

Sentinel-2 Products and Algorithms



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Sentinel-2 Mission

A high-resolution image of the Sentinel-2 satellite in orbit over Earth. The satellite is a large, gold-colored rectangular structure with various instruments and antennas. It is positioned diagonally across the frame, with the Earth's surface (oceans, clouds, and land) visible in the background. Three semi-transparent blue rectangular boxes are overlaid on the image, each containing white text. The first box is at the top, the second in the middle, and the third at the bottom.

Mission Overview

Products and Algorithms

Mission Performance Centre (MPC)

A high-resolution image of the Sentinel-2 satellite in orbit over Earth. The satellite is a large, gold-colored rectangular structure with various instruments and solar panels. It is positioned in the center of the frame, with the Earth's surface (oceans, clouds, and land) visible in the background.

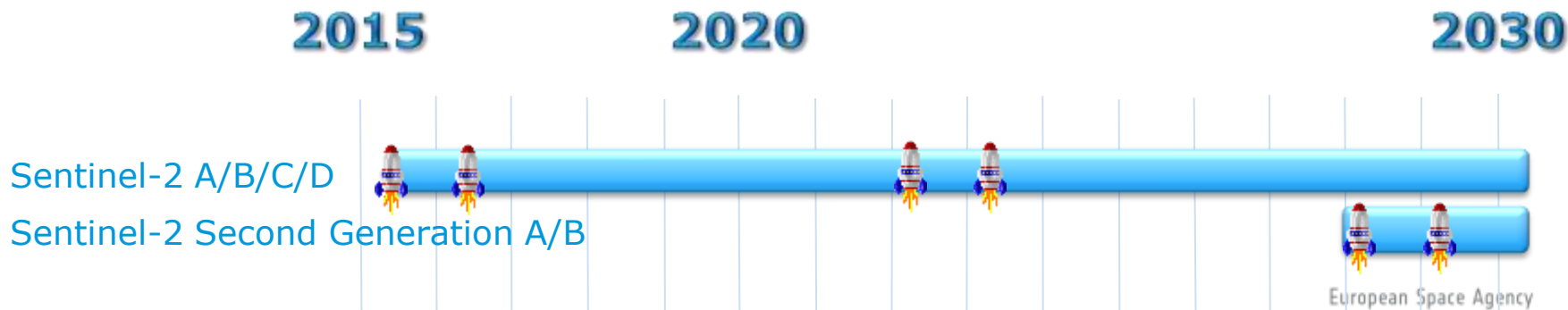
Mission Overview

Products and Algorithms

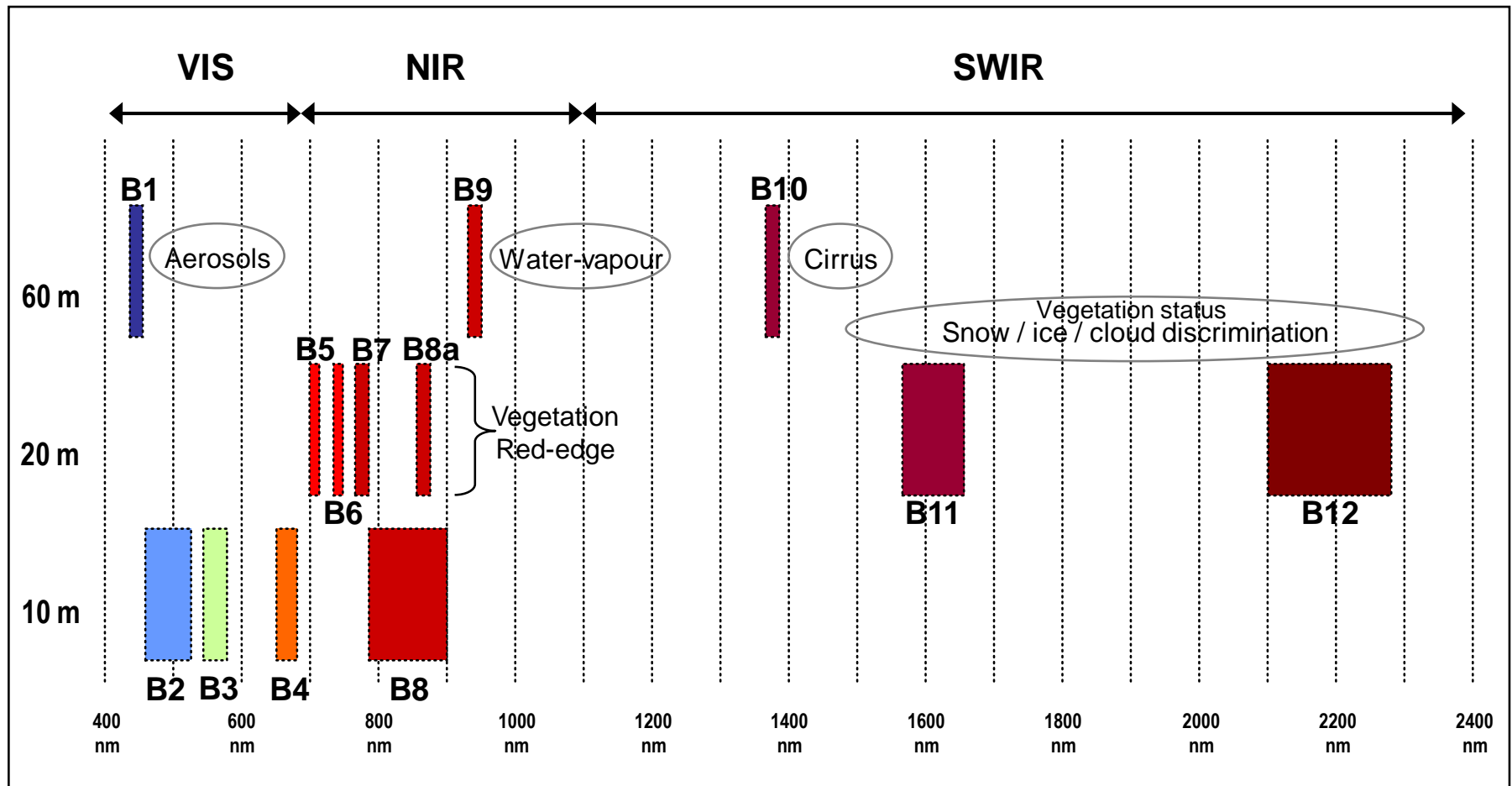
Mission Performance Centre (MPC)

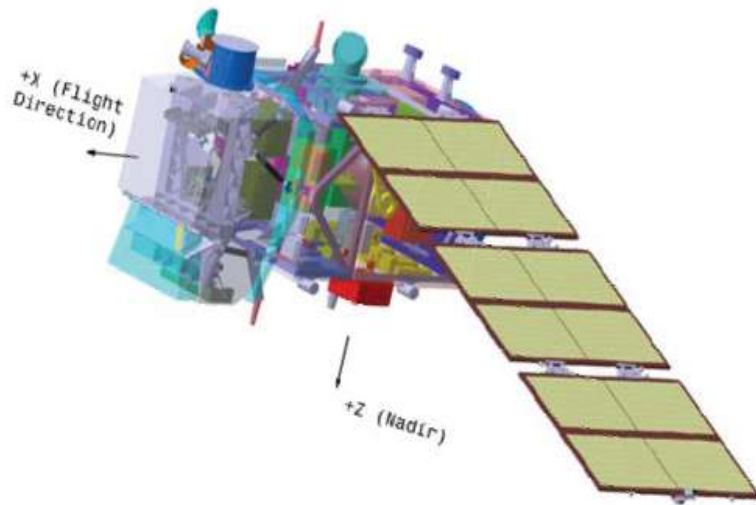
Mission Features

- **Spacecrafts**: 2 operating in twin configuration
- **Orbit**: Sun-synchronous at 786 km (14+3/10 revs per day), with LTDN 10:30 AM
- **MultiSpectral Instrument (MSI)**: pushbroom principle, filter-based optical system
- **Spectral bands**: 13 (in VIS–NIR–SWIR)
- **Spatial resolution**: 10m / 20m / 60m
- **Swath**: 290 km



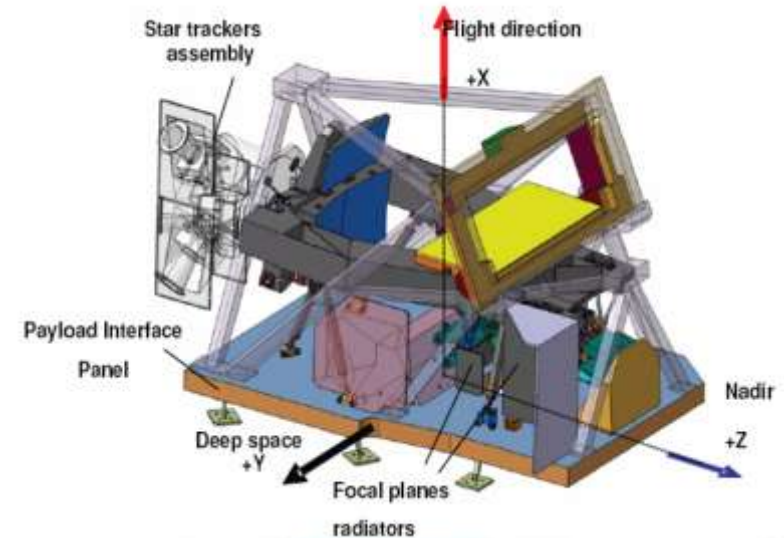
Spectral Bands and Spatial Resolution





Satellite

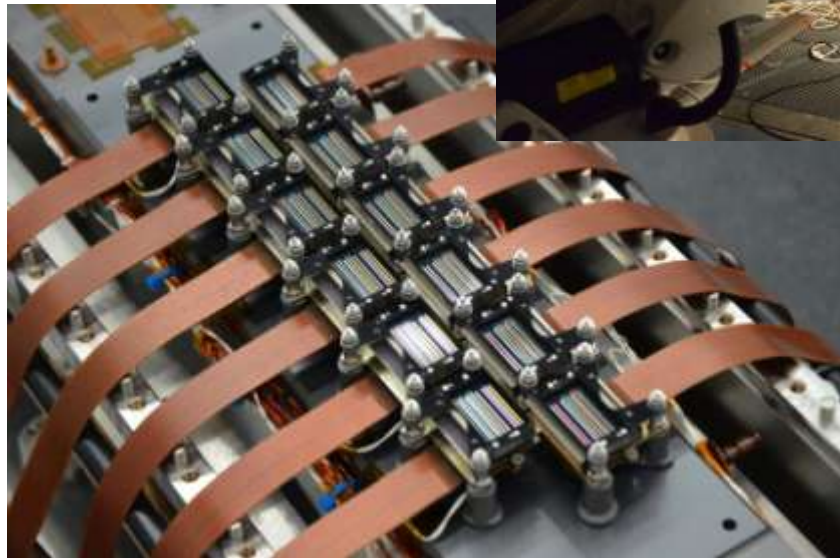
- Satellite mass: 1200 kg
- Satellite power consumption: 1250 W
- Hydrazine propulsion system (120 kg - including provision for safe mode, debris avoidance and EOL orbit decrease for faster re-entry)
- Accurate AOCS based on multi-head Star Tracker and fiber optic gyro
- X band mission data distribution (520 Mbits/sec)
- Mission data onboard storage: 2.4 Tbits



Multi-Spectral instrument (MSI)

- Filter based push broom imager (280 kg, 1 m³)
- Three mirrors silicon carbide telescope, with dichroic beam splitter
- Focal plane arrays: Si CMOS VNIR detectors, HgCdTe SWIR detectors.
- Onboard wavelet compression (divided by 3)
- Integrated video & compression electronics (state of the art wavelet compression)
- Radiometric resolution 12bits
- Daily generated telemetry: 1.4 TB

Multi-Spectral Instrument (MSI)



Sentinel-2 mission will combine a unique set of features:

1. Systematic acquisition of all land surfaces and coastal waters.
2. High revisit frequency (5 days periodicity, same viewing direction).
3. Large swath (290km).
4. High spatial resolution (10m / 20m / 60m).
5. Large number of spectral bands (13 in VNIR-SWIR domain).

Sentinel-2 Mission

A high-resolution image of the Sentinel-2 satellite in orbit. The satellite is a large, gold-colored rectangular structure with various instruments and solar panels. It is positioned against a background of Earth's surface, showing a mix of blue oceans, white clouds, and green landmasses. The satellite is oriented horizontally, with its long side facing the viewer.

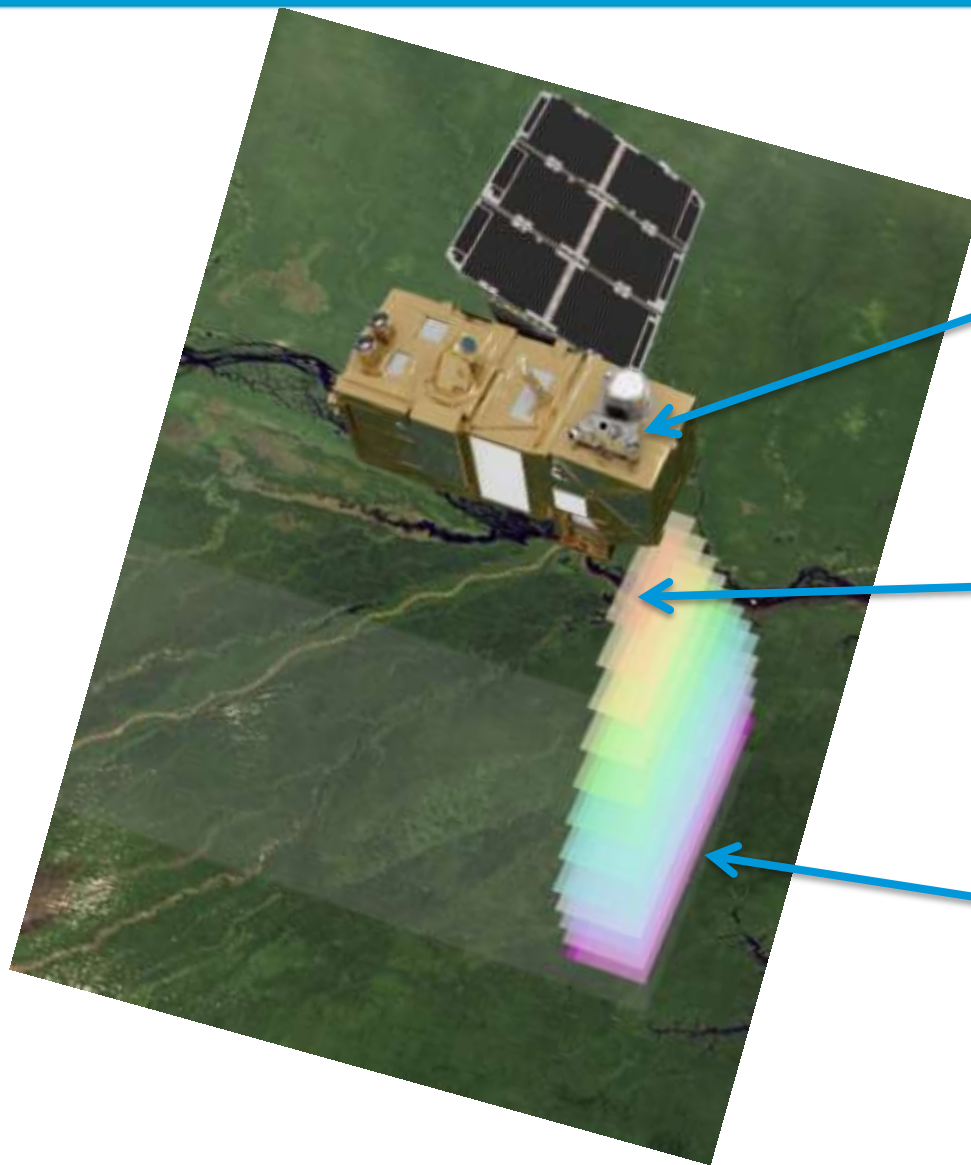
Mission Overview

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Mission Performance Centre (MPC)

Name	High-level Description	Production	Preservation Strategy	Volume
Level-1B	Top-of-atmosphere radiances in sensor geometry	Systematic	Long-term	~27 MB (each 25x23km ²)
Level-1C	Top-of-atmosphere reflectances in cartographic geometry	Systematic	Long-term	~500 MB (each 100x100km ²)
Level-2A	Bottom-of-atmosphere reflectances in cartographic geometry (prototype product)	On user side (using Sentinel-2 Toolbox*)	N/A	~600 MB (each 100x100km ²)

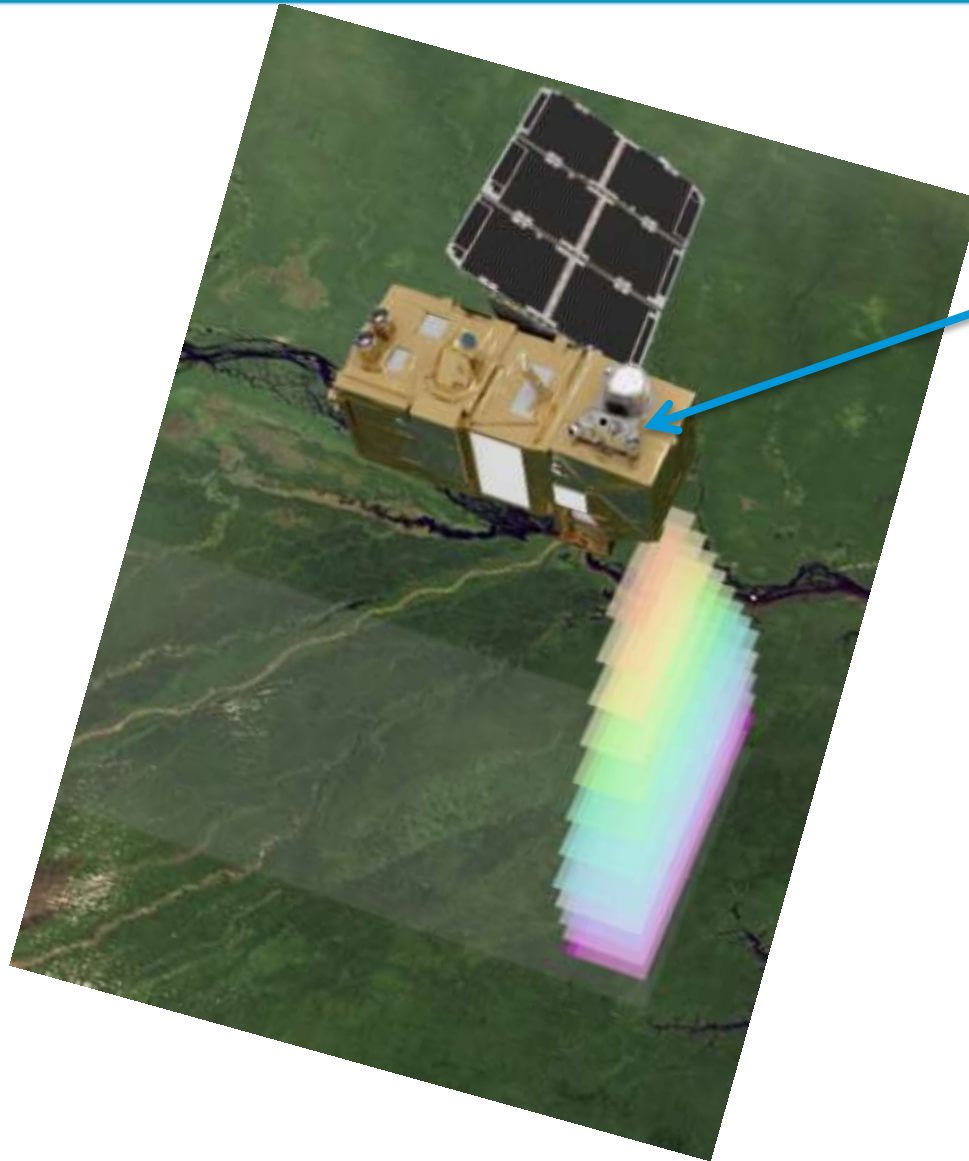
*: <https://sentinel.esa.int/web/sentinel/toolboxes/sentinel-2>



Level-1B

Level-1C

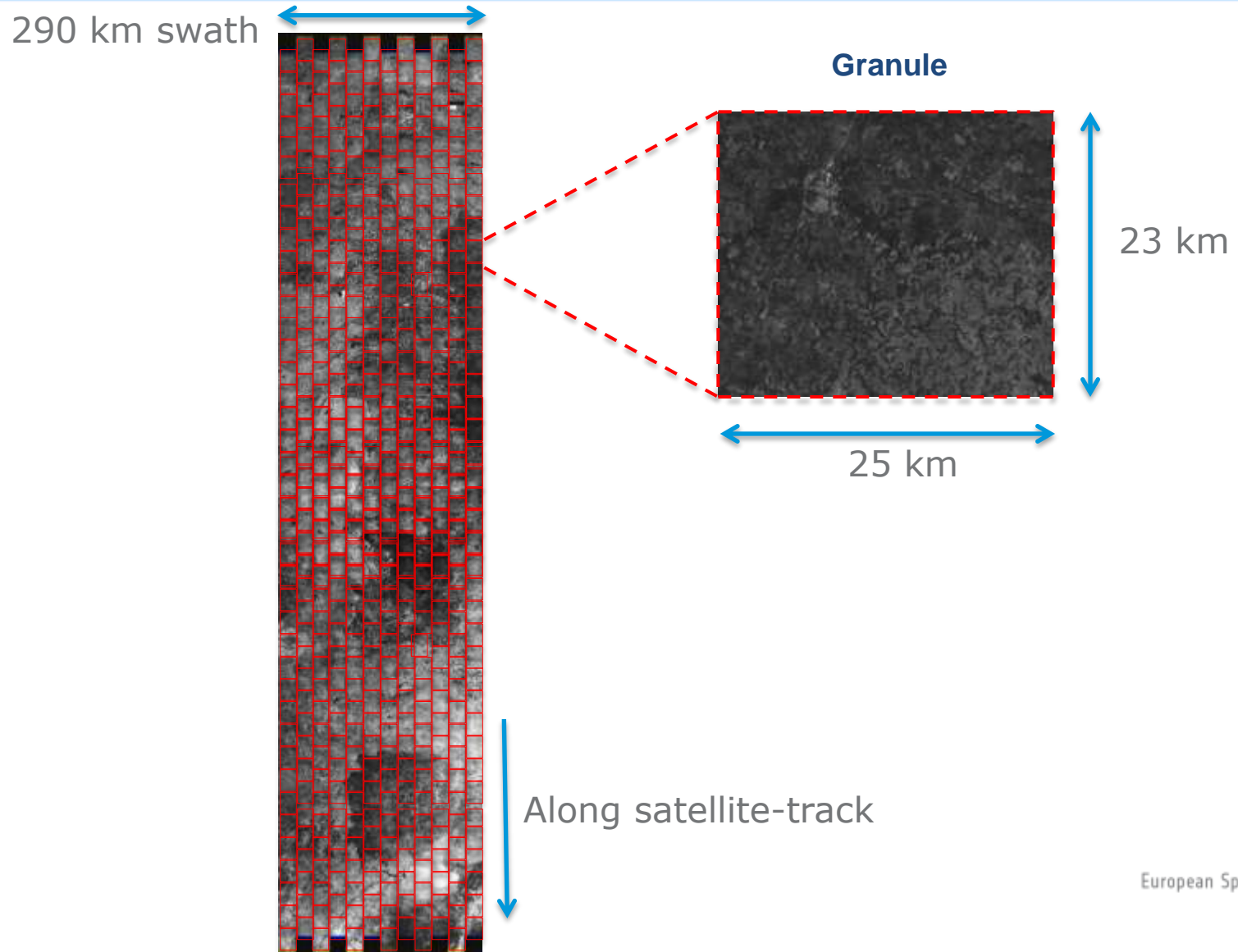
Level-2A



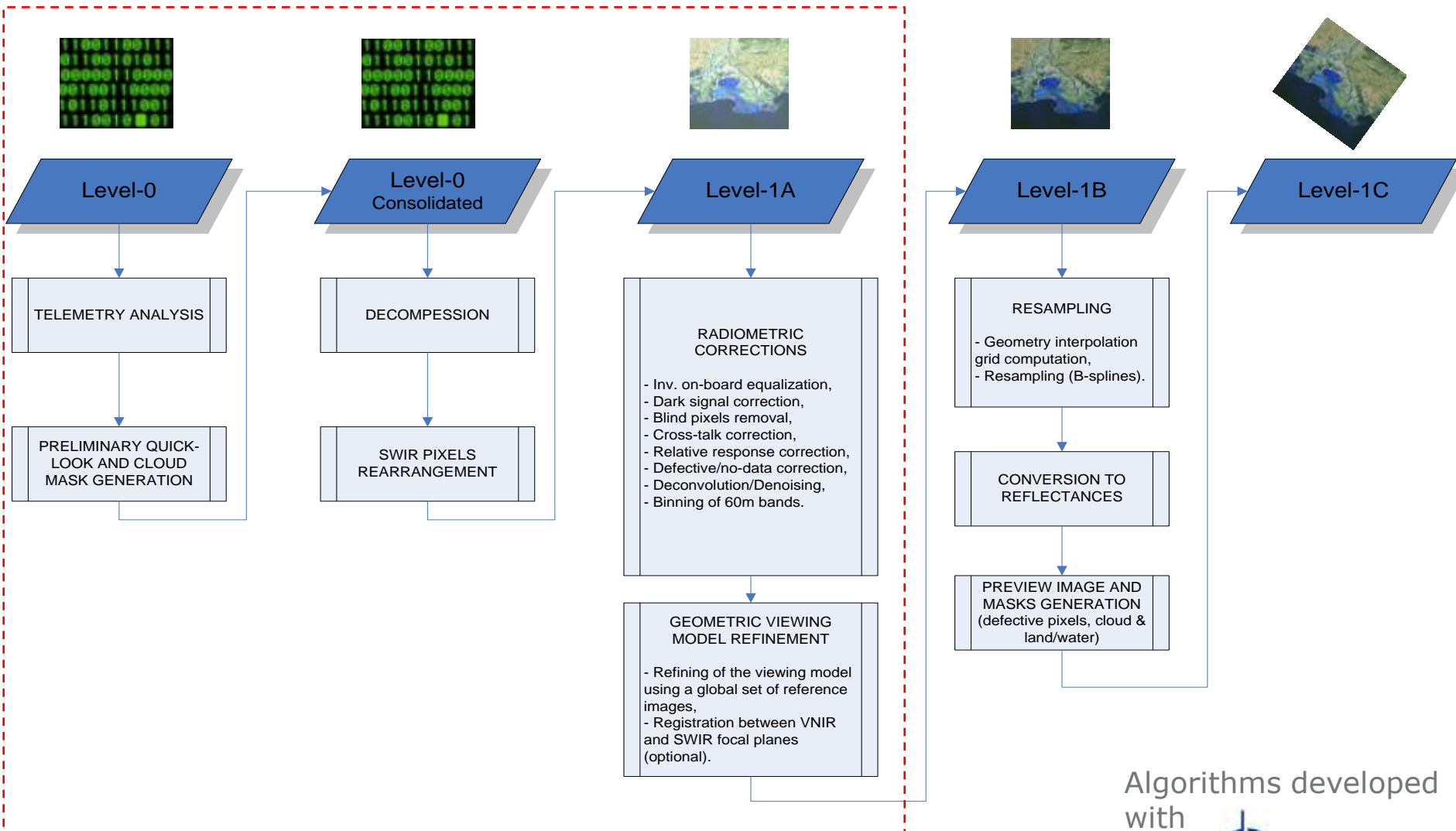
Level-1B

- Top-of-atmosphere (TOA) radiances in sensor geometry.
- Image radiometry key features:
 - ✓ Radiometric corrections for: dark signal, pixel response non-uniformity, defective pixels, etc.
 - ✓ Radiances coded in 12 bits.
- Image geometry key features:
 - ✓ Coarse registration between bands and between staggered detectors (no resampling).
 - ✓ Includes a refined geometrical viewing model calculated using a GRI (Global Reference Image).

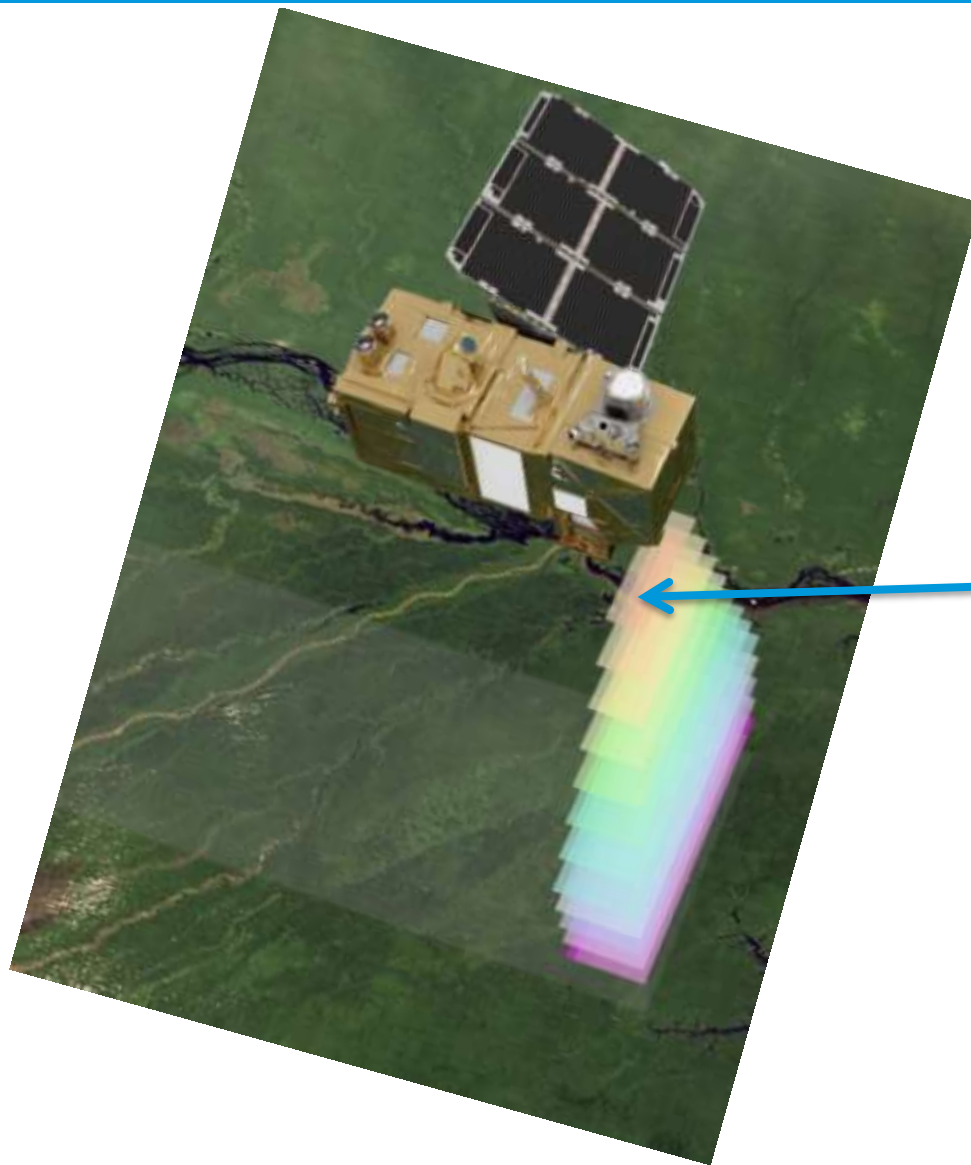
Level-1B / Product Example



Level-1B / Algorithm



Level-1C Product



Level-1C



- Top-of-atmosphere (TOA) reflectances in cartographic geometry
- Radiometry:
 - ✓ Reflectances coded in 12 bits.
 - ✓ Product includes all necessary parameters required to convert the provided reflectances into radiances.
- Geometry:
 - ✓ Projection UTM / WGS84.
 - ✓ Orthorectification uses an 90m-resolution DEM (PlanetDEM).
<http://www.planetobserver.com/products/planetdem/planetdem-90/>
 - ✓ Sub-pixel multi-temporal registration between images.

Level-1C / Tiling

- Cartographic Reference System: UTM (with $6^\circ \times 8^\circ$ grid zones).
- Each grid zone is split into $\sim 100 \times 100 \text{ km}^2$ UTM "Tiles".



Level-1C / Tile Example

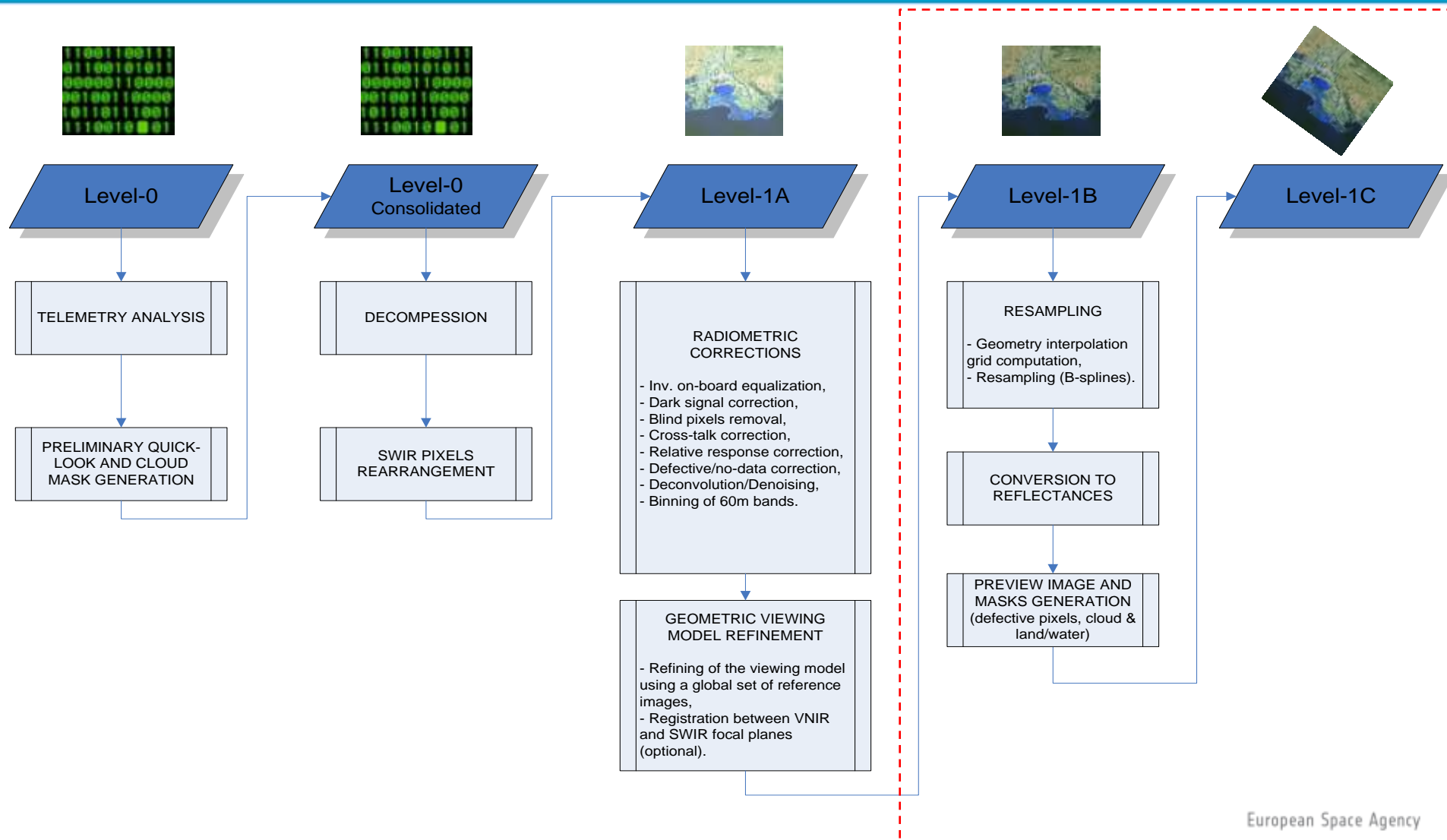
100 km



RGB composite
of a Level-1C Tile



Level-1C / Algorithm

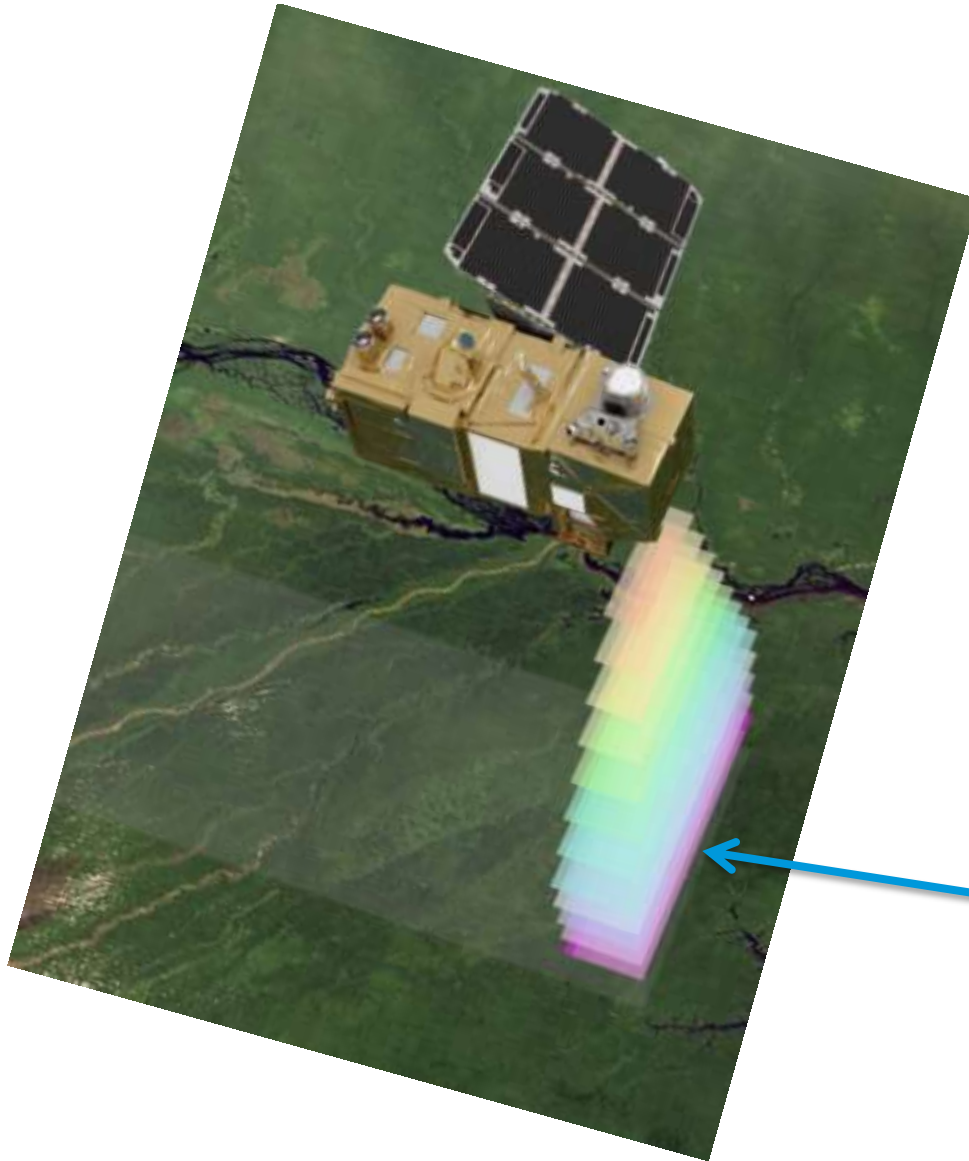


Level-1C / Data Quality Targets



Radiometric Data Quality	
Absolute radiometric uncertainty	3 % (goal) , 5 % (threshold)
Inter-band relative radiometric uncertainty	3%
Linearity knowledge accuracy	1%
Modulation Transfer Function (MTF)	0.15 to 0.3 (for 10m bands) <0.45 (for 20 & 60m bands)
Geometric Data Quality	
Absolute geolocation uncertainty	20m 2σ (threshold) 12.5m 2σ (goal) with GCPs
Multi-temporal registration	0.3 pixel 2σ (goal) with GCPs
Multi-spectral registration (for any couple of spectral bands)	0.3 pixel 3σ

Level-2A Product



Level-2A

- Bottom-of-atmosphere (BOA) reflectances in cartographic geometry.
- Products additionally include:
 - ✓ Scene Classification Map
 - ✓ Water Vapour Map
 - ✓ Aerosols Optical Thickness Map
- Algorithm includes:
 - ✓ Cloud and cloud shadow detection.
 - ✓ Cirrus detection and correction.
 - ✓ Slope effect correction.
 - ✓ BRDF effect correction.

Level-2A / Product Example

From left to right:

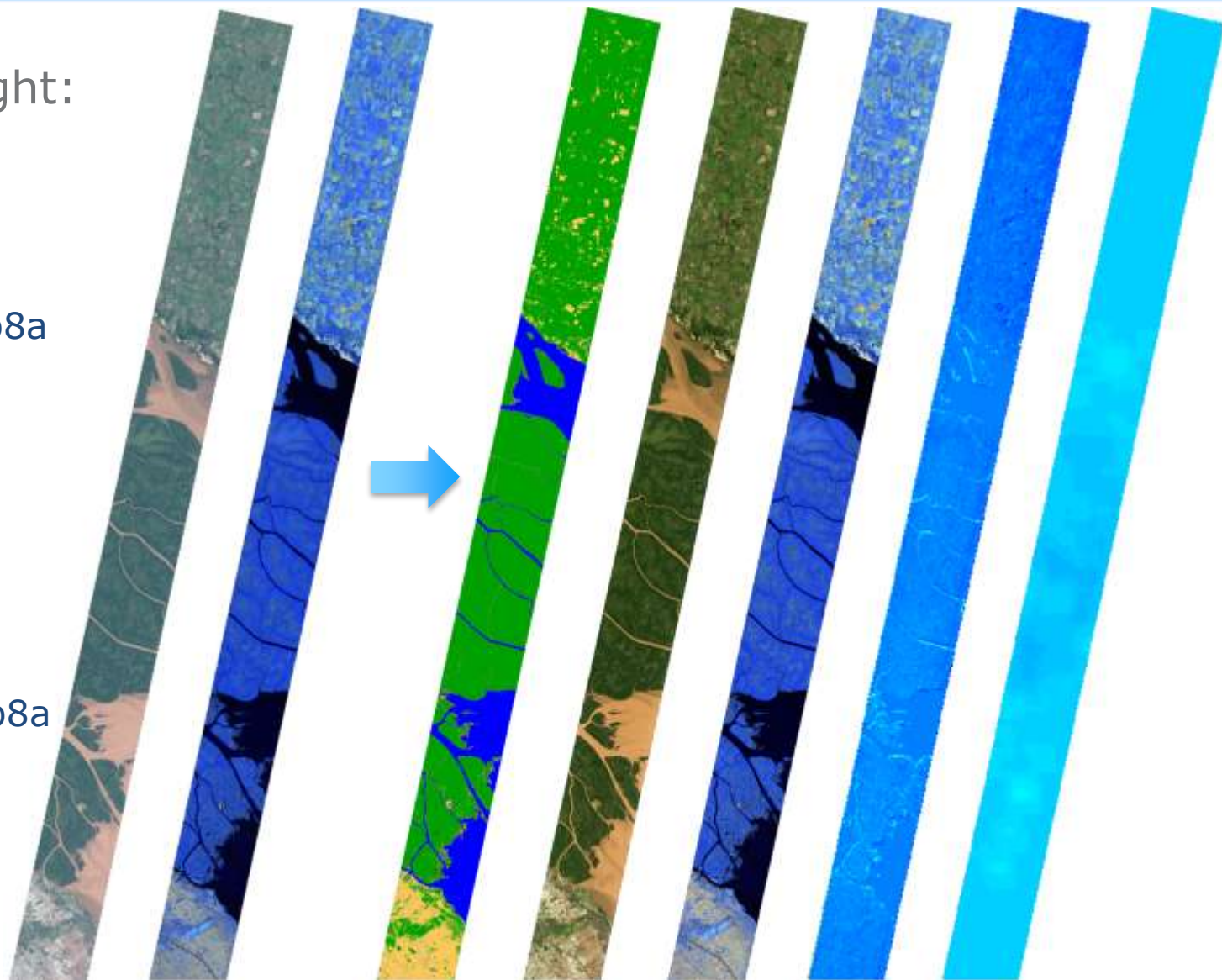
Level-1C

- TOA b4-b3-b2
- TOA b12-b11-b8a

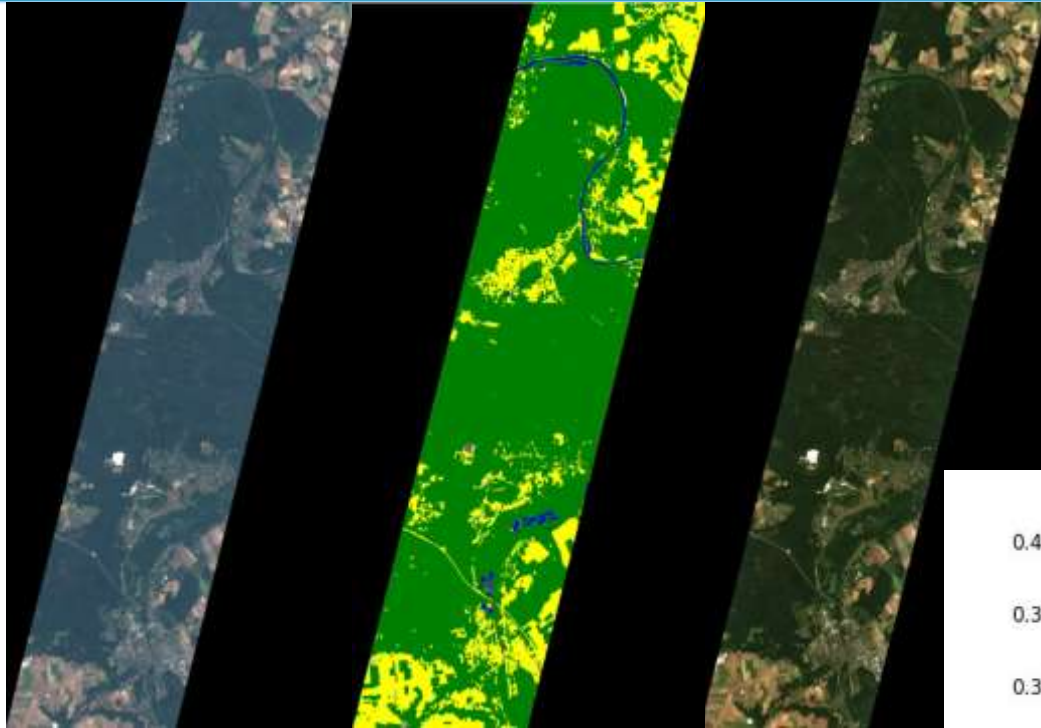


Level-2A

- Scene Classification
- BOA b4-b3-b2
- BOA b12-b11-b8a
- Water Vapour
- AOT



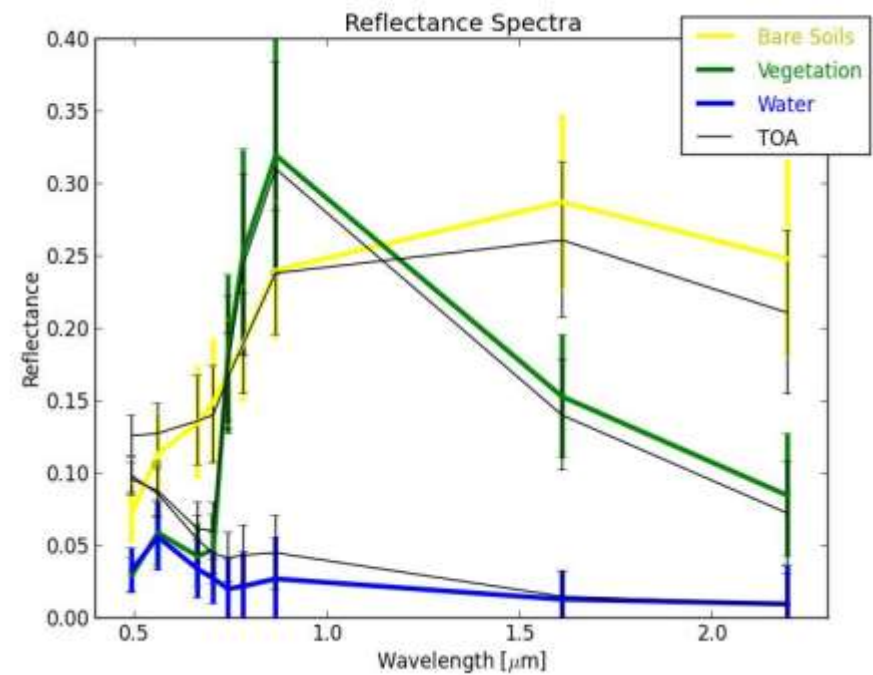
Level-2A / Product Example



Level-1C

Scene
Classification

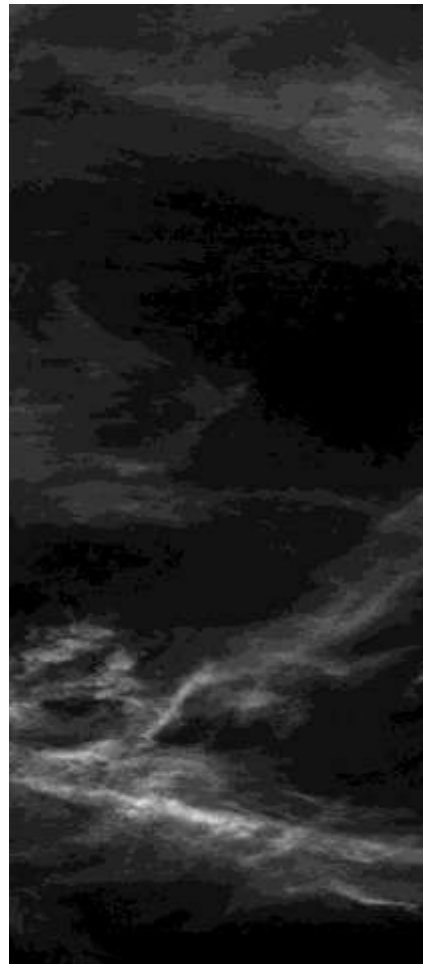
Level-2A



Level-2A / Cirrus Correction



TOA reflectance
(RGB composite = bands at
665, 560 and 443 nm)

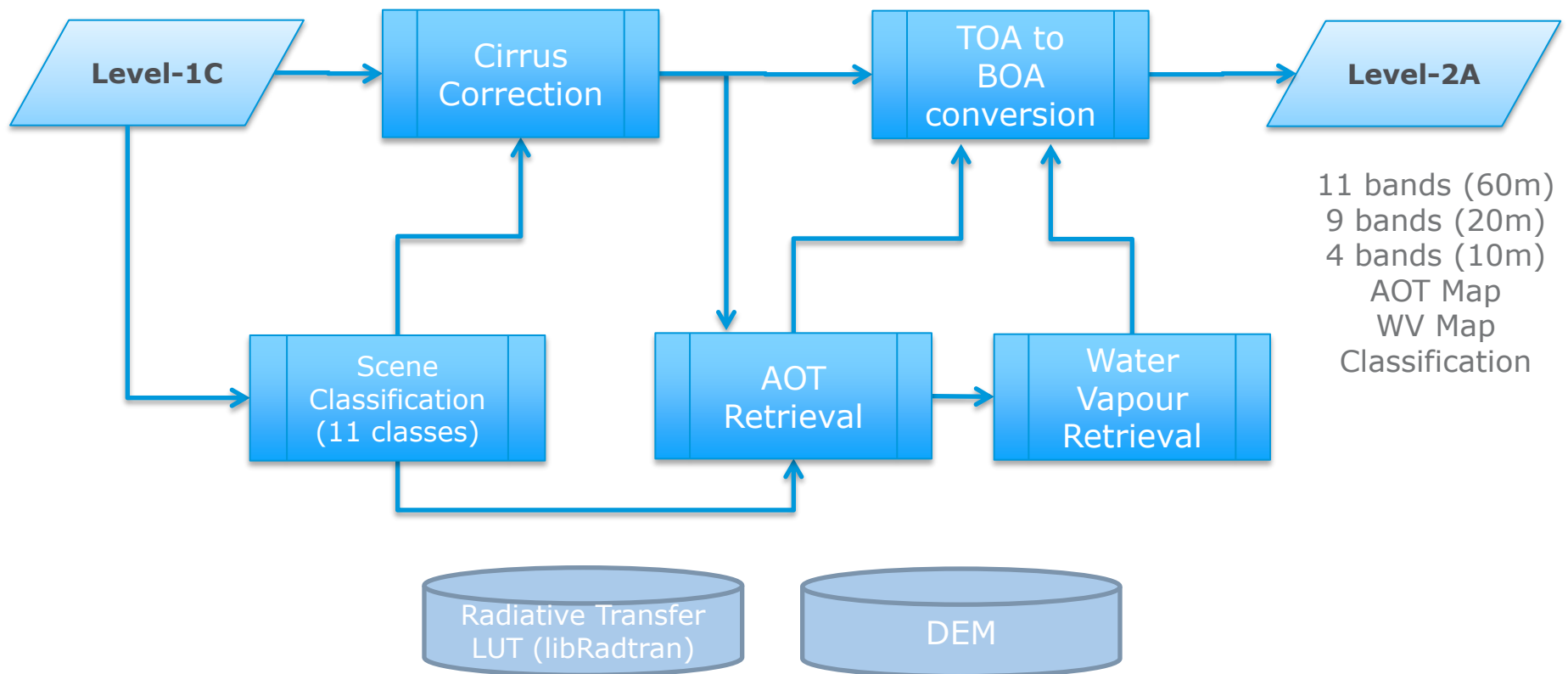


Cirrus band image
(1375 nm)



BOA reflectance
(After cirrus detection and
atmospheric correction)

Level-2A / Algorithm Overview



Algorithms developed
with



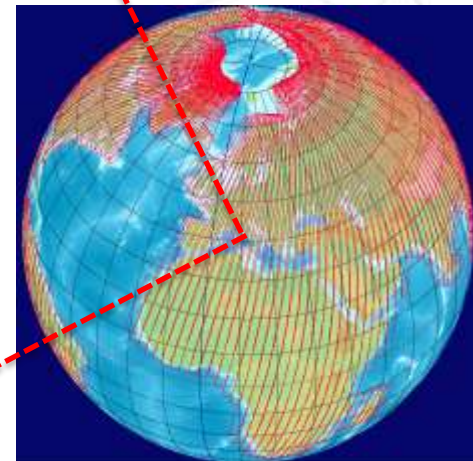
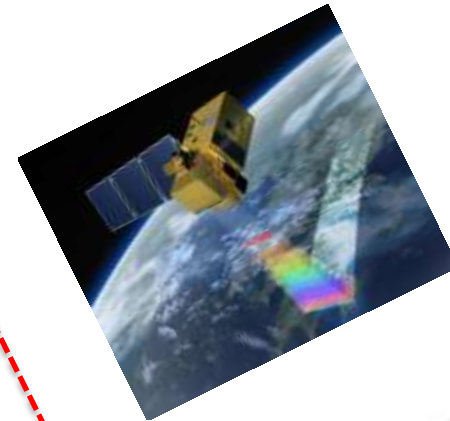
From Data Acquisition to Product Delivery

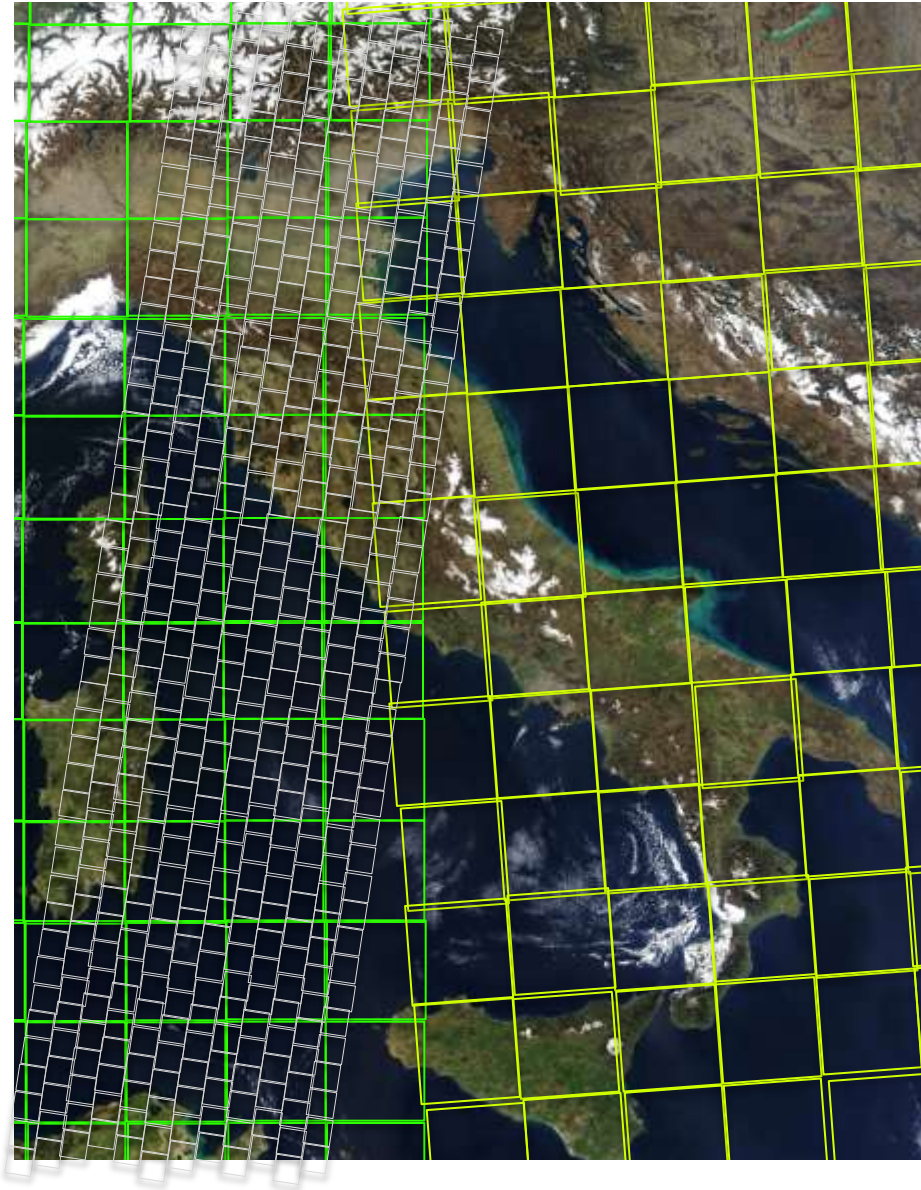


From Data Acquisition to Product Delivery



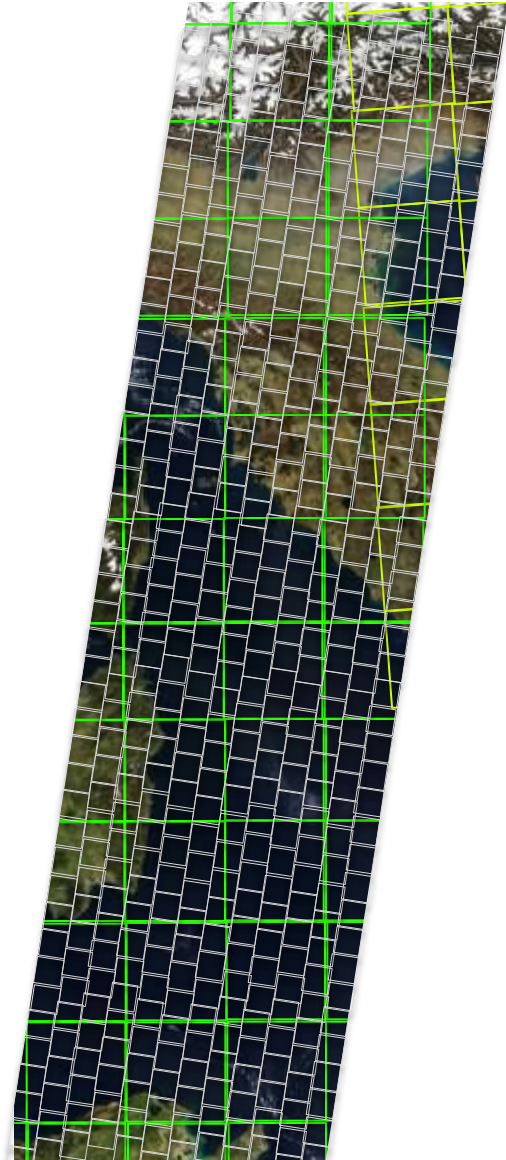
- Systematic acquisition.



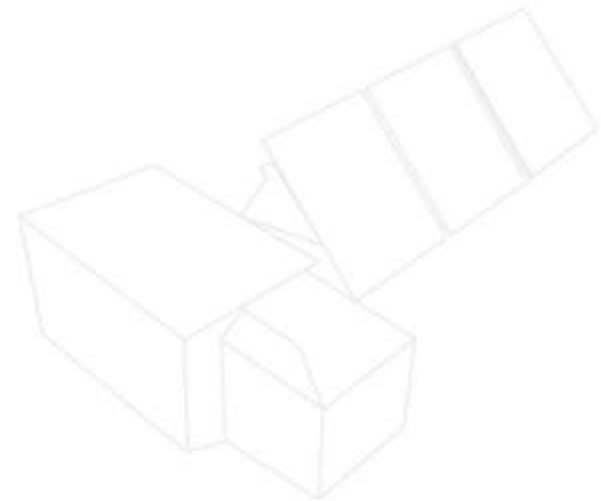


- Projection on UTM cartographic reference system





- Data-driven (systematic) processing and archiving of:
 - ✓ Granules (Level-1B)
 - ✓ Tiles (Level-1C)

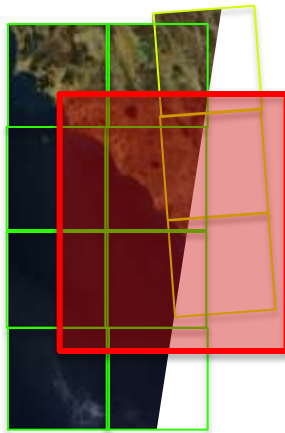




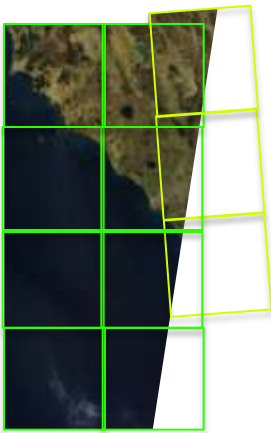
- User-driven data access.
- Product content is defined by the user at query time:
 - ✓ Area of interest
 - ✓ Product Level (1B/1C)
 - ✓ Product components (e.g. bands, metadata)



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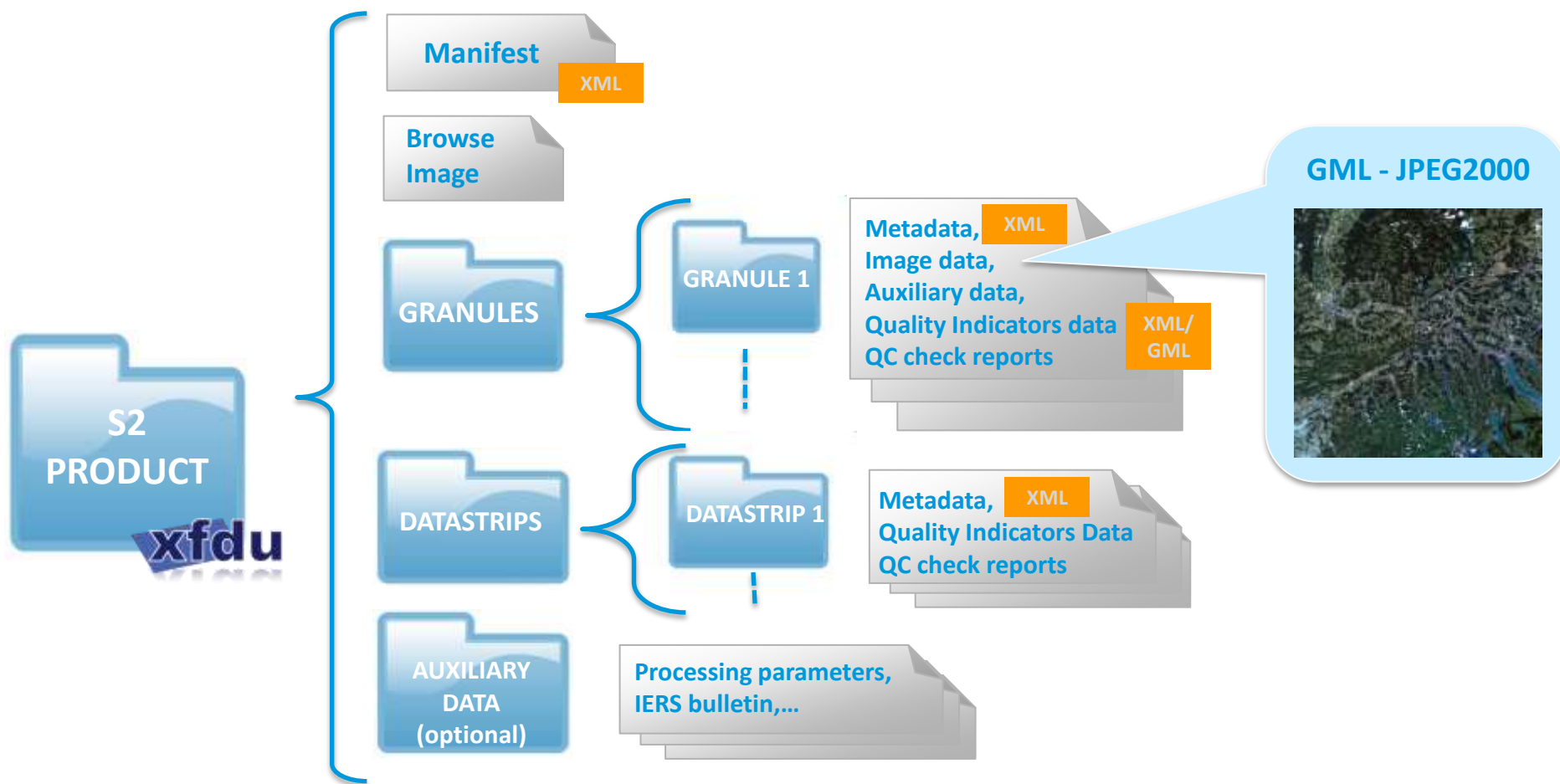


Level-1C Product (Sentinel-SAFE format)



- User-driven data access.
- Product content is defined by the user at query time:
 - ✓ Area of interest
 - ✓ Product Level (1B/1C)
 - ✓ Product components (e.g. bands, metadata)
- Product is packaged in:
 - ✓ Sentinel-SAFE format

Products Format : Sentinel-SAFE



- Level-1C test product available at: <https://sentinel.esa.int/web/sentinel/user-guides/sentinel-2-msi/test-data>

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Mission Overview

Products and Algorithms

Mission Performance Centre (MPC)

- The S2-MPC is the ground segment entity in charge of the following functionalities:
 - ✓ Calibration ([CAL](#))
 - ✓ Validation ([VAL](#))
 - ✓ Quality Control ([QC](#))
 - ✓ Data processors and tools corrective and perfective maintenance ([PTM](#)).
 - ✓ End-to-end system performance monitoring ([E2ESPM](#))
- S2-MPC is implemented through a scientific-industrial consortium.

S2-MPC Team



S2-MPC Expert Support Laboratories (ESL)



ESL Level-1 Calibration



ESL Level-1 Validation



ESL Level-2A





Thank you very much for your attention !

Further information available at: <http://sentinel.esa.int>