sentinel-1

→ RADAR VISION FOR COPERNICUS

Sentinel-1 Mission Status - Overview of Future Copernicus SAR missions (S1 NG & ROSE-L)

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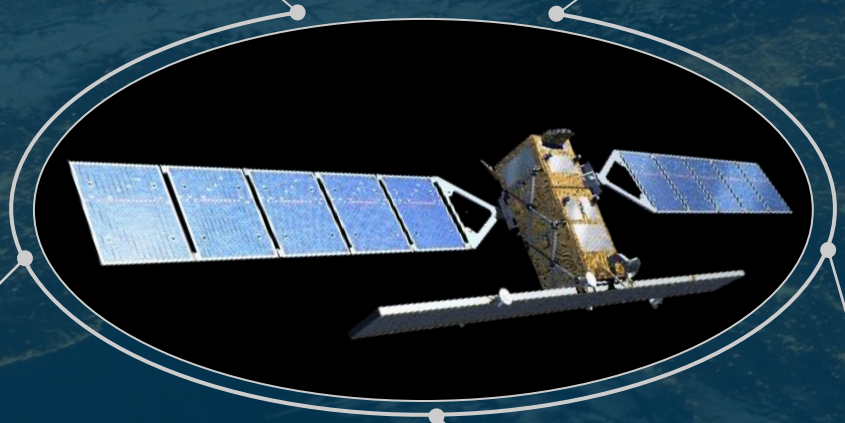
Sentinel-1 Mission in Brief

MISSION PROFILE

- Constellation of two identical SAR C-band (5.405 GHz) satellites: (A & B → C units)
- Near-Polar, sun-synchronous (dawn-dusk) orbit at 693 km altitude
- 7 years lifetime (consumables for 12 years)
- 12-day repeat cycle (each satellite), 6 days for the constellation

OPERATIONS

- Systematic SAR data acquisition using a predefined observation scenario
- Instrument duty cycle of max. 25 min/orbit in High Bit Rate modes (30 min outside eclipse) and 75 min/orbit in Low Bit Rate mode (Wave)



PROGRAMMATICS

- Sentinel-1C launch Q2 2023
- Sentinel-1D currently in storage to be launched as needed

PAYLOAD

- C-Band SAR
  - Centre frequency: 5.405 GHz
  - Polarizations: HH, VV, HH/HV, VV/VH
  - Incidence angle: 20º - 45º
  - Radiometric accuracy: 1 dB (3σ)
  - Radiometric stability: 0.55 dB (3σ), 0.45 (3σ) for S-1 C/D
  - NESZ: -22 dB
  - DTAR: -22 dB
- **AIS Instrument marine surveillance (for S-1 C and D)**

IMAGING MODES

- Strip Map Mode: 80 km swath and 5x5 m (range x azimuth) resolution
- Interferometric Wide-Swath Mode: 250 km swath, 5x20 m resolution
- Extra-Wide-Swath Mode: 400 km swath and 20x40 m resolution
- Wave Mode: 5x5 m resolution, leap-frog sampled images of 20x20 km

Sentinel-1 Mission Status Highlights

- **Sentinel-1B major anomaly** occurred on 23 Dec 2021, **end of mission was declared end July 2022**
  Note: all Sentinel-1B data are maintained in the long term archive and made accessible to users

- **Sentinel-1A**, launched in April 2014, **has reached its design lifetime of 7 years of operations**:

  https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-1/First_Copernicus_satellite_exceeds_design_working_life

- **Sentinel-1A is fully operational** and remains key for many Copernicus Services and users worldwide in the operational, scientific, commercial domains

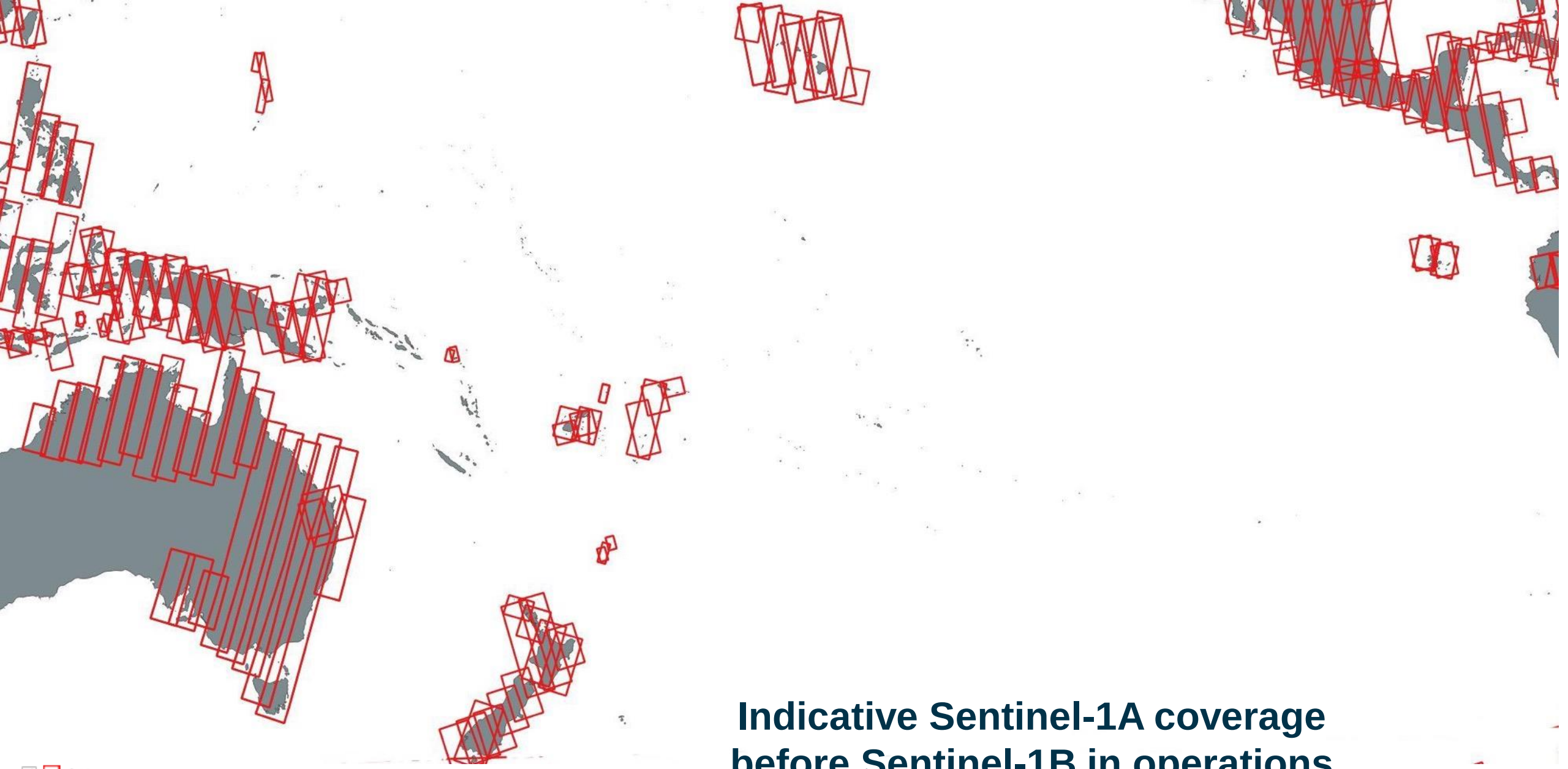
- Sentinel-1 contribution to **emergency activations** continues to be very high (about once a week in average), for flood monitoring in particular

Sentinel-1A observation plan – Coverage of Pacific Islands

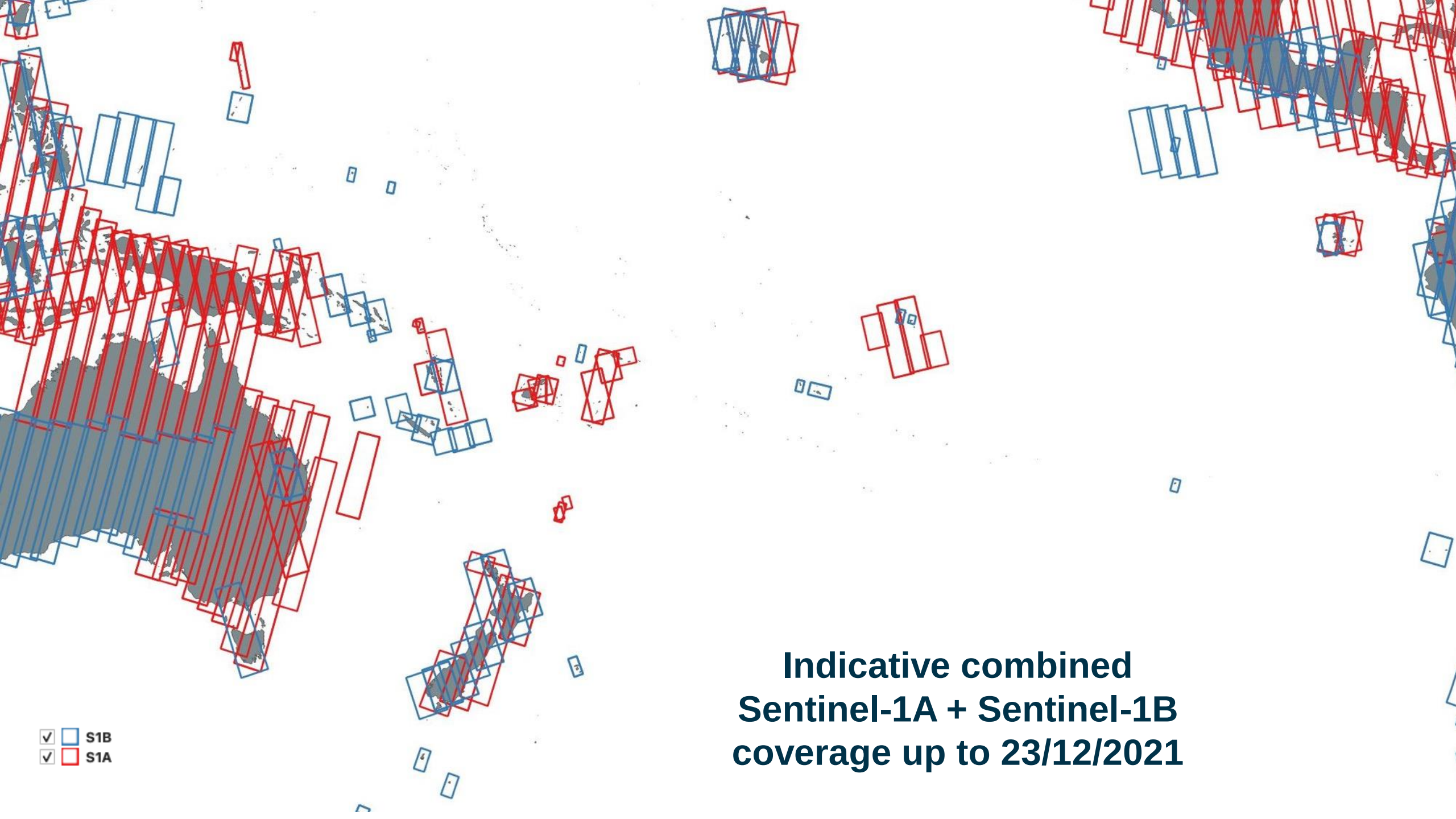
- Following the end of mission of Sentinel-1B, an adjustment of the Sentinel-1A observation plan was performed:
  - To some extent only, as **Sentinel-1A is operated close to its full mission capacity** (i.e. difficulty to accommodate additional observations)
  - Giving priority to Copernicus Services and Participating States to the Copernicus programme.

- The next 3 slides show the indicative **Sentinel-1 coverage over Pacific islands:**
  - With Sentinel-1A only before Sentibel-1B entered in operations (in Oct 2016)
  - With the Sentinel-1A + Sentinel-1B constellation
  - With Sentinel-1A only, as currently performed.

  Observation plan details available at:
  https://sentinels.copernicus.eu/web/sentinel/missions/sentinel-1/observation-scenario/acquisition-segments

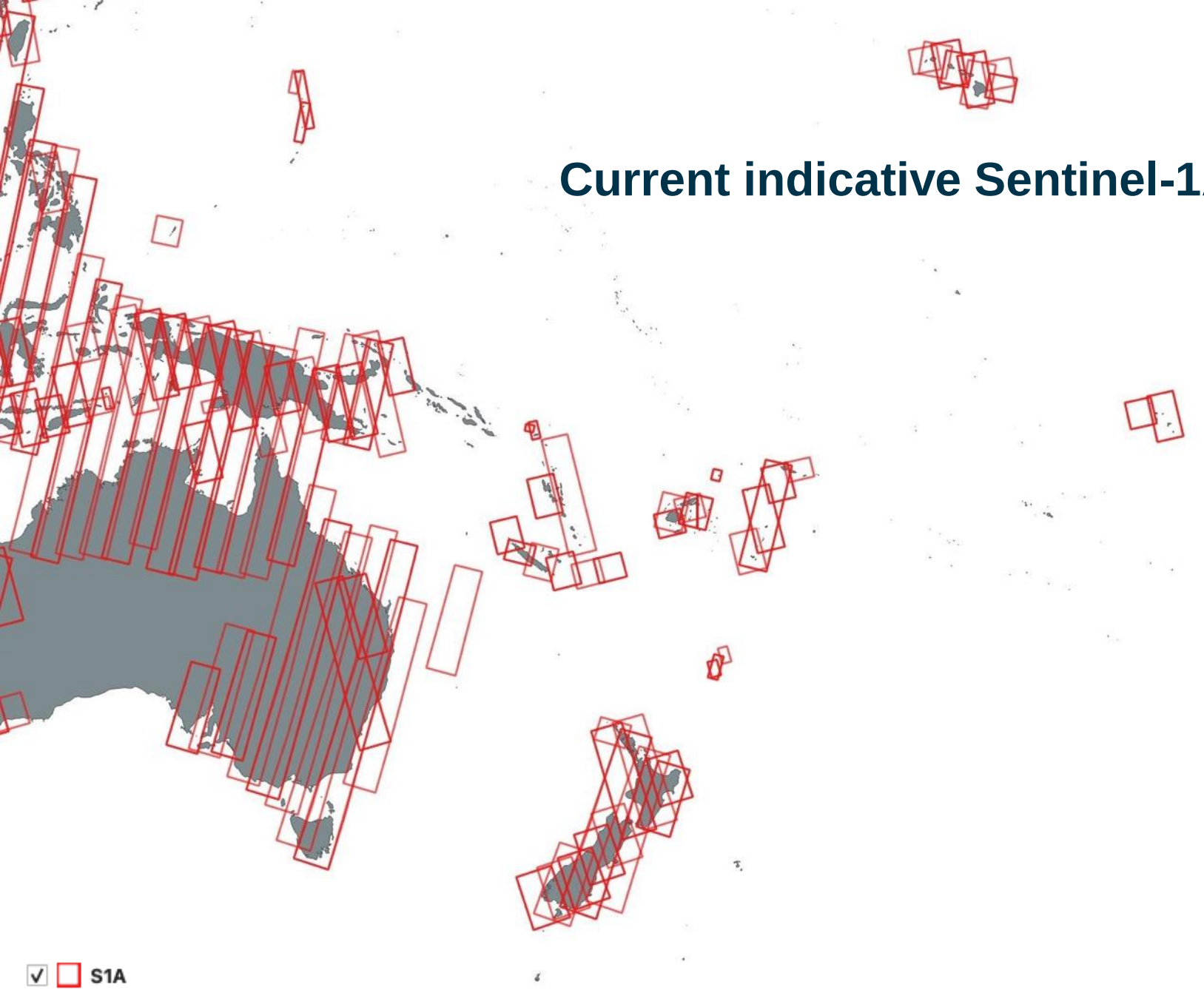


Indicative Sentinel-1A coverage before Sentinel-1B in operations



Indicative combined Sentinel-1A + Sentinel-1B coverage up to 23/12/2021

Current indicative Sentinel-1A coverage



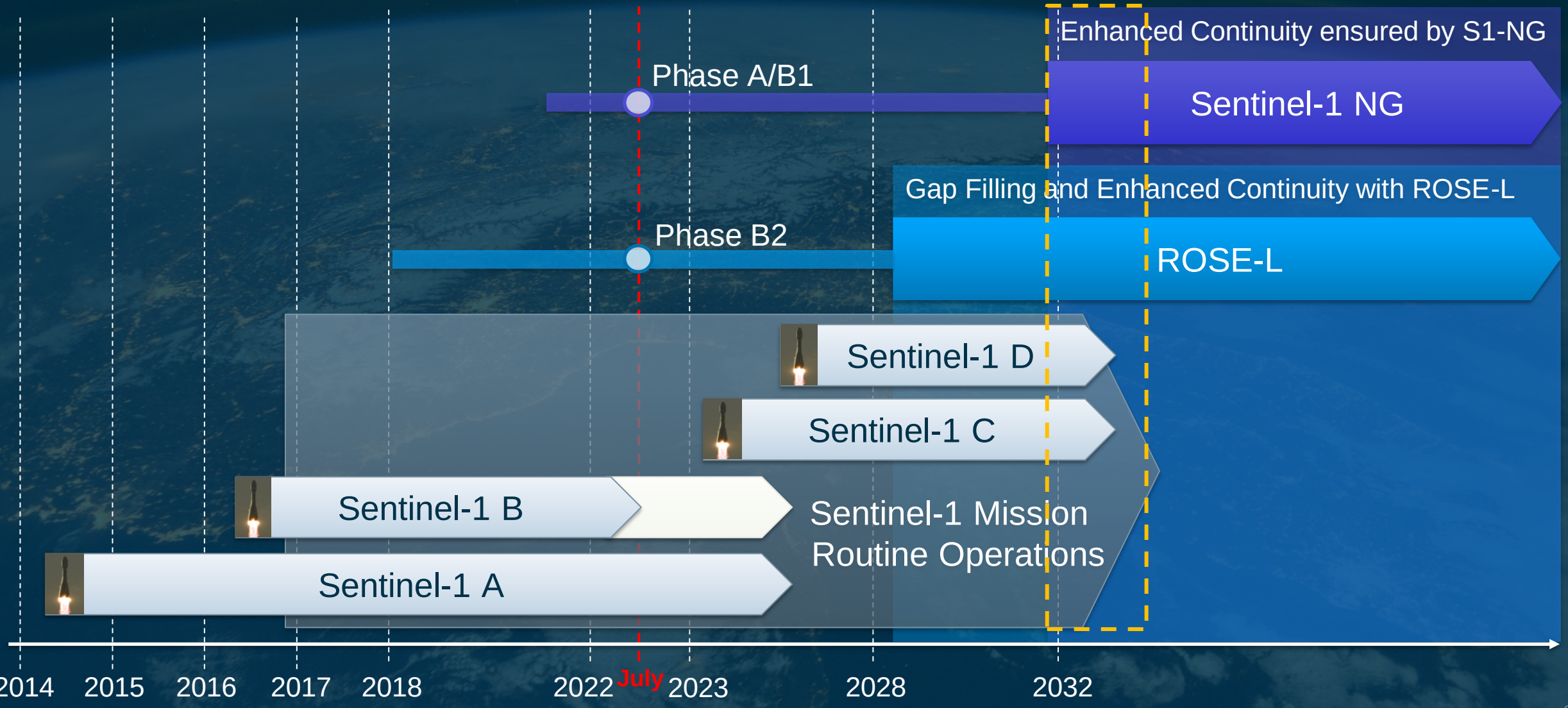
areas	mode	pol	passes	rel orbits
marquises	IW	DH	a	{6,108}
new caledonie	IW	DH	d	{8,81,154}
new caledonie	IW	DH	a	{125}
hawaii asc	IW	DV	a	{22,51,95,124}
hawaii desc	IW	DV	d	{14,58,87,160}
new zealand asc	IW	DV	a	{8,23,52,81,96,125,154,169}
new zealand desc	IW	DV	d	{44,73,146,175}
fidji island	IW	DV	a	{66,139}
fidji island	IW	DV	d	{44,146}
futuna	S3	DV	d	{146}
palau	IW	DV	d	{46}
galapagos asc	IW	DV	a	{33,106}
galapagos desc	IW	DV	d	{55,128}
mariana arc 1	S5	DV	d	{31}
mariana arc 2	S4	DV	d	{104}
mariana arc 3	S6	DV	a	{141}
melanesia	IW	DV	a	{22,51,95,124}
melanesia	IW	DV	d	{102}
new zealand volcanoes 1	S4	DV	a	{66}
new zealand volcanoes 2	S5	DV	a	{139}
new zealand volcanoes 3	S3	DV	d	{175}
tinakula asc	S5	DV	a	{154}
tinakula desc	S4	DV	d	{30}
caledonie	IW	DV	d	{59,132}
vanuatu	IW	DV	a	{81,154}

Sentinel-1 Mission Evolution

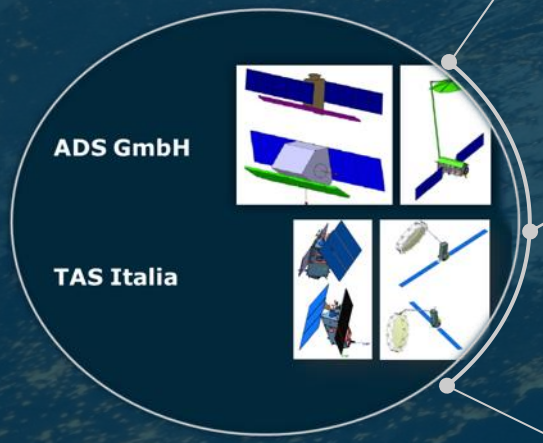
Sentinel-1C: launch currently planned in May-June 2023

Sentinel-1D: actions on-going to anticipate the launch in 2024-2025 (TBC)

Copernicus Timeline – Current and Future SAR Missions



Sentinel-1 Next Generation (NG) Highlights



OBJECTIVES

- *Ensure continuity* and expansion of services and applications relying on Sentinel-1
- *Enhance* existing services and applications
- *Enable* new application developments building on improved performance and observation gaps (e.g. resolution, revisit and others)

PROGRAMMATICS

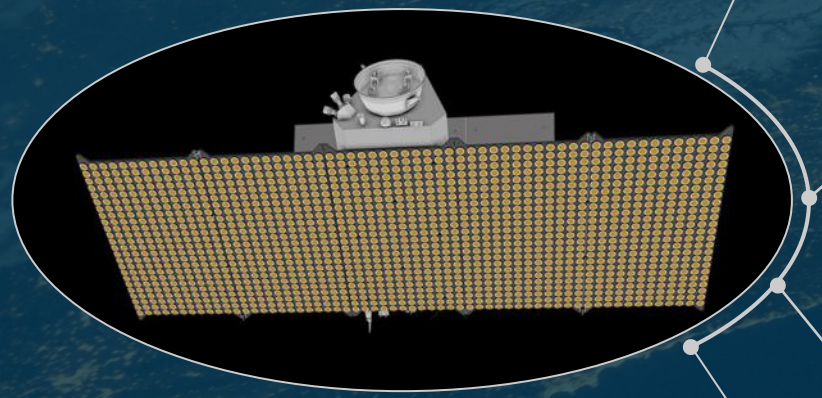
- Phase A/B1 in two years 2021-2023
- Development Phase (Phase B2/C/D) expected to start in 2023
- Expected launch > 2032

PERFORMANCE REQUIREMENTS

- Performance shall be equal or better than Sentinel-1 FG
- Revisit: 3 days Global, 0.5 days Arctic and sea ice
- Resolution ≤ 25 m^2
- NESZ ≤ -26 dB

Swath > 400 km
Duty cycle > 40%

Radar Observation System for Europe – L-band



OBJECTIVE

- *address information gaps* and provide new information not yet available through current Sentinel missions, responding directly and traceably to Copernicus user needs (EC, PEG, REDD+, etc..)

GENERAL

- L-Band SAR – 85 MHz ITU allocated band (1.215-1.300 GHz)
- Constellation of 2 satellites (PFM & FM2). Service continuity (no gaps) with Sentinel-1 FG and NG
- Consortium led by Thales Alenia Space Italy (TAS-I), involving 29 companies from 15 countries

MAIN PERFORMANCE REQUIREMENTS

- Revisit goal: 6 days Global, 3 days Europe and 1 day Arctic
- Resolution ≤ 50 m^2 (Dual-Pol)
- NESZ ≤ -28 dB

PROGRAMMATICS

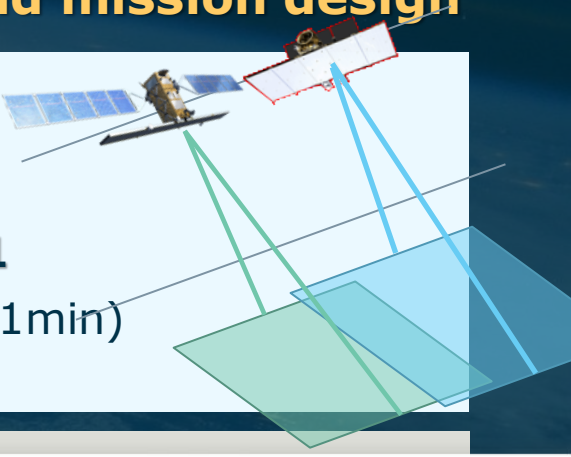
- Currently reaching end of Phase B2
- Science Plan activities start in 2022
- Launch of PFM expected in 2028

ROSE-L Mission Design Highlights

ROSE-L will augment Sentinel-1 by means of a **synergic acquisition plan and mission design**

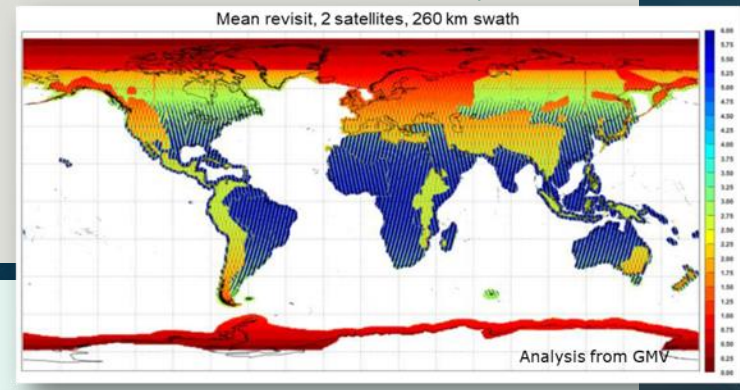
Collocation with Sentinel-1

- Same orbit configuration of Sentinel-1.
- Phasing of the orbital plane adjusted to follow the **same ground track of Sentinel-1**
- Mission design supports option for optimized revisit or convoy with Sentinel-1 (within 1min)



Extensive Global coverage and consistent long-term archive

- Coverage of Global land (except for South pole). **~ 38 min/orbit duty cycle**
- Consistent acquisitions through years for **long-term coherent data stacks**



Free, full and open data policy

Moving towards a **System of Systems concept** and enhanced information products

Concluding remarks

- Sentinel-1A mission operations on-going
- Efforts are being made to: 1- launch Sentinel-1C as soon as possible (target May-June 2023), to come back to the 2-satellite constellation scenario ; 2 - to advance the launch of Sentinel-1D to 2024-2025, to increase the robustness of the system
- Mission continuity and expansion of services & applications is ensured on the long term with the Sentinel-1 Next Generation, first launch planned in 2032+

- ROSE-L Copernicus Expansion SAR mission at L-band aimed at addressing information gaps and providing new information not yet available through current Sentinel missions

Sentinel-1 FG, ROSE-L and Sentinel-1 NG shall be addressed as a system of systems:

- ROSE-L same orbit, swath and acquisition geometry as Sentinel-1 (IWS) providing an operational dual-frequency system
- Synergies between C- and L-band expected to lead to enhanced and new information beyond what can be achieved for each mission taken in isolation
- Synergies with other missions such as Earth Explorer Biomass @P-band is also promising