



Introduction to ESA toolboxes

Fabrizio Ramoino

ESA–MOST China Dragon 4 Cooperation

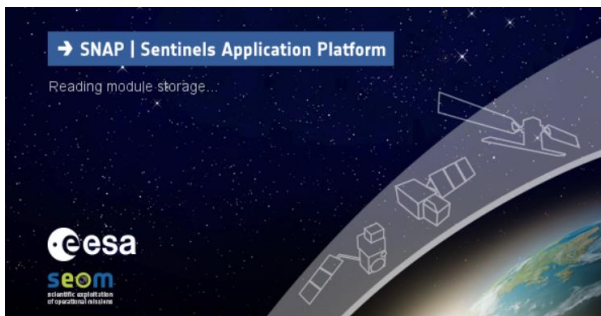
2019 ADVANCED INTERNATIONAL TRAINING COURSE IN LAND REMOTE SENSING

中欧科技合作“龙计划”第四期 **2019**年陆地遥感高级培训班

18 to 23 November 2019 | Chongqing University, P.R. China

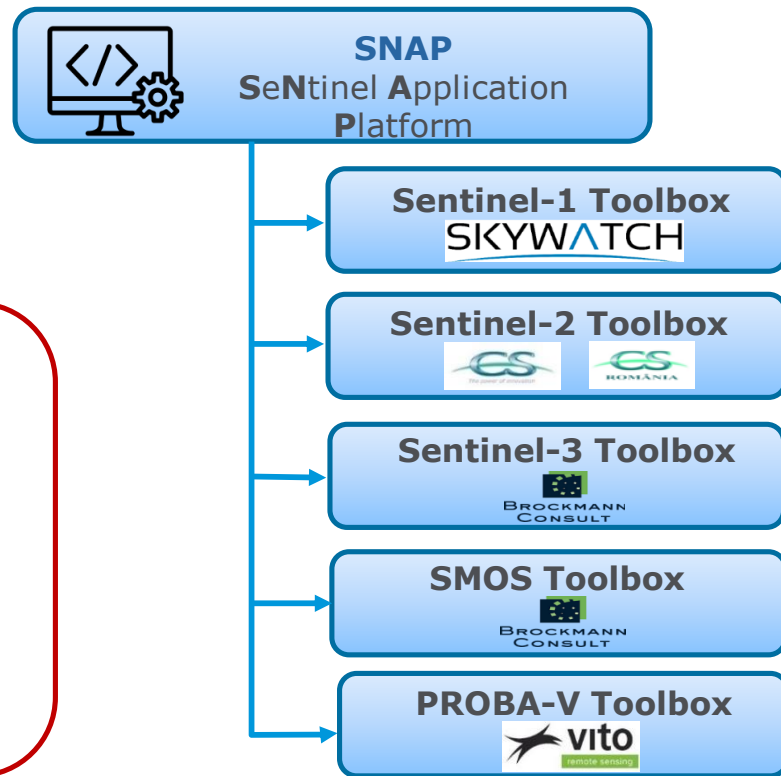


培训时间: 2019年11月18日-23日 主办方: 重庆大学

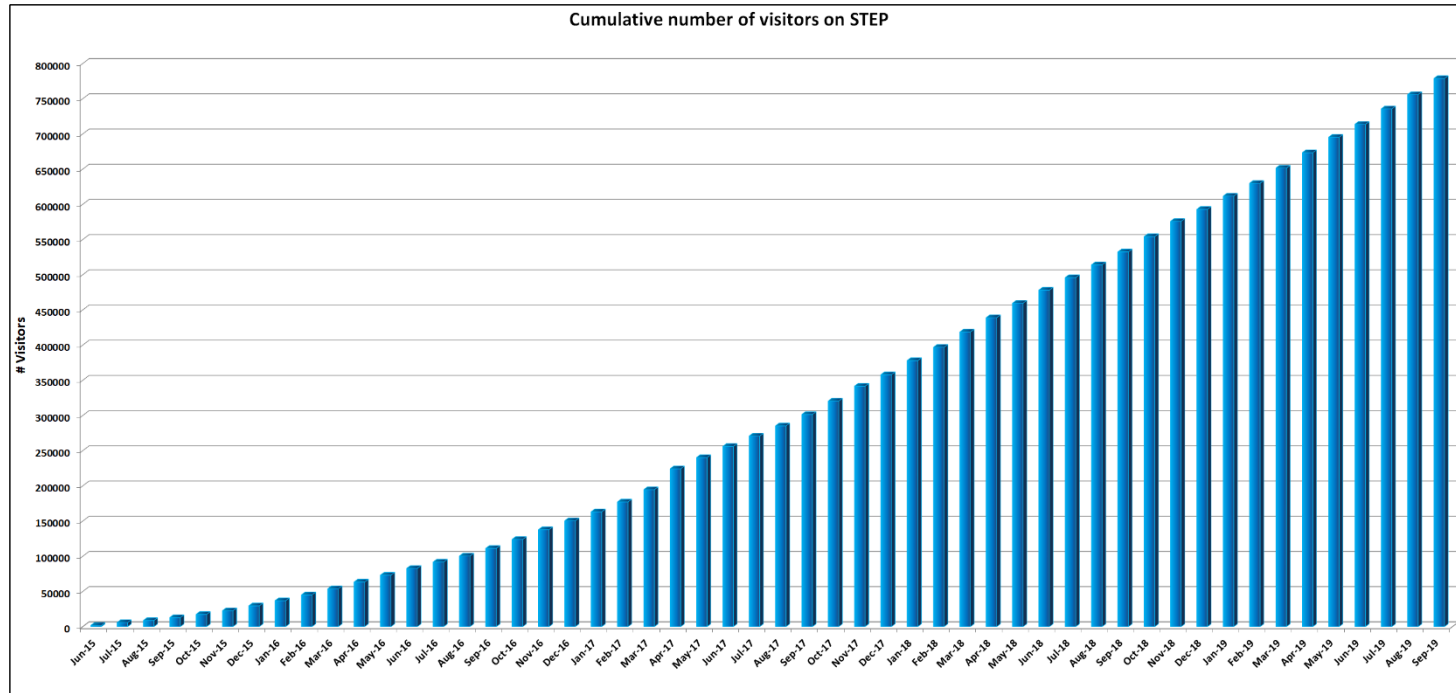


Download it at
step.esa.int

- ✓ Free and open source software
- ✓ Common Java core framework
- ✓ Joint development of SNAP platform for Sentinel and other toolboxes
- ✓ Interchangeable Java/Python plugins
- ✓ Portable engine to Cloud infrastructure
- ✓ User friendly: single installation, intuitive GUI, online help, tutorials, active user forum



SNAP downloads & STEP visits



STEP website exceeded 775.000 visit sessions from June 2015 until today



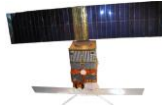
SNAP & SAR (Sentinel-1 Toolbox)



Sentinel-1



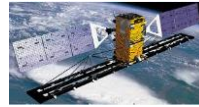
ENVISAT



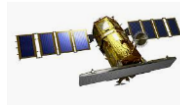
ERS-1



TerraSAR-X



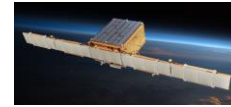
RADARSAT



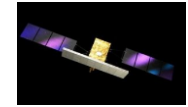
KOMPSAT-5



ALOS 1&2



ICEYE



COSMO-SkyMed

- Main features:** Absolute calibration, Multilooking, Speckle filtering, Precise orbits handling
- Coregistration of detected and complex products
- Full support of Sentinel-1 TOPS interferometry, debursting, slice assembly
- Terrain Correction
- SAR simulation and Layover and shadow masks
- Applications: oil spill detection, ship detection, wind field estimation etc.
- Fully integrated and featured InSAR tools for Stripmap and Zero-Doppler focused data
- Compatibility with PolSARpro Toolbox (Reader, Writer)
- Integrated Export to SNAPHU (interferometric phase unwrapping) and STAMPS (PS InSAR)



Main features:

- C-band (5.4 GHz) SAR
- Daily coverage of high priority areas
- Bi-weekly global coverage
- 12 days repeat cycle (6 days with both Sentinels 1A and 1B operational)
- 7 years design life time (consumables for 12 years)



Applications:

- Ice and marine/land monitoring
- Mapping in support of humanitarian aid in crisis situations

Sentinel-1A & B data



Available products

- Level 0 (L0-RAW)
- Level 1 Ground Range, Multi-Look, Detected Medium Resolution (L1-GRDM) and High Resolution (L1-GRDH)
- Level 1 Single-Look Complex (L1-SLC)
- Level 2 Ocean (L2-OCN)

2018



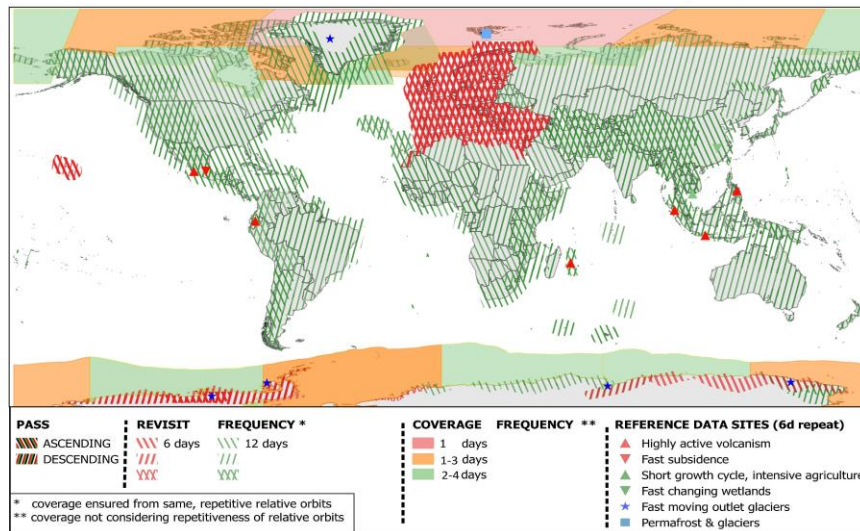
➔ 1,304,078 published products
(2.3 PB)

➔ 3,282,679 published products
from start of Ops to the end Y2018
(~5.8 PB)

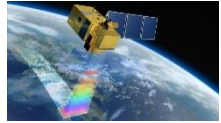
Sentinel-1 Constellation Observation Scenario: Revisit & Coverage Frequency



validity start: 02/2018



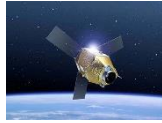
SNAP & Optical HR (Sentinel-2 Toolbox)



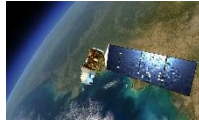
Sentinel-2



SPOT



Pleiades



Landsat



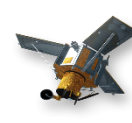
ALOS AVNIR



RapidEye



Komsat



Ikonos



Worldview

.....

Main features:

- **Sen2Cor** and **i-Cor** for Atmospheric Correction
- L2B **biophysical processor** (LAI, fAPAR, ...)
- Reflectance to Radiance Processor
- **Radiometric Indices**
 - ✓ **Vegetation indices:** DVI, RVI, PVI, IPVI, WdVI, TNDVI, GNDVI, GEMI, ARVI, NDI45, MTCI, MCARI, REIP, S2REP, IRECI, PSSRa
 - ✓ **Soil indices:** SAVI, TSAVI, MSAVI, MSAVI2, BI, BI2, RI, CI
 - ✓ **Water indices:** NDWI, NDWI2, MNDWI, NDPI, NDTI
- **IdePix Processor:** pixel classification
- **OTB tools:** Pansharpener, Rasterization, Segmentation, ...



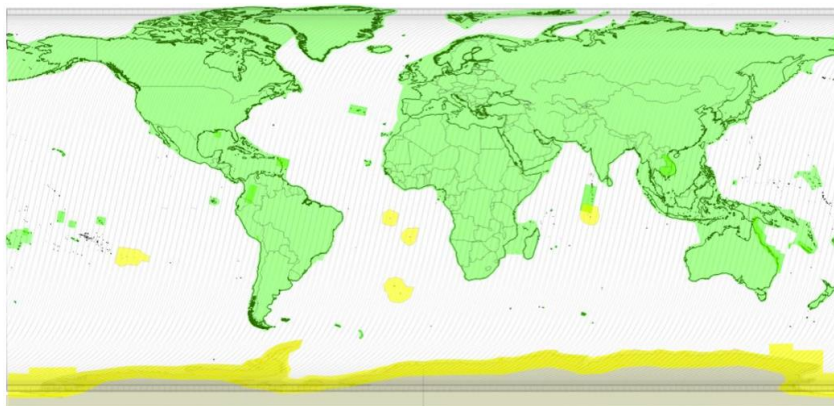
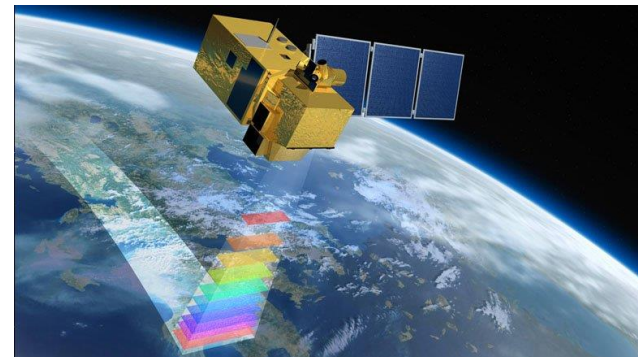
Sentinel-2 characteristics



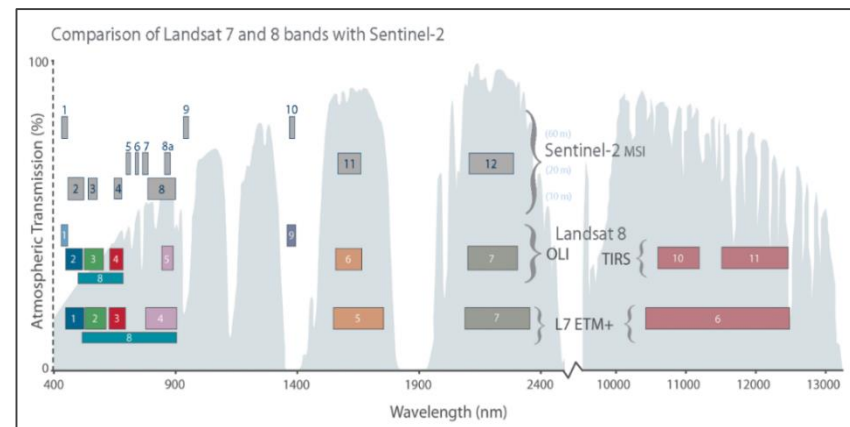
Optical mission for the monitoring of land and coastal regions

Main features:

- Constellation of two satellites (Sentinel-2A and Sentinel-2B)
- Multi-Spectral Instrument (MSI)
- Polar, sun-synchronous orbit at 786km and LTDN 10h30
- 10 days repeat cycle (5 days with both Sentinels 2A and 2B operational)
- Swath of 290km



5 days
10 days



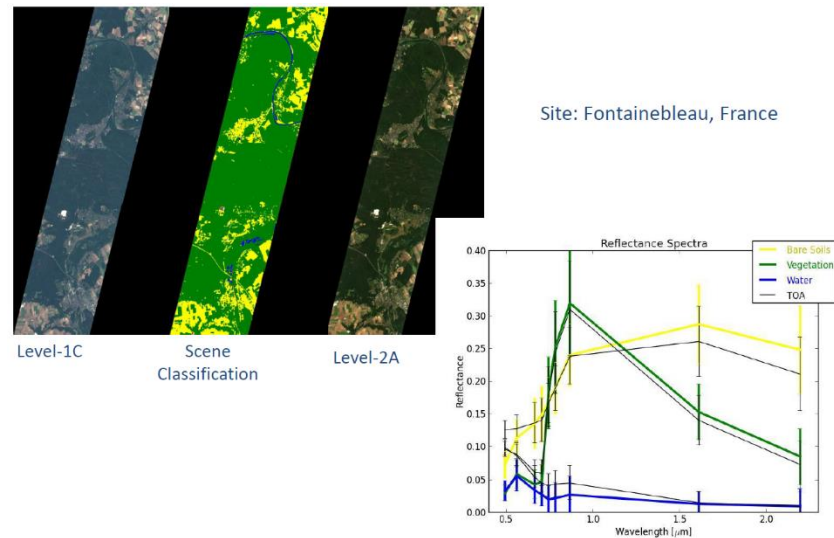
SENTINEL-2 products available for users (either generated by the ground segment or by the SNAP) are:

Level-1C

- Top-Of-Atmosphere reflectances in cartographic geometry
- Systematic generation and online distribution
- ~600MB (each 100km x 100km)

Level-2A

- Bottom-Of-Atmosphere reflectances in cartographic geometry
- Systematic and on-User side (using SNAP)
- ~600MB (each 100km x 100km)



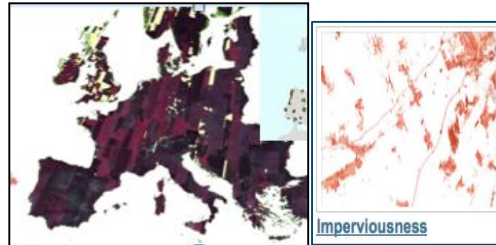
Products are a compilation of elementary granules of fixed size, along with a single orbit. A granule is the minimum indivisible partition of a product (containing all possible spectral bands).

For Level-1C and Level-2A, the granules, also called tiles, are 100x100 km² ortho-images in UTM/WGS84 projection.

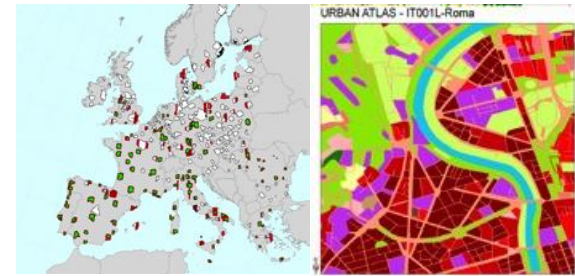
Sentinel-2 applications



Agriculture, Forests & Carbon, Vegetation monitoring



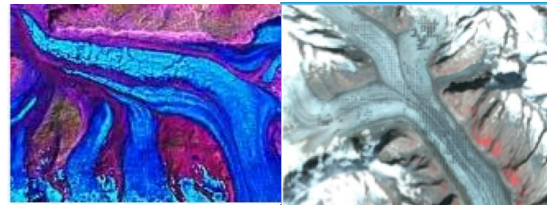
Land cover classification, high resolution layers & change



Regional to Urban Applications



Emergency management



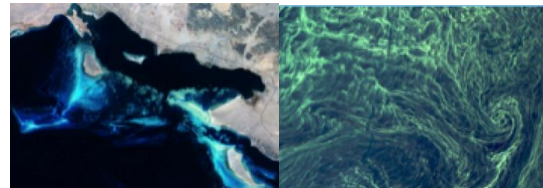
Glaciers & Ice



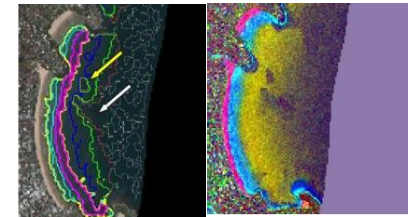
Global Land use & change



Geology



Water quality



Coastal zones/bathymetry



SNAP & Optical/Thermal MR (S3 Toolbox)



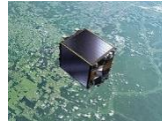
Sentinel-3



ENVISAT



ERS



Proba-V



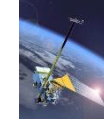
SPOT VGT



MODIS



AVHRR



VIIRS

.....

Main features:

- Visualizing spectrum of pixels
- **Uncertainty** visualization and propagation of uncertainty in BandMaths
- Pixel extraction tool
- Specific sensor processors:
 - ✓ *S3 OLCI Radiometry, S3 SLSTR PDU stitching*
 - ✓ *AATSR/SLSTR Reprojection*
 - ✓ *Performs radiometric corrections on MERIS*
- Optical water type classification based on atmospherically corrected reflectances
- FU (Forel-Ule) Classification used to derive the hue angle and FU value
- **IdePix Processor:** pixel classification
- FLH (Fluorescence Line Height) / MCI (Maximum Chlorophyll Index) retrieval
- FUB/WeW processor



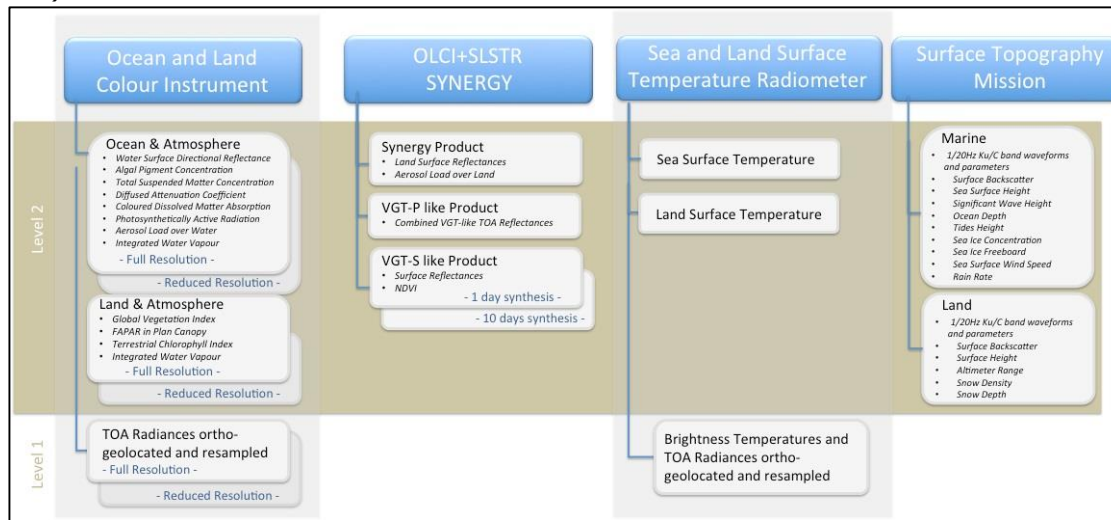
Sentinel-3 products



Sentinel-3 is an ocean and land mission and provides data continuity for the ERS, ENVISAT and SPOT-VGT satellites.

SENTINEL-3 makes use of multiple sensing instruments to accomplish its objectives:

- *SLSTR (Sea and Land Surface Temperature Radiometer)*
- *OLCI (Ocean and Land Colour Instrument)*
- *SRAL (SAR Altimeter)*
- *DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite)*
- *MWR (Microwave Radiometer)*



Access to Sentinels data



The Copernicus Open Access Hub provides complete, free and open access to Sentinel-1, Sentinel-2 and Sentinel-3 user products.

Go to <https://scihub.copernicus.eu/>

Welcome to the Copernicus Open Access Hub

The Copernicus Open Access Hub (previously known as Sentinels Scientific Data Hub) provides complete, free and open access to Sentinel-1, Sentinel-2, Sentinel-3 and Sentinel-5P user products, starting from the In-Orbit Commissioning Review (IOCR).

Sentinel Data are also available via the Copernicus Data and Information Access Services (DIAS) through several platforms .

Please visit our [User Guide](#) for getting started with the Data Hub Interface. Discover how to use the APIs and create scripts for automatic search and download of Sentinels' data.

Latest update: see the section on [Long Term Archive](#) for the upgrade of the interfaces for access to offline data.

For further details or requests of support please send an e-mail to eosupport@copernicus.esa.int

Reports & Stats
Data updated hourly

35,143
prod. published in the last 24h
(S1 + S2 + S3 + SSP)

148,927
downloads in the last 24h
(SciHub + API Hub + S-3 PreOps + S-5P PreOps)

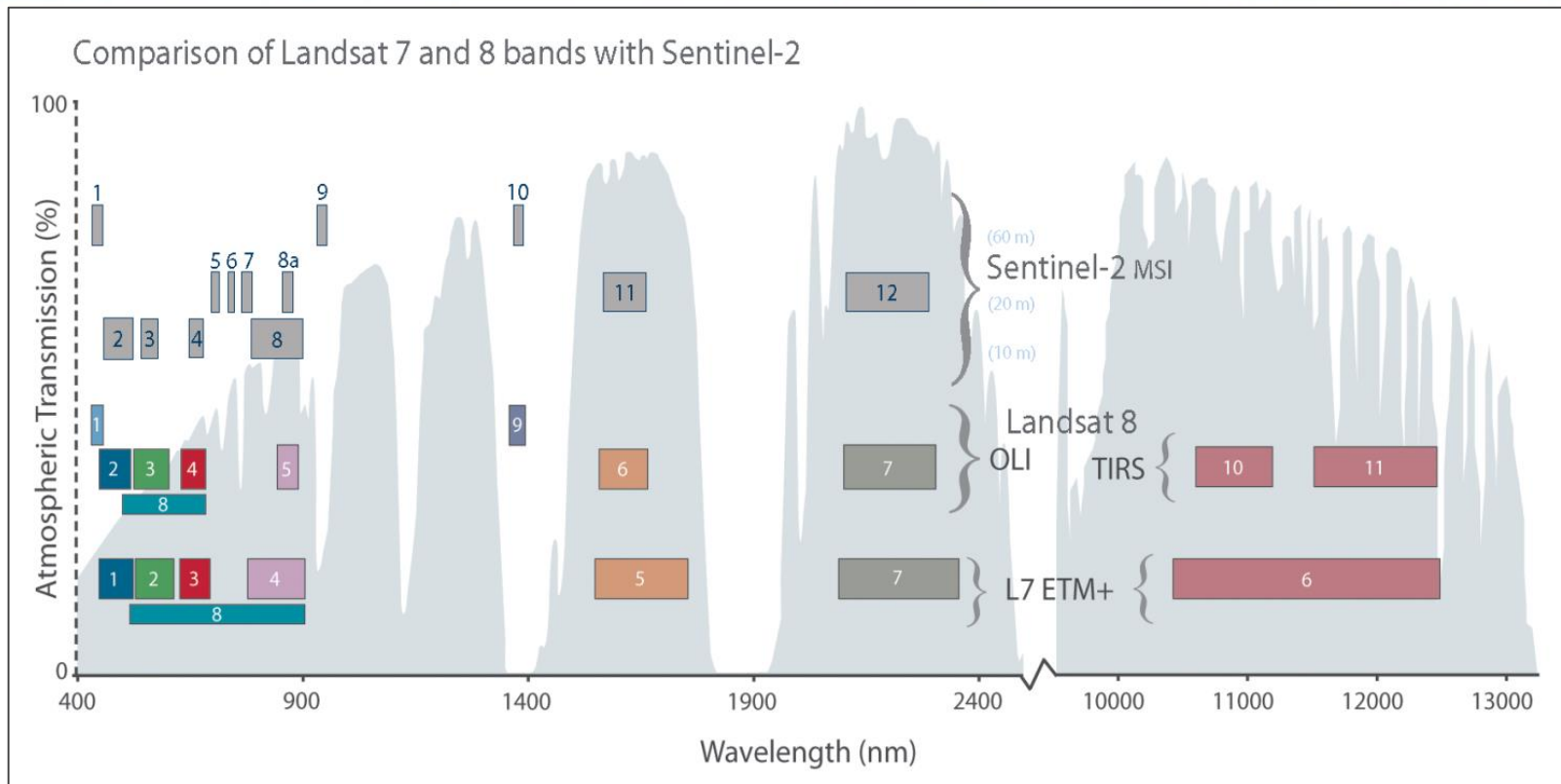
Reports

Resources

Open Hub **API Hub** **S-5P Pre-Ops** **GNSS Hub**



Sentinel-2 spectral bands



Sentinel-2 L2A data overview



Sen2Cor is the Atmospheric Correction processor used in the ESA Payload Data Ground Segment to generate S2 L2A data and it is distributed via STEP to be used as SNAP plug-in or via command line.

- ✓ Bottom-of-atmosphere (BOA) reflectances in cartographic geometry (UTM/WGS84)
- ✓ Products additionally include:
 - *Scene Classification Map*
 - *Water Vapor Map*
 - *Aerosols Optical Thickness Map*
- ✓ Algorithm includes:
 - *Cloud and cloud shadow detection*
 - *Cirrus detection and correction*
 - *Slope effect correction*
 - *BRDF effect correction*

Beyond Sen2Cor, Sentinel-2 data can be atmospherically corrected using others processors:

MAJA (developed by CESBIO/CNES)

i-COR (developed by VITO)

CorA (developed by Brockmann Consult)

LaSRC (developed by NASA GSFC/USA)



Sentinel-2 L2A data overview



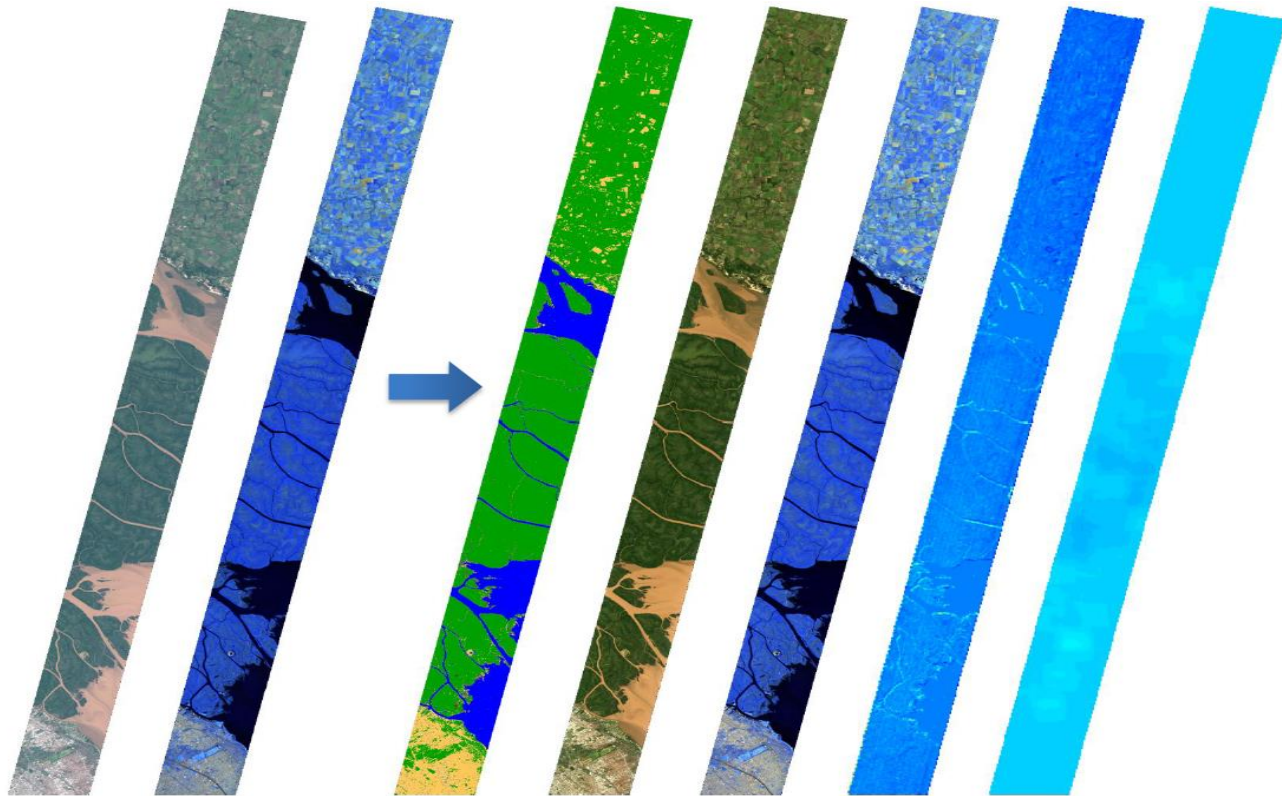
From left to right:

Level-1C [TOA]

- [RGB] B4-B3-B2
- [RGB] B12-B11-B8a

Level-2A [BOA]

- Scene Classification
- [RGB] B4-B3-B2
- [RGB] B12-B11-B8a
- Water Vapour
- Aerosols Optical Thickness



Essential pre-processing steps:

Resampling

The S2 products are multi-size

- B2, B3, B4 and B8 @ 10m
- B5, B6, B7, B8A, B11 and B12 @ 20m
- B1, B9 and B10 @ 60m

Needed if the user wants to combine bands with different spatial resolution

Subset (spatially/spectrally)

The S2 data are distributed in tiles 100x100 km² ortho-images in UTM/WGS84 projection.

Needed if the AOI covers a portion of the S2 scene or if only a subset of bands are useful in the next step (this will reduce the computation time)

Re-projection

If the AOI covers more than one S2 tile in different UTM zones the user needs to re-project in a common CRS before to mosaic them.

If the user wants to merge different data sources projected in different CRS.

To export the view in KMZ and visualise your output in Google Earth.

1) Overview of Sentinel-2 data

- ✓ Spectral bands
- ✓ Level 1C & 2A products intercomparison
- ✓ Pre-processing steps
- ✓ Graph builder

2) Burned area estimation

- ✓ Normalized Burn Ratio (NBR) calculation
- ✓ Burn severity estimation

3) Water change detection

- ✓ Second Normalized Difference Water Index (NDWI-2) calculation
- ✓ Sentinel Water Mask (SWM) calculation
- ✓ Create water mask based on NDWI2 and SWM
- ✓ Water change detection