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ROSE-L

Mission Objectives and Science Status

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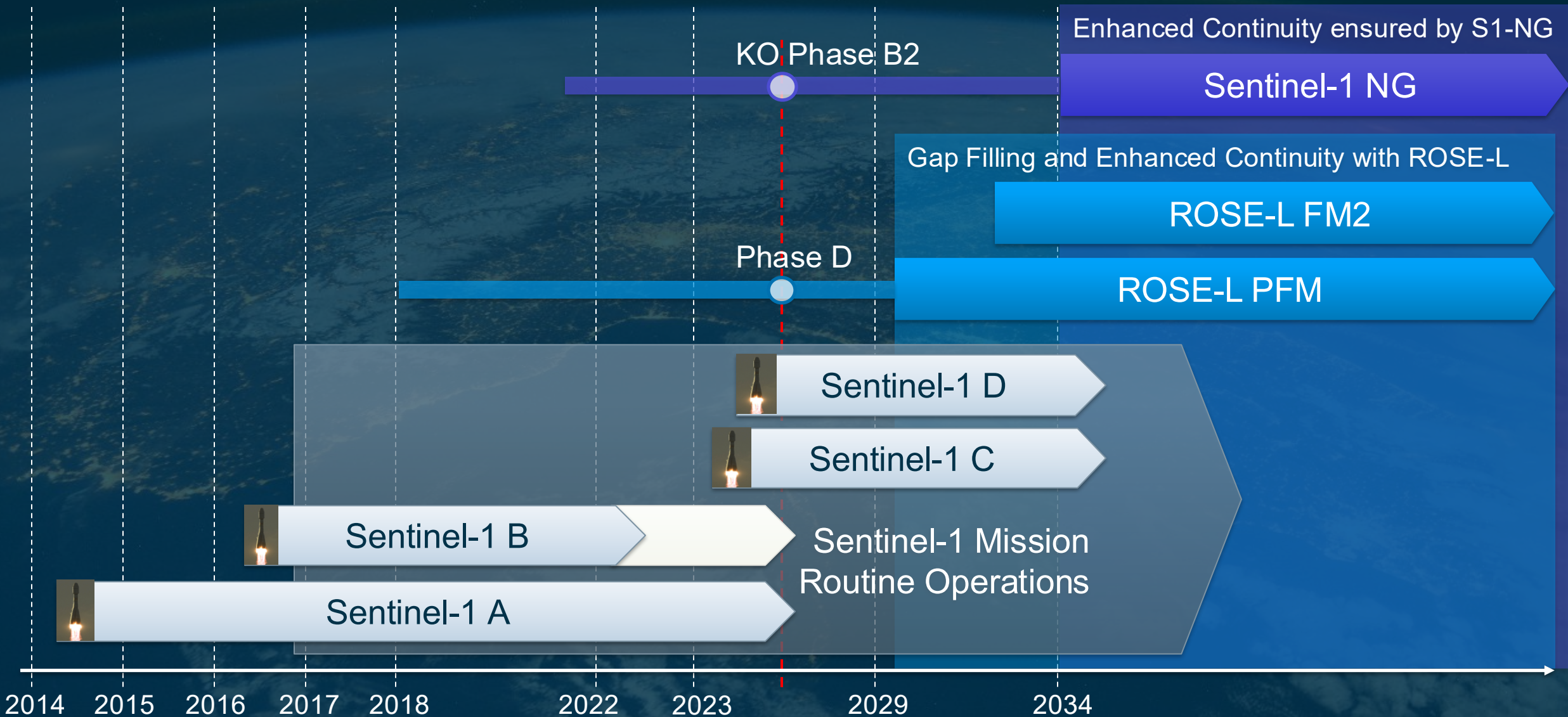
EUROPEAN SPACE AGENCY

Fringe 2026 Conference, Krakow, 16 June 2026

Copernicus SAR Timeline



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Copernicus SAR Timeline



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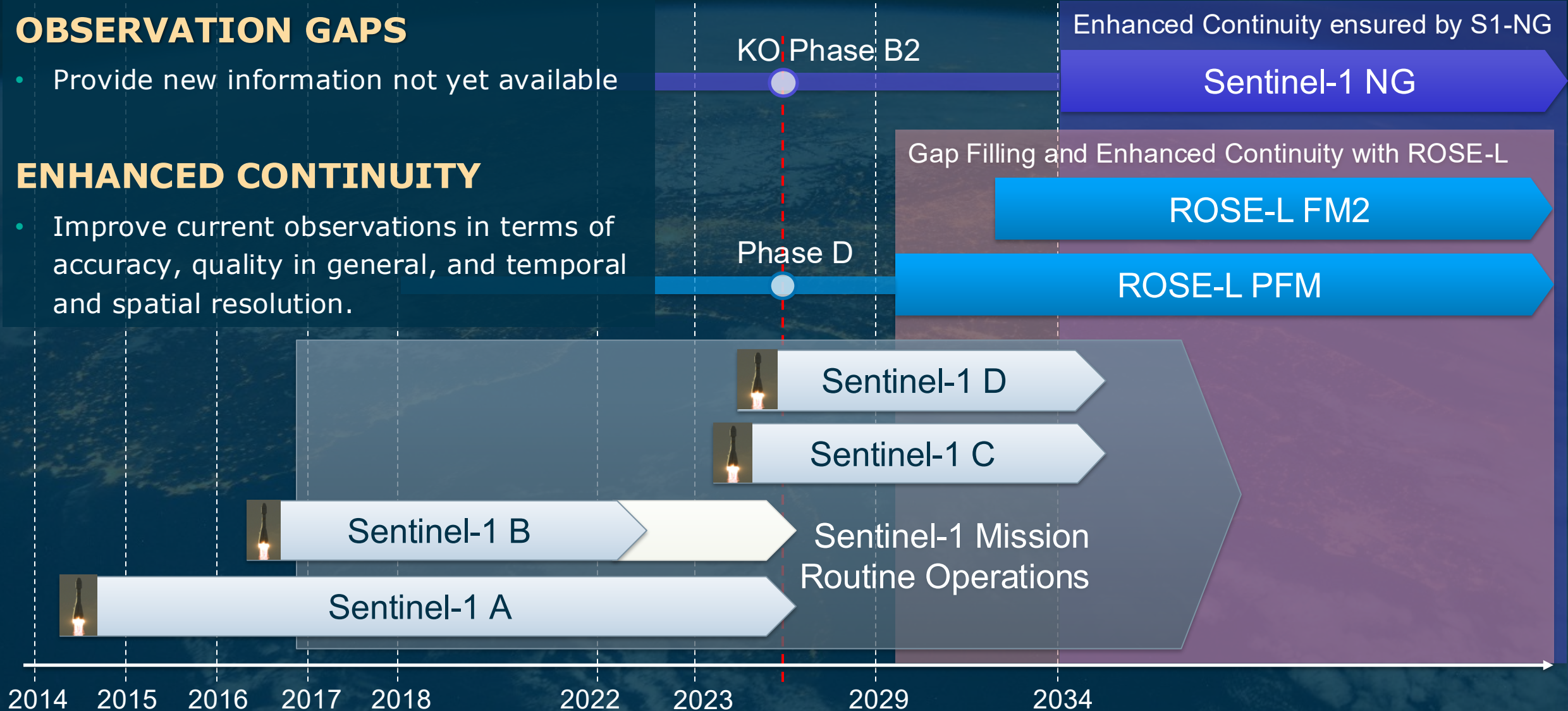


OBSERVATION GAPS

- Provide new information not yet available

ENHANCED CONTINUITY

- Improve current observations in terms of accuracy, quality in general, and temporal and spatial resolution.



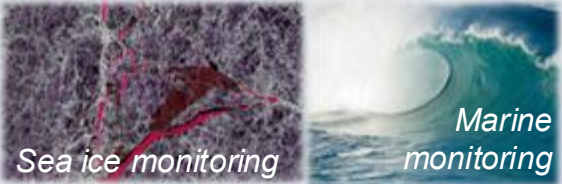
SAR Missions and Copernicus Services



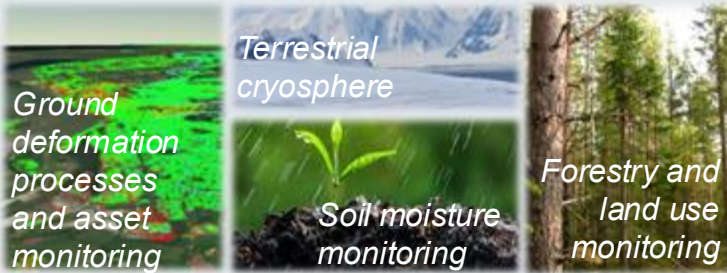
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Sea ice type, concentration and motion
Ice sheets & glaciers velocity
Grounding line
Snow water
Ice sheet melt/freeze extent
Permafrost thawing and extent



Sea ice type, concentration and motion
Iceberg location, size and drift
Ocean surface wind vectors
Swell properties
Ocean surface currents



Land use and land use change, including
agriculture and forestry
Soil moisture
Forest biomass and structure
Snow water
Wet snow extent
Ground movement

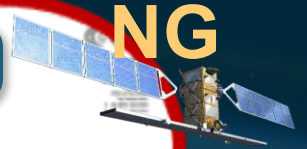


Flooded area
Ground movement
Soil moisture
Abrupt surface elevation changes



Iceberg location, size and drift
Vessel location, size and velocity
Oil spill location and morphology

MRD



Copernicus Sentinel-1 Next Generation
Mission Requirements Document

User Needs

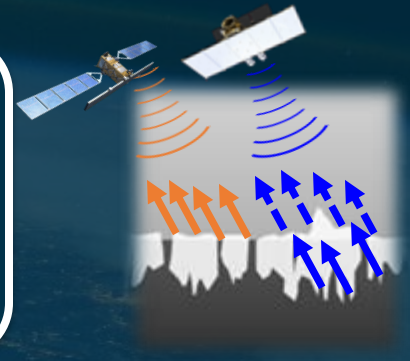
- Polar Expert Group
- REDD+
- UNFCCC
-

MRD



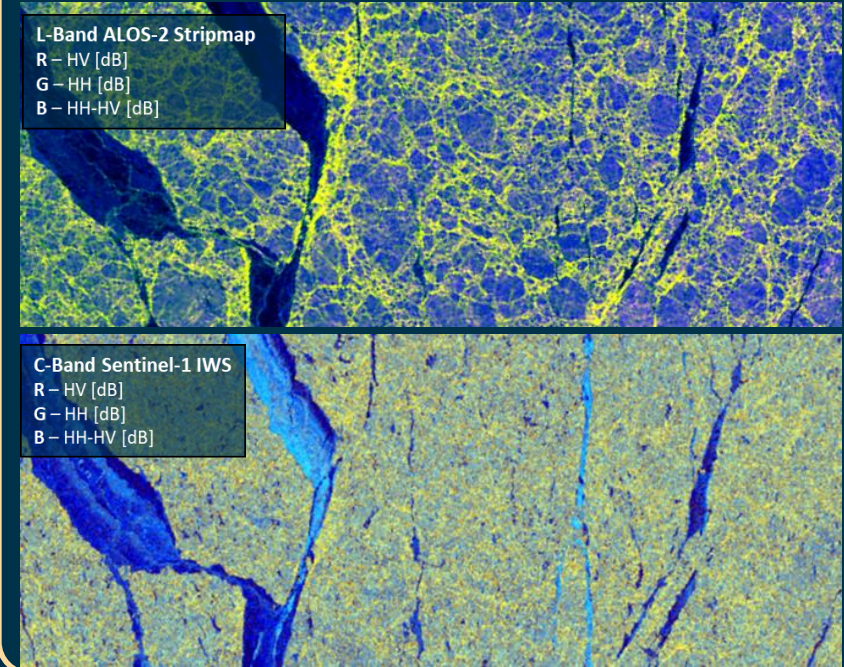
Copernicus L-band SAR Mission
Requirements Document





C-Band – Shorter wavelength (5.5 cm) more sensitive to displacement from superficial and unstable features

Sensing structure in Sea Ice



Application Needs and Mission Requirements



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Improved resolution : 50 m2 (RIWS mode)

- Provision of information at 0.25-0.5 ha resolution for agriculture and forestry
- High-resolution soil moisture products
- Maritime applications – iceberg and vessel detection

Low Noise level : NESZ $\leq$ -28 dB

- Sea ice mapping, marine and maritime applications
- Soil moisture products and flood detection

Repeat pass : 6 days with two satellites

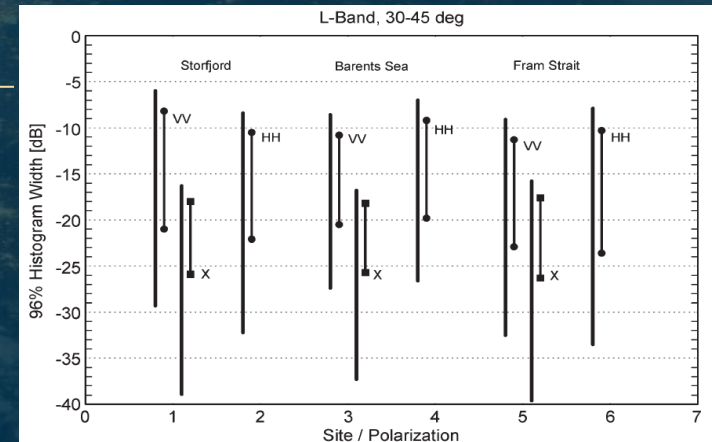
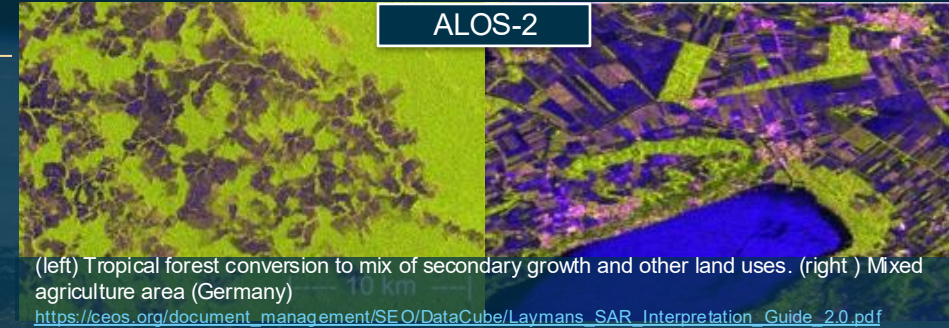
- Interferometric applications – surface deformation, land ice velocity, Snow Water Equivalent

Revisit : 1 day (Arctic), 3 days (Europe), 6 days (Global)

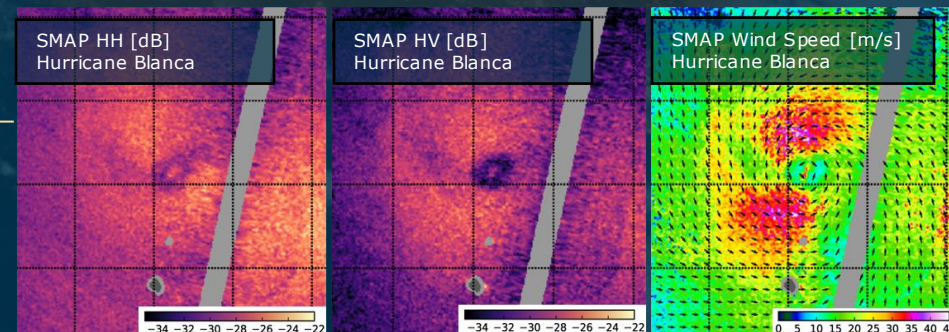
- Sea ice monitoring
- Geohazards – flooding, landslides and active tectonics
- Soil moisture and seasonal land monitoring (SWE)

Support of Wide-Swath Imaging over open oceans

- Mapping extreme wind events, such as hurricanes and cyclons

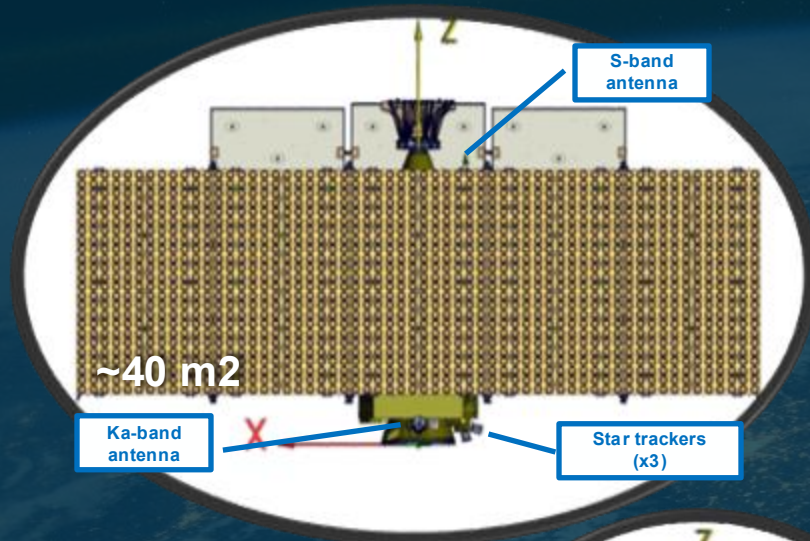


96 percentiles of radar intensity distributions for the investigated ICESAR images. E-SAR data indicated by thicker black lines, simulated L-band satellite images by thinner lines with black circles (like-polarization) or black squares (cross-polarization at their end. "X" is cross-polarization (HV and VH combined). From (Dierking, 2020)



From: Fore et al. 2019, On Extreme Winds at L-Band with the SMAP SAR





GENERAL

- ❖ Consortium led by Thales Alenia Space Italy (TAS-I), involving 29 companies from 15 countries
- ❖ Constellation of 2 right-looking satellites (PFM & FM2)
- ❖ Design enhancing synergies with Sentinel-1: same orbit, co-located swaths
- ❖ Currently in Phase D. System Critical Design Review declared successful on June 2025. All Top Technological Risks retired with the System CDR
- ❖ QAR scheduled late 2029

INSTRUMENT

- ❖ L-Band – 85 MHz ITU allocated band (1.215-1.300 GHz)
- ❖ Planar active array antenna of 11m x 3.6m
- ❖ SCORE in elevation
- ❖ MAPS in azimuth, 5 digital channels downlinked and combined on-ground
- ❖ Main mode: RIWS → ScanSAR Dual-Pol, 50 m2 res

BASELINE MODES

ROSE-L Wide Swath Modes

	<i>Dual-Pol (RIWS)</i>	<i>Quad-Pol (QWS)</i>
• Mode :	ScanSAR	ScanSAR
• Access :	29° - 46° (*)	25° - 42°
• Swath :	260 km	260 km
• Res. (gr x az) :	5 m x 10 m	5 m x 20 m
• NESZ :	< -28 dB	< -28 dB
• DTAR :	< -23 dB	< -23 dB
• Aux. Band:	up to 8 MHz	up to 8 MHz
* Full overlap with S1 IWS		

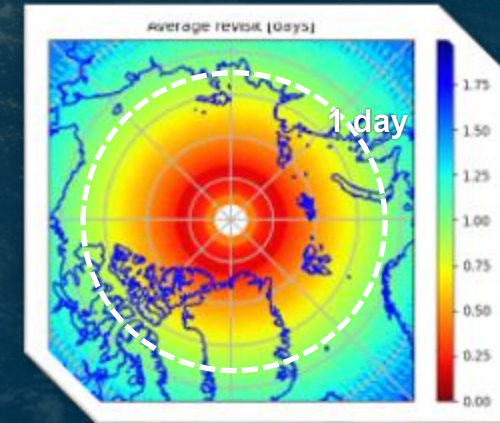
ROSE-L WAVE Mode

• Access :	Variable
• Swath :	20 km x 20 km vignettes (**)
• Resol. (gr x az) :	5 m x 10 m
• NESZ :	< -28 dB
• DTAR :	< -23 dB
** Vignette spacing 100km	

OPTIONAL MODE

ROSE-L Extra Wide Swath Mode (REWS)

- Swath : > 400 km
- Resolution : 20 (15) x 40 (35) m
- NESZ : < -30 dB



Access for 1
ROSE-L REWS

- Maintain operational flexibility (e.g. 1 satellite scenario or potential technical failure of 1 satellite)
- Respond to evolving requirements in 2030 time frame (e.g. on-demand observations such as for hurricane wind fields)

Design Synergies with Sentinel-1

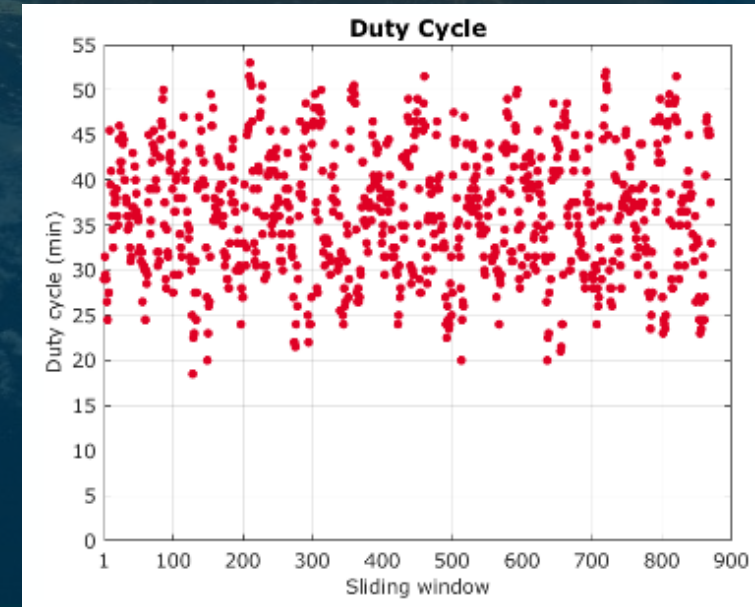
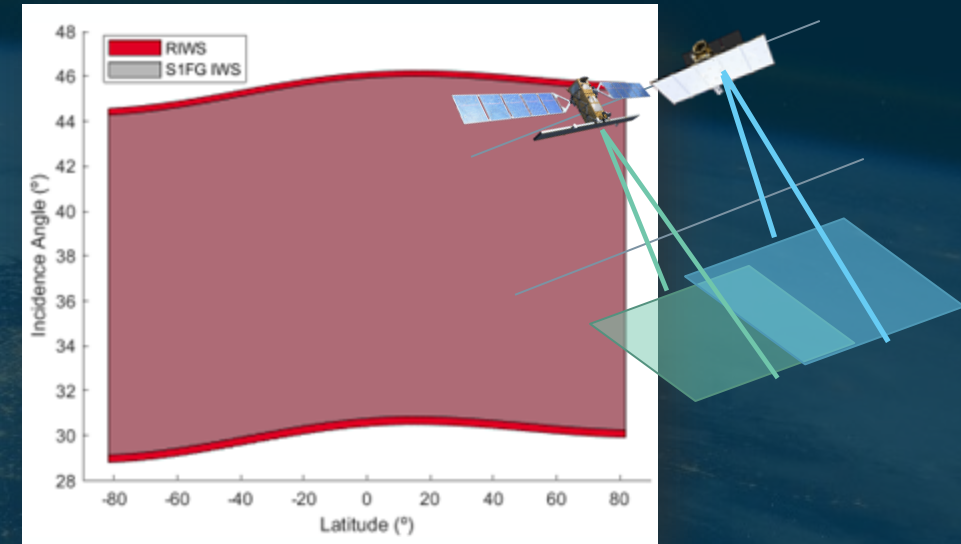


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Moving towards a **System of Systems paradigm** and enhanced information and services

- Meet services evolving service requirements in coverage, sampling, time series and coordinated Sentinel-1 and ROSE-L data streams co-located in space
- Same orbit configuration and **same ground track of Sentinel-1**
- **Main Dual-pol mode (RIWS) guarantees full swath overlap with S1 IWS**
- **Acquisition plan expected to be a superset of the acquisition plan of Sentinel-1.** All active Sentinel-1 tracks would be matched by the corresponding ROSE-L track
 - **~ 38 min/orbit duty cycle in RIWS mode**
 - **10 TB downlinked per day (> 5 x Sentinel-1)**
- Mission design supports **two phasing options** for:
 1. different orbit phasing for optimized revisit (e.g. 3 days baseline)
 2. convoy with Sentinel-1 (up to a minimum 1min baseline)



NOTE. The figure refers to the **sizing scenario**, not to the operational plan. Credit: GMV

Joint Access with Sentinel-1

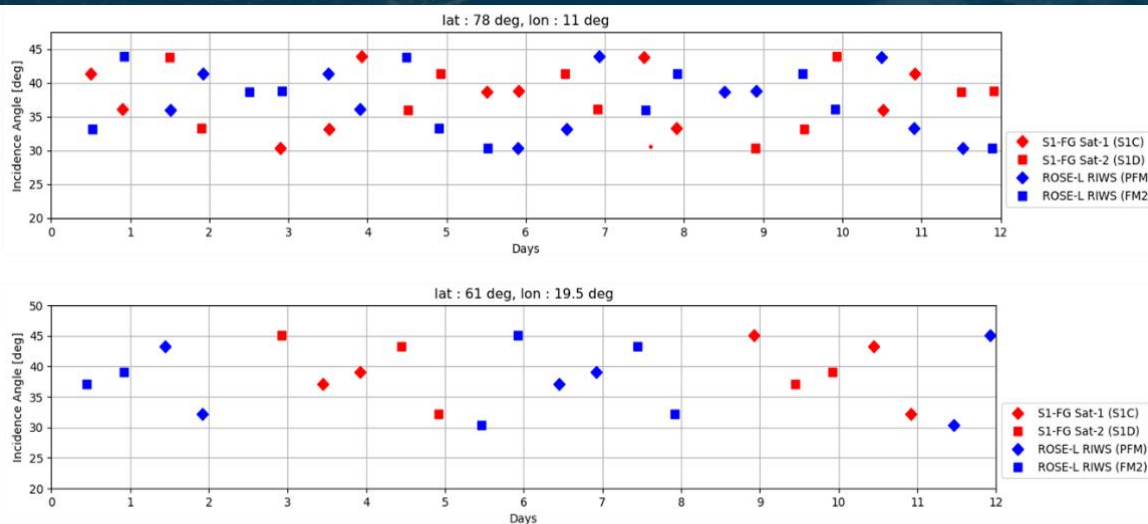


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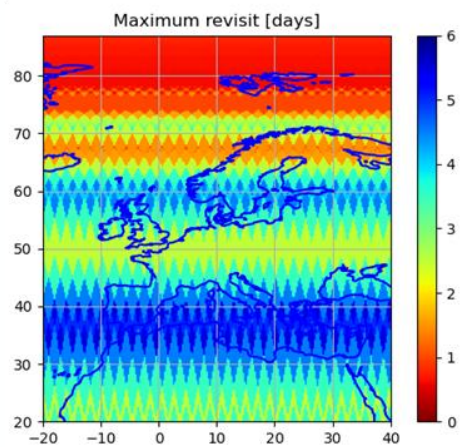
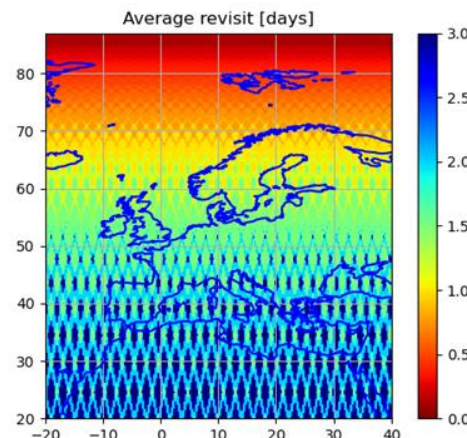
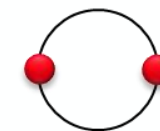
Joint access with Sentinel-1 in **optimised revisit configuration (3 days baseline) with IWS/RIWS**

- Average access capability ≤ 1 day for latitudes > 50 deg
- Mediterranean sea
 - Average revisit : 1 – 1.5 days (from 2 -3 days with single system)
 - Maximum revisit : 1 - 2.5 days (from 3.5 – 5.5 days with single system)



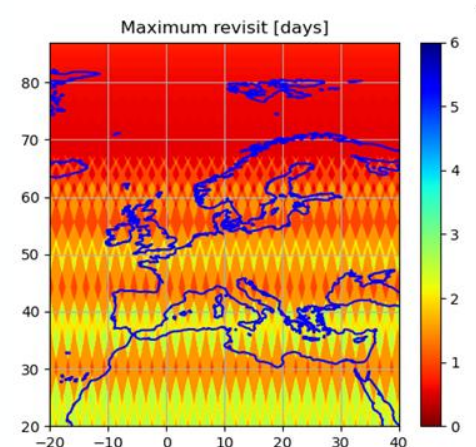
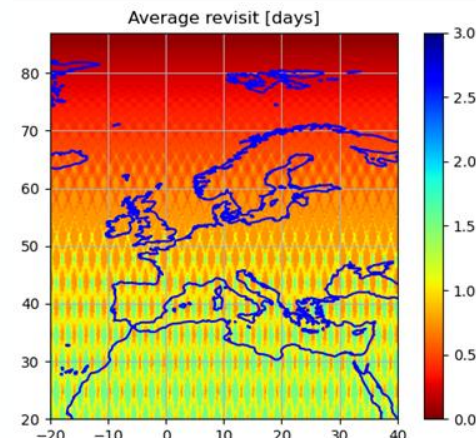
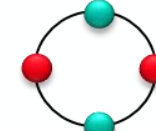
ROSE-L

Phasing
3d - 9d



S1FG + ROSE-L

Phasing
0d - 3d - 6d - 9d



Science Support to Product Preparation



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ROSE-L Science Support Plan to tackle Mission Trade-offs and mature Scientific Readiness Level. Ongoing activities:

Study on Ionosphere Mitigation Algorithms

- Review mitigation requirements and verify algorithm performance
- Design processing strategies for 1) NRT products, 2) Higher latency / Offline products (reprocessing)

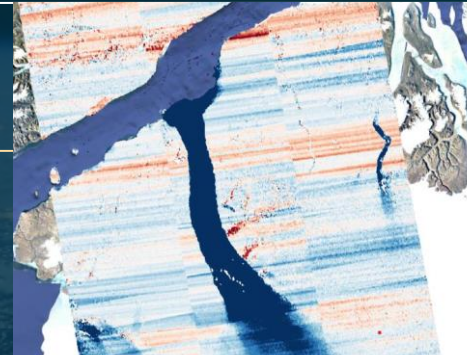
Studies on Models and Algorithms for Ocean Products

- Consolidate L-band GMF/MTF models and verify quality achievable by ROSE-L wide-swath and Wave Mode configurations

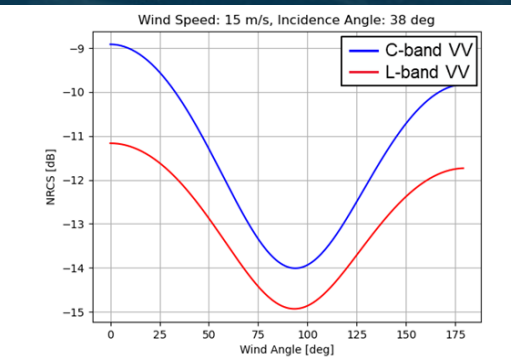
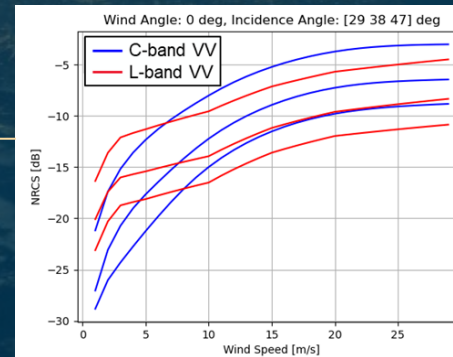
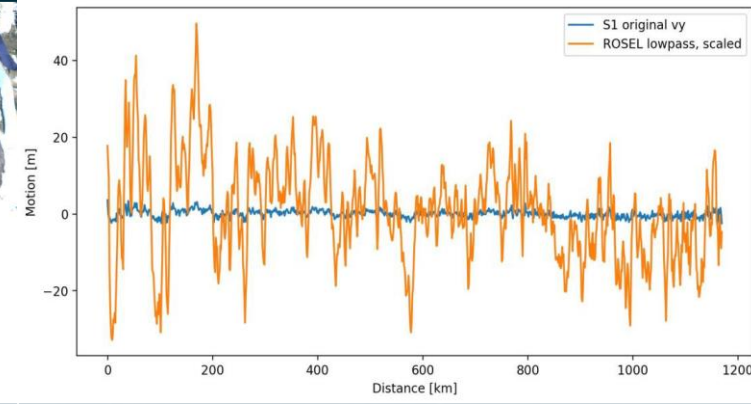
More on Wednesday,
Future SAR missions
and concepts 2

AgriROSE-L Campaign

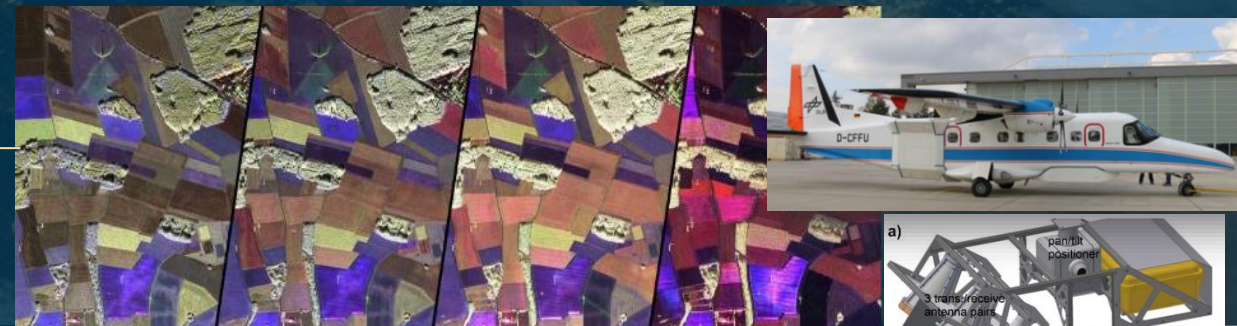
- Assess the sensitivity to moisture and crop conditions and simulate synergies with Sentinel-1 (and optical sensors)
- Address trade-off quad-pol versus more frequent revisits



Enveo az xcorrelation
deburst_track046_ft3_m20150205_s20150217_vel_ra_az_cor (*12)



GMF model from Yueh et al (2023), "L-Band Passive and Active Microwave Geophysical Model Functions of Ocean Surface Winds and Applications to Aquarius Retrieval"



Example of radar images collected over the Puch site (Germany) at X, C, S and L-bands (from left to right) during the AgriROSE-L campaign



ROSE-L FRIENDLINESS

- SAR formation mission concept abandoned after FM3 option expired at CDR
 - Option for Synch-link for phase synchronisation not exercised
 - Objectives requiring XT or AT companion formation not driving ROSE-L design
- ROSE-L system features still support potential operations with one or more additional companion satellites
- 'Best-effort' companion design and performance to be considered

NEW ESA STUDIES ON ROSE-L COMPANION SATELLITES (CS)

JUSTIFICATION

- Potential of ROSE-L CS to advance understanding in a significant number of environmental processes and progress the implementation of the Earth Observation Science Strategy 2040
- Capitalise on ESA and Member State investments in mission development including ROSE-L, EE10 Harmony and SAOCOM-CS

IMPLEMENTATION

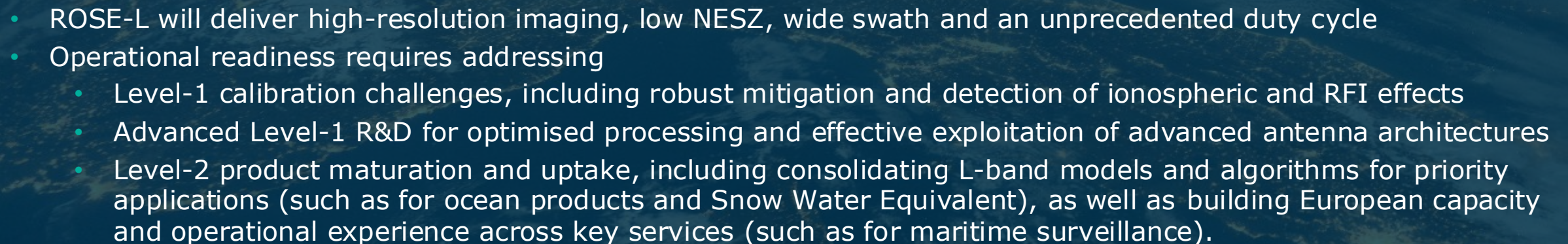
- Two parallel science studies to identify user-level information products, the corresponding observation needs and map them into candidate CS architectures, in both XT and AT configurations
- To be followed by Pre-Phase 0 study conducted by industry and guided by harmonised inputs from science studies

ESA, industry and the European Commission are preparing the Copernicus Expansion Mission in L-band to close critical information gaps and strengthen current Sentinel capabilities for Europe.

Sentinel-1 and ROSE-L should be addressed as a System-of-Systems

- Combined C-band and L-band observations can deliver enhanced and new information products
- Cross-mission synergies with Earth Explorer Biomass and other Copernicus Sentinels should be further explored

High performance and advanced technology, coming together with product preparation challenges

- 
- ROSE-L will deliver high-resolution imaging, low NESZ, wide swath and an unprecedented duty cycle
 - Operational readiness requires addressing
 - Level-1 calibration challenges, including robust mitigation and detection of ionospheric and RFI effects
 - Advanced Level-1 R&D for optimised processing and effective exploitation of advanced antenna architectures
 - Level-2 product maturation and uptake, including consolidating L-band models and algorithms for priority applications (such as for ocean products and Snow Water Equivalent), as well as building European capacity and operational experience across key services (such as for maritime surveillance).

Lessons from other L-band SAR missions will be critical, and cooperation with JAXA, NASA/JPL and CONAE will be essential to ROSE-L data readiness.

- International collaboration remains a strategic enabler for mission readiness and downstream uptake

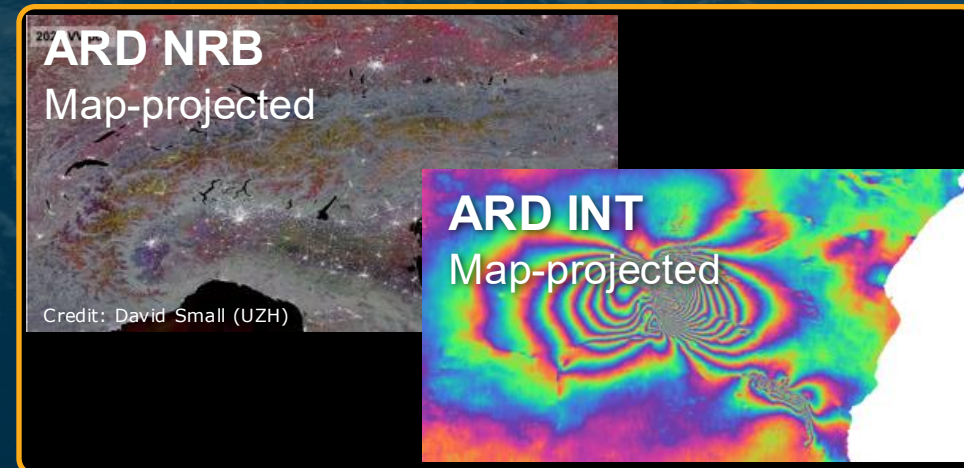
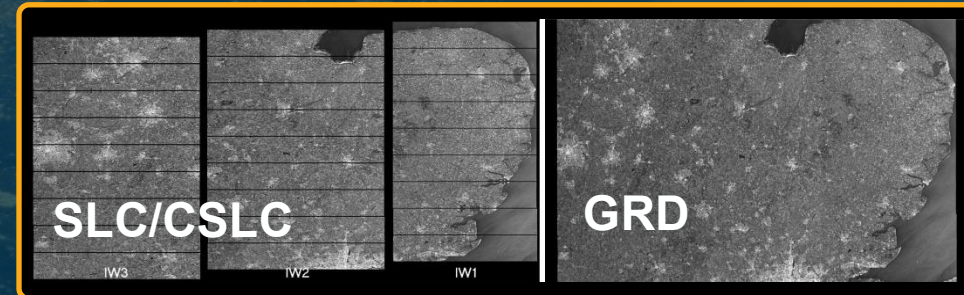
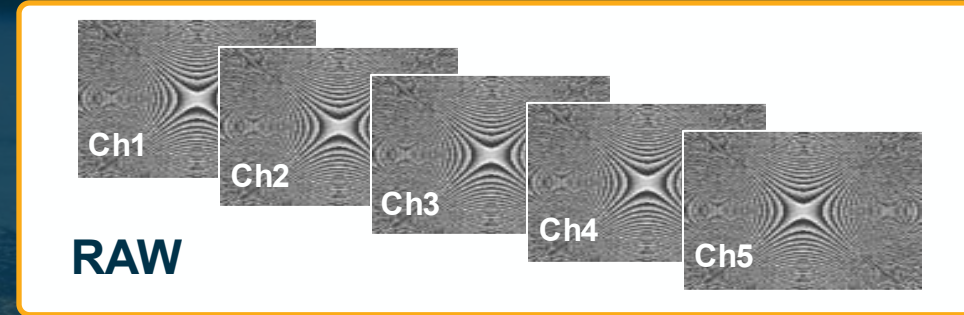
ROSE-L Products



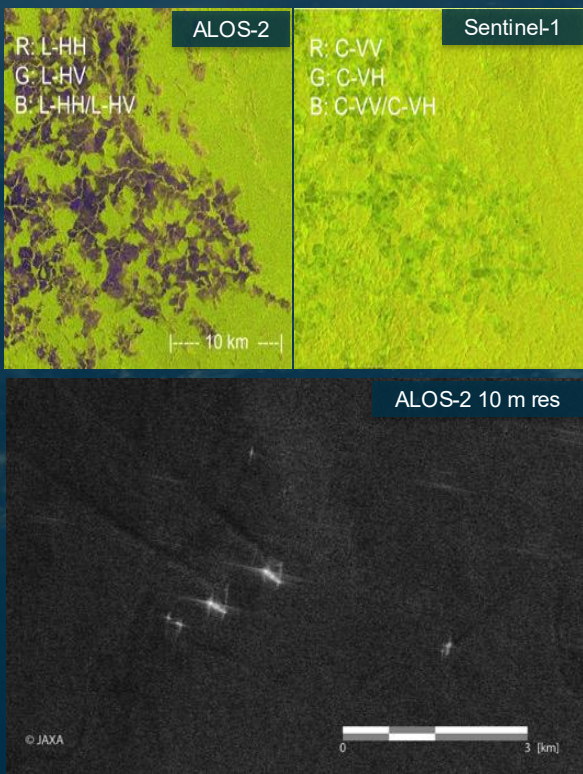
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- Free, full and open data policy
- **Access to Level-0 products**
 - Application-specific exploitation of 5 azimuth channels
- **Access to Level-1 products** will be made available to the users for all the acquisition modes
- **Homogenous and temporally consistent Level-1 dataset** throughout the mission lifetime
- **Moving to ARD (Analysis-Ready Data)** products in order to broaden user community on the use of dense time-series (NRB, INT, GSLC will be studied)
- **Preparation of Ocean and Forest Level-2 products processing capability**
 - Contracts already in place for development of Ground Prototype Processor, of Operational L2 Processor, and for design of Cal/Val strategy
- **Synergic strategy with Sentinel-1 (FG and NG)**
 - Study/development of harmonised product format for both Level-1 products and Level-2 products (e.g. ocean products)



Responding to Environmental, Social and Security Challenges



Ecosystems and Biomass Monitoring

- New timely information on land cover, biomass and soil moisture

Ocean Monitoring

- Improved hurricane monitoring and sea state mapping

Maritime Surveillance

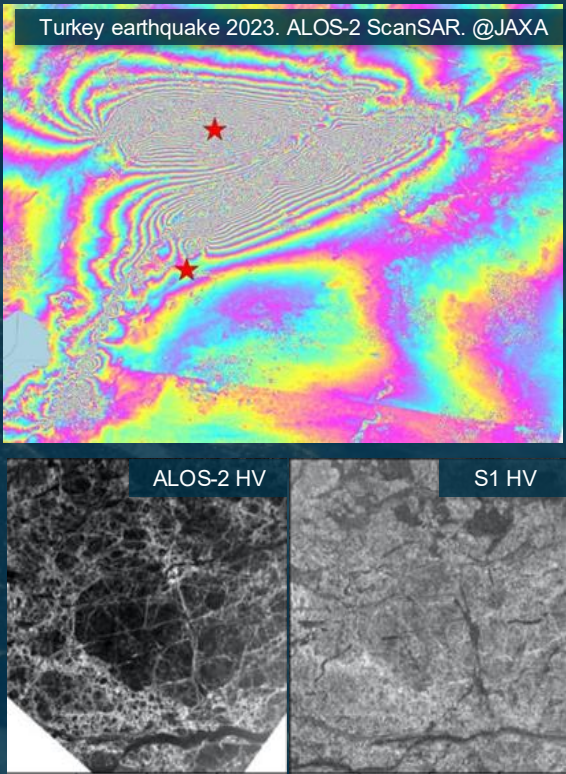
- Enhanced vessel and iceberg detection

Geohazards Monitoring

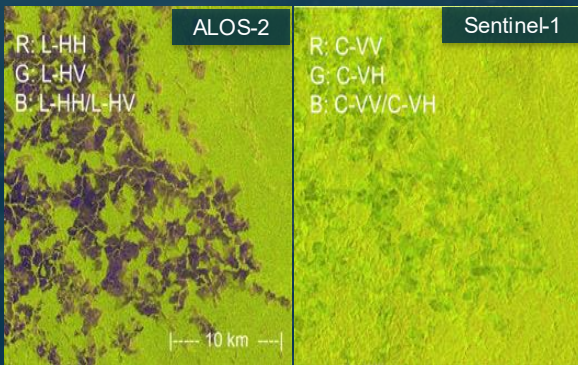
- New critical ground motion and flooding information over vegetated areas

Land and Sea Ice Dynamics Mapping

- Robust velocity retrieval of glaciers and ice shelves
- Enhanced daily mapping of sea-ice type and concentration



Responding to Environmental, Social and Security Challenges



Geohazards Monitoring

- *New critical ground motion and flooding information over vegetated areas*

Ecosystems and Biomass Monitoring

- *Enhanced timely information on land cover, biomass and soil moisture*

Arctic and Cryosphere Monitoring

- *Robust velocity retrieval of glaciers and ice shelves*
- *Enhanced daily mapping of sea-ice type and concentration*

Maritime Surveillance

- *Enhanced vessel and iceberg detection*

Ocean Monitoring

- *Improved hurricane monitoring and sea state mapping*

