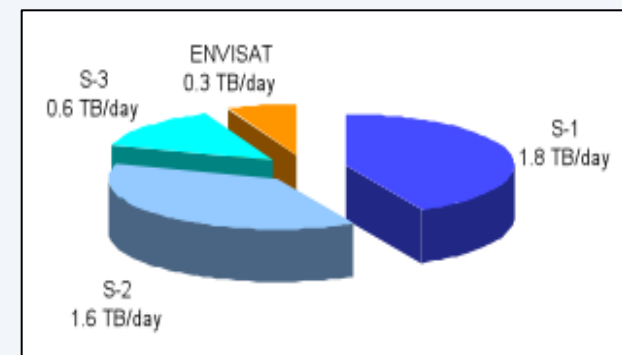


Sentinel-1/-2/-3 Core Products Overview



Meeting with Austrian Partners, 27 May 2014

Sentinel-1	Sentinel-2	Sentinel-3
PDGS Core production for users dissemination & retrieval		
SAR L0	-	-
SAR L1 SLC	MSI L1B	OLCI L1
SAR L1 GRD	MSI L1C	SLSTR L1
SAR L2 OCN (waves, wind, radial velocity)	[MSI L2A(*)]	OLCI Water Color L2
		OLCI Land L2
		SLSTR Water L2
		SLSTR Land L2
		SRAL L2
		Synergy/Vegetation L2



(*) L2A processor developed inside the S2 Toolbox for atmospheric corrections, which may be extended to become a CORE product, details tbc

	Corresponding average production rate (24h/24h)	Corresponding User products
Sentinel 1A *	150 Mb/s	L0 & all L1
Sentinel 2A *	200 Mb/s	All the different L1 (1700 GB/day per satellite in full ops)
Sentinel 3A	200 Mb/s	L1 & L2

(*) based on average 15min downlink/Orbit

LEVEL-0 PRODUCTS

- (FD)BAQ encoded, unprocessed instrument source packets, with additional annotations and auxiliary information to support the processing

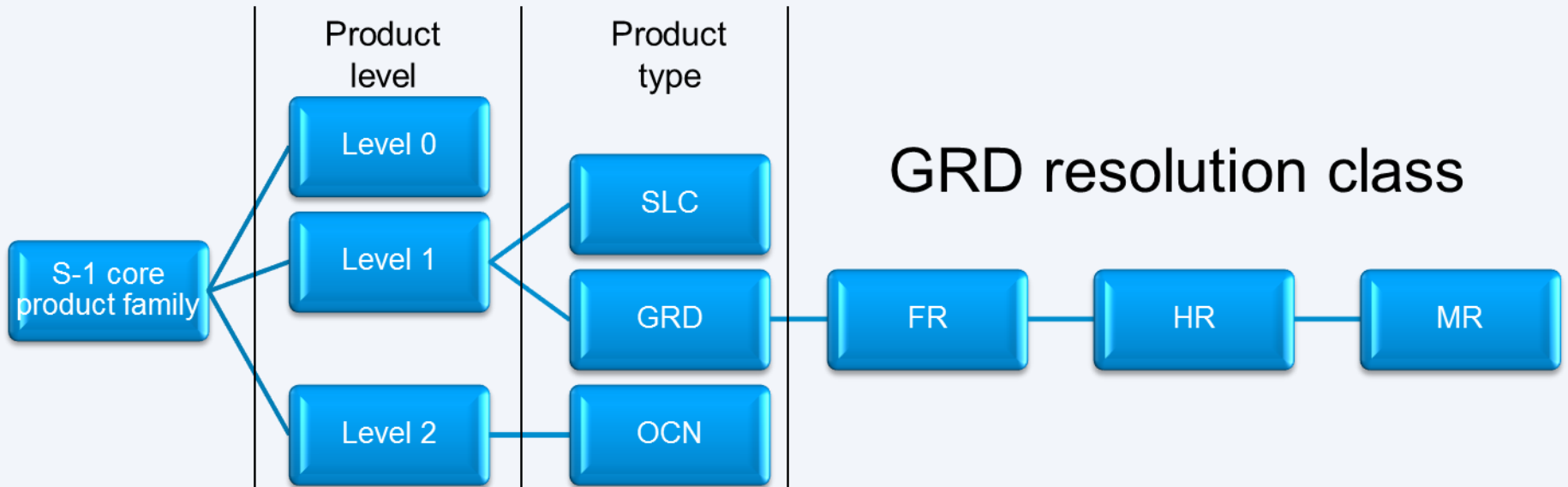
LEVEL-1 PRODUCTS

- Slant-Range Single-Look Complex Products (SLC)
 - Focused data in slant-range geometry, single look with phase and amplitude information with complete geo-reference information
- Ground Range Detected Products (GRD)
 - Focused data projected to ground range using an Earth ellipsoid model, detected and multi-looked. Original satellite path direction preserved and with complete geo-reference information.

LEVEL-2 PRODUCT

- Level-2 Ocean (Wind, Wave and Radial Velocities) products (OCN)
 - Ocean wind field, swell wave spectra and surface radial velocities information as derived from SAR data.
 - L2 ocean products are available for all modes

Sentinel-1 Product Family



Acquisition Mode	L0/1/2	Product type	GRD_FR	GRD_HR	GRD_MR
SM	✓	✓	✓	✓	✓
IW	✓	✓		✓	✓
EW	✓	✓		✓	✓
WV	✓	✓			

Sentinel-1 Level-1 Product Characteristics



Acq. Mode	Product Type	Resolution Class	Resolution ^{1,2} [Rng x Azi] ³ [m]	Pixel Spacing ² [Rng x Azi] [m]	No. Looks [Rng x Azi]	ENL ⁴
SM	SLC		1.7 x 4.3 to 3.6 x 4.9	1.5 x 3.6 to 3.1 x 4.1	1 x 1	1
	GRD	FR	9 x 9	4 x 4	2 x 2	3.9
		HR	23 x 23	10 x 10	6 x 6	34.4
		MR	84 x 84	40 x 40	22 x 22	464.7
IW	SLC		2.7 x 22 to 3.5 x 22	2.3 x 17.4	1	1
	GRD	HR	20 x 22	10 x 10	5 x 1	4.9
		MR	88 x 87	40 x 40	22 x 5	105.7
EW	SLC		7.9 x 43 to 15 x 43	5.9 x 34.7	1 x 1	1
	GRD	HR	50 x 50	25 x 25	3 x 1	2.9
		MR	93 x 87	40 x 40	6 x 2	12.7
WV	SLC		2.0 x 4.8 and 3.1 x 4.8	1.7 x 4.1 and 2.7 x 4.1	1 x 1	1
	GRD	MR	52 x 51	25 x 25	13 x 13	139.7

(1) For GRD, the resolution given at mid-range, mid-orbit and value at mid-orbit altitude, averaged over all swaths.

(2) For SLC the resolution and pixel spacing is range dependent

(3) For SLC products, the range coordinate is in slant range. All the other products are in ground range.

(4) For GRD IW/EW, the ENL is averaged over all swaths.

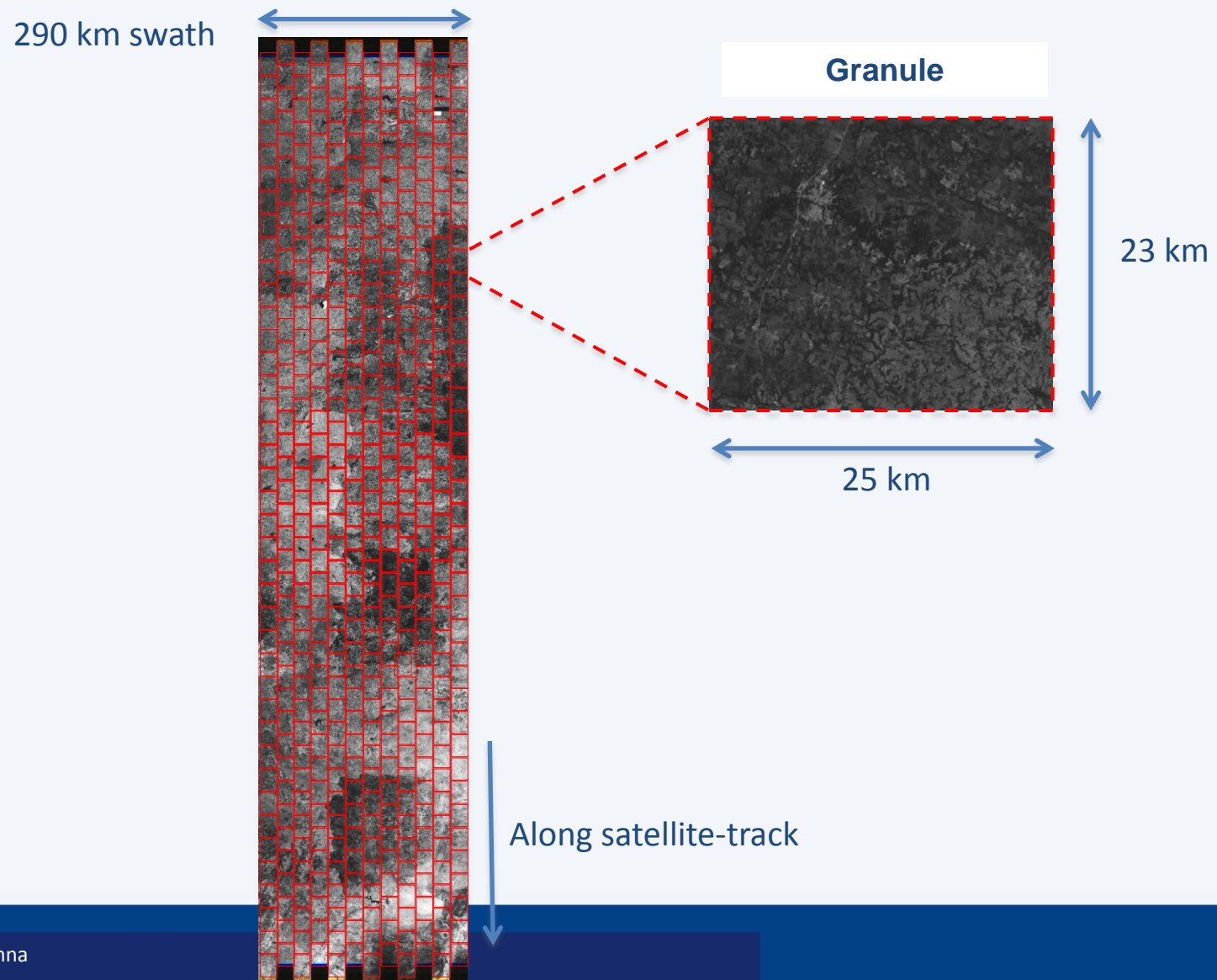
Sentinel-2 Products Summary

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 (UTM/WGS84)	Systematic	Long-term	~500 MB (each 100x100km ²)
Level-2A	Bottom-of-atmosphere reflectances in cartographic geometry	Currently on user side (using Sentinel-2 Toolbox) Future may become systematic	-	~600 MB (each 100x100km ²)

Sentinel-2 Level-1B / Definition

- Top-of-atmosphere (TOA) radiances in sensor geometry.
- Image radiometry key features:
 - ✓ Radiometric corrections include: dark signal, pixel response non-uniformity, defective pixels interpolation and restoration (deconvolution + denoising).
 - ✓ 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).

Sentinel-2 Level-1B / Product Example

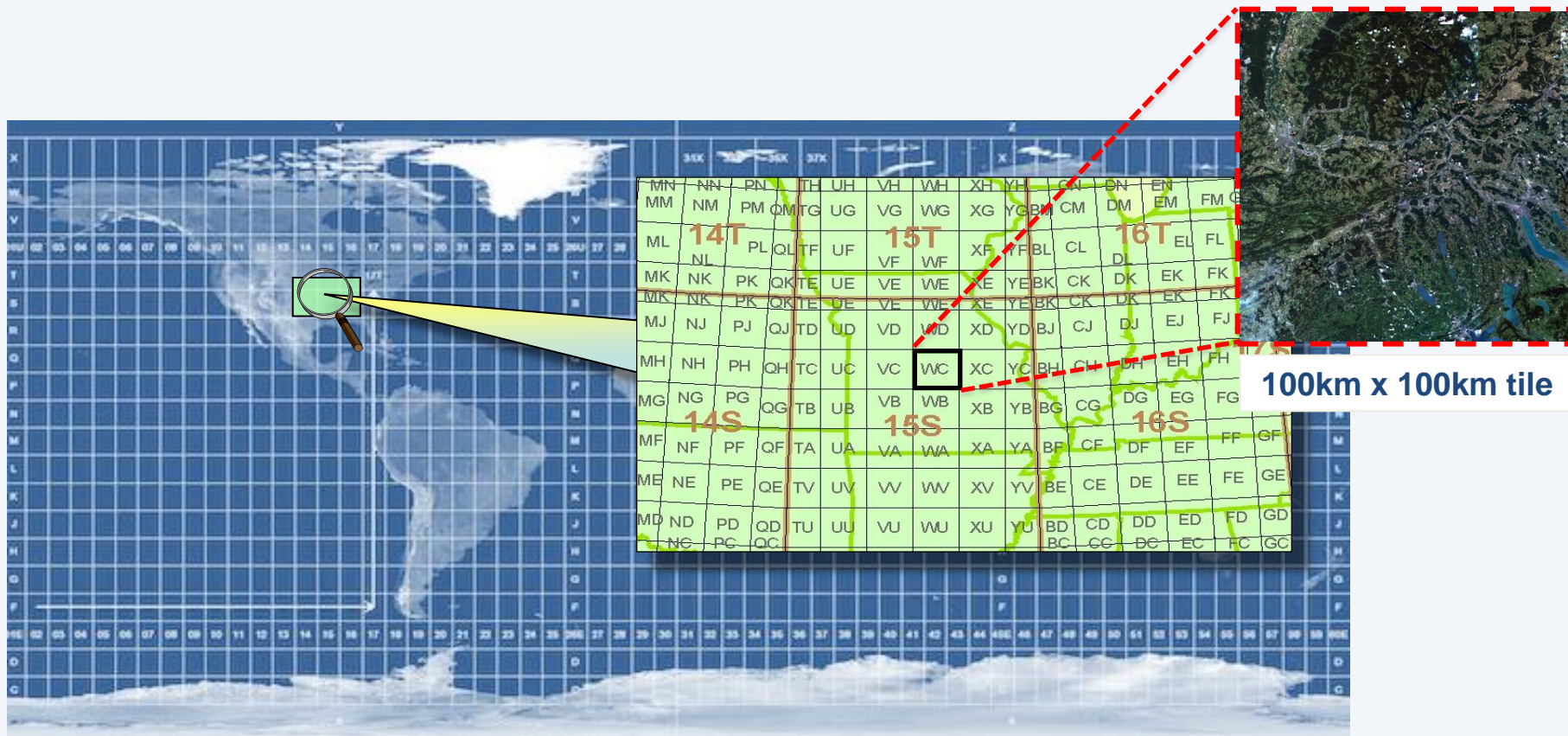


Sentinel-2 Level-1C / Definition

- Top-of-atmosphere (TOA) reflectances in cartographic geometry (UTM/WGS84).
- Image radiometry key features:
 - ✓ Radiometrically corrected data.
 - ✓ Reflectances coded in 12 bits.
 - ✓ Product includes all necessary parameters required to convert the provided reflectances into radiances.
- Image geometry key features:
 - ✓ Orthorectification uses an 90m-resolution DEM.
 - ✓ Sub-pixel multi-temporal registration between images.

Sentinel-2 Level-1C / Tiling

- Cartographic Reference System: UTM (with 6°x8° grid zones).
- Each grid zone is split into ~100x100km² UTM "Tiles".



Sentinel-2 Level-1C / Data Quality Targets

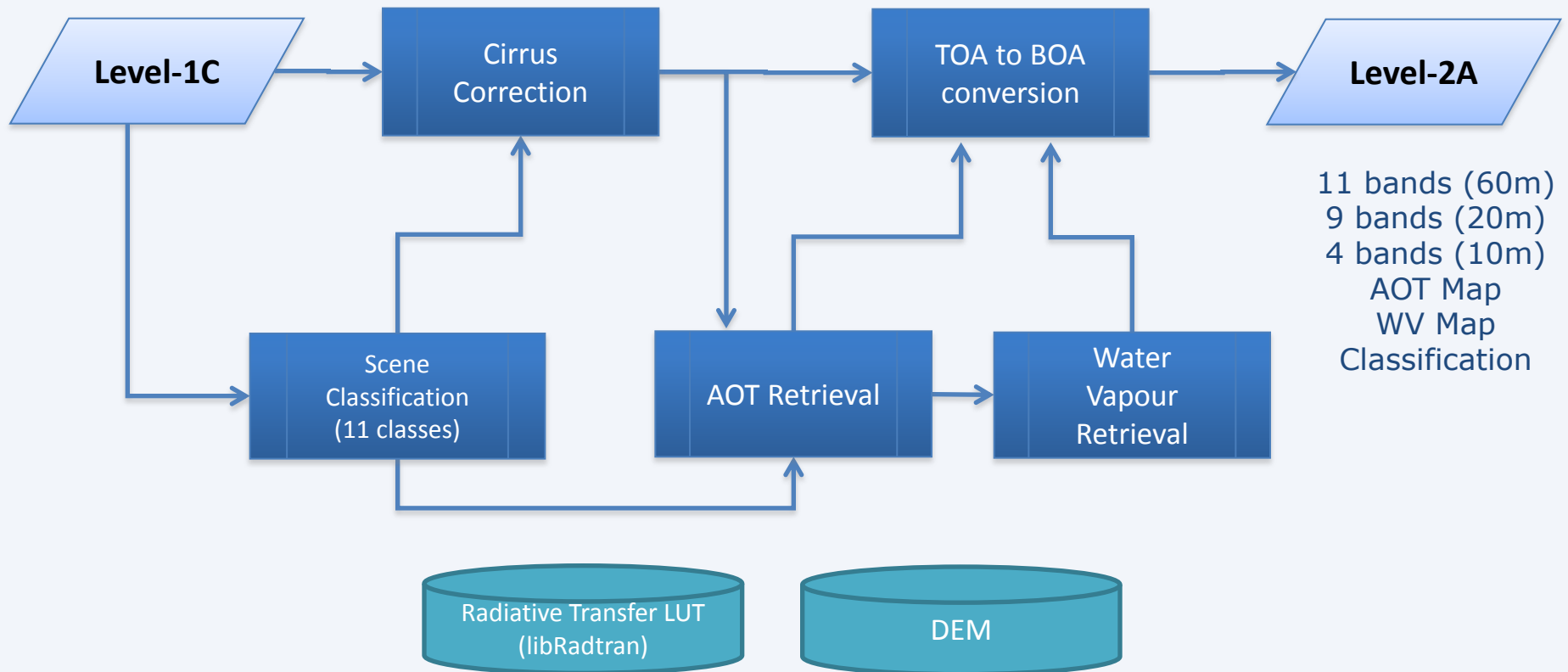


Radiometric Data Quality	
Absolute radiometric uncertainty	3 % (goal) , 5 % (threshold)
Inter-band relative radiometric uncertainty	3%
Linearity knowledge accuracy	1%
Modulation Transfer Function (MTF)	0.15 to 0.3 (for 10m bands) <0.45 (for 20 & 60m bands)
Geometric Data Quality	
Absolute geolocation 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

For further at:

http://esamultimedia.esa.int/docs/GMES/Sentinel-2_MRD.pdf

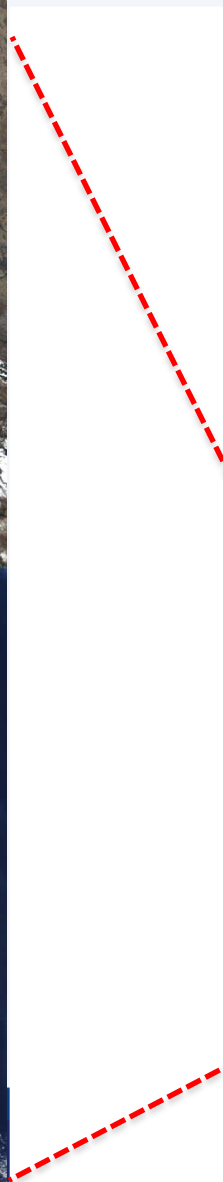
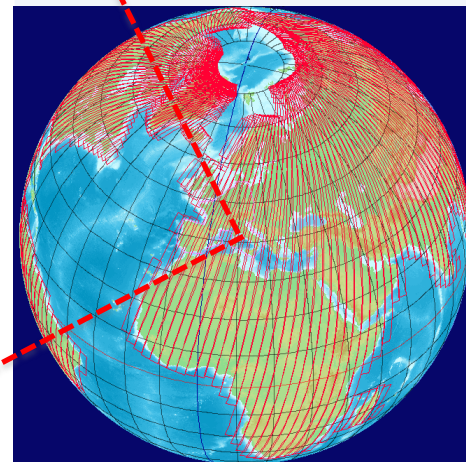
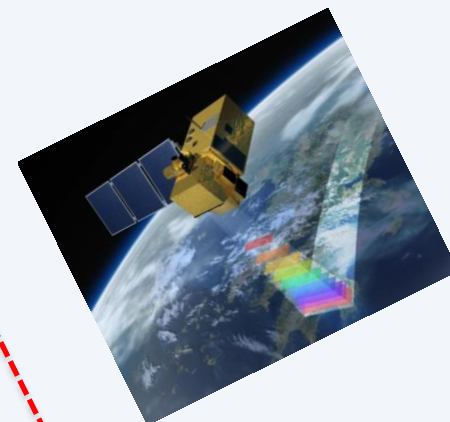
Sentinel-2 Level-2A / Algorithm Overview

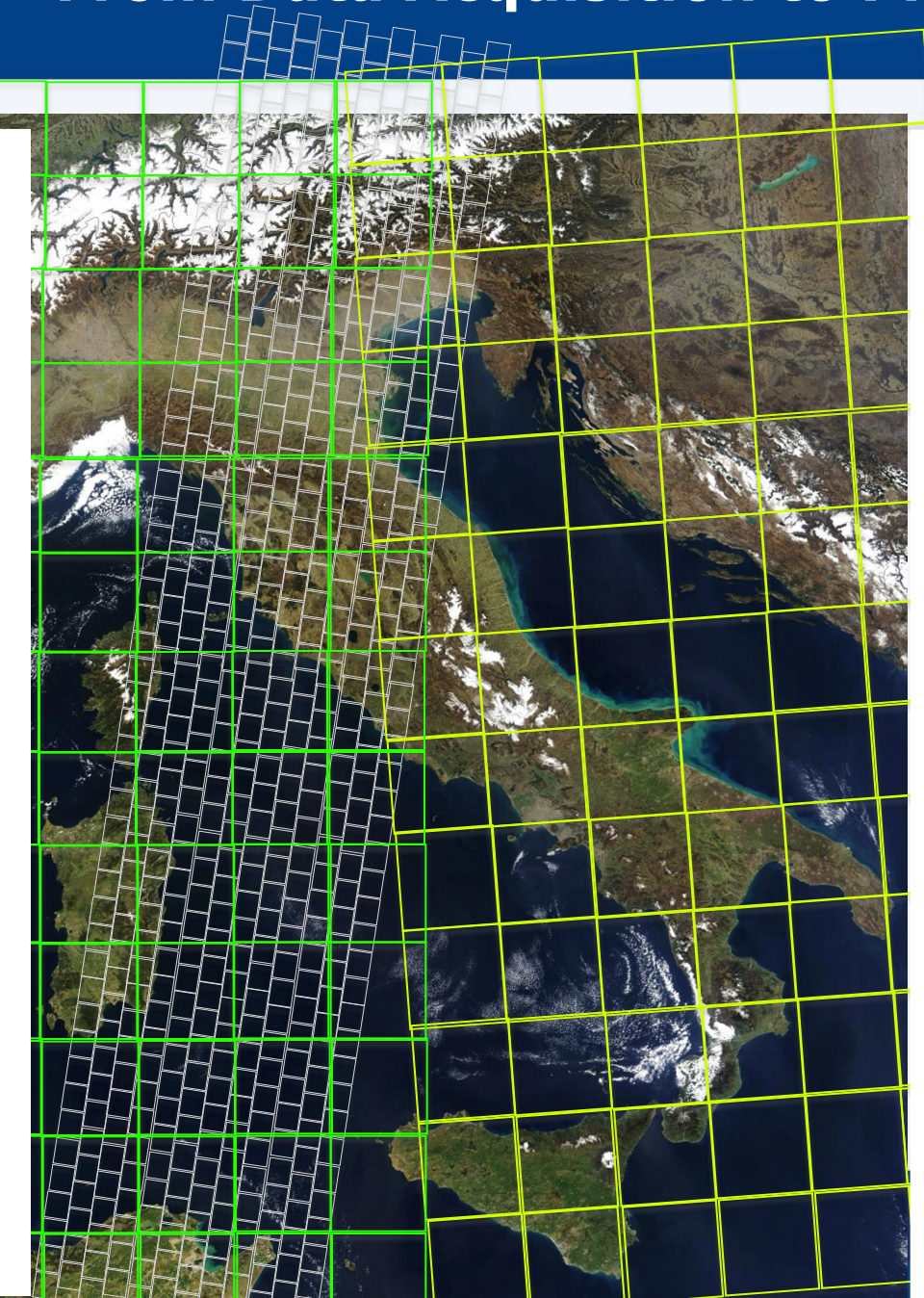


Algorithms developed with

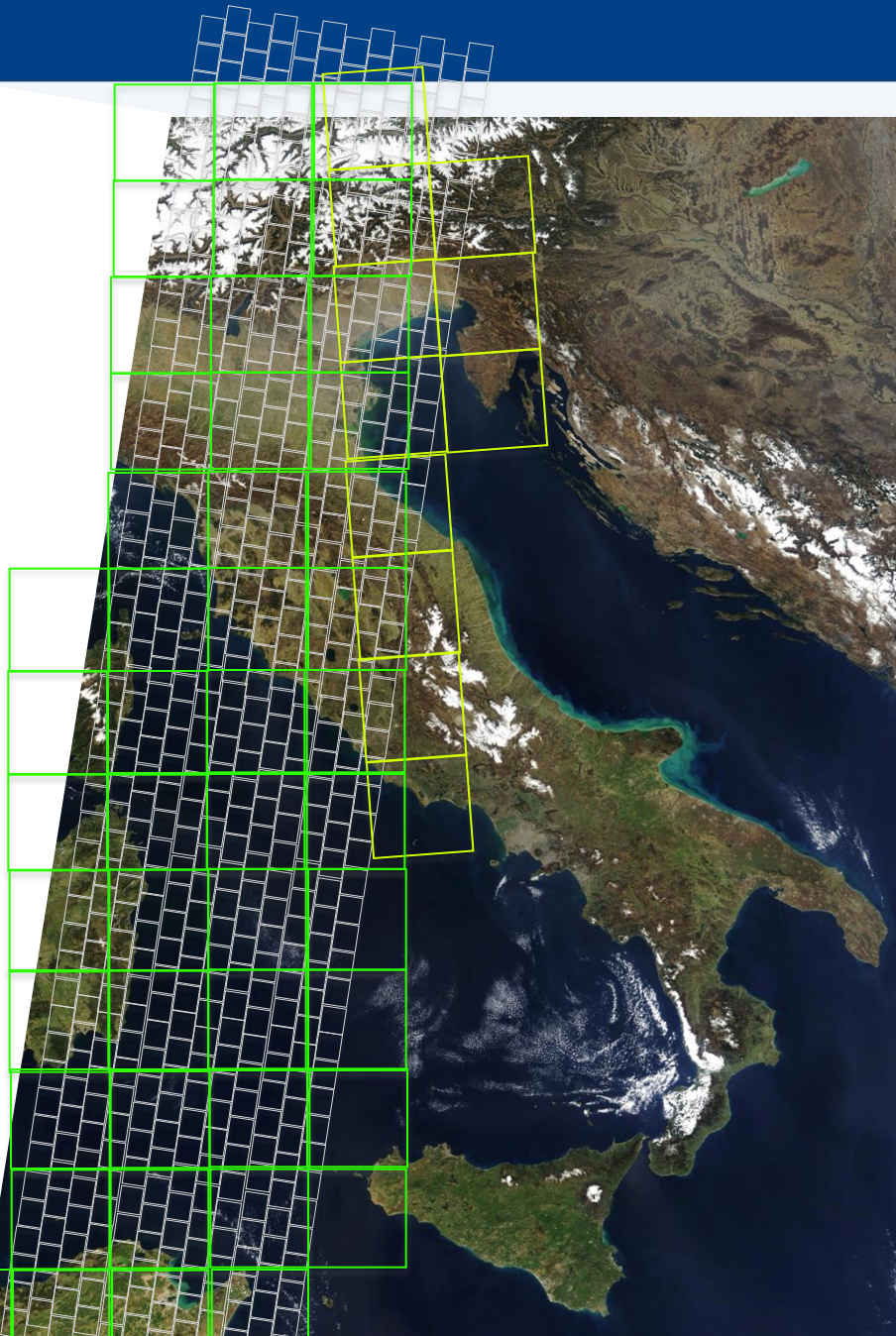


From Data Acquisition to Product Delivery

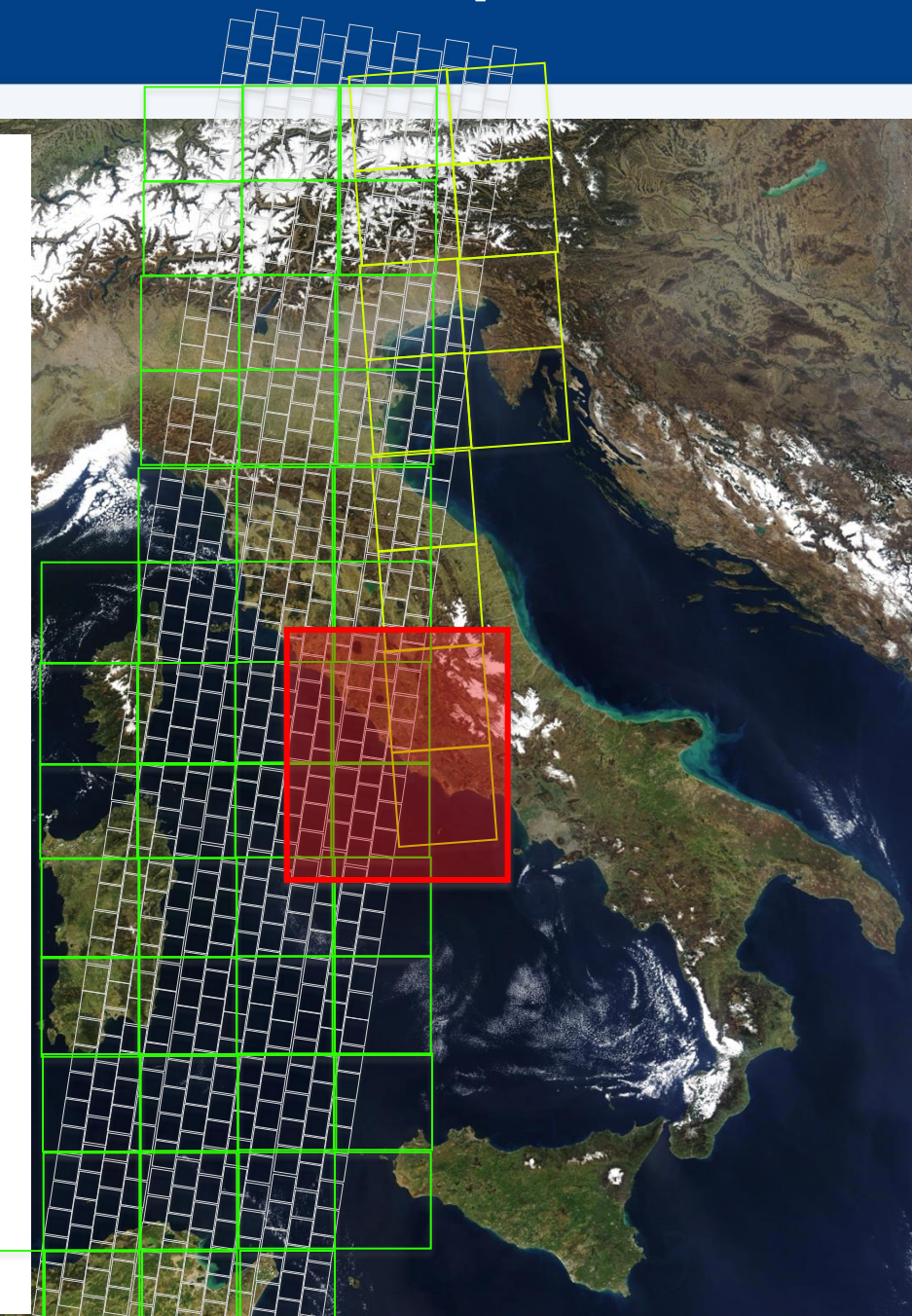




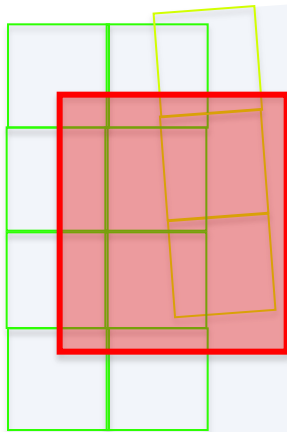
- Projection on UTM cartographic reference system



- 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)

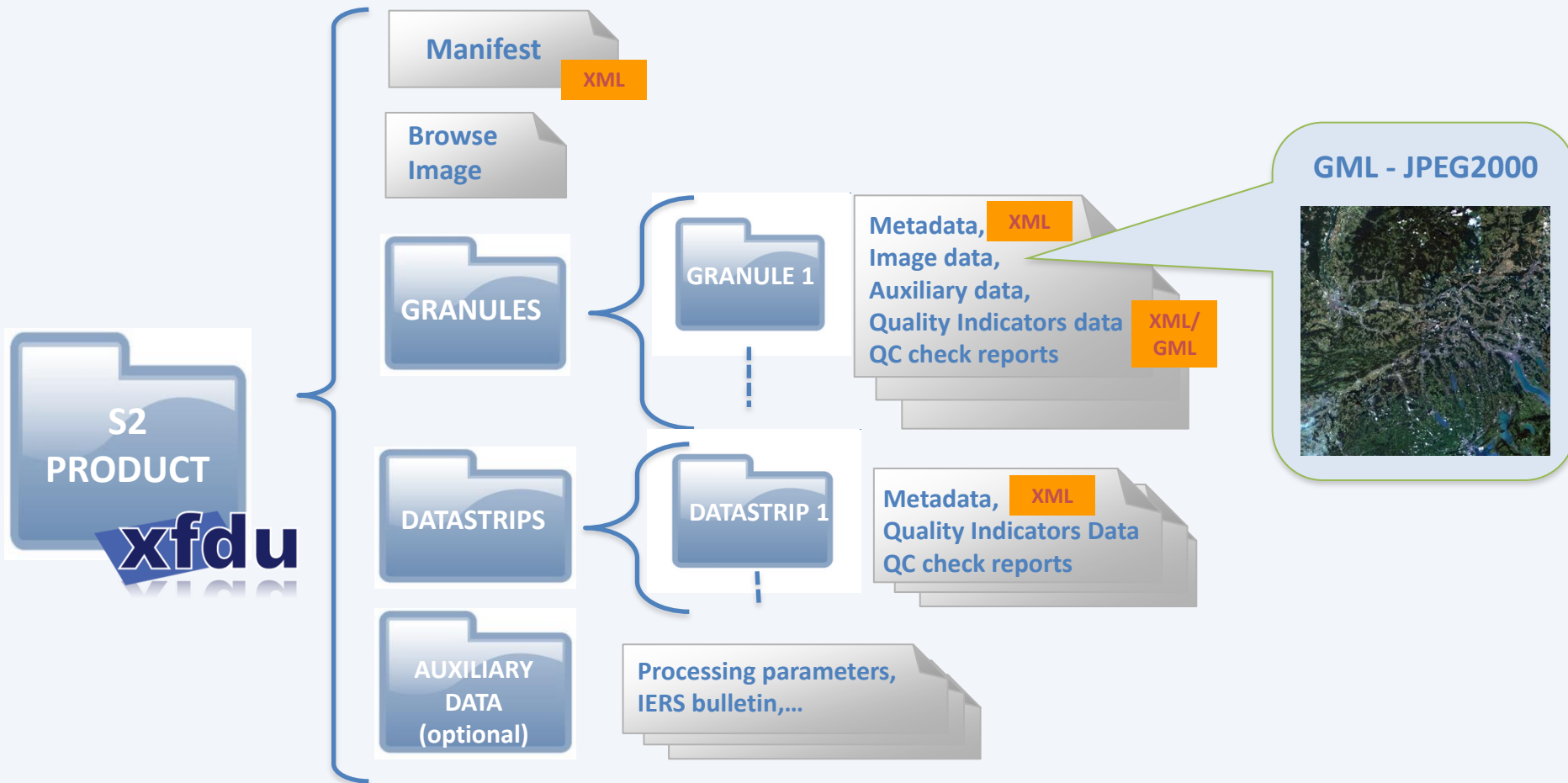


- User-driven data access.
- Product content is defined by the user at query time:
 - ✓ Area of interest
 - ✓ Product Level (1B/1C)
 - ✓ Product components (e.g. bands, metadata)
- Products are packaged in:
 - ✓ Sentinel-SAFE format

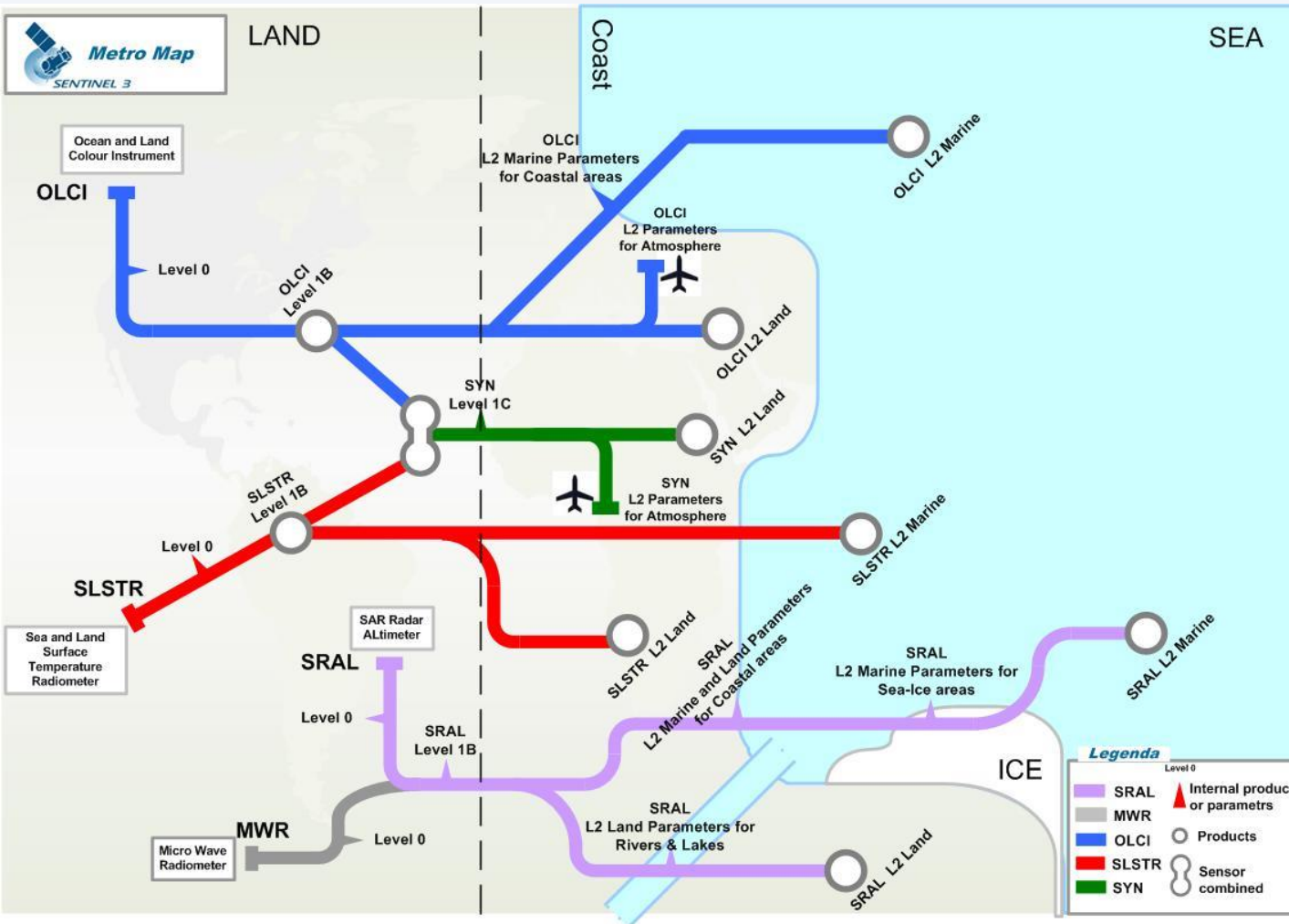


- User-driven data access.
- Product content is defined by the user at query time:
 - ✓ Area of interest
 - ✓ Product Level (1B/1C)
 - ✓ Product components (e.g. bands, metadata)
- Products are packaged in:
 - ✓ Sentinel-SAFE format

Products Format : Sentinel-SAFE



Sentinel-3 Core PDGs Production Map



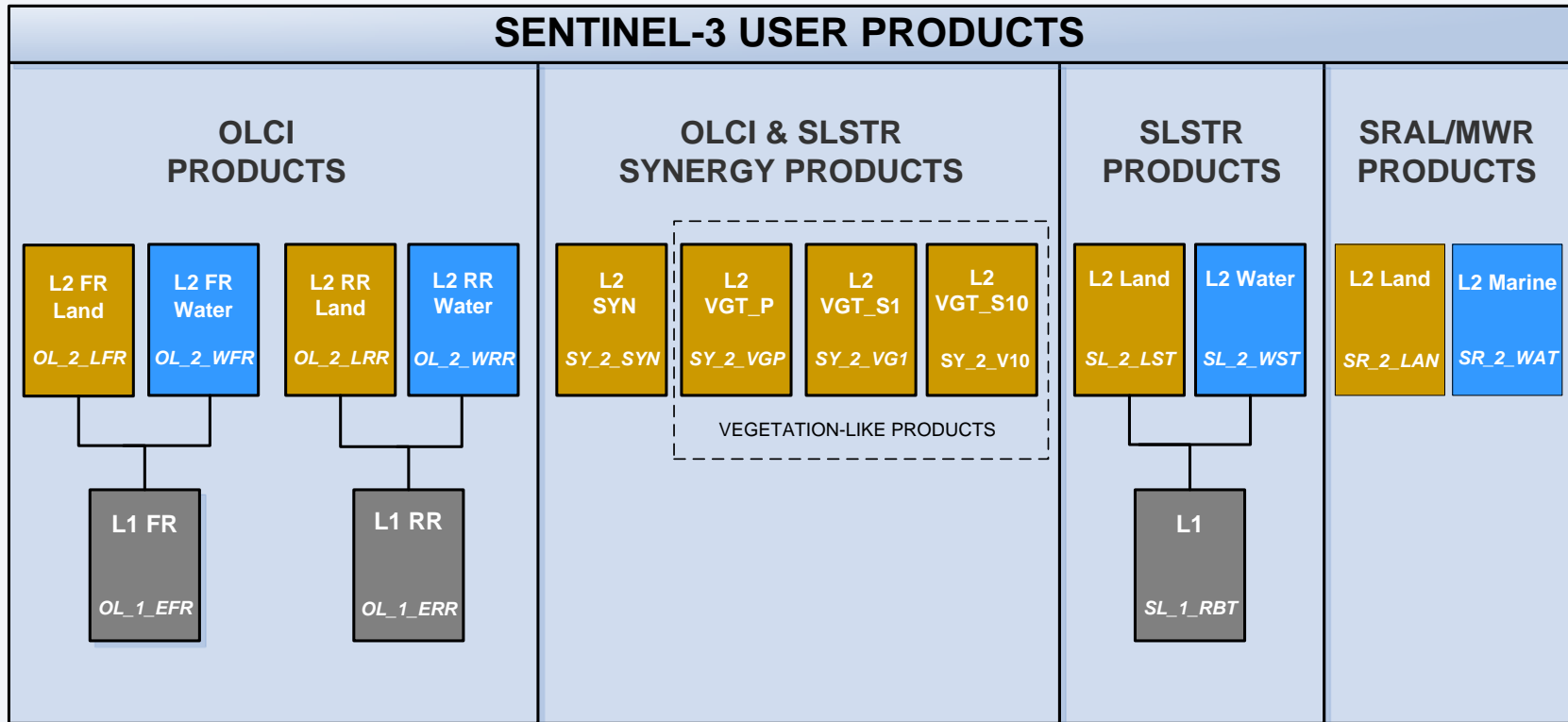
S-3 production is global and systematic

S-3 production is NRT (<3h from sensing) or NTC*

ESA & EUMETSAT ensure the same S-3 L1B core systematic production

* production starts not later than 24h from the reception of the last necessary data

S-3 User Products Tree



L2 Marine Products



























L2 Land products



L1 Products

Sentinel-3 Core PDGS

Optical geophysical parameters list

Geophysical Product	Application Domain	Spatial Resolution	Continuity	Measurement Source
Normalised Water Surface Reflectances		300 m 1 km	Envisat	OLCI
Chlorophyll Concentration for open ocean waters		300 m 1 km	Envisat	OLCI
Chlorophyll Concentration for Coastal waters		300 m 1 km	Envisat	OLCI
Total suspended Matter		300 m 1 km	Envisat	OLCI
Diffuse attenuation coefficient		300 m 1 km	GCM (e.g. MODIS)	OLCI
Coloured Detrital and Dissolved Material		300 m 1 km	Envisat	OLCI
Photosynthetically active radiation	 	300 m 1 km	Envisat	OLCI
Aerosol Optical Depth over water	 	300 m 1 km	Envisat	OLCI
Aerosol Angstrom exponent over water	 	300 m 1 km	Envisat	OLCI
Integrated Water Vapour Column		300 m 1 km	Envisat	OLCI
Sea Surface Temperature		1 km	Envisat	SLSTR
Land Surface Temperature		1 km	Envisat	SLSTR
Surface Reflectances over Land	 	300 m	Envisat	OLCI+SLSTR
Aerosol Optical Depth over Land	 	300 m	Envisat	OLCI+SLSTR
Aerosol Angstrom exponent over Land	 	300 m	Envisat	OLCI+SLSTR
Vegetation-like Surface Reflectances 1 day Synthesis		1 km	Vegetation	OLCI+SLSTR
Vegetation-like Surface Reflectances 10 days Synthesis		1 km	Vegetation	OLCI+SLSTR
Vegetation Normalised Difference of Vegetation Index		1 km	Vegetation	OLCI+SLSTR

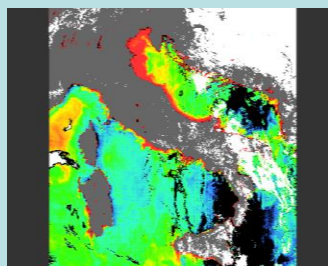
Optical production organisation

Example of geophysical product:

OLCI Terrestrial Chlorophyll Index (OTCI)
Chlorophyll Concentration for open ocean waters (CHL_OC4ME)

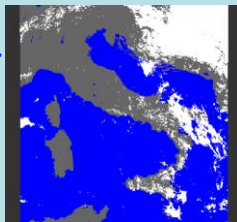


Land products



Marine products

The Land and Water masks are perfectly complementary.

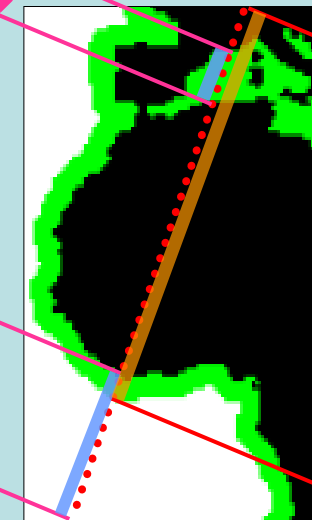


**The cloud mask is provided in white for a better interpretation of the information.*

SRAL production organisation

Measurements included in the MARINE product

Measurements included in the LAND product



**The Land and Water masks are in overlap to ensure analysis of transition and meaningful continuity of segments*

Product Type	Level	Description	Size (GByte/orbit)
OL_1_EFR___	1	Full Resolution top of atmosphere	29.90
OL_2_WFR___	2	Full Resolution Water & atmosphere parameters	33.40
OL_2_LFR___	2	Full Resolution Land and Atmosphere parameters	7.32
OL_1_ERR___	1	Reduced Resolution top of atmosphere	1.70
OL_2_WRR___	2	Reduced Resolution Water & atmosphere parameters	2.10
OL_2_LRR___	2	Reduced Resolution Land and Atmosphere parameters	0.50

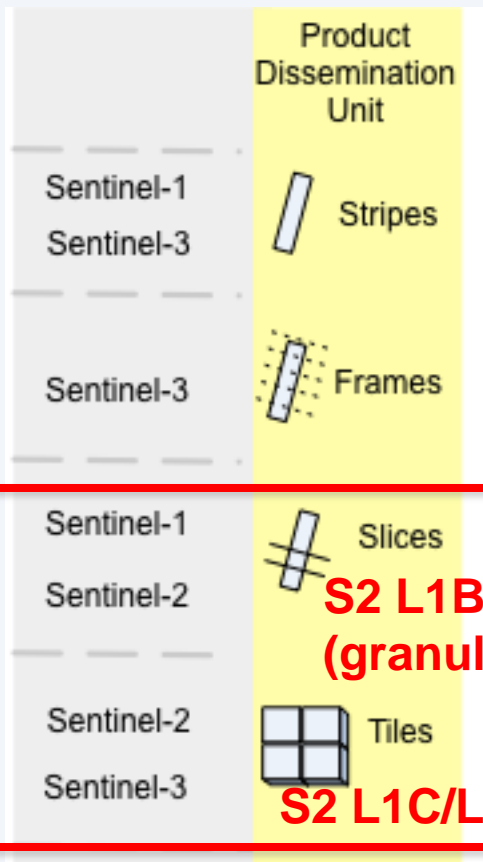
Product Type	Level	Description	Size (GByte/orbit)
SL_1_RBT___	1	Brightness temperatures and radiances	45.60
SL_2_WST___	2	Level 2P Sea Surface Temperature (GHRSSST like)	2.33
SL_2_LST___	2	Land Surface Temperature Parameters	2.81

Product Type	Level	Description	Size (GByte/orbit)
SY_2_SYN__	2	Surface Reflectances and Aerosol measurements over Land	30
SY_2_VGP__	2	1 km VEGETATION Like product (~VGT-P) - TOA Reflectances	1.21

Product Type	Level	Description	Size
SY_2_VG1__	2	1 km VEGETATION Like product (~VGT-S1) 1day synthesis surface reflectances and NDVI	7.72 (GByte per day)
SY_2_V10__	2	1 km VEGETATION Like product (~VGT-S10) 10days synthesis surface reflectances and NDVI	7.72 (Gbyte every 10 days)

PRODUCT TYPE	LEVEL	DESCRIPTION	SIZE (GBYTE/ORBIT)
SR_2_LAN__	2	1Hz and 20Hz Ku and C bands parameters (LRM/SAR), waveforms. Over land, coastal areas, land ice and inland water.	0.07
SR_2_WAT__ -	2	1Hz and 20Hz Ku and C bands parameters (LRM/SAR), waveforms. Over open ocean, coastal areas, sea-ice and part of land within a certain distance from the coastline	0.09

The Sentinels PDGSs implement specific products apportionment in-line with mission characteristics, products data volume and compatibility with similar missions



A **stripe** coincides either with a complete dump or large acquisition segment (e.g. pole to pole)

A **frame** is identified by means of a fixed reference system based on along track coordinate and along orbit cycle coordinate

A **slice** corresponds to pre-defined time interval of measurement data

A **tile** corresponds to image subset remapped into a well-defined geographic projection