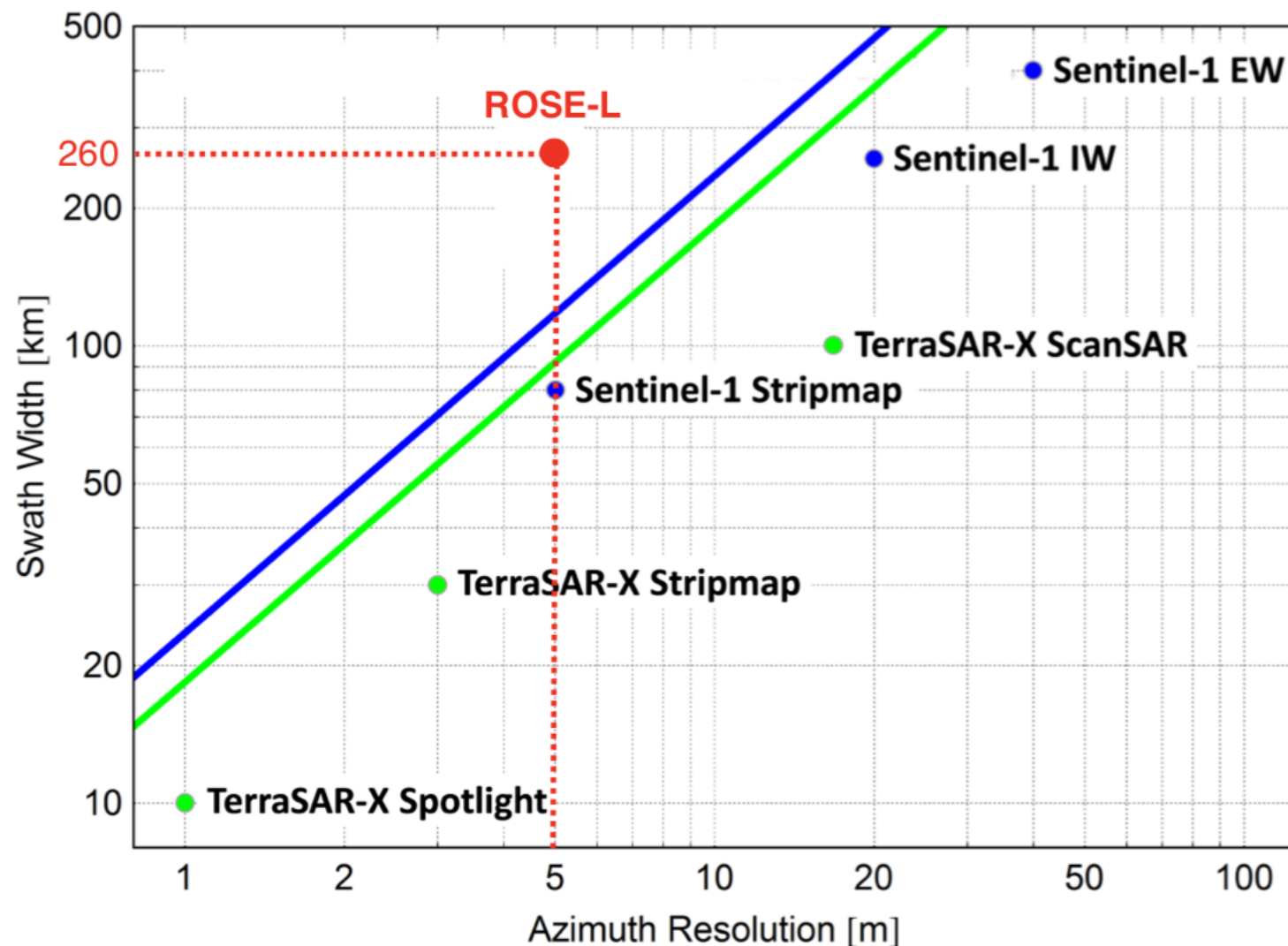
- Challenge to trace radiometric resolution to user requirements and in specification
 - Continuity argument: as good or better than existing satellites
 - Dynamic range of L-band SAR signal as function of geophysical parameter of interest e.g. contrast in land cover classes
 - Radiometry allocation to ionosphere and satellite
- 0.5dB radiometric stability mission goal. Error does not dominate at 50L/2db class contrast



- dual-polarization: nominal mode for systematic imaging of global land and ice
- quad-polarization: for specific applications
- wave mode: providing systematically vignettes over open ocean

Parameter	Dual-pol	Quad-pol	Wave Mode
Ground resolution cell	< 50 m ²	< 100 m ²	< 50 m ²
Swath/coverage	> 260 km	> 260 km	Vignettes: 20 km x 20 km Center distance: 100 km
Incidence angle	25 ⁰ – 46 ⁰	fixed within 25 ⁰ –46 ⁰	varying within 25 ⁰ –46 ⁰

- Swath width: 260 km
 - + Azimuth resolution: 50m2 e.g. 5 x 10m
 - + NESZ < -28 dB
 - + Total ambiguities < -25 dB
 - + Dual-pol (baseline) + quad-pol mode at lower resolution (100m2)
 - + L-band
 - + VEGA-C launcher
 - + High Duty Cycle
- = Challenging Requirements but Phase AB1 results indicate feasible*



- ROSE-L is a L-band SAR mission currently and is one of the six Copernicus High Priority Expansion missions
- ROSE-L leverages unique information *only available through the longer L-band wavelength* to address measurement gaps and meet need for enhanced information products of Copernicus Services and in support of European policies
- Invitation for Phase-B2CDE1 issued on Nov 1st 2019 with deadline on March 2nd 2020. Expect to kick-off project with industry by June 1st 2020
- ROSE-L launch foreseen in mid-2027
- ROSE-L as the “first” L-band SAR mission in the 2028+ timeframe should play an important role as an “anchor point” for international collaboration
 - First step: ESA-JAXA agreement for dedicated acquisitions with ALOS PaISAR-2 mission and Sentinel-1



Copernicus

Europe's eyes on Earth

