Introduction to ESA toolboxes

Magdalena Fitrzyk

ESA–MOST China Dragon 4 Cooperation

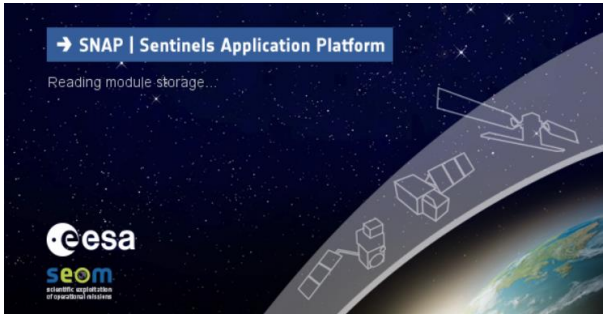
2019 ADVANCED INTERNATIONAL TRAINING COURSE IN LAND REMOTE SENSING

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

SNAP



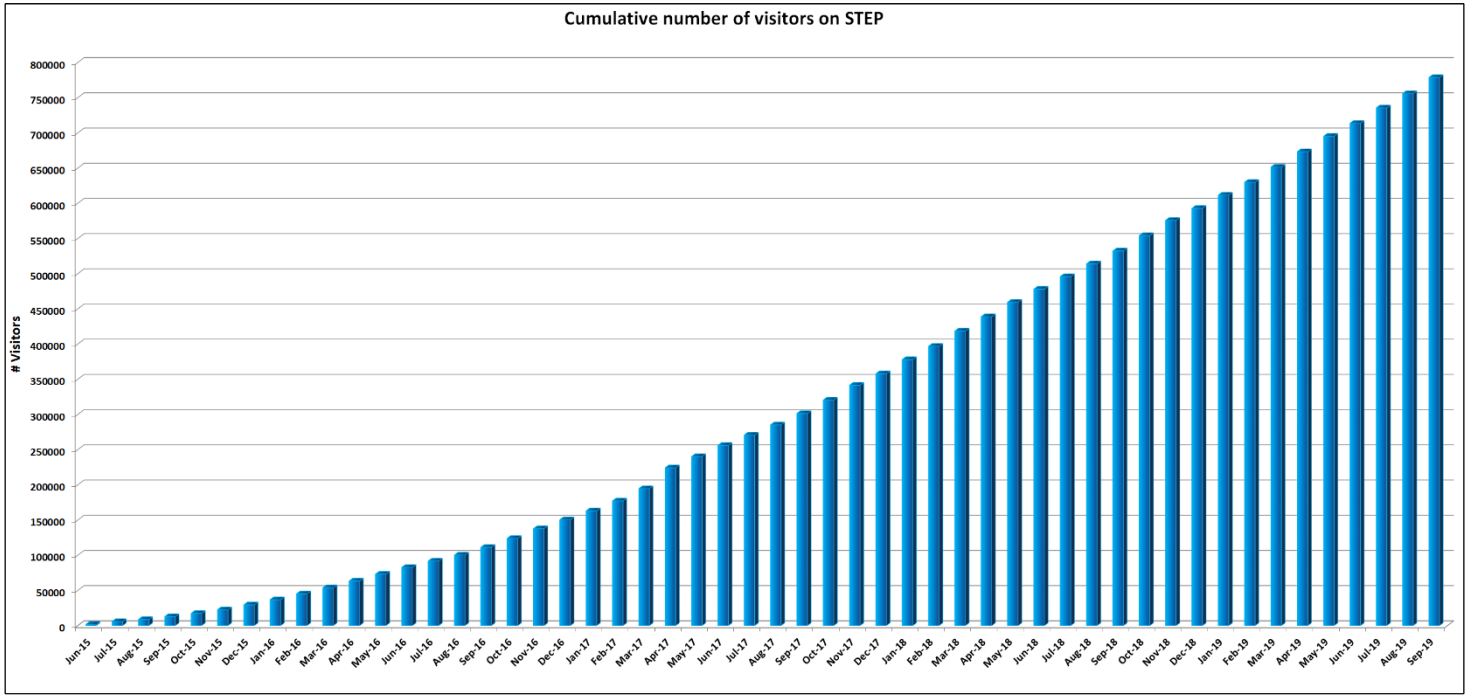
Download it at
step.esa.int

- ✓ 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
SeNtinel Application Platform

- **Sentinel-1 Toolbox** SKYWATCH
- **Sentinel-2 Toolbox**
- **Sentinel-3 Toolbox** Brockmann Consult
- **SMOS Toolbox** Brockmann Consult
- **PROBA-V Toolbox** VITO

SNAP downloads & STEP visits



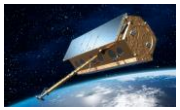
STEP website exceeded 775.000 visit sessions from June 2015 until today

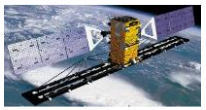
SNAP & SAR (Sentinel-1 Toolbox)

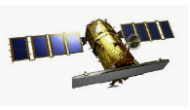

Sentinel-1


ENVISAT


ERS-1

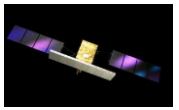

TerraSAR-X


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)

Sentinel-1 characteristics

Main features:

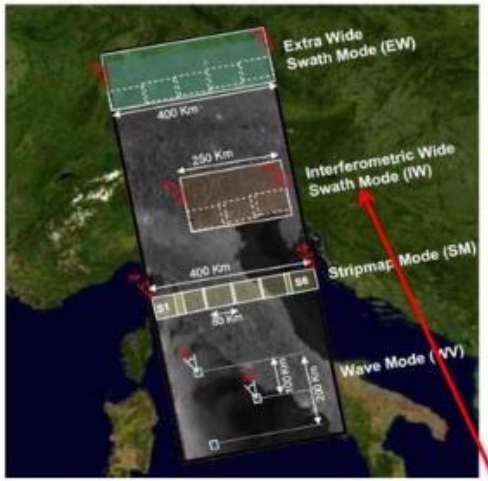
- → C-band (5.4 GHz) SAR
- → Daily coverage of high priority areas
- → Bi-weekly global coverage
- → 12 days repeat cycle (6 days with both Sentinels 1A and 1B operational)
- → 7 years design life time (consumables for 12 years)

Applications:

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

Sentinel-1 characteristics

Sentinel-1 observation scenario
SAR Operational Modes



	GRD Level 1 product resolution	Swath Width	Polarisation
EW	50m (3 ENL)	> 400 km	HH+HV or VV+VH
IW	20m (5 ENL)	> 250 km	HH+HV or VV+VH
SM	9m (4 ENL)	> 80 km	HH+HV or VV+VH
WV	50m (140 ENL)	20 x 20 km² at 100 km spacing	HH or VV

IW: main mode over land and coastal areas

Sentinel-1A & B data

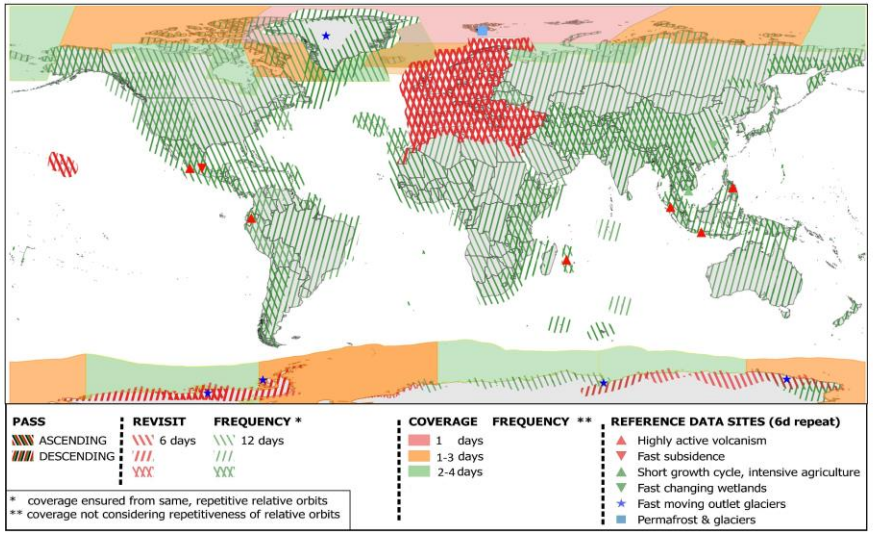
Available products

- 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)

Sentinel-1 Constellation Observation Scenario: Revisit & Coverage Frequency

sentinel-1

validity start: 02/2018

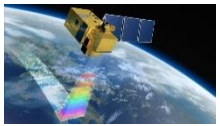


2018

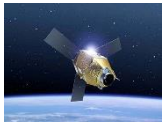
1,304,078 published products (2.3 PB)

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

SNAP & Optical HR (Sentinel-2 Toolbox)


Sentinel-2


SPOT


Pleiades


Landsat


ALOS AVNIR


RapidEye


Kompsat


Ikonos


Worldview

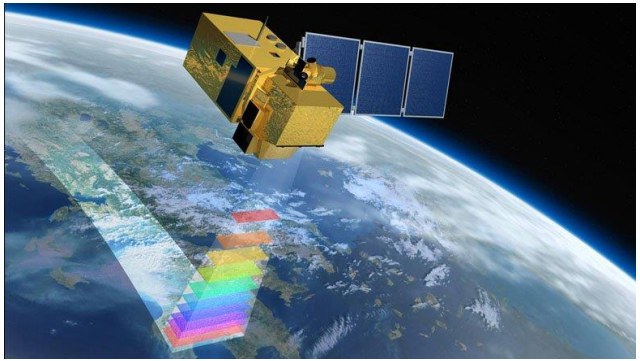
.....

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:** Pansharpening, Rasterization, Segmentation, …

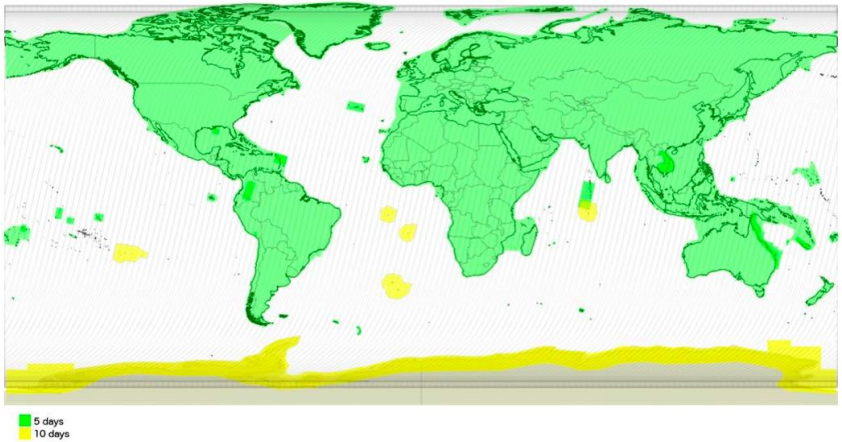
Sentinel-2 characteristics

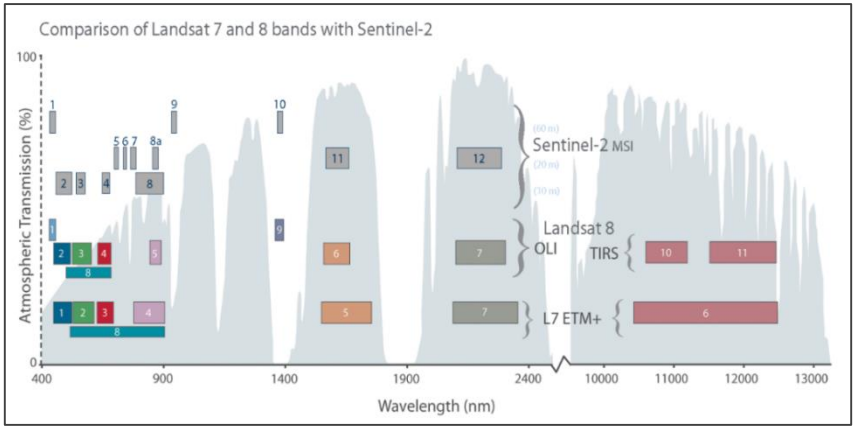
Optical mission for the monitoring of land and coastal regions



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



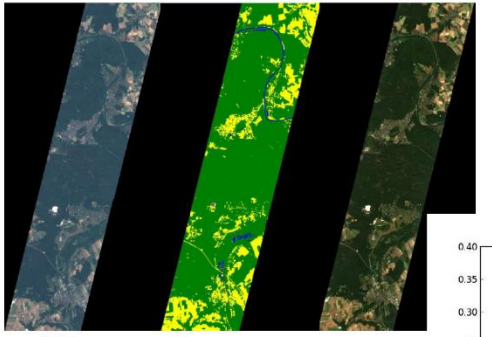


Sentinel-2 products

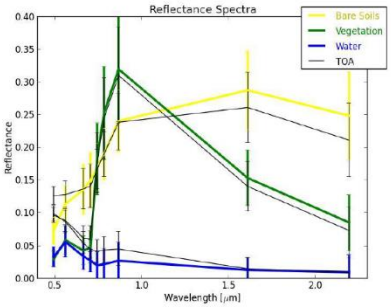
SENTINEL-2 products available for users (either generated by the ground segment or by the SNAP) are:

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)



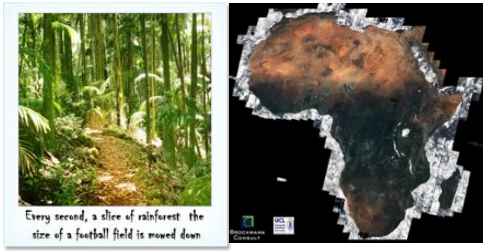
Site: Fontainebleau, France



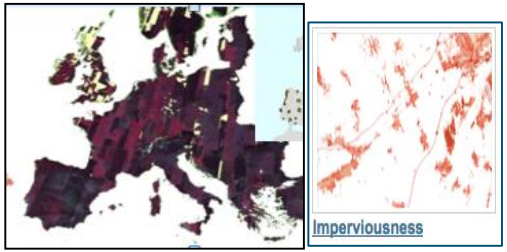
Products are a compilation of elementary granules of fixed size, along with a single orbit. A granule is the minimum indivisible partition of a product (containing all possible spectral bands).

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

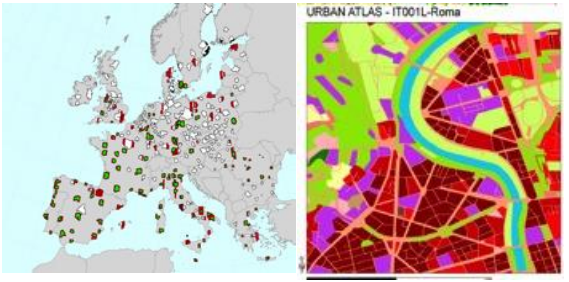
Sentinel-2 applications



Agriculture, Forests & Carbon, Vegetation monitoring

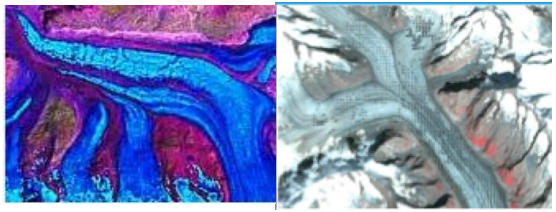


Land cover classification, high resolution layers & change



Regional to Urban Applications

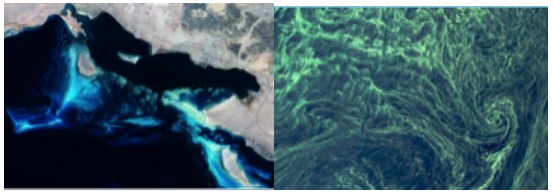
Emergency management



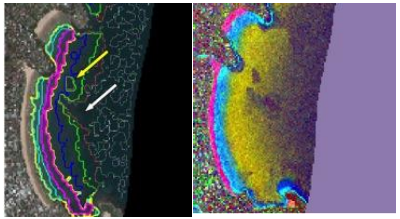
Glaciers & Ice

Global Land use & change

Geology



Water quality



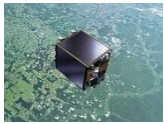
Coastal zones/bathymetry

SNAP & Optical/Thermal MR (S3 Toolbox)

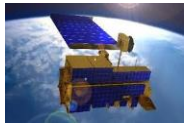

Sentinel-3


ENVISAT

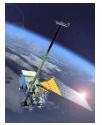

ERS


Proba-V


SPOT VGT


MODIS


AVHRR


VIIRS

.....

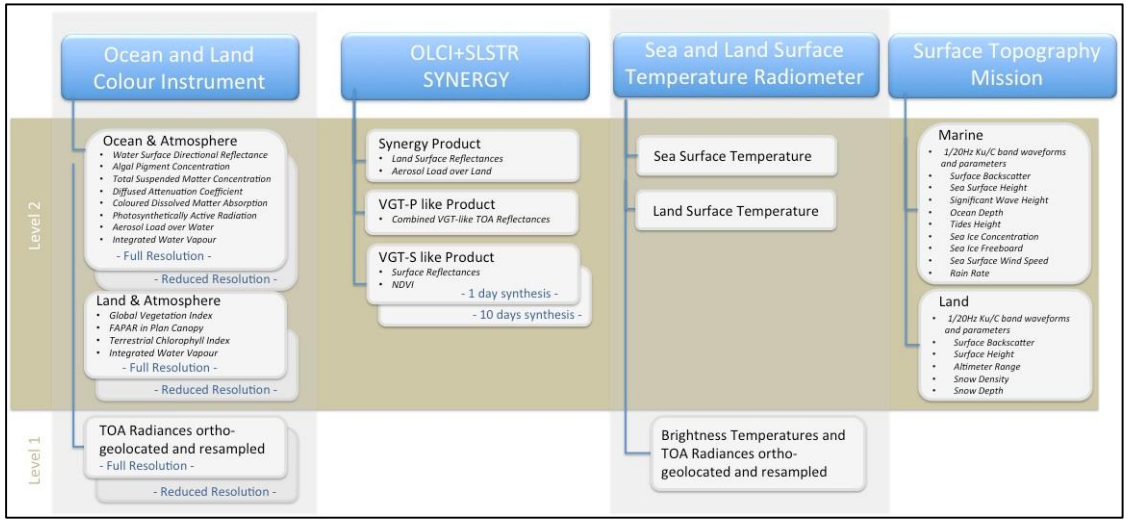
Main features:

- 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 Regridding*
  - ✓ *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:

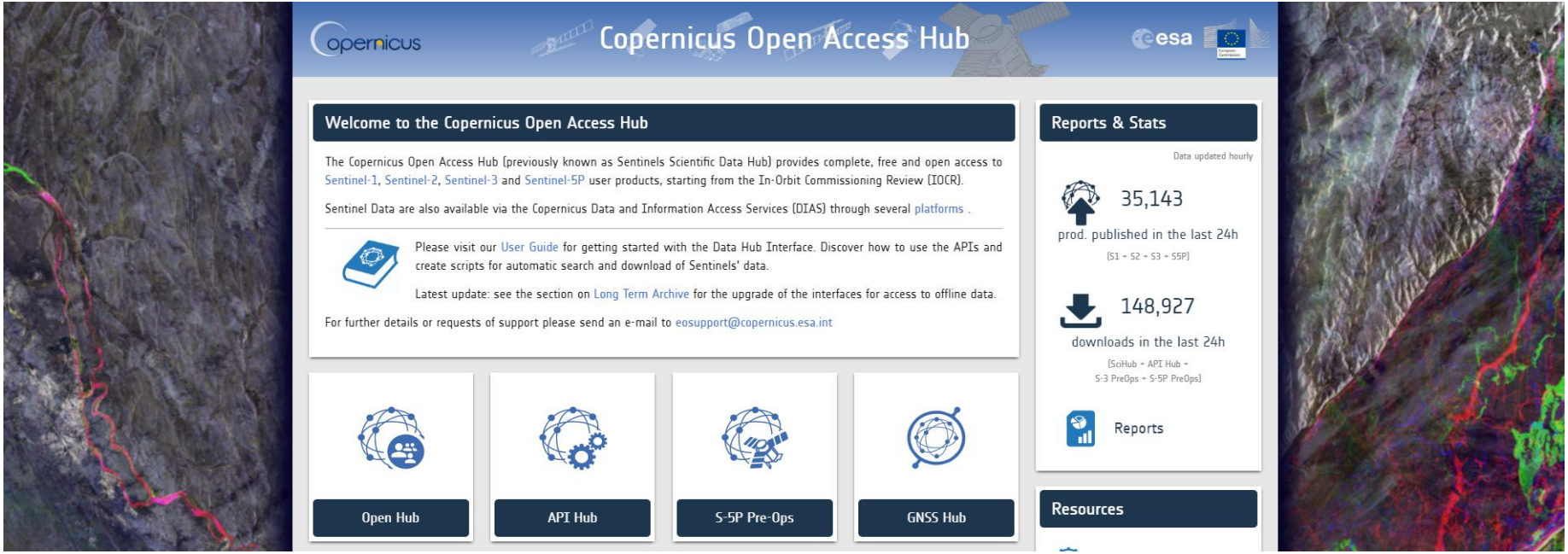
- ***SLSTR*** *(Sea and Land Surface Temperature Radiometer)*
- ***OLCI*** *(Ocean and Land Colour Instrument)*
- ***SRAL*** *(SAR Altimeter)*
- ***DORIS*** *(Doppler Orbitography and Radiopositioning Integrated by Satellite)*
- ***MWR*** *(Microwave Radiometer)*



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/



Sentinel-1 level 1 GRDH

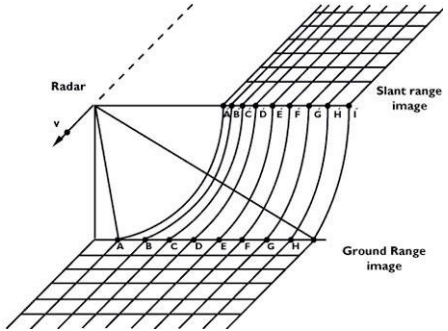
Available products

•Level 0 (L0-RAW)

•Level 1 Ground Range Detected, Multi-Looked, projected to ground range using Earth ellipsoid model WGS84-Medium Resolution (L1-GRDM) and High Resolution (L1-GRDH)

•Level 1 Single-Look Complex (L1-SLC)

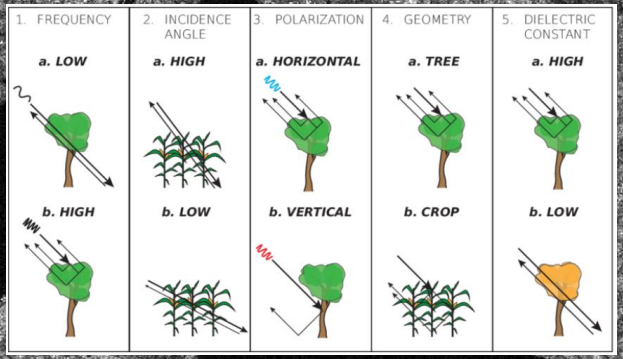
•Level 2 Ocean (L2-OCN)

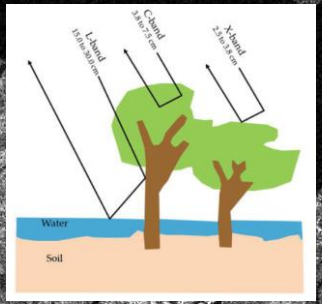


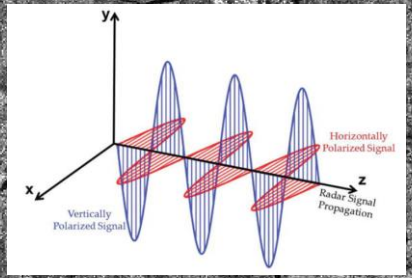
REMEMBER

In GRD data

- Ground range coordinates are the slant range coordinates projected onto the ellipsoid of the Earth.
- Pixel values represent detected amplitude – the power of reflected signal which depends on the surface scattering characteristics
- Phase information is lost.
- The resulting product has approximately square resolution pixels and square pixel spacing with reduced speckle at a cost of reduced spatial resolution.

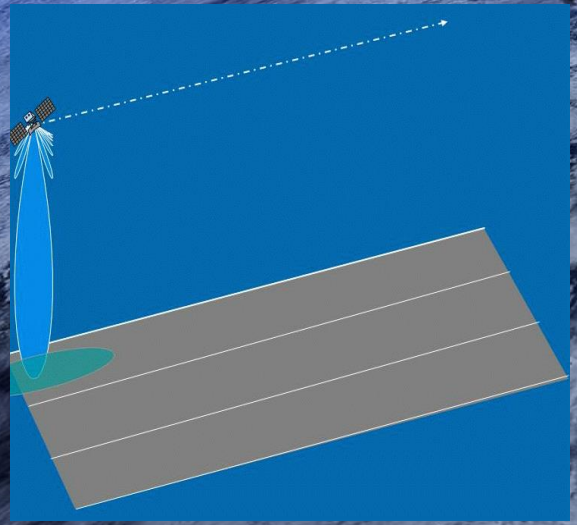

1. FREQUENCY
a. LOW
b. HIGH
2. INCIDENCE ANGLE
a. HIGH
b. LOW
3. POLARIZATION
a. HORIZONTAL
b. VERTICAL
4. GEOMETRY
a. TREE
b. CROP
5. DIELECTRIC CONSTANT
a. HIGH
b. LOW


L-band
C-band
X-band
Water
Soil


y
x
z
Horizontally Polarized Signal
Vertically Polarized Signal
Radar Signal Propagation

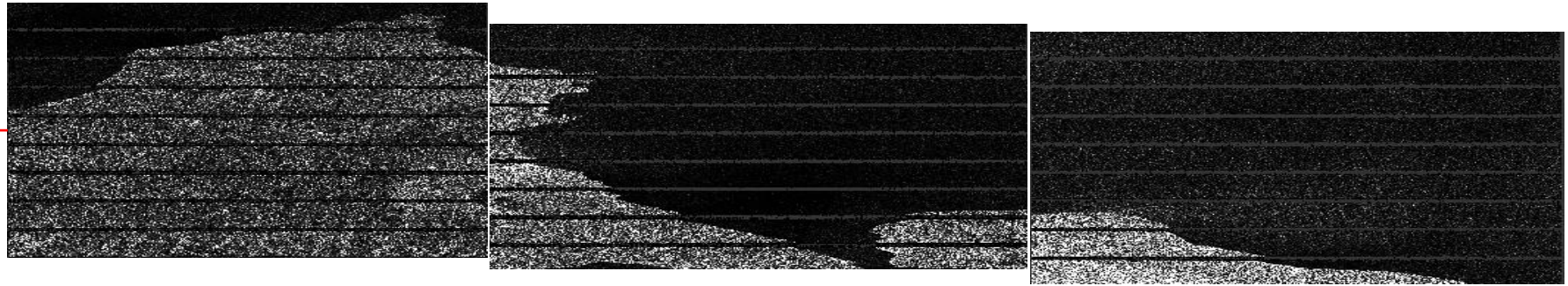
Sentinel-1 data acquisition

Terrain **O**bservation
by **P**rogressive **S**cans
(TOPS)



Sentinel-1 level-1 SLC

Bursted IW SLC



TOPSAR Split to choose a subswath and bursts for the AOI

Example for SAR data usage in SNAP

Sentinel-1 GRDH

- File/Open Product/S1A_IW_GRDH_1SDV_20151003…
- Expand the product in Product Explorer and view the list of bands and metadata
- Inspect the image in the World View, main window, navigation and Color Manipulation windows
- Subset the image to the AOI

Sentinel-1 SLC

- File/Open Product/S1A_IW_SLC__1SDV_20151003…. metadata, bands, image inspection
- Expand the product in Product Explorer and view the list of bands and metadata
- Inspect the image in the World View, main window