Copernicus Sentinel-2 Mission Status and Outlook

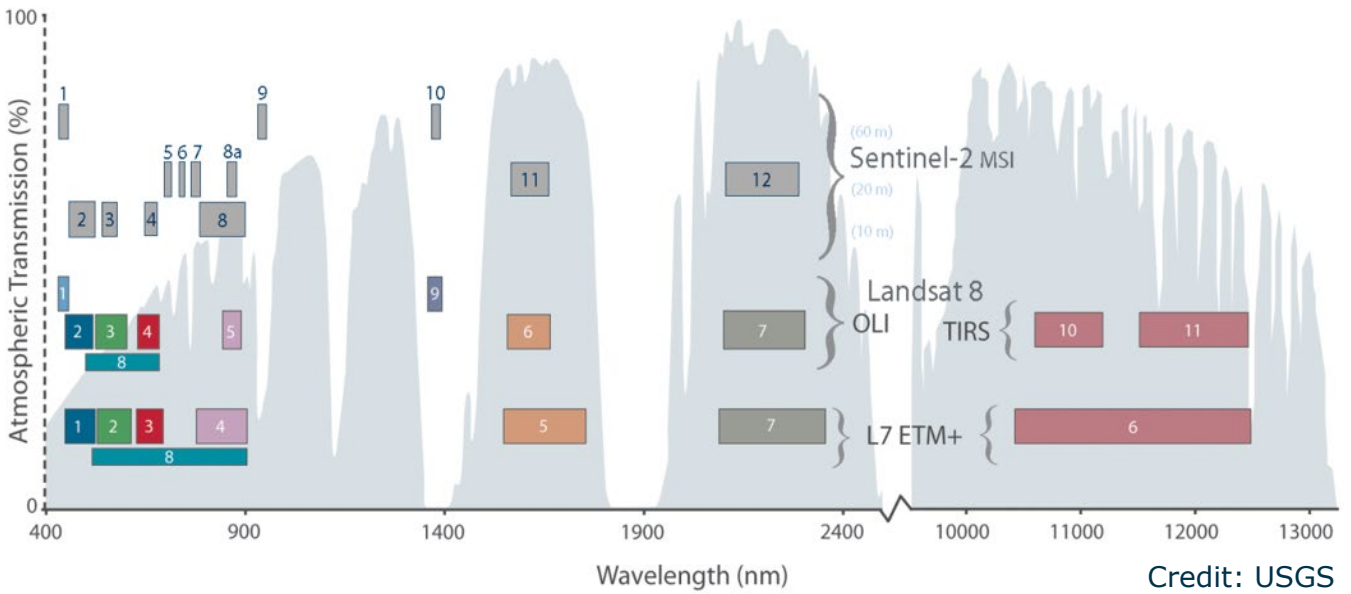
Ferran Gascon, Olivier Colin, Jean-Baptiste Gratadour, Andrea Ferrari, Valentina Boccia,
Davide Moretti, Franco Marchese, Kate Symonds, Constantin Mavrocordatos, et al.

25 May 2022

Living Planet Symposium 2022, Bonn

Sentinel-2 Mission

- ✓Optical multi-spectral mission for the monitoring of land and coastal regions.
- ✓Constellation of two satellites (currently Sentinel-2A and Sentinel-2B).
- ✓Polar sun-synchronous orbit at an altitude of 786km, with LTDN (Local Time of Descending Node) 10h30.
- ✓Swath of 294km.



Credit: USGS

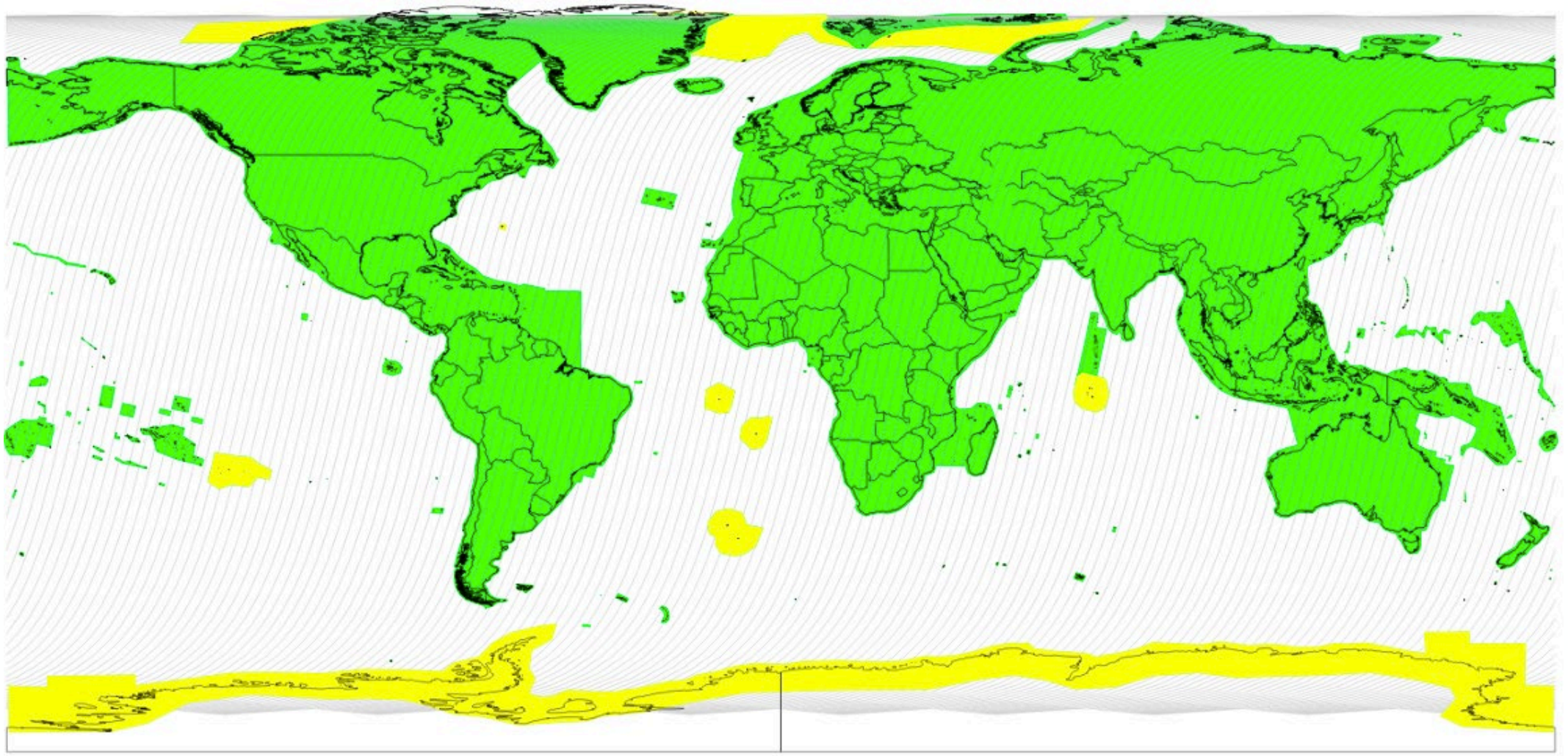
- ✓ Free & open products for feeding a large range of applications.

Mission Status Highlights

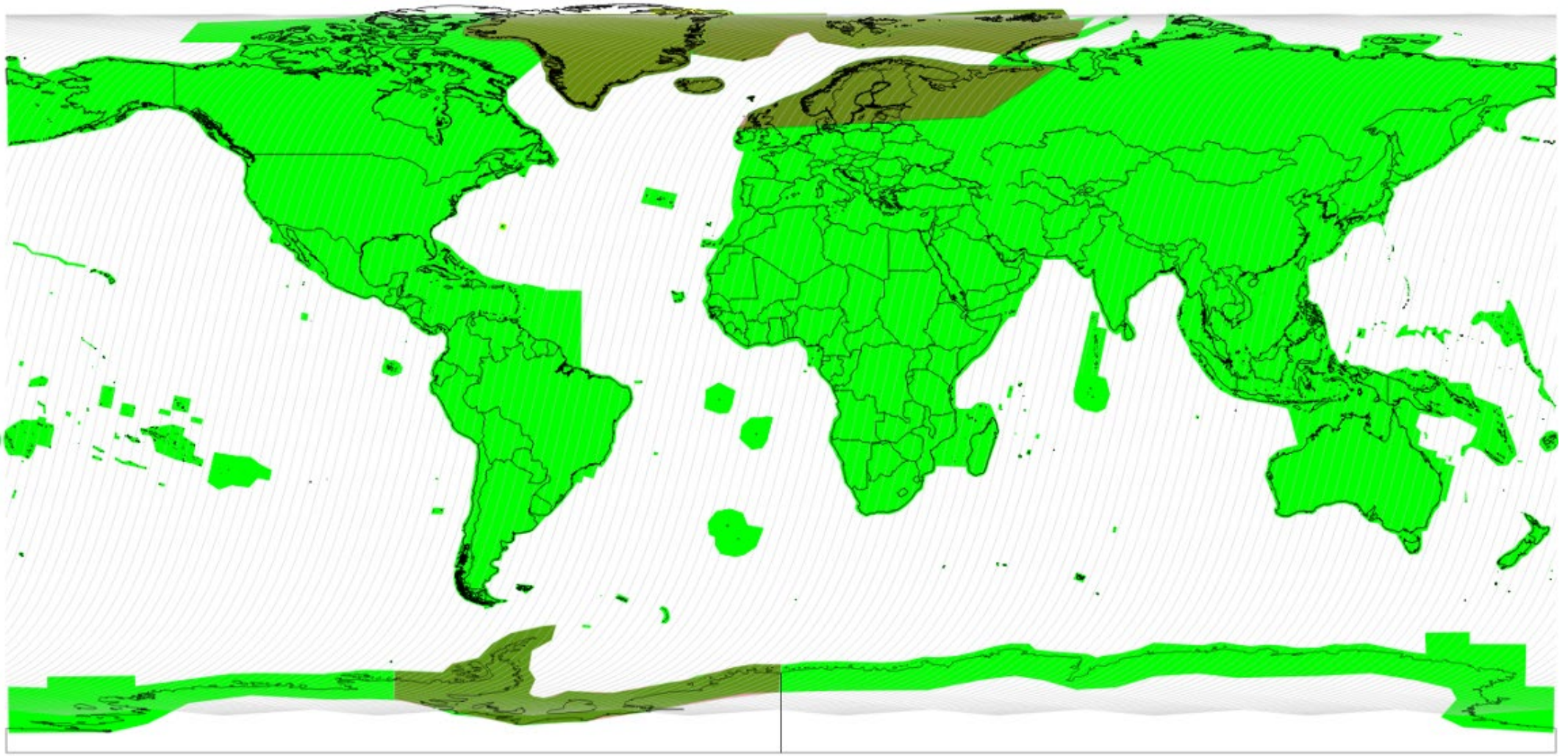
- ✓ Good health of both Sentinel-2A and Sentinel-2B satellites.
- ✓ Observation scenario further extended.
- ✓ New Processing Baseline generating CEOS-ARD (Analysis Ready Data) compliant products.
- ✓ New pilot production for Level-2H and Level-2F products over Belgium under evaluation.
- ✓ Towards Sentinel-2 Collection-1.
- ✓ Top European mission in terms of scientific peer-reviewed publications and distributed data volume.

Normalised Difference Vegetation Index (NDVI) dynamic map by https://apps.sentinel-hub.com/digital_twin_sandbox/

Observation Scenario



Observation Scenario

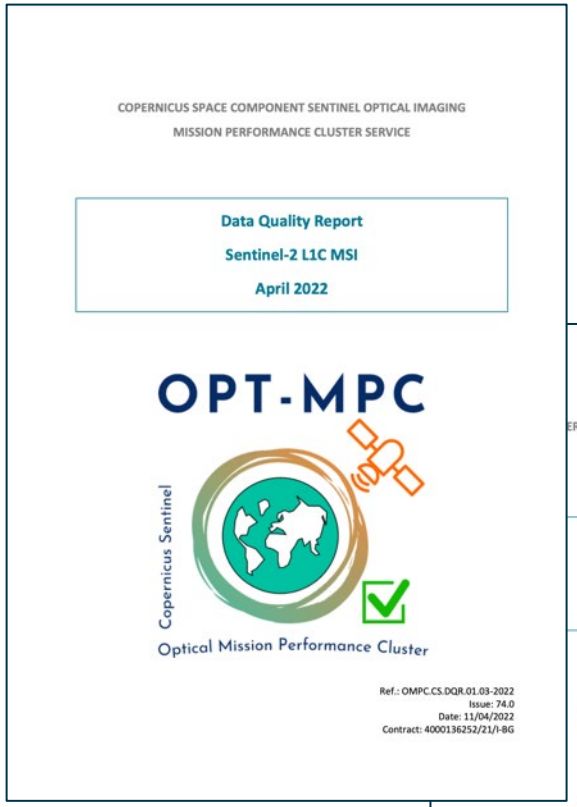


SZA
=
Sun
Zenith
Angle

Sentinel-2 Products

Type	Code	Description	Users	Coverage
Core Products	Level-1B	Top-of-atmosphere radiances in sensor geometry	Expert users	Global (distributed over Alps and Norway)
	Level-1C	**Top-of-atmosphere reflectances in cartographic geometry**	**All users**	**Global**
	Level-2A	**Surface reflectances in cartographic geometry**		
Pilot Products	Level-2H	Harmonised Sentinel-2 + Landsat-8/9 surface reflectances in cartographic geometry	On-demand	Pilot productions
	Level-2F	Fused Sentinel-2 + Landsat-8/9 surface reflectances in cartographic geometry		

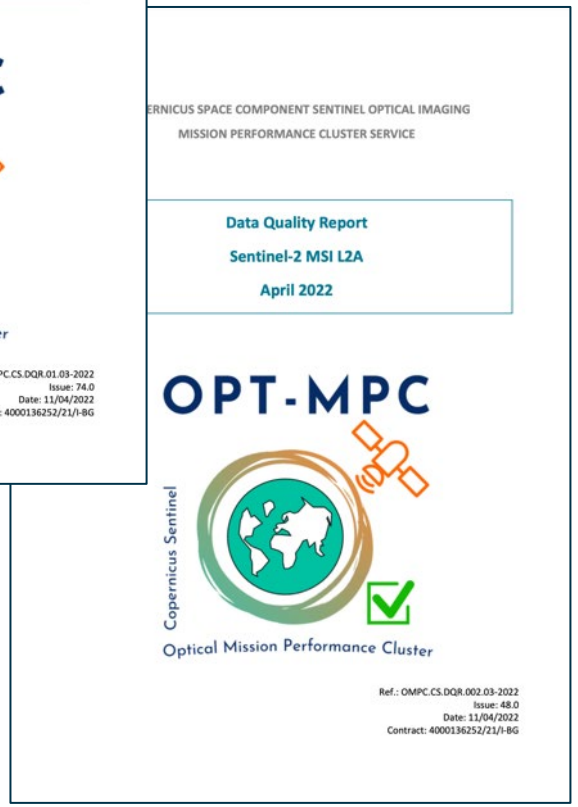
Sentinel-2 Data Quality


COPERNICUS SPACE COMPONENT SENTINEL OPTICAL IMAGING
MISSION PERFORMANCE CLUSTER SERVICE

Data Quality Report
Sentinel-2 L1C MSI
April 2022

OPT-MPC
Copernicus Sentinel
Optical Mission Performance Cluster

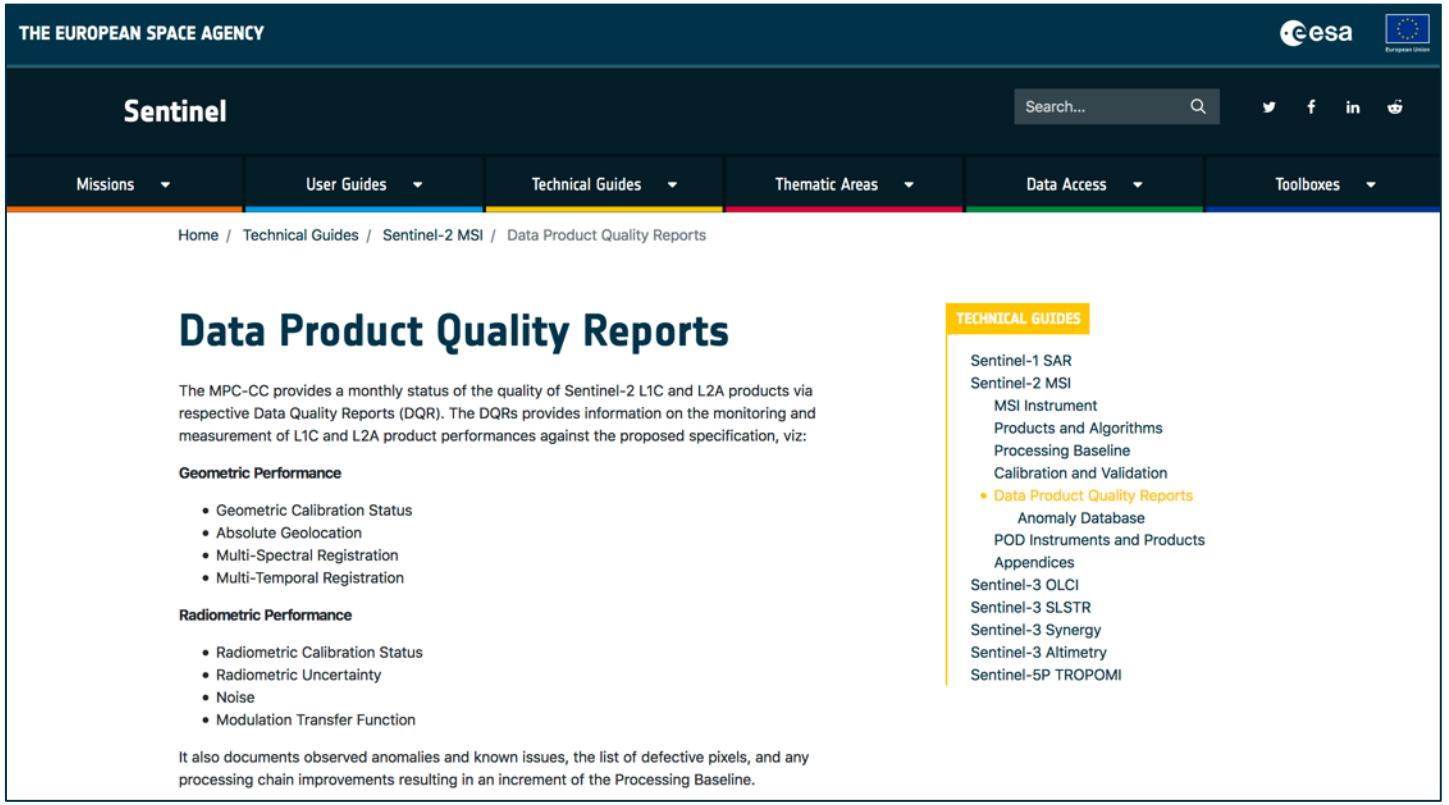
Ref.: OMPC.CS.DQR.01.03-2022
Issue: 74.0
Date: 11/04/2022
Contract: 4000136252/21/I-BG


ERNICUS SPACE COMPONENT SENTINEL OPTICAL IMAGING
MISSION PERFORMANCE CLUSTER SERVICE

Data Quality Report
Sentinel-2 MSI L2A
April 2022

OPT-MPC
Copernicus Sentinel
Optical Mission Performance Cluster

Ref.: OMPC.CS.DQR.002.03-2022
Issue: 48.0
Date: 11/04/2022
Contract: 4000136252/21/I-BG



https://sentinels.copernicus.eu/ca/web/sentinel/data-product-quality-reports

Main Recent Achievements

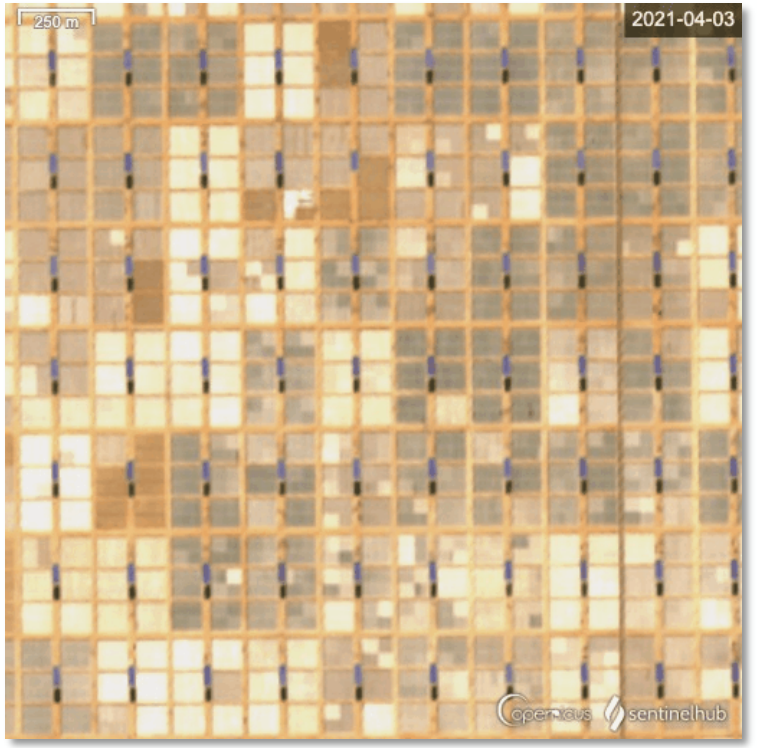
- 2021 August: Worldwide deployment of the geometry-refined production.
- 2021 December: Publication of Sentinel High-Level Operations Plan (HLOP) issue 3.1
- 2021 December: Generation Level-2H and Level-2F pilot production over Belgium for evaluation.
- 2022 January: Upgrade of Level-1C and Level-2A products (baseline for coming Collection 1).
- 2022 January: Level-2A product compliant to CEOS-ARD (Analysis Ready Data) specifications.
- 2022 January: Release of new Sen2Cor Level-2A stand-alone processor (version 2.10).

New Sentinel-2 Products Geometric Refinement

Improvement of previous in-flight performances :

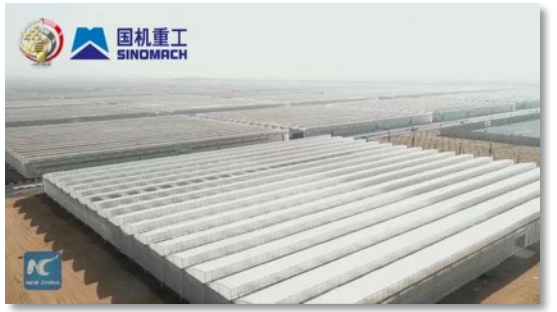
- ✓ Absolute geolocation accuracy from 11m improved to **8 m** (CE95).
- ✓ Multi-temporal co-registration accuracy from 12m improved to **5 m** (CE95).

Not Refined Geometry



Refined Geometry

Egypt's former desert

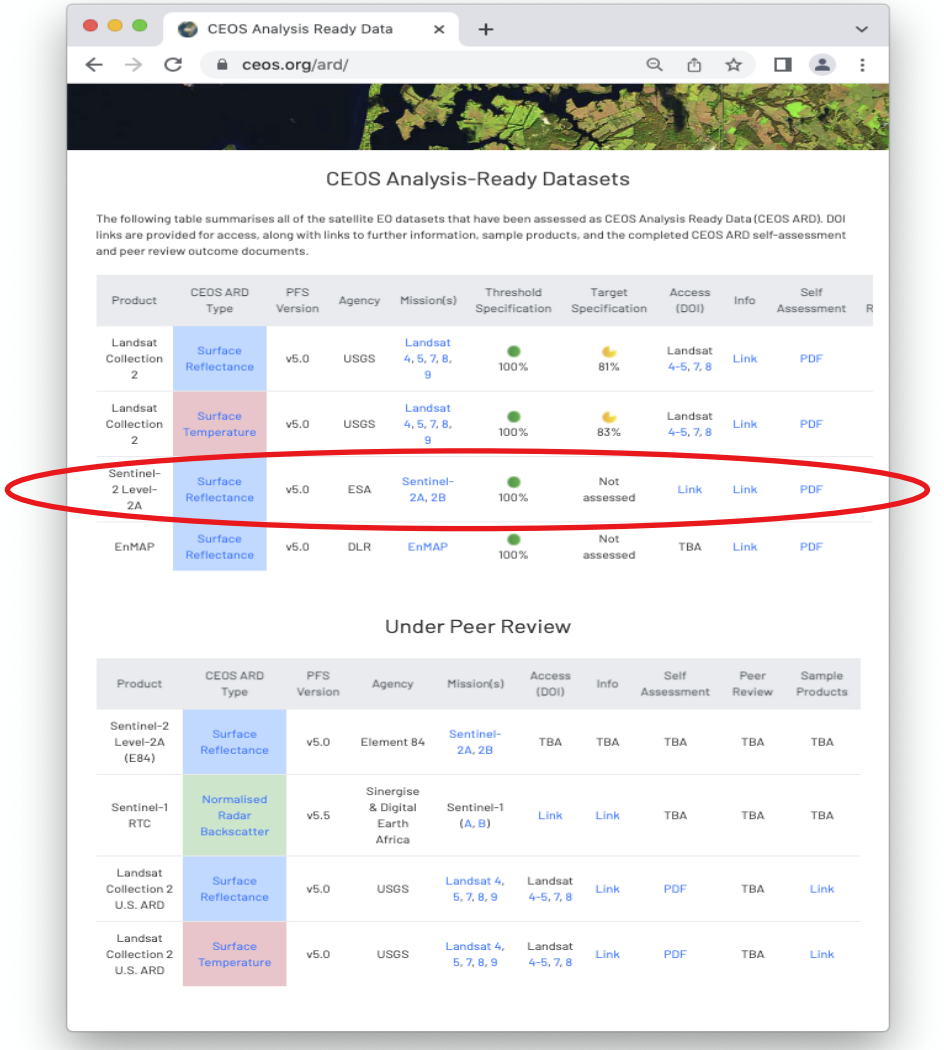


Copyright: New China TV

Copyright: contains modified Copernicus Sentinel data (2020), processed with Sentinel Hub EO Browser

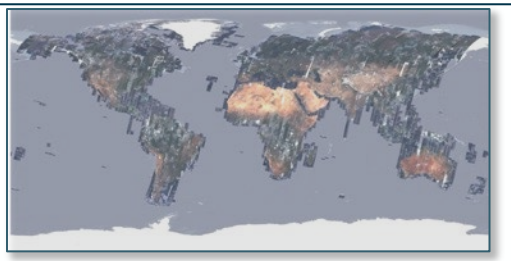
CEOS-ARD Compliance

https://ceos.org/ard



Interoperability with Landsat

- ✓**Geometry :**
  - ✓S2 GRI (Global Reference Image)
  - ✓Copernicus DEM (Digital Elevation Model)
  - ✓CEOS DEMIX (DEMs Intercomparison eXercise)
  - ✓DGGS (Discrete Global Grid System)
- ✓**Level-1 Radiometry :**
  - ✓Pre-flight sensor comparison using an integrating sphere
  - ✓S2 spectral responses close to Landsat-8/9
  - ✓Absolute radiometry inter-comparison
- ✓**Level-2A Radiometry and Cloud Mask:**
  - ✓CEOS ACIX (Atmospheric Correction Intercomparison eXercise)
  - ✓CEOS CMIX (Cloud Mask Intercomparison eXercise)
  - ✓CARD4L [http://ceos.org/ard]
- ✓**Level-2H and Level-2F**
  - ✓Sen2Like



Open Access Article

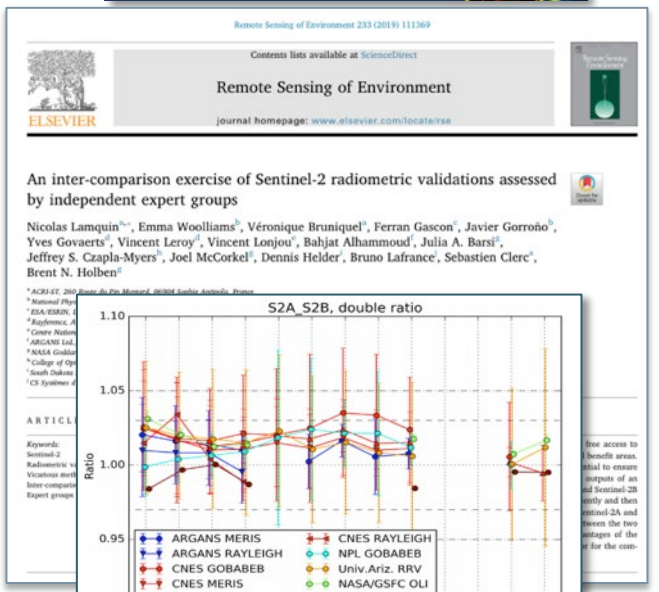
Harmonizing the Landsat Ground Reference with the Sentinel-2 Global Reference Image Using Space-Based Bundle Adjustment

by Rajagopalan Rengarajan [1,*], James C. Storey [1] and Michael J. Choate [2]

[1] KBR, Sioux Falls, SD 57030, USA
[2] U.S. Geological Survey, Earth Resources Observation and Science Center, Sioux Falls, SD 57030, USA
* Author to whom correspondence should be addressed.

Remote Sens. **2020**, *12*(19), 3132; https://doi.org/10.3390/rs12193132

Received: 3 August 2020 / Revised: 18 September 2020 / Accepted: 20 September 2020 / Published: 24 September 2020



Remote Sensing of Environment 233 (2019) 111369

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

ELSEVIER

An inter-comparison exercise of Sentinel-2 radiometric validations assessed by independent expert groups

Nicolas Lamquin[a,*], Emma Woolliams[b], Véronique Bruniquel[a], Ferran Gascon[c], Javier Gorroño[b], Yves Govaerts[d], Vincent Leroy[d], Vincent Lonjou[e], Bahjat Alhammoud[f], Julia A. Barsi[g], Jeffrey S. Czapla-Myers[h], Joel McCorkel[i], Dennis Helder[j], Bruno Lafrance[e], Sebastien Clerc[a], Brent N. Holben[g]

Fig. 10. Double ratios g(S2A)/g(S2B) for each calibration validation method.

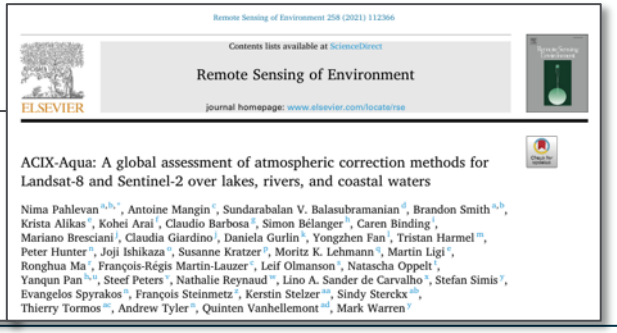
remote sensing

MDPI

Article

Atmospheric Correction Inter-Comparison Exercise

Georgia Doxani [1,*], Eric Vermote [2,*], Jean-Claude Roger [2,3], Ferran Gascon [4], Stefan Adriaensen [5], David Frantz [6,†], Olivier Hagolle [7], André Hollstein [8], Grit Kirches [9], Fuqin Li [10], Jérôme Louis [11], Antoine Mangin [12], Nima Pahlevan [2,13], Bringfried Pflug [14] and Quinten Vanhellemont [15]



Remote Sensing of Environment 258 (2021) 112366

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

ELSEVIER

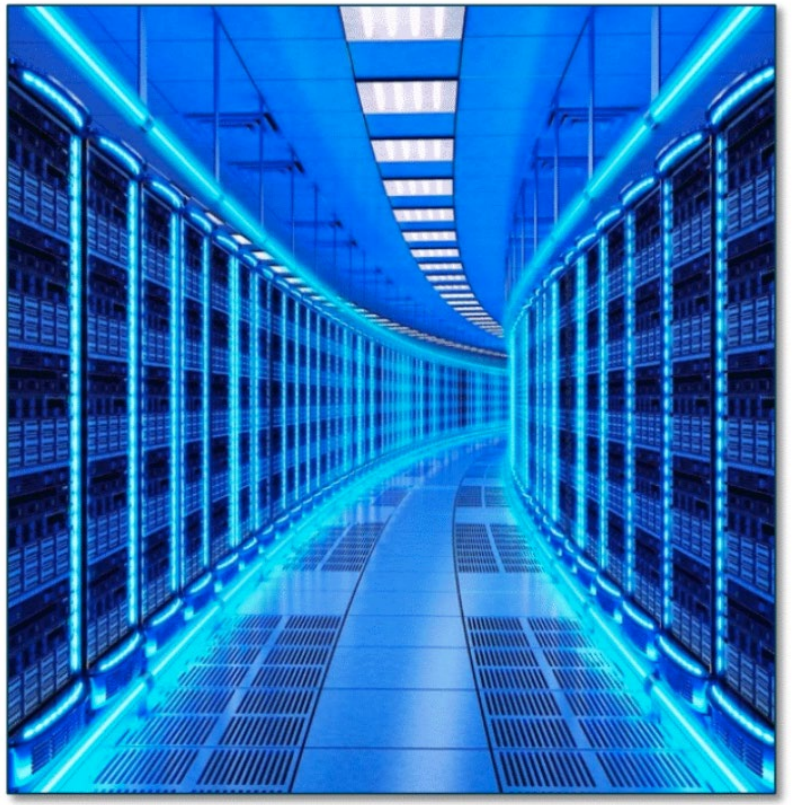
ACIX-Aqua: A global assessment of atmospheric correction methods for Landsat-8 and Sentinel-2 over lakes, rivers, and coastal waters

Nima Pahlevan [a,b,*], Antoine Mangin [c], Sundarabalan V. Balasubramanian [d], Brandon Smith [a,b], Krista Alikas [e], Kohei Arai [f], Claudio Barbosa [g], Simon Bélanger [h], Caren Binding [i], Mariano Bresciani [l], Claudia Giardino [l], Daniela Gurlin [k], Yongzhen Fan [i], Tristan Harmel [m], Peter Hunter [n], Joji Ishikaza [o], Susanne Kratzer [p], Moritz K. Lehmann [q], Martin Ligi [e], Ronghua Ma [r], François-Régis Martin-Lauzer [s], Leif Olmanson [t], Natascha Oppelt [u], Yanqun Pan [b,v], Steef Peters [w], Nathalie Reynaud [w], Lino A. Sander de Carvalho [x], Stefan Simis [y], Evangelos Spyrakos [z], François Steinmetz [s], Kerstin Stelzer [aa], Sindy Sterckx [ab], Thierry Tormos [ac], Andrew Tyler [z], Quinten Vanhellemont [ad], Mark Warren [y]

Mission Outlook

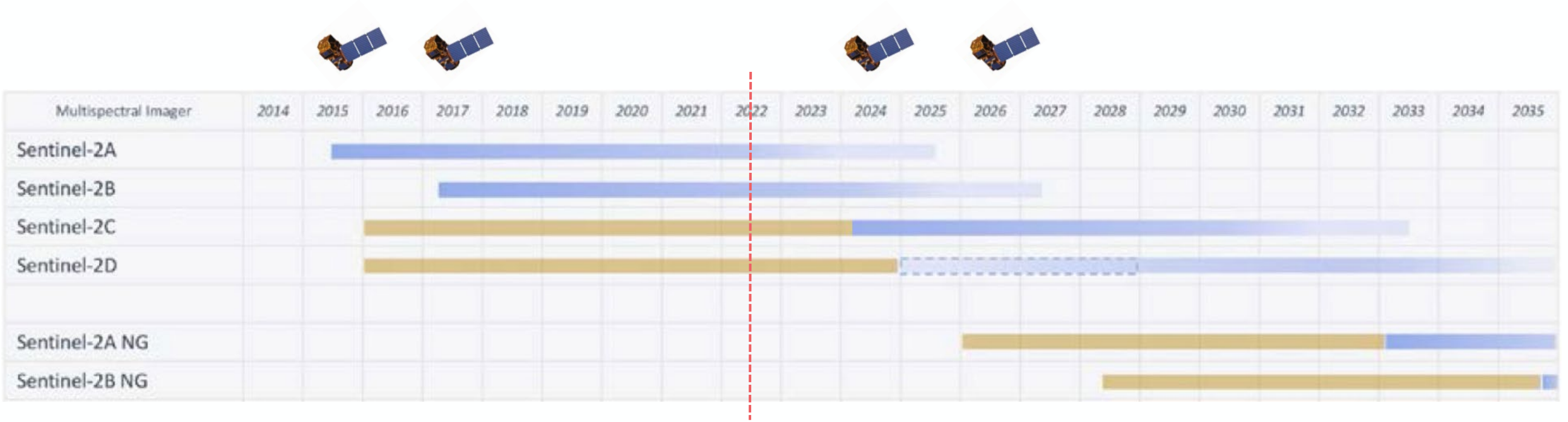
- Sentinel-2 archive reprocessing to generate Collection-1.
- Distribution of Sentinel-2 GRI (Global Reference Image) as a free & open product.
- Completion of the Ground Segment Transformation (with new Data Distribution service).
- Evaluation of S2-Landsat harmonised and fused products for pilot production over Belgium.
- Development of new Aquatic Reflectance layer within Level-2A product.
- Explore usage of DGGS (Digital Global Grid System).
- Definition of new product evolutions.
- Replacement of current flying units.

Towards Sentinel-2 Collection 1



- Collection 1 generated by reprocessing full S2 archive for both Level-1C and Level-2A products.
- Reprocessing campaign foreseen to start in June 2022, published progressively on DIAS platforms and completed by Q1 2023.
- Using latest processing baselines for Level-1C and Level-2A products.
- Collection 1 will be CEOS-ARD compliant [http://ceos.org/ard].

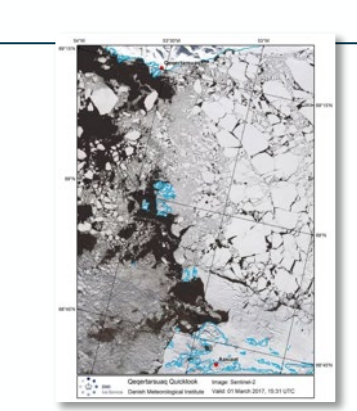
Schedule Overview

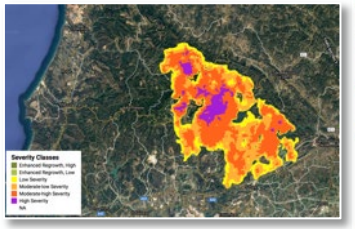


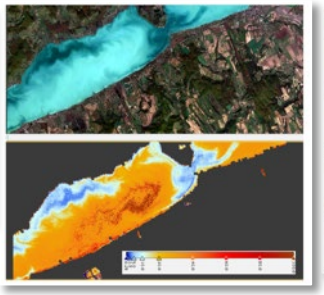
- The 2-satellite constellation operations remains the baseline.
- Third unit (S2A as baseline) will be parked in orbit and kept in hot stand-by.

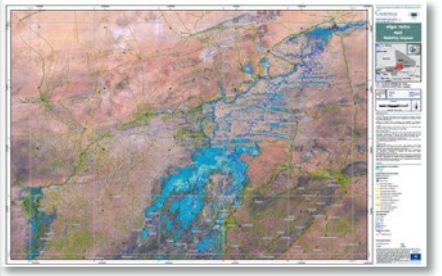
Broad Range of Applications

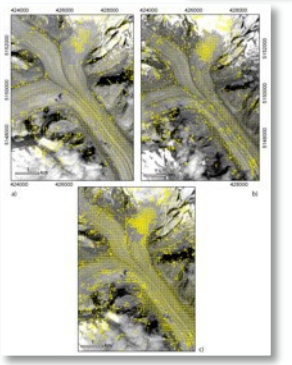
CEMS Copernicus Emergency Management Service	- Emergency response to rapid mapping (burnt area, flood, landslides, volcanoes) - Risk recovery (e.g. crop change, floods) - Validation (e.g. fires, floods, landslides) - EFFIS/GWIS (Burned area mapping, fire severity and vegetation recovery
CMEMS Copernicus Marine Environment Monitoring Service	- Sea-ice charting - Coastal waters Turbidity - Coastal waters Total Suspended Matter
CLMS Copernicus Land Monitoring Service - Global and Pan-European Components	- Hot Spot Monitoring for EU field projects and international policies - Global Mosaics - Inland waters Turbidity - Inland waters Total Suspended Matter - Biophysical products - Land cover products
CSS Copernicus Security Service Copernicus Maritime Surveillance Service European Maritime Safety Agency / CleanSeaNet	- Oil spill detection and polluter identification (CleanSeaNet) - Maritime surveillance (e.g. ship detection, search and rescue, anti-piracy)
CSS – SEA Copernicus Security Service Support to External Action	- Up-to-date background information - Integration with very high resolution imagery - Feature of interest extraction
C3S Copernicus Climate Change Service	- Glaciers mapping - Glaciers flow velocities

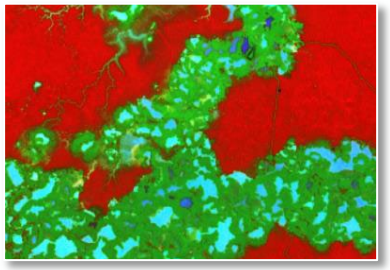








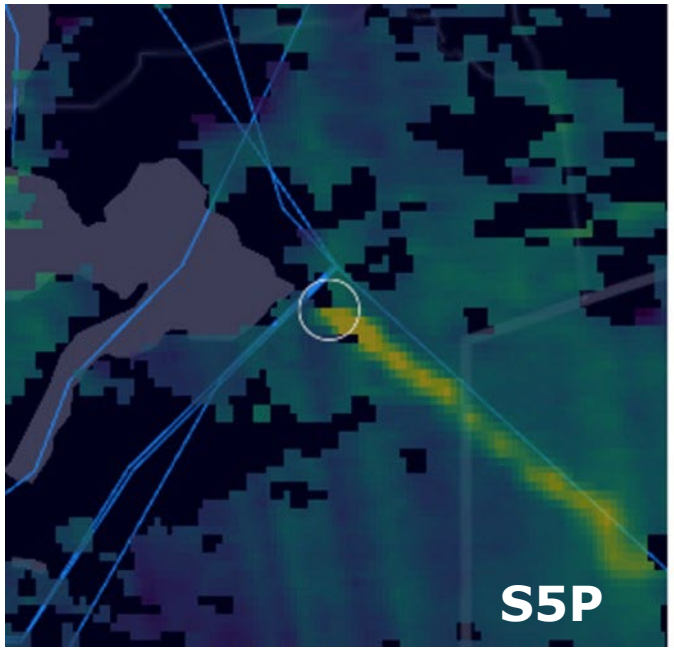


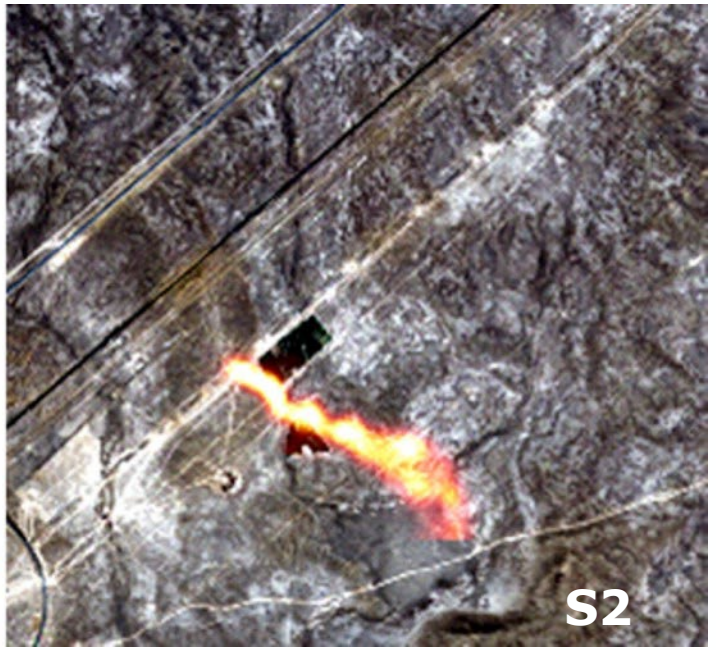


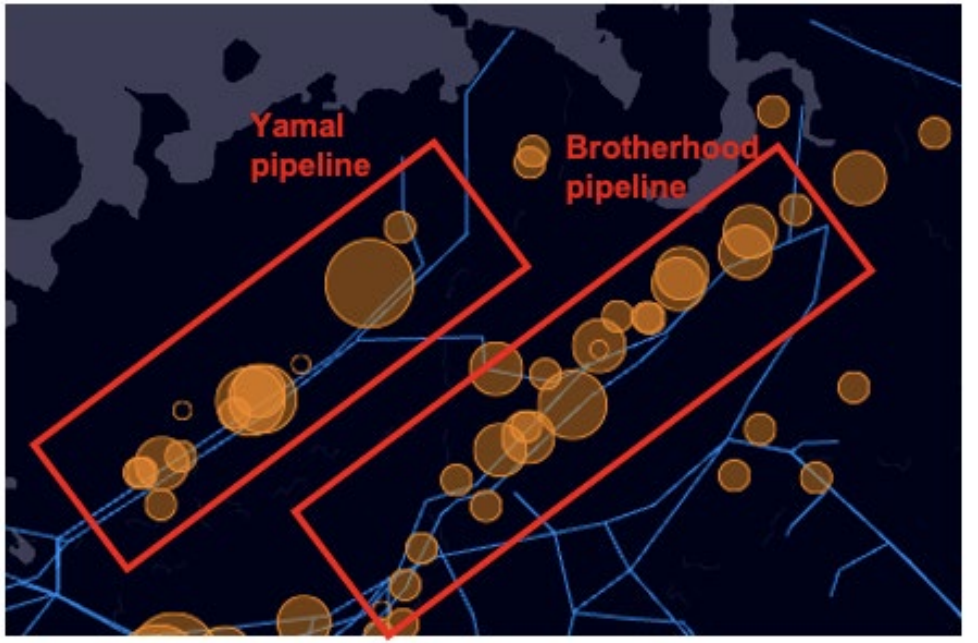
… as well as in national services, and the scientific and commercial domains

Sentinel-2 Mapping High-resolution Methane Emissions

- Sentinel-2 used to detect individual methane leakages from natural gas facilities worldwide.

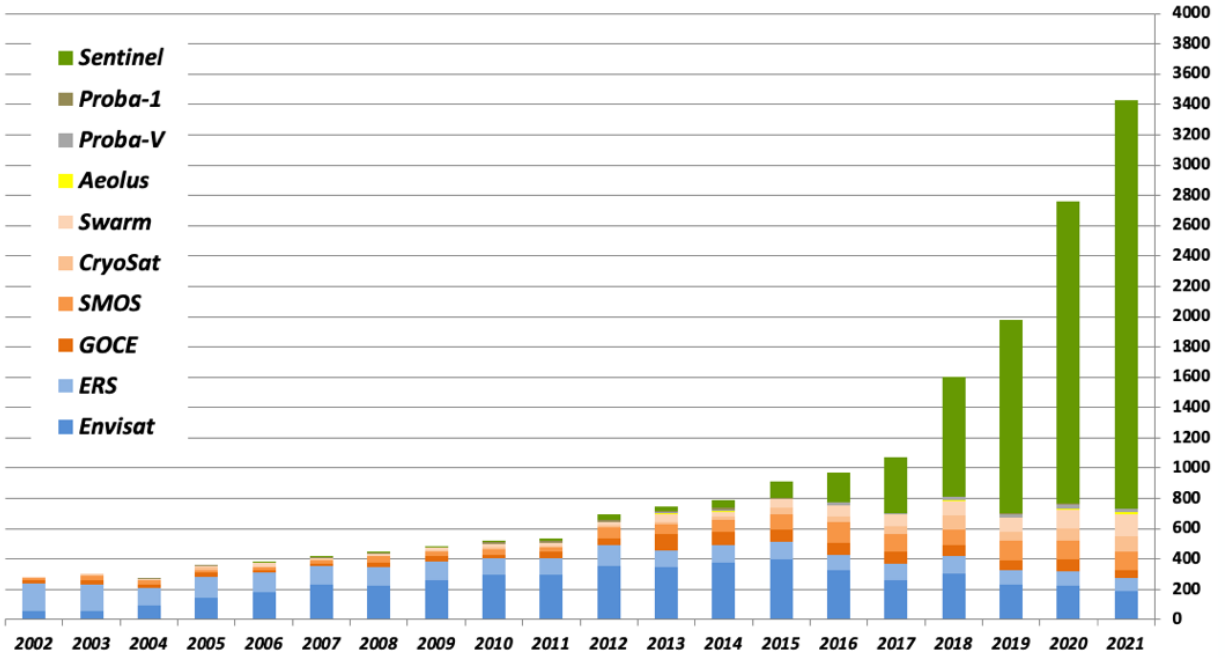


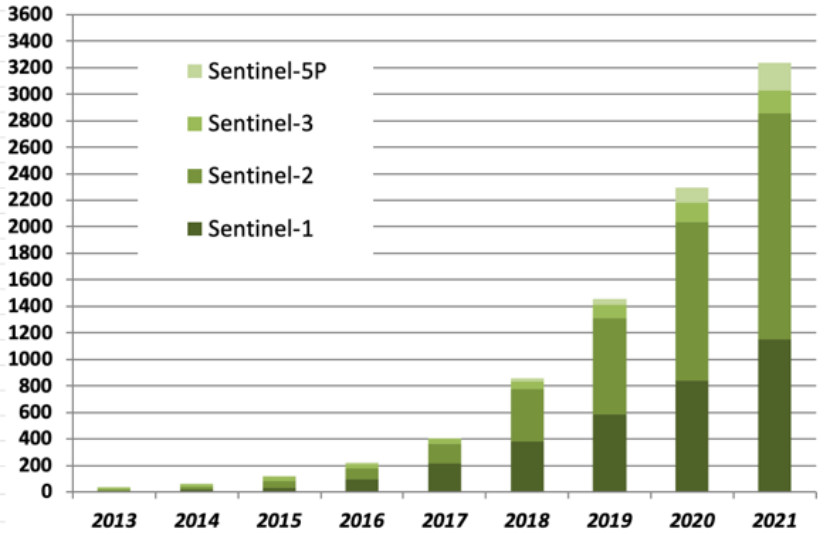




https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Monitoring_methane_emissions_from_gas_pipelines

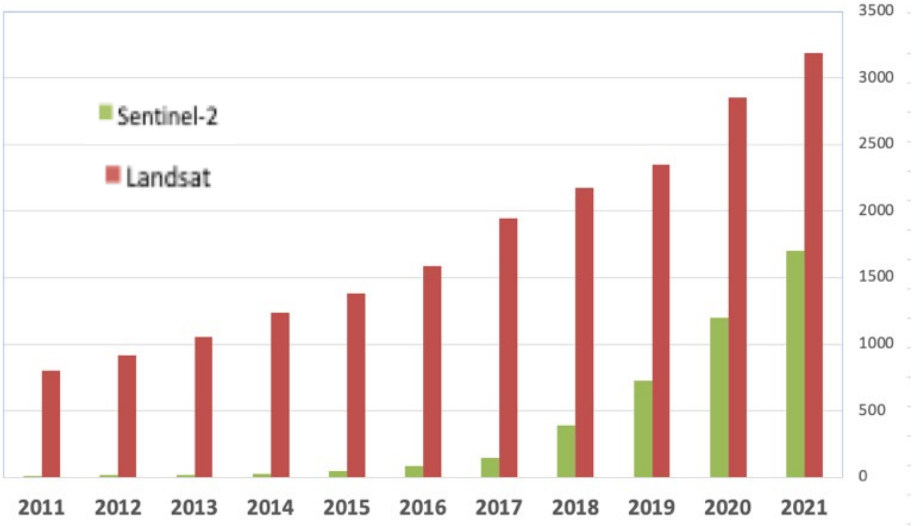
Peer-Reviewed Publications





sentinel-2

1704 publications in 2021



Method: Based on Elsevier SCOPUS database, exact number of peer reviewed publications searching for mission/instrument name within papers title, abstract and keywords, and excluding conference papers.

Thank you

https://sentinels.copernicus.eu/ca/web/sentinel/missions/sentinel-2/mission-status