

# GMES Space Component

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## Sentinels and GMES Contributing Missions

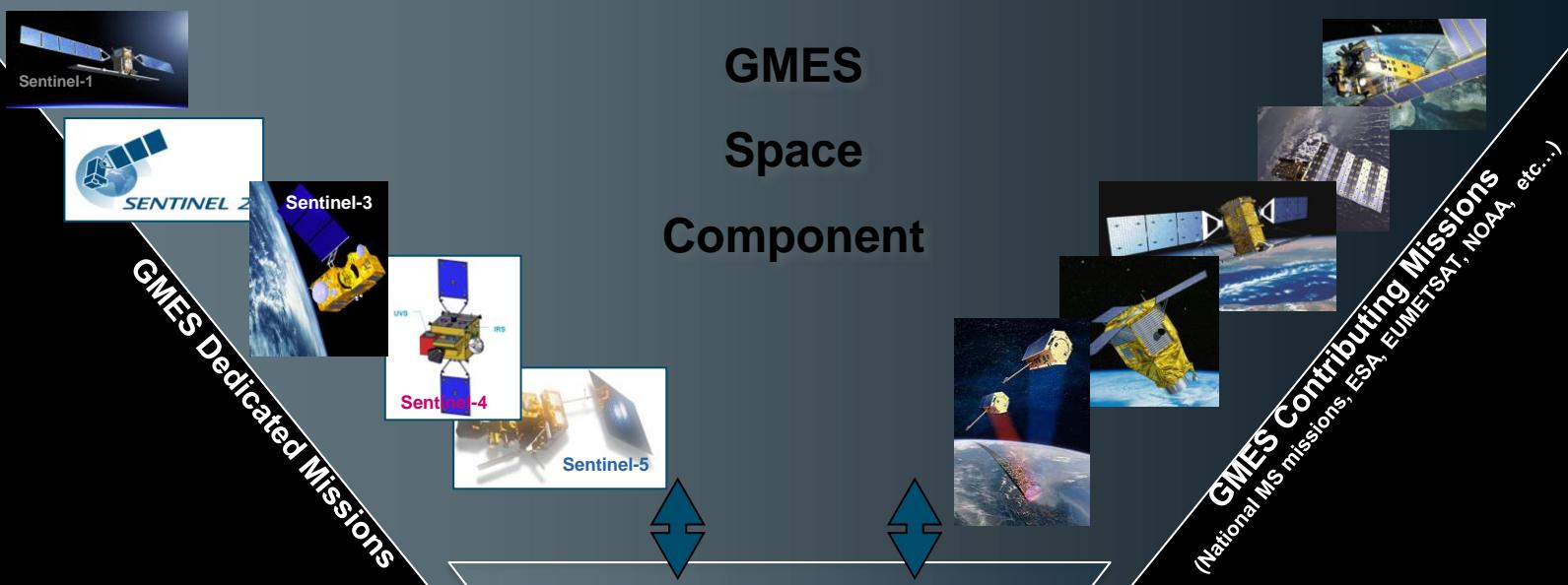
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# GMES Global Land workshop

12-13 December 2011, Lisbon (Portugal)



# GMES Space Component



GMES Service Component



# GMES dedicated space missions: the Sentinels



## **Sentinel 1 – SAR imaging**

All weather, day/night applications, interferometry



## **Sentinel 2 – Multi-spectral imaging**

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



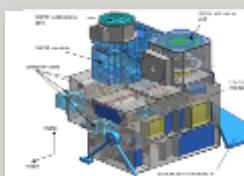
## **Sentinel 3 – Ocean and global land monitoring**

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



## **Sentinel 4 – Geostationary atmospheric**

Atmospheric composition monitoring, trans-  
boundary pollution

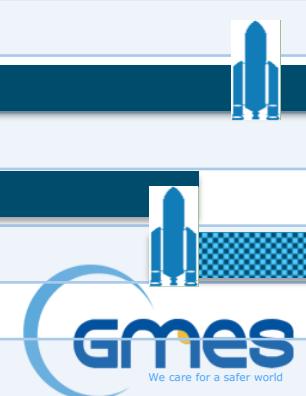
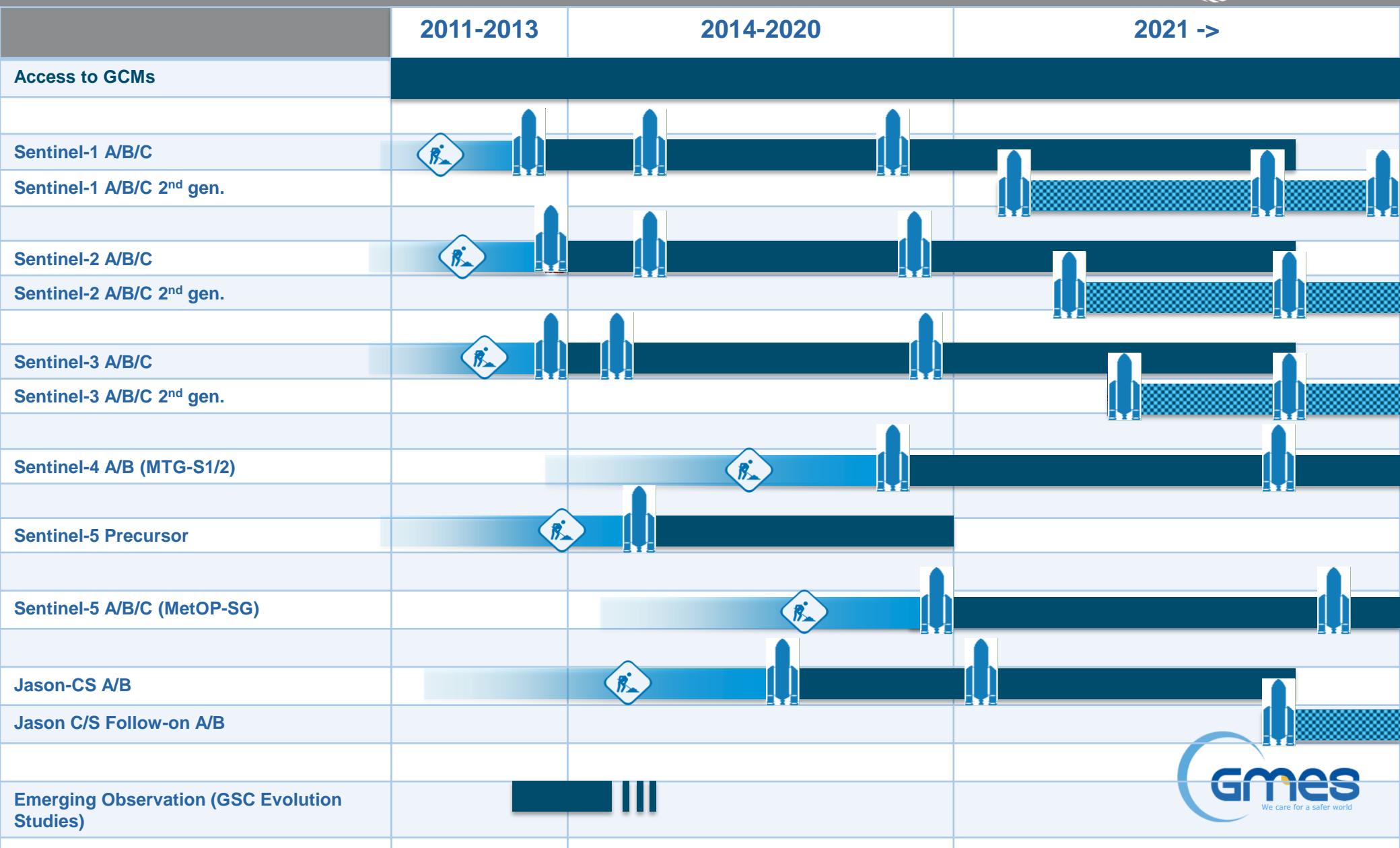


## **Sentinel 5 – Low-orbit atmospheric**

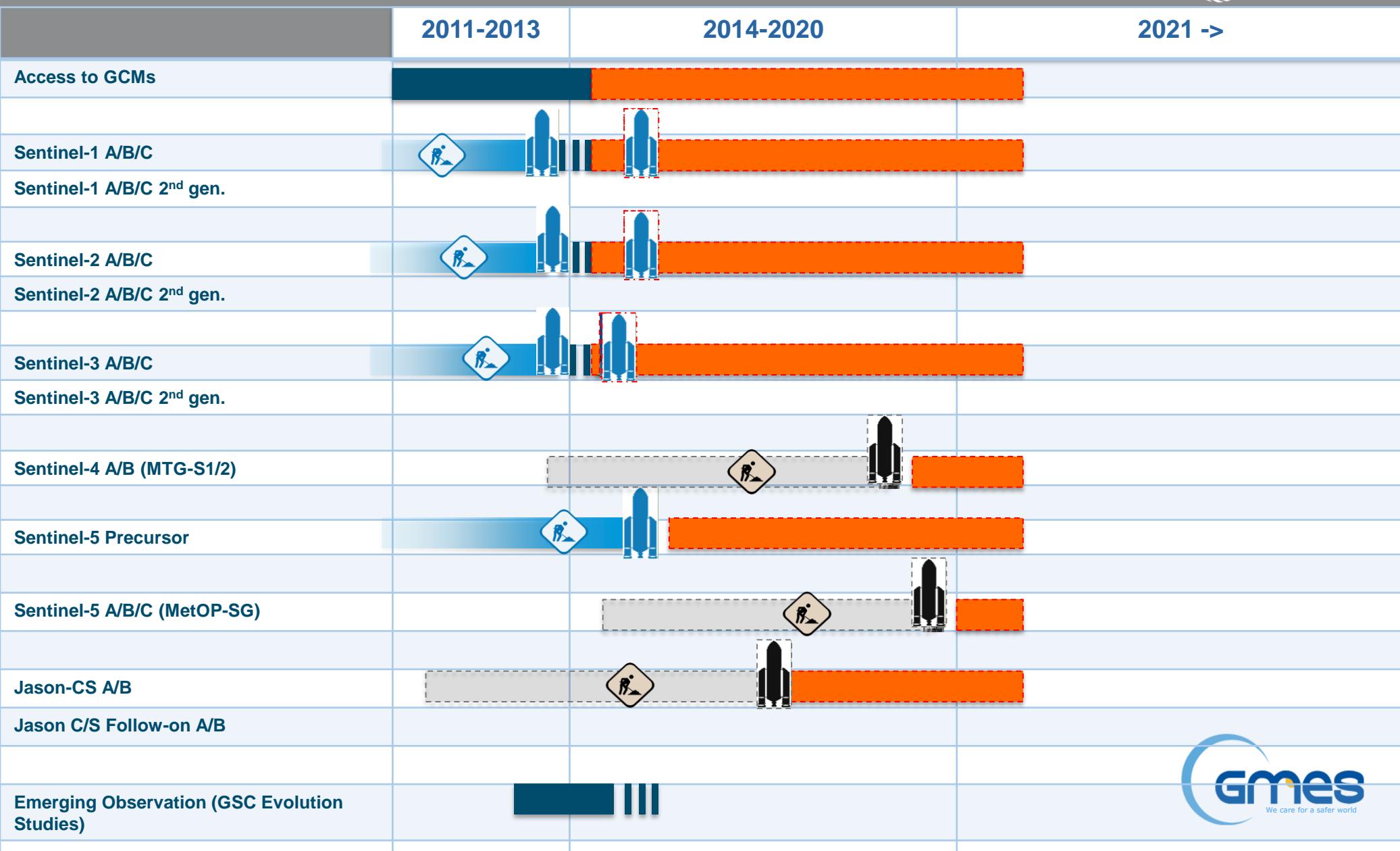
Atmospheric composition monitoring  
(S5 Precursor launch in 2015)



# GMES Long-Term scenario (preliminary)



# GMES Long-Term scenario (preliminary)



# GMES sustainability: securing funds for the next period



**EC excluded GMES funds from MFF** “For projects such as ... GMES, where the costs and/or the cost overruns are too large to be borne only by the EU budget, the Commission proposes to foresee their funding outside the MFF after 2013.” **COM(2011) 500 final, 29/06/2011**

“creates high uncertainty for GMES[...] It would be more than likely that this option would mean a discontinuation of GMES [...]. It would lead to sunken costs and past investments would be lost.” **SEC(2011)868 final, 29/06/2011**

**EC proposed to fund GMES with a separate budget** “proposed to set-up a specific GMES fund with financial contributions from all EU Member States based on their GNI.” **COM(2011) 831 final, 30/11/2011**

**Several ESA Member States and the EU Parliament have raised concerns if GMES is outside from the MFF**

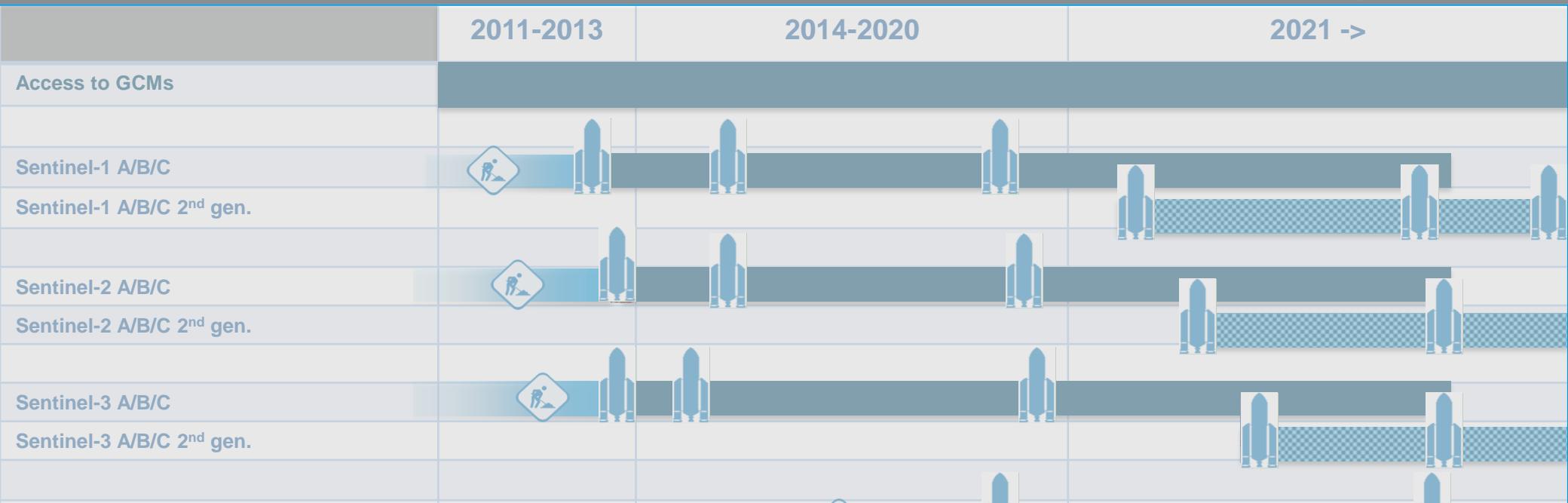
→ **GMES 2014-2020 still needs to be secured**

**Users should be aware that GMES is AT RISK**

**Users should be aware that Sentinels launches are AT RISK**

**Users are invited to support GMES to their Ministries**

# Conclusions



*GMES is a unique Programme.*

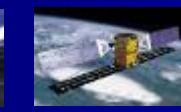
*It requires political support today more than ever!*

# GMES Space Component infrastructure



## Sentinel missions

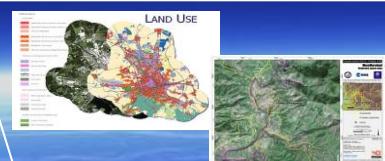
SAR – Multi-spectral – Ocean/Land – Atmospheric (LEO and GEO); launched from 2013 onwards



## ***Contributing missions***

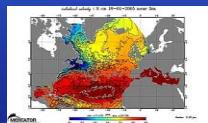
## Operating today

### Free & Open Data Policy



## USERS

## SERVICES



## Distributed Ground Segment

# Data Access today: Missions, Owners/Operators and data types



## 1. Industrial Contracts

	Optical	SAR
Medium Resolution	<ul style="list-style-type: none"><li>• Vito (Spot VGT)</li></ul>	<ul style="list-style-type: none"><li>• MDA (Radarsat-2)</li></ul>
High Resolution	<ul style="list-style-type: none"><li>• Euromap (IRS-P6),</li><li>• Spot Image (Spot 4),</li><li>• Rapideye,</li><li>• DMCII (DMC UK2)</li><li>• Deimos (Deimos 1/2)</li></ul>	<ul style="list-style-type: none"><li>• MDA (Radarsat-2),</li><li>• eGeos (Cosmo Skymed),</li><li>• Infoterra/Astrium (Terrasar-X, Tandem-X)</li></ul>
Very High Resolution	<ul style="list-style-type: none"><li>• Euromap (Cartosat),</li><li>• Spot Image (Spot 5, Formasat, Spot 6, Pleiades),</li><li>• eGeos (Ikonos, GeoEye),</li><li>• EUSI (Ikonos, Quickbird, Worldview),</li><li>• Imagesat (EROS)</li><li>• DMCII (Nigeriasat)</li></ul>	<ul style="list-style-type: none"><li>• MDA (Radarsat-2),</li><li>• eGeos (Cosmo Skymed),</li><li>• Infoterra/Astrium (Terrasar-X, Tandem-X)</li></ul>

## 2. Contributions free of charge

1. ESA contribution (*ERS, ENVISAT, EEs, Proba, ALOS archive and other TPMs*)
2. CNES/France (*Jason, Calipso, Parasol*)
3. EUMETSAT (*MetOp, MSG, other Eumetsat provided Missions*)

# CORE datasets (predefined) – who can use it?



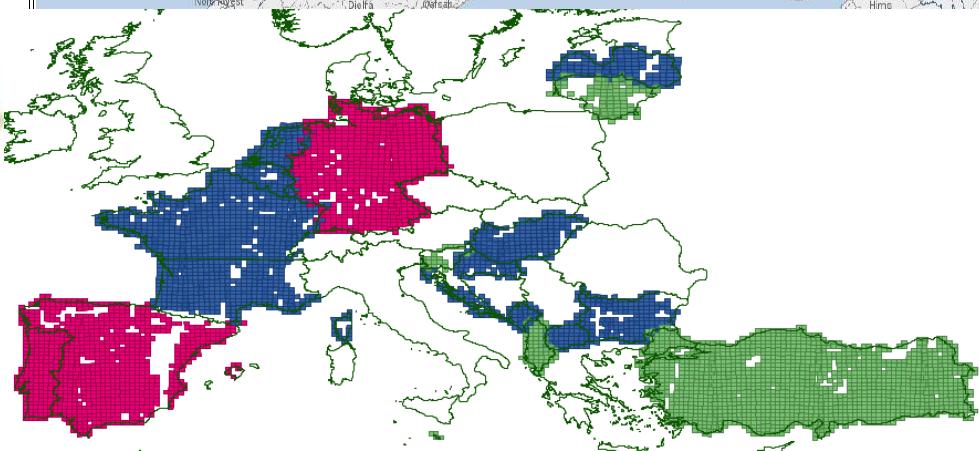
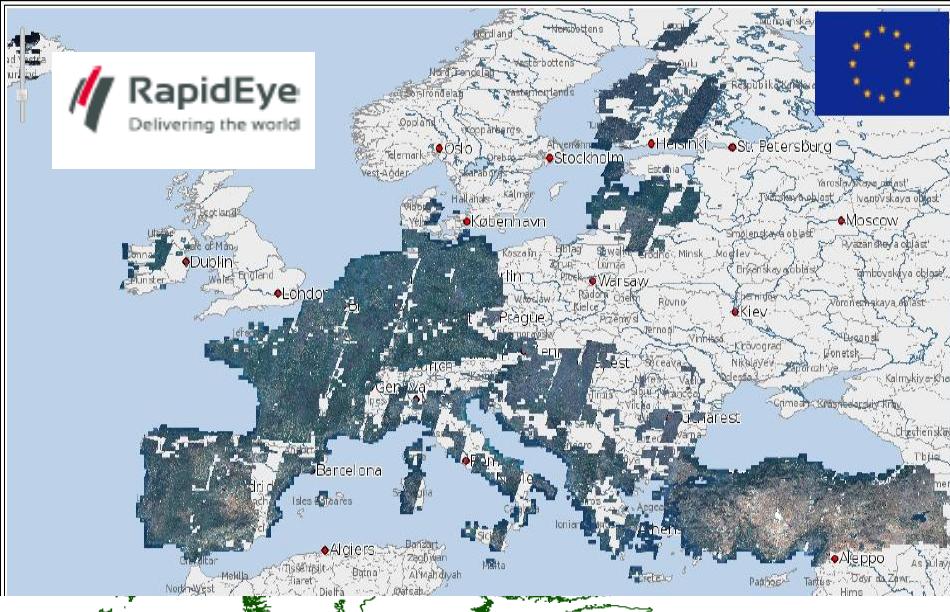
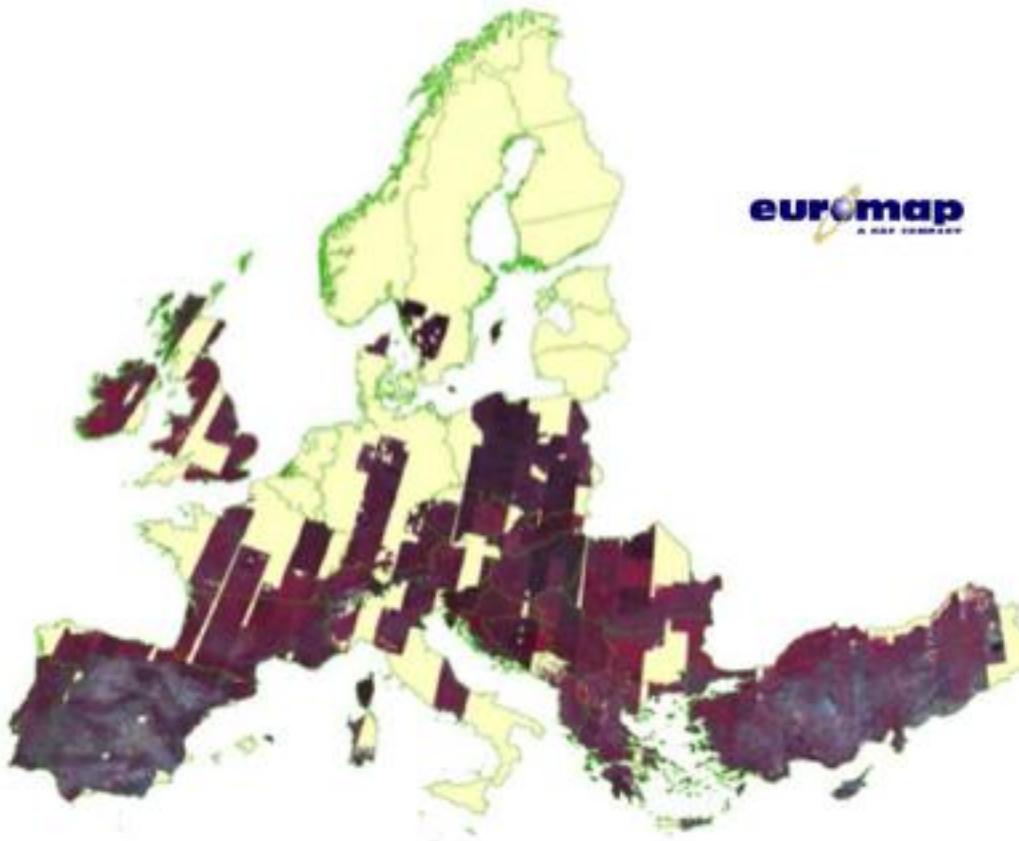
## Which GCM contributes?

Data Set	Licensing					Providers									
	FP7 Projects	EU Institutions	Public Authorities in MS	International Org.+NGOs	Public	Astrium/Spot Image	DMC	Deimos	MDA	Euromap	Rapideye	E-geos	Astrium/Infoterra Germany	EUSI	Imagesat
Optical HR Pan EU coverages 2012 (CORE_001a/CORE_001b)					b	b	b		X	X					
Access to former pan EU coverage archives (CORE_002)					X				X				X		
Optical VHR2 coverage over EU 2011-2013 (CORE_003)					X	b			b	b	b		b	b	
Optical worldwide LR coverage (CORE_004, CORE_005)															X
Optical worldwide MR coverage (CORE_006, CORE_007)															X
European Monthly MR composites 2011-2013 (CORE_008)										X					
Sub-Saharan Optical coverage HR2 2011-2013 (CORE_009)						b	X								
Access to former sub-Saharan Africa coverage (CORE_010)						X	X					x	x		
Sea Ice Monitoring (CORE_011)									X			x	x		
Other Marine requirements (CORE_012 to CORE_014)						ESA, CNES and EUMETSAT Data Supply (No contract)									
Atmosphere requirements (CORE_015 to CORE_024)						ESA and EUMETSAT Data Supply (No contract)									

  Download Service  
  View Service

X Contracted Supplier  
b Backup Mission

# CORE\_01 High resolution 2011-2012 – Coverage 1 & Coverage 2



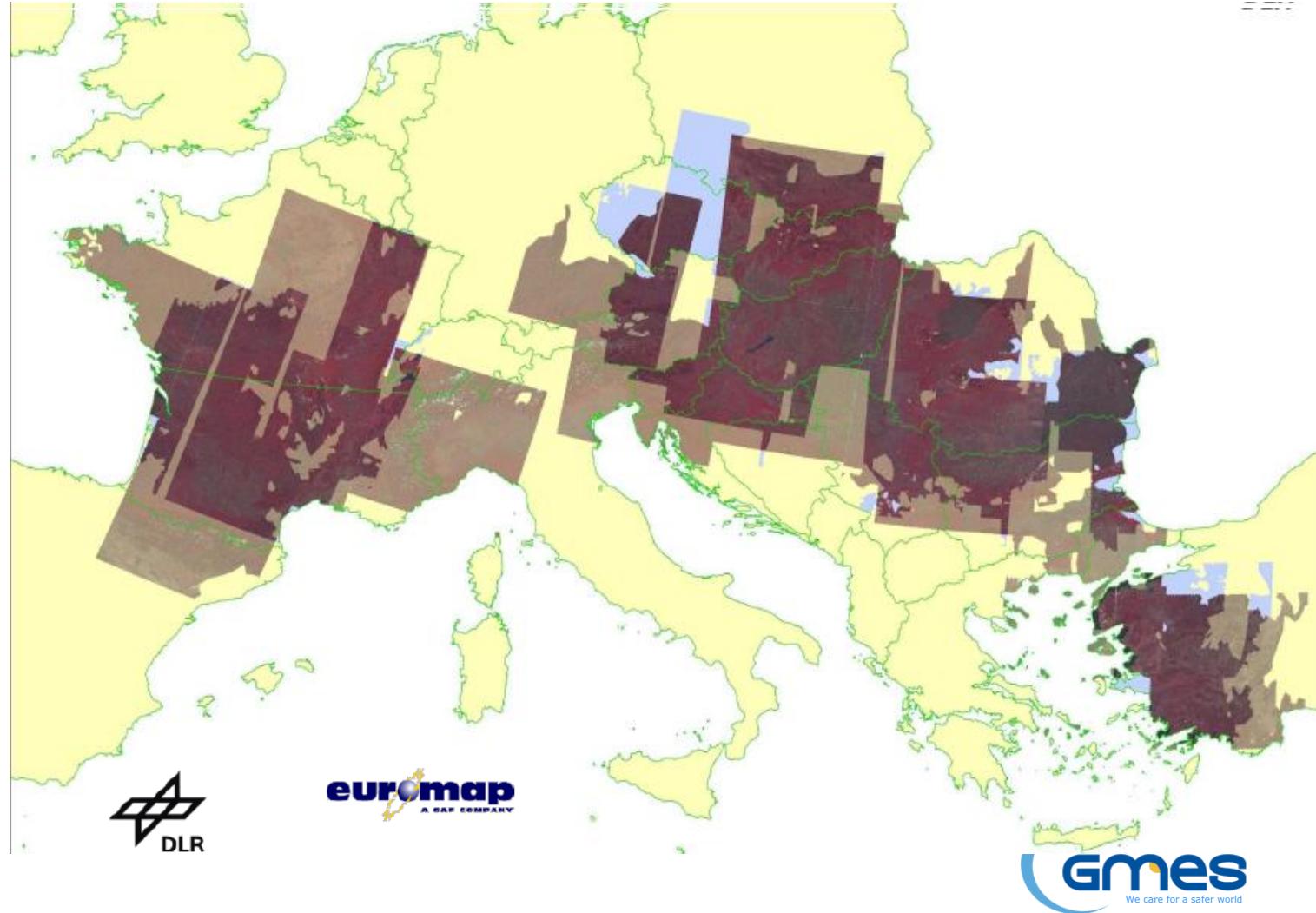
# CORE\_008 Europe medium resolution monthly coverages



Awifs Mar to Oct 2011

3 criteria:

- a minimum of 20.000 km<sup>2</sup> contiguous area each
- intersecting with CORE\_001
- acquired at least 3 times cloud-free between Mar, Apr, May, Jun



# CORE\_009 Africa high resolution coverage 2011 (2012)

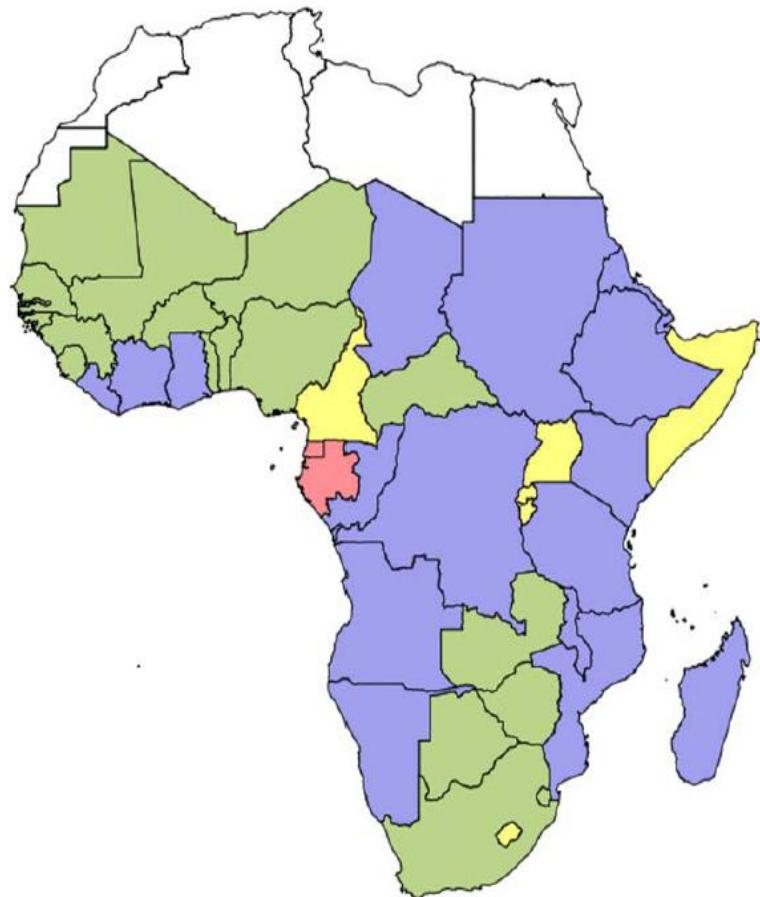


Figure 4: Cloud-free coverage per country expressed as percentage of the total country area



Legend:

Country cloud-free coverage

- 100 %
- 95-99 %
- 90-94 %
- 80-89 %
- <80 %

- 24 Mio km<sup>2</sup> acquired at 99% in 2011
- 22m resolution, 3-bands
- Confluence points at 1x1 degree acquired at 98%
- Delivery starting in 2012

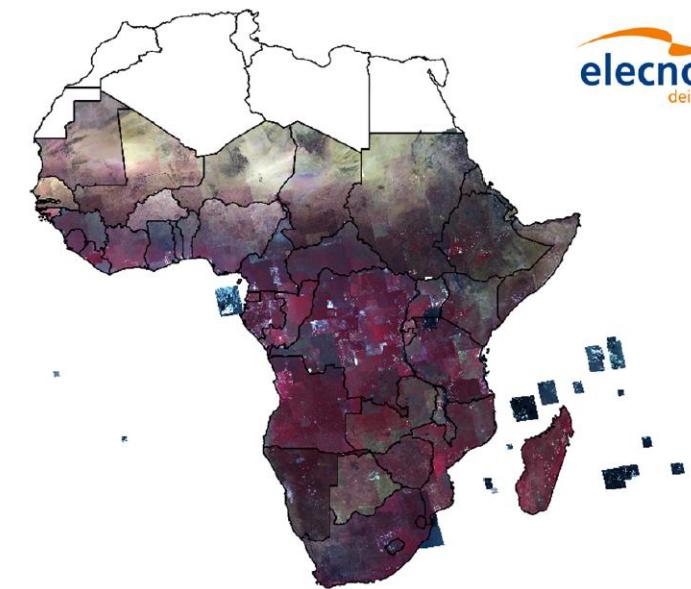


Figure 3: Status of dataset DWH\_MG2\_CORE\_09 Country Coverage Level 1 as of mid November 2011

# CORE\_04/05 (06/07) Worldwide medium/low resolution coverage – VGT & Envisat MERIS



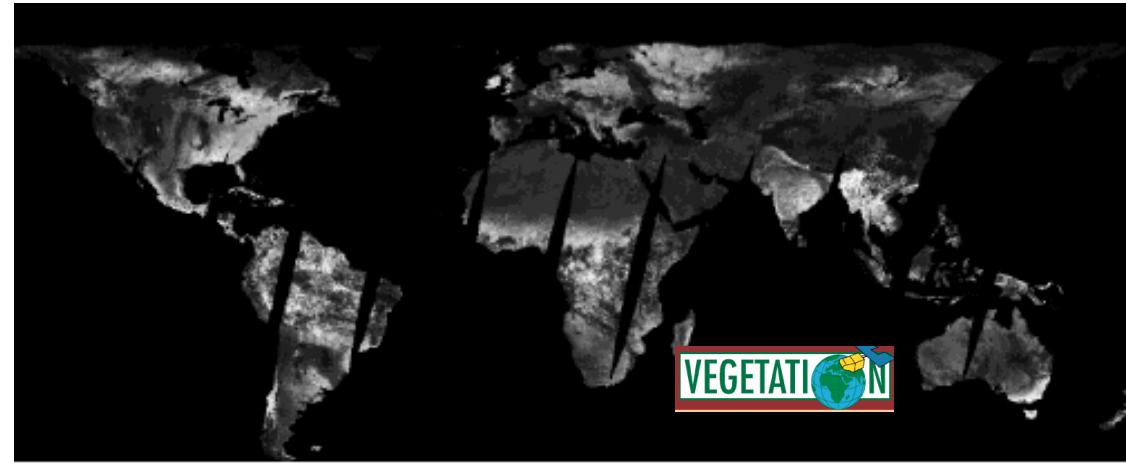
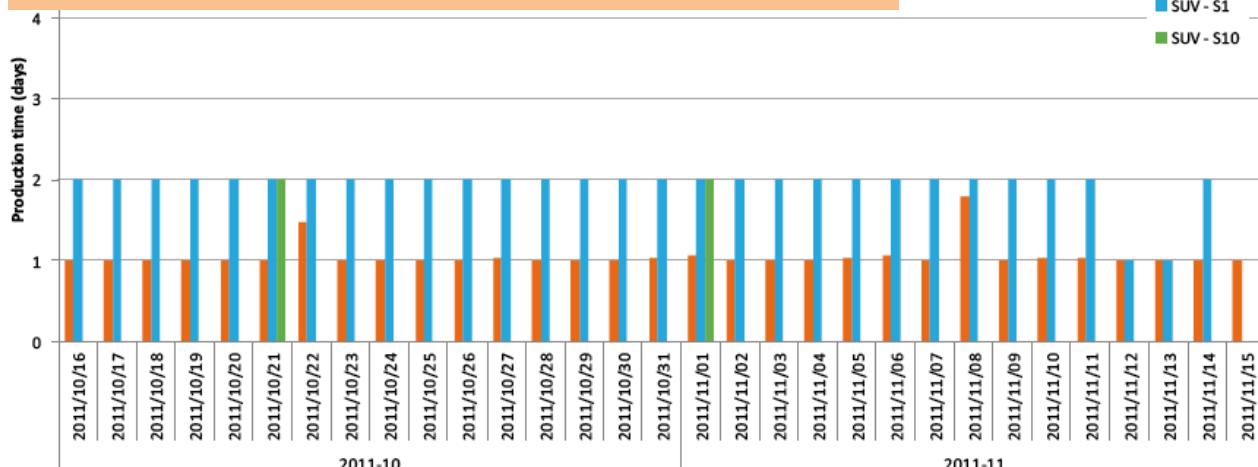
## DWH\_MG3\_CORE\_06: Optical worldwide MR coverage

**Dataset Description:** A daily worldwide coverage in MR data with imaging multi-spectral radiometers/scatterometers for the production of biophysical parameters and ECVs for global land monitoring.

GCME: ESA

MER FRS 1P 1394  
Total number of products delivered

The only global imaging dataset currently required in the DWH, and used by a GMES Service on global scale!



Description		June 2011	Q2 cum	July 2011	August 2011	September 2011	Q3 cum	October 2011	November 2011
P	successful segments/expected segments: [%]	100	100	98.40	99,28	99,70	99,35	99,90	99,78
S1	successful products/expected products [%]	100	100	100	100	100	100	100	100
S10	successful products/expected products [%]	100	100	100	100	100	100	100	100
ALL	successful products/expected products [%]	100	100	98.45	99.31	99,71	99,38	99,91	99,79

Figure 3-1: Production time for P, S1 and S10-products

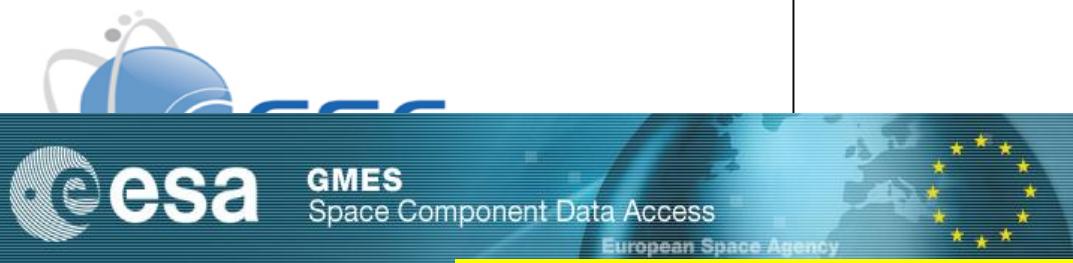
# GSC-DA Portal & Data Access Portfolio



ESA UNCLASSIFIED – For Official Use

## DOCUMENT

GMES Space Component Data Access Portfolio:  
Data Warehouse 2011-2014



<http://gmesdata.esa.int/>

**GSC Data Access**

- About GSC Data Access
- How to Access
- Browse Data
- Data Access Portfolio
- Derby Software Tool

**News**

- Operational News Archive
- News Archive
- RSS Feeds

**GSCDA Terms and Conditions**

- Terms and Conditions
- FAQ

## DAP contains

- Background information on GSC-DA
- Operational information, e.g. 24/7 services
- Details per GCMs
- All **CORE** datasets with baseline licences (no options)
- All **ADDITIONAL** datasets with initial quota (2011)



**Besides this, the GCMs of course have more capabilities and also serve other customers, just 2 examples from DMCii & European Space Imaging (EUSI):**

# Current DMC Constellation



Satellite	Launched	Bands	Resolution	Swath
<b>UK-DMC2</b>	2009	G,R,NIR	22m	650km
<b>Deimos-1</b>	2009	G,R,NIR	22m	650km
<b>NigeriaSat-X</b>	2011	G,R,NIR	22m	650km
<b>NigeriaSat-2</b>	2011	B,G,R,NIR	5m/32m	80km/650km
<b>Beijing-1</b>	2005	G,R,NIR	32m	650km

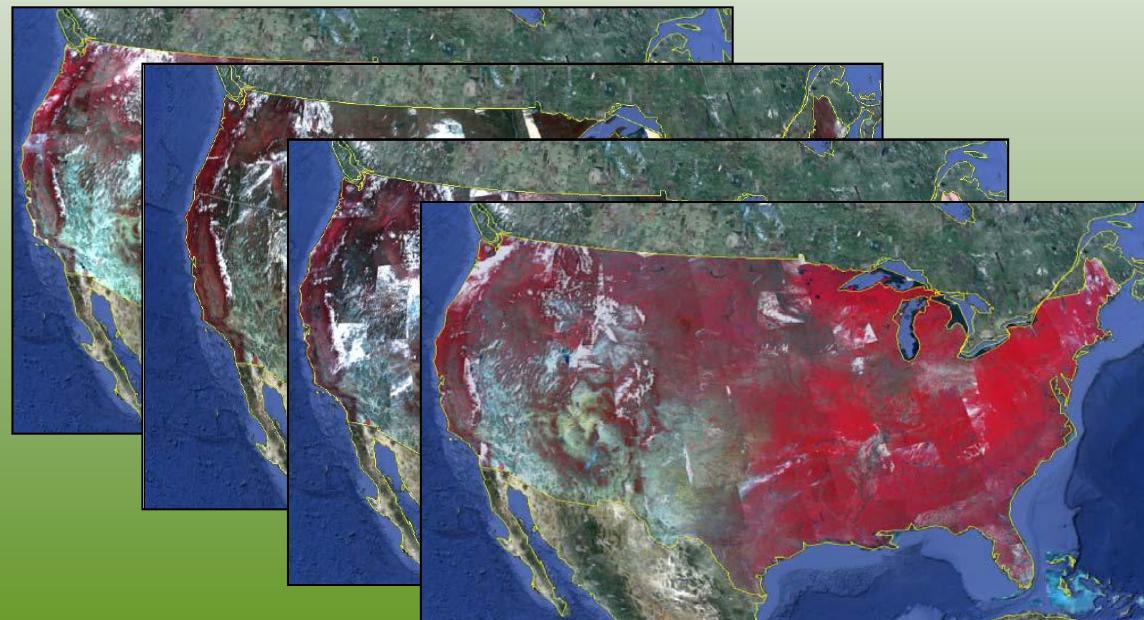
- Combined revisit of 1-2 days globally
- Total capacity up to 40 Million km<sup>2</sup> per day
- Constellation concept designed for regular monitoring of very large areas



Amsterdam, UK-DMC2

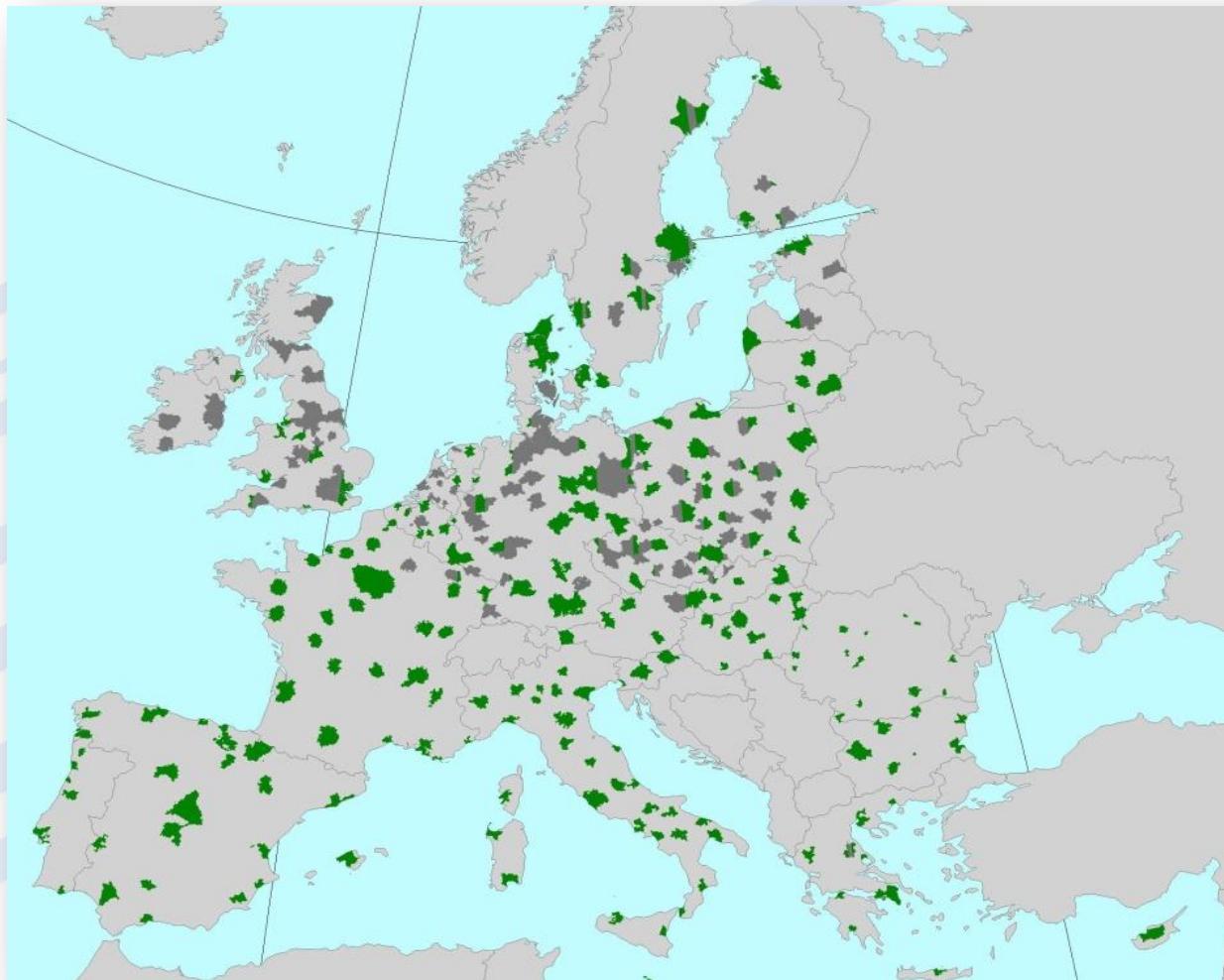
# Example: USA Multitemporal Coverage 2011

- For USDA Crop Monitoring
- Satellites used: Deimos-1 and UK-DMC2
- Complete coverage of lower 48 States every 15-days
- 12 coverages May–October 2011
- Average 91% cloud-free per coverage
- 150 Million km<sup>2</sup> of cloud-free imagery delivered
- USDA reported improved crop classification results



Courtesy of Astrium

# WorldView-2, 50cm, 8-band collections for the Urban Atlas



**Collection status:  
30 October 2011**

- 368,000 km<sup>2</sup> successfully collected = 62,8%
- 196 of 305 LUZ completed within the specs = 64,3%
- EUSI plans to complete the cloud-free coverage in 2012

# GMES dedicated missions: Sentinels



## **Sentinel 1 – SAR imaging**

All weather, day/night applications, interferometry

mid 2013 / 2015



## **Sentinel 2 – Multi-spectral imaging**

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

end 2013 / 2015



## **Sentinel 3 – Ocean and global land monitoring**

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

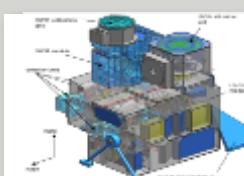
end 2013 / 2014



## **Sentinel 4 – Geostationary atmospheric**

Atmospheric composition monitoring, trans-  
boundary pollution

2020



## **Sentinel 5 – Low-orbit atmospheric**

Atmospheric composition monitoring  
(S5 Precursor launch in 2015)

2020+





# Sentinel-1 Mission Overview

# Sentinel-1: C-band SAR mission



- ✓ **Data continuity of ERS and ENVISAT missions**
- ✓ **GMES radar imaging mission for ocean, land and emergency services**



- ✓ **Applications:**
  - monitoring sea ice zones and the arctic environment
  - surveillance of marine environment (e.g. oil spill monitoring)
  - maritime security (e.g. ship detection)
  - wind, wave, current monitoring
  - monitoring of land surface motion (subsidence, landslide, tectonics, volcanoes, etc.)
  - support to emergency / risk management (e.g. flooding, etc.) and humanitarian aid in crisis situations
  - mapping of land surfaces: forest, water and soil, agriculture, etc.

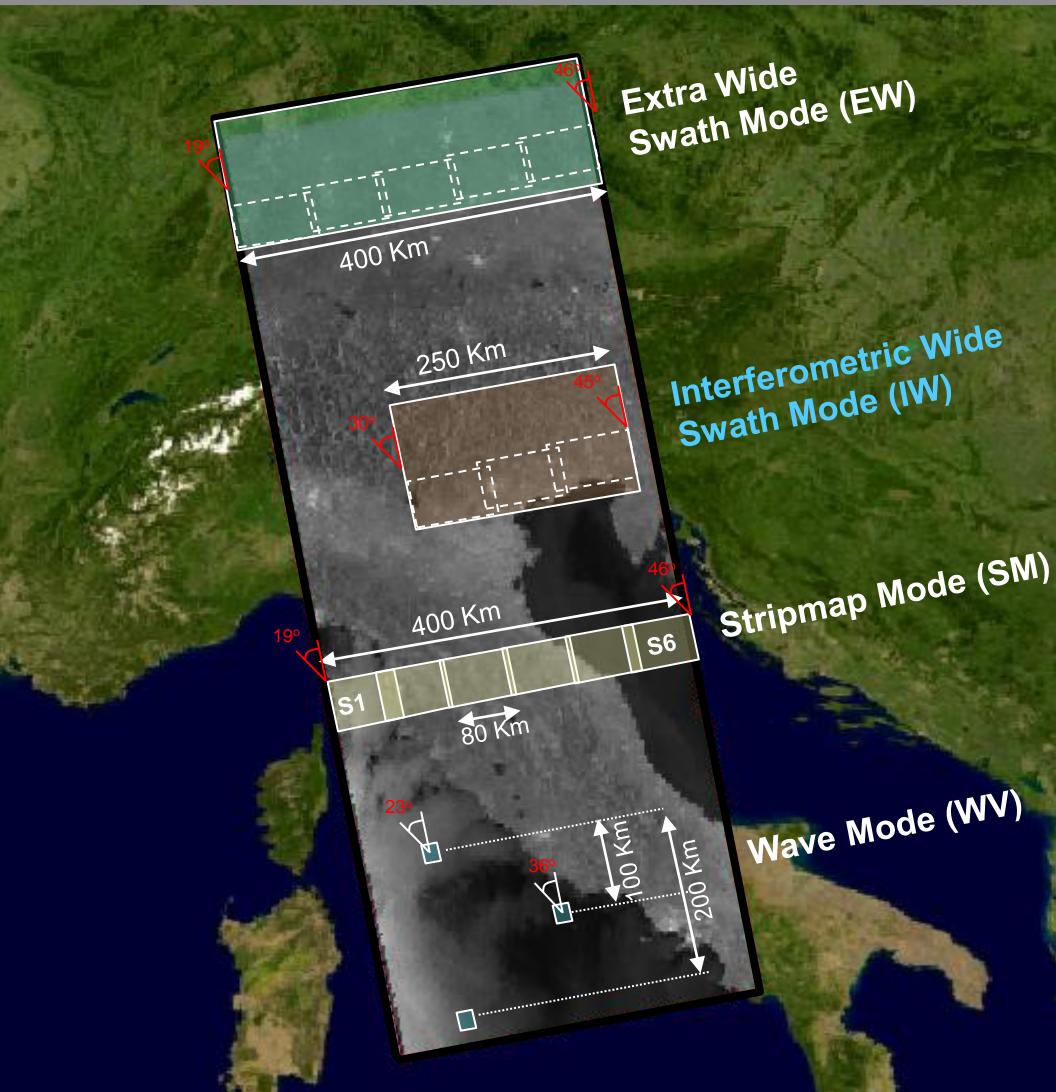
**The Sentinel-1 mission is based on a constellation of 2 satellites**

Sentinel-1A to be launched in **May 2013**

Sentinel-1B under procurement, launch date is TBD (indicatively 2015)



# Sentinel-1 SAR Modes



Sentinel-1 SAR can be operated in 4 exclusive imaging modes with different resolution and coverage:

Mode Rate	SAR Mode
High Bit Rate (HBR)	IW
	EW
	SM (S1 → S6)
Low Bit Rate (LBR)	WV

Polarisation schemes for IW, EW and SM:

- single polarisation: HH or VV
- dual polarisation: HH+HV or VV+VH

For Wave mode: HH or VV

For all of these operating modes, the same family of products is available to users.

# Sentinel-1 observation scenario



The Sentinel-1 observation scenario is currently under definition.



## High level strategy

- optimum use of SAR duty cycle (**25 min/orbit**), taking into account the various constraints (e.g. limitation in the number of X-band RF switches, mode transition times)
- **Wave Mode** continuously operated **over open oceans**, with lower priority w.r.t. the other high rate modes
- IW or EW modes operated over pre-defined geographical areas:

→ **Over land: pre-defined mode is IWS**

→ **Over seas and polar areas, and ocean relevant areas:** pre-defined mode is either **IWS or EWS**

- In **exceptional** cases only, **emergency observation** requests may alter the pre-defined observation scenario, with e.g. the use of the Strip Map mode



# Sentinel-1 services and applications over land



- These services or applications cover a wide range of different thematic domains
- They do not require data in quasi real time (apart from the ones in support to emergency / crisis management), few of them require data in 3 hours NRT from sensing
- These services / applications include:
  - Risk management in support to flooding, earthquake, subsidence, landslides (background mapping)
  - Terrain motion monitoring (subsidence, landslides)
  - Specific security services
  - Global tectonic areas and volcano monitoring
  - Ice sheets monitoring (Greenland, Antarctica)
  - Glacier and snow monitoring
  - River and lake ice monitoring
  - [Forest mapping](#)
  - [Global land mapping \(soil moisture, land cover & change monitoring, agriculture, etc.\)](#)



What of this will be contained in the Global Land Service?



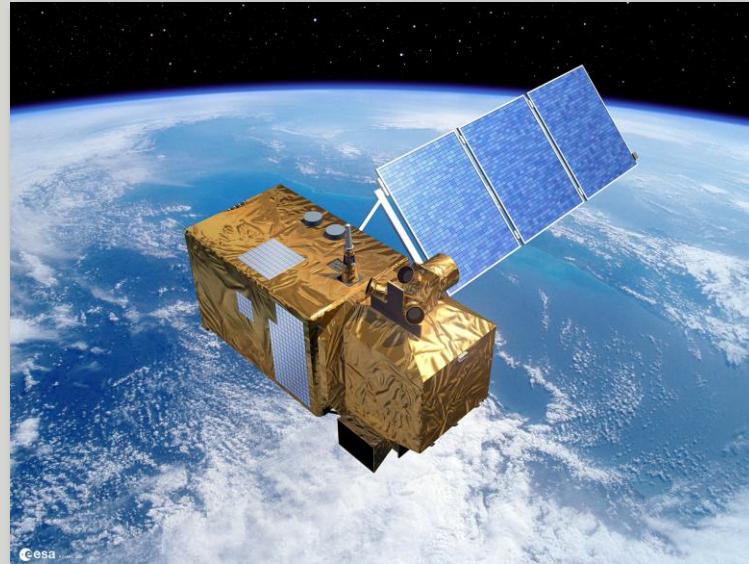
# High level strategy to fulfil observation requirements for services over land



## During Full Operational Capability operations

- Systematic (or very frequent) mapping of tectonic / subsidence / landslides / volcano areas to support operational services based on INSAR  
→ Need to provide pairs in both ascending / descending passes
- Regular mapping of areas prone to risks to acquire strategic background data (e.g. for flood)
- Regular mapping of areas to support GMES security services
- Regular mapping of ice sheets (Greenland, Antarctica), polar coastal regions and of relevant areas for glacier and snow monitoring (based on season)
- **Regular global coverage of all land areas (frequency TBD based on system capacity, detailed simulations to be performed), supporting among others forest mapping, soil moisture, land cover change, crop monitoring, etc. based on seasonal requirements**  
→ Baseline mode of operations: IW, if possible in dual-polarisation (HH+HV). Single polarisation HH however sufficient for INSAR applications





## Sentinel-2 Mission overview

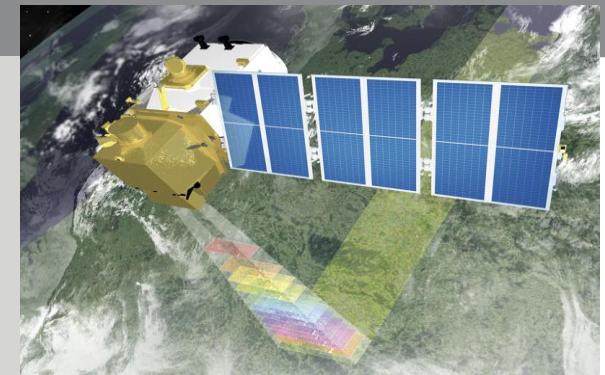
# *Sentinel-2: multispectral optical mission*



✓ **Data continuity of Landsat and Spot-4/-5 missions**

✓ **Applications:**

- European and global Land cover/Land use, Vegetation and Forest monitoring
- Global carbon, Crop monitoring, Spatial planning (vegetation, urban)
- Water services, Soil erosion, large scale natural or man made disasters, surveillance of infrastructures
- support to emergency / risk management (e.g. flooding, etc.) and humanitarian aid in crisis situations
- mapping of land surfaces: forest, water and soil, agriculture, etc.
- Thematic services: Sustainable management of developing countries, Nature protection services, support to humanitarian aid, Food security

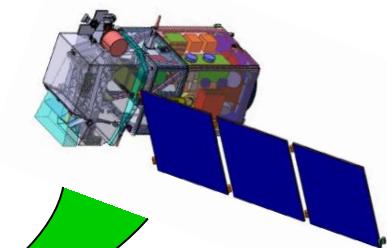
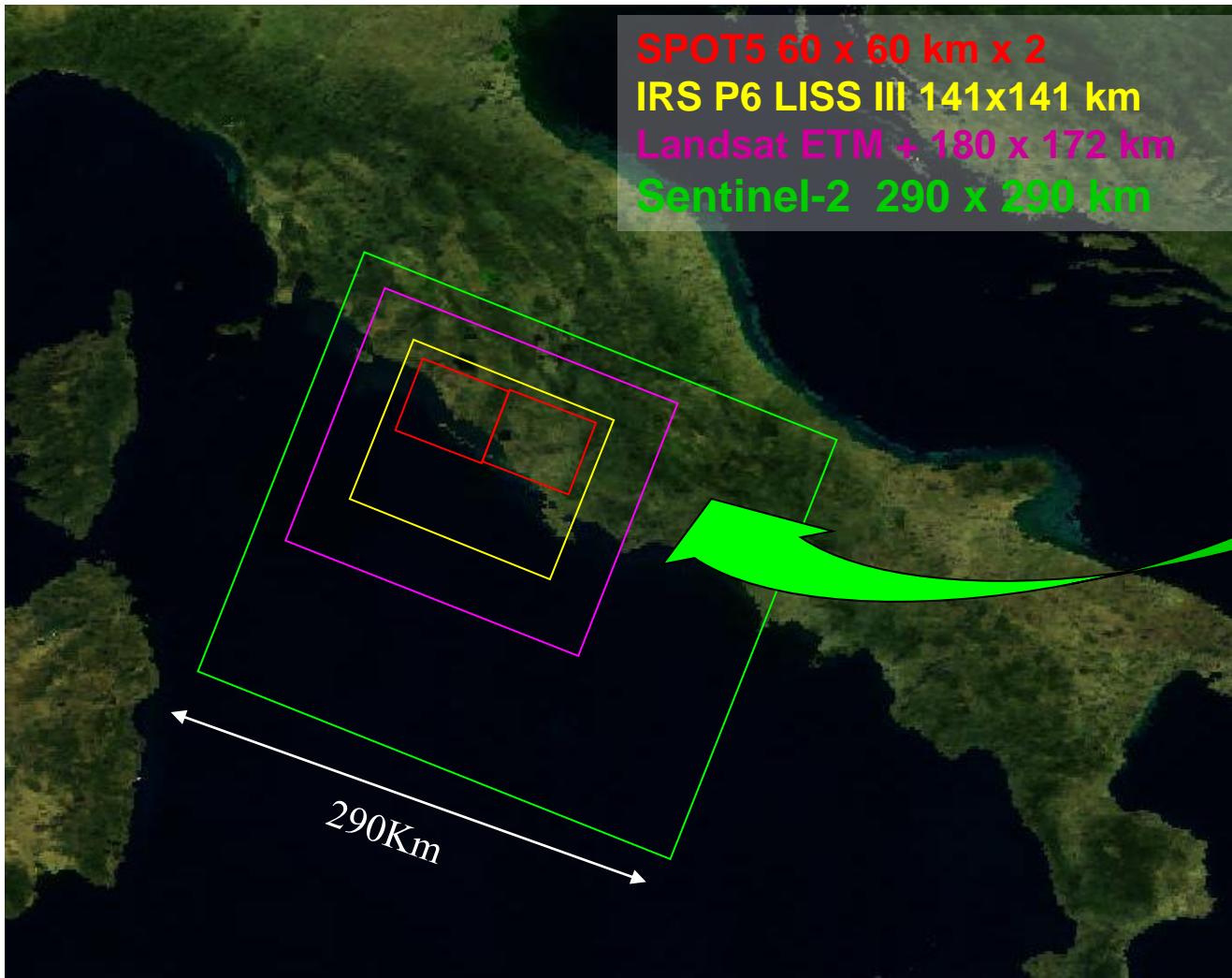


**The Sentinel-2 mission is based on a constellation of 2 satellites**

Sentinel-2A to be launched in **Nov 2013**

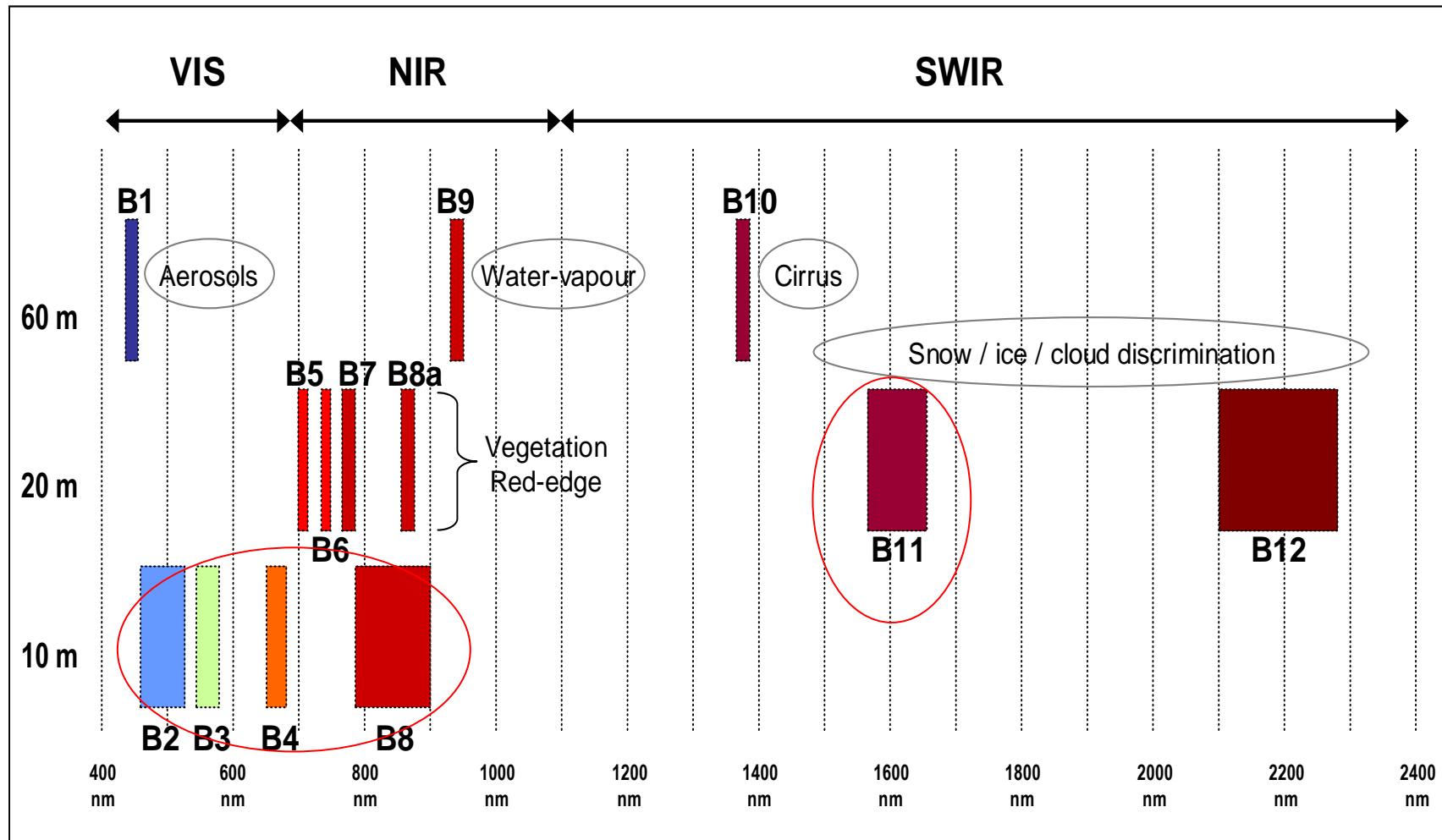
Sentinel-2B under procurement, launch date indicatively 2015

## *Sentinel-2: Swath width*



High revisit time →  
assured by twin satellite  
observations performed  
over a very large swath

# Sentinel-2: Spectral bands

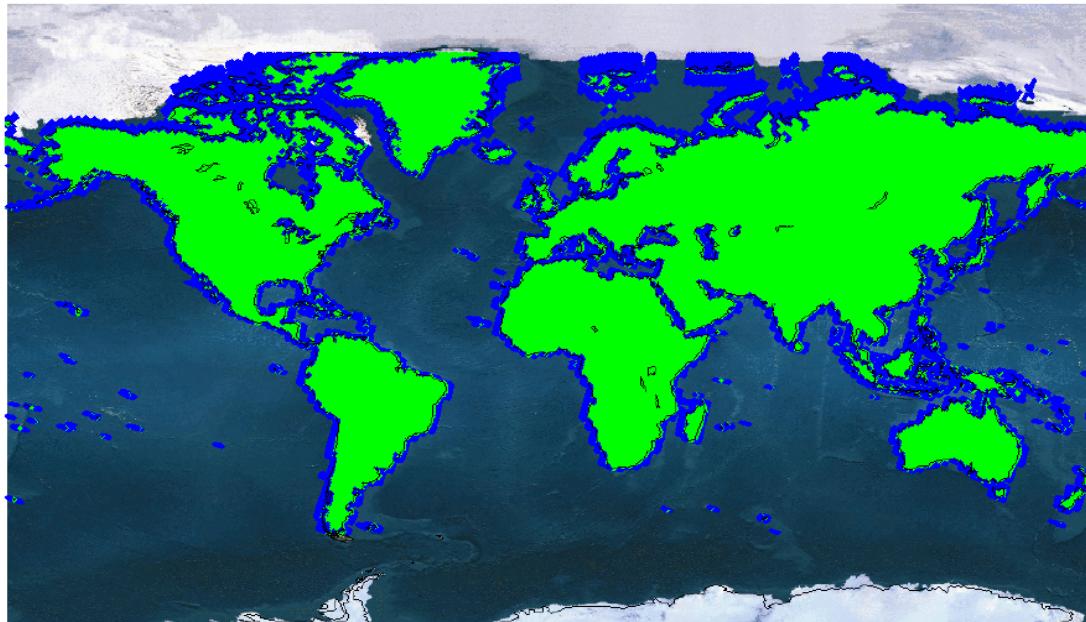


# *Systematic observation scenario of Sentinel-2*



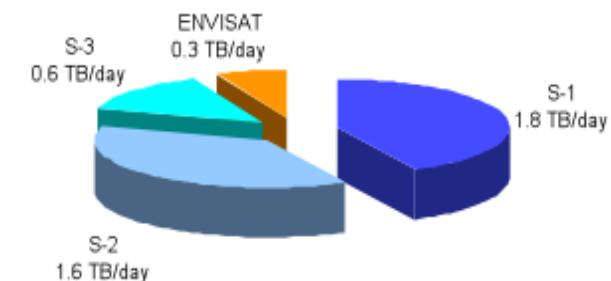
## Geographical coverage:

1. All land areas between 56° S and 83° N including major islands (>100 km<sup>2</sup>)
2. EU islands/islands < 20 km from the coast
3. the whole Mediterranean Sea
4. all inland water bodies and all closed seas

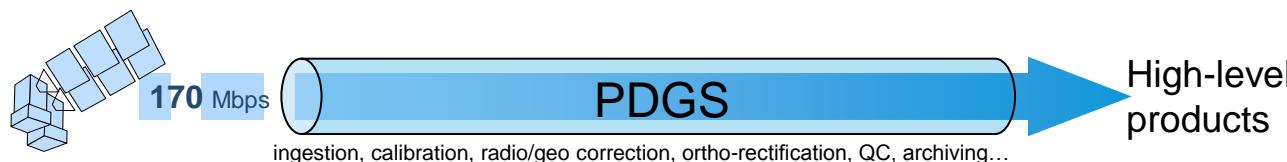


## 1. The systematic observation scenario leads to

- a. In average ~17 minutes of MSI operation/orbit → 0.8 TBytes daily of compressed raw data for one satellite (1000 CDs!)
- b. Equivalent continuous raw data supply rate of ~ 170 Mbps to be sustained with two satellites
- c. Comparatively, the MSI pixel supply rate (490 Mbps) is ~ 50x that of MERIS/FR
- d. Product archive of 27 PBytes after 12 years
- e.

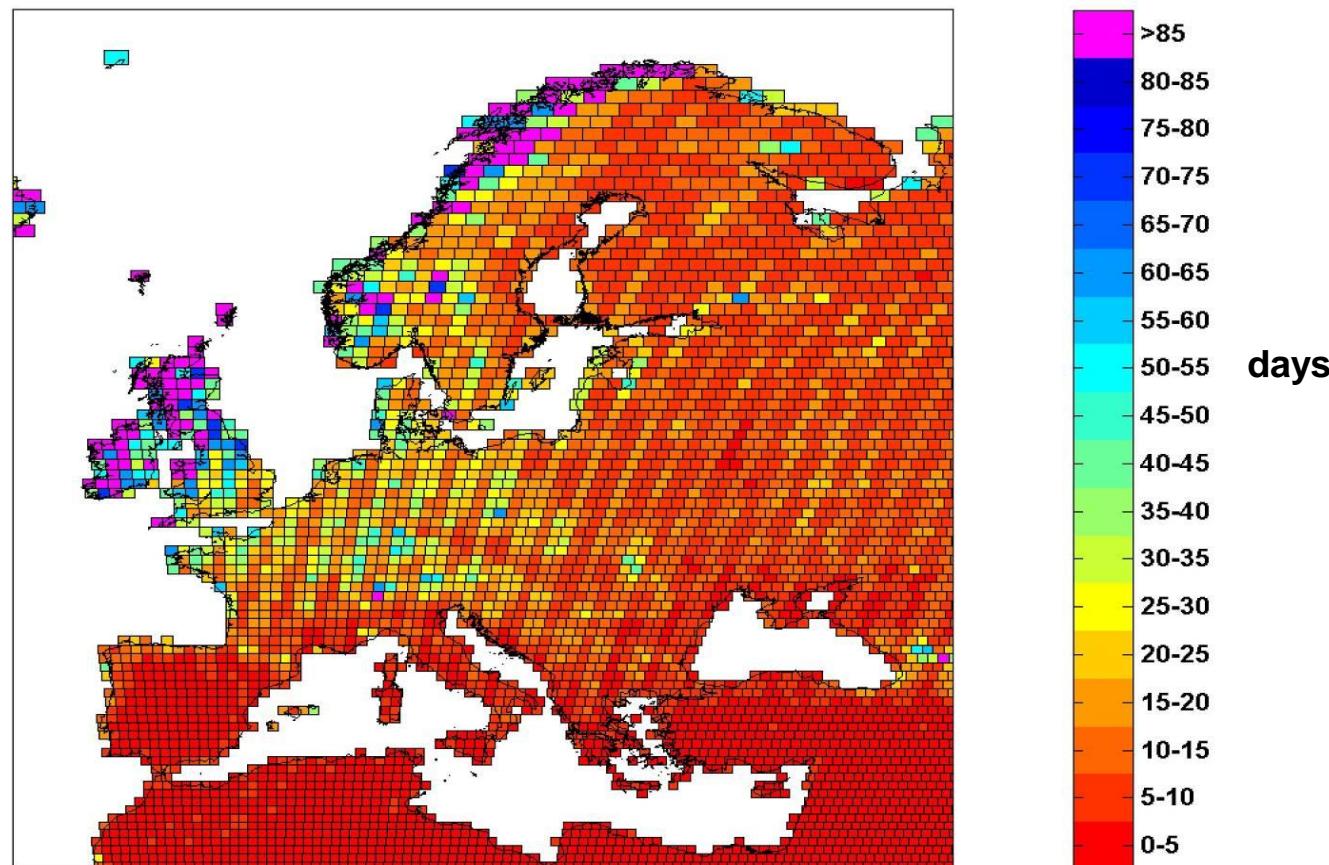


## 2. The systematic processing scenario requires sustaining this flow down to the availability of high-level and quality proof products in the archives ready for downstream usage



## Revisit time over Europe in summer with 2 satellites (considering cloud cover)

Maximum effective coverage time for SC1 & SC2 (days) (<15% cloud cover; 68% confidence)

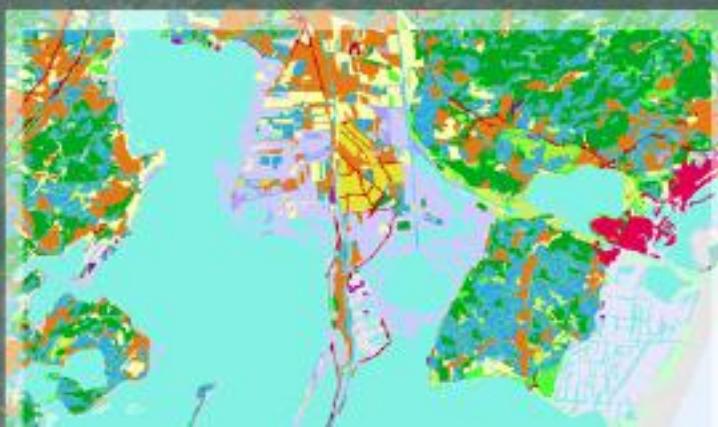


## → SENTINEL-2 PREPARATORY SYMPOSIUM

23-27 April 2012 | ESA-ESRIN | Frascati (Rome) Italy



European Space Agency



### DEADLINES

[www.S2symposium.org](http://www.S2symposium.org)

1 <sup>st</sup> announcement	27/06/2011
Abstract Submission open	19/09/2011
Submission of Abstracts	12/12/2011
Notification of Acceptance	20/02/2012
Issue of Preliminary Programme	05/03/2012
Opening of Registration	05/03/2012



## Sentinel-3 Mission overview

# Sentinel-3 mission instruments

- **Ocean and Land Colour Instrument (OLCI):**

with 5 cameras, each covering a spectral range from 400 to 1020 nm, binned to 15 (MERIS) & 6 additional bands

Swath: 1270 km, full resolution 300m

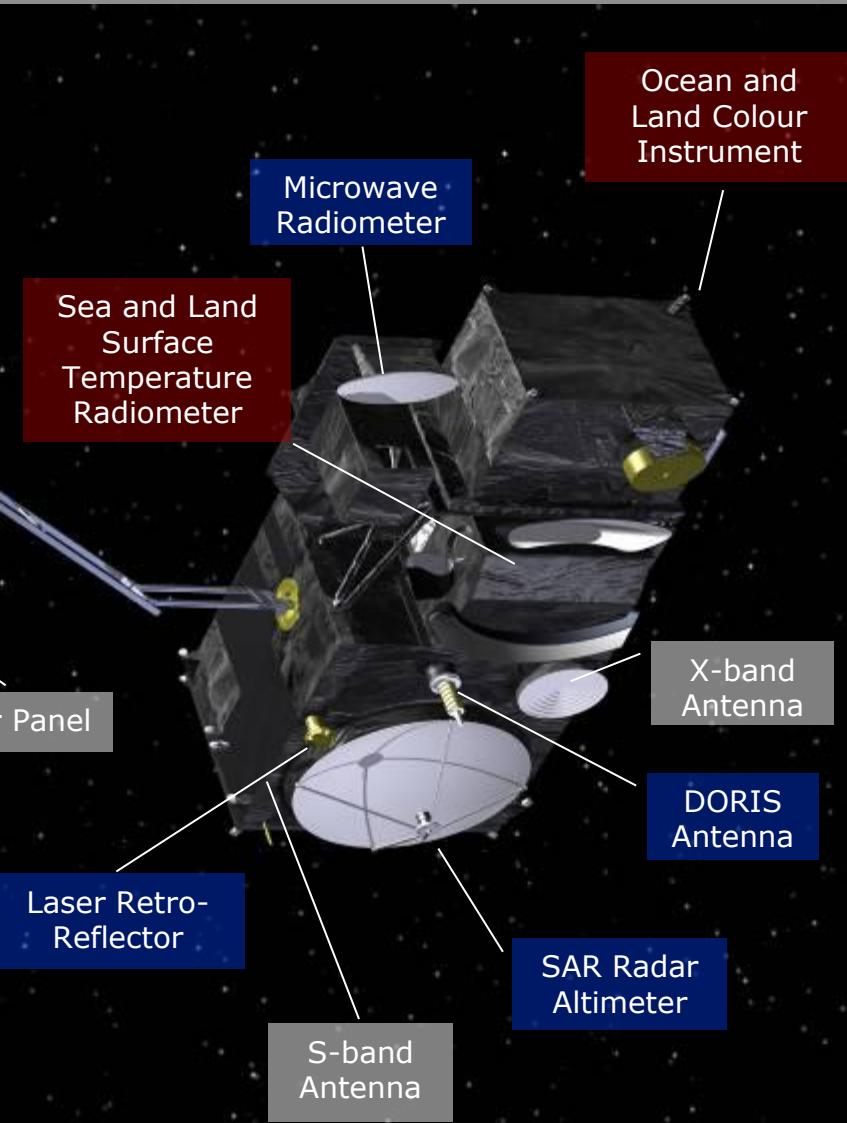
- **Sea and Land Surface Temperature Radiometer (SLSTR):**

with 7 AATSR & 2 additional bands, plus 2 additional Fire channels, with 500 m (solar) and 1 km (TIR) ground resolution

Swath: 1420 km/750 km (single or dual view)

- **Topography package:**

SRAL Ku-C altimeter (LRM and SAR measurement modes), MWR, POD (with Laser Retro Reflector, GPS and DORIS)



# Sentinel-3 Revisit time



- Key elements of the Sentinel-3 mission are:
  - Short Revisit times for optical payload, even with 1 single satellite

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



# Sentinel-3 instrument operations



- The Sentinel-3 instruments provide the sensing of the data autonomously on-board the spacecraft on the basis of predefined geographic data and selection of observation mode depending on the surface over which the spacecraft is flying.
- These autonomous operations are based on on-board mechanisms controlling the various instrument mode transitions as a function of the satellite orbital position.
- The data latency requirement is to acquire all data within 3 hours from sensing.



# Way forward with Global Land for the Sentinels



- ESA currently makes simulations for the Sentinels acquisition scenarios based on all known requirements, including currently known SAR requirements (e.g. Envisat background mission) or those from current CORE Services (MyOcean, SAFER, GMOSAIC, Geoland-2)
- The current CORE Services do not necessarily use the full spectrum of EO data or provide full spectrum of services (e.g. Geoland-2 hardly uses any SAR data today), therefore it is crucial to understand:



What sub-services will the Global Land Service contain? Which EO data will be required (beyond known from DWH/DAP-R) which is marginal in data volumes?

How will the Global Land be organised? It is not assumed that there will be a new interface for discussion of observational requirements.

How to make sure that the the Global and regional Land Service absorb the high data volumes from the Sentinels-1, -2, -3 into proper processing chains?

It is assumed that the GMES Services can receive, process the large volumes of Sentinel data and disseminate within their Service consortium.



# Thank you!

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