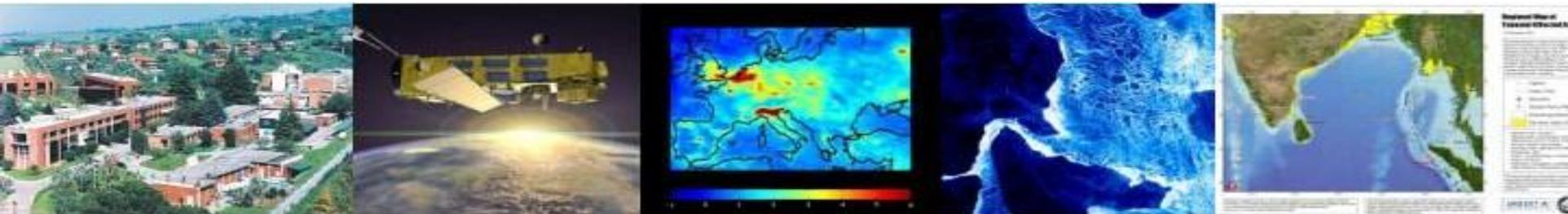


Sentinel-2

- part of the GMES Space Component



Bianca Hoersch- ESA
Third Party & Sentinel-2 Mission Manager

LST – 12 Feb 2013, CA

- GMES Space Component (GSC) & Sentinels
- GSC Operations Concept & Core Ground Segment
- **Heritage: Landsat as a learning case for Sentinel-2**
- **Sentinel-2:**
 - **mission overview, status**
 - **Observation strategy, data volumes, user access**
 - **Preparatory activities & simulations**
 - **Cal-Val**
- Other Sentinels & ESA EO missions



Global Monitoring for Environment and Security is a user-driven EU led initiative designed to establish a European capacity for the provision and use of operational monitoring information

- **Services Component – coordinated by EC**
 - Information services in response to European policy priorities
- **In-situ component – coordinated by EEA**
 - Observations mostly within national responsibility with coordination at European level
- **Space Component – coordinated by ESA**
 - Sentinels Missions - EO missions developed specifically for GMES
 - Contributing Missions - offering part of their capacity to GMES (EU/ESA MSs, EUMETSAT, commercial, international)

GMES dedicated missions: Sentinels



Sentinel-1 (A/B) – SAR imaging

All weather, day/night applications, interferometry



Sentinel-2 (A/B) – Multi-spectral imaging

Land applications: urban, forest, agriculture,...
Continuity of Landsat, SPOT



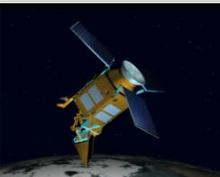
Sentinel-3 (A/B) – Ocean and global land monitoring

Wide-swath ocean color, vegetation, sea/land
surface temperature, altimetry



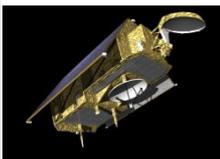
Sentinel-4 (A/B) – Geostationary atmospheric

Atmospheric composition monitoring, trans-
boundary pollution



Sentinel-5 precursor/ Sentinel-5 (A/B) – Low-orbit atmospheric

Atmospheric composition monitoring



Jason-CS (A/B) – Low inclination Altimetry

Sea-level, wave height and marine wind speed



Sentinel Data Policy
=
full and open access to Sentinel data to all users

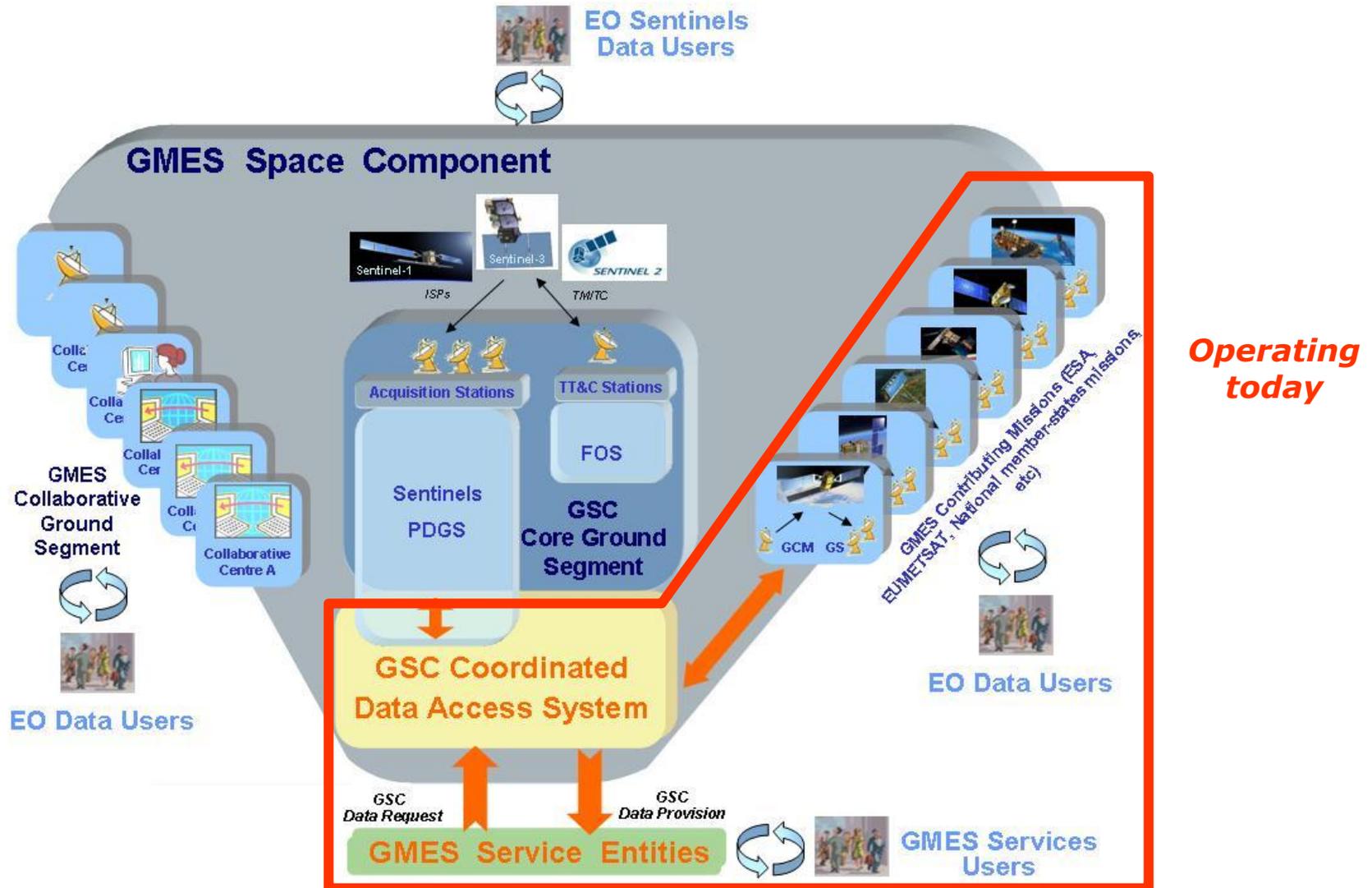
- Aim for maximum availability of data & corresponding access services
- Support to increasing demand of EO data for
 - implementation of environmental policies
 - climate change initiatives

In practical terms:

- Anybody can (has the right to) access acquired Sentinel data
- Licenses for the Sentinel data are free of charge
- Online access with users registration including acceptance of generic Terms and Conditions, at no fees, within the technical and financial limits (available operations budget).

- The ‘GSC Operations Concept’ refers to the period from mid 2014 onwards by when 'operational budgets' from the EC are expected to be available, the [Multi-annual Financial Framework \(MFF\) 2014-2020](#) and the [GMES Space Component \(GSC\) share](#) are under definition these days...
- An initial **ramp-up phase** is envisaged marking the transition towards the full operational capability:
 - progressive integration of each Sentinel spacecraft in the GSC overall system
 - a gradual evolution in the performance
 - ✓ in the data throughput and timeliness
 - ✓ in the services to users
 - ✓ in the availability of the overall system
- The amount of funding available will determine the pace of the ramp-up from a ‘Launch-Commissioning’ configuration to the Full Operational configuration

Ground Segment Architecture



ESA today coordinates for GMES access to data from GMES Contributing Missions...



ESA Observing the Earth GMES **GMES Space Component Data** <http://gmesdata.esa.int>

- GSC Data Access**
 - About GSC Data Access
 - How to Access
 - Data Access Portfolio
 - CDS Tools
 - CDS Infrastructure
 - Derby Software Tool
- News**
 - Operational News Archive
 - News Archive
 - RSS Feeds
- GSCDA Terms and Conditions**
 - Terms and Conditions
 - FAQ
- GMES Services**
- GSC Mission Groups**
- GSCDA Data Provision Status**
 - Dataset Implementation Status - January 13
 - CORE Datasets - January

12-Feb-2013

Data Access Portfolio

The Data Access Portfolio Document defines the datasets that are available to the GMES Services in the second phase of the GSC Data Access (2011-2014). [Read more](#)



Latest News

- 11 February 2013**
[New update of the Data Access Portfolio \(DAP V2.6.1\)](#)
- 27 December 2012**
[New update of the Data Access Portfolio \(DAP V2.6\)](#)
- 27 December 2012**
[CORE_09 availability in CDS archive](#)



Operational News

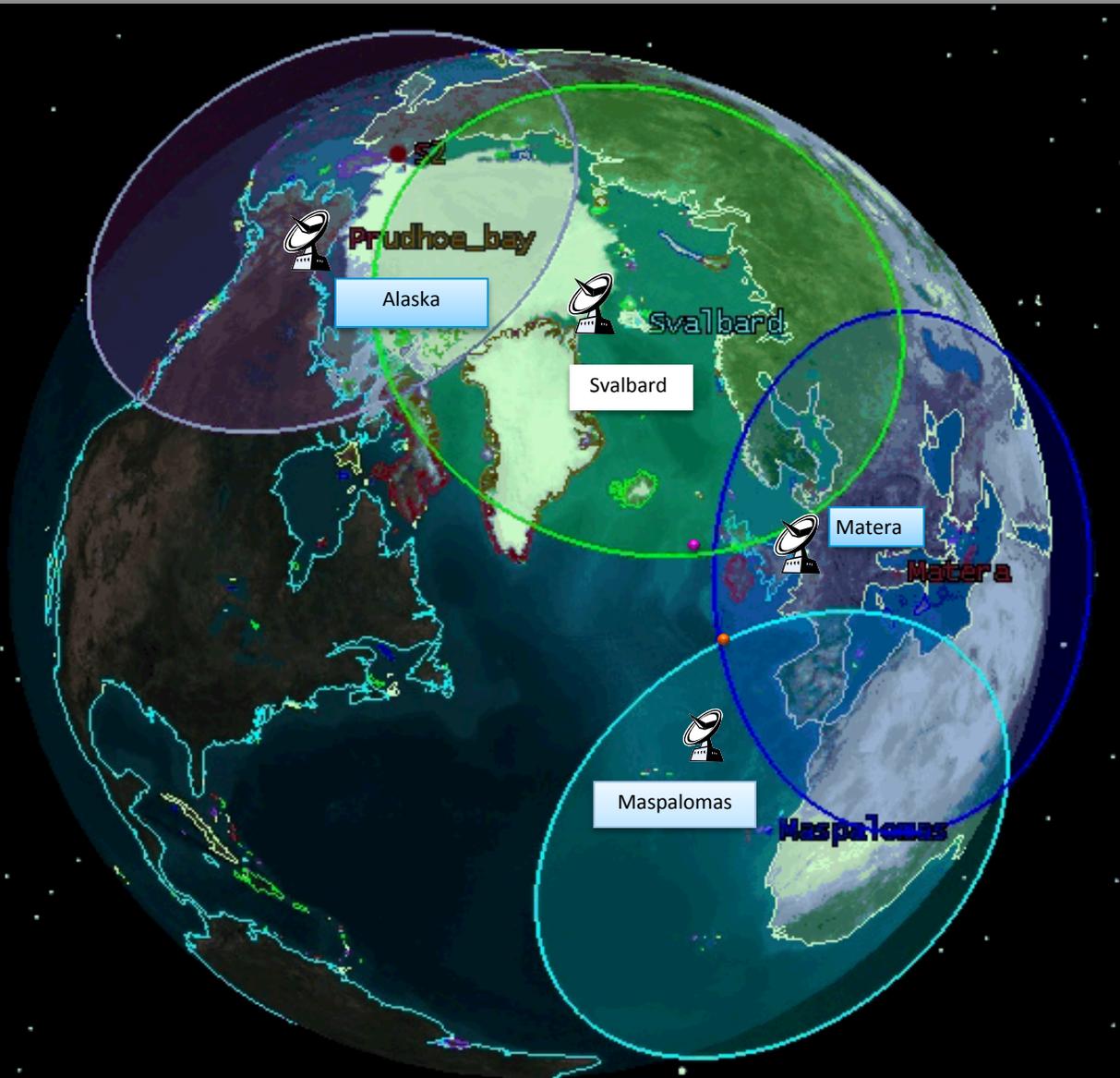
- 01 February 2013**
[CORE_01 Coverage 1: replacement of SPOT-4 products over Iceland](#)

- ### In Depth
- #### GMES Space Component Contributors
- ESA
 - ASI
 - Astrium GEO-Information Services
 - CNES
 - CSA
 - Deimos Imaging
 - DLR
 - DMCii
 - e-GEOS
 - EUMETSAT
 - Euromap/GAF
 - European Space Imaging
 - ImageSat International
 - MDA
 - RapidEye
 - VITO
- ### Related Links
- 
- an Space Agency

The GMES Space Component (GSC) Operations Concept relies on a GSC Ground Segment consisting of:

- a **GSC Core Ground Segment**, with **GSC-funded Functions and Elements**, providing :
 - the primary access to Sentinel Missions data as well as
 - the coordinating access functions to Contributing Missions data

- a **GSC (Sentinel) Collaborative Ground Segment**, with **non GSC-funded Functions and Elements**, providing:
 - a supplementary access to **Sentinel** Missions data, i.e. either through specific data acquisition services, or specific data products
 - **the frame for international cooperation (second step after Member States)**



Core Ground Stations:

- Matera



- Maspalomas



- Svalbard

- Alaska



...later EDRS to be added

Data Core NRT & Offline Processing Centers



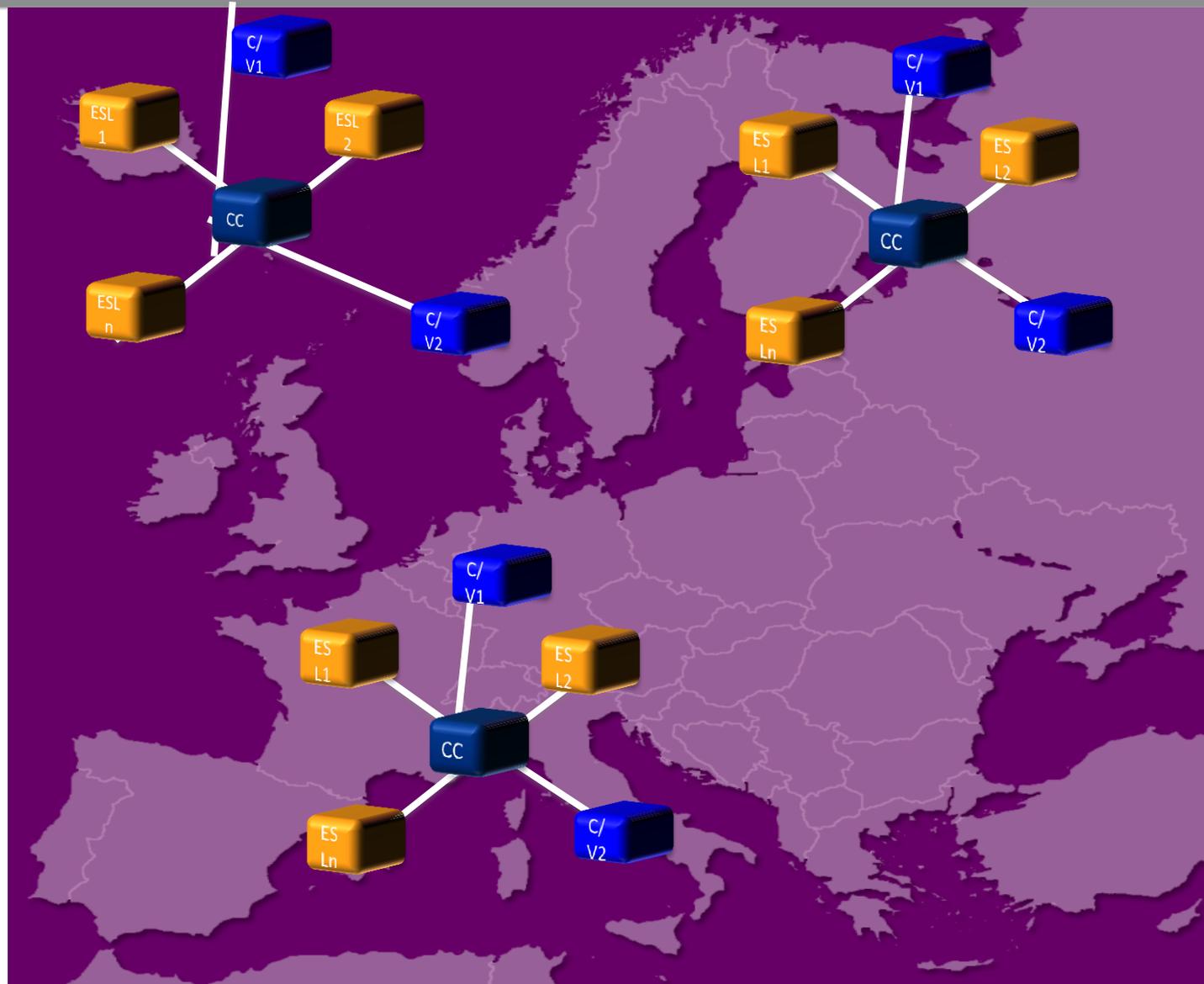
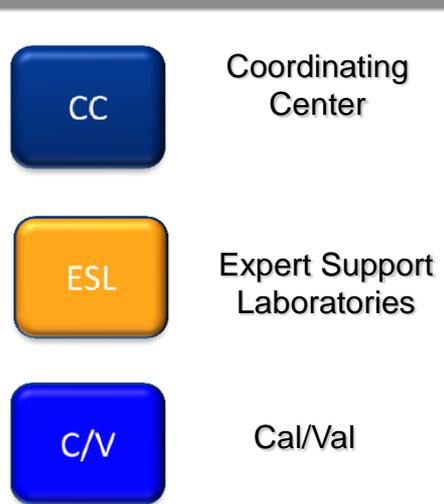
Near Real Time Processing Centre



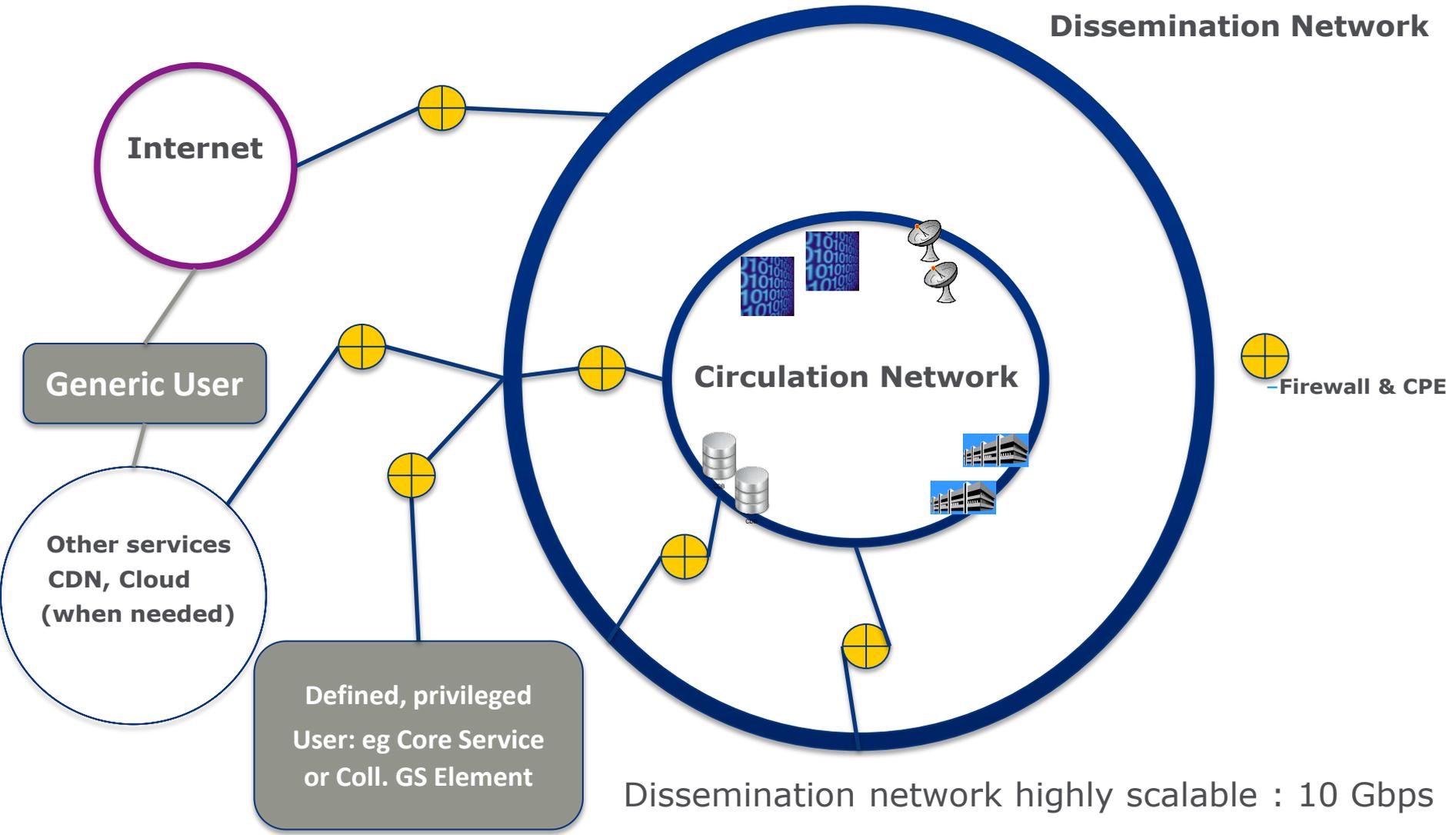
Archive and Offline Processing Centre

Mission Performance Centers

→ See slides later for S-2 cal/val



- 3 separated ITTs
- 3 MPC main contracts: MPC-S1, **MPC-S2**, MPC-S3
- Various sub-contracts are expected for ESL, Cal/Val, science expertise



Dissemination network highly scalable : 10 Gbps

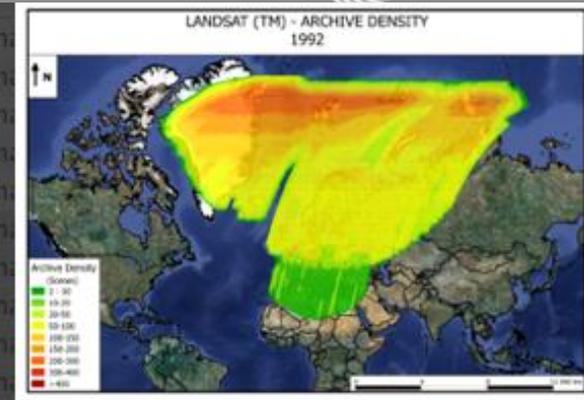
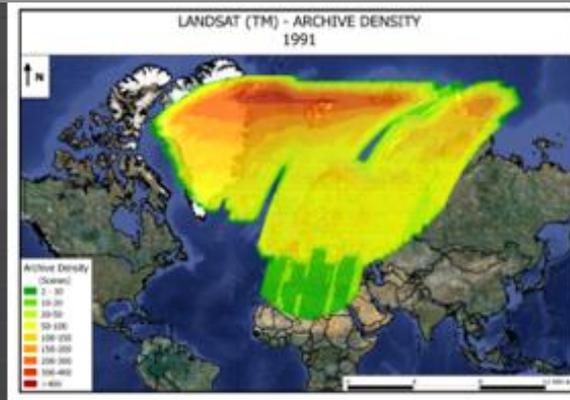
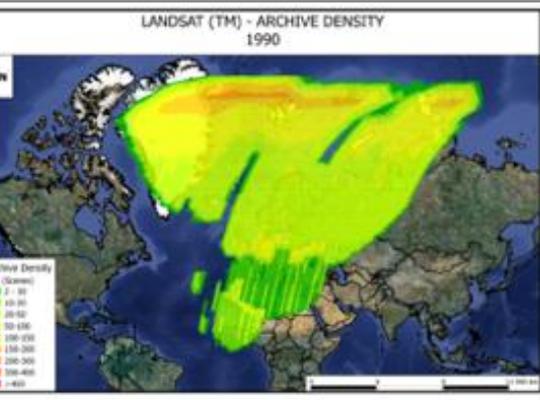
- The ESA Landsat archive holds **325 Terrabyte** from **~40 years**:

- 223 TB of Landsat-4/-5 TM
- 73 TB of Landsat-7 ETM
- 29 TB of Landsat-1/-5 MSS



- Since Nov 2011 ESA has **opened** its vast Landsat archive, containing around **1.5 Mio UNIQUE** scenes, free of charge access
 - order on-demand open since 15 months
 - **systematic processing** ongoing, first 50% of TM data assumed online by end year, repatriation to **USGS** expected to start over summer with first data batches
- **> 450 research projects** have registered for Landsat so far

Landsat archive...1.5 Mio products



LS_TM_Density_1995.jpeg

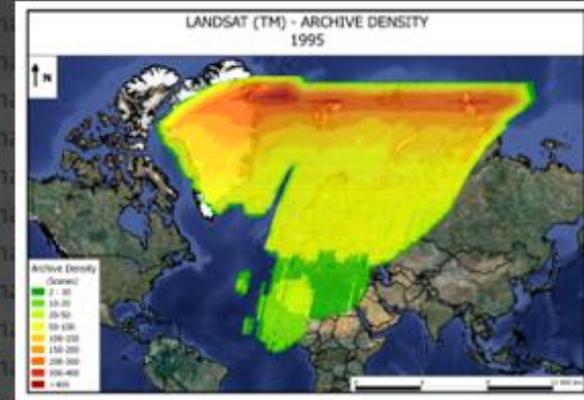
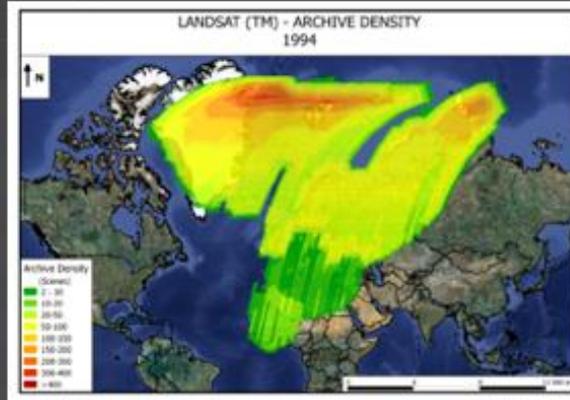
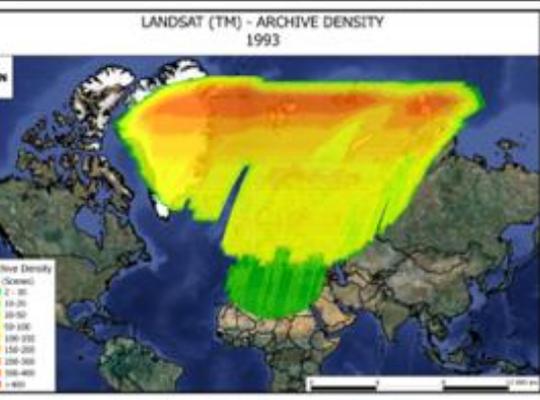
Today, 10:48 AM

1.2 MB

LS_TM_Density_1996.jpeg

Today, 10:51 AM

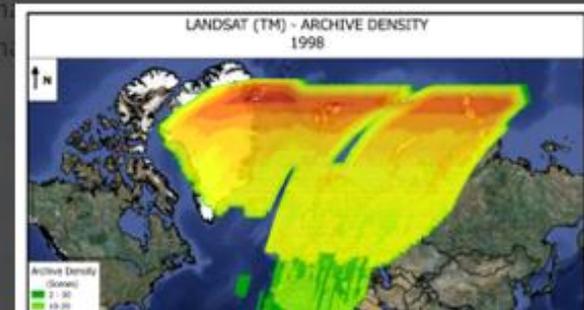
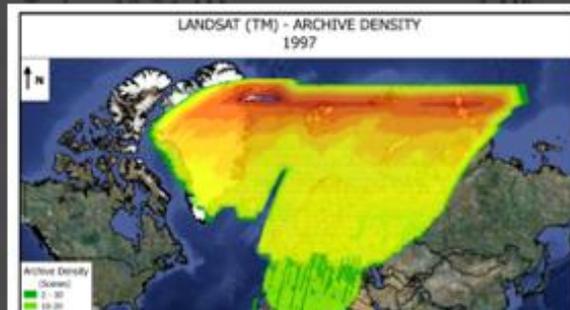
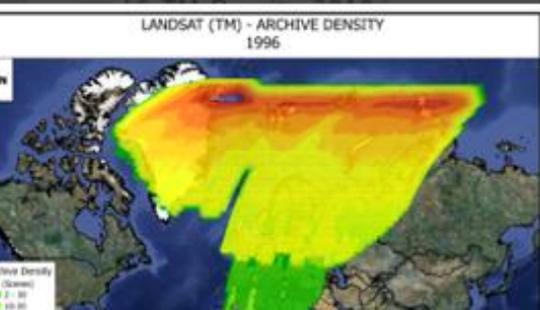
1.2 MB



LS_TM_Density_2009.jpeg

Today, 10:21 AM

1.1 MB



What do we learn from Landsat for S-2?

1. Instruments, bands, applications needs....
2. Ground segment & operations concept with high level of automation
3. Products & Data quality
4. **OPEN DATA POLICY!!!!**
5. Continuity
6. User needs & behaviour:

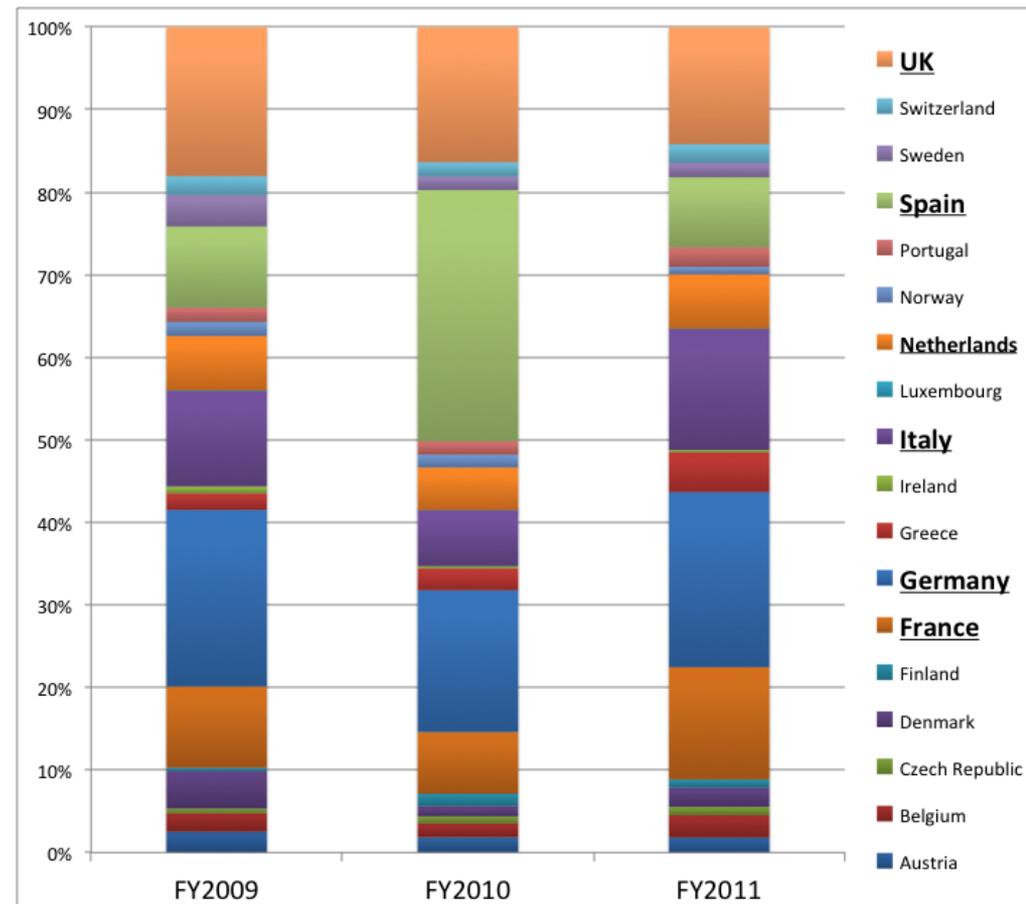
Are our S-2 users 'predictable'?

What is their data access behavior?

Frequency? Preferred areas?

Which are the active users?

7. etc.



from optical ESA Third Party Missions...towards Sentinel-2



Mission	Area	Spectral bands	Swath [km]	Spatial resolution [m]	Product size [MB]	Years in archive	Archive total [TB]	ESA Archive/year [TB]
Landsat	Europe Africa	7+TIR	180	30/15	30- 230	40	325	8
ALOS AV2		4+pan	70	10	150	5	63	12
SPOT	global	5	60	10/20	36	26	13	0.5
Proba-1		63	15	18/36	110	10	0.7	0.07
Rapideye, IRS, DMC, Deimos...	Europe, Africa
LDCM	Europe	9+2	180	30/15	30-230	0 BUT counting!!		
Sentinel-2	Global Land	13	290	10/20 [60]	500	12.5+	7500+	600

Europe GMES requirements:

2 cloud-free coverages per year (so far acquired in 2 years 2011-2012) - Status on 15.08.2012, and country-specific windows



= 85%



DWH_MG2_CORE_01 - OPTICAL HR PAN EU COVERAGES

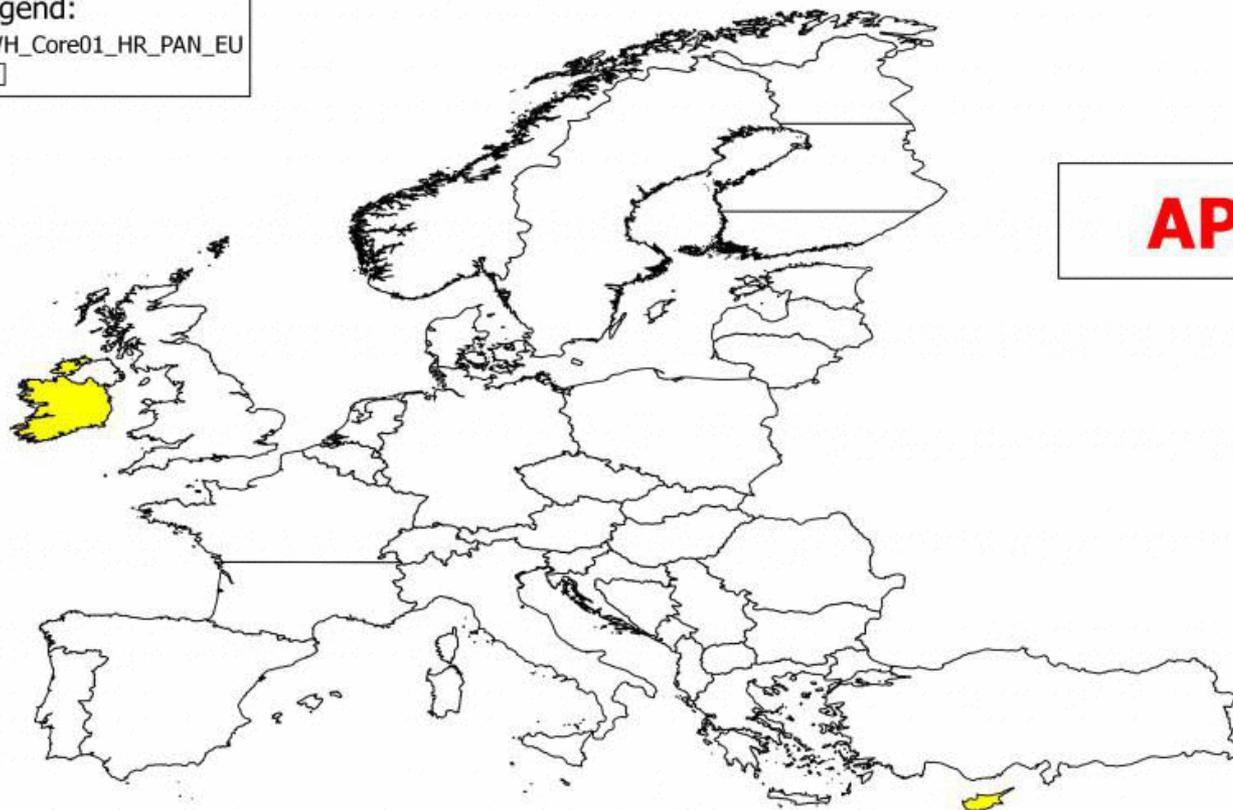
CONSTRAINTS: TWO COVERAGES DURING THE VEGETATION SEASON/MINIMUM TEMPORAL SEPARATION: 6 WEEKS/
TEMPORAL ACQUISITION WINDOWS SPECIFIED
REPRESENTATION BASED ON NARROW WINDOW DEFINITION/FULL MONTH

Legend:

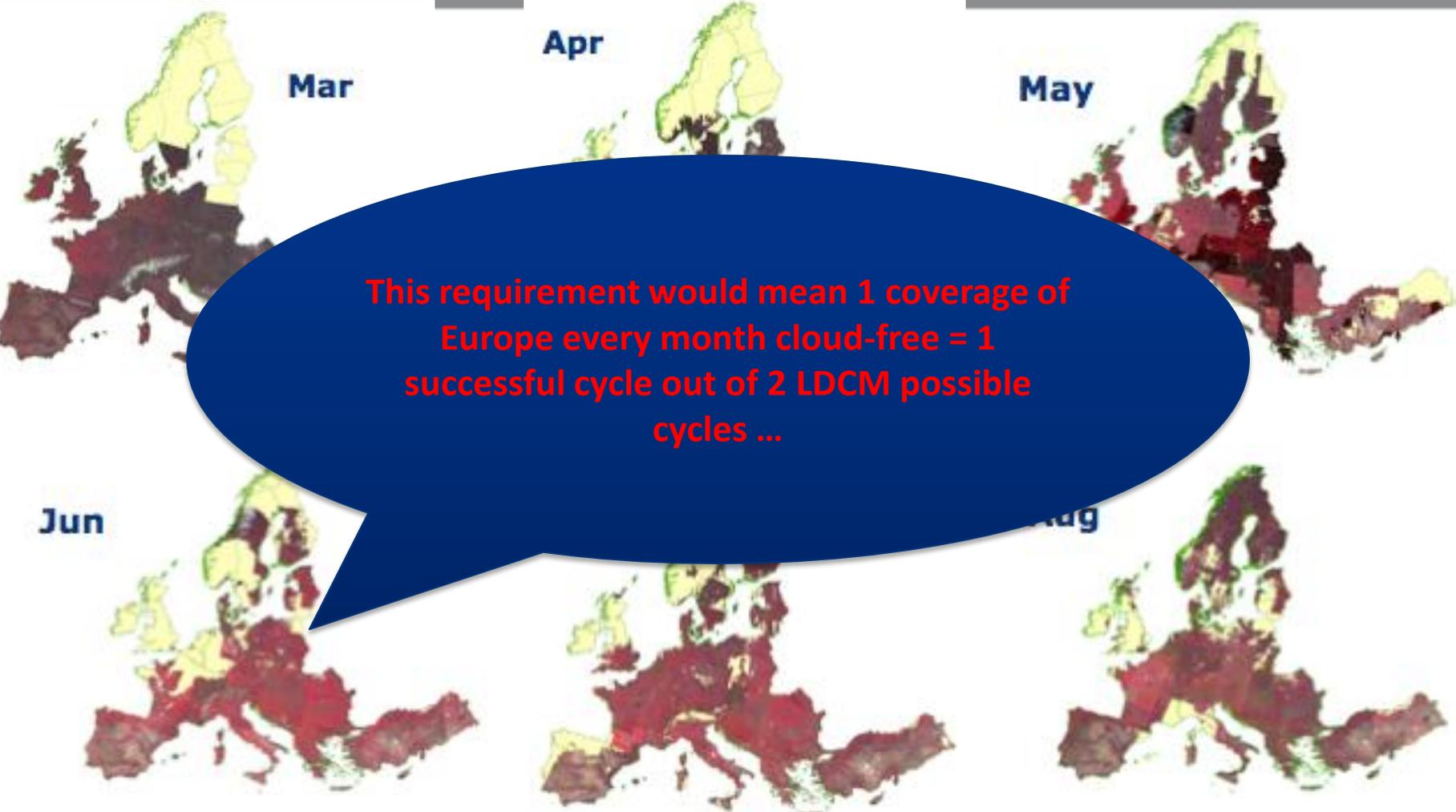
DWH_Core01_HR_PAN_EU



APRIL



Monthly Europe coverage Mar-Aug 2012 with Awifs data (60m, 740km swath, with tasking) – how to ‘translate into LDCM’?

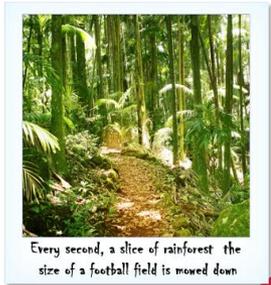


This requirement would mean 1 coverage of Europe every month cloud-free = 1 successful cycle out of 2 LDCM possible cycles ...



– 70-85% each month

A variety of applications will be served by S2



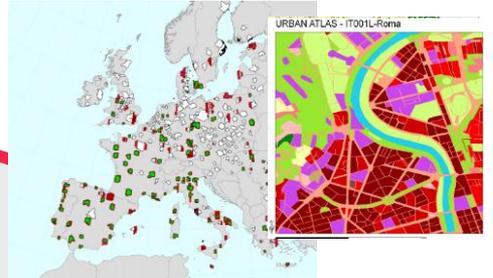
Every second, a slice of rainforest the size of a football field is mowed down



Forests & Carbon, Vegetation monitoring/change
(Credit: GEO-FCT/Tropforest project)

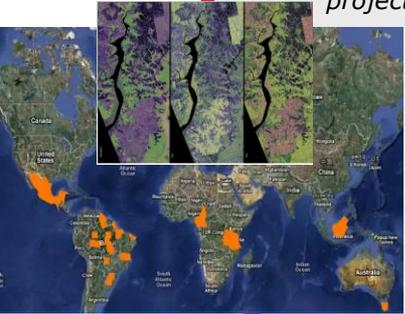


European, African coverages for land cover classification/CORINE
IMAGE2006, IMAGE2009 etc.
(Credit: Euromap, DMCii-Deimos, USGS)



Repetitive coverages/change detection: Urban Atlas
(Credit: EUSI, SIRS)

Global Land cover Land use
(Credit: GLOBCover ESA)



Emergency management: flooding
(Credit: SAFER, DLR)

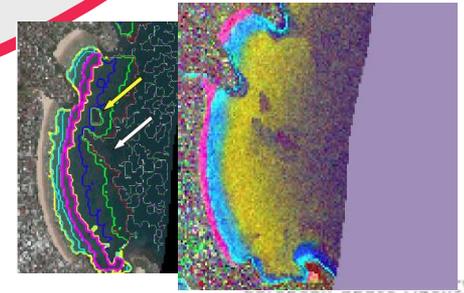
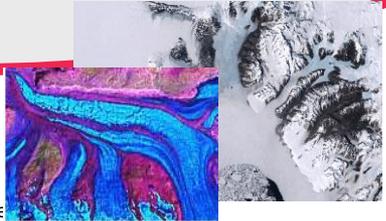
Geology
(Credit: USGS)



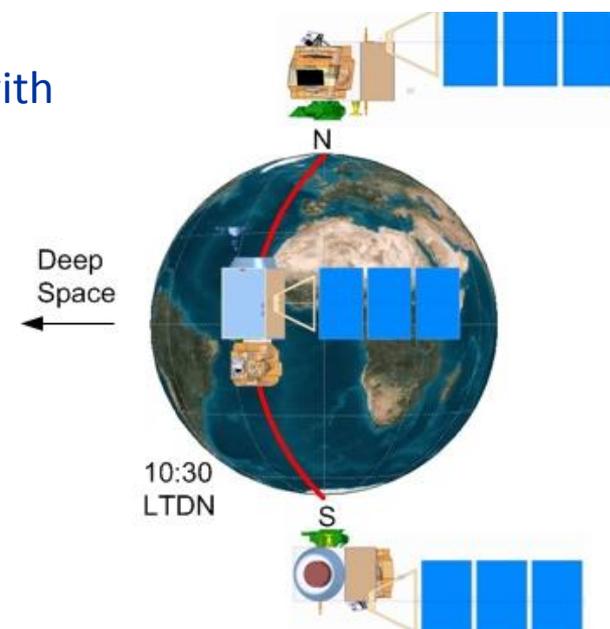
Coastal zones/bathymetry
(Credit: R. Merton et al.)



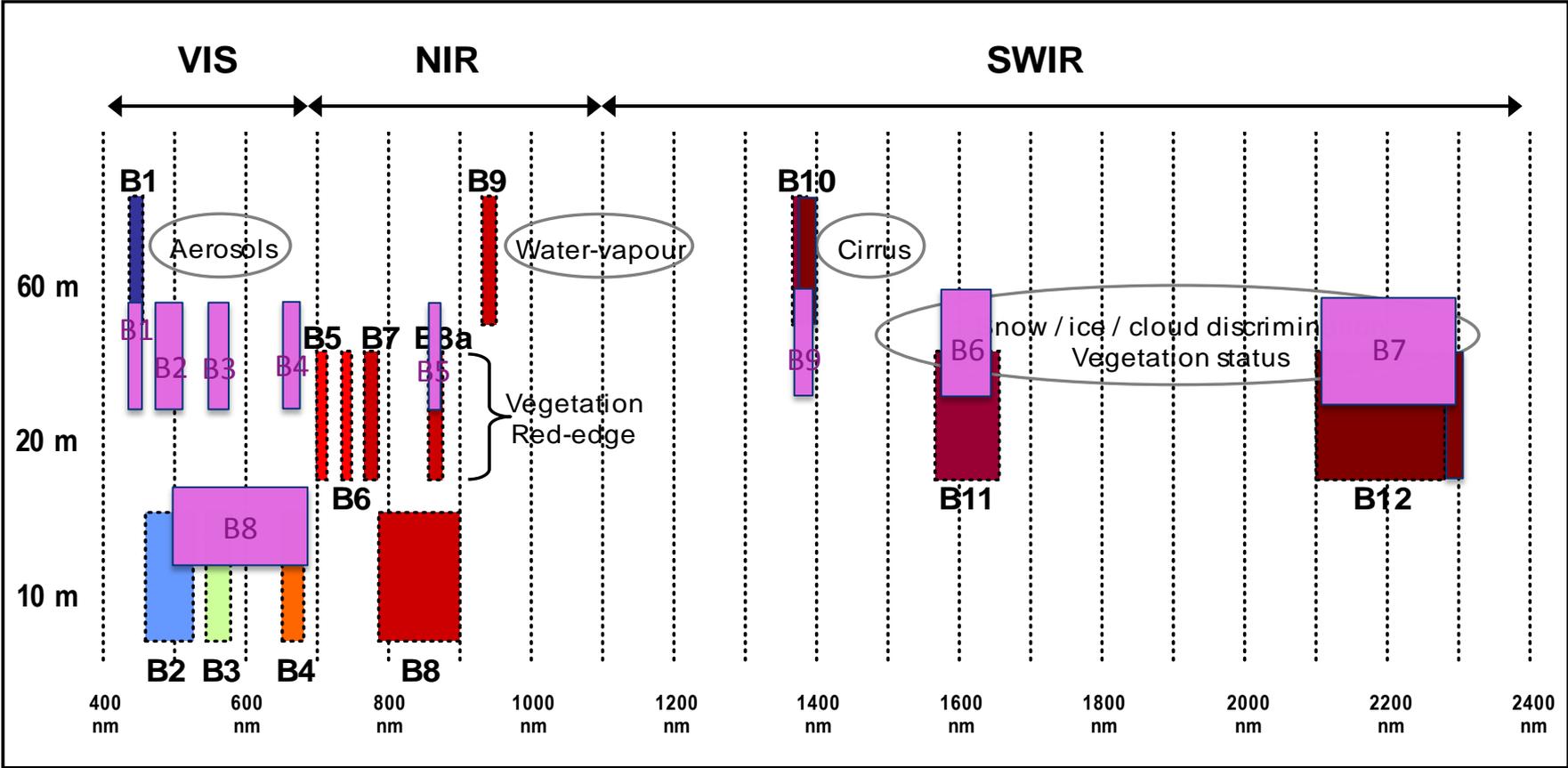
Glaciers and ice
(Credit: LIMA Project)



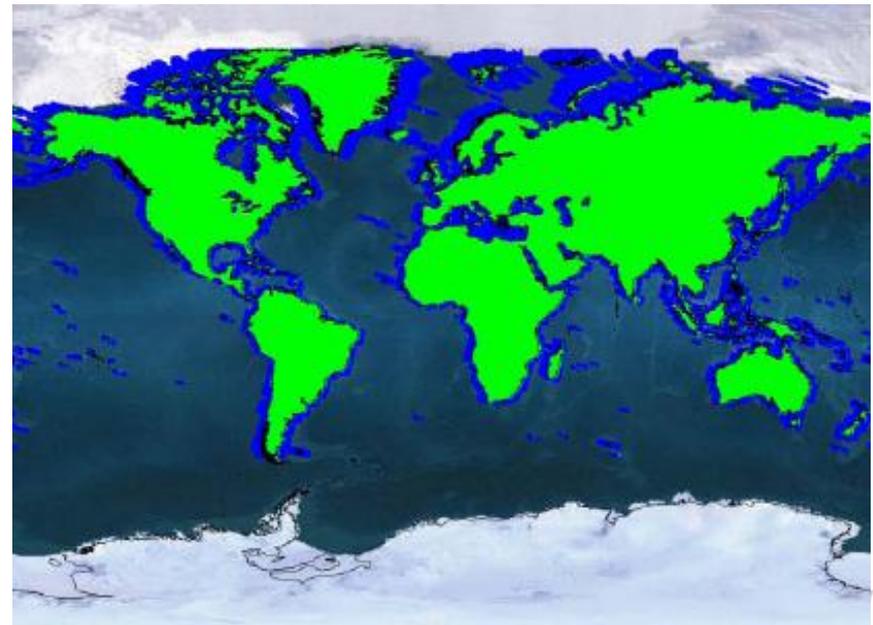
- **Spacecrafts:** 2 operating in twin configuration
- **Spectra bands:** 13 (VIS–NIR–SWIR spectral domains)
- **Spatial resolution:** 10m / 20m / 60m
- **Orbit:** Sun-synchronous at 786 km (14+3/10 revs per day), with LTDN 10:30 AM
- **Multispectral Instrument:** operating in pushbroom principle, filter based optical system, low noise imagecompression techniques
- **Lifetime:** 7.25 years, extendable to 12 years
- **Launch:** currently planned for summer 2014



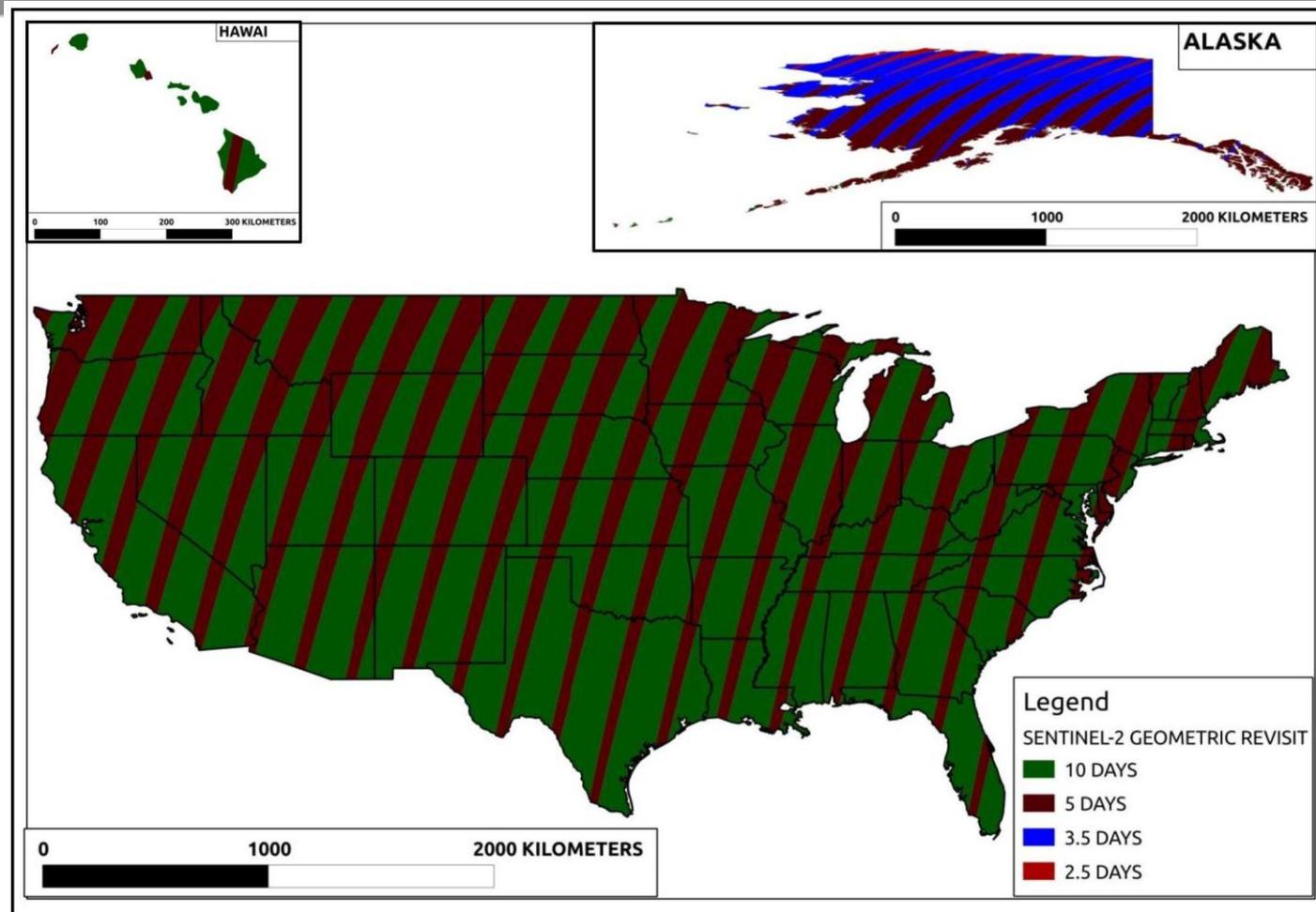
Sentinel-2 spectral bands overlaid with LDCM OLI bands



- **290 km swath**
- **Systematic acquisition and processing of Level-1 data on:**
 - All land surfaces between 56deg South latitude and 84deg North latitude
 - Major islands (greater than 100 km² size), EU islands and all the other small islands located at less than 20km from the coastline
 - Mediterranean Sea, all inland water bodies and all closed seas
 - Specific acquisition campaigns as required
- **10-day revisit with 1 satellite**
- **5 day revisit with 2 satellites**



SIMULATED SENTINEL-2A GEOMETRIC REVISIT OVER THE US



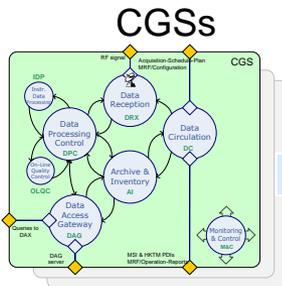
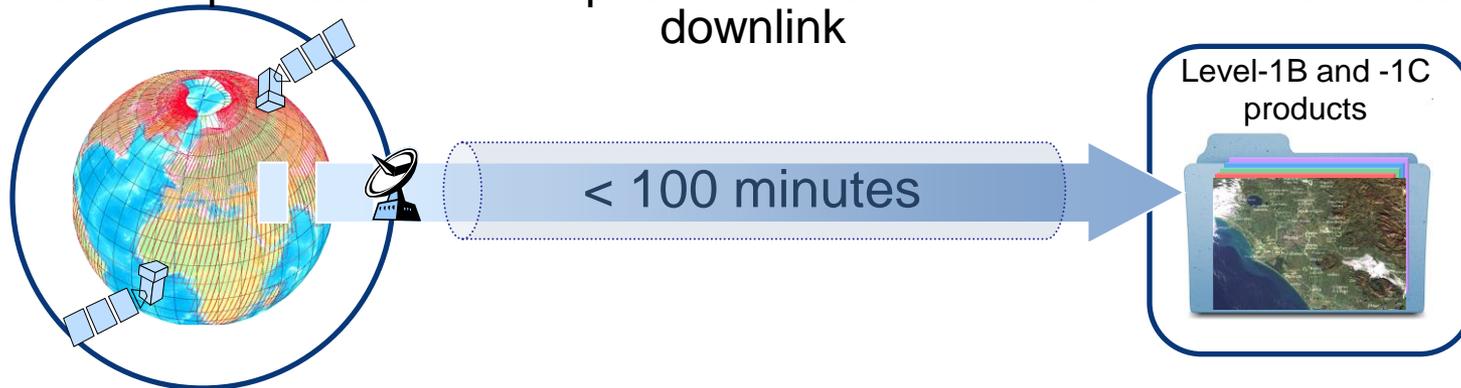
*Calculated from simulated swath intersections

- landmasses according to baseline definition
- assuming full nominal operation
- not regarding SZA limits

Sentinel-2 data volume

- X band downlink with data rate of **490 Mbit/s** (after on-board wavelet compression) → **50x ENVISAT MERIS/FR**
- average **~17 minutes of instrument MSI operation/orbit**
- **800 GB per day** compressed raw data (~1100 CDs), i.e. **400 TB per year** from 1 satellite
- Equivalent **continuous raw data supply rate of ~170 Mbps** (compressed) to be sustained on ground for 2 satellites
- One **100km x 100km portion** of MSI image weights **~500 MBytes** (J2K compressed)
- Product archive of about **2.4 Petabytes/year**, cumulating over **27 Petabytes after 12 years**
- Three main categories of **operational latency**: Nominal (available in 24 hours from sensing), Near Real Time (available in 3 hours from sens.), Real Time (available in 100 minutes from sens.)
- **Dissemination to users** is based on a free and open data policy, leading to:
 - An estimate of over **1 Terabyte daily** of high-level products to be supplied in average from the archives
 - A sustained **average polling throughput of ~110 Mbps , 1/4 with NRT timeliness**

The PDGS will process all data up to Level-1C within 100 minutes after satellite downlink



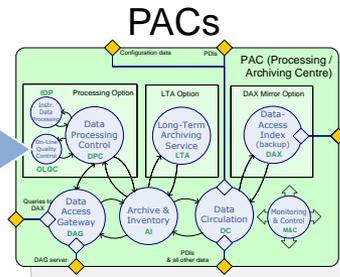
Short term rolling availability from stations

< 100 minutes after station acquisition



Centralised & transparent access

internal circulation within typically a week



Long-Term availability from PACs

Sentinel-2 products

Level-1B Product – *For expert users*

Radiometrically corrected and kept in original sensor geometry (12 separate staggered detectors)

- Dark signal, pixels response non uniformity, optical & electrical crosstalk, defective pixels, restoration, and special averaging for 60m bands.
- Geometric model appended

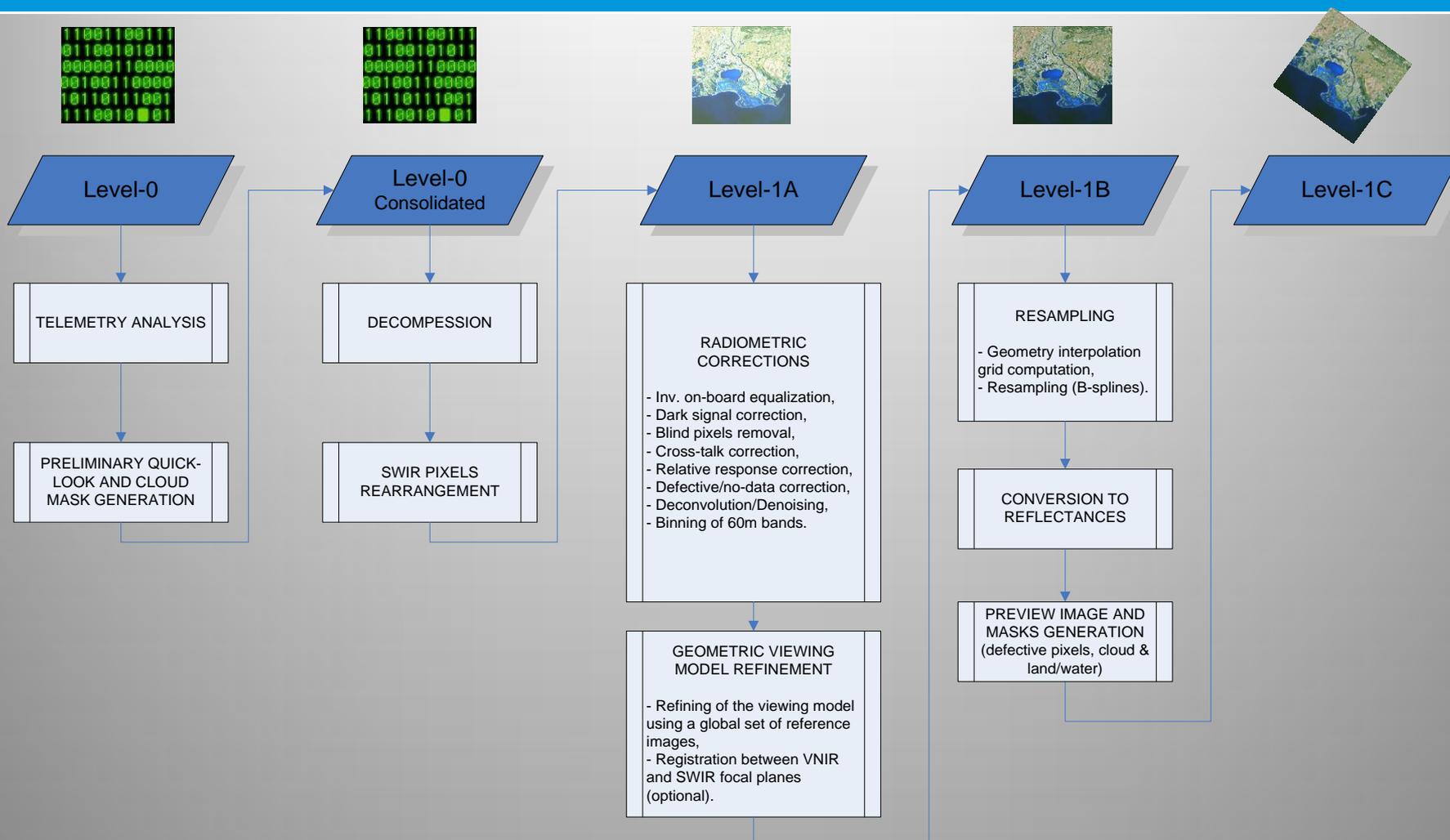
Level-1C Product

TOA Reflectance/Radiance, UTM
Orthorectified based on DEM (10m)

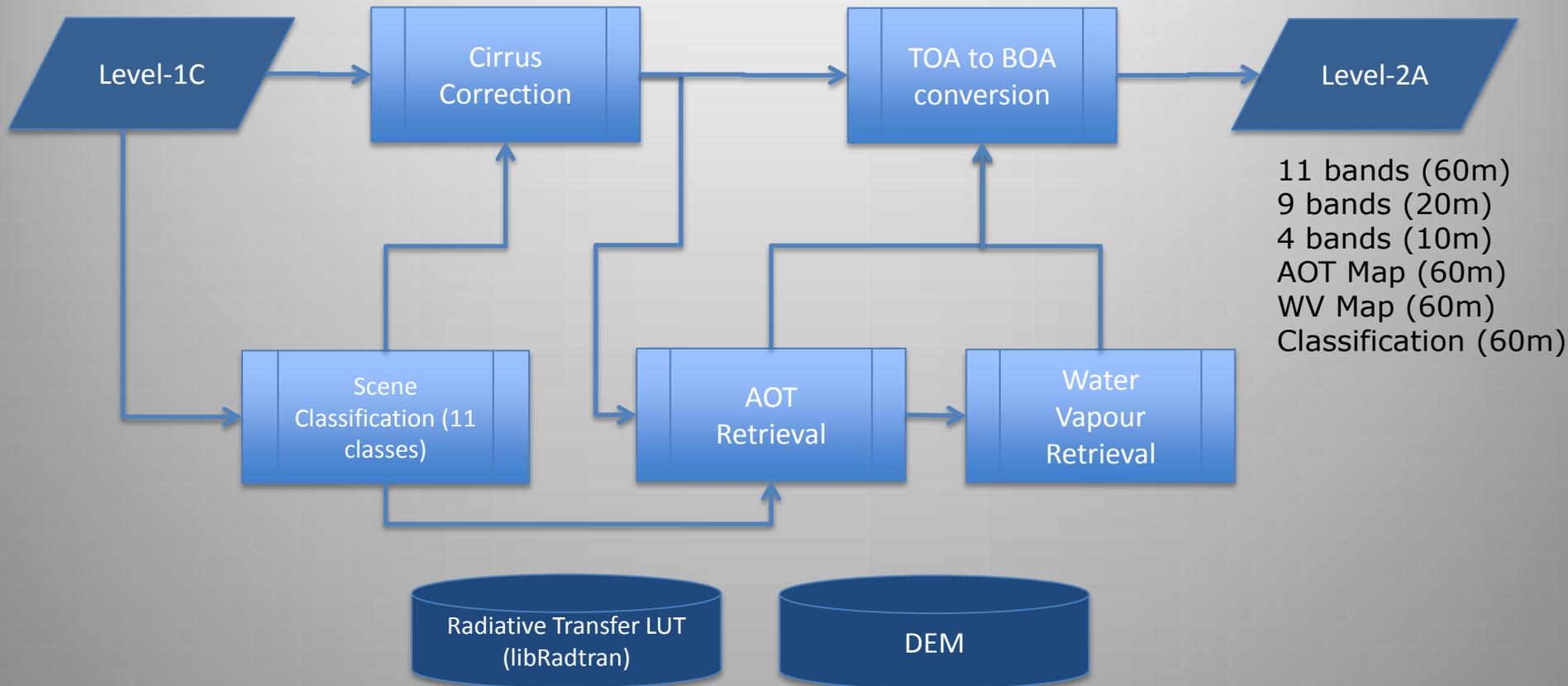
Atmospheric correction

Other ‘collaborative’ products opportunities: land cover classification, geophysical variables etc.
→ outside the scope of the Core ground segment, but can be added as ‘Collaborative ground segment’ funded and operated elsewhere

In addition, a User Toolbox software featuring an atmospheric correction processor will be provided for users to run on their own platforms to output BOA reflectance and enhanced cloud screening from the Level-1C images.



- Level-2A processing on user side (using Sentinel Exploitation Tools).



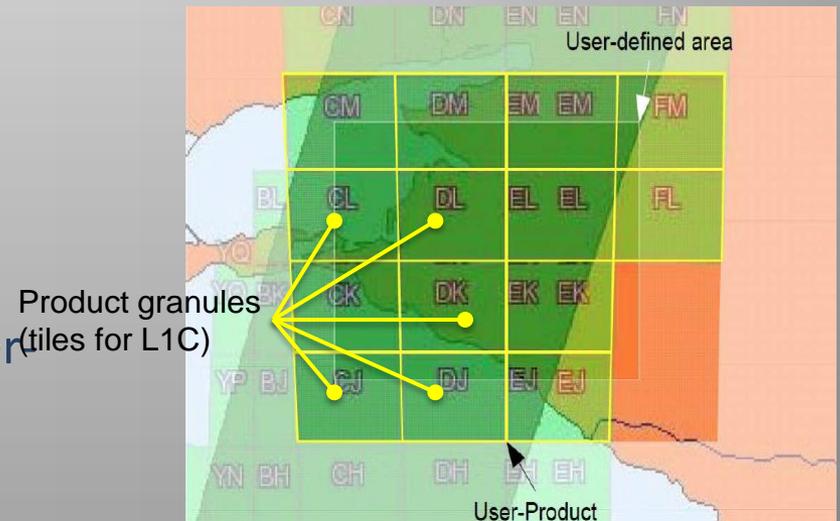
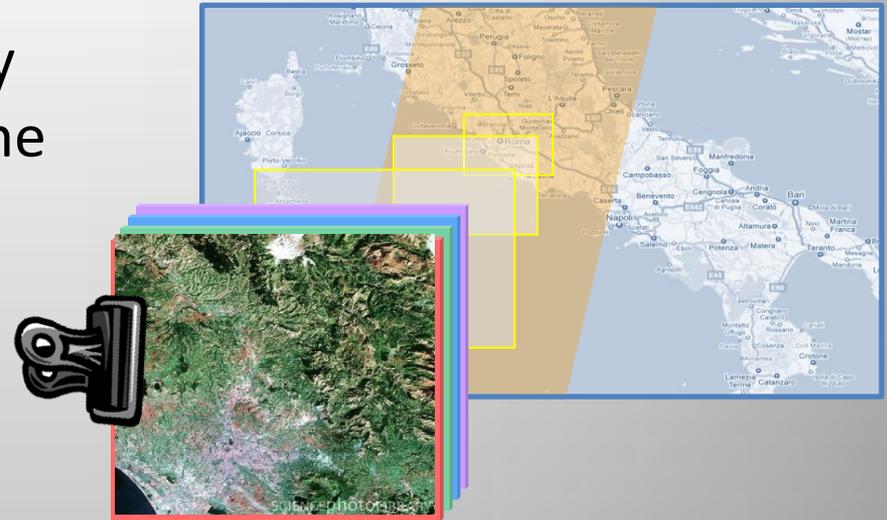
Algorithms developed with



The GSC User Services (cf. <http://gmesdata.esa.int>) are being upgraded to support the Sentinels. Here an overview portfolio of common functions supported:

	User REGISTRATION	Management of user account creation with dedicated username and password (one single login for all missions and services)
	User ACCESS MANAGEMENT	Management of user requests for category assignment (upon agreement of Terms and Conditions)
	DISCOVERY	Dataset and product search
	VIEW	Visualization of browse images
	DOWNLOAD	Interactive Download (via web browser or using a specific download manager) Systematic background download based on defined filters (e.g. area, time window, product type, ...)
	BULK DISSEMINATION	Dissemination of large volume of products on physical media, by land mail.
	EMERGENCY	Opening of an emergency “dossier” upon user call and management of data collection (tasking, selection from archive) N/A for Sentinel-2
	OFFLINE MAPPING	Coordination of data collection for ad-hoc requests (e.g. creation of cloud-free collections for S2)
	HELP DESK	Support and communications to users. Management of inquiries, complains, and suggestions. Advertisement of datasets. Escalation of issues to dedicated mission level specialists and help desks.

- Product contents are defined by the user at query/download time
 - Area of interest
 - Selected product components (level, bands, metadata, etc)
- Product Data Handling
 - Product data is archived as elementary product “granules” (slices for L1B or tiles for L1C) following a geographical split
 - Product granules are assembled during download into the final “User-Products” transparently to the user



To cut the big volumes challenge...into pieces !

		Product Dissemination Unit
Sentinel-1	Sentinel-3	 Stripes

Sentinel-3		 Frames

Sentinel-1	Sentinel-2	 Slices S2 L1B

Sentinel-2	Sentinel-3	 Tiles S2 L1C

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

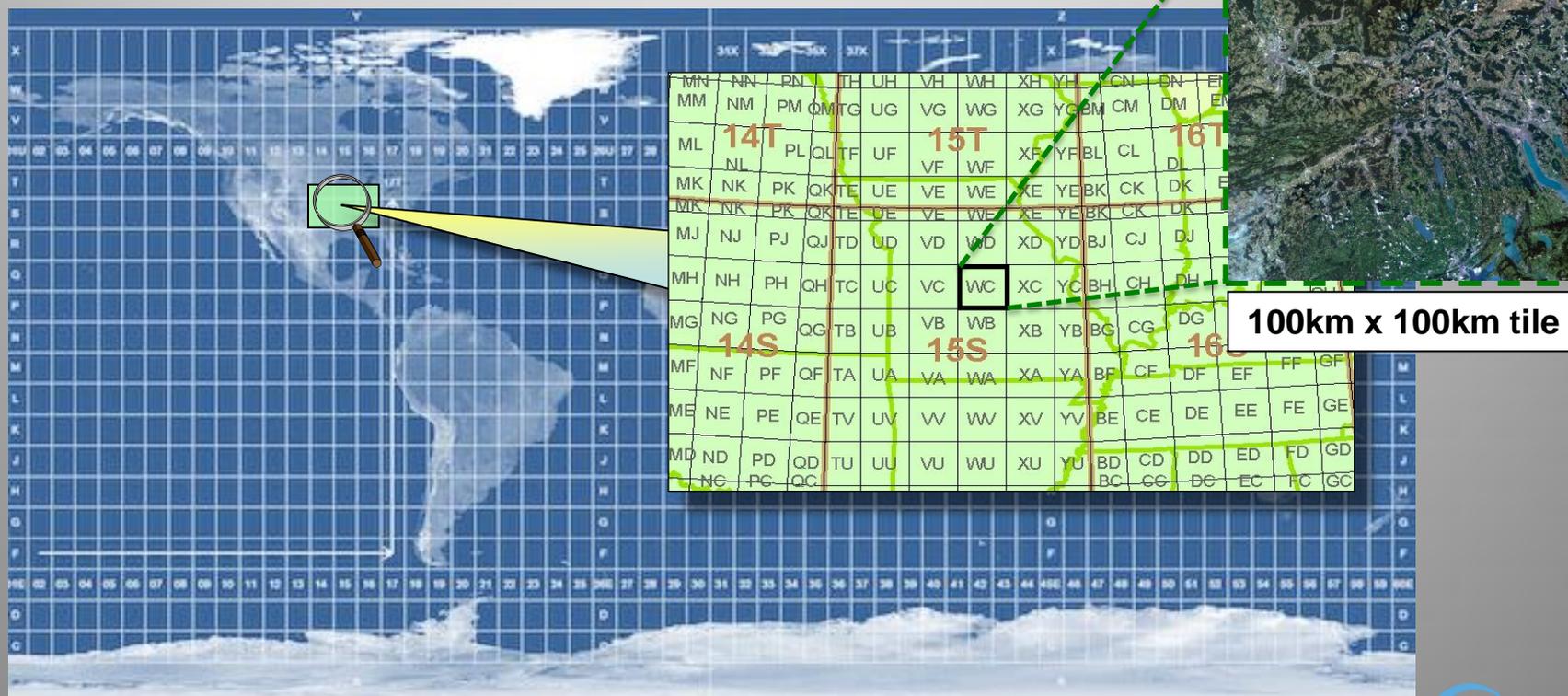
A **slice** corresponds to pre-defined time interval of measurement data

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

- Following native MSI on-board scene and detector split
- 1 granule:
25km across-track x 23km along-track
- Along-track band co-registration is performed with respect to one reference band.
- An average orbit corresponds to ~ 3500 granules, i.e. $\sim 2 \times 10^7$ /year/satellite
- One Level-1B granule weights ~ 27 MB (with all bands and JPEG2000 lossless).



- Global Reference System in UTM space (6°x8° grid zones)
- Each grid zone is split into 100x100km (TBC) UTM “tiles”
- An average orbit covers ~200 tiles, i.e. 10^6 /year/satellite.
- One tile weights ~ 500MB with all bands

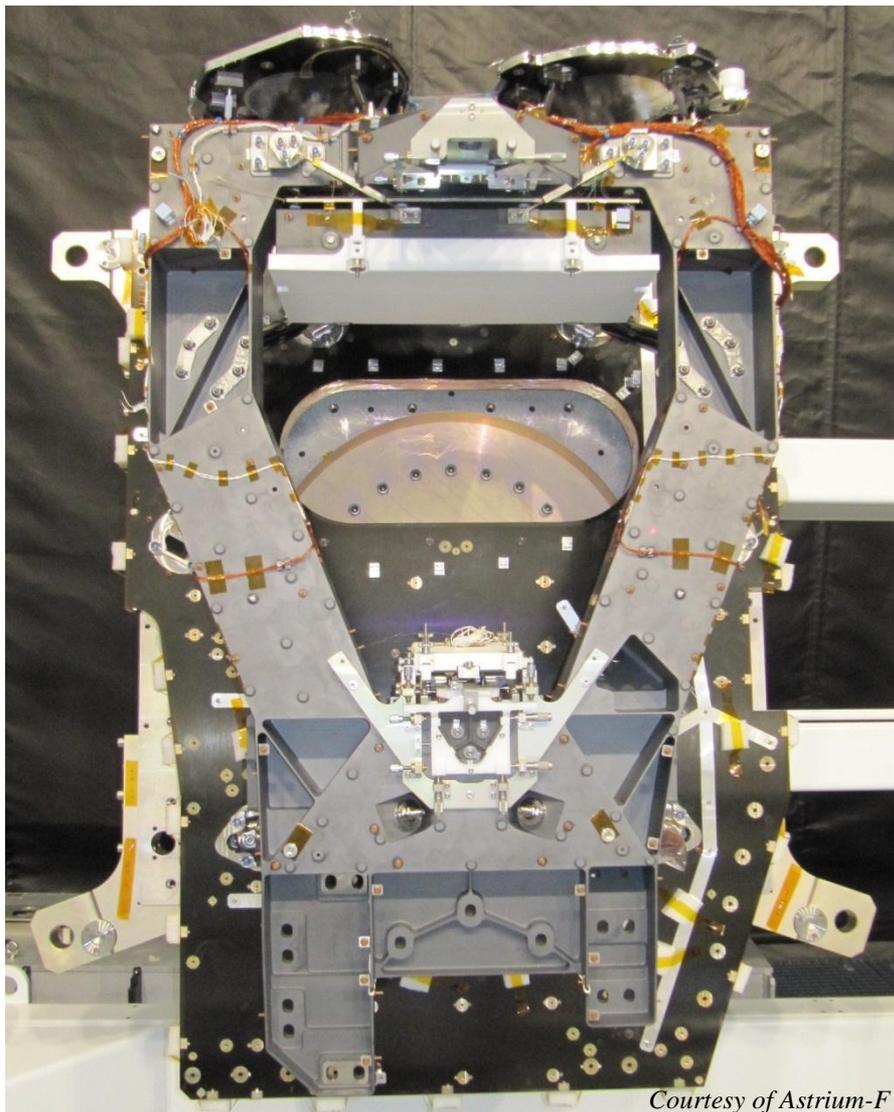


100km x 100km tile

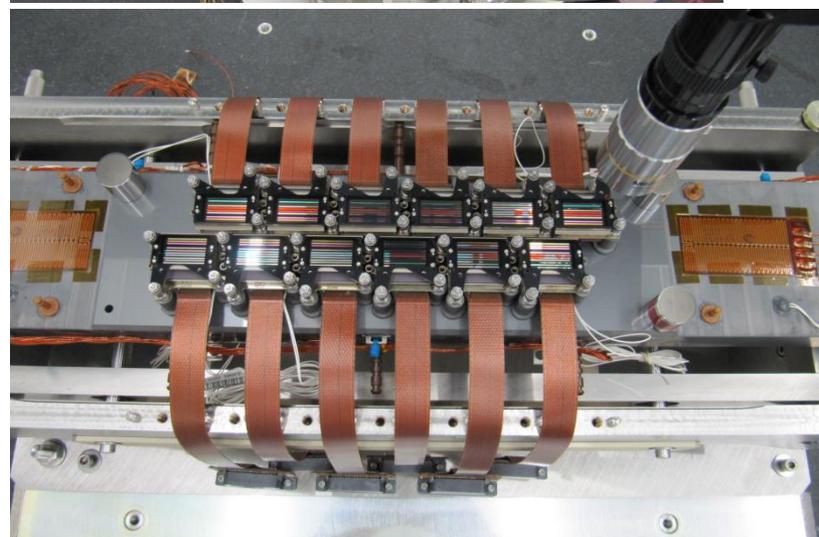
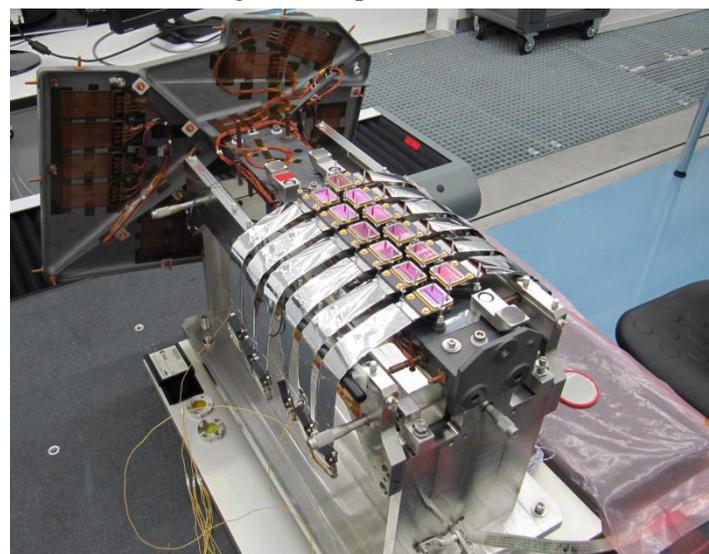
Option	
Spectral Bands Selection (Band list)	List of spectral bands to be included in the image data
Metadata Level (Brief / Standard / Expert)	Level of metadata provided
Include Preview (Boolean)	To include preview image in product itself
Include Auxiliary Data (Boolean)	To embed auxiliary data files in the product (e.g. processing parameters)
Merge Along-track (Boolean) TBC	Applicable to S2_MSI_0 and S2_MSI_1B and S2_MSI_0 only To merge along-track the image data of the granules

Sentinel-2 some fotos

Instrument flight telescope (Astrium-F, BOOSTEC, AMOS)



SWIR flight focal plane (Astrium-F & SOFRADIR)



VNIR flight focal plane (Astrium-F & E2V)



MultiSpectral Instrument telescope under integration at ASTRIUM-SAS

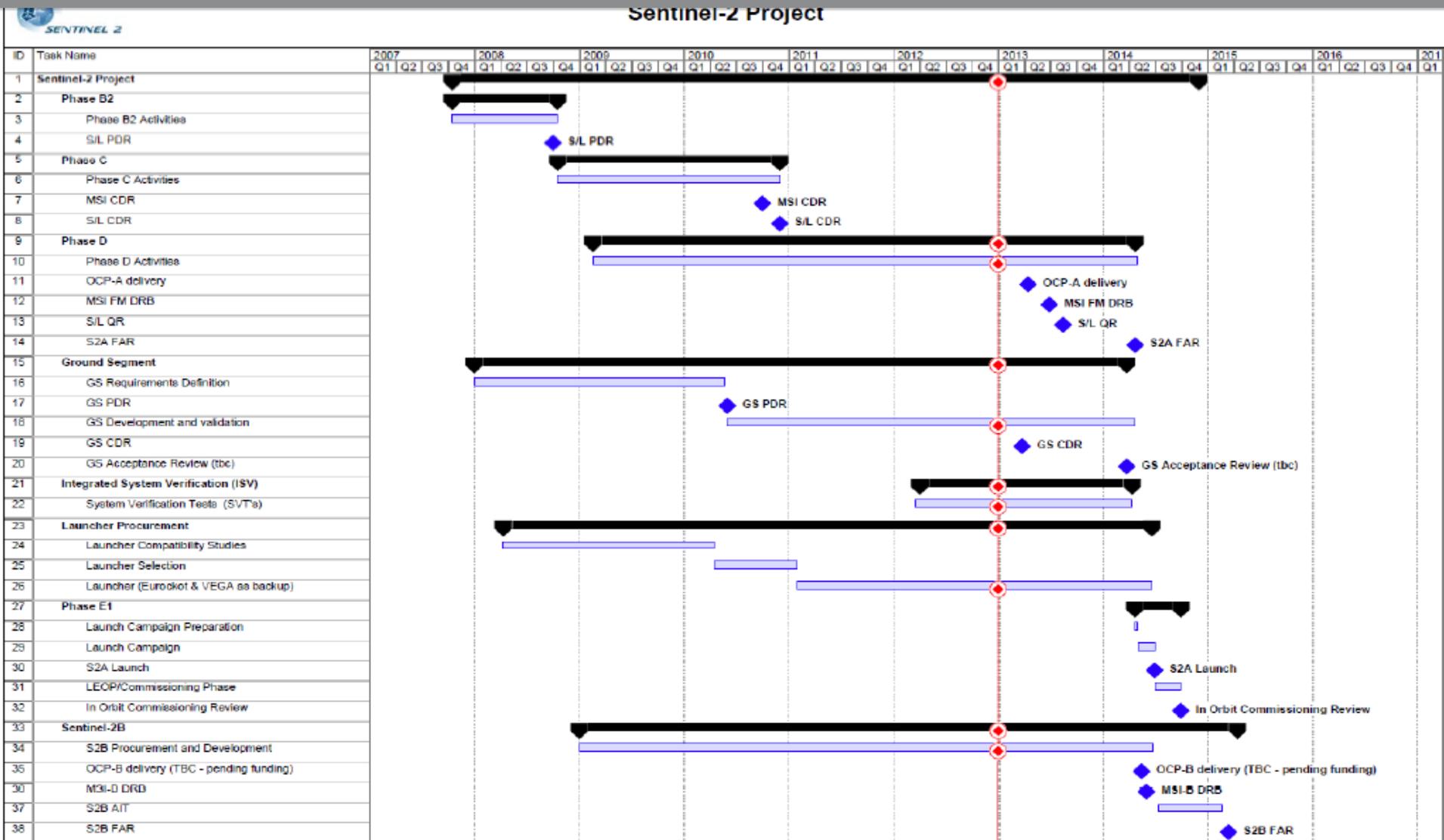
The MultiSpectral instrument telescope features a large baseplate and three mirrors in silicon carbide. These mirrors have been accurately aligned. In the next integration phase, the two focal planes will be integrated within the telescope.

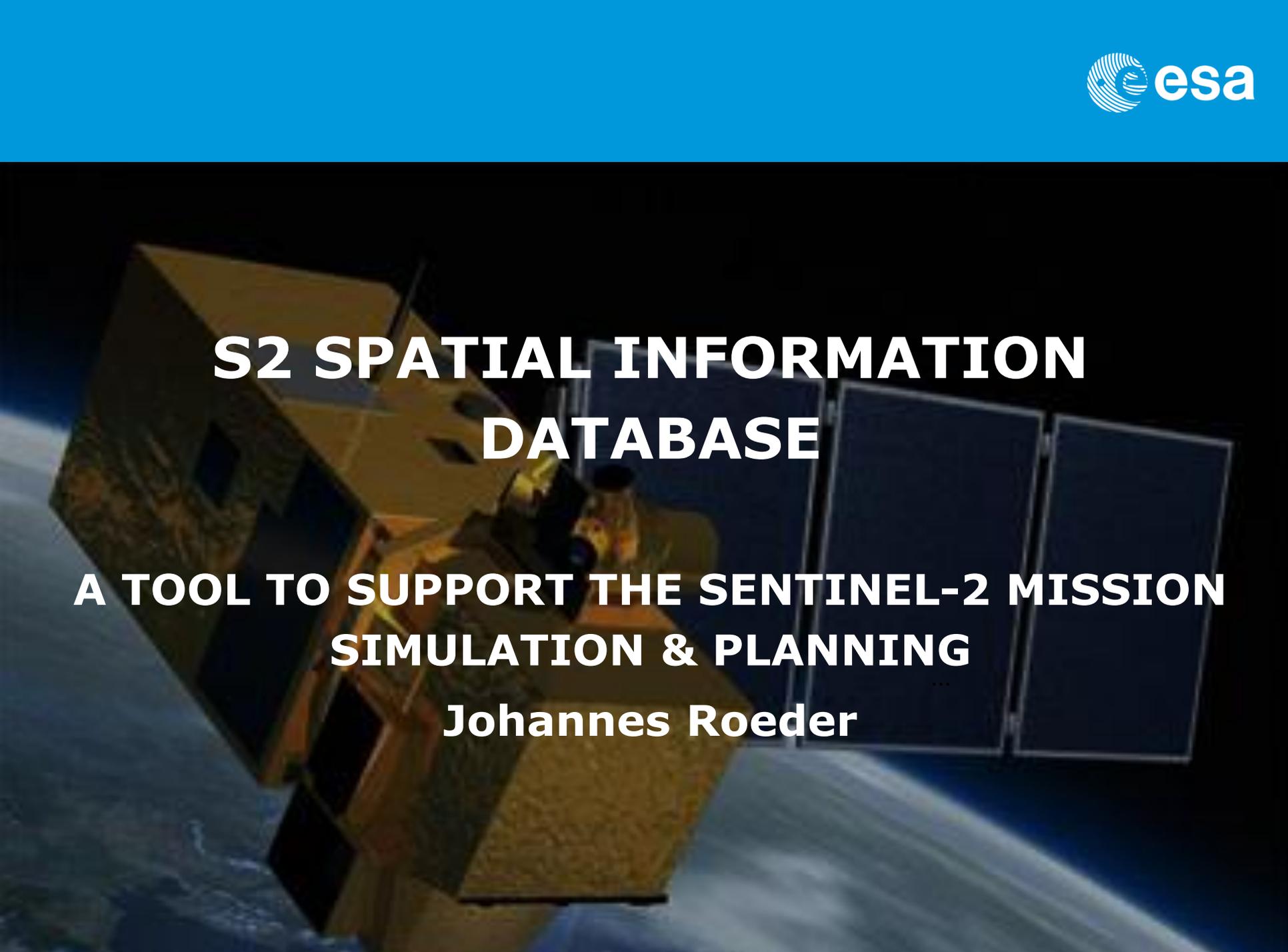
Credits: ASTRIUM-SAS

Integration of the Sentinel-2 Instrument VNIR focal plane.



Sentinel-2 Project



A 3D rendering of the Sentinel-2 satellite in space, with Earth's surface visible in the background. The satellite is gold-colored with various instruments and solar panels.

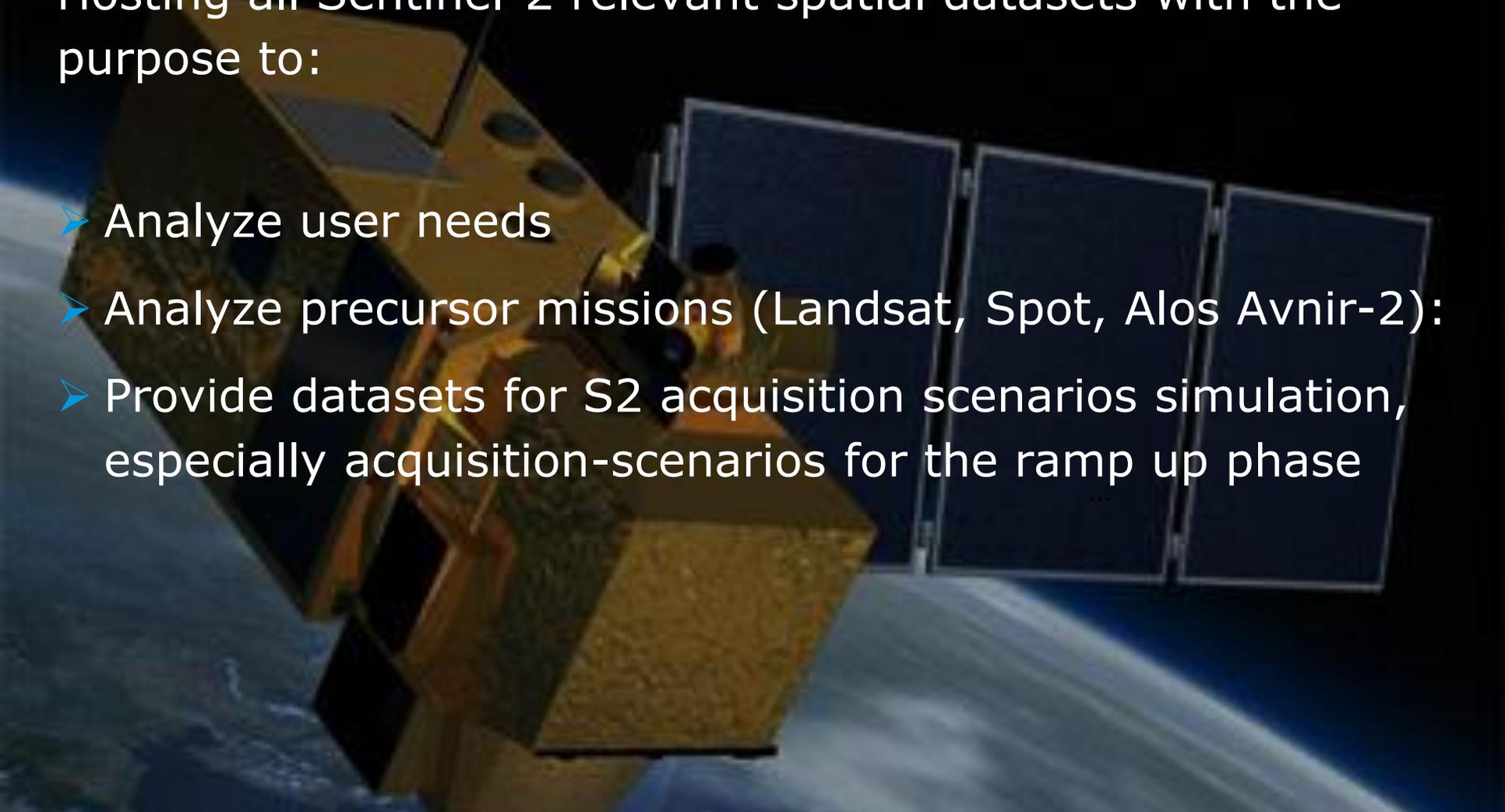
S2 SPATIAL INFORMATION DATABASE

**A TOOL TO SUPPORT THE SENTINEL-2 MISSION
SIMULATION & PLANNING**

Johannes Roeder

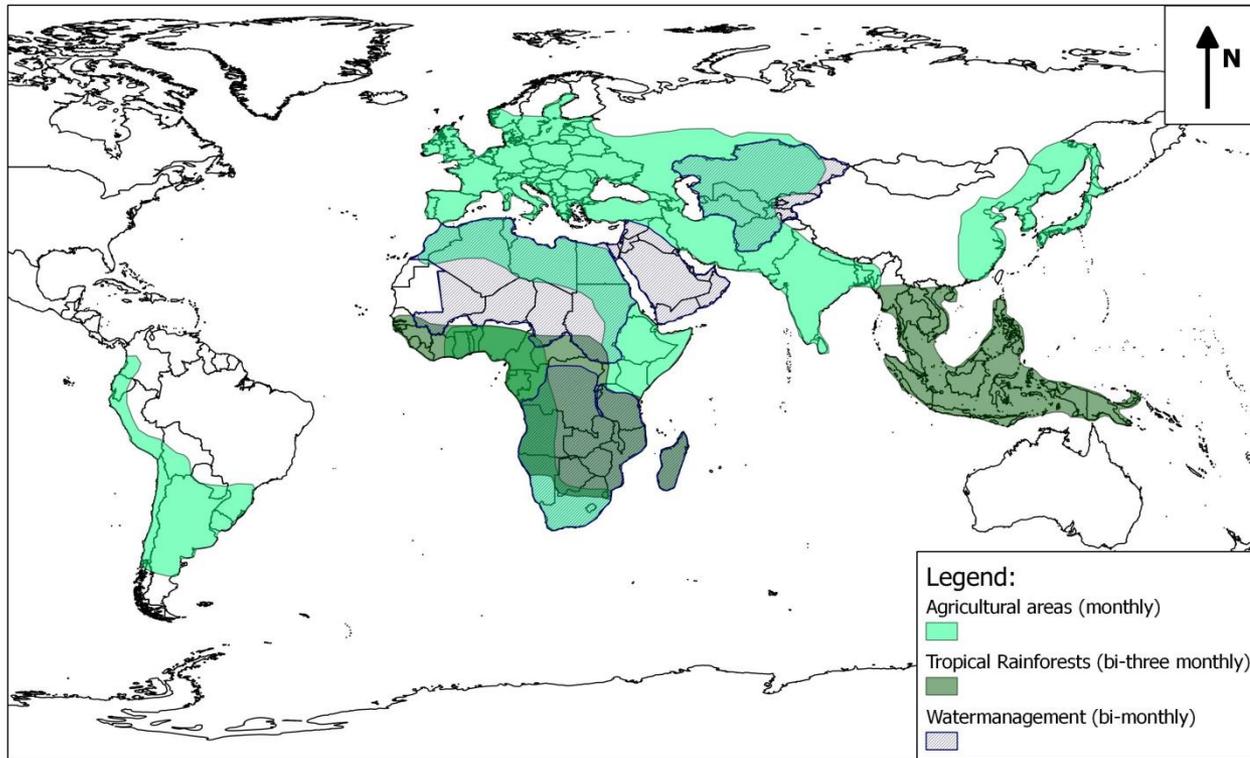
Hosting all Sentinel-2 relevant spatial datasets with the purpose to:

- Analyze user needs
- Analyze precursor missions (Landsat, Spot, Alos Avnir-2):
- Provide datasets for S2 acquisition scenarios simulation, especially acquisition-scenarios for the ramp up phase



COLLECTING THE MEMBERSTATES NEEDS:

EXAMPLE OF NATIONAL REQUIREMENTS: PART OF THE DATASETS (INCLUDING FREQUENCY) ASKED BY GERMANY



DWH-CORE

DWH-ADD

NATIONAL

ARCHIVES

NON-MRD

BASIC DATASETS

- A dialogue with the ESA-memberstates concerning their acquisition requirements was started (based on a first questionnaire)
- The requirements stated will be checked for feasibility and can be successively refined

LEARNING FROM PRECURSOR MISSIONS:

DWH-CORE

DWH-ADD

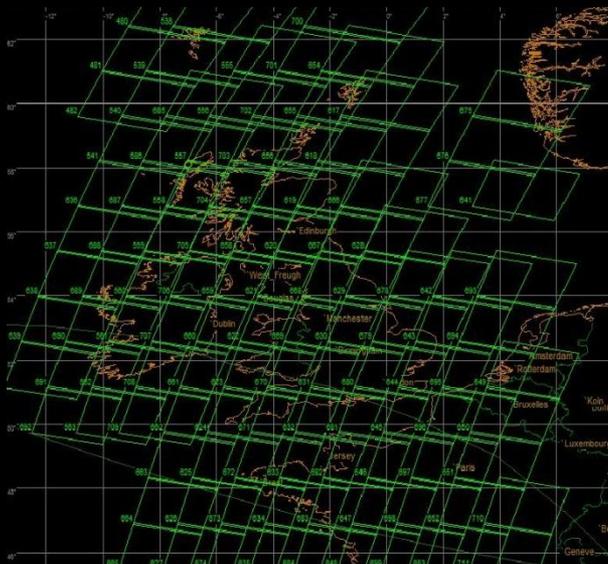
NATIONAL

ARCHIVES

NON-MRD

BASIC DATASETS

- Reliable predictions on effective revisit rates to expect for S2 are crucial for many GMES project planers yet today
- So far in simulations used synoptical cloud maps provide only coarse information



e.g. 711 Acquisitions over Britain and northern France in 2003 (Landsat 5 TM / Landsat 7 ETM hosted on ESA-servers)



... only 84 (11,8 %) are cloudfree...with only neglectible areas covered in Britain

LEARNING FROM PRECURSOR MISSIONS:

- Currently computations are ongoing to exploit the 40 years of experiences and (meta-)data from the Landsat missions

DWH-CORE

DWH-ADD

NATIONAL

ARCHIVES

NON-MRD

BASIC DATASETS

Full earth-explorer metadata catalogue provided by USGS* (1972-2012)

ESA Landsat archives over Europe and Africa (1990-2012)

Metadata-migration

S2-SPATIAL INFORMATION DATABASE

- Constraints:
- Remove duplicate records
 - Remove records with biased cloud cover information

Will allow queries on Landsat effective revisit rates during the last 40 years on small spatial scales as well as globally with high temporal resolution (LS geometric revisit is at least 18 days)



Intersection grid defining WRS-1/WRS-2 Tile membership in S2-tiling grid (based on quarter Landsat PR)



IMPACTS OF ACQUISITIONS BEYOND BASELINE ?

DWH-CORE

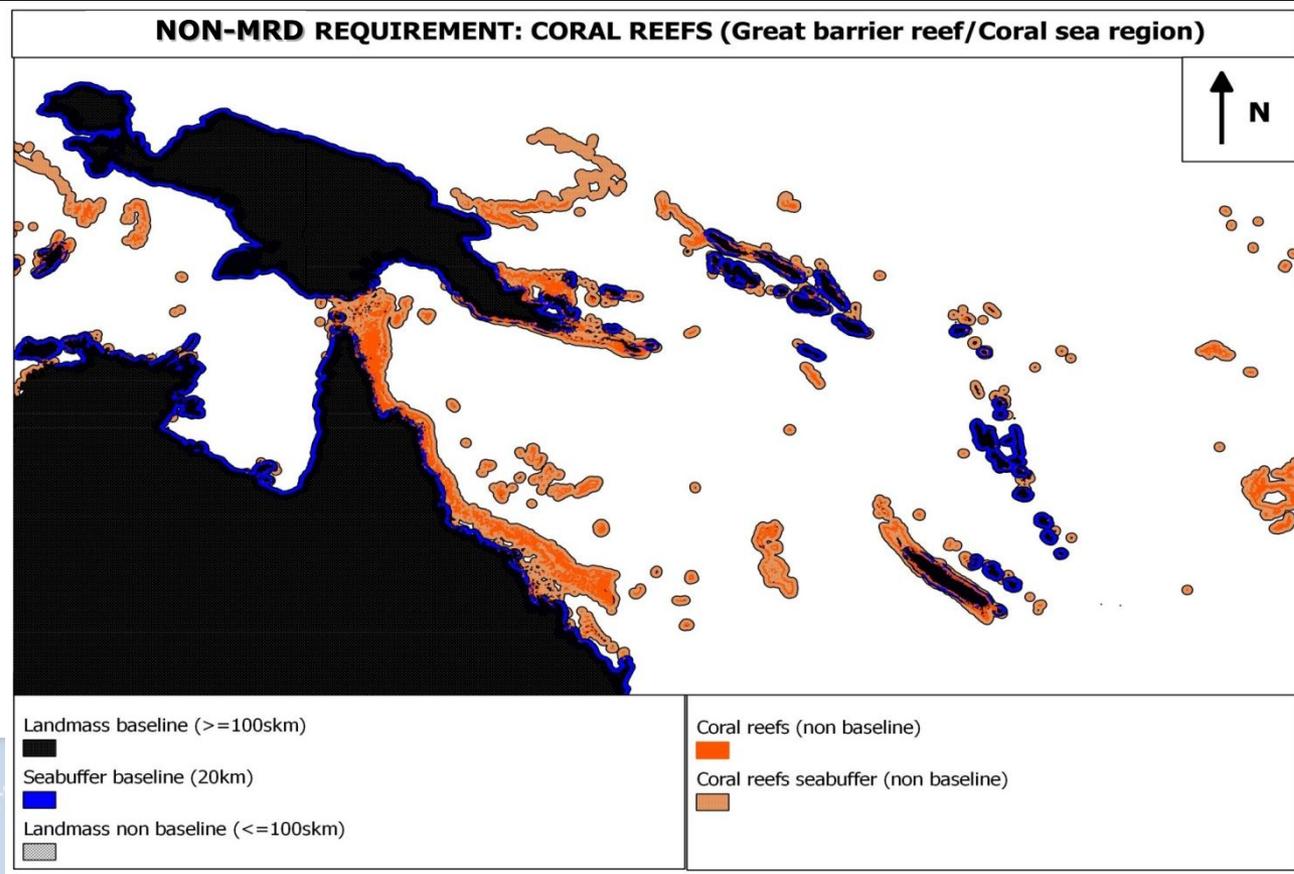
DWH-ADD

NATIONAL

ARCHIVES

NON-MRD

BASIC DATASETS



➤ Technical impacts on mission costs? (elongated acquisition strips, switch on/of aging)

➤ Interference with other acquisition aims? (recorder occupancy)



IMPACTS OF ACQUISITIONS BEYOND BASELINE ?

DWH-CORE

DWH-ADD

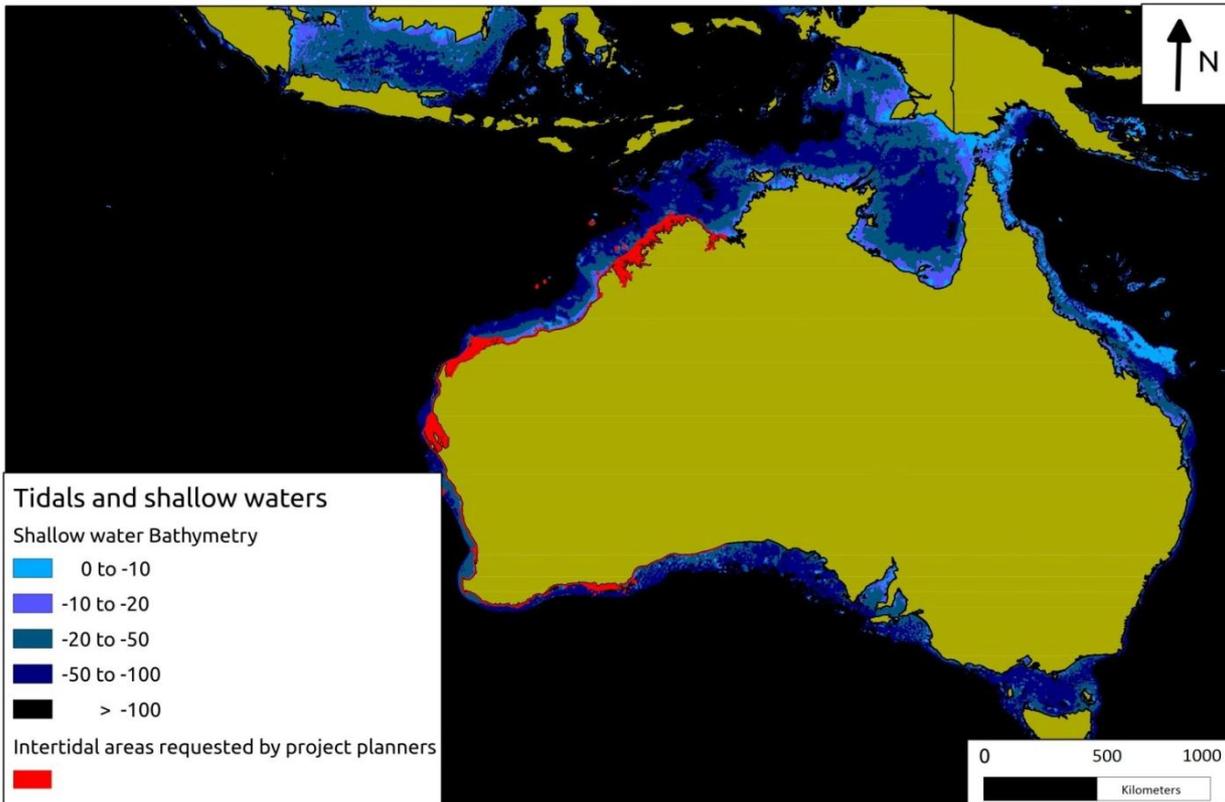
NATIONAL

ARCHIVES

NON-MRD

BASIC DATASETS

NON-MRD REQUIREMENT: INTERTIDAL AREAS AND SHALLOW WATERS



➤ Technical impacts on mission costs? (elongated acquisition strips, switch on/of aging)

➤ Interference with other acquisition aims? (recorder occupancy)

IMPACTS OF ACQUISITIONS BEYOND BASELINE ?

DWH-CORE

DWH-ADD

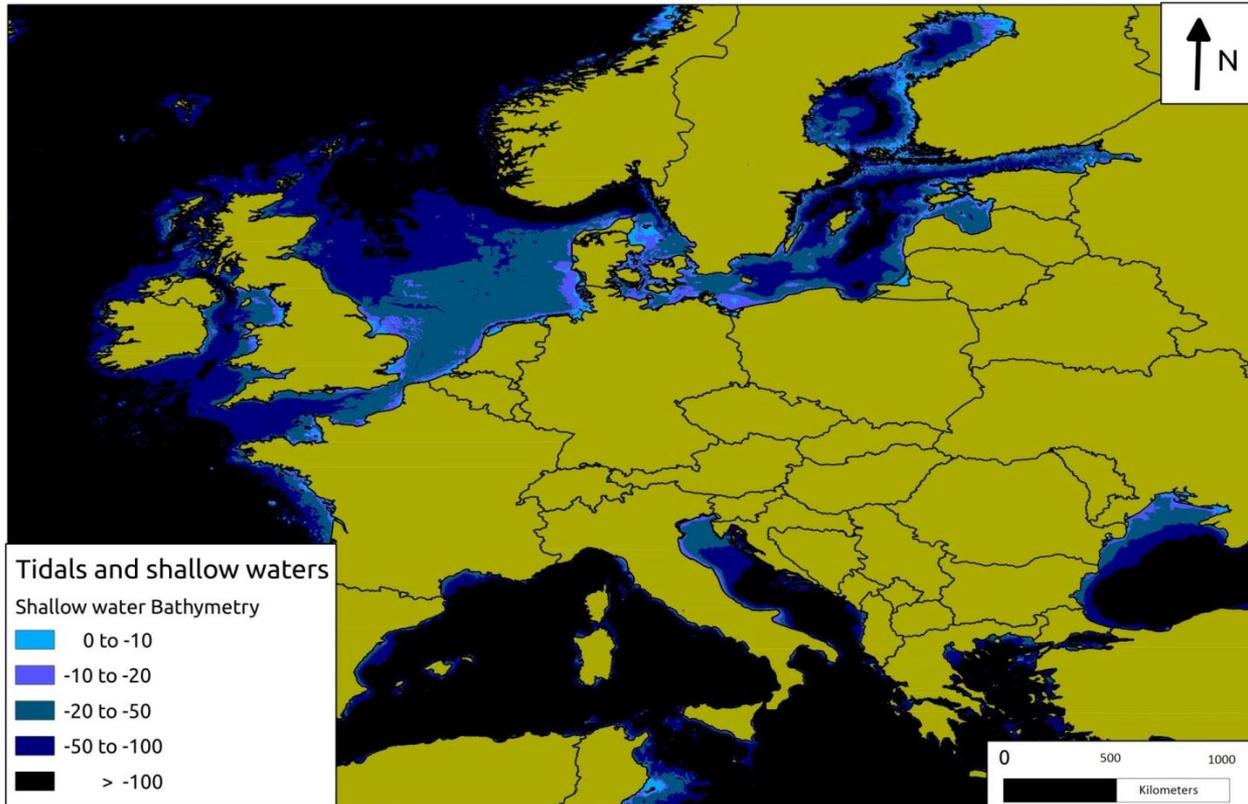
NATIONAL

ARCHIVES

NON-MRD

BASIC DATASETS

NON-MRD REQUIREMENT: INTERTIDAL AREAS AND SHALLOW WATERS



➤ Mudflats and intertidal flats as highly vulnerable and intensively studied ecosystems cover a considerable surface not only in Europe, but all over the world...

IMPACTS OF ACQUISITIONS BEYOND BASELINE ?

DWH-CORE

DWH-ADD

NATIONAL

ARCHIVES

NON-MRD

- As there is an emphasised request on vegetation related products, demands will decrease during northern winter
- Will this free capacities for an Antarctica acquisitions (over 14 000 000 skm)

NON-MRD REQUIREMENT: Antarctica coverage

Legend:
 Antarctic shelves and glacier
 Antarctic land surface
 20 km seabuffer

SGS changing world | NSF | NASA | British Antarctic Survey | Image Mosaic Of Antarctica (LIMA)

DCM will cover Antarctica twice per year

- View LIMA
- Download Mosaics and Landsat Scenes
- Download Customized Area
- Download LIMA Poster, Maps, and More from
- Interactive Atlas
- Order USGS Maps, Posters, and Wall Art
- Browse the Digital Library
- Locate GIS Resources

LANDSAT IMAGE MOSAIC OF ANTARCTICA

Created for the International Polar Year 2007-2008
 Sponsored by the U.S. Geological Survey, National Science Foundation, National Aeronautics and Space Administration, and the British Antarctic Survey

Newsroom
Educational Resources (USGS)
Faces of Antarctica (NASA)
Discovering Antarctica (BAS)
Contact Us

International Polar Year (IPY 2007-2008), LIMA brings the coldest continent on Earth alive in greater detail than ever before through this virtually cloudless, seamless, and high resolution mosaic of Antarctica.

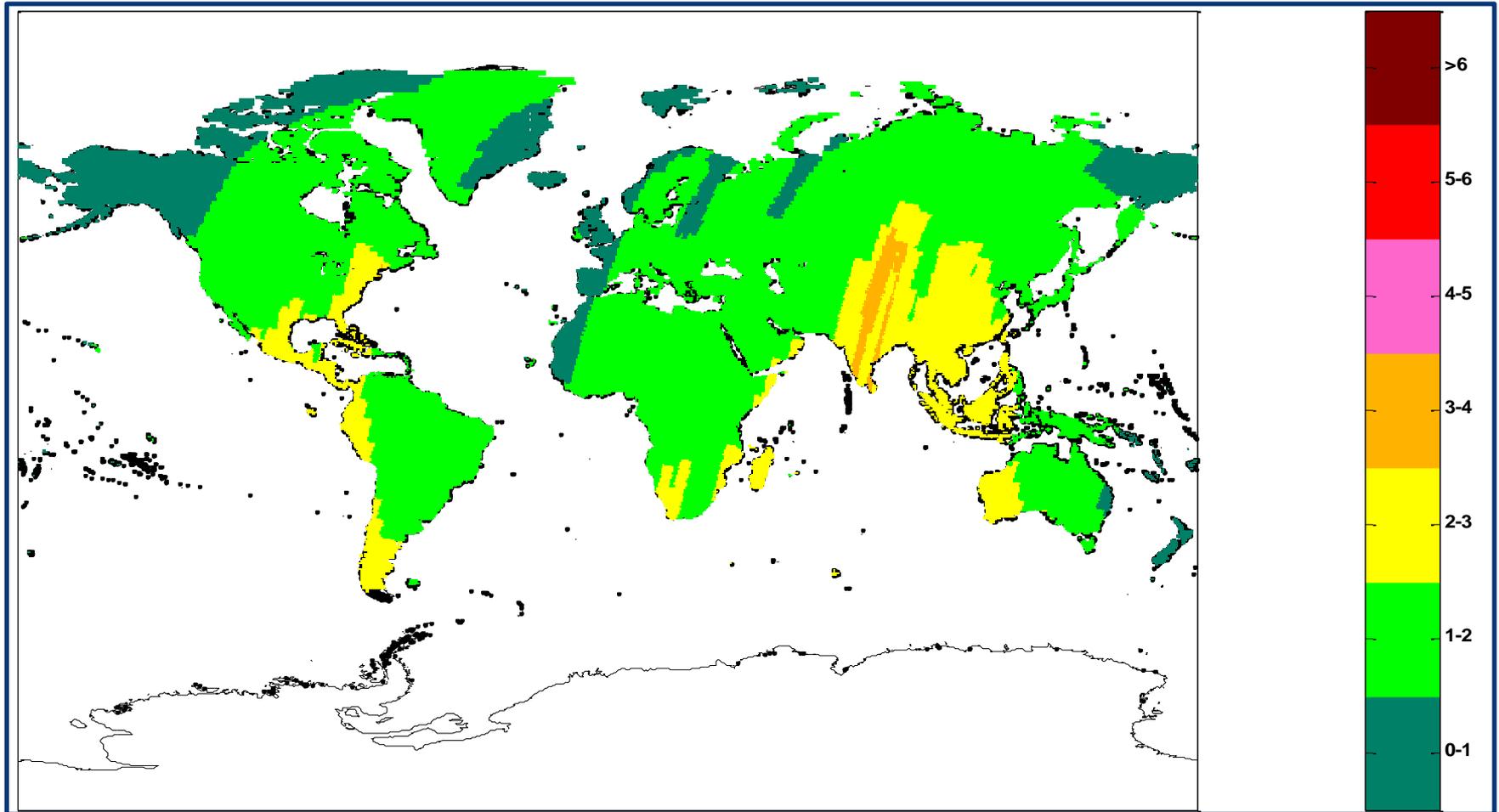
The LIMA project is a joint effort of the United States Geological Survey (USGS), the British Antarctic Survey (BAS), and the National Aeronautics and Space Administration (NASA), with funding from the National Science Foundation (NSF), created from more than 1,000 Landsat ETM+ scenes.

The LIMA project is a scientific outcome of the IPY. LIMA truly fulfills the IPY goals. LIMA is an international effort, supports current scientific polar research, encourages new projects, and helps the general public understand and changes happening to this southernmost environment. Researchers and the general public can download LIMA and all of the component Landsat scenes at no charge.

The LIMA project is a continent and zoom in to see the stunning detail of this Natural-Color, Pan-Sharpened LIMA (bands 3, 2, 1). LIMA covers the entire continent except from the South Pole at 90 degrees south latitude, where Landsat has no coverage because of its near-polar orbit. To provide a continental view, the image above has LIMA 3, 2, 1 overlaying the MODIS Mosaic of Antarctica (MOA).

The LIMA project includes McMurdo Station, the largest research base in Antarctica. Located at the tip of Hut Point Peninsula on Ross Island, McMurdo has been continually operated by the United States of America since 1956. Ross Island is roughly 72 km (45 mi) across. The flat, white areas are the Ross Ice Shelf and other sea ice off the coast of Antarctica. Also visible are the Erebus Glacier Tongue, the Erebus Glacier, and the Royal Society Range.

Simulation: Nominal acquisition scenario with 4 stations



Age of the data (in hours) accumulated on board at the time it is received at the PDGS ground station

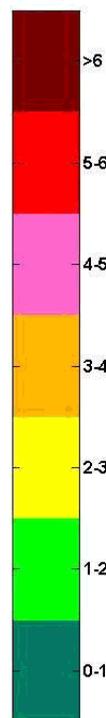
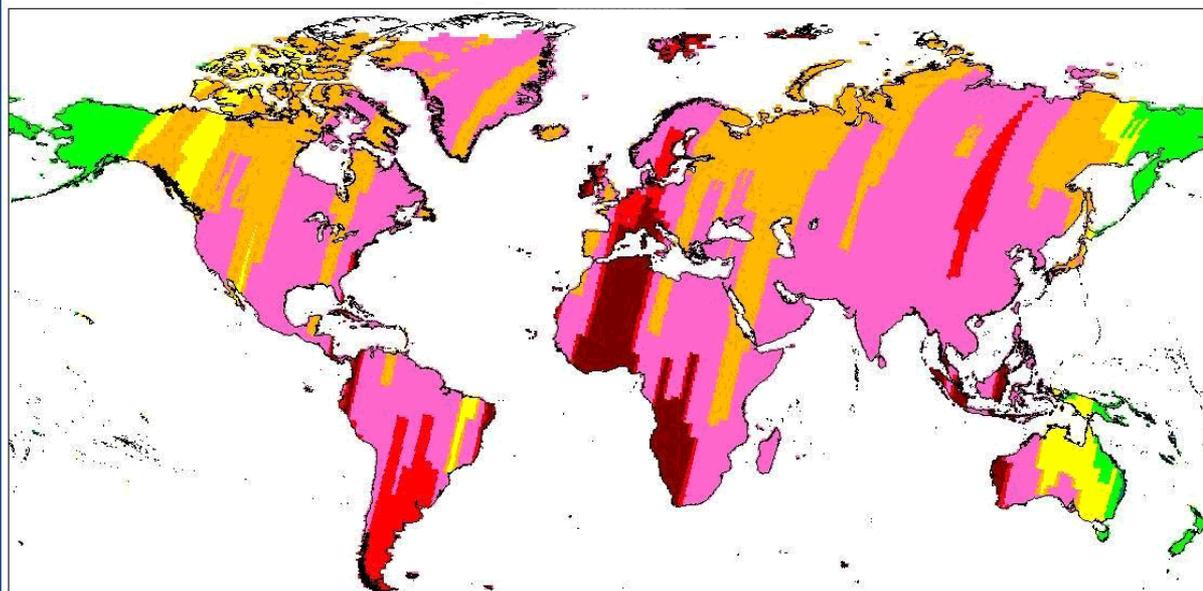
Reduced station scenario (ramp-up with 3 stations) NRT – Forcing over Europe



Autumnal Basic Scenario (Autumn equinox)

NRT applied: None

Average download ageing (hours)

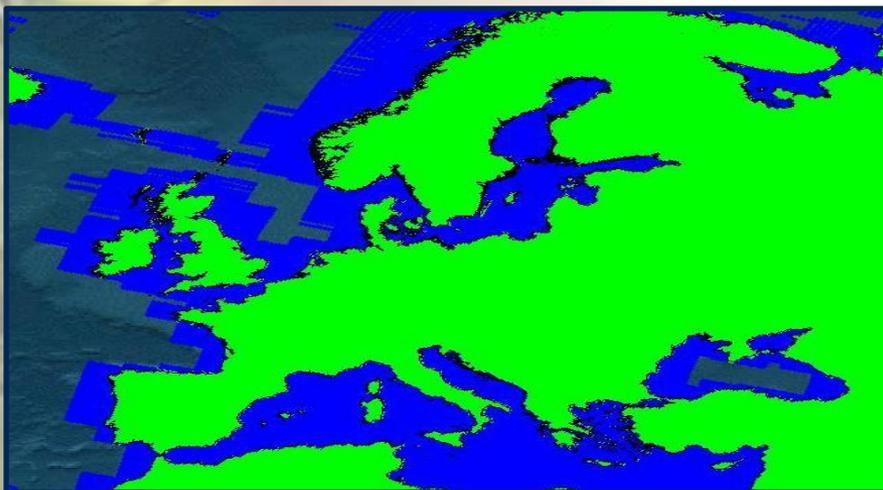
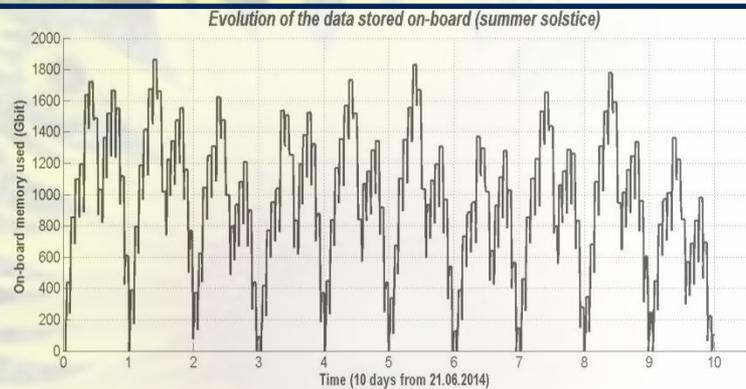


- Notice the increasing latency of Asian data with increasing NRT-area over Europe
- Notice that there is no (EU-Scenario) or only slight (EEA-38-Scenario) impact on data acquired over the western hemispherical areas, due to the almost complete recorder dump over the “empty atlantic” orbits with long contact times

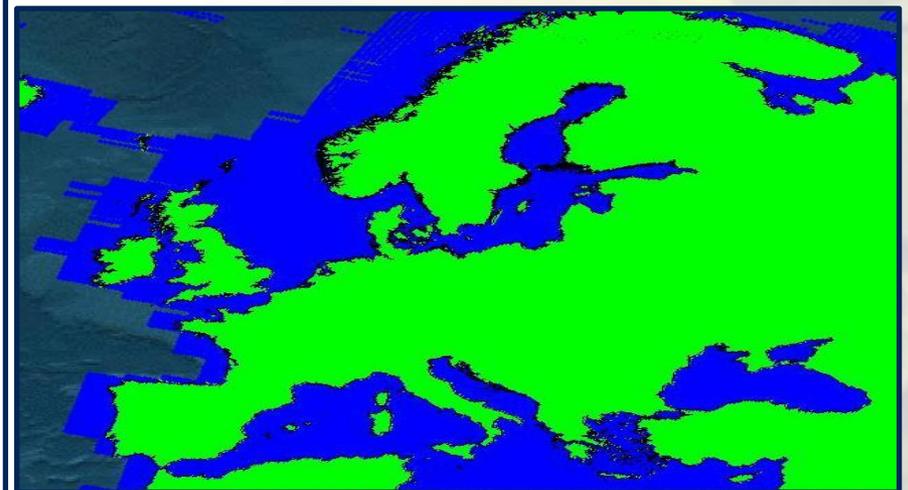
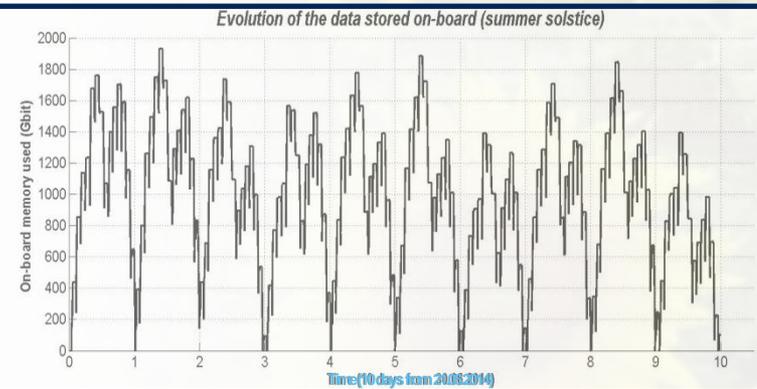
Additional Scenarios: Enlarged Acquisition over European Waters

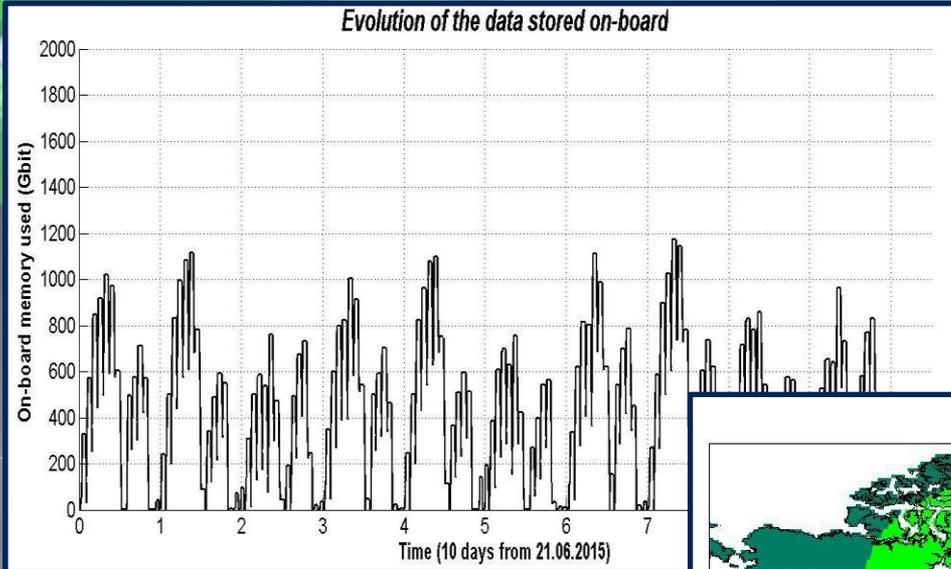


BASE SCENARIO
NOT ACQUIRING: SIBERIA: MIN. SKIPPED AREA



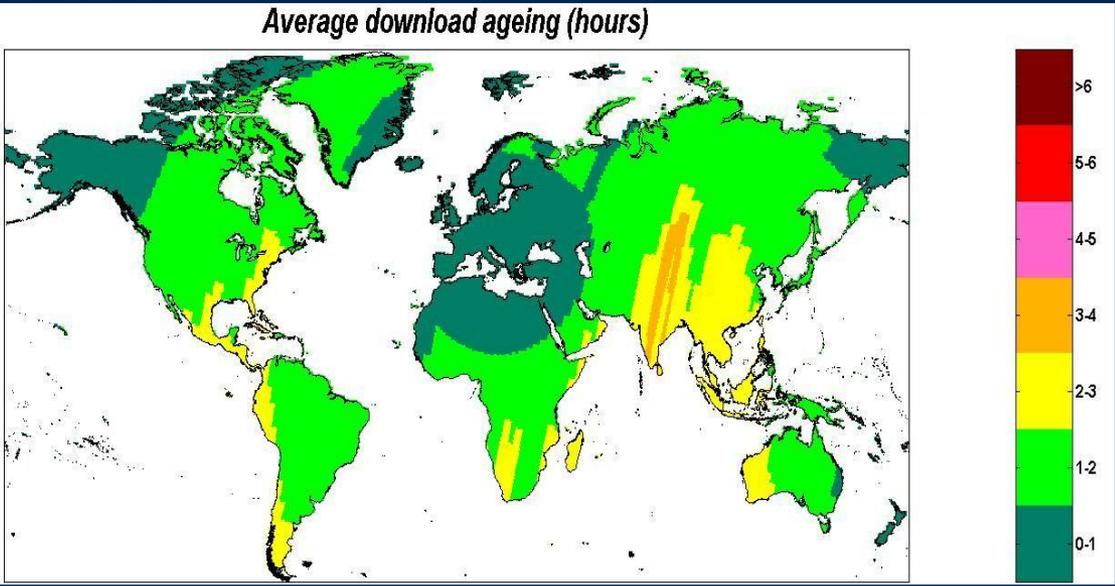
NOT ACQUIRING: SIBERIA: MIN. SKIPPED AREA
ADDITIONAL ACQUIRING: NORTH-/BAL TIC-/BLACK SEA



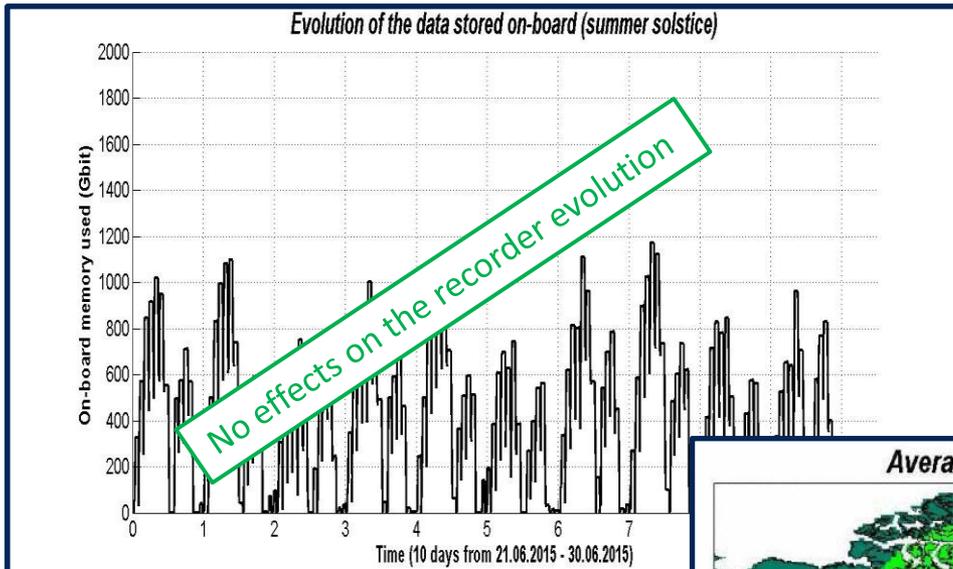


**Matera as a CoreGS
Operating in Direct Downlink
mode**

- Coverage area expanded to cover Black Sea & Baltic Sea
- Matera as CoreGS applying DD
- Technical implementation on the
- Simulator assumes 2 antennas at Matera, one is configured as a CollGS Antenna, the other like a nominal CoreGS Antenna.

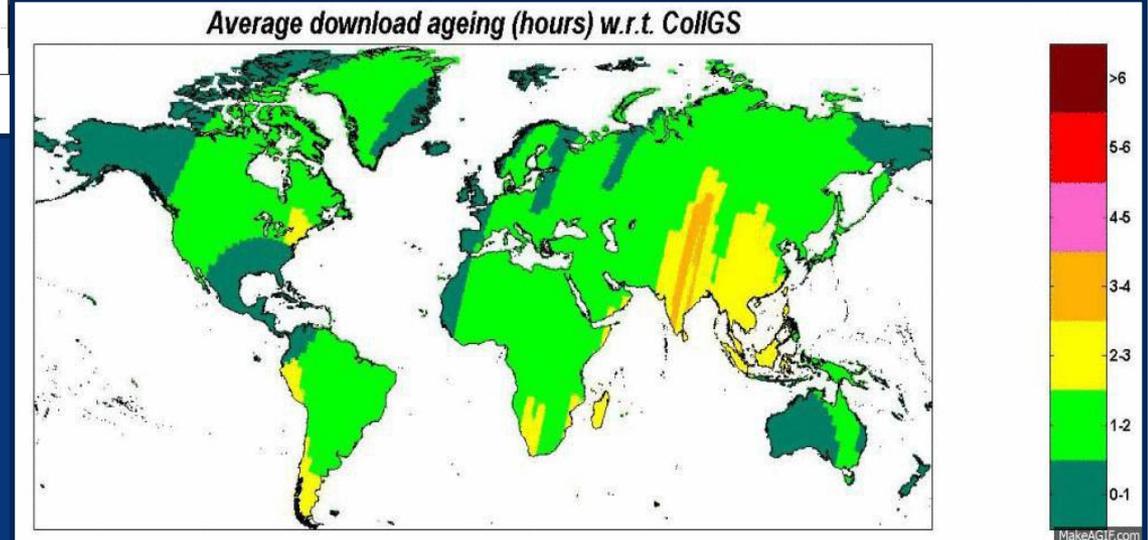


Nominal Operations - Impacts of other stations non-overlapping with CORE



**Effect of a DD-CollGS
Non-overlapping visibility
to CoreGS
(Examples USN-Western
Australia & Chetumal)**

- Coverage area expanded to cover Black Sea & Baltic Sea
- CollGS Chetumal (MEX/GER) (18.49°N / -88.29°W)
- CollGS USN-Western-Australia (SE/AU) (-29.08°S / 115.58°W)

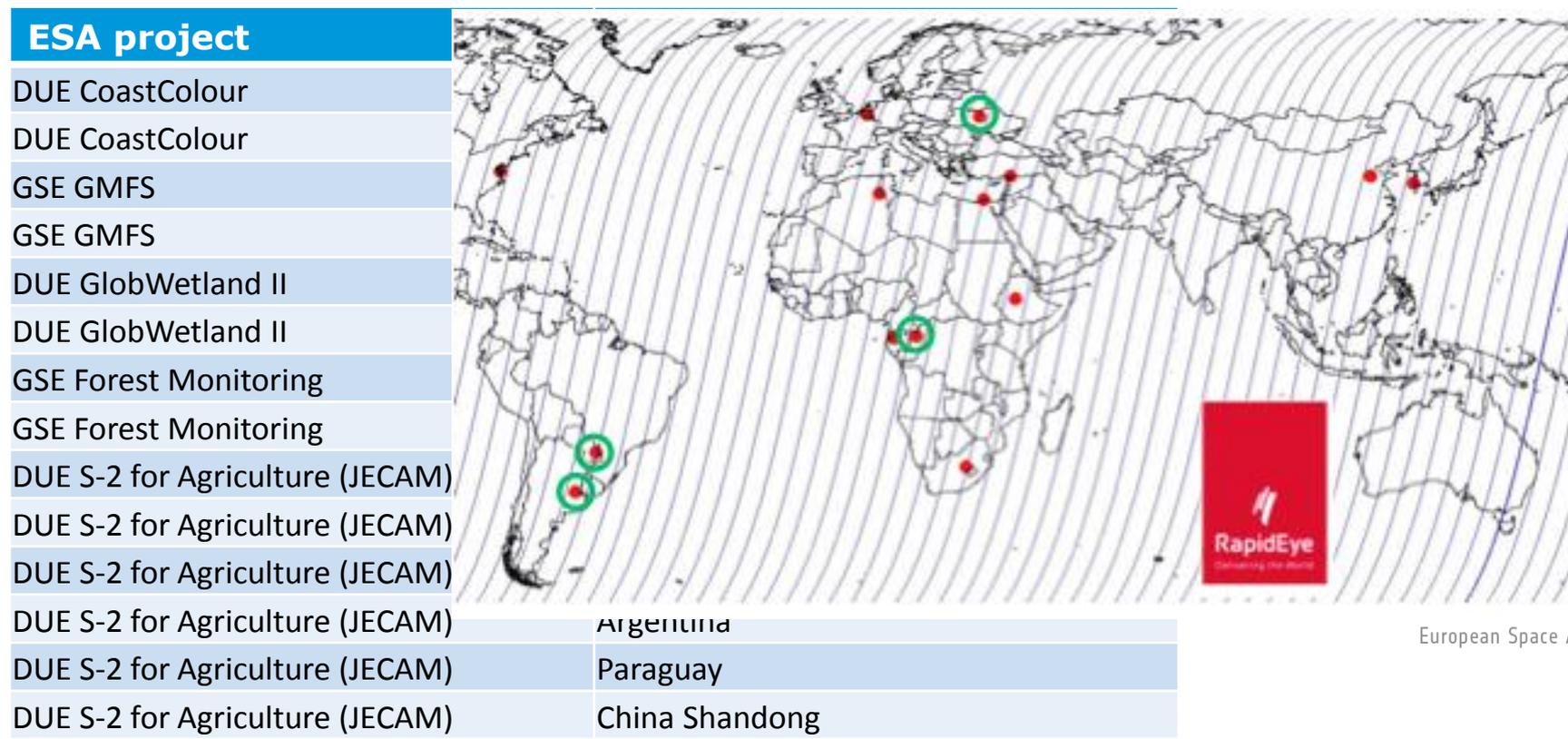


SPOT4-Take5 – ESA Sites

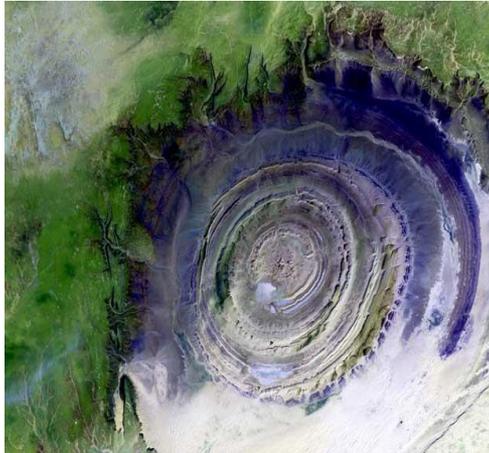
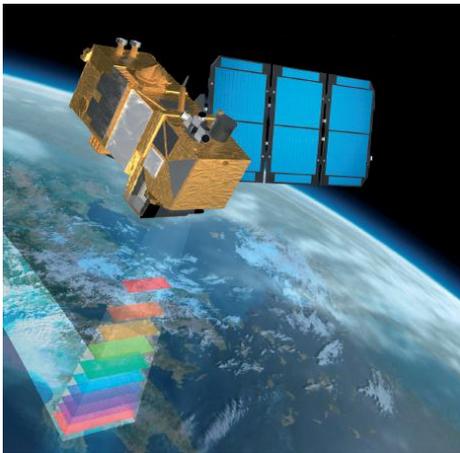


SPOT4-Take5 Initiative (in collaboration with CNES/CESBIO) & Rapideye & LDCM

- 14 sites globally distributed selected for ESA projects
- 5 days repeat cycle, February-May time period
- SPOT4 L1c and L2a to be delivered by CNES (delivery February level 1A, higher products end of June)



Sentinel-2 Cal/Val Activities and Potential Cooperation with LDCM



Ferran Gascon

- Data Quality Targets
- Cal/Val Activities
- MPC (Mission Performance Centre)
- Potential lines of cooperation LDCM/S2

Radiometric 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 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

L1 Calibration Activities



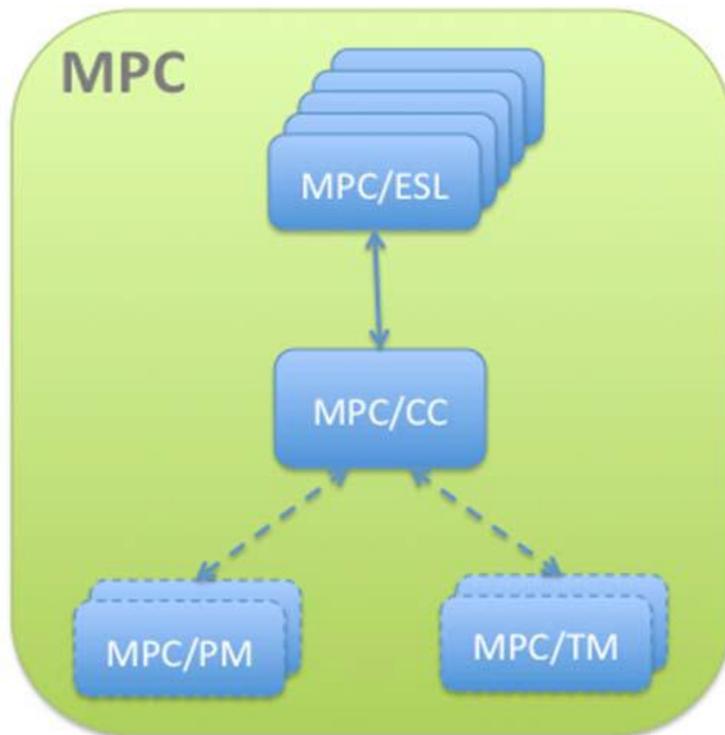
		Activity	Nominal / Contingency
Level-1	Radiometric Calibration	Dark Signal Calibration	Nominal
		Relative Gains Calibration	Nominal
		Absolute Radiometric Calibration	Nominal
		SWIR Detectors Re-arrangement Parameters Generation	Contingency
		Crosstalk Correction Calibration	Contingency
		MSI Refocusing	Contingency
	Geometric Calibration	Global Reference Images Generation	Nominal
		Absolute Calibration of the Viewing Frames for the Reference Band	Contingency
		Relative Calibration of the Viewing Frames for Non-Reference Bands	Contingency
		Absolute Calibration of the Focal Plane for the Reference Band	Contingency
		Relative Calibration of the Focal Plane for Non-Reference Bands	Contingency

L1 Validation Activities



		Activity	Nominal / Contingency
Level-1	Radiometric Validation	Equalization Validation	Nominal
		Absolute Radiometry Vicarious Validation	Nominal
		Absolute Radiometry Cross-Mission Validation	Nominal
		Multi-temporal Relative Radiometry Vicarious Validation	Nominal
		Inter-band Relative Radiometric Uncertainty Validation	Nominal
		SNR Validation	Nominal
		Pixel Response Validation	Nominal
		MTF Validation	Nominal
	Geometric Validation	Geolocation Uncertainty Validation	Nominal
		Multi-spectral Registration Uncertainty Validation	Nominal
		Multi-temporal Registration Uncertainty Validation	Nominal
		Global Reference Images Validation	Nominal

- The MPC is a distributed centre in charge of the following functionalities:
 - Calibration (**CAL**) – the objective of which is to update on-board and on-ground configuration data in order to meet product quality requirements.
 - Validation (**VAL**) – the objective of which is to assess, by independent means with respect to the methods and tools used for calibration, the quality of the generate data products.
 - Quality Control (**QC**) – the objective of which is to routinely monitor the status of the sensor and to check if the derived products.
 - Data processors and tools corrective and perfective maintenance (**PTM**).
 - End-to-end system performance monitoring (**E2ESPM**) – objective is to monitor the performance of the Sentinel-2 system operations.



- The MPC is composed of the following entities:
 - **ESL** (Expert Support Laboratories)
 - **CC** (Coordinating Centre)
 - **PM** (Processors Maintenance)
 - **TM** (Tools Maintenance)
- Selection of MPC consortium ongoing. Kick-off foreseen March 2013.

Potential Lines of Cooperation on Cal/Val between LDCM and Sentinel-2



- The cooperation with LDCM for Cal/Val activities could be seen around the following **four+1 lines** (after pre-flight calibration of 2012, see presentation on Thursday):
 1. Share test sites and exchange of methods/results.
 2. TOA radiances cross-mission comparison.
 3. Organization of shared field campaigns.
 4. Organization of workshops with both LDCM and S2 Cal/Val teams for exchanging information on results and methods.
 5. +detailed debrief at next LST from LDCM Commissioning Phase activities possible?

Share test sites, methods and results

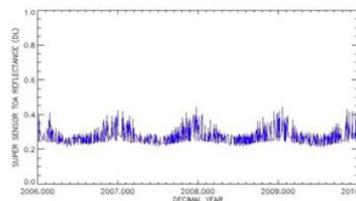
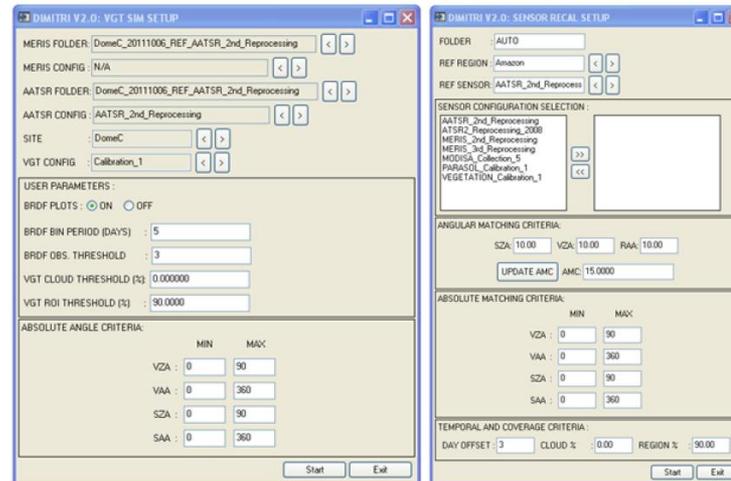
- Preliminary list of test sites defined (to be consolidated with MPC during 2013).
- Main equipped sites foreseen are: LaCrau (France), Boussole (France), Barrax (Spain), Dome-C (Antarctica),...
- Main non-equipped sites foreseen are: North-Africa desert, Greenland, Indian Ocean, Pacific South, Uyuni Salt Lake,...



Location of foreseen test sites over Europe and Northern-Africa

TOA radiances cross-mission comparison

- Foreseen the use of **DIMITRI** (<http://www.argans.co.uk/dimitri/>) and possibly **SADE** database (<http://smc.cnes.fr/CALIBRATION>).
- Use of **shared sites** would allow routine cross-mission radiometry comparison.
- Foreseen to have a **systematic ingestion of LDCM data in DIMITRI** database.



DIMITRI screenshot

Organization of shared field campaigns

- Foreseen ad-hoc field campaigns during routine operations (Phase-E2) for the validation of Level-2A products (BOA reflectance and simplified scene classification).
- Sentinel-2 team is looking for partnerships (at European or international level) with other missions for organizing common field campaigns.

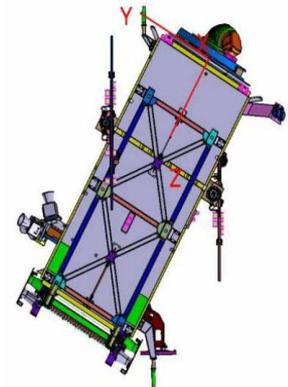
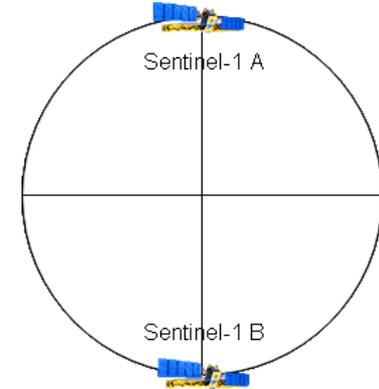


1. Usage of same DEM?
2. Usage of GCPs; Landsat Mosaic for S2 and S2
GRI for LDCM...?

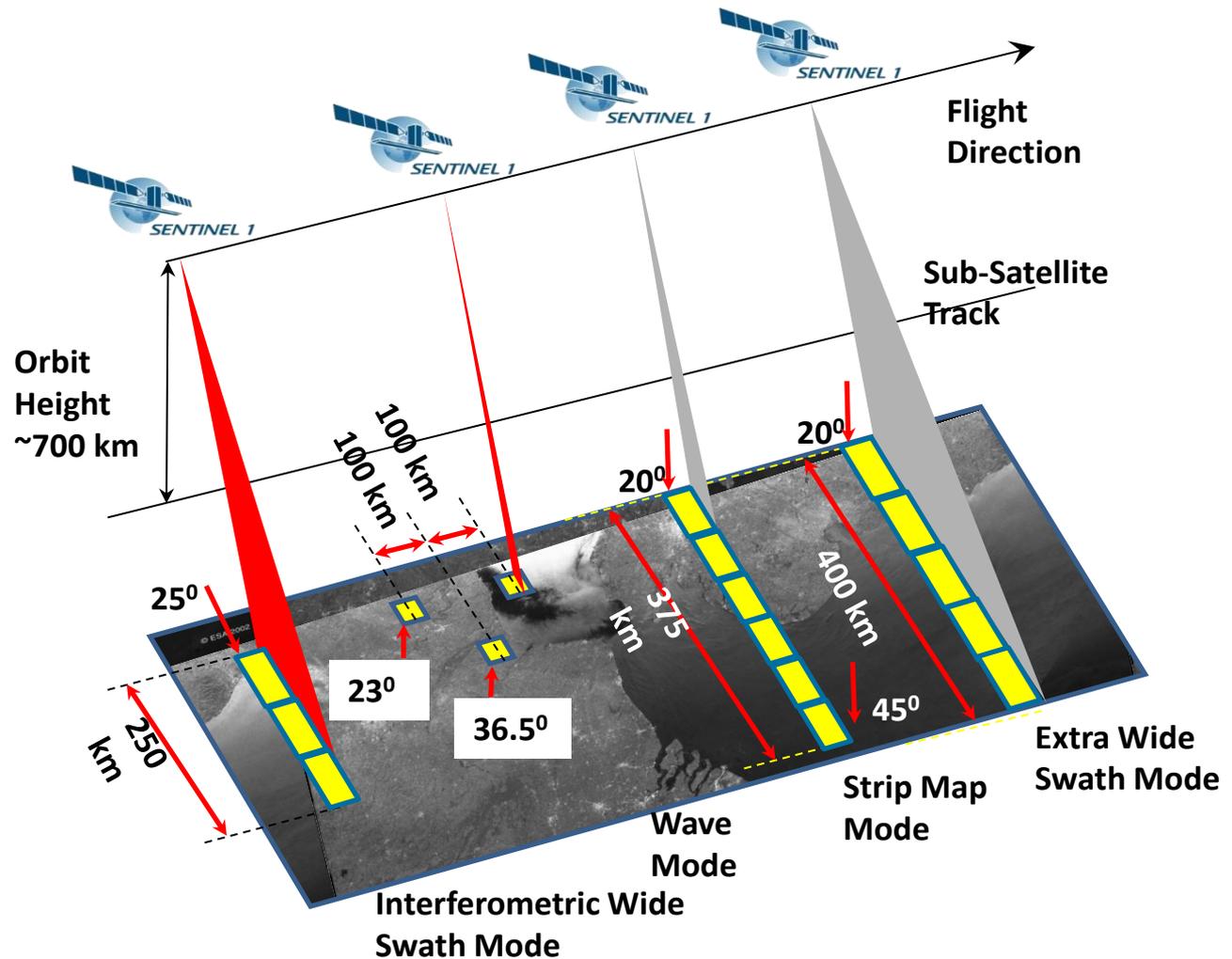
Sentinel-1 Mission Facts



- Constellation of two satellites (A & B units)
- **C-Band Synthetic Aperture Radar Payload (at 5.405 GHz)**
- 7 years design life time with consumables for 12 years
- Near-Polar sun-synchronous (dawn-dusk) orbit at 698 km
- 12 days repeat cycle (1 satellite), 6 days for the constellation
- Both Sentinel-1 satellites in the same orbital plane (180 deg phased in orbit)
- On-board data storage capacity (mass memory) of 1400 Gbit
- Two X-band RF channels for data downlink with 2 X 260 Mbps
- On-board data compression using Flexible Dynamic Block Adaptive Quantization (FDBAQ)
- Optical Communication Payload (OCP) for data transfer via laser link with the GEO European Data Relay Satellite (ERDS)
- Launch of Sentinel-1A scheduled for **October 31st, 2013**



Sentinel-1 SAR Modes





Sentinel-3

SLSTR nadir: 1420km

Offset westward from nadir

SLSTR oblique: 750 km

Centred at nadir

OLCI: 1270 km

Westward inclination to avoid sunglint

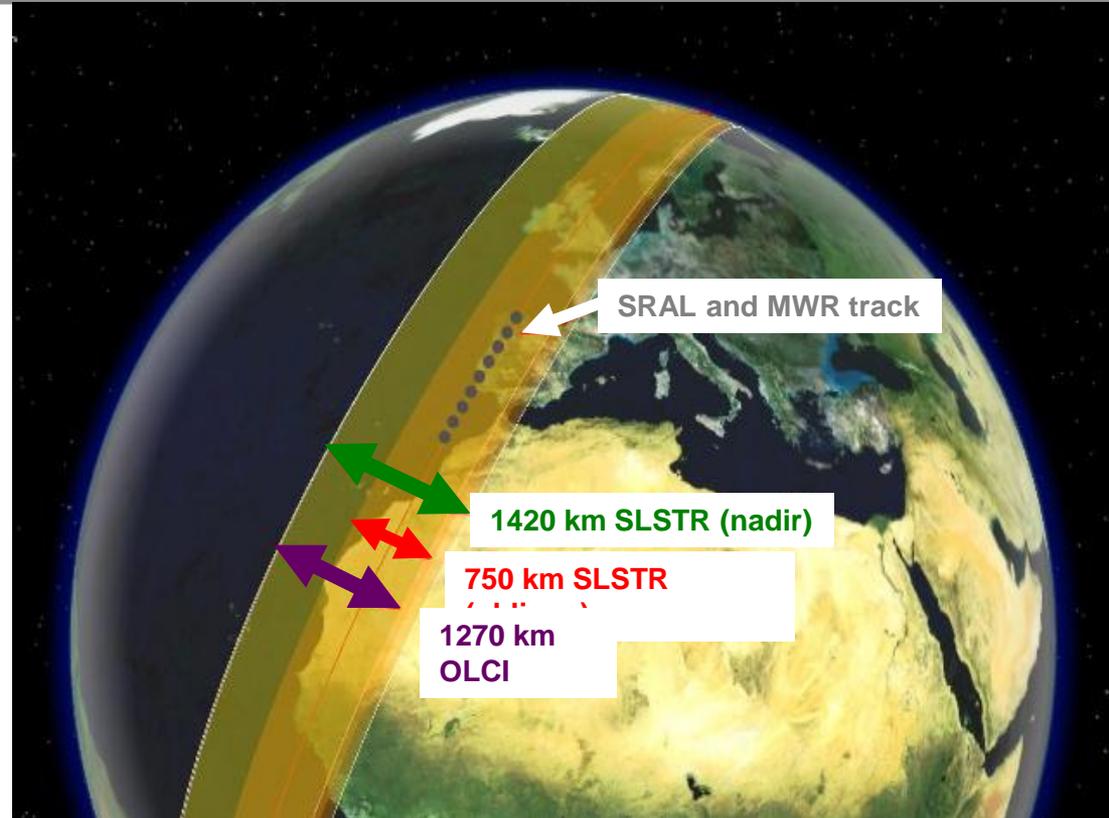
Fully within SLSTR nadir and oblique swath

SRAL: > 2km

Centred at nadir and fully within SLSTR and OLCI swath

MWR: 20 km

Centred at nadir and fully co-located with SRAL



Sentinel-3 Revisit time and coverage

Key elements of the Sentinel-3 mission are:

Topography Mission:
ground track repeatability,
dense spatial sampling



Ground tracks after 1 complete cycle (27 days)
S3A & S3B

Optical Mission:
Short Revisit times for optical
payload, even with 1 single satellite

		Revisit at Equator	Revisit for latitude > 30°	Spec.
Ocean Colour (Sun-glint free, day only)	1 Satellite	< 3.8 days	< 2.8 days	< 2 days
	2 Satellites	< 1.9 days	< 1.4 days	
Land Colour (day only)	1 Satellite	< 2.2 days	< 1.8 days	< 2 days
	2 Satellites	< 1.1 day	< 0.9 day	
SLSTR dual view (day and night)	1 Satellite	< 1.9 days	< 1.5 days	< 4 days
	2 Satellites	< 0.9 day	< 0.8 day	

- Near-Real Time (< 3 hr) availability of the L2 products
- Slow Time Critical (STC) (1 to 2 days) delivery of higher quality products for assimilation in models (e.g. SSH, SST)

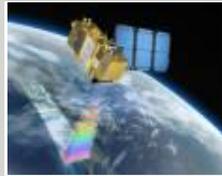
GMES dedicated missions: Sentinels



Sentinel-1 (A/B) – SAR imaging

All weather, day/night applications, interferometry

2013 /2015



Sentinel-2 (A/B) – Multi-spectral imaging

Land applications: urban, forest, agriculture,...
Continuity of Landsat, SPOT

2014 /2016



Sentinel-3 (A/B) – Ocean and global land monitoring

Wide-swath ocean color, vegetation, sea/land
surface temperature, altimetry

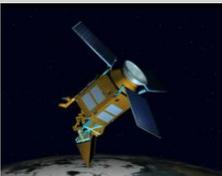
2014/2017



Sentinel-4 (A/B) – Geostationary atmospheric

Atmospheric composition monitoring, trans-
boundary pollution

2019/2027



Sentinel-5 precursor/ Sentinel-5 (A/B) – Low-orbit atmospheric

Atmospheric composition monitoring

2015/2020/2027



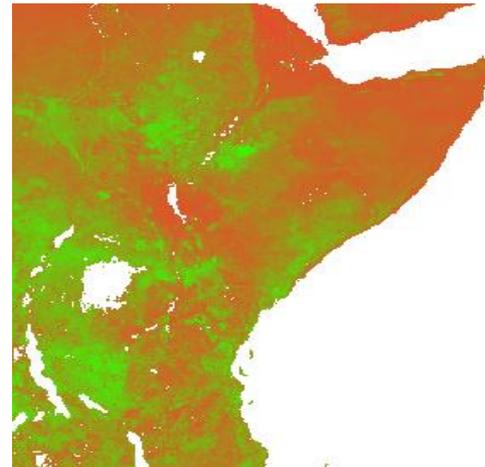
Jason-CS (A/B) – Low inclination Altimetry

Sea-level, wave height and marine wind speed

2018/2023



- Envisat: 10 years in operation reached; lost contact 8th April 2012
- ERS-2 de-orbiting summer 2011
- Proba-1 (hyperspectral CHRIS): 12th year in space, proposed to be operated for 1 more year
- Earthwatch Programme's first operational mission, bridging the gap until Sentinel-3:
Proba-V (VEGETATION) launch planned in April 2013 (4 bands, 300/1000m resolution, 2250km swath), for launch on Vega from Kourou



The ESA Earth Explorer Missions



Gravity
GOCE

17 March 2009



Soil Moisture
Ocean Salinity

SMOS

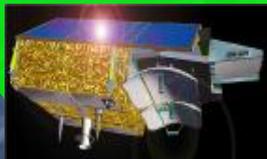
2 Nov. 2009



Cryosphere

Cryosat

8 April 2010



Magnetic field

Swarm

2013

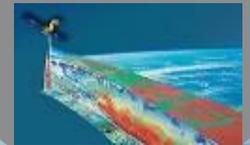


**ADM
AEOLUS**



7th EE

**EARTH
CARE**



Thank you very much!

