

European Space Agency

Frank Martin Seifert
Earth Observation Programme
ESRIN, Frascati, Italy
Email: Frank.Martin.Seifert@esa.int

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Montreal, Canada. 6-8 March 2012

- ENVISAT → <http://www.esa.int/envisat>
- Unique acquisition mode **ASAR IS4** in alternate polarisation **VV/VH** until mid 2011
 - ~ 25 m spatial resolution
 - 35 days revisit → 30 days since end 2010
- Twice a year wall-to-wall coverage with **C-band** of all national demonstrators in cooperation with CSA
- Monthly to quarterly coverage of validation sites
- Building up C-band dense time series together with Radarsat-2 of selected priority 1 VS
- Examples over selected VS in IS4 and IS1



ENVISAT Orbit Change



ENVISAT orbit change in autumn 2010 to extend operation to 2013+



→ Gaps of some km at the Equator in IS4 AP!

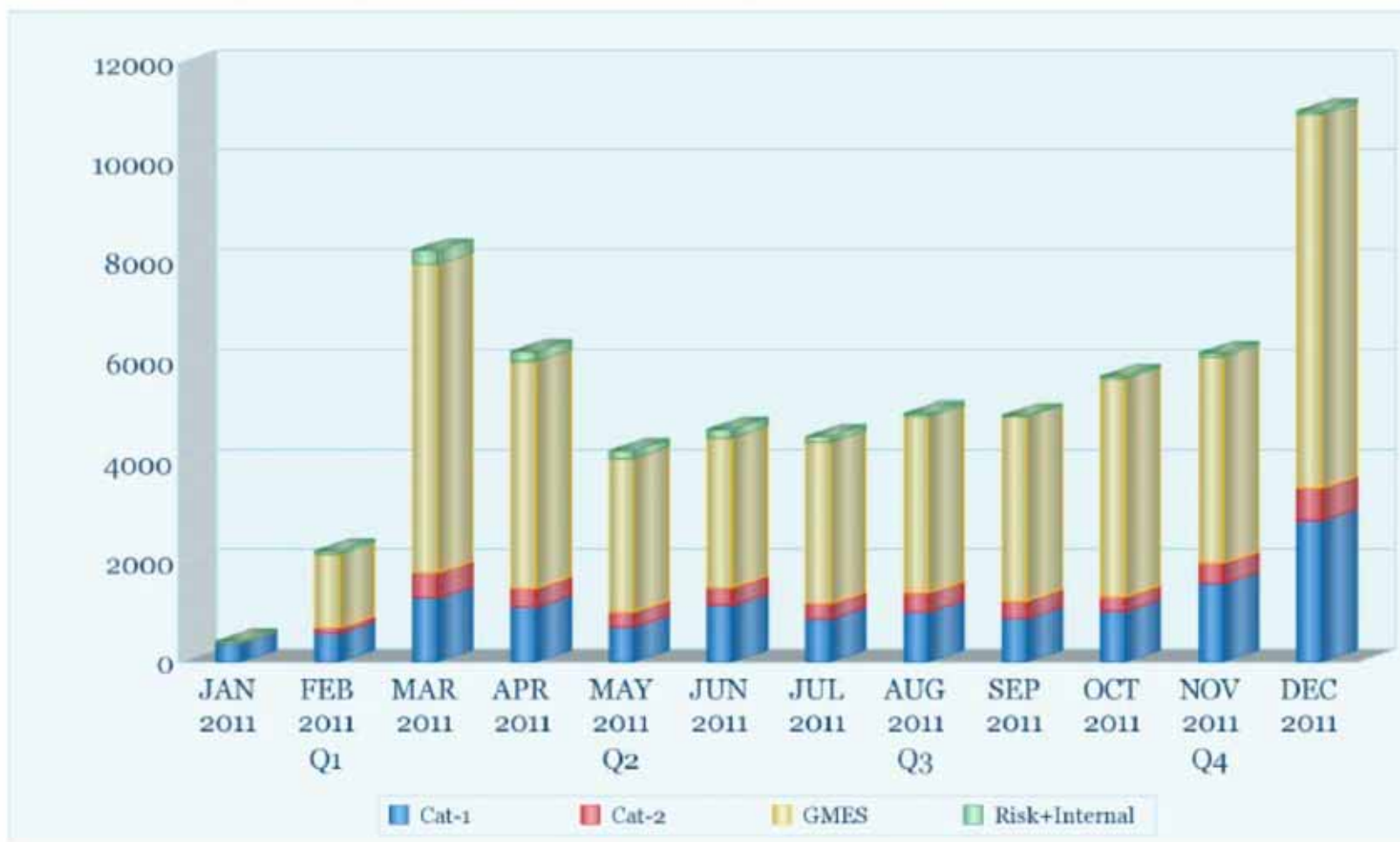
	Envisat extension orbit (i.e. from 02 November 2010)	Envisat nominal orbit (i.e. until 22 October 2010)
Repeat cycle	30 days (431 orbits per cycle)	35 days (501 orbits per cycle)
Orbit control	Only altitude control, no inclination control (i.e. inclination drift)	Altitude and inclination control (i.e. maintenance of ground track within ± 1 km)
Date	± 10 min	± 5 min

→ Changed to IS1 in alternate polarization

ENVISAT ASAR – Mission Planning



ENV Regional Mission (High Bit Rate) - Minutes Planned (Last Year)



High Bit Rate includes Image Mode, Alternate Polarisation Mode and Wide Swath Mode

ASAR was operated with a pre-defined planning until Feb 2011

GMES Sentinel Missions



Sentinel 1 – SAR imaging

All weather, day/night applications, interferometry

2013 (A), 2015+ (B)



Sentinel 2 – Multispectral imaging

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

2013 (A), 2015+ (B)



Sentinel 3 – Ocean and global land monitoring

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

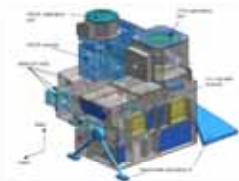
2013 (A), 2015+ (B)



Sentinel 4 – Geostationary atmospheric

Atmospheric composition monitoring, trans-
boundary pollution

2018



Sentinel 5 and Precursor – Low-orbit atmospheric

Atmospheric composition monitoring

2014 (5P), 2019



Free and open data policy!



Priorities for the preparation of pre-defined observation scenarios

Priority	Data Use
1 (FIRST Priority)	GMES use and National utilisation by Participating States in accordance with the GMES Space Component Programme Declaration
2	Other

Note: in all cases, the Sentinel data are available free of charge and following acceptance of the Terms and Conditions for the use of the data.

Sentinel-1: C-band SAR mission



✓ Data continuity of ERS and ENVISAT missions

✓ GMES C-band 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 launch date is 2015 (TBC)



Sentinel-1 SAR operational modes

Data recording / transmission capabilities



SAR operation modes:

Default modes:

- Interferometric Wide Swath (IWS): 250 km swath; level-1 product best res.: 20 m
- Wave (WV): sampled images of 20x20 km at 100 km along the orbit, alternating into 2 incidence angles; level-1 product best resolution: 50 m

Additional modes:

- Extra Wide Swath (EWS): 400 km swath; level-1 product best res.: 50 m
- Strip Map (SM): 80 km swath, 6 possible incidence angles; level-1 product best resolution: 9 m
(planned to be used exceptionally only)

SAR Duty cycle:

→ up to 25 min/orbit in high rate acquisition modes

Data recording / transmission capabilities :

- On-board data storage capacity of 1400 Gbit
- Two X-band RF channels of 260 Mbps each
- Equipped with an Optical Communication Terminal for GEO laser link with European Data Relay System



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
- **IWS** or EWS 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

High Level Strategy to fulfill 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 and “operational science” 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 (e.g. G-Mosaic)
- 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), supporting among others **forest mapping (e.g. REDD)**, soil moisture, land cover change, crop monitoring, etc. based on seasonal requirements

→ Baseline mode of operations: **IWS, if possible in dual-polarisation (HH +HV)**. Single polarisation HH however sufficient for INSAR applications



Initial Sentinel-1 Observation Scenario & Evolution



From Commissioning Phase to Full Operational Capability (FOC)

- a very basic observation / operations scenario will support the Commissioning phase
- Ramp-up phase: the scenario will gradually evolve from initial operations up to Full Operational Capability of the first satellite.



Evolution during GSC operational phase, to cope in particular with:

- The inclusion of the 2nd Sentinel-1 satellite leading to the Full Operational Capacity of the missions with the 2-satellite constellation during the EU Operational Programme (2014+)
- The gradual use of the EDRS system to improve the data download capacity
- The evolution of the requirements from the services, the evolution of the “perimeter” of the GMES services as defined by the EC
- The constraints on the space and ground segment resources (e.g. core and collaborative ground station networks)
- The contribution of (and interoperability with) RCM

➔ It is planned to set up a procedure for a regular (e.g. yearly) update of the S-1 observation plan during routine operations



Synergy Sentinel-1 / RCM



- CSA-ESA discussions on-going to explore synergies between Sentinel-1 and Radarsat Constellation Mission (RCM) and in view of a certain level of interoperability between the missions
- RCM – Sentinel-1 interoperability would bring strong benefits to users
- The following interoperability items are explored:
 - Joint / integrated pre-defined observation plans (complementarities in observations / modes, increased revisit, etc.)
 - Level 1 Product format
 - Harmonisation of catalogue interface
 - Development of common tools
 - Harmonised communication, joint publications etc.
- A joint calibration working group is being set up



*In addition, **cooperation to support international activities** should be continued (example of the International Polar Year, GEO FCT), setting up complementary observations (e.g. sharing of Arctic / Antarctic coverage).*



Sentinel-2: Multispectral Optical Mission

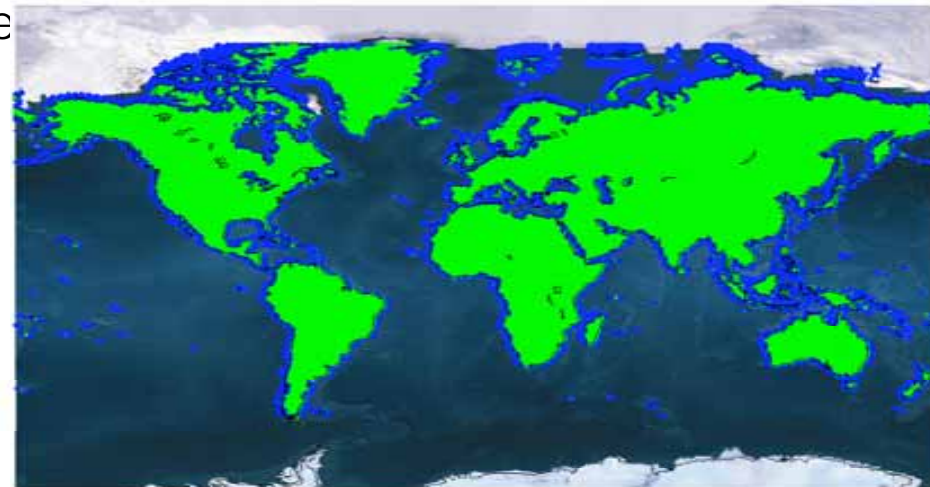


- ✓ **2 Satellites** in twin formation, **launch Nov 2013** (and 2015)
- ✓ **Orbit:** Sun-synchronous at 786 km (14+3/10 revs/day), with **LTDN 10:30 AM**
- ✓ **Revisit: 5 days** at equator (with 2 satellites) under same viewing conditions;
- ✓ **Multispectral Instrument:** pushbroom with 13 bands in the visible, near infra-red (VNIR) and short wave infra-red (SWIR) part of the spectrum
- ✓ High **spatial resolution:** 10m, 20m and 60m;
- ✓ Wide **field of view:** 290 km
- ✓ **Duty cycle:** average 17 min/orbit, maximum 32 min /orbit
- ✓ **Lifetime:** 7.25 years, extendable to 12 ye

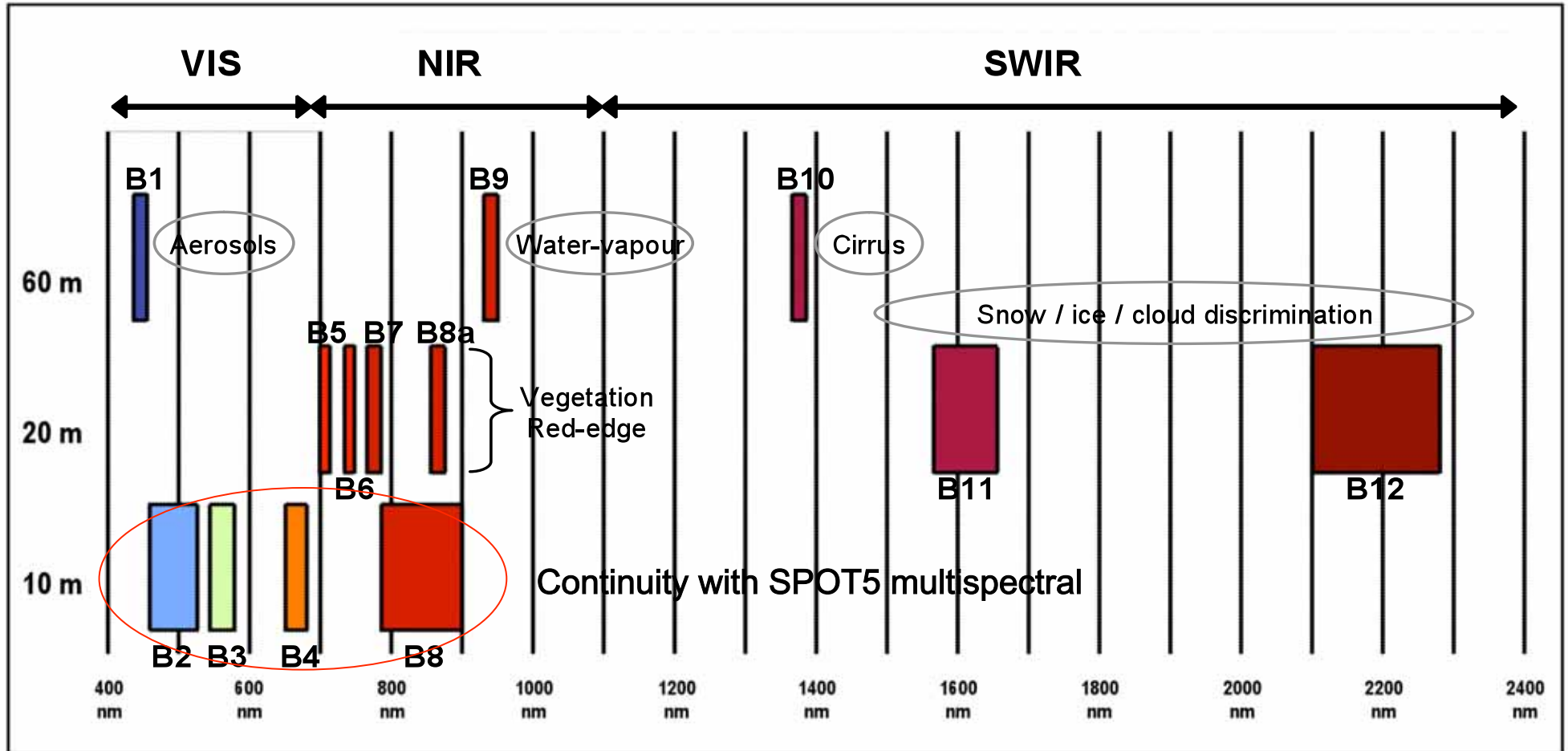


Geographical Coverage:

- All land masses 56° S bis 83° N incl. major islands (>100 km²)
- All EU islands < 20 km off the coast
- All Mediterranean
- Inland waters and all closed seas



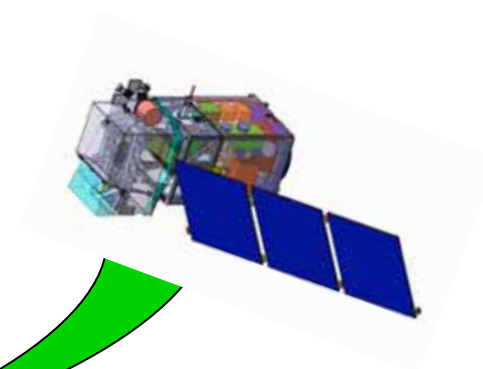
Sentinel-2: 13 Spectral Bands



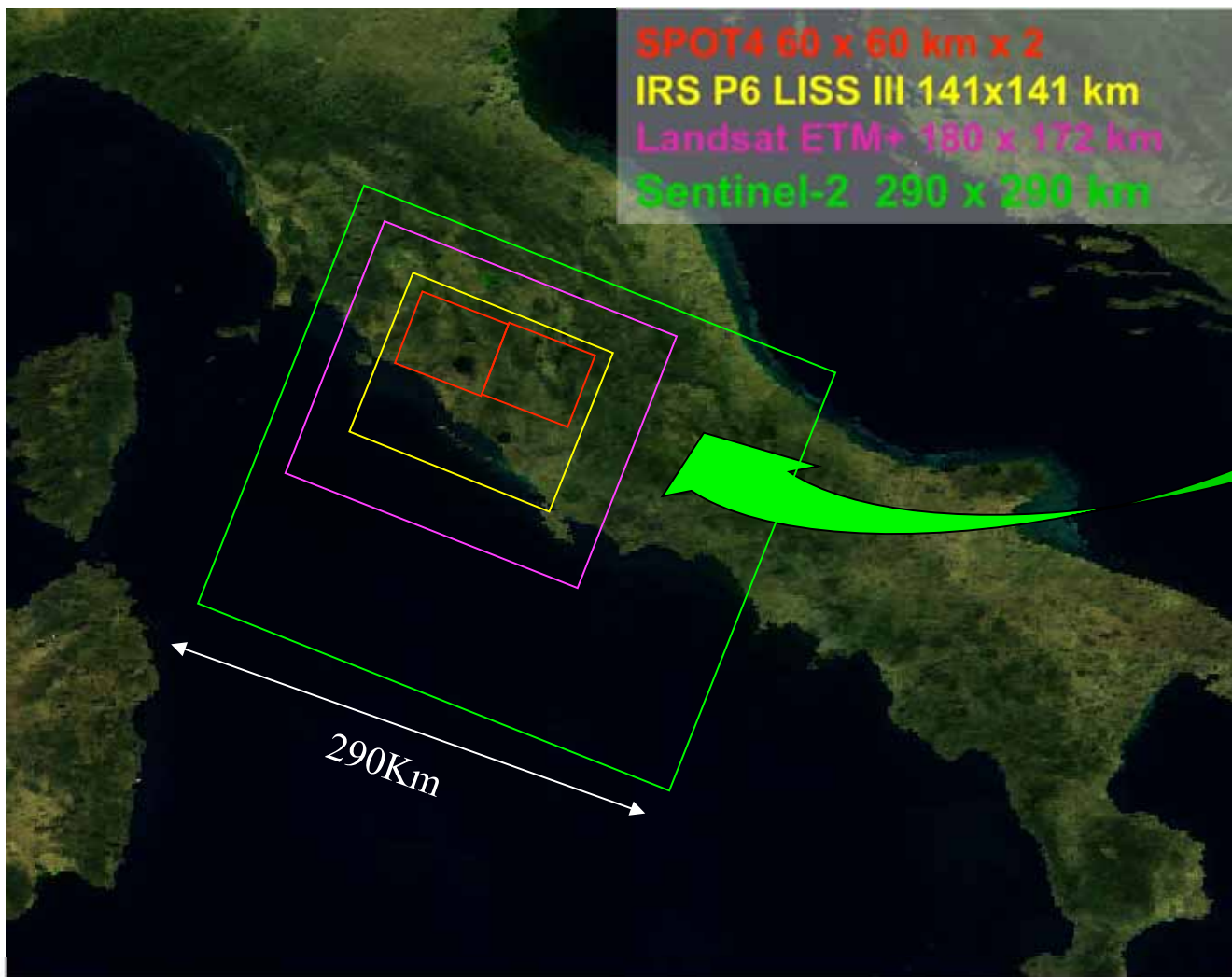
Sentinel-2: Swath



SPOT4 60 x 60 km x 2
IRS P6 LISS III 141x141 km
Landsat ETM+ 180 x 172 km
Sentinel-2 290 x 290 km



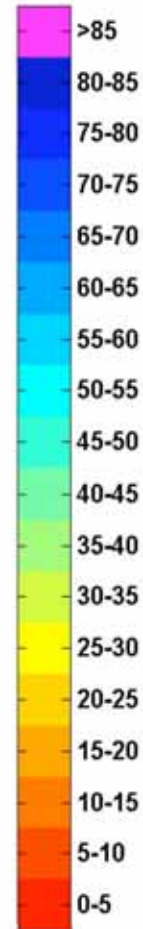
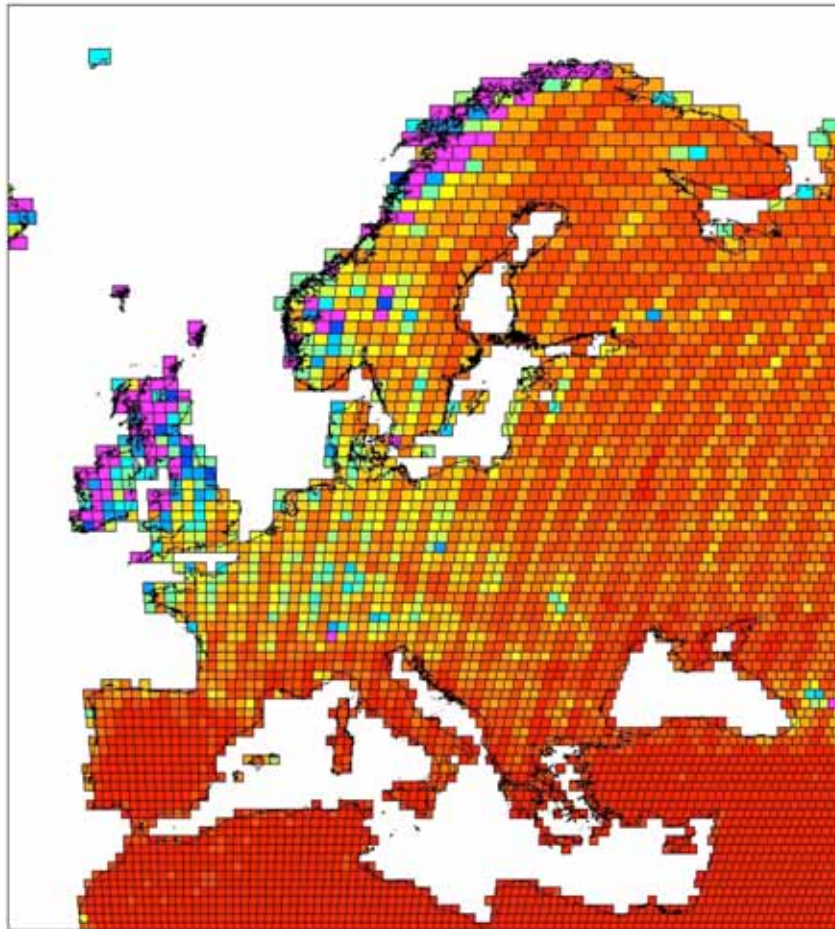
High revisit time assured by twin satellite observations performed over a very large swath



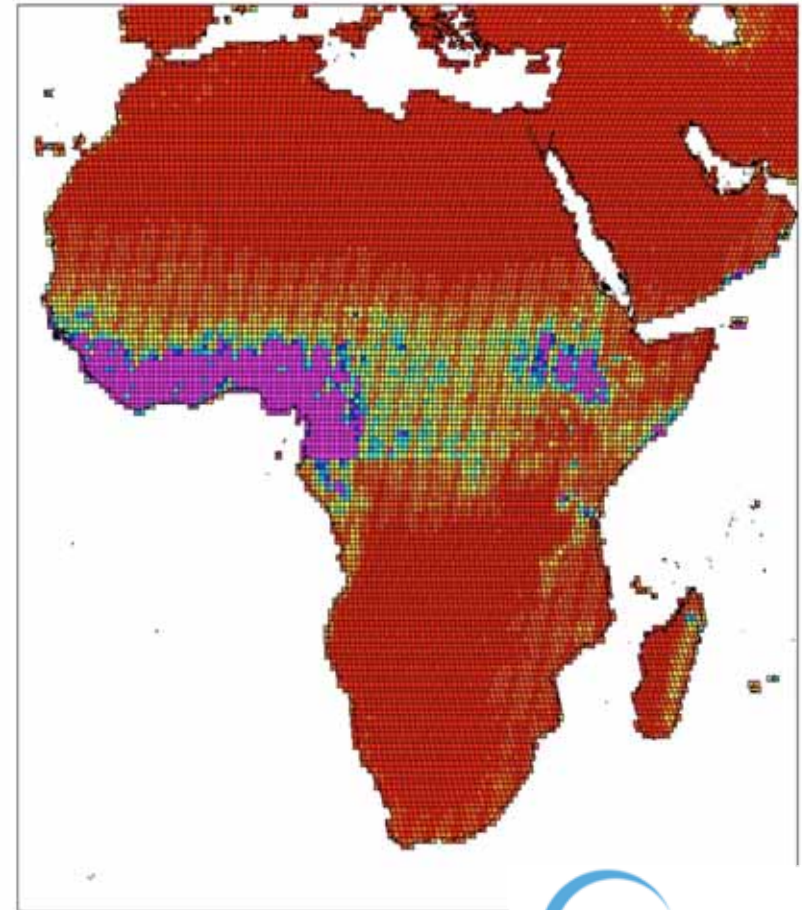
Sentinel-2 simulated repeat rates – in summer with 2 Satellites



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



days



Sentinel-2 Symposium



→ **SENTINEL-2**

PREPARATORY SYMPOSIUM

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



<http://www.s2symposium.org/>

