GMES and European Earth Observation Missions

DLR – Conabio Workshop:
Use of remote sensing data for environmental and civil security applications in Mexico

Gunter Schreier
Head Business Development
DLR-DFD, Oberpfaffenhofen, Germany
Mexico City, April 22nd to 24th, 2008

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

GMES: Global Monitoring of Environment and Security

- **The next EU flagship for Space after Galileo** (*2nd Space Council, June 2005*)
- **An EU-led initiative, in which the Commission will manage actions for identifying and developing *services* relying both on in-situ and remote sensing data and ESA will implement the *space component*. *National missions* are part of the space component.**
- **GMES is European contribution to GEO/GEOSS**
- **Implementation thru:**
  - **ESA GMES space component (incl. ground segment interfaces)**
  - **EU FP7 Space budget (R&D budget)**
  - **Dedicated direct actions (European and national)**
  - **Guideline: Munich Roadmap**

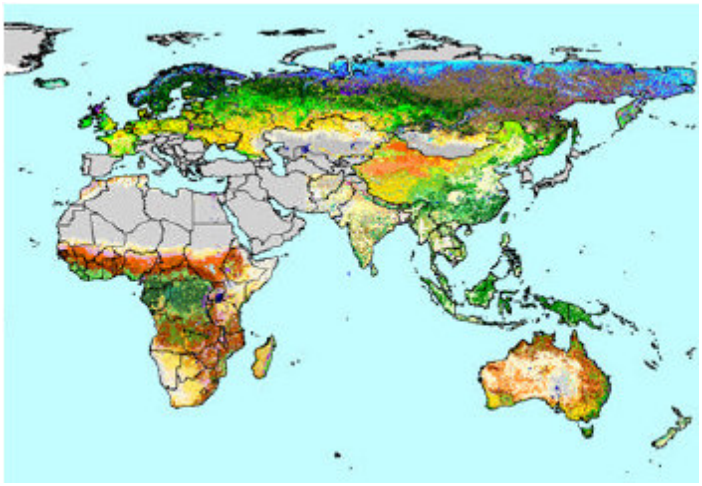
Environment and Security

Environment

Protecting the planet by

better measurements of environmental stress, biodiversity, desertification, carbon fluxes, pollution, urbanisation, eutrophication….

→ slow-change, coarse resolution data



Security

Protecting the individual by

Monitoring threats and vulnerabilities

Providing early warnings (increase preparedness)

Supporting operations

→ rapid change, high resolution data

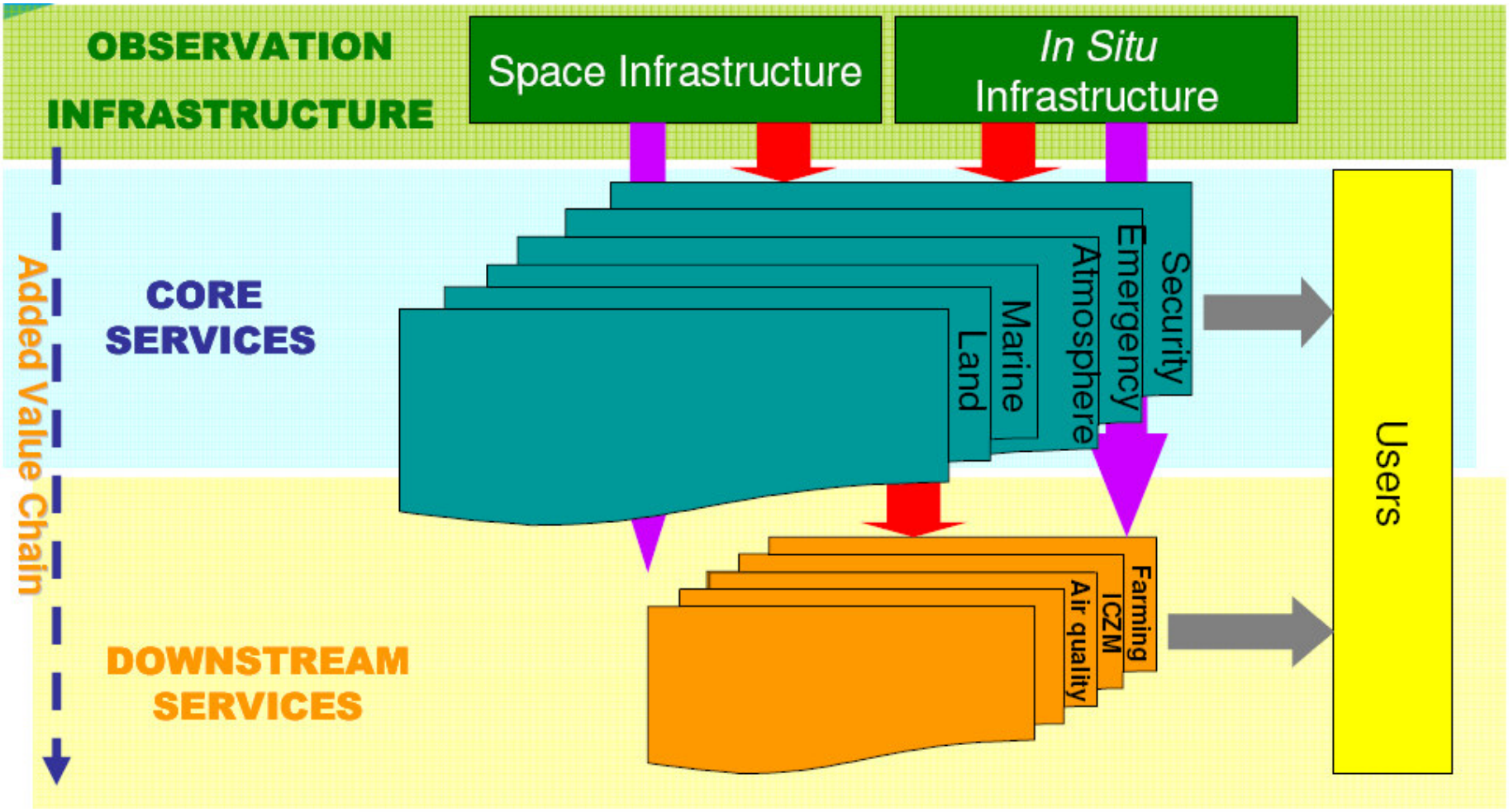
GMES: Global Monitoring of Environment and Security

Three Core Services

Plus Two Pilot Services

Downstream Services, t.b.d.

GMES: Global Monitoring of Environment and Security



The European Fleet of GMES Satellites

2001 - 2005 | 2006 - 2010 | 2011 - 2015

Science

CryoSAT SMOS SWARM EarthCARE
Earth Explorer CryoSAT II
GOCE ADM-Aelous

Operational

ENVISAT
Earth Watch
ERS-1/2

esa
European Commission

GMES
Sentinels
SAR
Superspectral/Infrared
Ocean Monitoring
Atmosphere LEO
Atmosphere GEO

National
Dual Use
Private

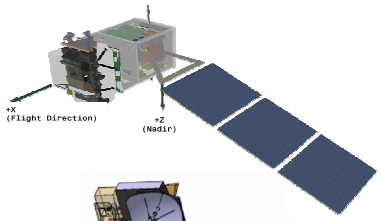
Terra-SAR-X
Terra-SAR-X (private)
TanDEM
Cosmo Skymed
Pleiades
SPOT Series
AstroTerra
Rapid Eye
Rapid Eye (Next)
EnMAP

GMES dedicated missions: Sentinels

Sentinel 1 – SAR imaging

2011

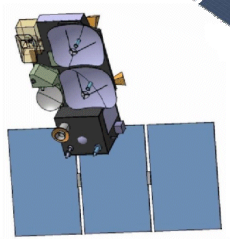
All weather, day/night applications, interferometry



Sentinel 2 – Multispectral imaging

2012

Land applications: urban, forest, agriculture, etc Continuity of Landsat, SPOT data



Sentinel 3 – Ocean and global land monitoring

2012

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

Sentinel 4 – Geostationary atmospheric

2017+

Atmospheric composition monitoring, trans-boundary pollution

Sentinel 5 – Low-orbit atmospheric

2019+

Atmospheric composition monitoring

ESA SENTINEL - 1

Main Objectives

Provide continuity of C-band radar observations & Satisfy the GMES service requirements in terms of data availability, coverage & revisit, timeliness and the quality of its data products by:

- an operational concept based mostly on the use of a pre-defined acquisition scenario
- a systematic processing
- the NRT on-line delivery of data products

Main Characteristics

Orbit: Near Polar Sun-Synchronous
Repeat cycle: 12 days. 175 orbits
Payload: C-Band Synthetic Aperture Radar
Constellation: Sentinel-1 system will be composed of two satellites, Sentinel-1 A & B, to be launched 2 years apart

Parameter	Value
Centre Frequency	5.405 GHz
Bandwidth	0 ÷ 100 MHz (programmable)
Polarization	HH+HV, VV+VH
Pulse Width	5-100 µs (programmable)
Transmit Duty cycle	12% max
Pulse Repetition Frequency	1000 ÷ 3000 Hz (programmable)
Data Compression	Selectable, according to BC - BAQ
Instrument mass	927 kg
DC Power consumption	< 3700 W
Antenna Size	12.3 m x 1.02 m
Number of tiles	14
Number of T/R modules per tile	20
RF Peak Power	~ 4.2 kW

Schedule

Launch: Q4 2011 (Sentinel-1A)

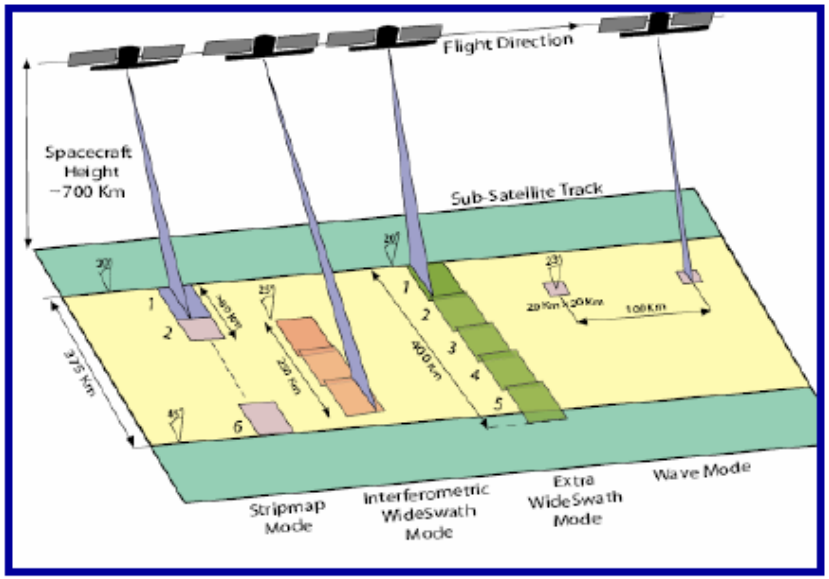
ESA SENTINEL - 1

- **Interferometric Wide Swath Mode**
  ScanSAR based with progressive azimuth scanning, dual polarization, large swath, high spatial resolution, burst synchronisation for ScanSAR interferometry

- **Extra Wide Swath Mode**
  ScanSAR based, dual polarization, very large swath, reduced spatial resolution.

- **StripMap Mode**
  Dual polarization, medium swath, high radiometric performance, very high spatial resolution

- **Wave Mode**
  Sampled StripMap mode, single polarization, low data rate.



Mode	Polarization	Swath Width	Resolutions
StripMap	HH-HV, VV-VH	> 80 Km	5m (range) x 5m (azim)
Interferometric WideSwath	HH-HV, VV-VH	250 Km	5m (range) x 20m (azim)
Extrawide Swath	HH-HV, VV-VH	400 Km	25m (range) x 100m (azim)
Wave Mode	HH, VV	20 Km x 20 Km (Vignette)	20m (range) x 5m (azim)

Duty cycle per orbit
(sizing requirements):
- 5 min in Stripmap mode
- 15 min in IWS mode
- 40 min in WV mode

ESA SENTINEL - 2

SENTINEL 2

Main Objectives

- To provide continuity of Landsat and SPOT, by making continuous observations on all land surfaces
- To establish a European source of data fulfilling the requirements of the GMES services (Land Use, Forest, Emergency)

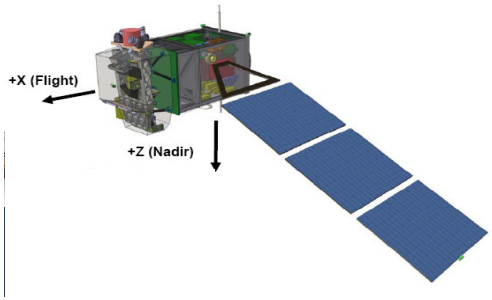
Orbit: Near Polar Sun-Synchronous
Repeat cycle: 10 days. 143 orbits
Payload: Multi-spectral Instrument (MSI)
Constellation: Sentinel-2 system will be composed of two satellites, Sentinel-2A&B, to be launched ~2 years apart

Coverage: Systematic imaging of all land surfaces between 83 N and 53 S with SZA better than 75 deg.

Launch: Q4 2012

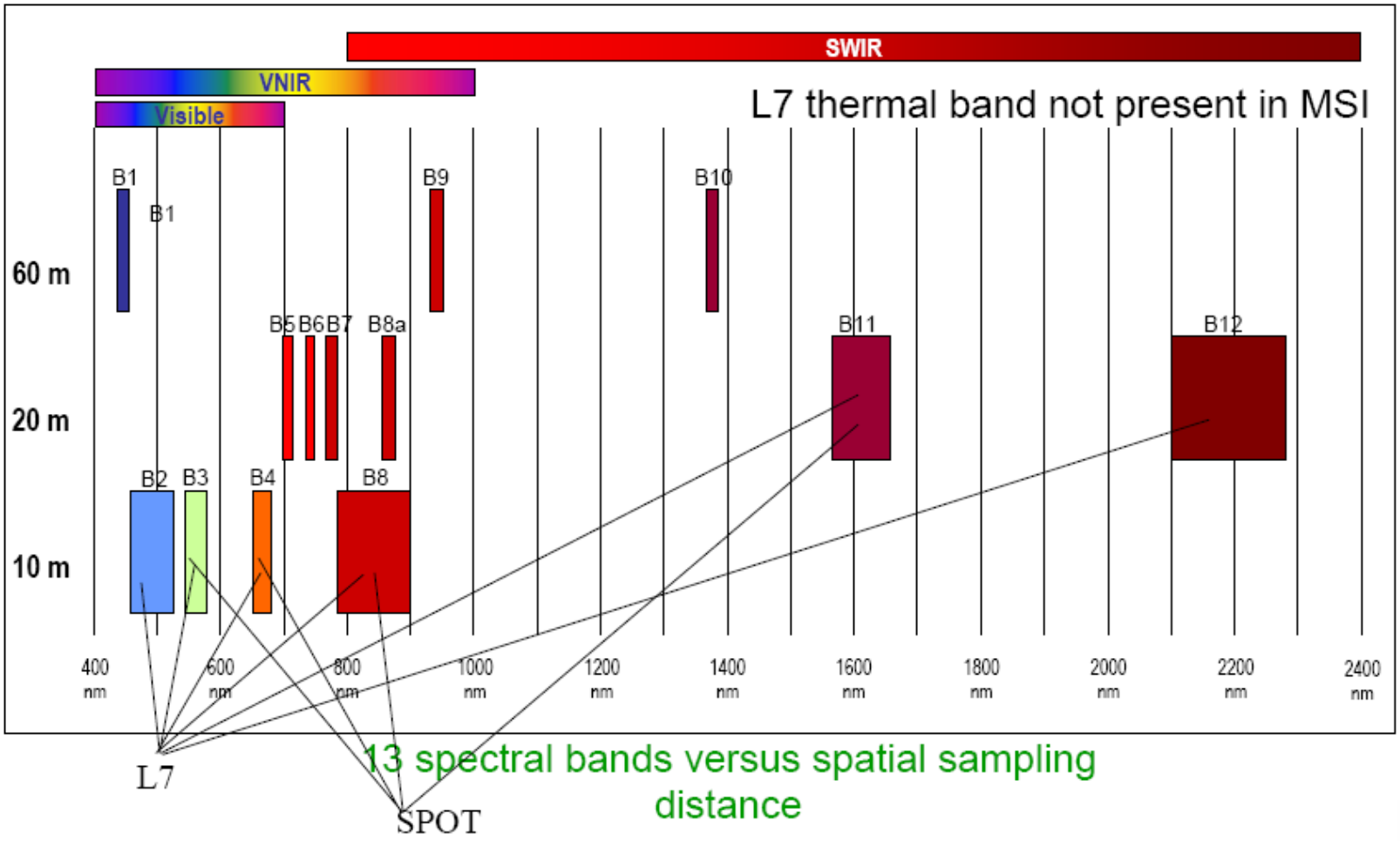
ESA SENTINEL - 2

- **MSI (Multi-Spectral Imager)**
  - Swath: 285 Km
  - 13 Bands @ 10-60 m resolution, from VNIR to SWIR
  - Radiometric Resolution 12 bit
  - Onboard calibration
  - Push-broom technology

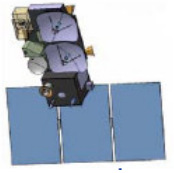


- **Accurate geo-location**
  - Standard product: orthorectified corrected image (including atmosphere)
  - <20m 2sigma achievable automatically using AOCS

ESA SENTINEL - 2



ESA SENTINEL - 3



Main Objectives

Provide continuity of medium resolution sensors by ensuring the provision of:

- Ocean observations data (i.e. Sea-Surface Height, Sea-Surface Temperature, Ocean Colour)
- Land optical observation products (i.e. Land Colour, Land Surface Temperature)
- Ice topography products (i.e. Sea Ice, Ice sheet interiors, ice sheet margins)
- Land hydrology products (i.e. water surface levels for river and lakes)

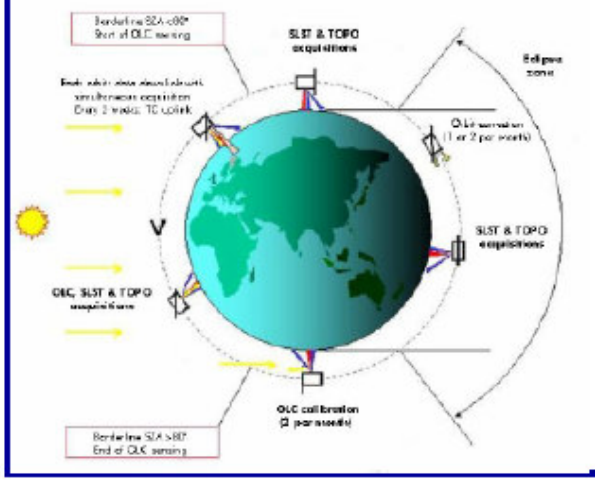
Main Characteristics

Orbit: Near Polar frozen Sun-Synchronous
Repeat cycle: 27 days. 385 orbits
Payload: An Ocean and Land Colour Instrument (OLCI)
A Sea and Land Surface Temperature (SLST) Instrument
A Radar Altimeter (SRAL)

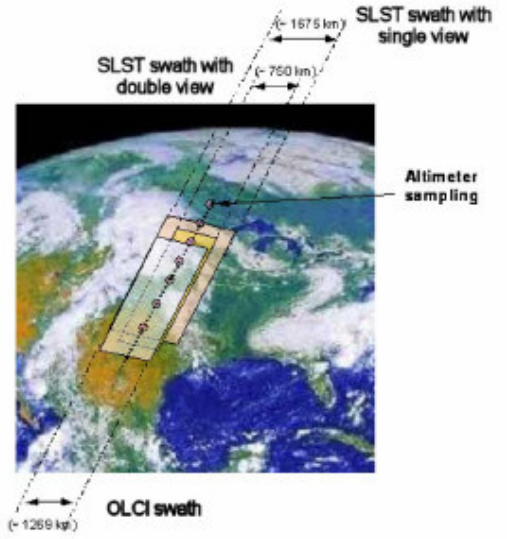
Schedule

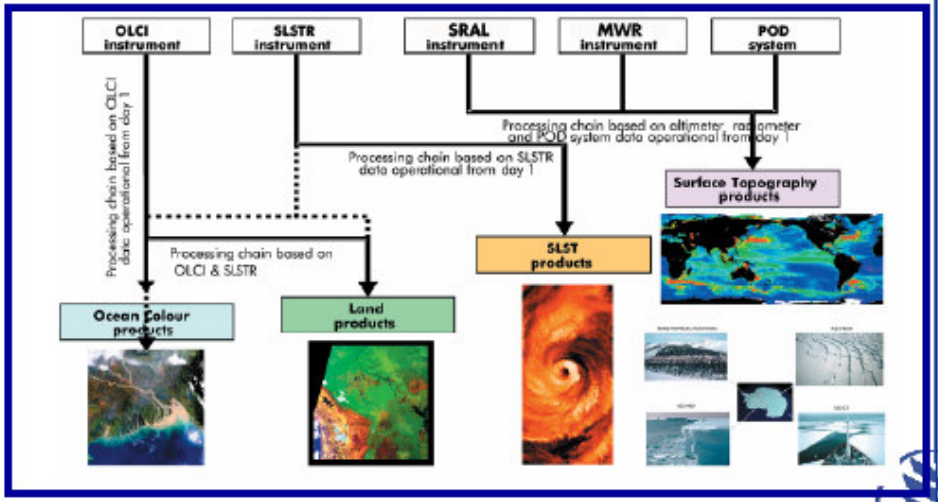
Launch: Q4 2012 (Sentinel-3A)

ESA SENTINEL - 3



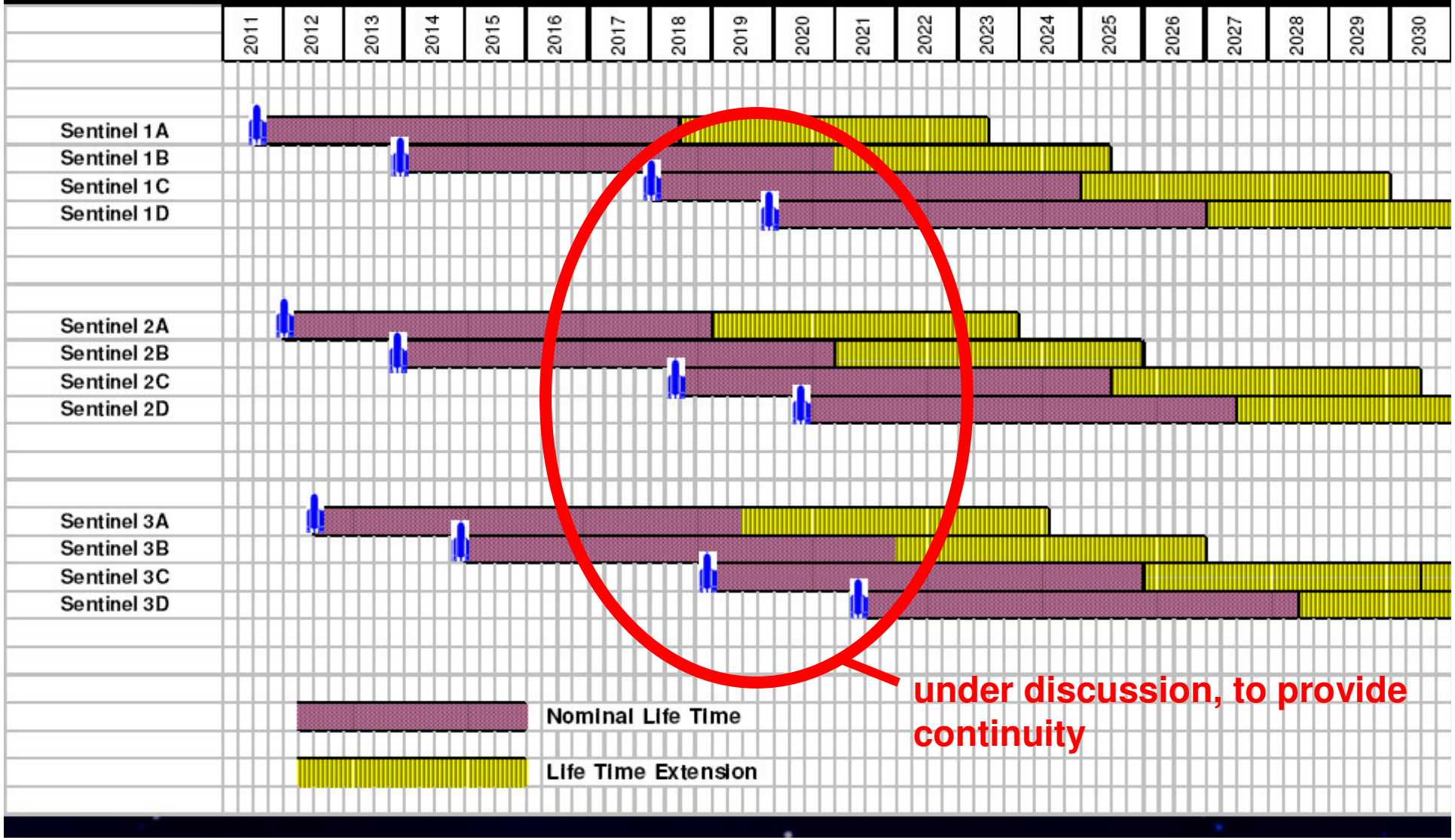
- Systematic payload operations based on:
  - the orbital revolution number
  - the angular position on orbit
- Full OLCI coverage from SLST
  Synergic "Vegetation like" product



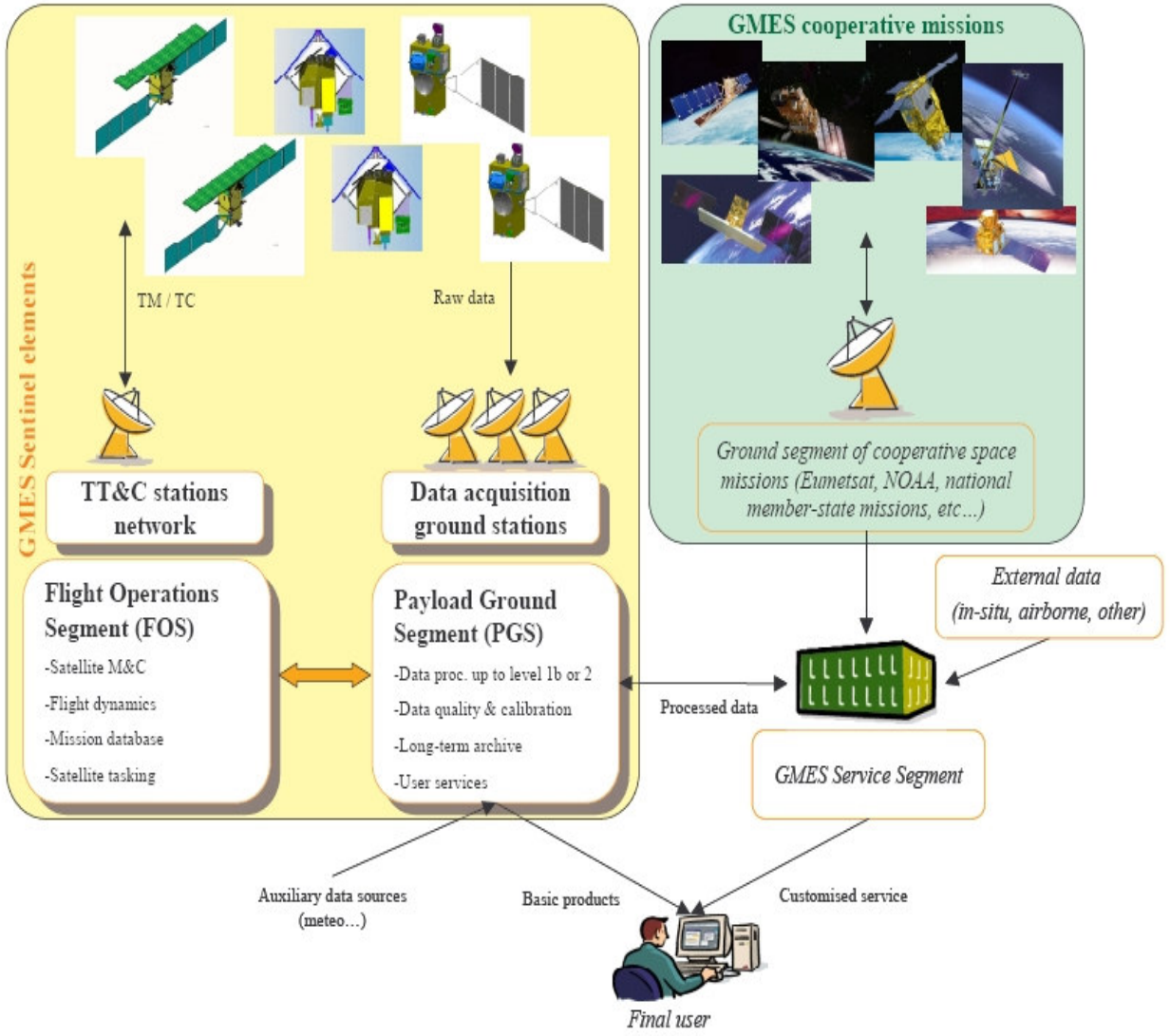


• Illustrations are courtesy from S3 Industrial project team

Possible long-term scenario (Sentinels-1/-2/-3 only)



GMES Ground Segment and Data Access



GMES Ground Segment is composed of

➡ **FOS**

to operate spacecraft platform and payload

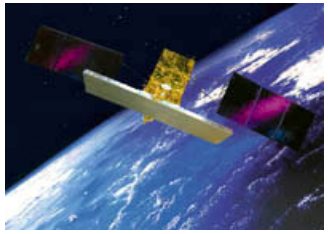
➡ **PDGS**

to distribute EO data and products to user communities

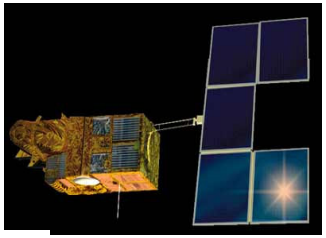
Contributions to GMES Space Component

National, Eumetsat and Third Party Missions for GMES

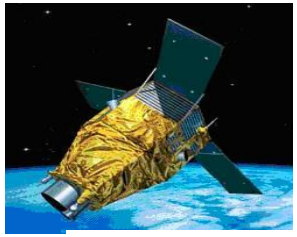
(list non exhaustive)



CosmoSkymed

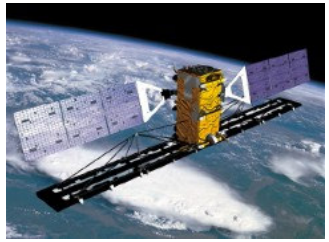


SPOT

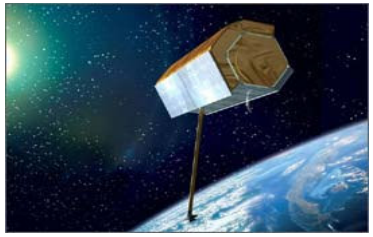


Pléiades

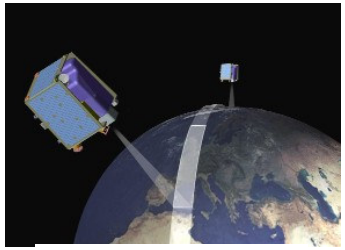
Jason



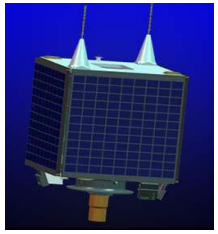
Radarsat



Terrasar-X

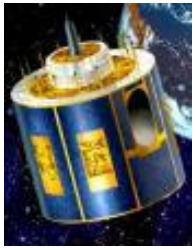


RapidEye



DMCs

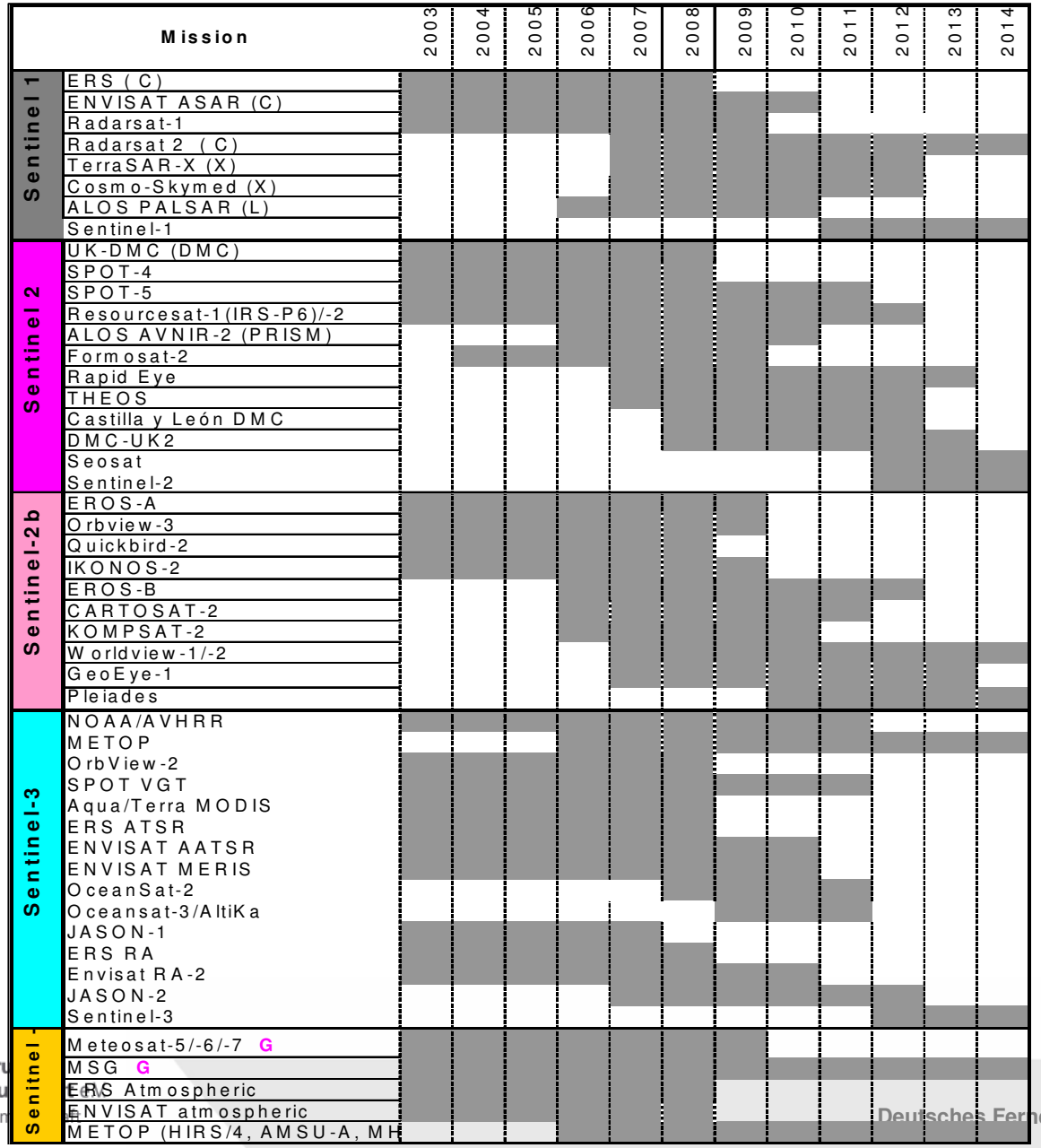
METOP



MSG

+ Seosat, TanDEM-X, EnMap, Venus, Altika, etc.

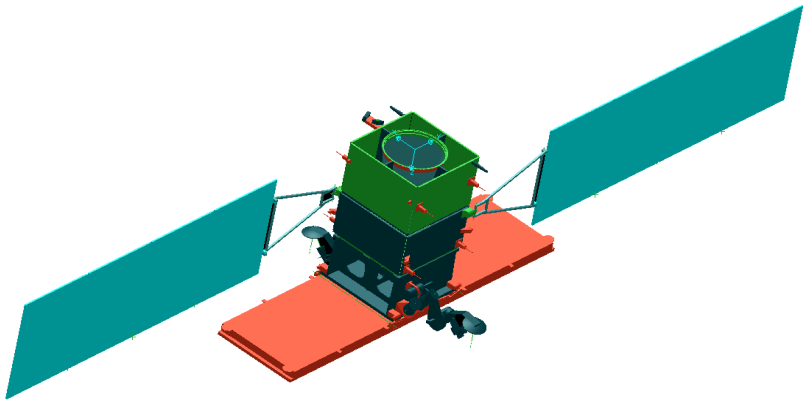
The extended fleet of GMES Satellites

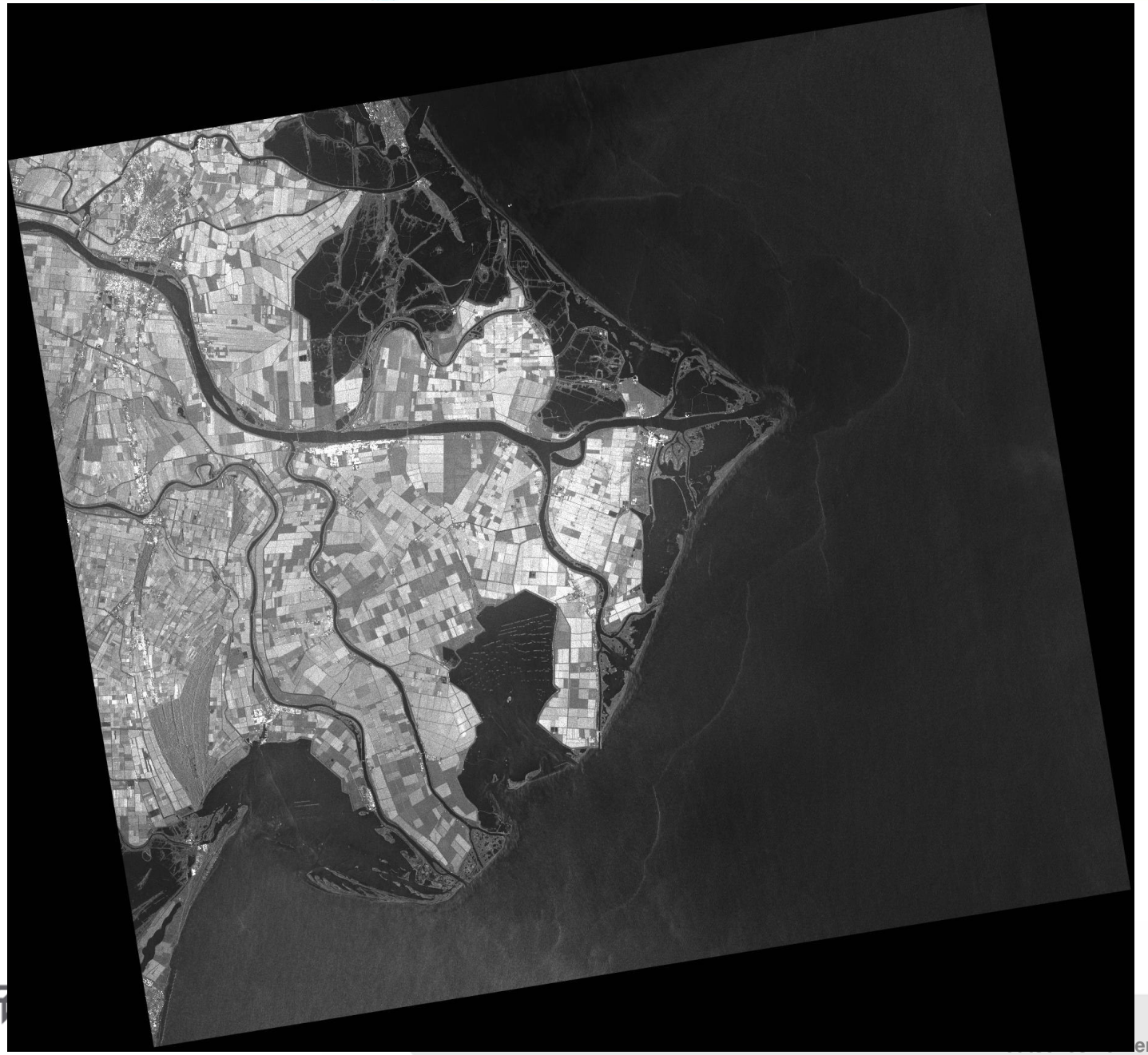


Source: ESA

Cosmo SkyMed

- **Owner**
  - ASI
  - Military and commercial use
- **Constellation**
  - 4 active satellites in 2 orbital planes
- **Lauch date**
  - June 7th, 2007 (1st sat)
- **Prime Instrument**
  - X-Band SAR, single and dual polarizations
- **Resolution/swath**
  - Spotlight better than 1 m
  - HIMAGE 5m /40 km
  - WIDEREGION 30 m / 100 km
  - HUGEREGION 100 m / 200 km
  - PINGPONG (dual pol) 15m/ 30 km

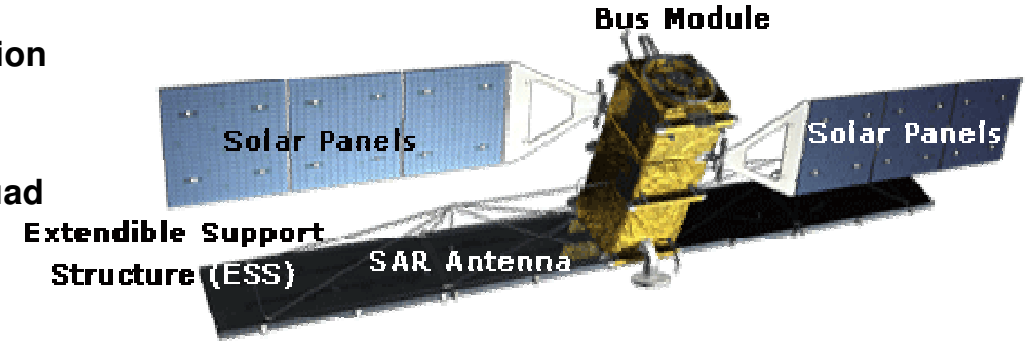


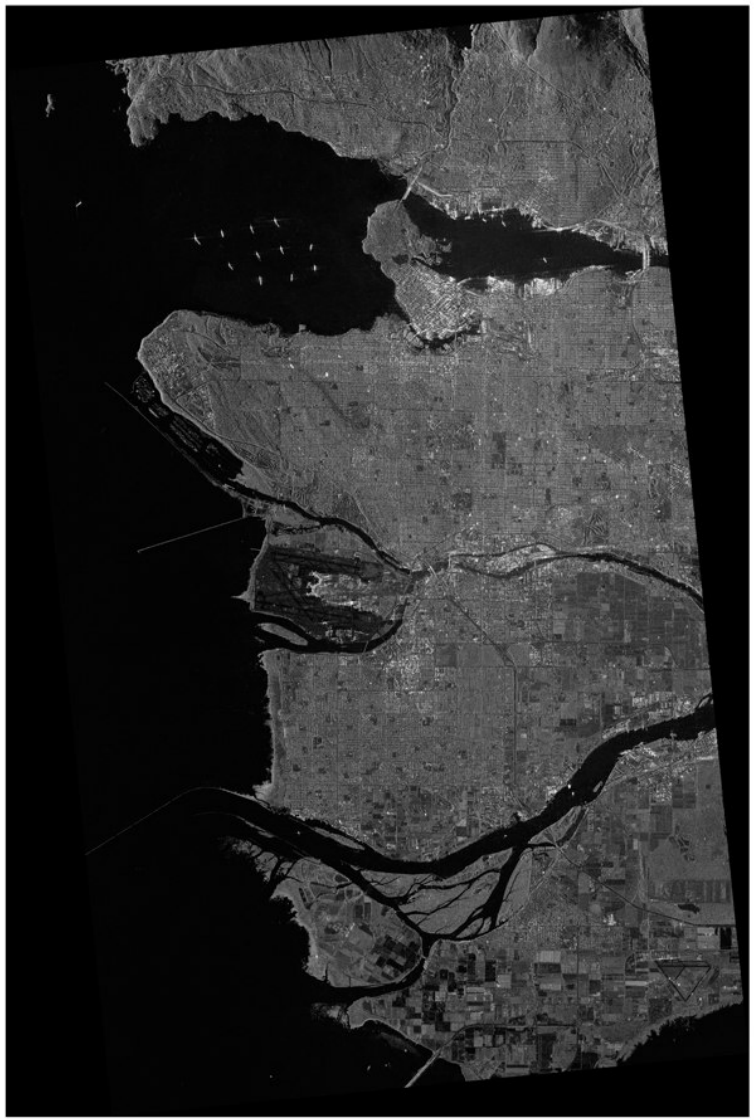


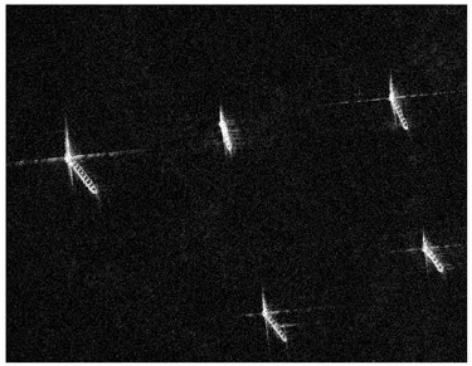
Po-Delta
Cosmo-Skymed
5 m res.

Radarsat-2

- Owner
  - **MacDonald Dettwiler Corporation, Canada**
- Lauch date
  - **December 14th, 2007**
- Orbit
  - **789 km @ 98,5 deg inclination**
- Prime Instrument
  - **C-Band SAR, single and quad polarizations**
- Resolution/swath
  - **Ultrafine: 3 m**
  - **Multi-Look Fine: 8m**
  - **Standard: 25m**
  - **Standard Quad Pol: 15m**
  - **ScanSAR Narrow: 50m**
  - **ScanSAR Wide: 100m**



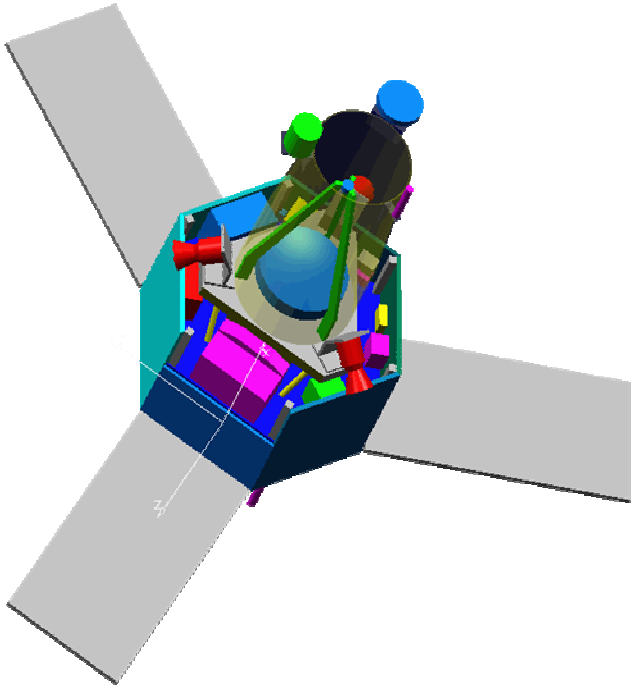




Vancouver, BC
Radarsat-2
Ultrafine mode

Pleiades (F)

- Owner
  - **CNES**
  - **Commercial distribution**
  - **(incl. Military use)**
- Constellation
  - **Two active satellites**
- Lauch date
  - **mid 2009**
- Prime Instrument
  - **High resolution optical imager**
- Resolution/swath
  - **0,7 m pan & 4* 2,8 m ms / > 20km**



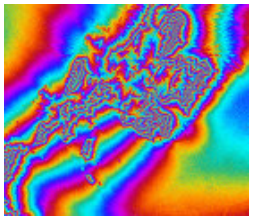
German contribution to the GMES space component

Sentinel 1: SAR Imaging:

SRTM

TerraSAR-X

TanDEM-X



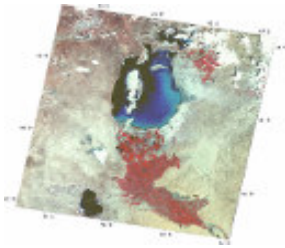
Sentinel 2: Superspectral Imaging:

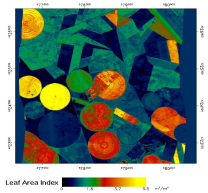
BIRD

RapidEye

IRS-P6; ResourceSAT

EnMAP





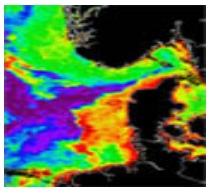
Sentinel 2b: Very High resolution optical mapping:

IKONOS, **GeoEye-1**

CartoSAT-1, **CartoSAT-2**

Sentinel 3: Ocean Monitoring:

EnMAP



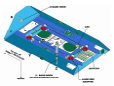
Sentinel 4 & 5 atmospheric monitoring:

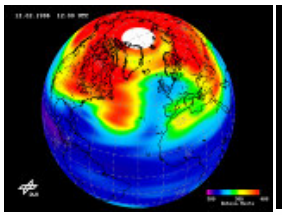
GOME

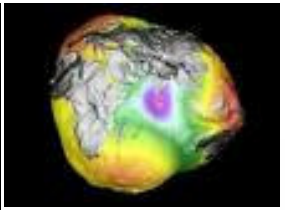
Sciamachy

Earth System understanding:

Grace, Champ







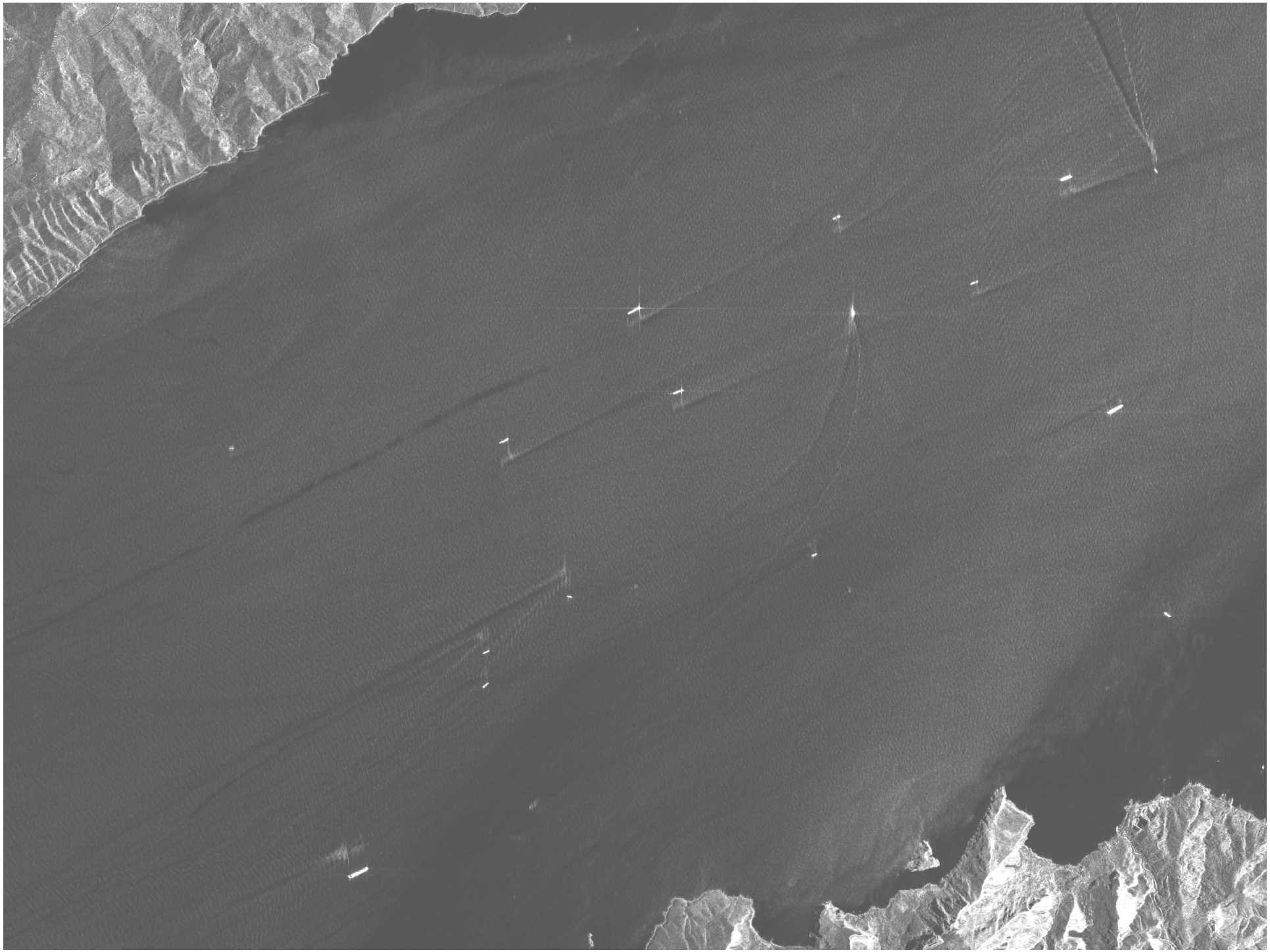
TerraSAR-X – First German SAR Satellite

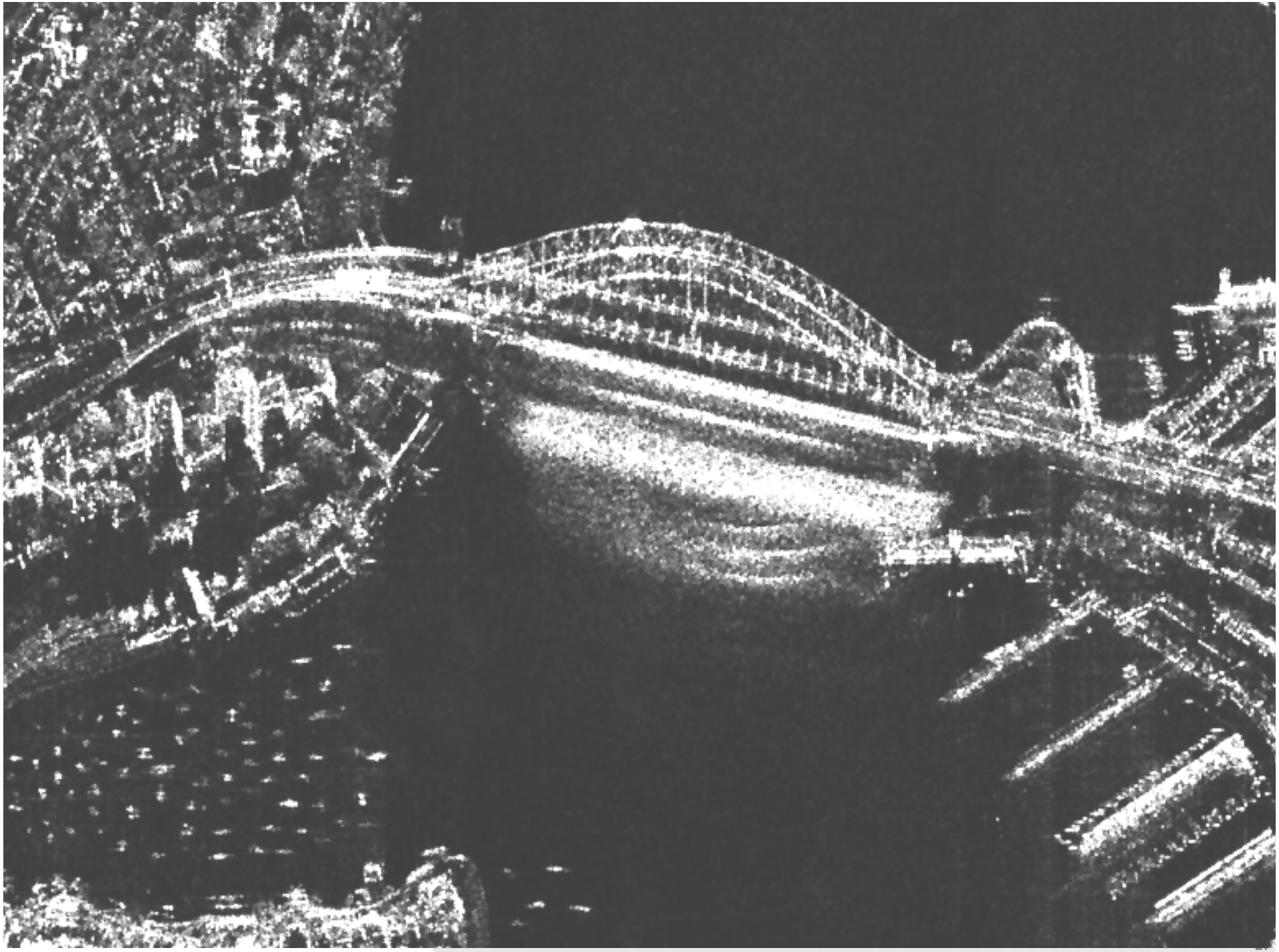
Launch: June 15, 2007

Orbit: 514 km

Spat. Res.: down to 1 m

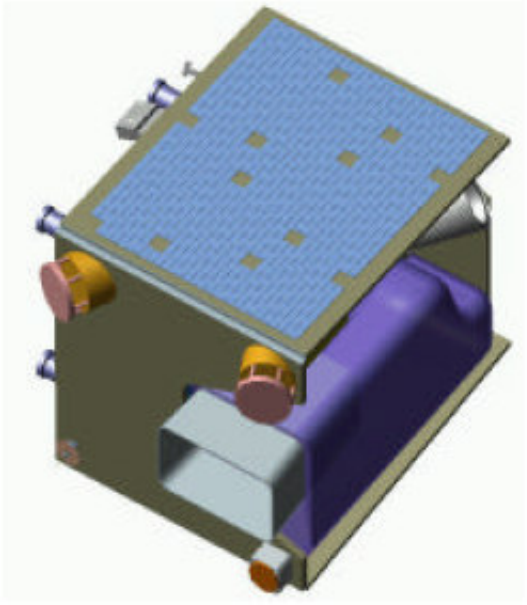
- Approved formation flight with TanDEM-X (Launch 2009)
- Mission control, data acquisition, processing and distribution from DLR institutes in Oberpfaffenhofen
- Scientific coordination and applications: DLR-DFD
- Commercial distribution: Astrium/InfoTerra
- Contribution to GMES

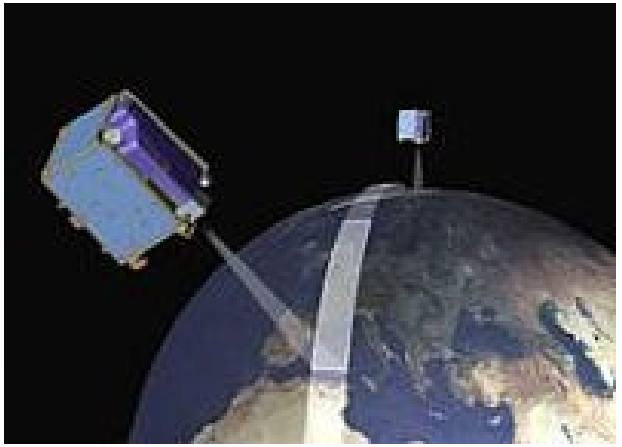




RapidEye (D)

- Owner
  - **Rapid Eye AG, Germany**
  - **Private and public investors**
- Constellation
  - **Five active micro satellites in constellation, 3 planes**
- Lauch date
  - **Mid 2008**
- Prime Instrument
  - **Optical, 5 bands**
- Resolution/swath
  - **6,5 m / 80km**



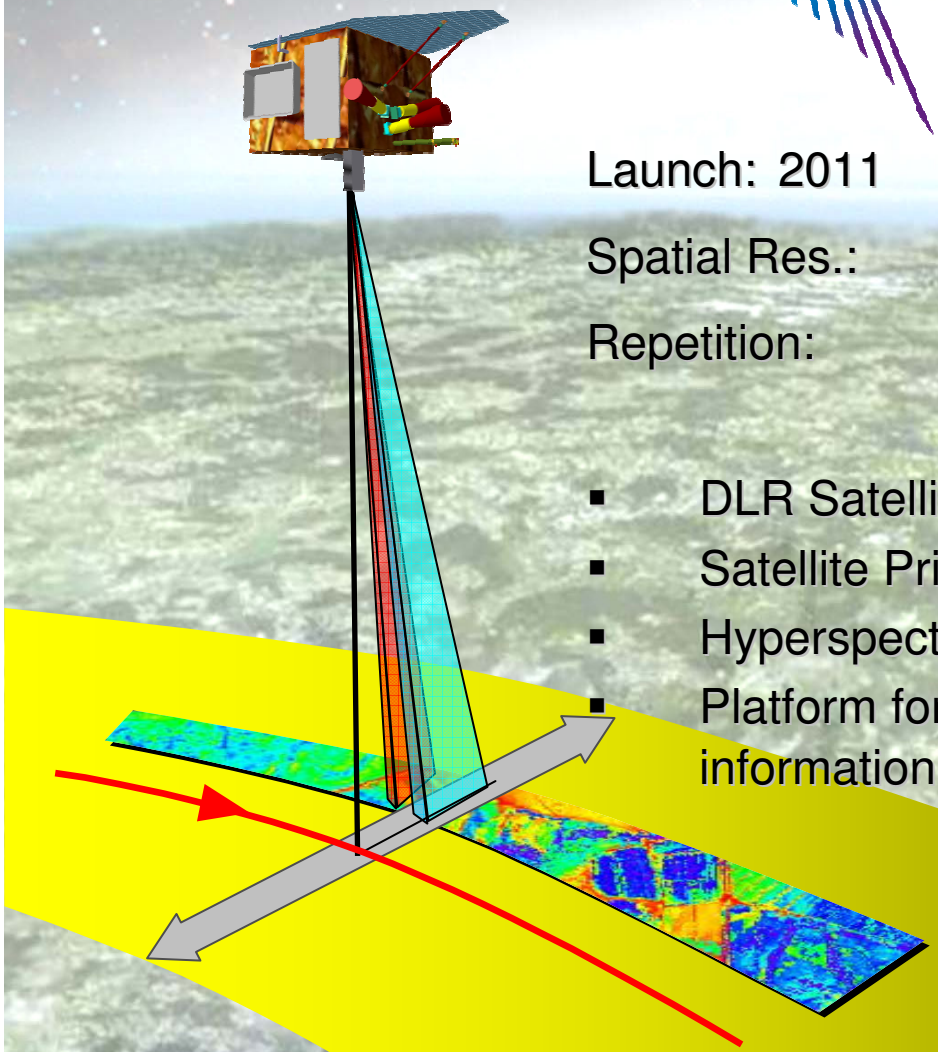


RapidEye system characteristics

Mission characteristic	Information
Number of Satellites	5
Spacecraft Lifetime	7 years
Orbit Altitude	630 km in Sun-synchronous orbit
Equator Crossing Time	11:00 am (approximately)
Sensor Type	Multi-spectral push broom imager
Spectral Bands	Capable of capturing any of the following spectral bands: Name — Spectral Bands (nm) Blue — 440 – 510 Green — 520 – 590 Red — 630 – 685 Red Edge — 690 – 730 NIR — 760 – 850
Ground sampling distance (nadir)	6.5 m
Pixel size (orthorectified)	5 m
Swath Width	77 km
On board data storage	1500 km of image data per orbit
Revisit time	Daily (off-nadir) / 5.5 days (at nadir)
Image capture capacity	4 million sq km/day
Dynamic Range	12 bit

Environmental Mapping and Analysis Program

EnMAP Hyperspectral Imager



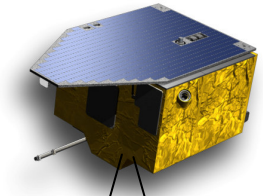
Launch: 2011

Spatial Res.: 30m at 30km swath

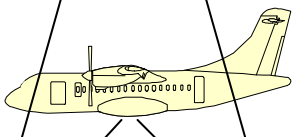
Repetition: 5 days at +/- 30° off-nadir

- DLR Satellite, Principle investigator: GFZ
- Satellite Prime: Kayser-Threde, Munich, Germany
- Hyperspectral instrument, >200 channels (420–2450 nm)
- Platform for further operationalization of methods for information retrieval for land surface monitoring

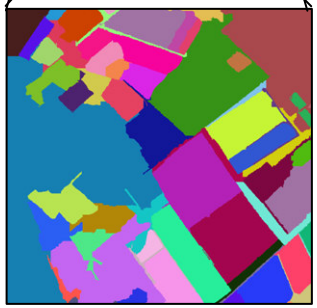
EnMAP – Principle and Applications



EnMAP

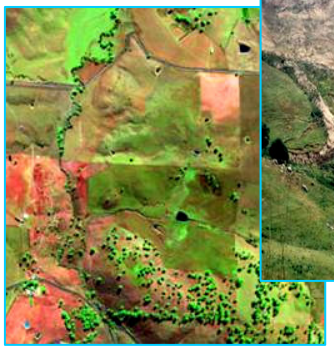


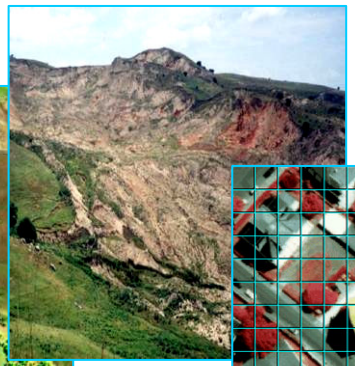
ARES



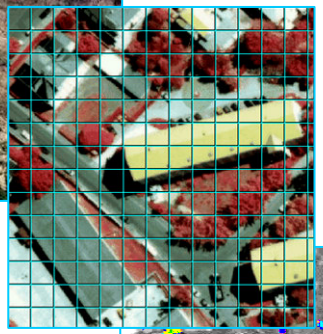
parameter extraction and modeling

management of agricultural and forest ecosystems

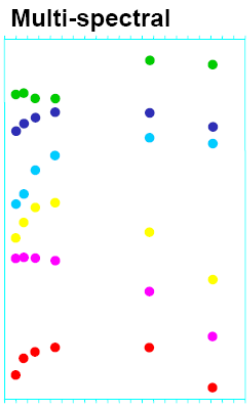


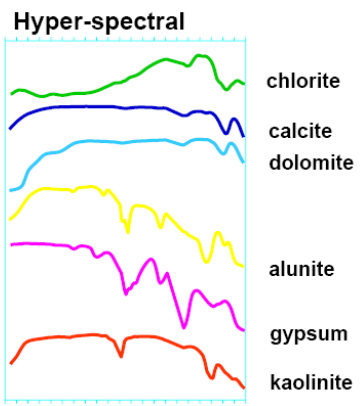


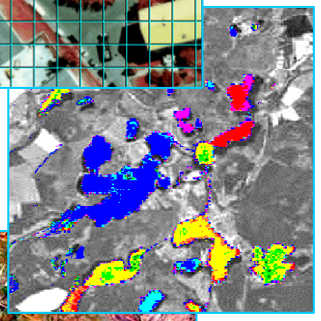
hazard assessment



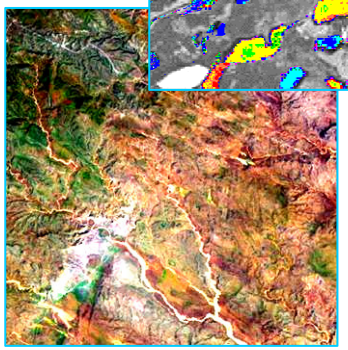
urban develop-ment



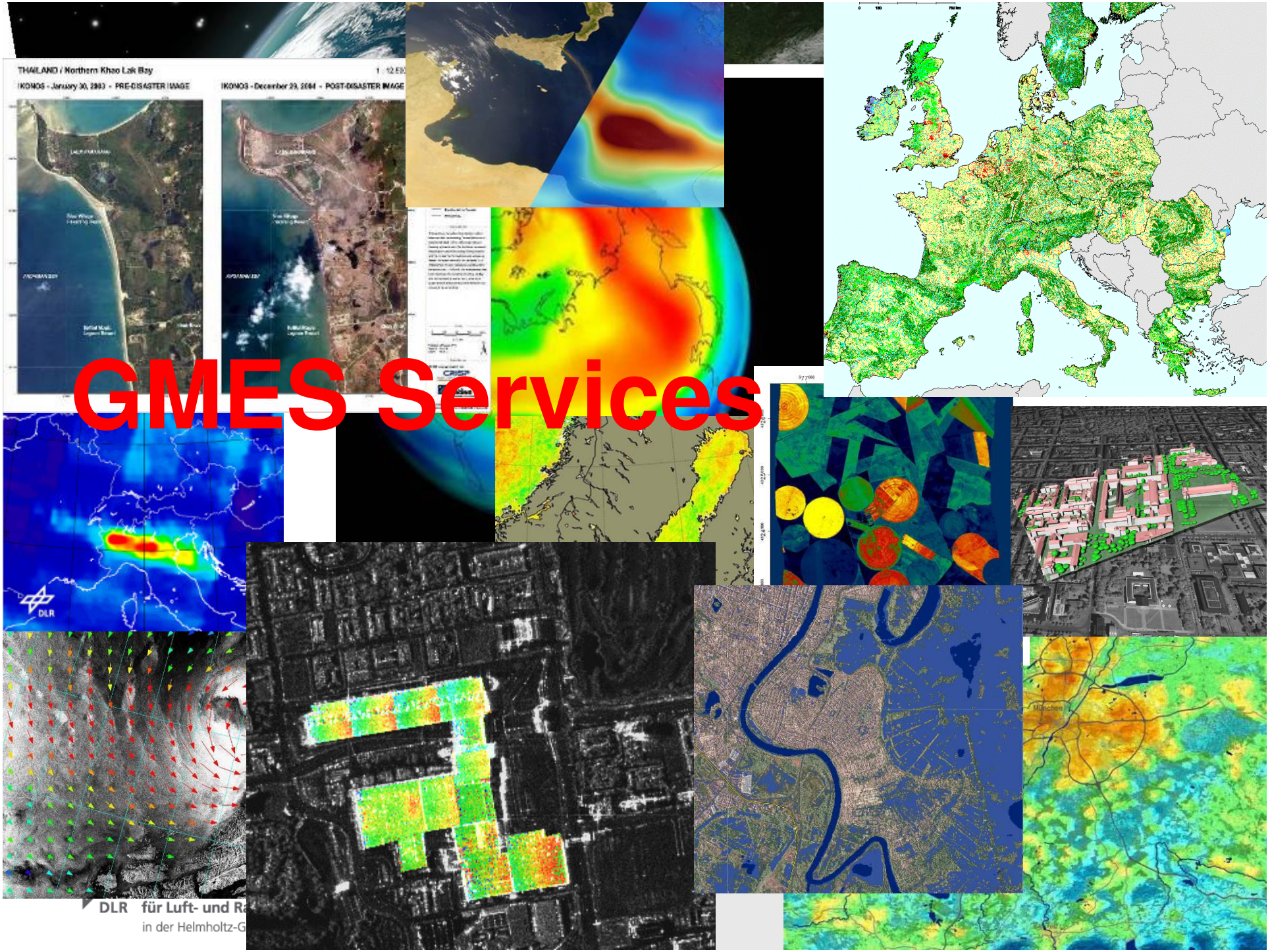




inland water

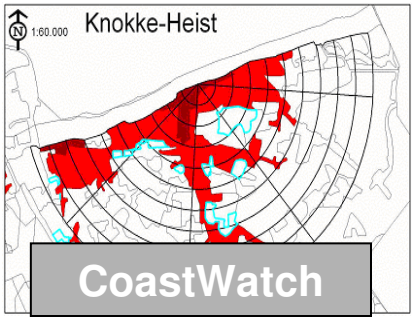


dry-land degradation

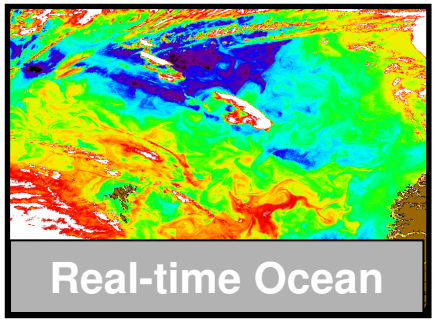


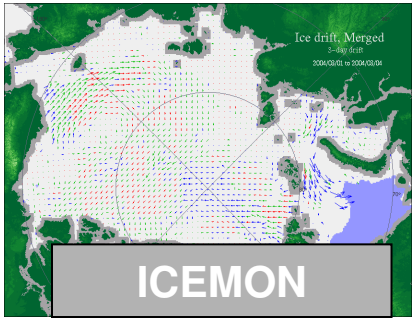
DLR für Luft- und Ra
in der Helmholtz-G

ESA GSE Initial Services in consolidation

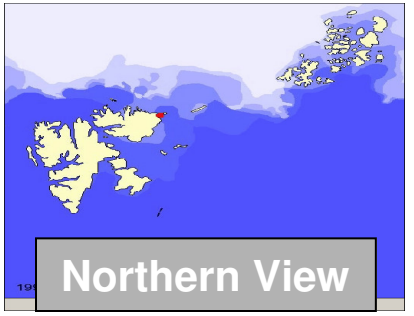


CoastWatch

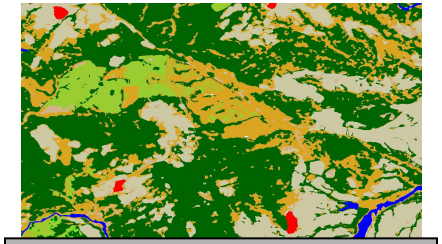

Real-time Ocean

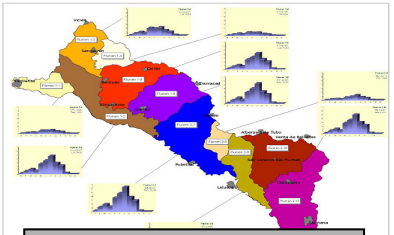


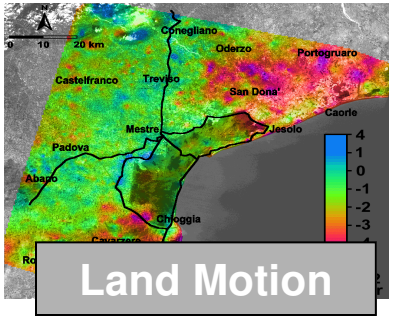
ICEMON


Northern View


Risk fire & flood


Forest Monitoring

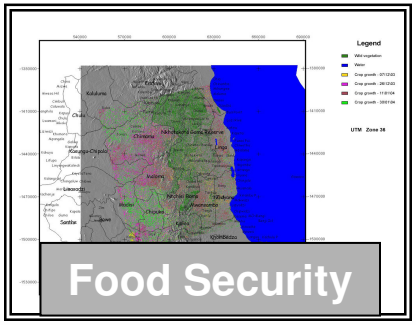

Soil & Water

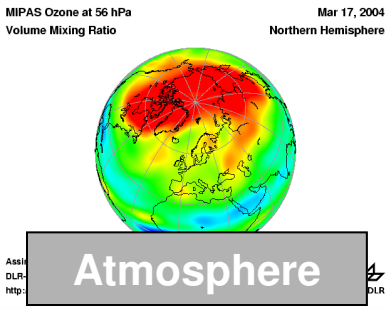


Land Motion


Urban Services

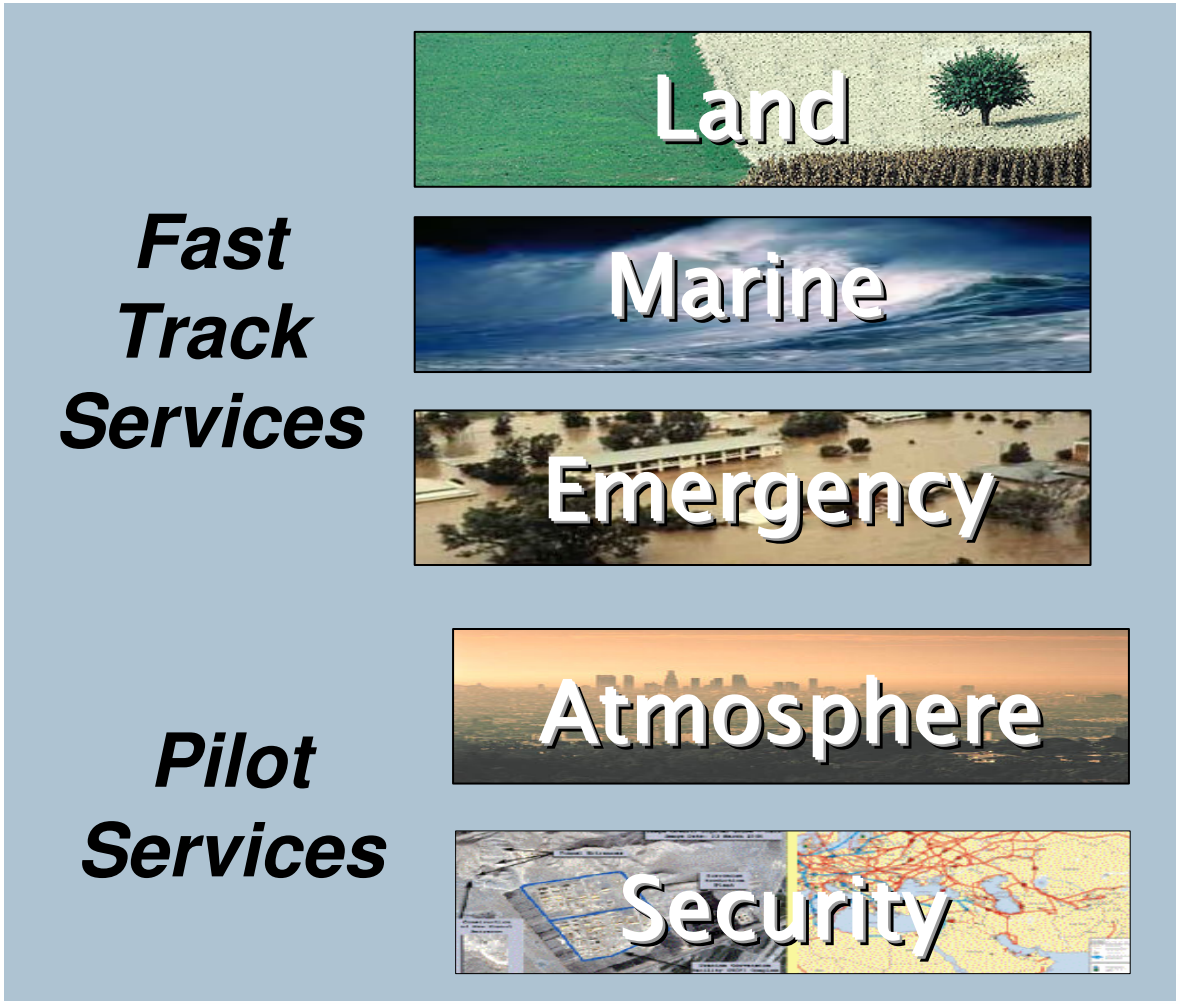

Humanitarian Aid


Food Security

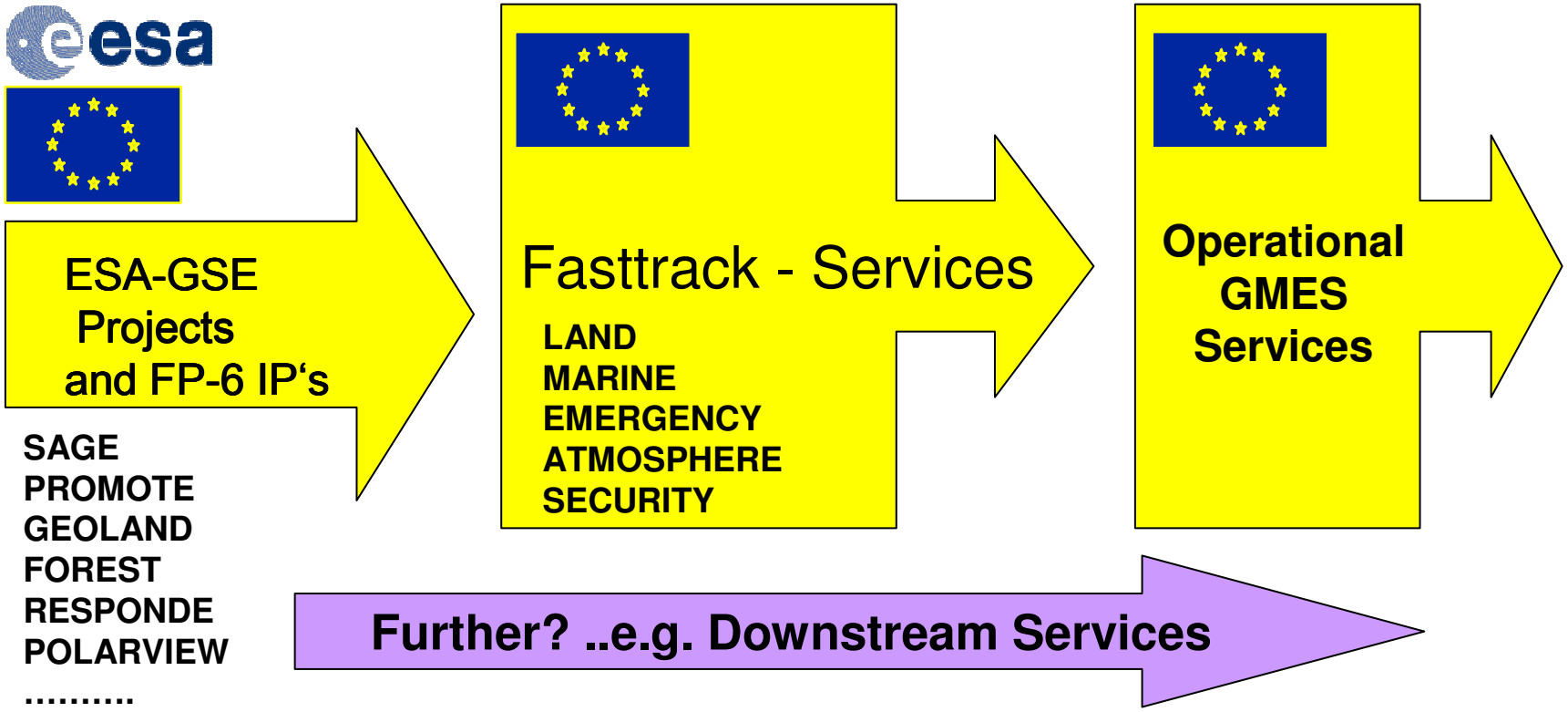


Atmosphere

The GMES service element



GMES Services and Evolution Overview



FP- 6 and ESA-Resources + FP- 7 Resources + Resources of DG's? + ?

2002 - 2007 **2006 - 2008** **>> 2008 …**

GMES Services implementation

Under implementation of FP7 (start 2008)

Five Proposals by European Consortia
- **GeoLand II**
- **MyOcean**
- **SAFER**
- **MACC**
- **G-Mosaic**

Under implementation of FP7 (call end 2008)

Thank You

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