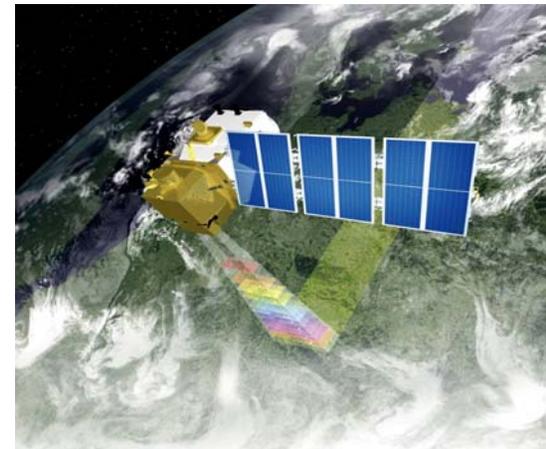


# ***GMES Space Component & Sentinel(-2)***



Bianca Hoersch  
**Third Party Mission Manager / Sentinel-2 Mission Manager**  
**European Space Agency**

[bianca.hoersch@esa.int](mailto:bianca.hoersch@esa.int)

1. Programme & Status of GMES/ GMES Space Component
2. Requirements: the GMES Services
3. GMES Space Component(s)
  - Sentinels
  - GMES Contributing Missions
  - Requirements collection & Data Access
4. Focus Sentinel-2
5. Sentinel Data Policy
6. GMES Space Component Operations Concept
  - Core ground segment
  - Collaborative ground segment
7. Way ahead/schedule

# **Programmatic status & Organisation of GMES/ GMES Space Component**

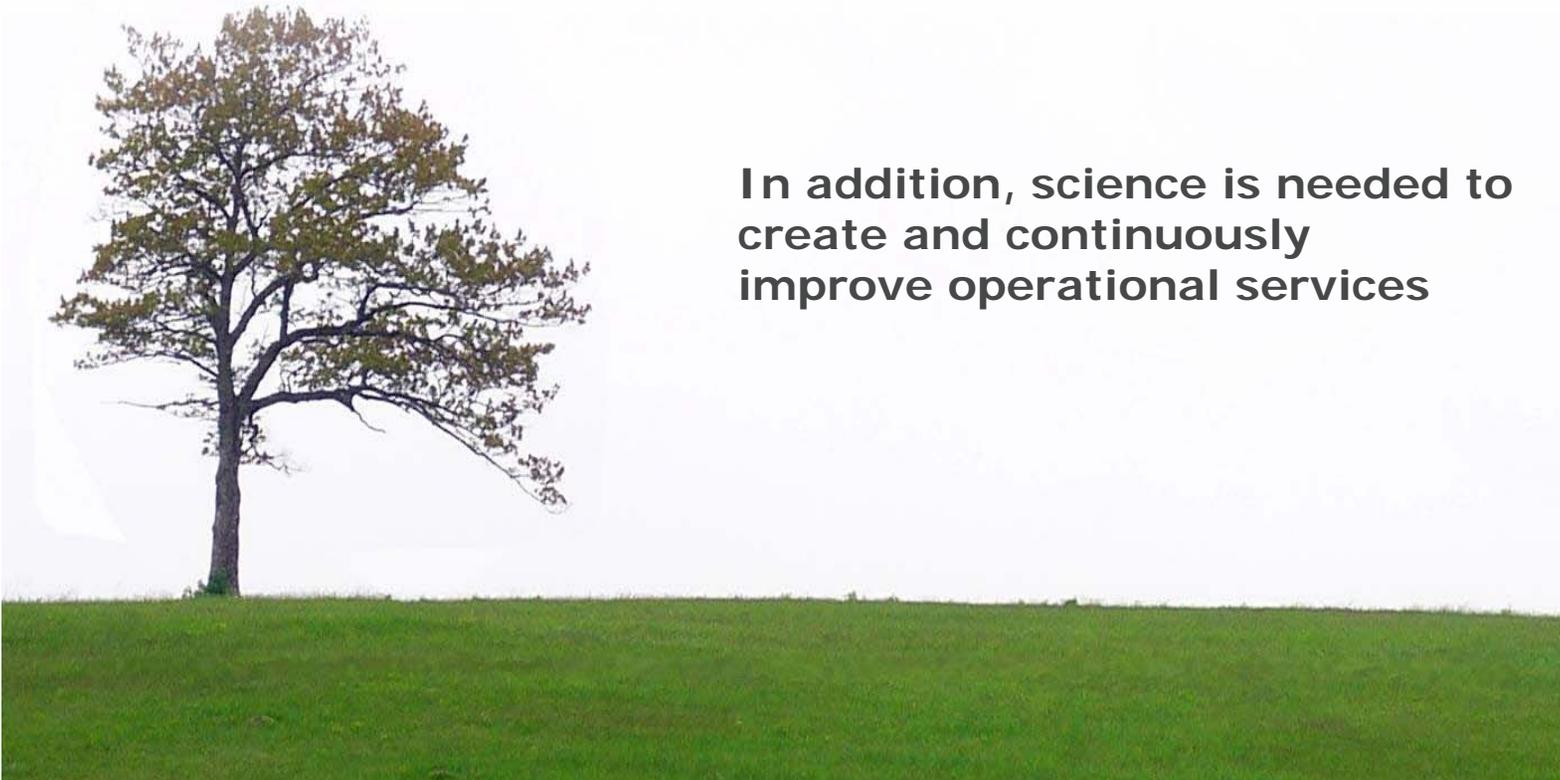
# Goal of GMES



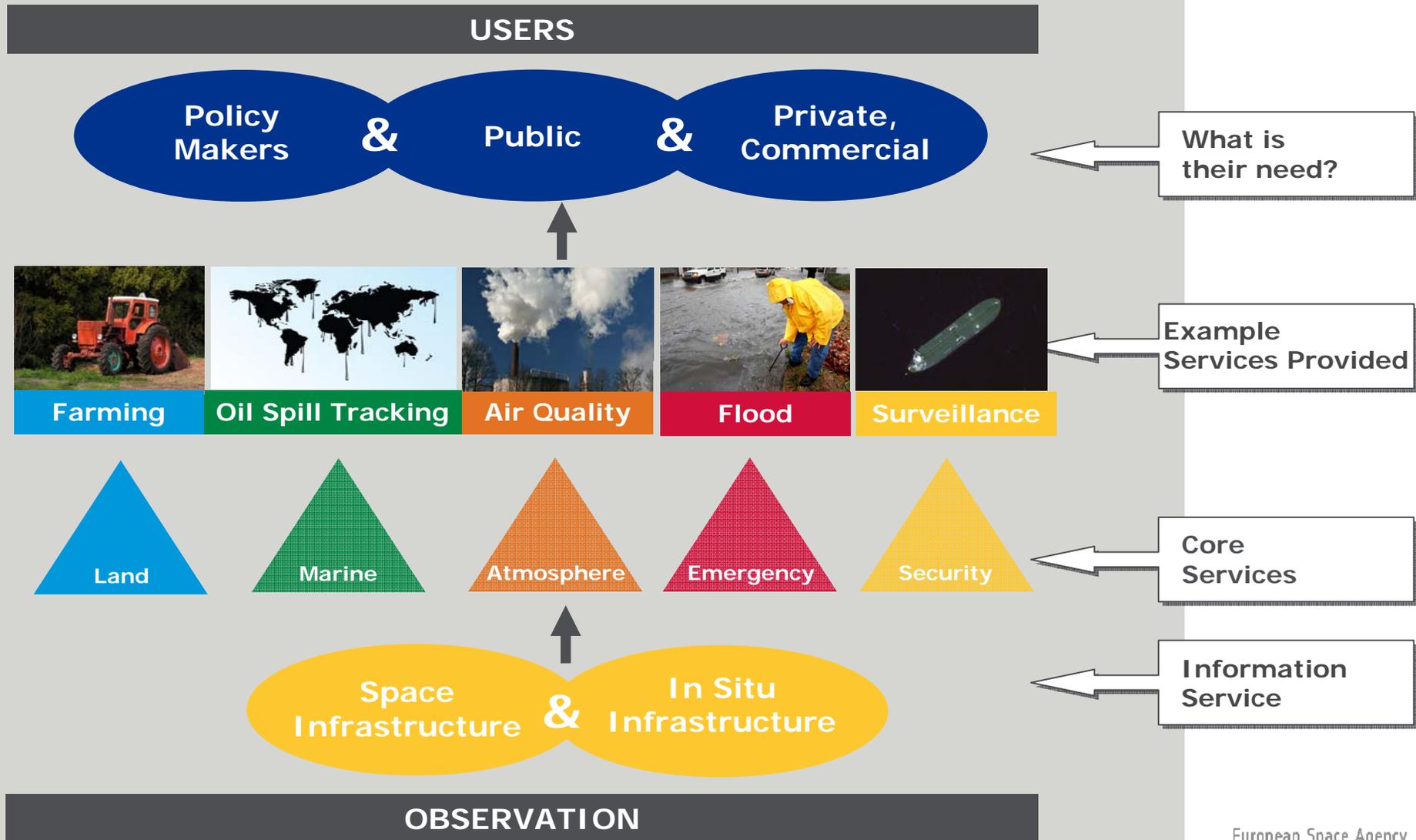
**GMES aims at developing operational services, following the example of meteorology, but for other domains such as:**

- emergency management
- air quality monitoring
- land monitoring
- ocean & sea ice monitoring etc...

**In addition, science is needed to create and continuously improve operational services**



# GMES Overall View

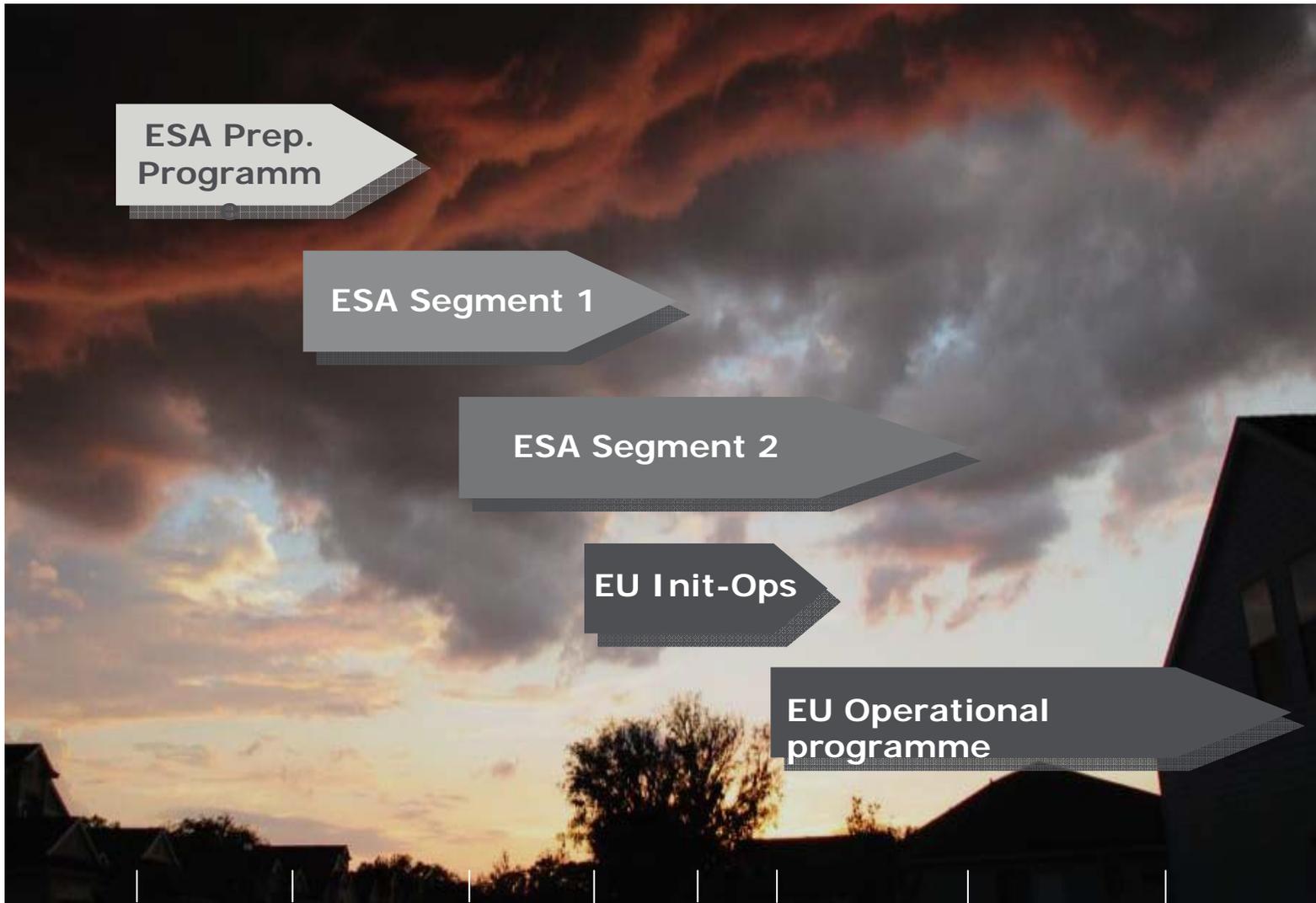


## GMES is an EU led initiative

- **Services Component – led by EC**
  - Produces information services in response to European policy priorities in environment and security
  - Relies on data from in-situ and space component
- **In-situ component – led by EEA**
  - Observations mostly within national responsibility, with coordination at European level
- **Space Component – led by ESA**
  - Sentinels - EO missions developed specifically for GMES:
  - Contributing Missions - EO missions built for purposes other than GMES but offering part of their capacity to GMES (EU/ESA MSs, EUMETSAT, commercial, international)



# GMES Space Component Phasing



2004

2006

2009

2011

2013

2014

2017

2023

Landsat Science Team meeting, Mountain View, 19 Jan 2010

B. Hoersch

European Space Agency

## 1. Build-up phase

development of first generation of Sentinels, data access to MS/EUM missions, ground segment, early operations: ~ 2.2 bn€

### Financing – ESA GSC programme

- 758 M€ Segment 1
- 831 M€ Segment 2

### Financing – EC FP7

- 600 M€ FP7 Space

Additional funding is required in ~2011 to complete build-up

## 2. Operational Programme

development of recurrent Sentinel satellites, operational access to Member State / Eumetsat missions, GSC routine operations, evolution of GSC: ~ 500 M€/year (2008 e.c.), to be consolidated.

Operational elements expected to be funded by EC, R&D elements by ESA

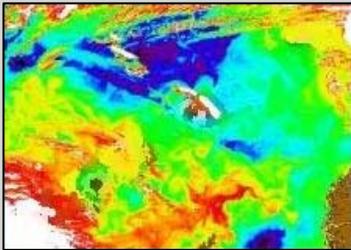
# GSC next programmatic steps



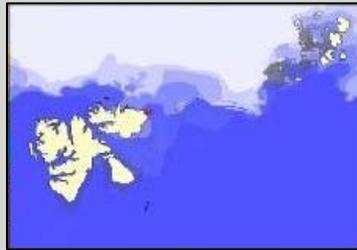
- Consolidate GSC Long Term Scenario
- Prepare GMES/GSC Governance
- Obtain timely funding for Sentinel Initial Operations and GSC build-up completion
- Ensure that operational funding is in place before the launch of the Sentinels
- Consolidate ESA/EC position on the Sentinel and CMs data policy
- Develop the 'S' of GMES

# GMES Services

# ESA Funded GMES Services made the start



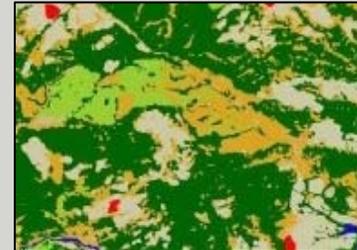
MarCoast



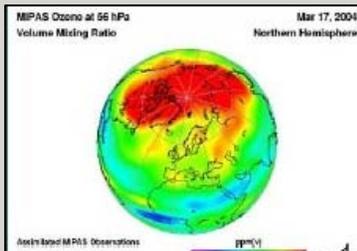
PolarView



GSE Land



Forest Monitoring



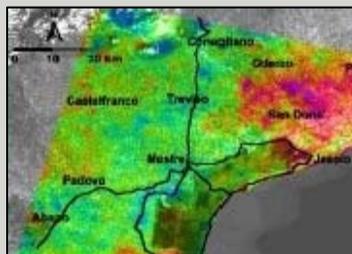
Promote



Risk-EOS



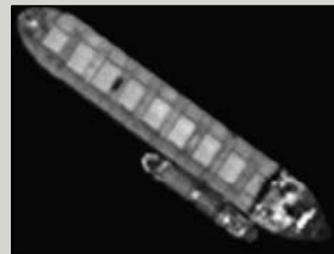
GMFS



TerraFirma



Respond



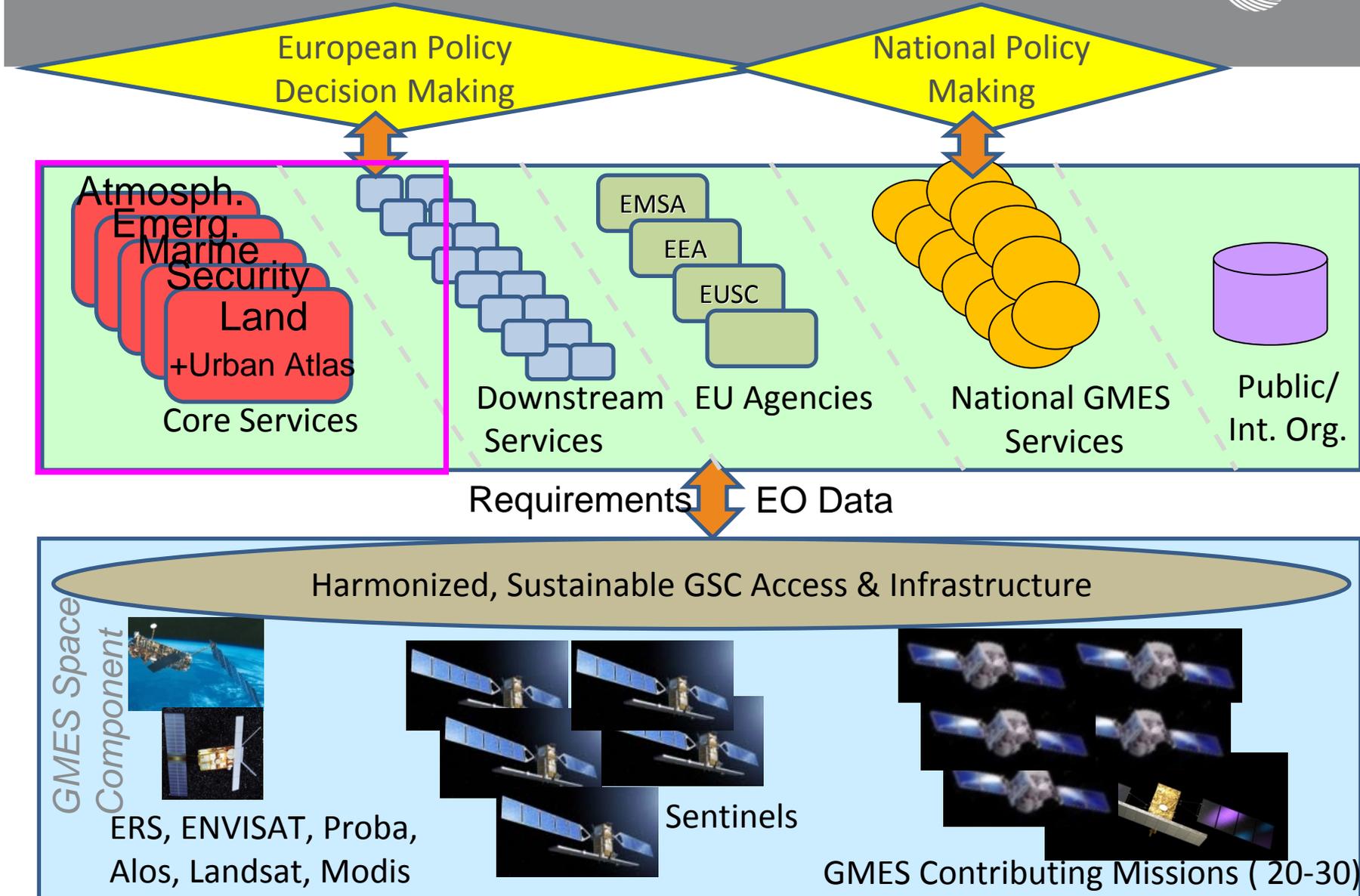
Mariss

130 M€ by  
ESA MS

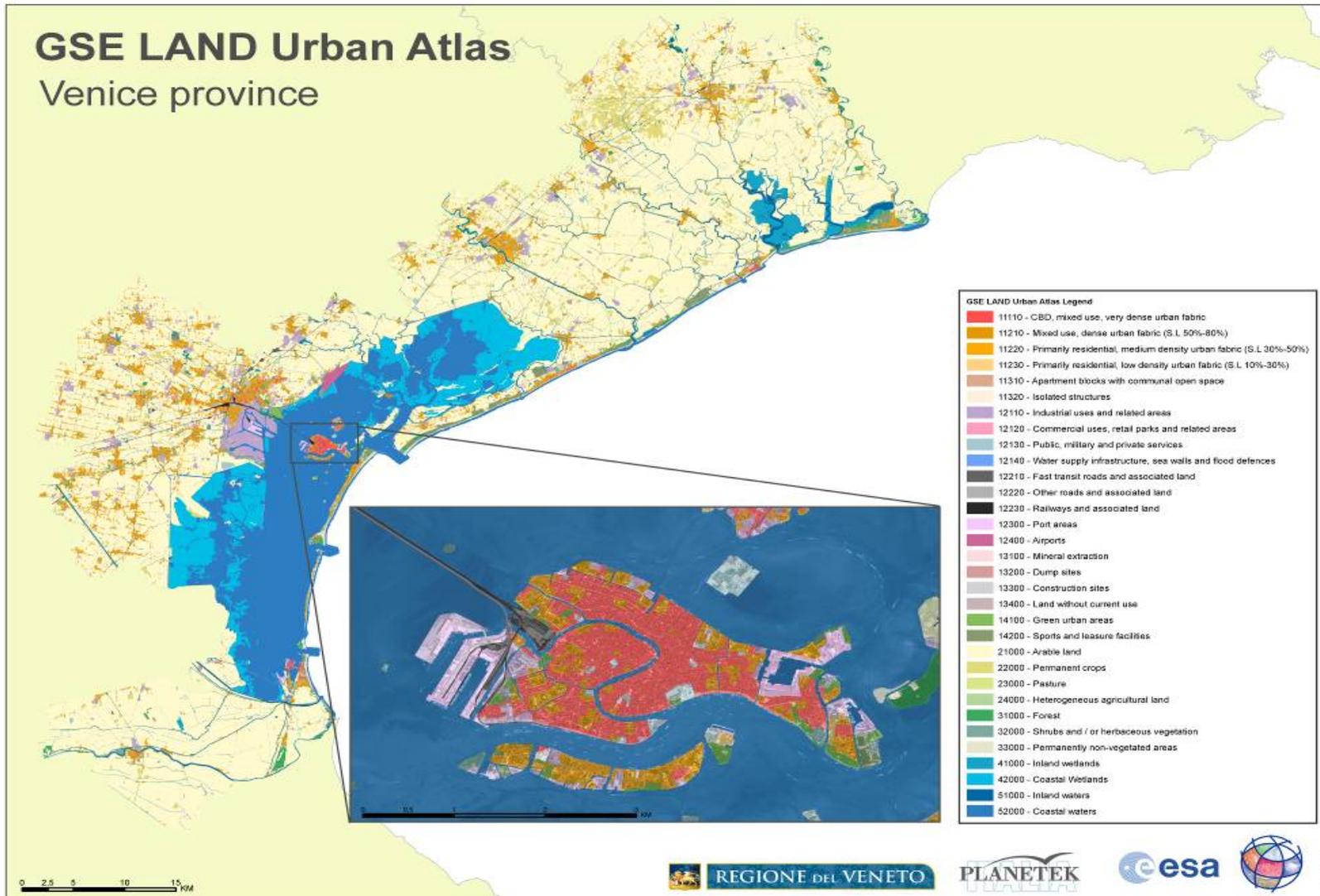
Period 2003–  
2011

400+ user  
organisations

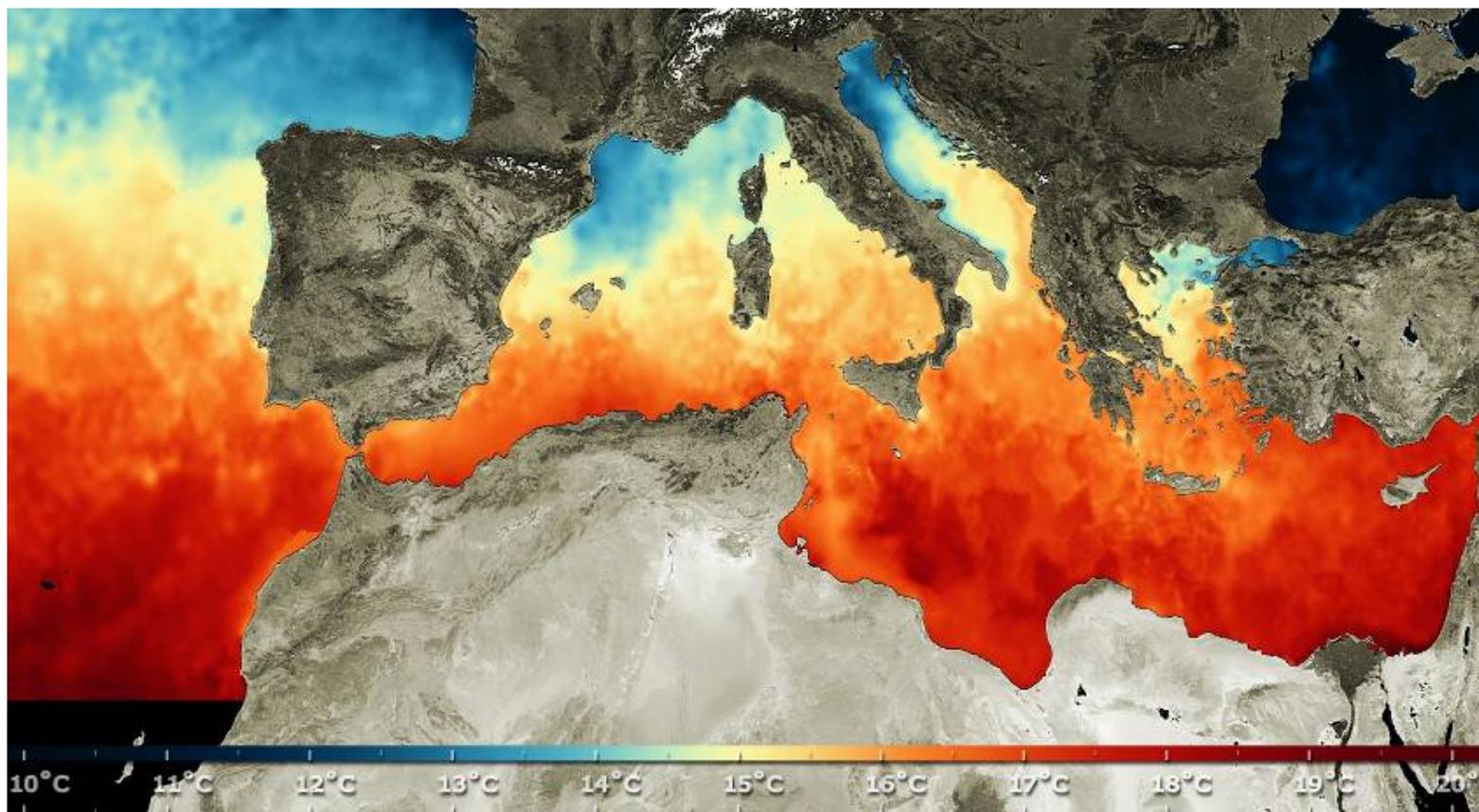
# GMES landscape evolution



# Example of land service: Land classification and planning



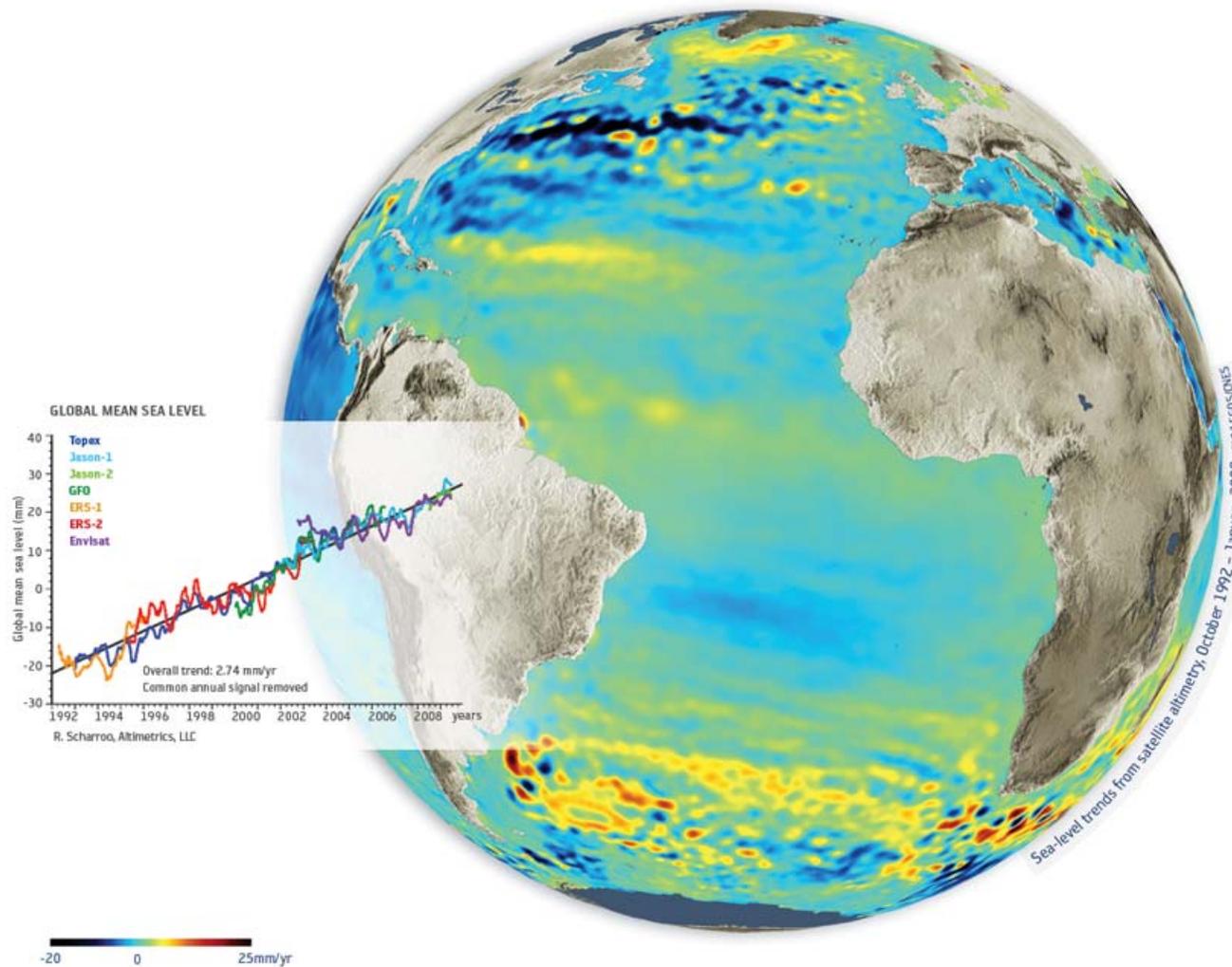
# Example of marine service: Marine Monitoring



2006 sea  
Surface  
Temperature  
over the  
Mediterranean

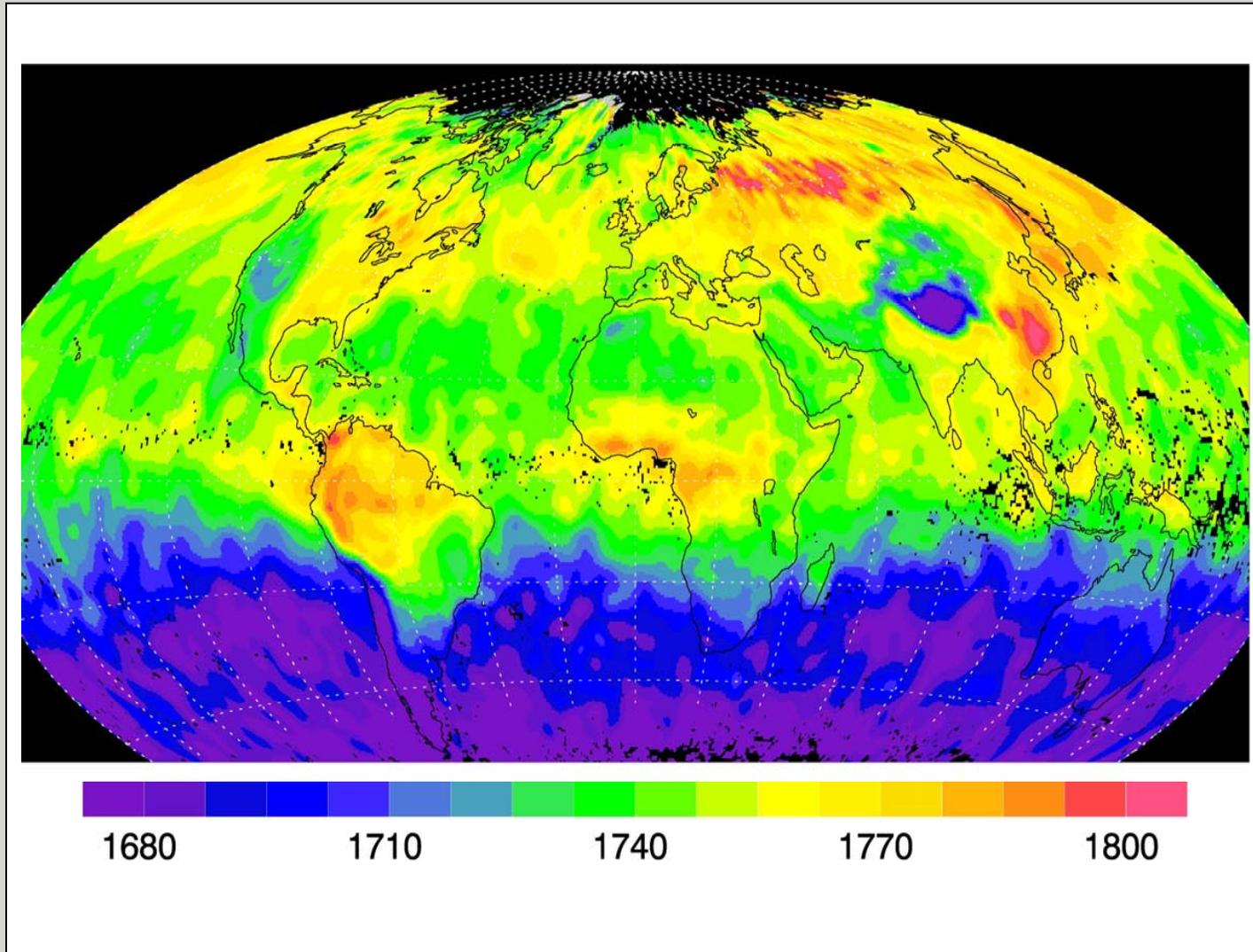
Credits:  
Medspiration

# Example of marine service: Global Sea Level Rise



Sea level rise from several satellite radar altimeters

# Example of atmospheric service: CH<sub>4</sub> Concentration



**2003-2005  
ESA's  
Envisat  
global  
atmospheric  
methane  
distribution  
(air mole  
fractions in  
parts per  
billion)**

Credits: ESA  
and  
University of  
Bremen

# Example of Emergency service: flooding



Elbehochwasser April 2006 - Satellitenbildkarte Großraum Dresden 1 : 50.000

1 : 50.000



Zentrum für satellitengestützte Kriseninformation  
 Notfallkartierung & Katastrophenmonitoring  
 Deutsches Fernerkundungsdatenzentrum  
 Deutsches Zentrum für Luft- und Raumfahrt  
 DLR

Legende

- Siedlung
- Wald
- Verkehrswege
- Ackerflächen
- Normalpegel
- Überflutungsfläche

Interpretation

Das Ende März einsetzende Tauwetter zusammen mit starken Niederschlägen nach dem 26. März 2006 führte zu stark ansteigenden Pegeln im gesamten mitteleuropäischen Raum und speziell an der Elbe. Die Überflutungsfläche wurde aus Satellitendaten (IRS-P6 / US3 II) vom 2. April 2006 extrahiert und über eine Landabstufung vom 24. September 2000 gelegt. Das beobachtete Gebiet wies nur eine geringe Brechung auf, dennoch konnte an einigen Stellen die überflutete Fläche nicht mit vollständiger Sicherheit aus den Satellitenbildern kartiert werden. Zum Aufnahmezeitpunkt der Satellitenaufnahme erreichte der Pegel in Dresden eine Höhe von 732 cm.

Maßstab

0 1000 2000 3000 4000 m N  
 Maßstab: 1:50.000 (für DIN A1 Druck)

Referenzkoordinatensystem: Geographische Koord.  
 Projektion: UTM Zone 32 N Geographisch (DMS)  
 Sphäroid: WGS 84 WGS 84  
 Datum: WGS 84 WGS 84

Datenquellen

IRS-P6/US3 II © Eurmap 2006  
 LANDSAT-7 ETM © USGS 2000

Prozessierung/Analyse

Bildprozessierung und Kartenerstellung durch DLR:  
 - Flutkarte aus IRS-P6/US3 II  
 Karte erstellt am 4. April 2006 von ZFG/DLR DE.

Weitere Informationen: <http://www.risk-EO3.com>

**Flooding management in the Elbe region of Germany – April 2006**

Credits: NRSA, USGS, DLR/GMES, RISKEOS

# Example of Security service: Humanitarian Aid

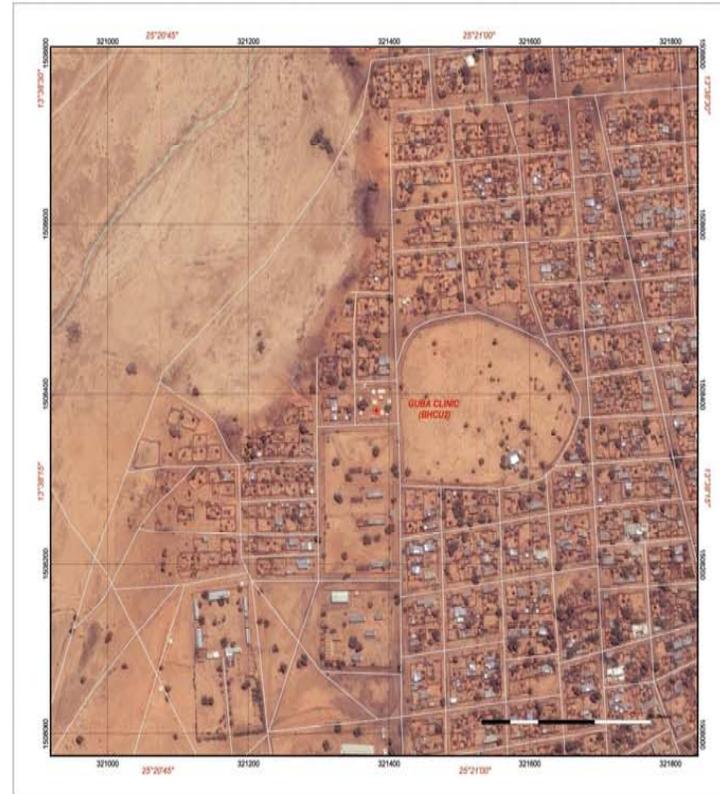
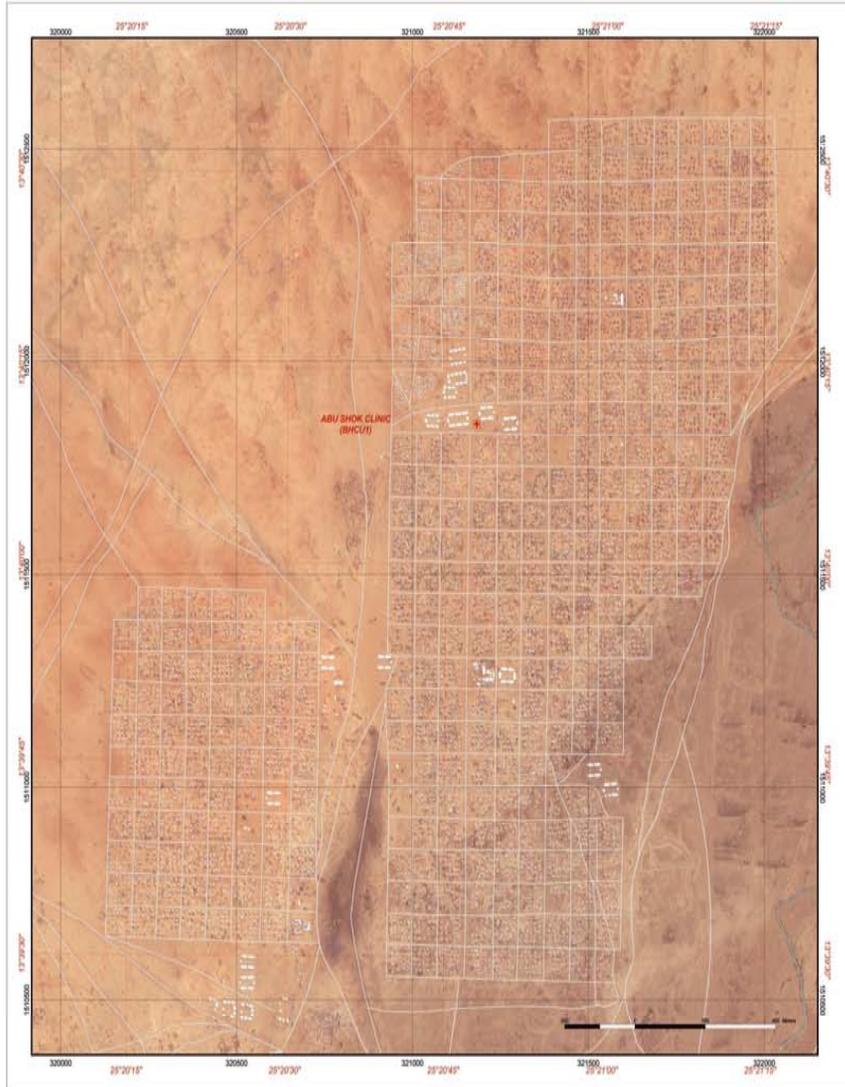


SUDAN/DARFUR - ABU SHOK IDP CAMP

1:4000

SUDAN/DARFUR - GUBA CLINIC

1:2000



Abu Shok  
(Darfur)  
Internal Displaced  
Persons  
camp

<p><b>Localization</b></p>	<p><b>Legend</b></p> <ul style="list-style-type: none"> <li> Built-up area and road network within urban area</li> <li> Desert and sparse settlements with tracks</li> <li> Camp and Clinic</li> <li> Non-perennial inundated area (road and irrigated area)</li> </ul>	<p><b>Interpretation</b></p> <p>Information were digitized on basis of the ICNOSIS (in resolution satellite imagery).</p> <p>The background ICNOSIS image allows different surface properties to be pictured, such as desert of sand and rocks, walls and river beds, road networks and houses settlements.</p> <p>The high resolution image makes it possible to distinguish existing buildings, infrastructures and camps.</p> <p>The road classes were interpreted from the image without claim for to completeness or total correctness.</p> <p>The ICNOSIS image allows an anticipated positional accuracy of CPO 15m.</p> <p><b>Data Source</b></p> <p>Natural color image ICNOSIS from 08/14/2004</p> <p>ICNOSIS © 2004 by Keyhole, Inc.</p>	<p><b>Processing/Analysis</b></p> <p>Image processing by KEYHOLE s.a</p> <ul style="list-style-type: none"> <li>- Band combination</li> <li>- Orthorectification</li> </ul> <p>Map created September, 6th 2004 by KEYHOLE s.a</p> <p>info@keyhole.com www.keyhole.com</p> <p><b>Projection</b></p> <p>Projection: UTM Zone 33 N Spheroid: WGS84 Datum: WGS 84</p> <p></p> <p><b>RESPOND HUMANITARIAN GLOBAL RAFFAELI SERVICES</b></p> <p>For more information visit: <a href="http://www.respond-ha.org">http://www.respond-ha.org</a> Send us an email: <a href="mailto:Sendus@respond-ha.org">Sendus@respond-ha.org</a></p>
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# GMES Space Component(s)

# Space Council Resolution/Role of ESA in GMES: as GSC Coordinator ESA manages



## ➤ **the overall GMES Space Component**

- definition of overall GSC architecture and plan for future evolutions
- managing GSC overall operations (system responsibility)
- Coordinating access to Sentinels & GMES missions from national, EUMETSAT and third party satellite owners

## ➤ **Is the development and procurement Agency for dedicated space infrastructure**

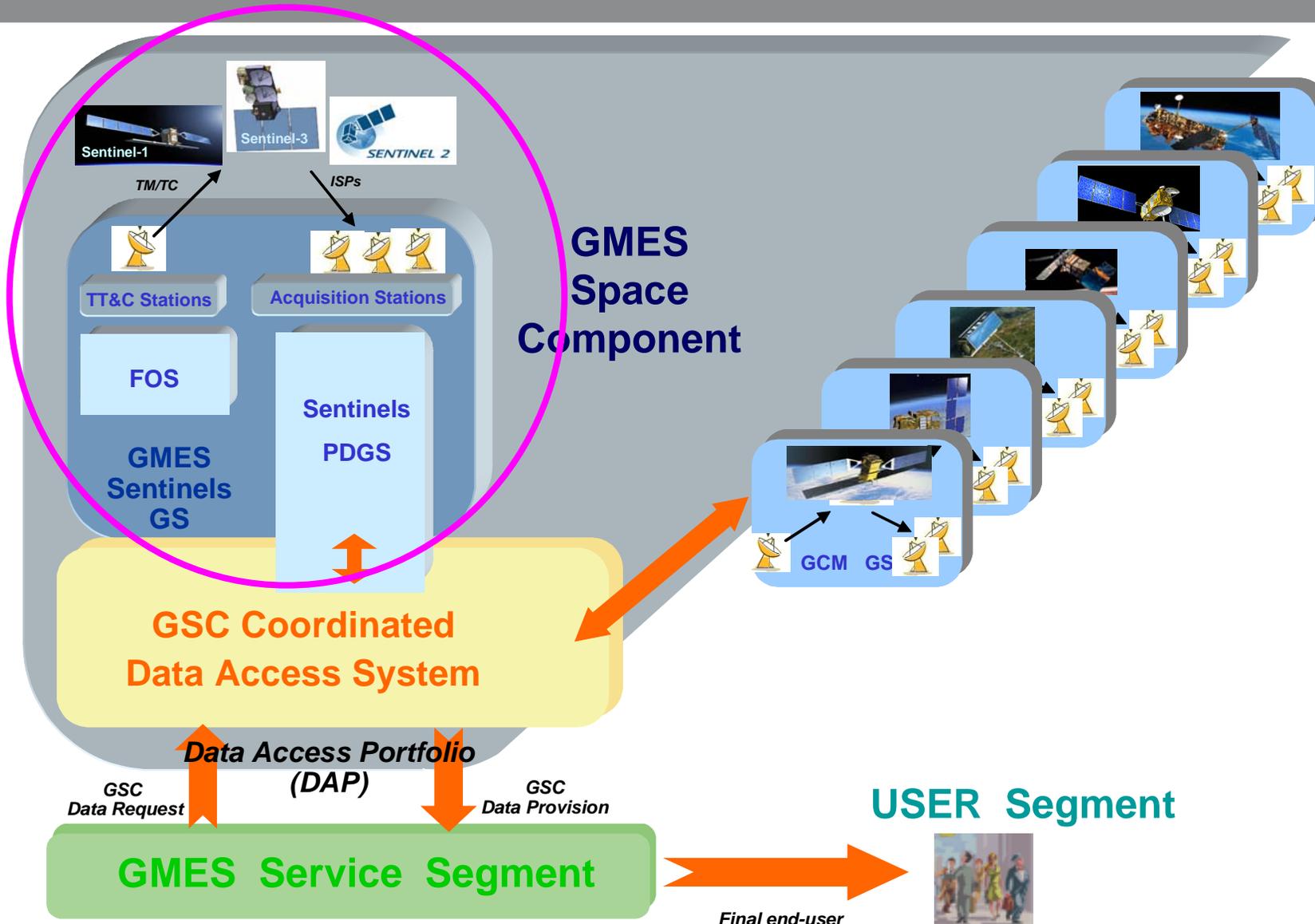
- Development of first spacecraft and Ground Segment
- Procurement of recurrent elements

## ➤ **and in addition, ESA is the interim operator of Sentinel 1, -2 and Sentinel-3**

- EUMETSAT is the proposed operator of Sentinel-3 (Marine), Sentinel -4 and -5



# GMES Space Component(s) & Data Access Coordination...



Landsat Science Team meeting, Mountain View, 19 Jan 2010 information products B. Hoersch

# GMES dedicated missions: Sentinels



## Sentinel 1 – SAR imaging

All weather, day/night applications, interferometry

2012, 2014+



## Sentinel 2 – Multispectral imaging

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

2013, 2014+



## Sentinel 3 – Ocean and global land monitoring

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

2013, 2014+

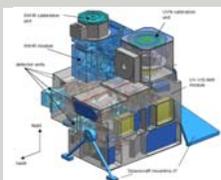


## Sentinel 4 – Geostationary atmospheric

Atmospheric composition monitoring, trans-  
boundary pollution

2018

+



## Sentinel 5 and Precursor – Low-orbit atmospheric

Atmospheric composition monitoring

2014, 2020



# Sentinel-1: C-band SAR mission



## ✓ **Applications:**

- ice and marine/land monitoring
- mapping in support of humanitarian aid in crisis situations

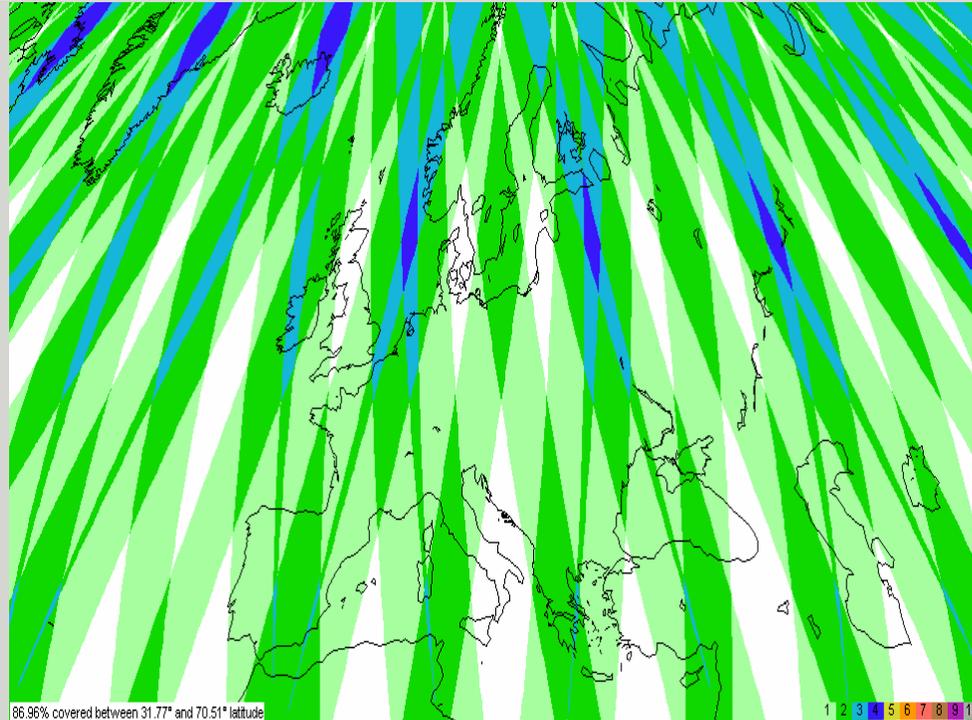


- ✓ **4 nominal mutually exclusive operation modes**
- ✓ **2300 Kg spacecraft mass**
- ✓ **Sun synchronous orbit at 693 km mean altitude**
- ✓ **12 days repeat cycle**
- ✓ **7 years design life time, consumables for 12 years**

# Sentinel-1: C-band SAR mission



- 20 min/orbit (Orbital period: 98.6 minutes)
- Daily coverage of high priority areas, e.g. Europe, Canada, shipping routes.
- Bi-weekly global coverage



1 day coverage (IW mode) Europe

Operation modes:

Modes	Resolution	Swath Width	Polarisation
Stripmap (SM)	5 x 5 m <sup>2</sup>	> 80 km	HH+HV or VV+VH
Interf. Wideswath (IW)	5 x 20 m <sup>2</sup>	> 250 km	HH+HV or VV+VH
Extra Wideswath (EW)	25 x 100 m <sup>2</sup>	> 400 km	HH+HV or VV+VH
Wave (W)	5 x 20 m <sup>2</sup>	20 x 20 km <sup>2</sup> at 100 km spacing	HH or VV

# Sentinel-2: Superspectral imaging mission



## ✓ Applications:

- generic land cover maps
- risk mapping and fast images for disaster relief



## ✓ 13 spectral bands (VIS, NIR, SWIR)

## ✓ Spatial resolution of 10 m and 290 km swath

## ✓ 1200 kg

## ✓ 5 days revisit time with 2 satellites

## ✓ Sun synchronous orbit, 786 km mean altitude

## ✓ 7 years design life time, consumables for 12 years

See below

# Sentinel-3: Ocean & global land mission



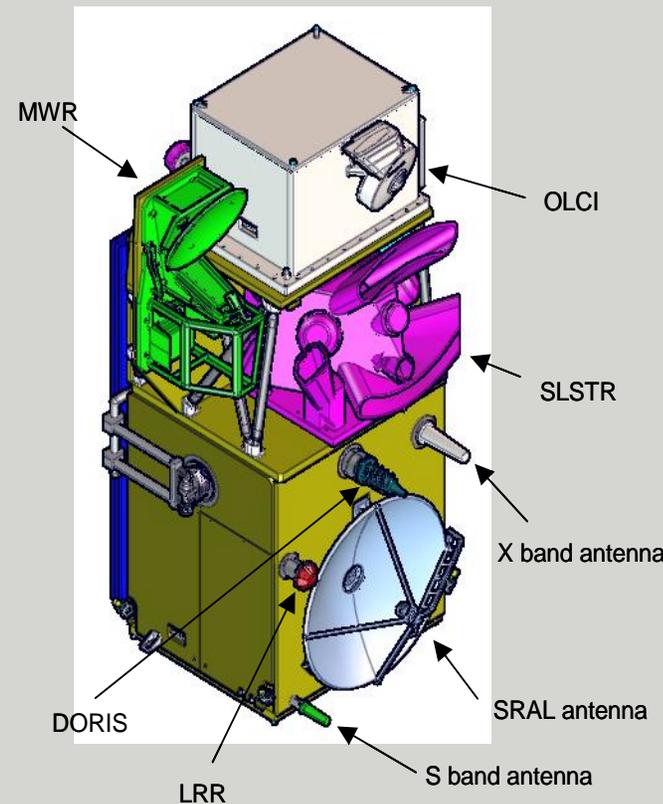
## ✓ **Applications:**

- Sea/land colour data and surface temperature
- sea surface and land ice topography



- ✓ **1250 kg spacecraft mass**
- ✓ **Sun synchronous orbit at 814.5 km mean altitude over geoid**
- ✓ **27 days repeat cycle**
- ✓ **7 years design life time, consumables for 12 years**

- **Ocean and Land Colour Instrument (OLCI):**  
with 5 cameras covering 400 to 1020 nm, binned to 15 (MERIS) & 6 additional bands  
Swath: 1100 km
- **Sea and Land Surface Temperature Radiometer (SLSTR):**  
with 7 AATSR & 2 additional bands, with 500 m (solar) and 1 km (TIR) on ground resolution  
Swath: 1160 km/750 km (single or dual view)
- **RA package:**  
SRAL Ku-C altimeter (LRM and SAR measurement modes), MWR, POD (with Laser Retro Reflector, GPS and DORIS)



# Sentinel-4: GEO atmospheric mission



## ✓ **Applications:**

- air quality, climate forcing and stratospheric ozone and solar radiation

## ✓ **Instrumentation:**

- UV-VIS-NIR-SWIR spectrometer and thermal IR sounder
- cloud imager



- ✓ **Spatial sampling 8 x 8 km<sup>2</sup> and spectral resolution between 0.12 nm (near-IR) and 0.5 nm (UV, visible)**
- ✓ **Geostationary orbit, at 0° longitude**
- ✓ **Embarked on MTG-Sounder Satellite and operated by EUMETSAT**

# Sentinel-5: LEO atmospheric mission

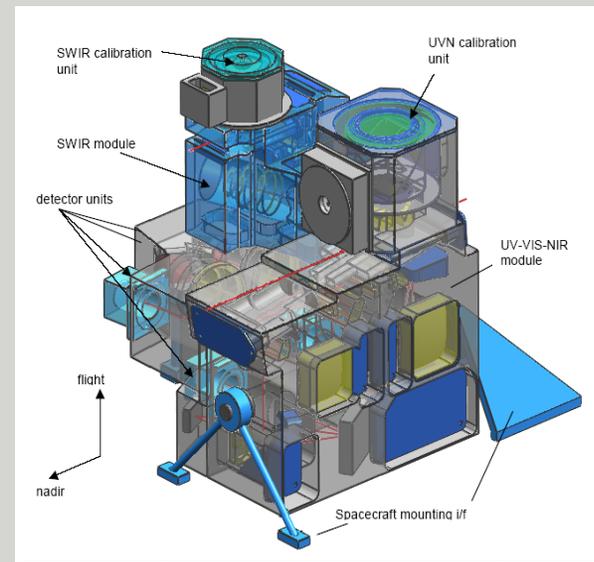


## ✓ **Applications:**

- air quality, climate forcing and stratospheric ozone and solar radiation

## ✓ **Instrumentation:**

- UV-VIS-NIR-SWIR spectrometer and thermal IR sounder
- cloud imager



- ✓ **Sun-synchronous Low Earth Orbit platform at 824 km mean altitude**

- ✓ **Spectral resolution between 0.25 nm and 1.1 nm**

- ✓ **Sentinel-5 embarked on post-EPS and operated by EUMETSAT**

# Sentinel-5 precursor: LEO atmospheric mission

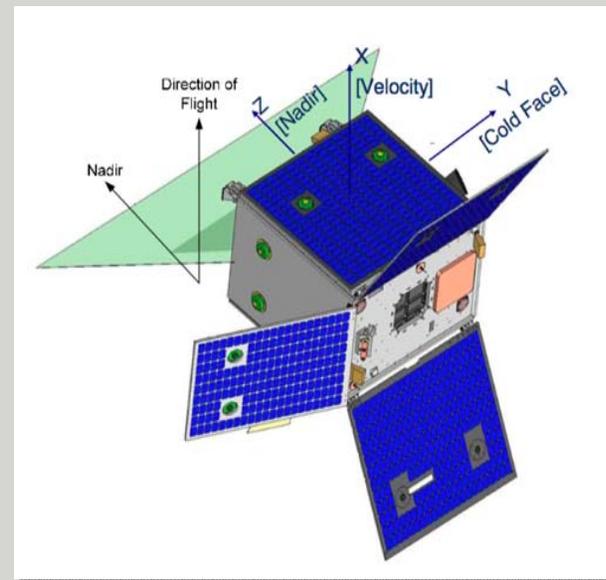


## ✓ **Applications:**

- air quality, climate forcing and stratospheric ozone and solar radiation

## ✓ **Instrumentation:**

- UV-VIS-NIR and SWIR spectrometers
- no thermal IR sounder
- no cloud imager



- ✓ **Sun-synchronous Low Earth Orbit platform at 824 km mean altitude**

- ✓ **Spectral resolution between 0.25 nm and 1.1 nm**

- ✓ **To fill data gaps (2015-2020)**

# Sentinel-4/-5: System trade-off for climate protocol monitoring and air quality

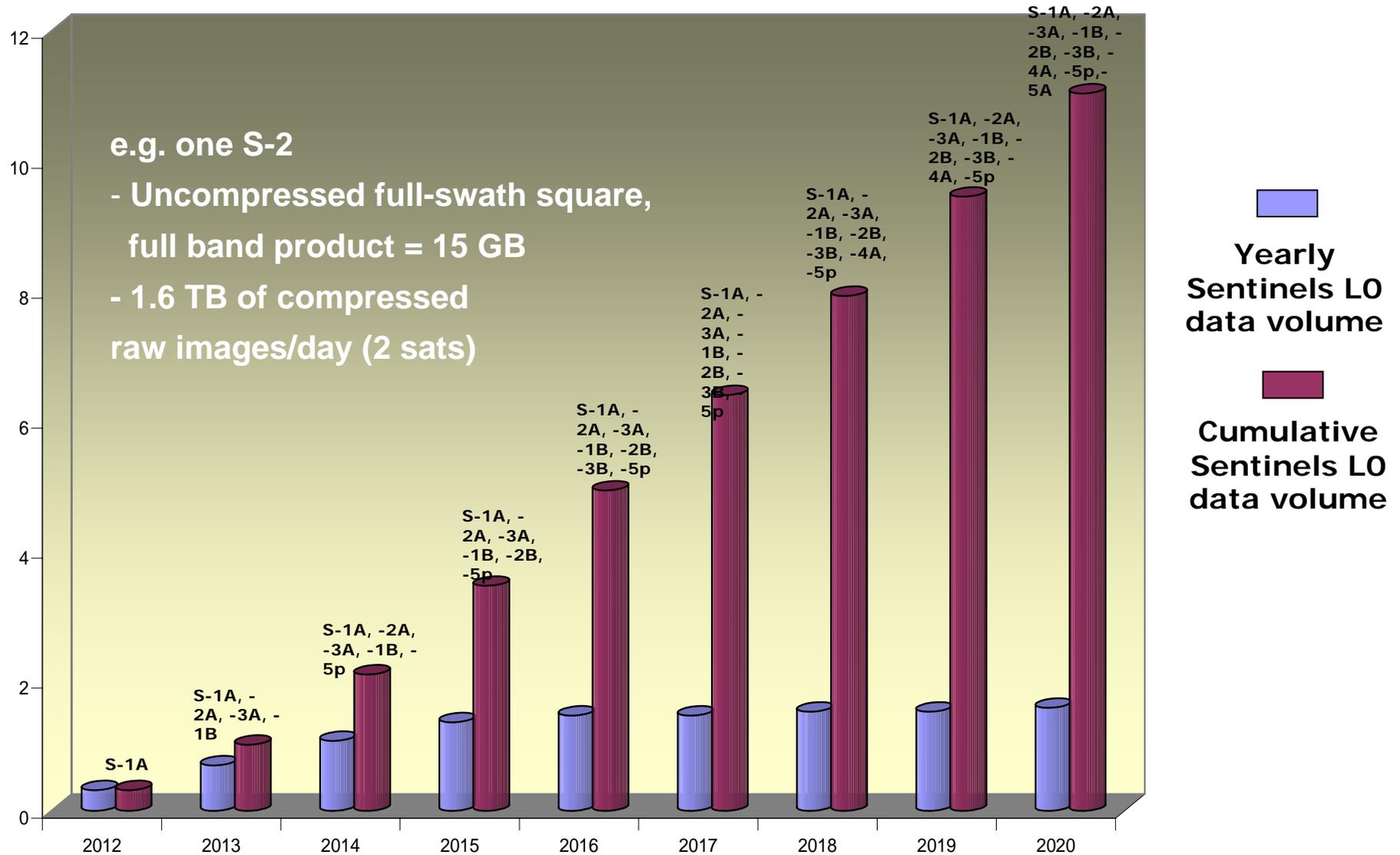


- ✓ Air quality and climate protocol monitoring missions can be combined due to large overlap of requirements.
- ✓ System concept driven by air quality geographical coverage and time resolution requirements. Trade-off between geographical coverage and temporal sampling:

Option	Latitude range [deg]	Longitude range [deg]	Revisit time	Implementation option
1	a 30 - 65 N	30 W - 45 E @ 40 N	0.5 - 1 h solar ch. 0.5 - 2 h thermal ch.	1 GEO
	b All	All	24 h @ fixed L.T.	1 SSO
2	30 - 60 N & 30 - 60 S	All	2 h	Constellation of drifting LEO / MEO
	30 N - 30 S	All	6 h	
3	All	All	4 h	Constellation of SSO

- **Option 1 selected:** lowest cost, synergy with meteorological payload through implementation on EUMETSAT platforms and highest diurnal sampling frequency over Europe

# L0 Sentinels data volume for archiving (in PB/year)

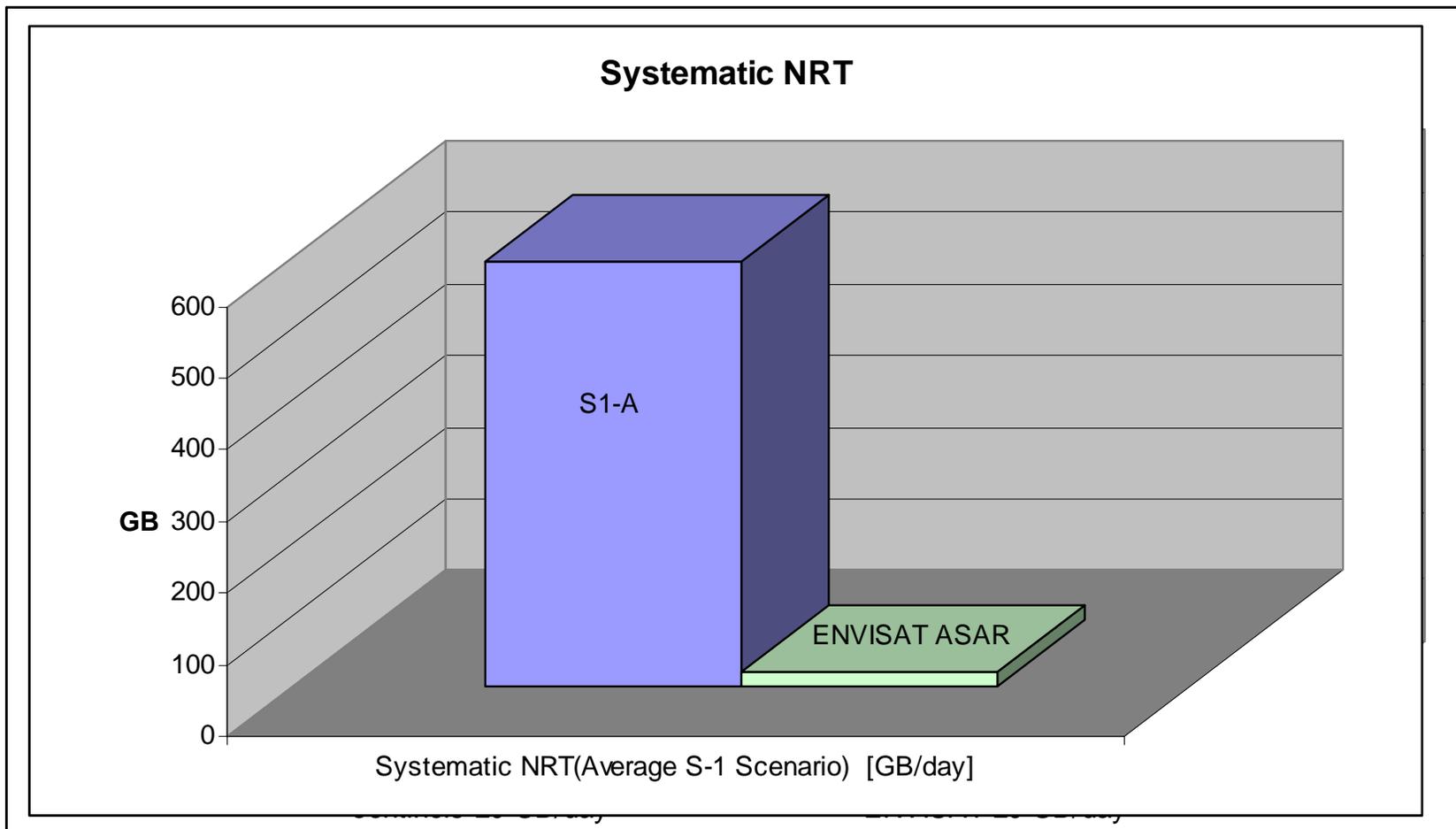


Landsat Science Team meeting, Mountain View, 19 Jan 2010

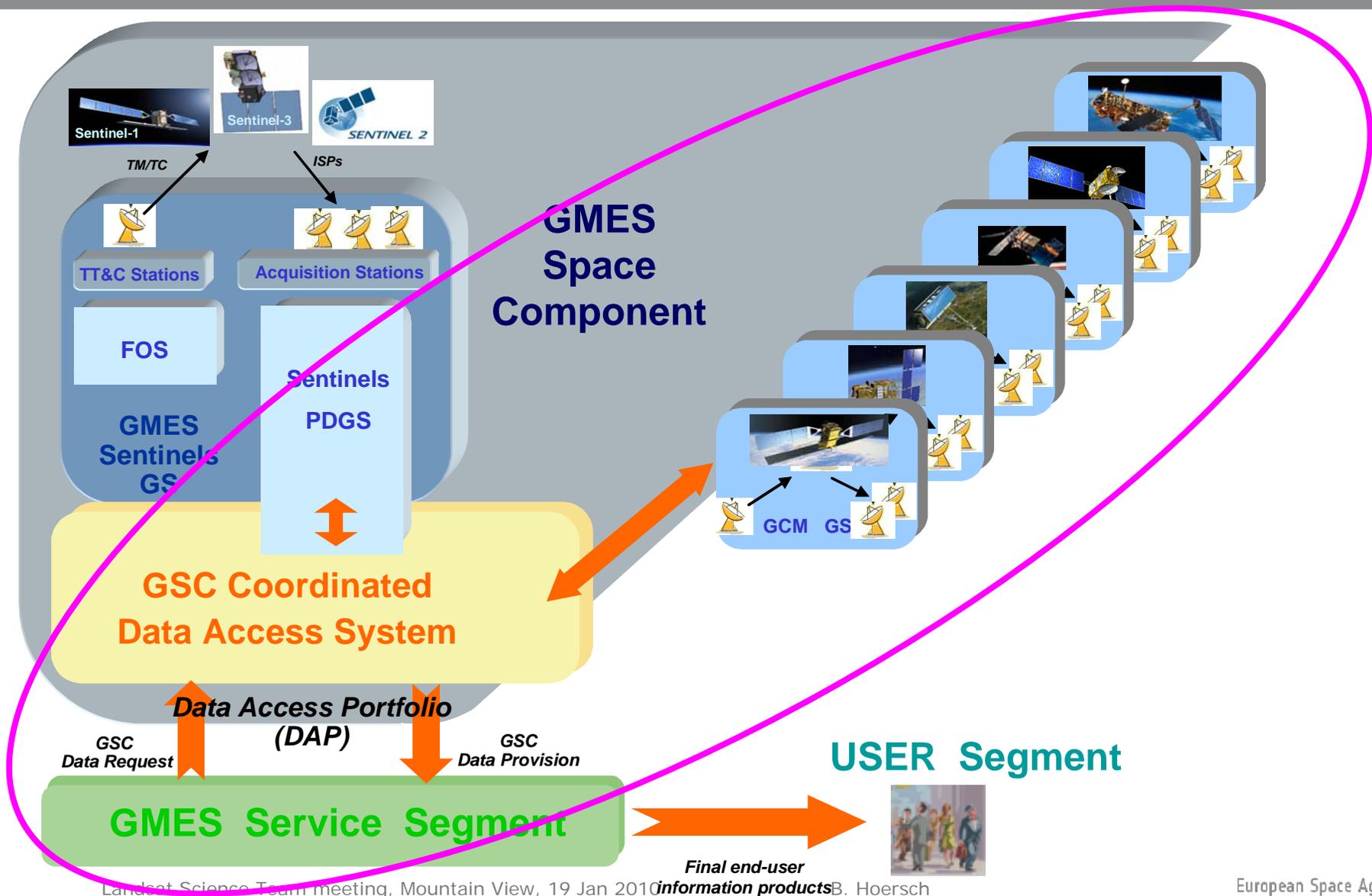
B. Hoersch

European Space Agency

# Sentinel data volume compared to Envisat



# GMES Contributing Missions...

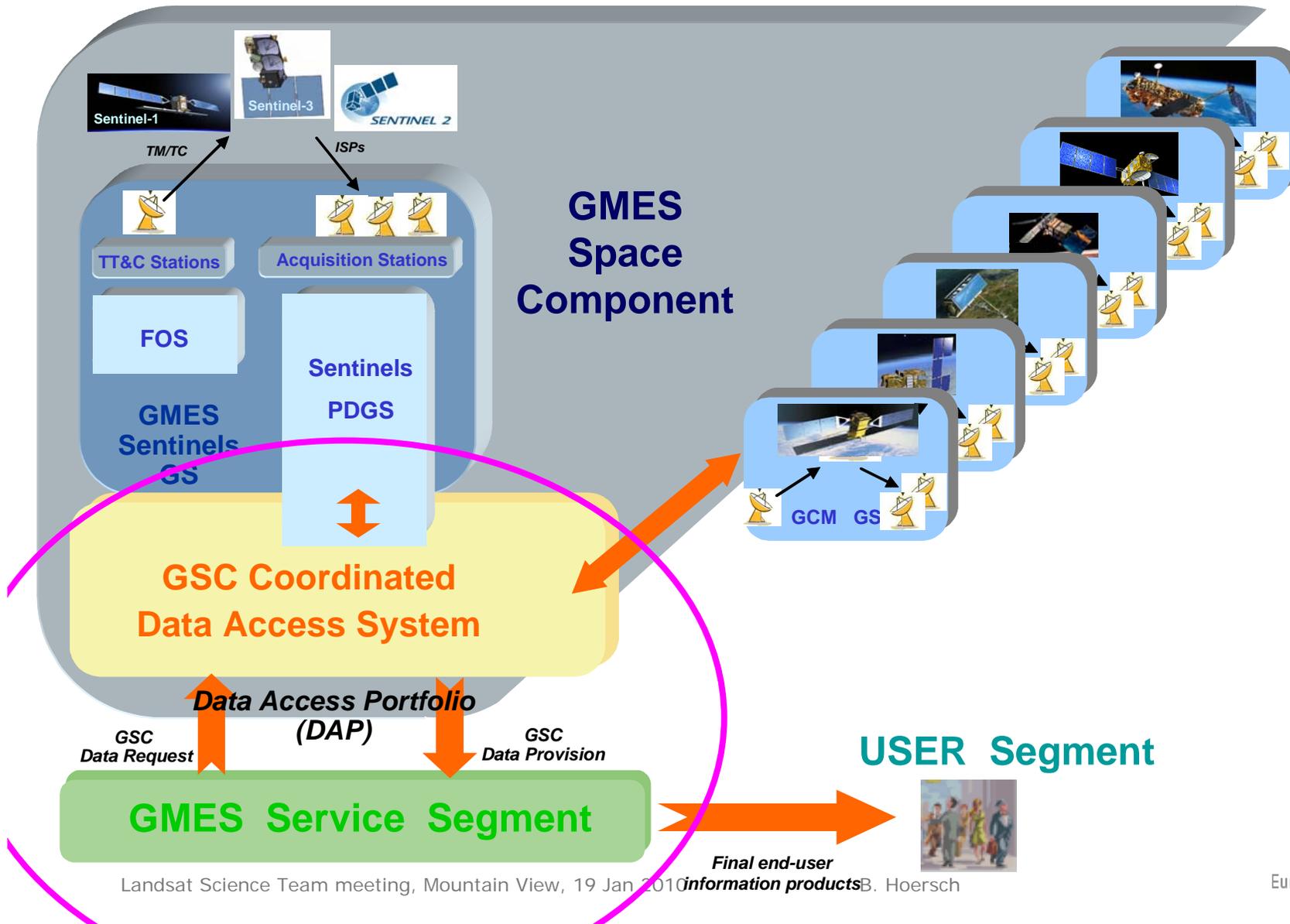


Landcat Science Team meeting, Mountain View, 19 Jan 2010

## ▶ ▶ ▶ SYNERGY EFFECTS

- **Sharing infrastructures and resources & Budget optimisation**
- **Access to space infrastructure worth 3Bio Euro at a **cost** of at least **2 orders of magnitude** lower...**
- **Many contributions today for free** e.g. ESA (equivalent ~35 Mio Euro licence fees), Eumetsat, CNES

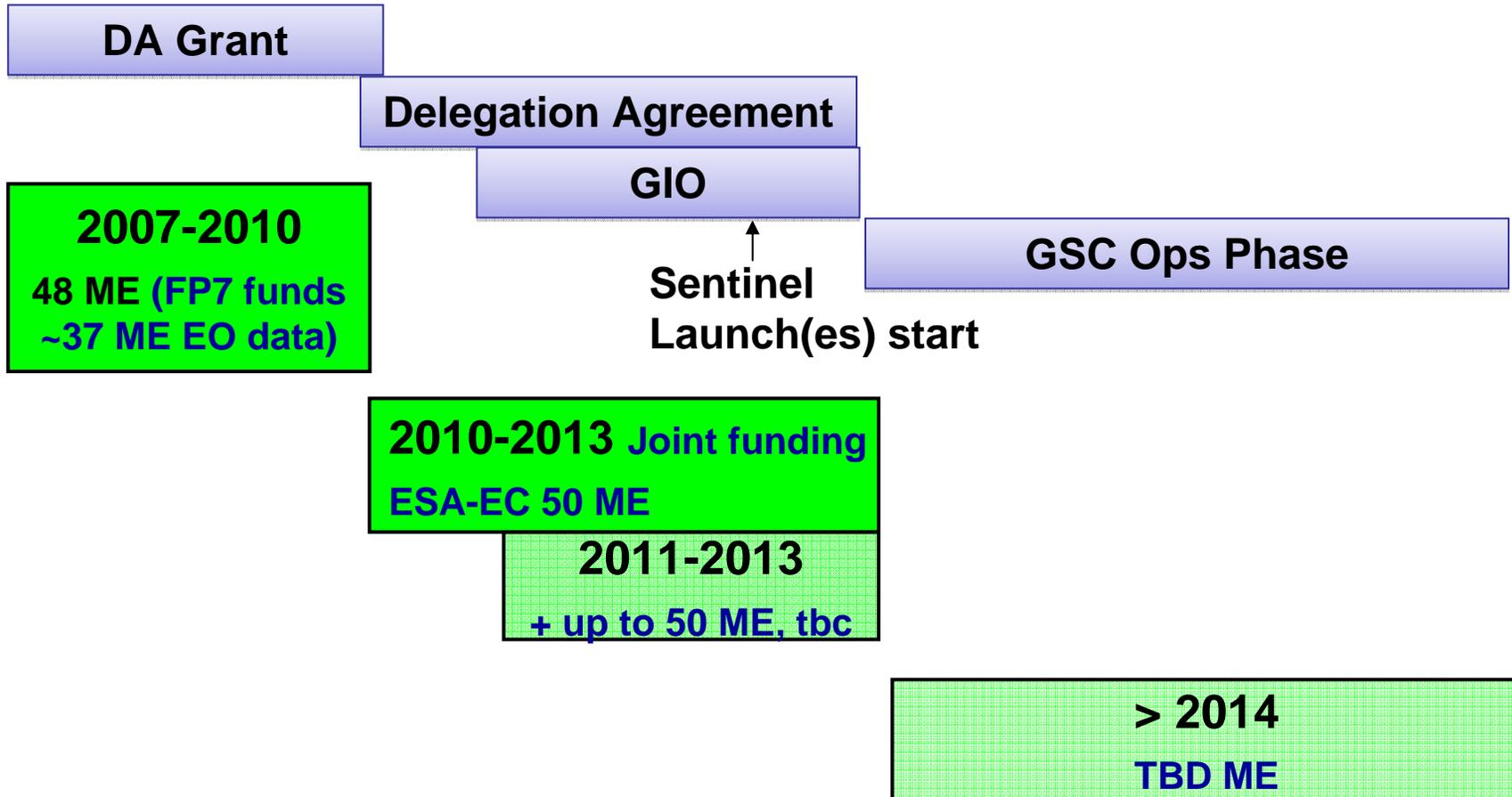
# GMES Space Component(s) & Data Access Coordination...



Landsat Science Team meeting, Mountain View, 19 Jan 2010

Final end-user information products B. Hoersch

# Phases & funding in DA



# GSCDA Web portal: the entry point



<http://gmesdata.esa.int>

esa GMES Space Component Data Access  
European Space Agency

ESA Observing the Earth GMES GMES Space Component Data

**GSC Data Access**

- About GSC Data Access
- Browse Data
- GSCDA Terms and Conditions
- Terms and Conditions
- FAQ

**GMES Core**

- About GSC Data Access
- Browse Data
- GSCDA Terms and Conditions
- Terms and Conditions
- FAQ

**GSC Mission**

- Terms and Conditions
- FAQ

**GSC Data Portal**

- Terms of Use
- Contact Us

**Semantic Search**

**Fast Domain Navigator**

### Browse GMES Contributing Missions

#### Search Results

22 Results

» **Datasets : EUROPEAN URBAN ATLAS 2009 OPTICAL (DAP\_MG3\_02)**

Mapping for city planning at local scale  
Temporal extent of dataset: 2009 and 2010  
This dataset will be built using instruments from Mission Group 2b: Very ...

» **Datasets : AFS FOR VALIDATION AND VERIFICATION FOR I (DAP\_MG2B\_03)**

Area Frame Sampling (AFS) for validation and verification of forest cover. AFS yearly tracking (Forest). 9 European mini sites inside (5 x 5 km): archive + 2009

» **Datasets : BIOPHYSICAL PRODUCTS VALIDATION AREAS (DAP\_MG2\_02)**

Selected sites for the validation of biophysical parameter  
This dataset will be built using instruments from Mission Group 2: High-Resolution Multispectral Imaging

» **Datasets : AGRO-ENVIRONMENTAL ANALYSIS SITES (DAP\_MG2\_03)**

GSC - Resource Details - Microsoft Internet Explorer

Address: [http://gmesdata.esa.int/web/gsc/resource\\_details?p\\_p\\_id=rdtPortlet\\_WAR\\_gscportlet&p\\_p\\_lifecycle=0&p\\_p\\_state=normal&p\\_p\\_mode=view](http://gmesdata.esa.int/web/gsc/resource_details?p_p_id=rdtPortlet_WAR_gscportlet&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view)

### Systematic Global LR Land Coverage

**Summary** | [Full Description](#)

**GSCDA Terms and Conditions**

» **DAP\_MG3\_02**

Terms and Conditions > Weather and climate variability: low resolution multi-model carbon accounting system accounting for weather and climate variability, coupled with EO data assimilation schemes to support Kyoto reporting activities and post-Kyoto negotiations. Con. Monitoring for

FAQ >

**Area of interest:**  
Global (Land)

**Current Status (initial operations):**  
The following ERS and ENVISAT data products are available for the Dataset:  
-Envisat AATSR level1 Near Real Time production (ATS\_TOA\_1P)  
-ERS-2 Wind Scatterometer Near Real Time products (UWI Fast Delivery products)  
-ERS-2 Wind Scatterometer full mission reprocessing (ASPS UWI, ASPS level 1.5 and level 2 products)

The following VEGETATION data products are available for the Dataset:  
- VGT-P products (physical values) available 2 days after the image acquisition  
- VGT-S1 products (daily synthesis) available 2 days after the image acquisition  
- VGT-S10 products (ten-day synthesis) available 2 days after the end of a 10-day period

**Comments:**  
ERS-2 Wind Scatterometer data are only acquired over ESA low-bit-rate ground stations visibility since 22 June 2003; reprocessing of the whole mission is on-going with the Advanced Scatterometer Processing System (ASPS); data are progressively made available on-line.

VEGETATION-1 Data (VGT-1 products) have geo-location accuracy of 500m.

Available Instrument/Product Quality Specifications and Quality Background Documentation can be found in the documentation section hereafter. In the future this will be a link to the CQC database.

**ONLINE ACCESS URL ENVISAT AATSR level 1 (ATS\_TOA\_1P) NRT delivery:**  
[ftp://oa-es.eo.esa.int/DAP\\_MG3\\_02](ftp://oa-es.eo.esa.int/DAP_MG3_02)  
[ftp://oa-ks.eo.esa.int/DAP\\_MG3\\_02](ftp://oa-ks.eo.esa.int/DAP_MG3_02)

**ONLINE ACCESS URL ERS Wind Scatterometer NRT delivery:**  
[ftp://oa-es.eo.esa.int/DAP\\_MG3\\_02/ERS/WSC\\_UWI\\_1P](ftp://oa-es.eo.esa.int/DAP_MG3_02/ERS/WSC_UWI_1P)

offering e.g. Large Coverages

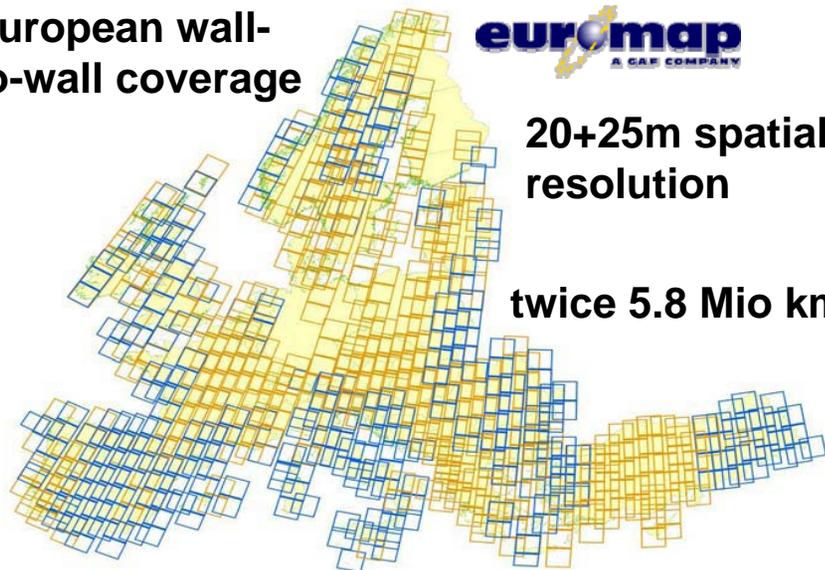


European wall-to-wall coverage



20+25m spatial resolution

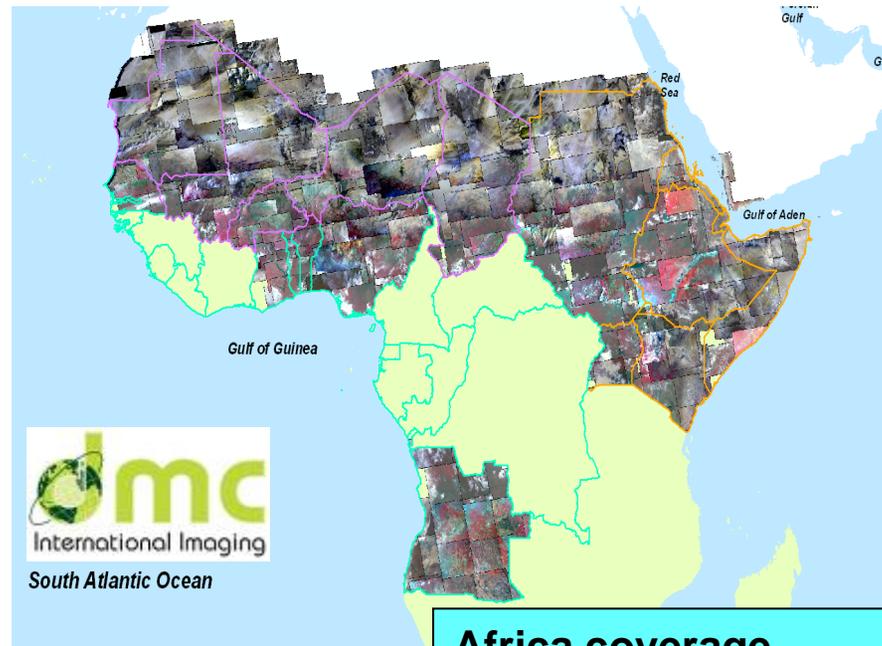
twice 5.8 Mio km<sup>2</sup>



Coverage 1

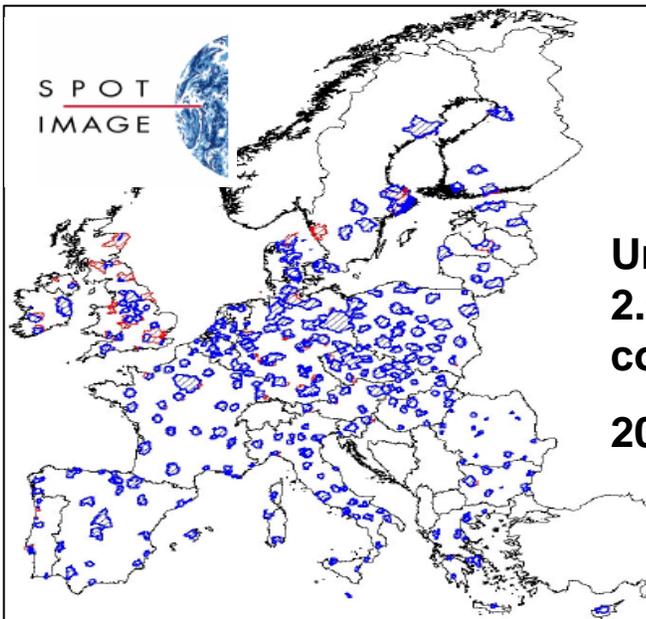


Coverage 2

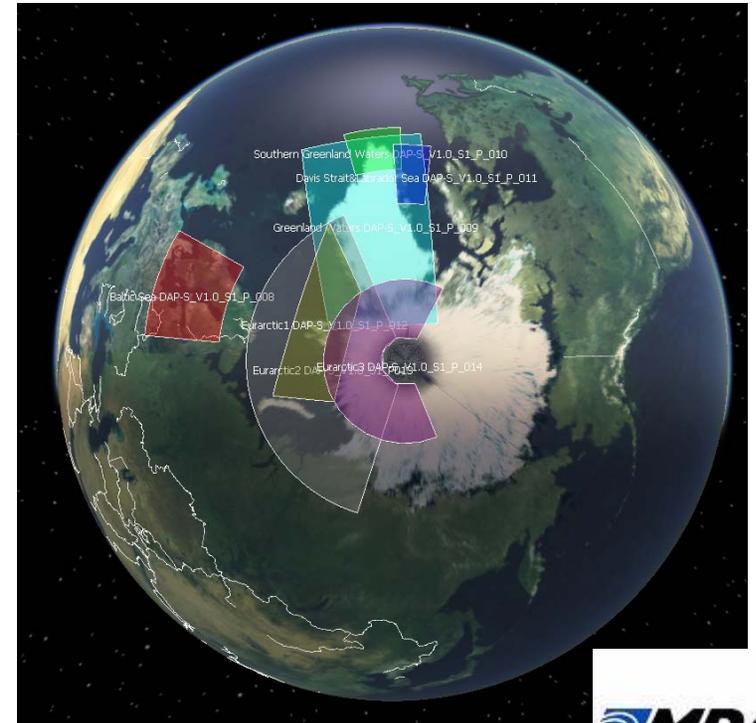


Africa coverage  
(22/32m) 2009/2010  
Once 24 Mio km<sup>2</sup>

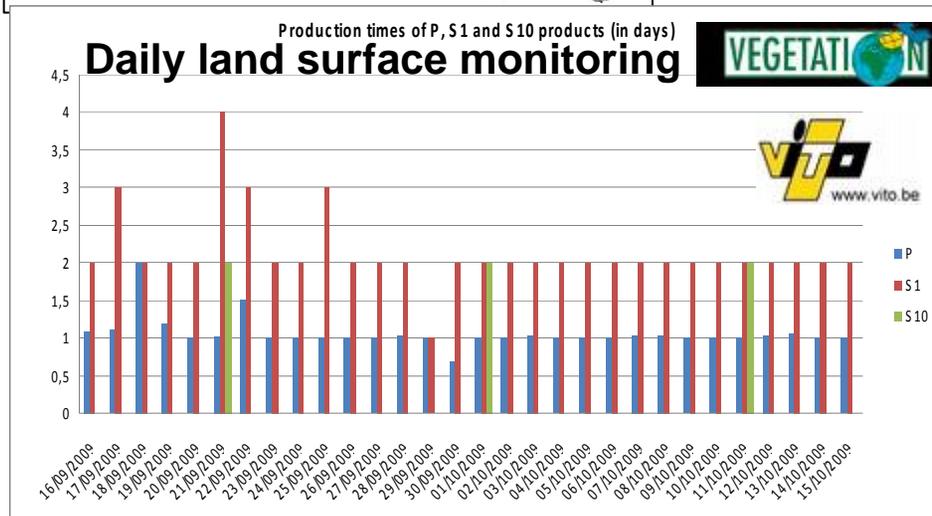
# or repeat coverages & Systematic daily monitoring



**Urban Atlas  
2.5m/10m repeat  
coverage  
2006 & 2009/10**



**Daily Arctic Sea Ice Regions,  
C-band SAR, NRT...**

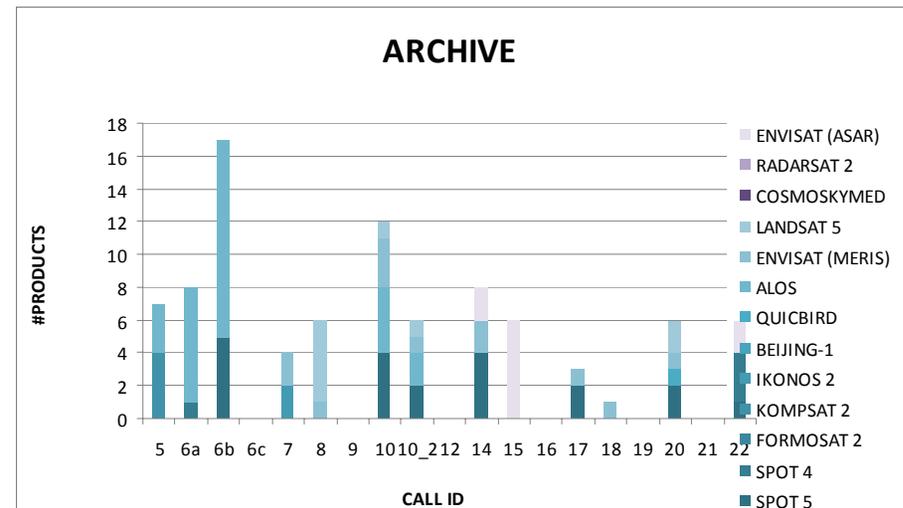
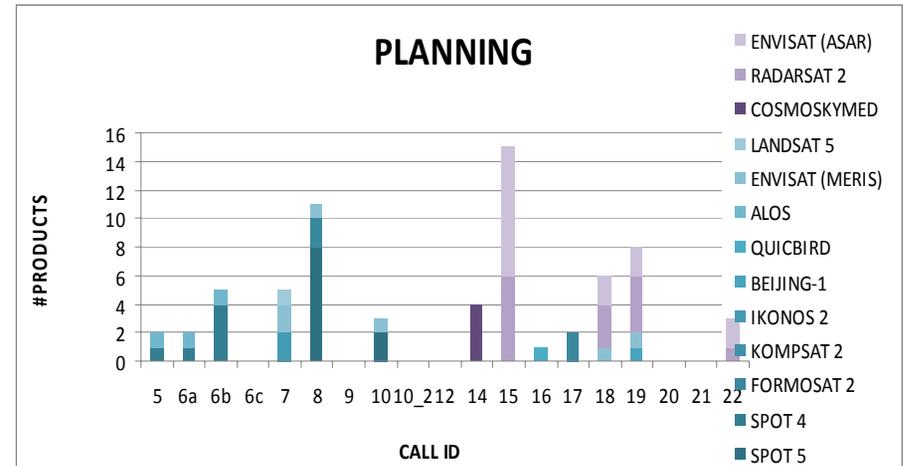


# or Emergency service

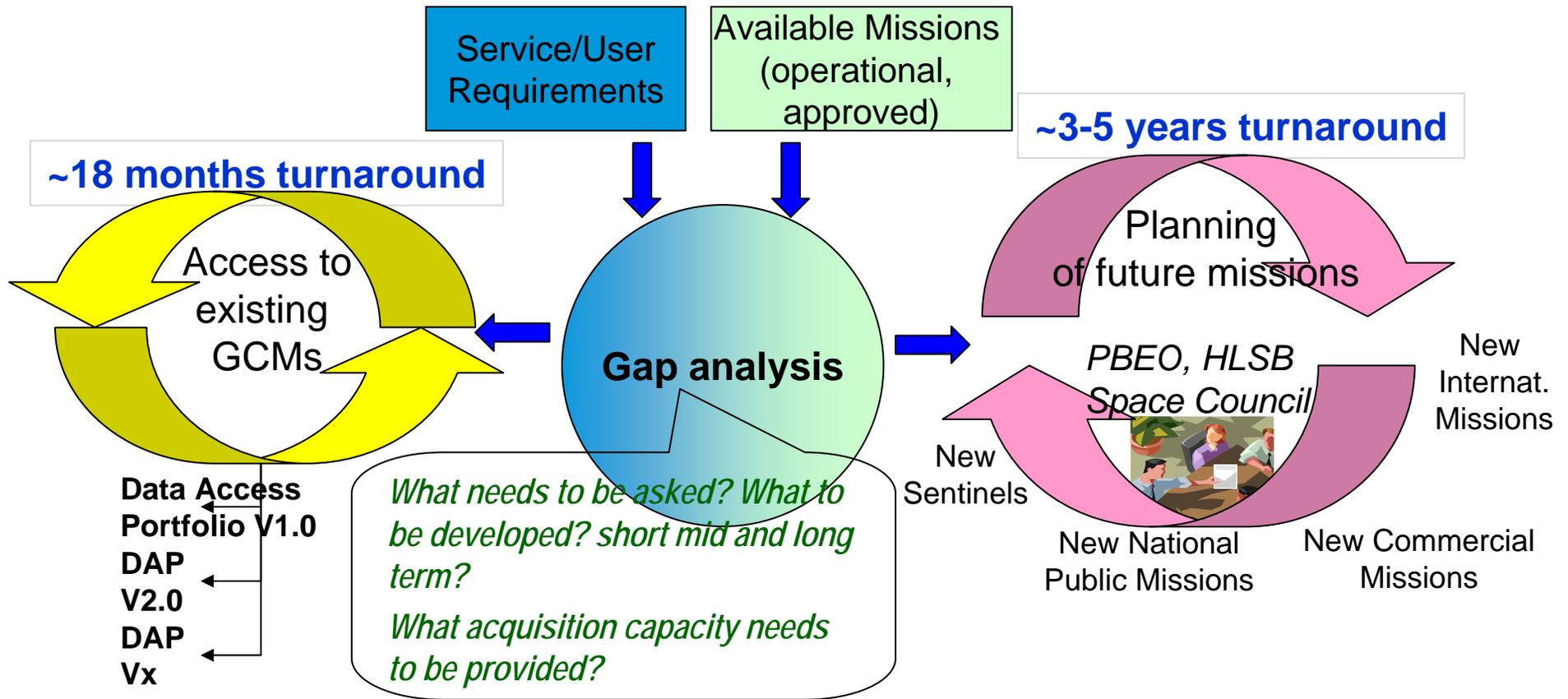


Open 12 hours/7 days, to be **extended to 24/7** soon

- **19** SAFER calls handled
- **158** scenes delivered
  - 68 new planning
  - 90 archived products
- Acquisition **speed increasing**, with some GMES Contributing Missions < 2 days from notification to delivery!



# Long-Term Plan for Sentinel and GMES Contributing Missions during Operations Phase: Requirements



Integration, Validation, Contracts, Agreements  
= coherent Ops Management of GSC  
towards GMES Service Component



# Focus: Sentinel-2

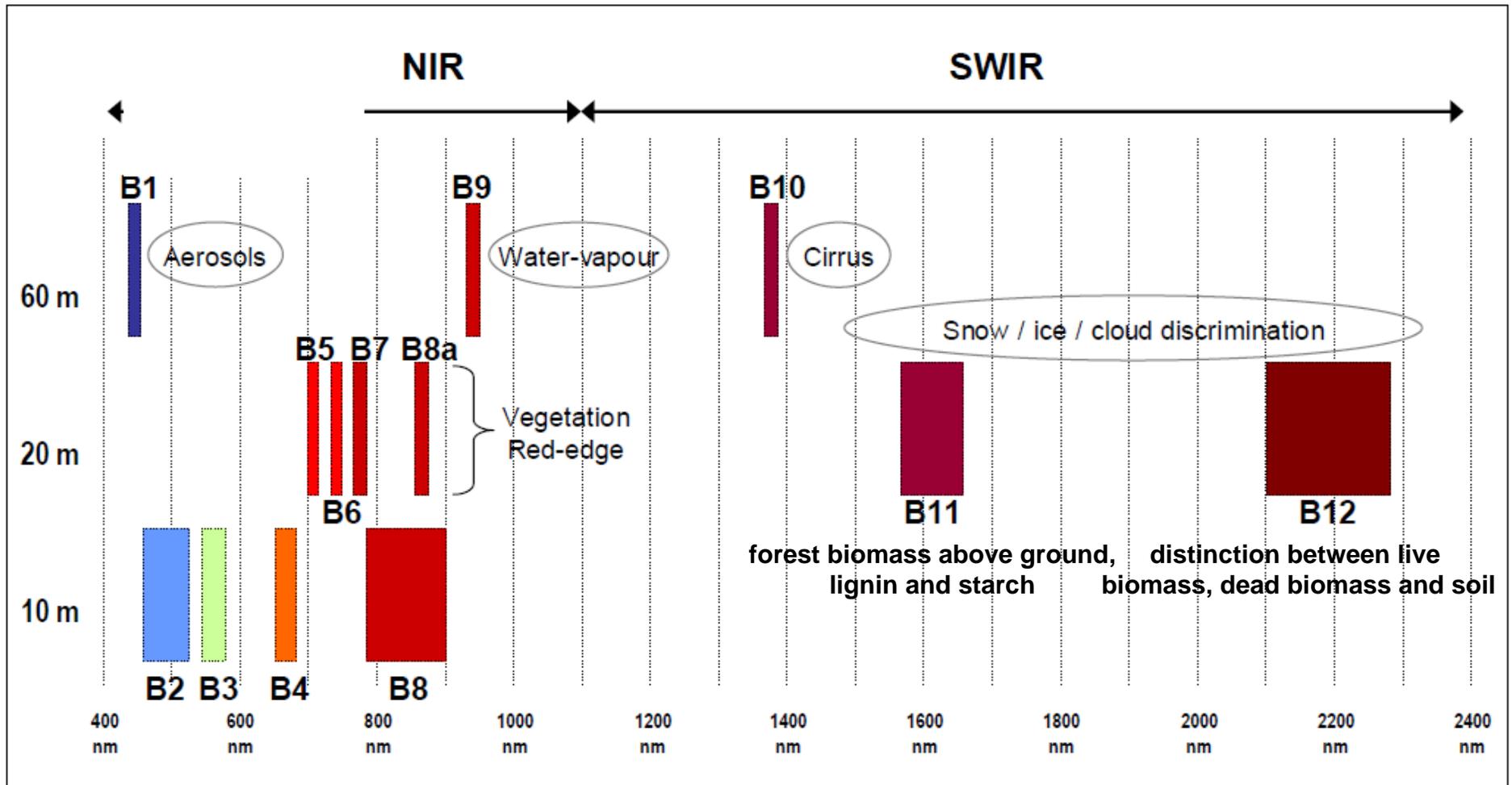
- Overall Mission Lifetime 15 years (2 satellites)
- Nominal In-Orbit Lifetime 7.25 years
  - Consumables for additional 5 years
- Nominal Orbit Sun Synchronous 786km mean altitude  
10:30 LTDN
- Global revisit time 5 days (2 satellites)
- Maximum Imaging/ Orbit 40 minutes
- High Quality Mission Products Level 0, 1a, 1b, 1c, 2a

# Satellite Payload: Multi Spectral Instrument (MSI)



- Pushbroom Multi Spectral Imager
- SiC Telescope
- Separate VNIR & SWIR Focal Plane Assembly (FPA)
- SWIR passively cooled                      13 Spectral Bands VNIR & SWIR  
(443nm – 2190nm)
- Spectral Resolution                              15nm – 180nm
- Spatial Resolution                                10m, 20m and 60m
- Swath    290 km
- Radiometric Resolution                        12bit
- Radiometric Accuracy                         < 5%

# MSI Spectral Bands



# System



## – Ground Station Scenario

Core Stations:

Kiruna, Svalbard, Maspalomas,  
Prince Albert

## – Reliability/availability

> 0.7 / 97%

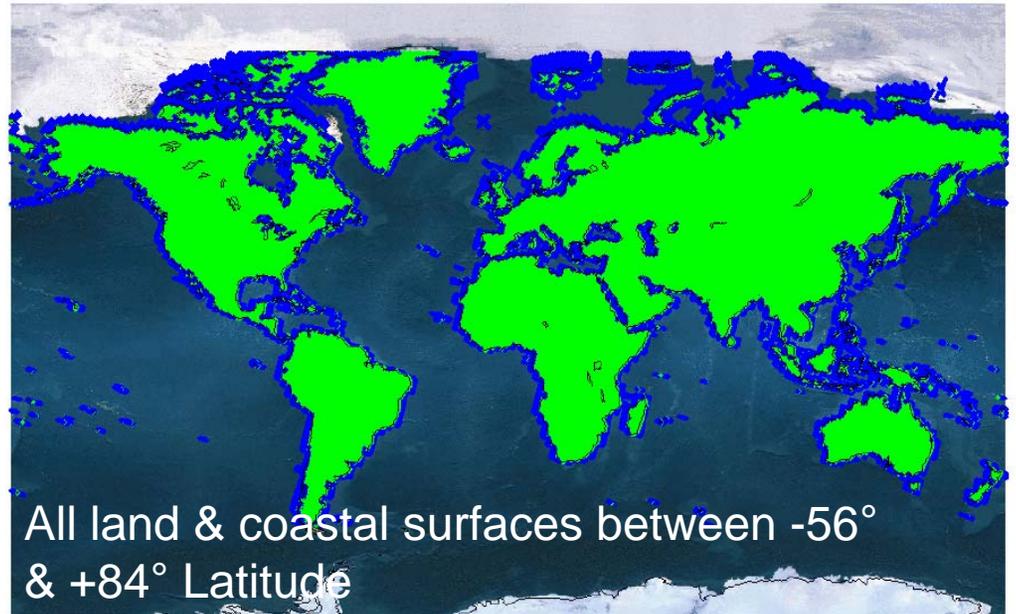
## – Geogr. Land Coverage

-56° to +83° latitude

Tbc by  
ITT 2010

## Launcher

- Nominal Vega (1400kg)
- Back-Up Rockot (1160kg)

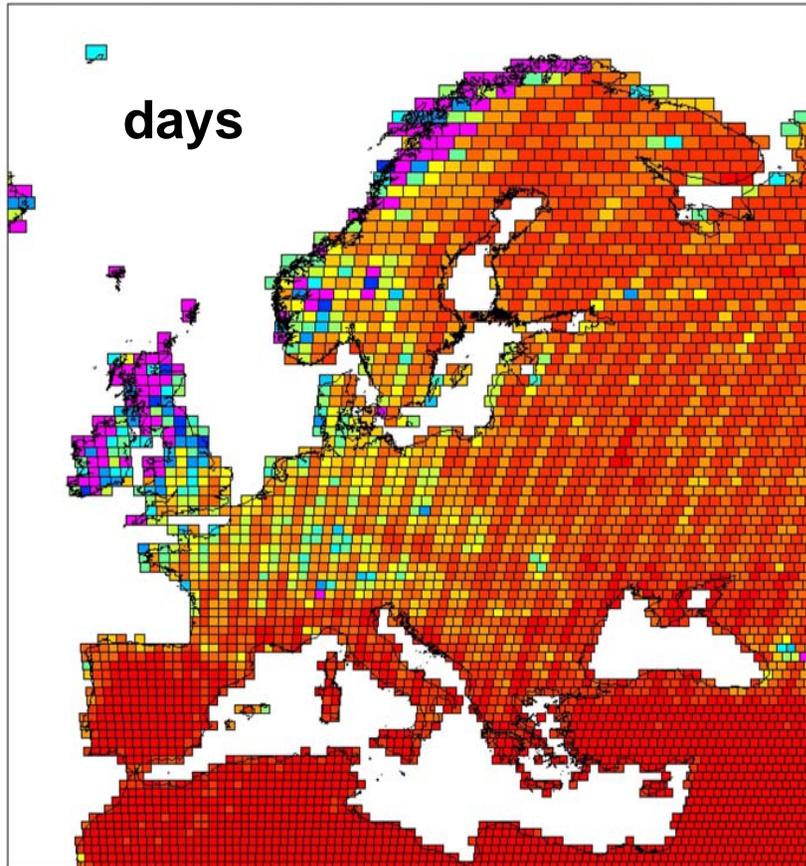


# Effective Coverage Time

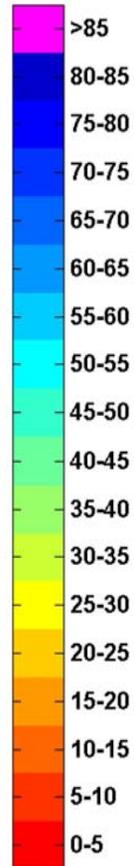


## Coverage time over Europe in summer with 2 satellites

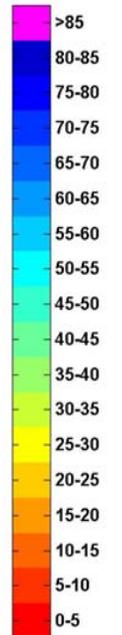
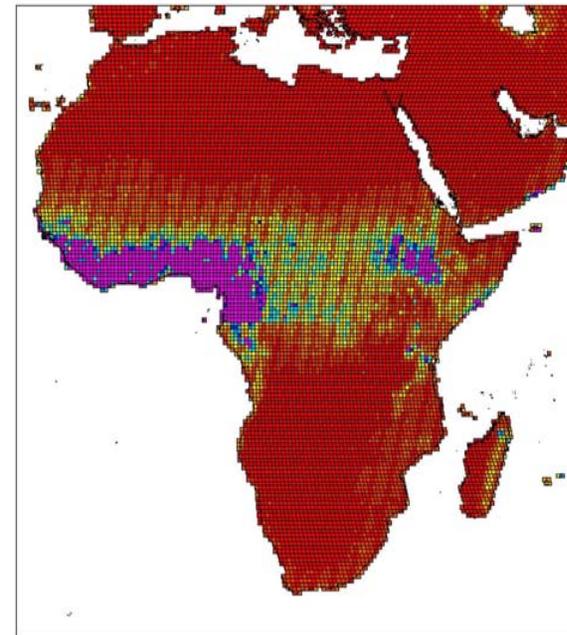
Maximum effective coverage time for SC1 & SC2 (days) (<15% cloud cover; 68% confidence)



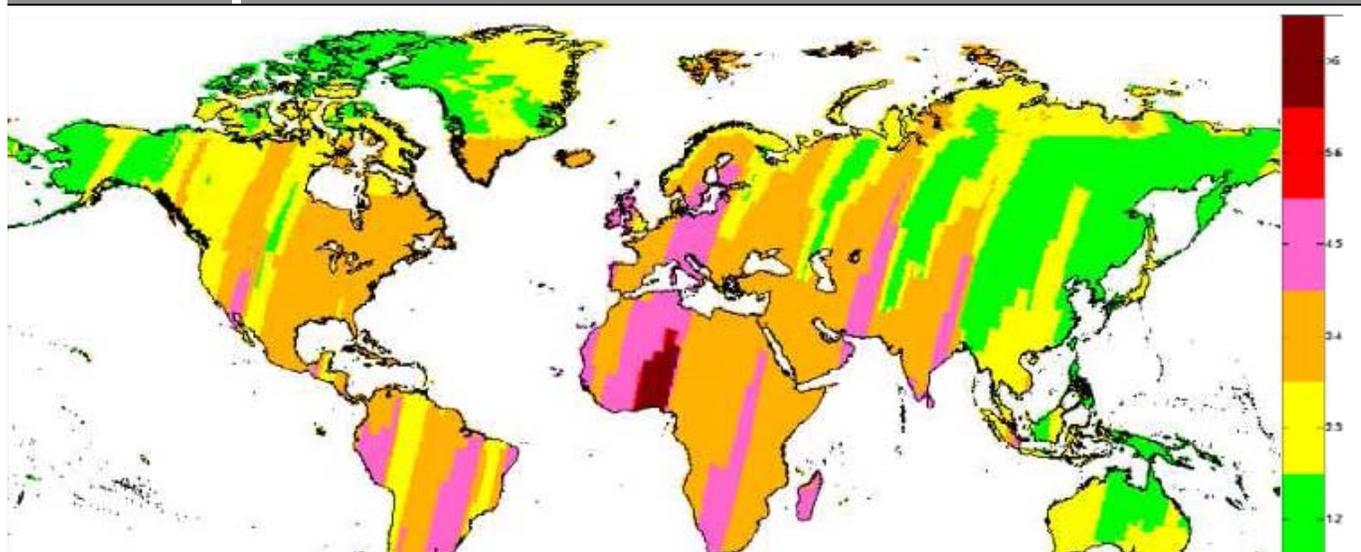
ds)



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

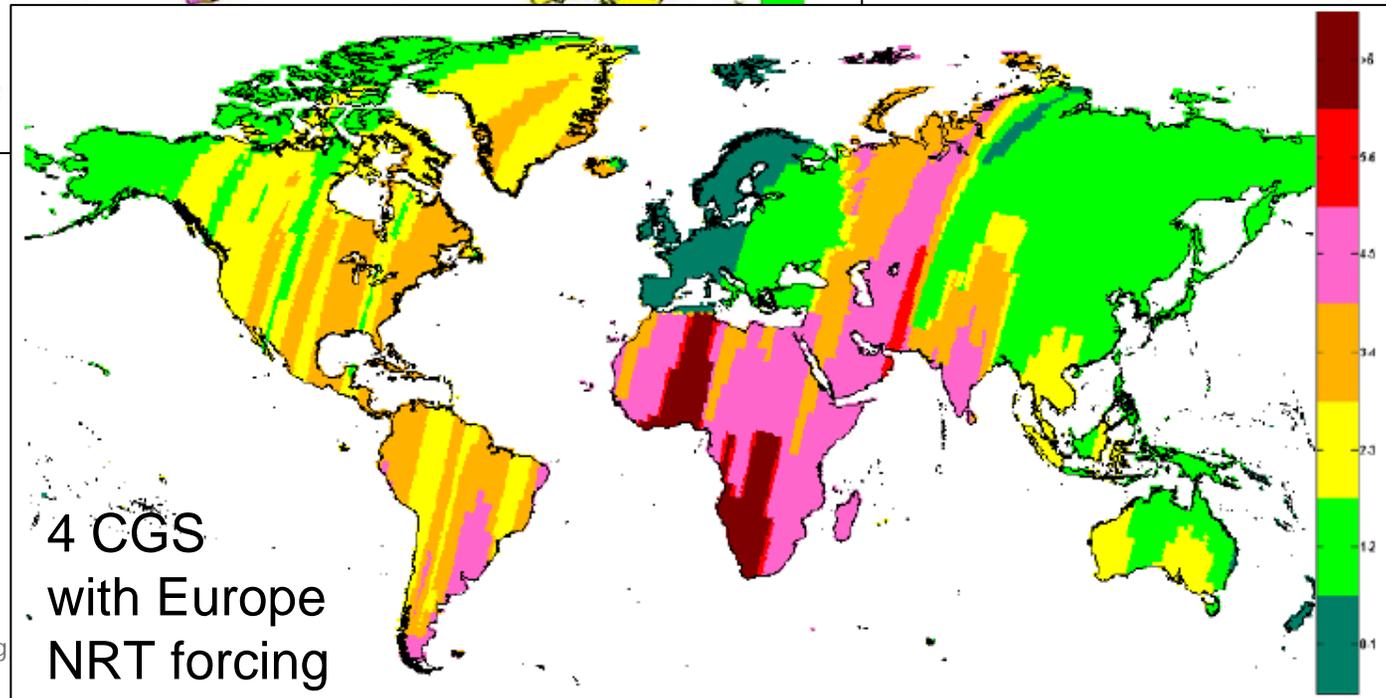


# Potential Data latency: from acquisition to downlink



Average 6.3 h

4 CGS  
no NRT forcing



Average 7.6 h

4 CGS  
with Europe  
NRT forcing

# Image Quality Performance



## Geometric Performances

A priori accuracy of image location: 2km max (3 $\sigma$ )	without processing
Accuracy of image location: 20m (3 $\sigma$ )	After image processing without control points
Accuracy of image location: 12.5m (3 $\sigma$ )	After image processing with control points
Multi-temporal registration: 3m (2 $\sigma$ ) for 10m bands 6m (2 $\sigma$ ) for 20m bands 18m (2 $\sigma$ ) for 60m bands	After image processing with control points
Multi-spectral registration for any couple of spectral bands: 3m (3 $\sigma$ ) for 10m bands 6m (3 $\sigma$ ) for 20m bands 18m (3 $\sigma$ ) for 60m bands	After image processing with control points

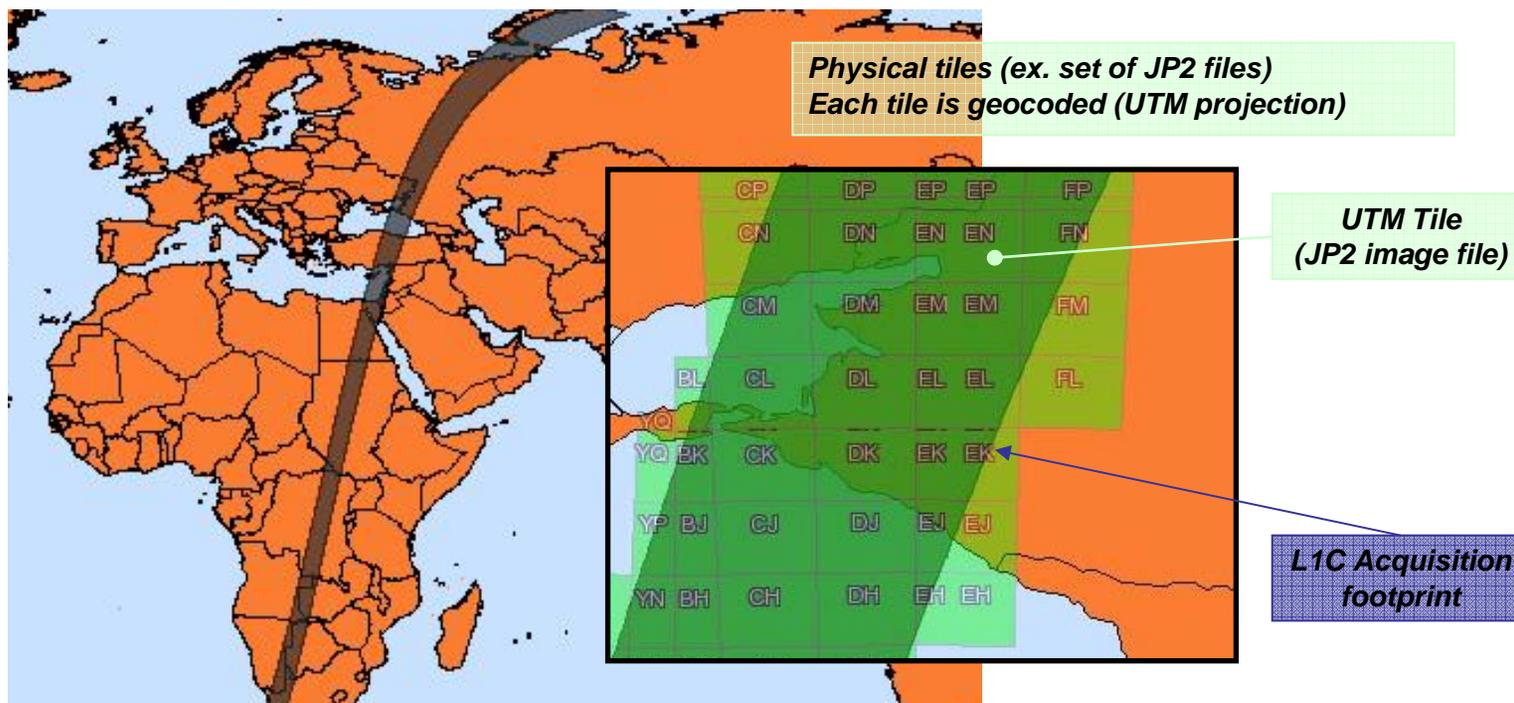
- **Level 0** and **Level 1A** are system products and correspond respectively to raw compressed and uncompressed data.
- **Level 1B** is radiometrically corrected
  - Dark signal, pixels response non uniformity, optical & electrical crosstalk, defective pixels, restoration, and binning for 60m bands.
  - Geometric model refined using Ground Control Points (GCP) from a global reference image (geometric model is appended to the product but not applied).
- **Level 1C** provides orthorectified top-of-atmosphere reflectances with a sub-pixel multi-spectral and multi-date registration.
- **Level 2A** provides orthorectified bottom-of-atmosphere reflectances
  - Enhanced Cloud Screening
  - Atmospheric Corrections
    - Thin Cirrus & Haze, Aerosols
    - Slope and Adjacency effects correction
    - Reverse modelling of atmospheric scattering, solar irradiance, and direct/diffuse transmittance, etc
  - Ready to support Geophysical variables extractions
    - FAPAR, LAI, Leaf chlorophyll content, Simplified land cover classification



# Sentinel-2 MSI Orbit Mapping



- L1C/L2A Images are orthorectified and geocoded into the preset and invariant UTM grid
- All tiles covered by the image along the swath are created, archived and accessible separately (tiles ~500MBytes each)
- In Addition: Planned to provide also a TCI (True-color image) in full res



# Sentinel 2 Nominal Operations



- Max 40 min/orbit duty cycle; power/energy constraints current assumptions: 24 (-30) min /orbit acquisition (490 Mb/s)
- Systematic recording and downlink (520 Mb/s) of data to minimum 4 core ground stations in X-band & alternatively EDRS/Ka-band, tbc
- Systematic processing up to level-1C/2A with near-real-time capability (< 3hours from data sensing for tbc areas),
- Generation of predefined cloud-free coverage products for GMES data users
- Long-term archiving and download access to the data, download latency optimised for recent data
  
- Start of operations planned summer 2013

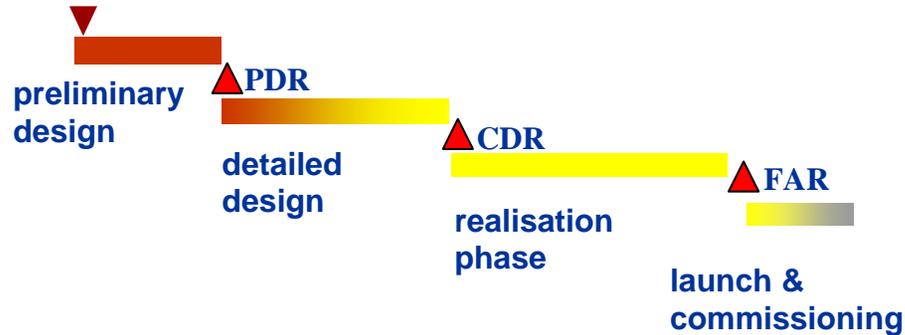
# Programme Development



## System schedule

2008 2009 2010 2011 2012 2013

contract signature



## Subsystem PDGS/GS schedule

PDGS SRR Dec 2009...

GS PDR start in Q2/2010

PDGS ITT in Q4 2010

PDGS CDR in Q3/2011

...GS ORR Q3/2012



# Sentinel Data Policy

## “Full and open access to Sentinel data to all users”

### This includes

- Anybody can access acquired Sentinel data
- Licenses for the Sentinel data are free of charge
- Online access with users registration including acceptance of generic T&C

ESA/EC joint principles for the Sentinel Data Policy

- approved by ESA member states at PB-EO in September 2009, and
- to be approved by EC as part of Regulation of the European Parliament and the Council at the end of 2010

## What does it mean?

*Technically:* Improved availability and easier access to EO data, simple data dissemination system and interfaces to users

*Politically:* Continue international trend for full and open access to EO data, in line with GEO data sharing principles, setting context for future data policies

*Economically:* Supports growth of VACs' business, thus enabling growth and job creation; Increased uptake of EO data opens new markets and supports development of new products

# Sentinel Data Policy III



- The Sentinel Data Policy is **one element** of the overall GMES Data and Information Policy
- The Sentinel Data Policy is **applicable to data derived from Sentinel missions** (1-5, S-5 precursor) and the respective core ground segment.
- Sentinels = **result of a gap analysis** of available satellite capacities in Europe. Access to **GMES Contributing Missions** (public, commercial) is and will remain essential.
- **Future Sentinel** missions will be selected on the same basis taking into account the **complementarities** between Sentinel and Contribution mission data. This is elaborated in the GSC Long Term Scenario.
- ESA/EC joint principles for the Sentinel Data Policy
  - i. approved by ESA member states at PB-EO in September 2009, and
  - ii. to be approved by EC as part of Regulation of the European Parliament and the Council at **the end of 2010**

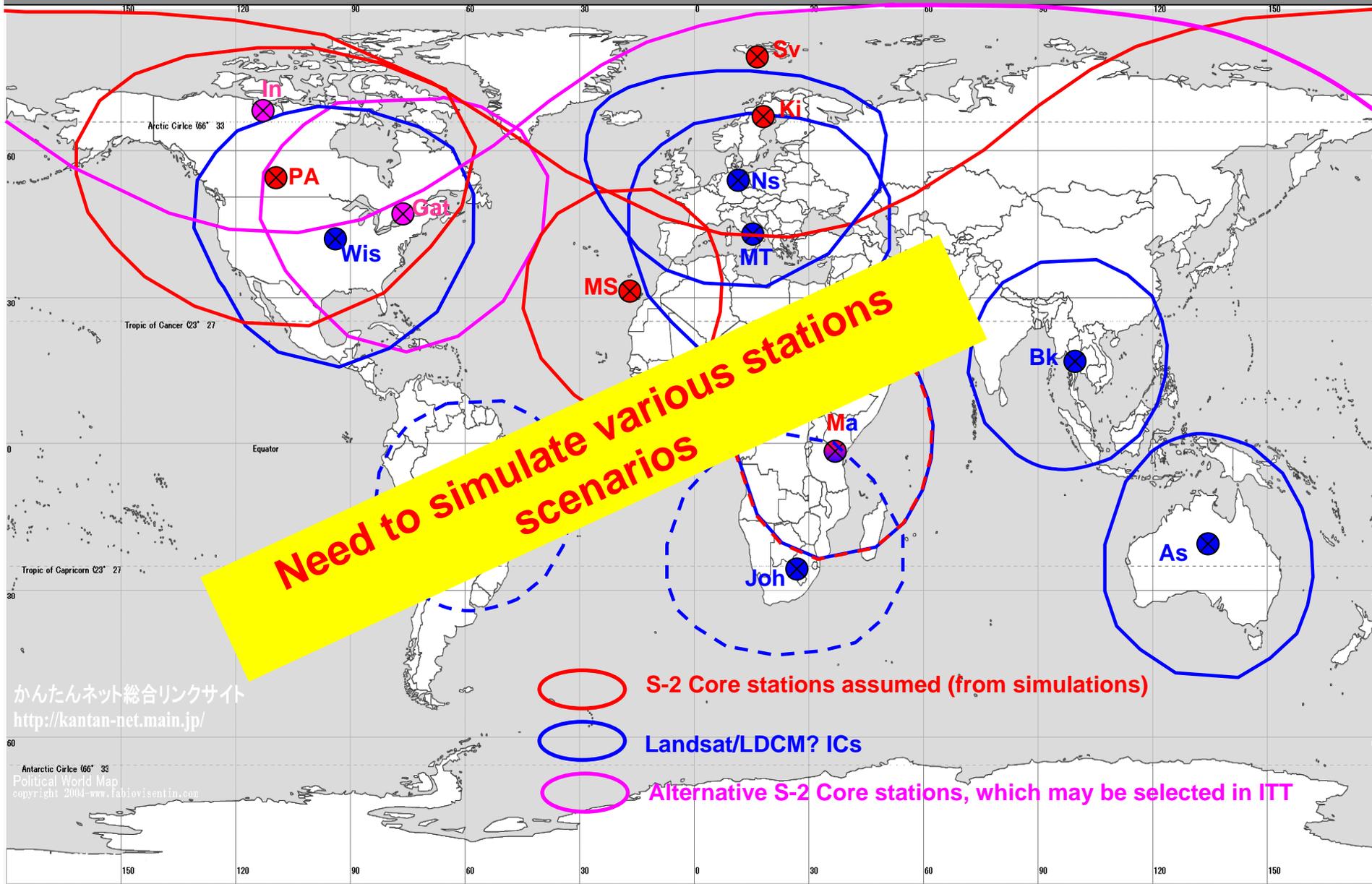
- Implementation of the joint principles for the Sentinel Data Policy defined in
  - the **GSC operations concept**: defines functionalities of the core and collaborative ground segment, and
  - the **HLOP**: defines the priorities in data acquisition/provision applicable to all Sentinel missions during the operations of the GSC, and
  - the **Terms and Conditions** for the use of the Sentinel Data.

# GMES Space Component Operations Concept

- is based on
  - Sentinel missions 1-5
  - GMES Contributing Missions
  - coherent
    - data access management (mission capacity analysis etc)
    - technical interfaces (Data access integration layer)
  
- and includes
  1. The **GSC core ground segment** and
  2. The **collaborative ground segment** (= national ground segment facilities and GMES services), applicable to both, Sentinel and Contributing Missions

- The **GSC core ground segment** will
  - ensure all basic services up to level 2 data products
  - mainly be based on systematic product generation & online data distribution
  - maintain a well-defined product list (products and combined data sets/coverage)
  - include a data access integration layer (multi-mission planning, user registration, download and data delivery services for Sentinels and data from GMES Contributing Missions)
  
- The **collaborative ground segment** (= national ground segment facilities and GMES services) will complement the GSC core ground segment through
  - Regional and national products (e.g. data formats and algorithms)
  - Service specific delivery mechanisms (e.g. direct downlink)
  
- The Sentinel Data Policy is applicable to data from the GSC core ground segment.
  
- Special agreements will be put in place to regulate data policy issues for the collaborative ground segment.

# TBC: S-2 & LDCM potential acquisition stations



# Potential Sentinel collaborative GS: regional dissemination partners?



# GSC Operations Concept: Examples of tbd

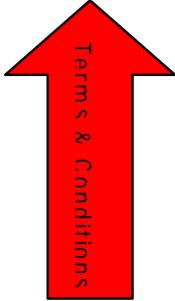
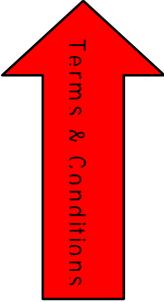


- **European Data Relay satellite (EDRS)**
- **Direct downlink capabilities versus priorities (Near Real-time versus quasi real-time)**
- **GSC Facilities competitive selection process & outcome**
- **Sharing across Sentinels incl. conflicts in x-band downlinks**
- **Core vs Collaborative ground segment:**
  - **National collaboration opportunities**
  - **International collaboration opportunities**
- **Technical project phasing versus programmatic programme phasing**
- **While European requirements process gathering is well established, National Requirements process is tbd**
- **Etc.**

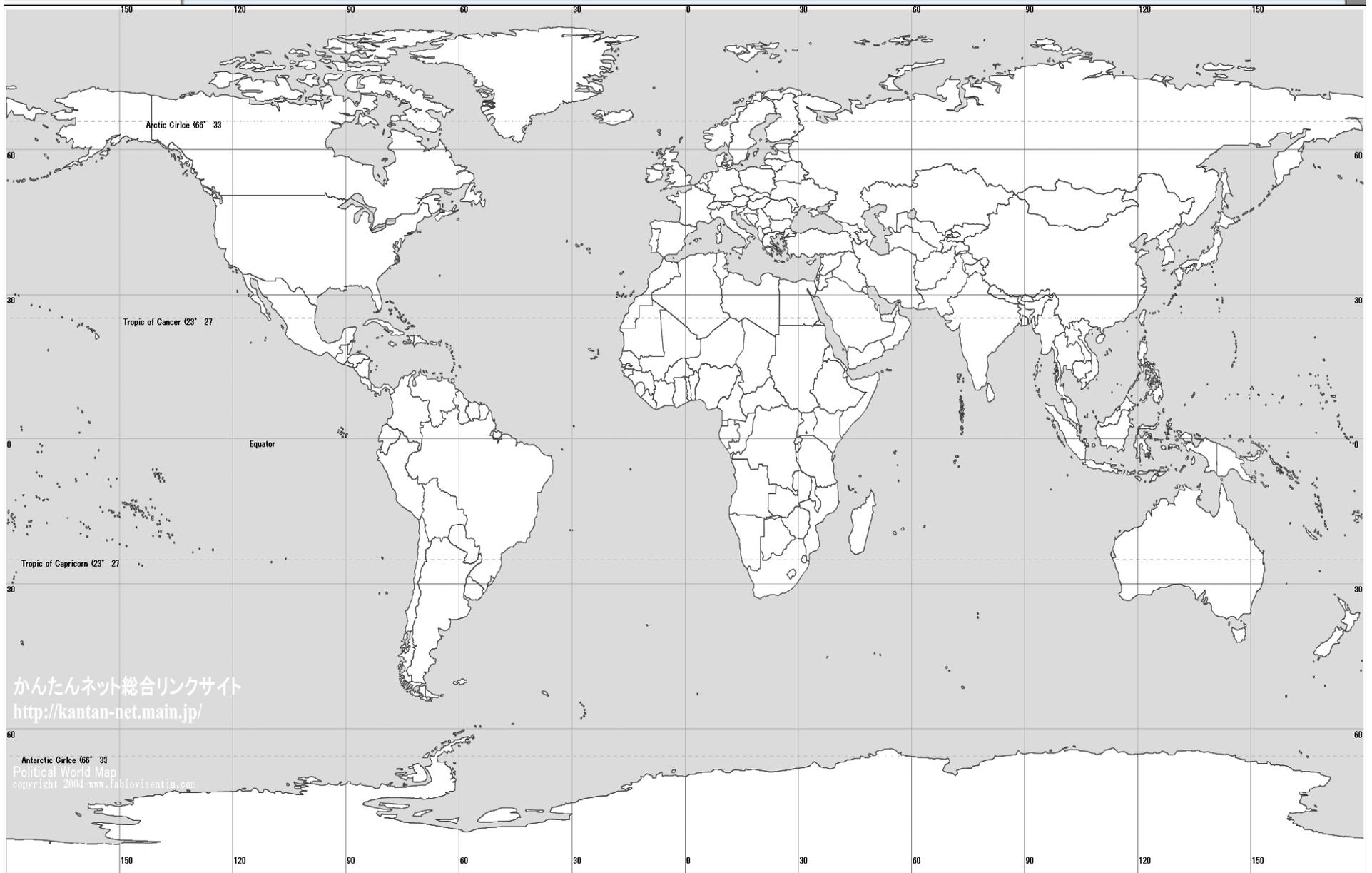
- ESA will generate a **Sentinel High Level Operations Plan (HLOP)**, which will
  - define the priorities in data acquisition/provision applicable to all Sentinel missions
  - prioritise user access for different types of users
  
- Priorities are applied **only in case of technical or financial constraints** or incompatibility of requirements exceeding the satellite or ground segment capacity
  
- Aim is to **minimize** the cases for which a **priority scheme** is needed → maximisation of **systematic** acquisition, systematic processing and systematic data availability.
  
- Conflicts may occur due to
  - Instrument planning and operation modes conflicts
  - Product generation capacity
  - Data delivery capacity

# Sentinel data for GMES and other uses

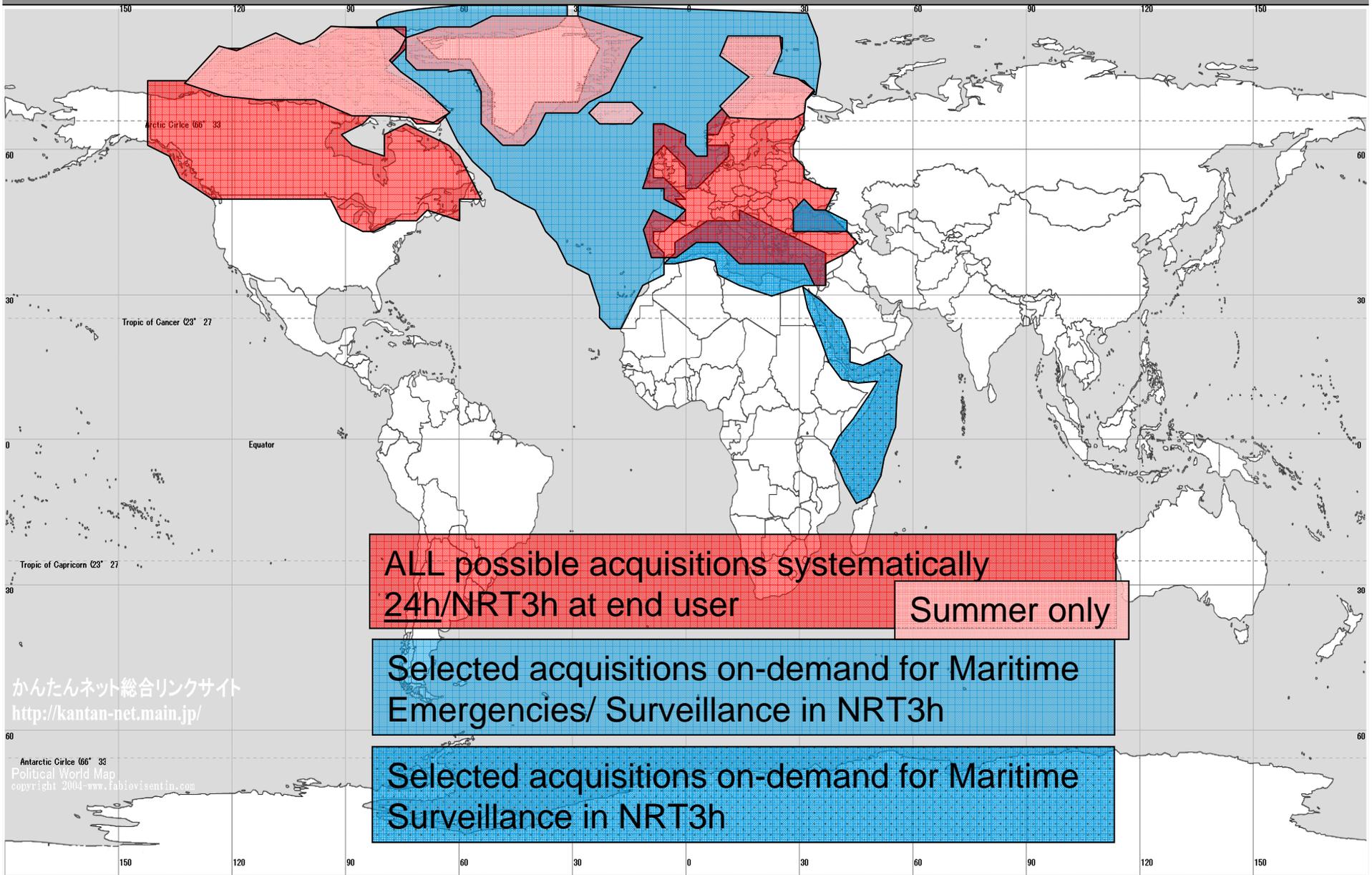


GMES Use			Other Use			
Core Services	Downstream Services	Any other GMES Services	Utilisation by Participating States	International cooperation agreements	Science Use	Other Operational use
 <b>Free Access</b>			 <b>Free Access</b>			
Priority management in case of conflicts through HLOP						
<b>Sentinel Data Policy</b>						

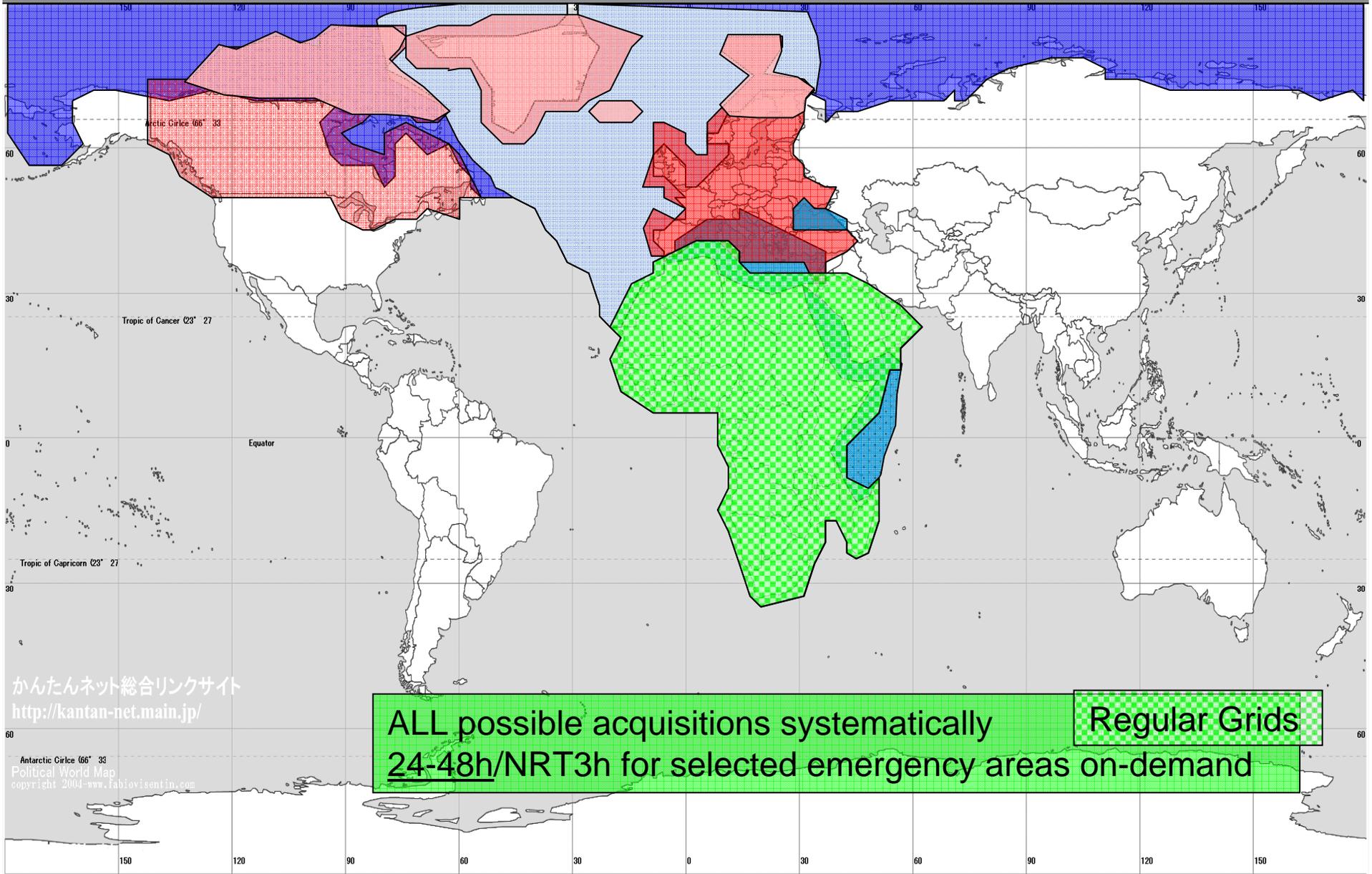
# Tbc, HLOP: geographic and data acquisition priorities



# Tbc Priority 1: Europe mainland and Europe Seas/Coasts

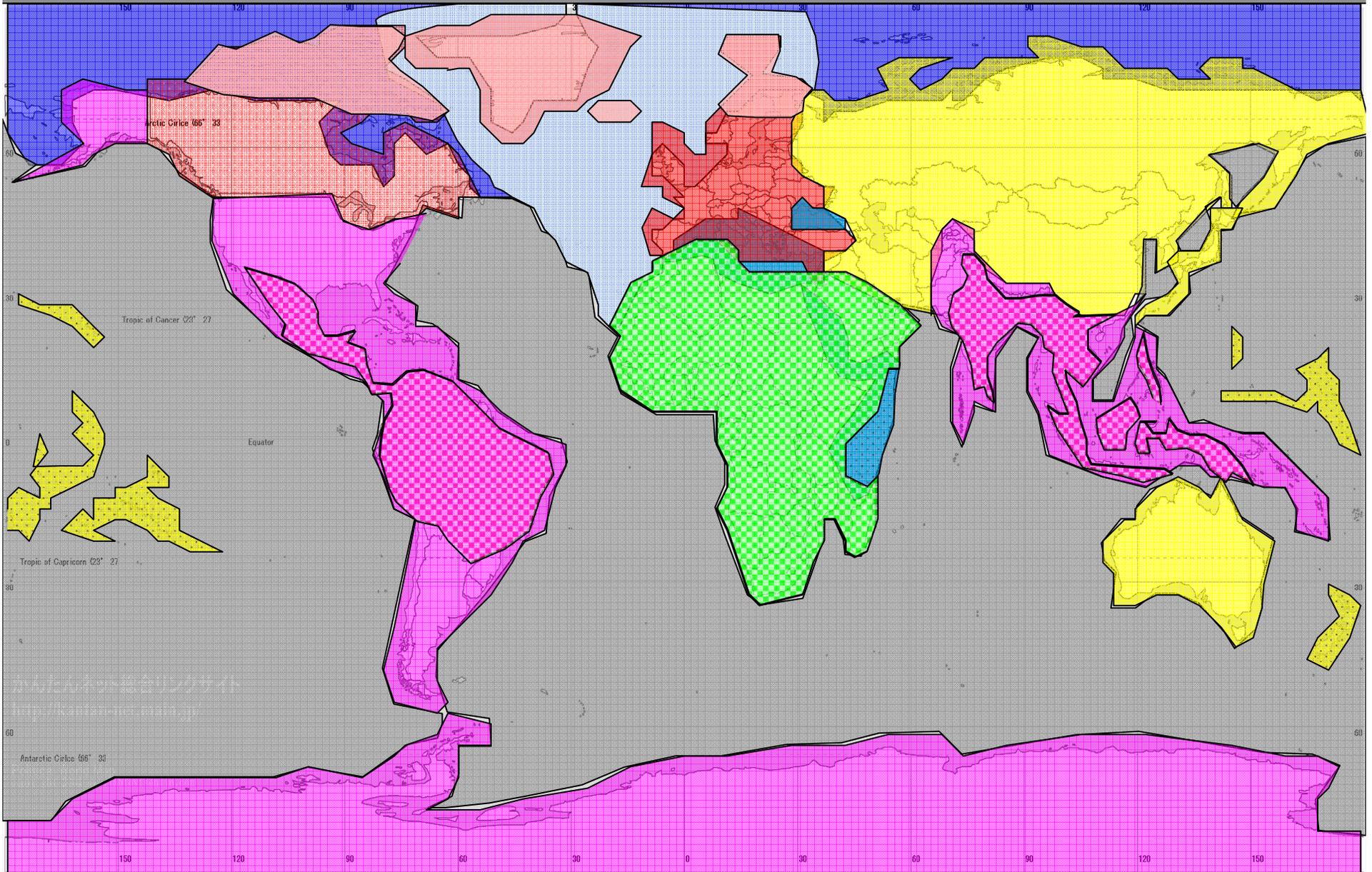


# Tbc Africa & Arctic



かんたんネット総合リンクサイト  
<http://kantan-net.main.jp/>

# Tbc different Priority areas



# Next Steps



- Prepare draft Ops Concept for Presentation to Feb PB-EO
- Consolidate Member States comments
- Prepare Final Ops Concept for Presentation to May PB-EO
- HLOP to May PBEO
- GSC Facilities ITT Q4/2010
- Continue to seek national/international collaborative ground segment agreements
- Continue to follow requirements as expressed by all stakeholders, and consolidate operations concepts /prepare Phase E of the Sentinels