MINISTERSTVO ŠKOLSTVA, VEDY, VÝSKUMU A ŠPORTU SLOVENSKEJ REPUBLIKY

ESA ECS Training Course on Earth Observation in Slovakia

17th – 21th September 2018

ESA Earth Observation Introduction

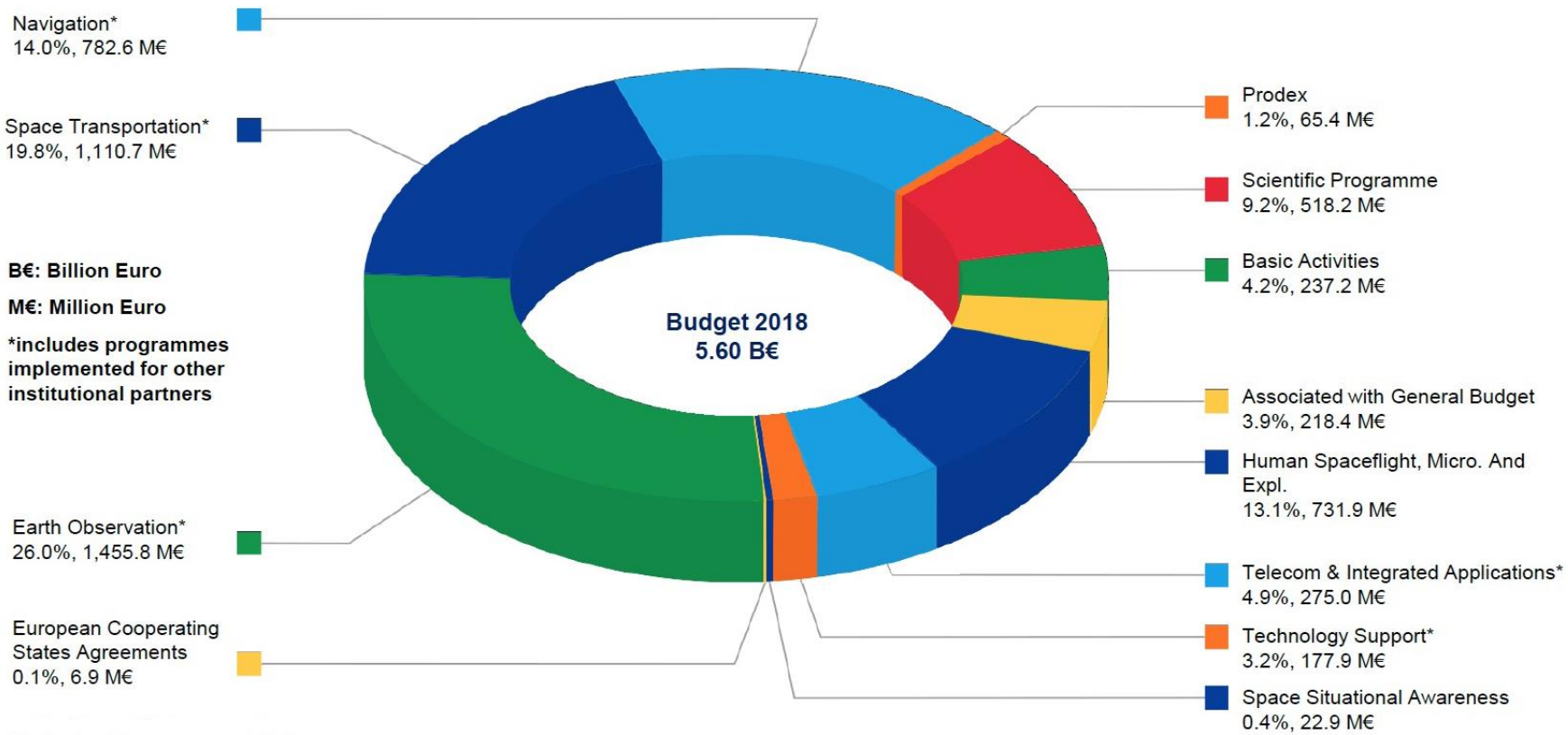
Francesco Sarti

Sept 2018

ESA facts and figures

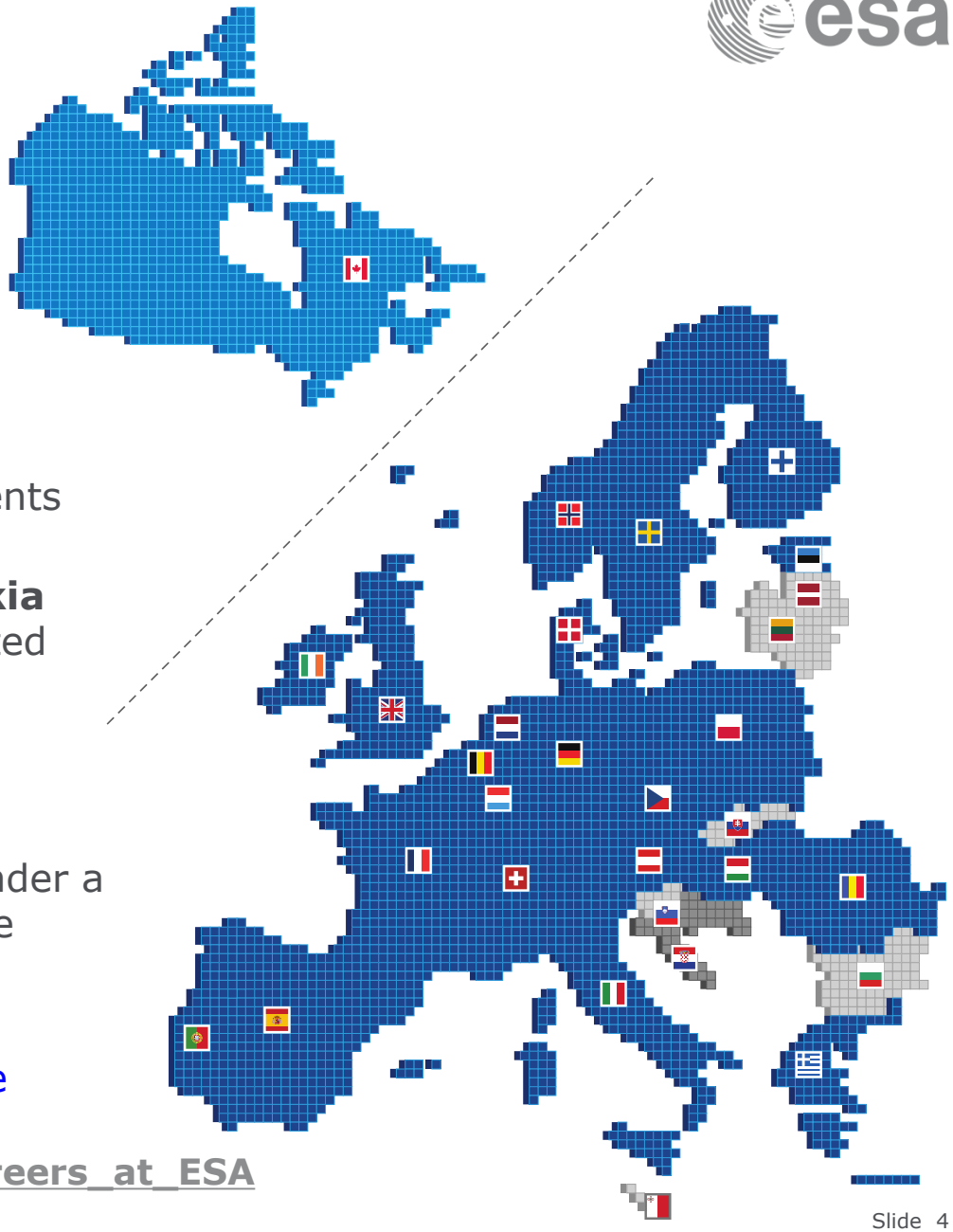
- Over 50 years of experience
- 22 Member States
- Eight sites/facilities in Europe, about 2200 staff
- 5.6 billion Euro budget (2018)
- Over 80 satellites designed, tested and operated in flight

ESA Budget per Domain - 2018



Member States

ESA has 22 Member States: 20 states of the EU (AT, BE, CZ, DE, DK, EE, ES, FI, FR, IT, GR, HU, IE, LU, NL, PT, PL, RO, SE, UK) plus Norway and Switzerland. Slovenia is now an associate member.



7 EU States (*) have Cooperation Agreements with ESA:

Bulgaria, Cyprus, Latvia, Lithuania, **Slovakia** are so-called **ECS**, activities are implemented through the Plan for European Cooperating States (**PECS**);

Croatia and Malta are Cooperating States.

Canada takes part in some programmes under a long-standing Cooperation Agreement since 1979.

(*) possibility to apply to some ESA trainee positions (temporary positions): YGT, RF.

See: https://www.esa.int/About_Us/Careers_at_ESA
(→ STUDENT OPPORTUNITIES)

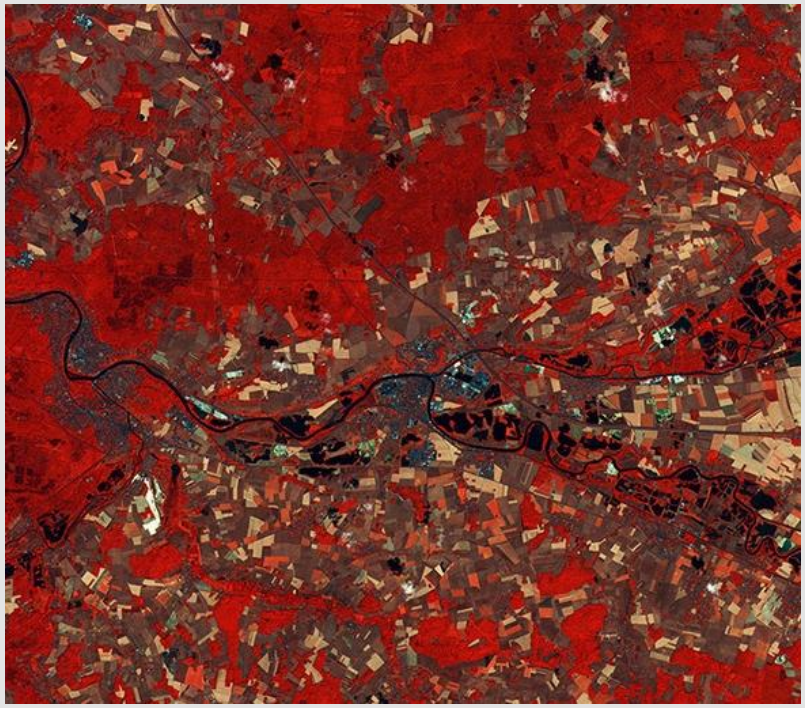
EARTH OBSERVATION

Pioneers in Earth observation

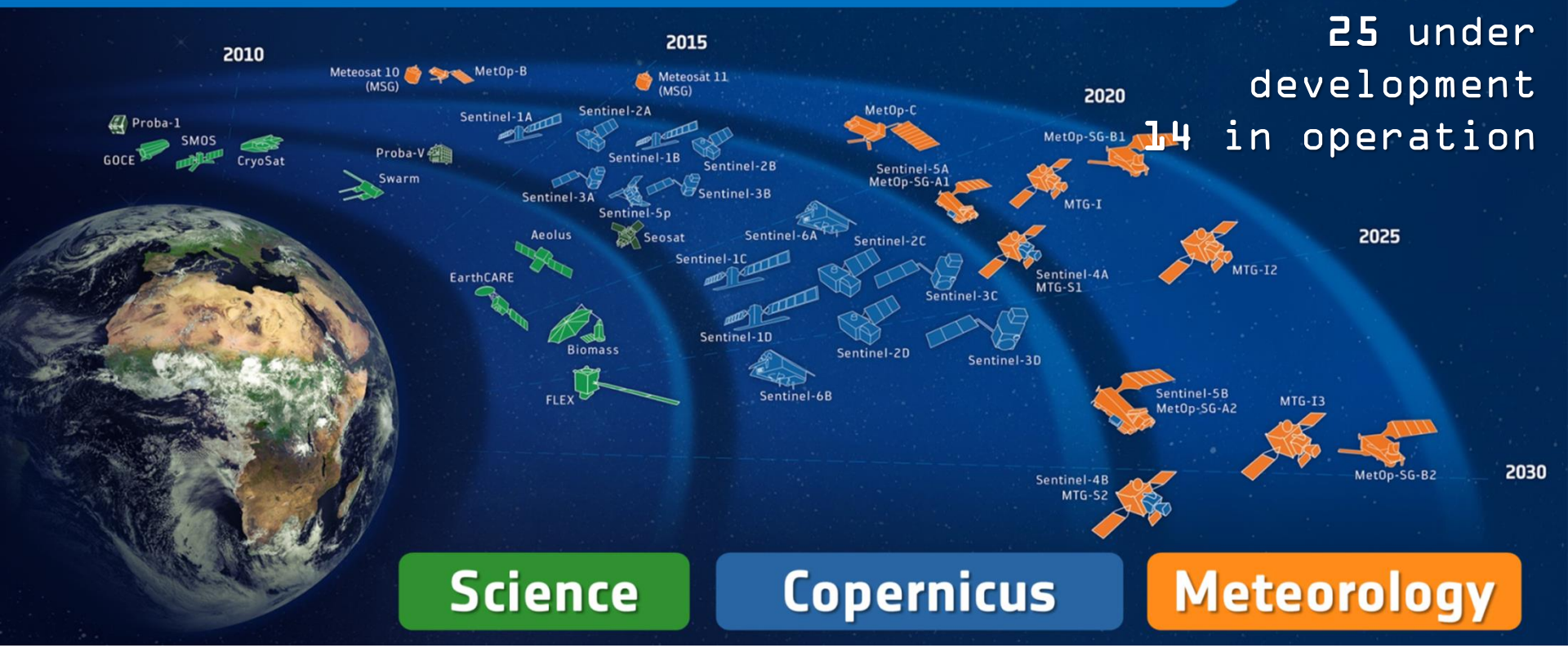
ESA has been dedicated to observing Earth from space ever since the launch of its first meteorological mission, **Meteosat-1** in 1977.

ERS-1 (1991–2000) and **ERS-2** (1995–2011) providing a wealth of invaluable data about Earth, its climate and changing environment.

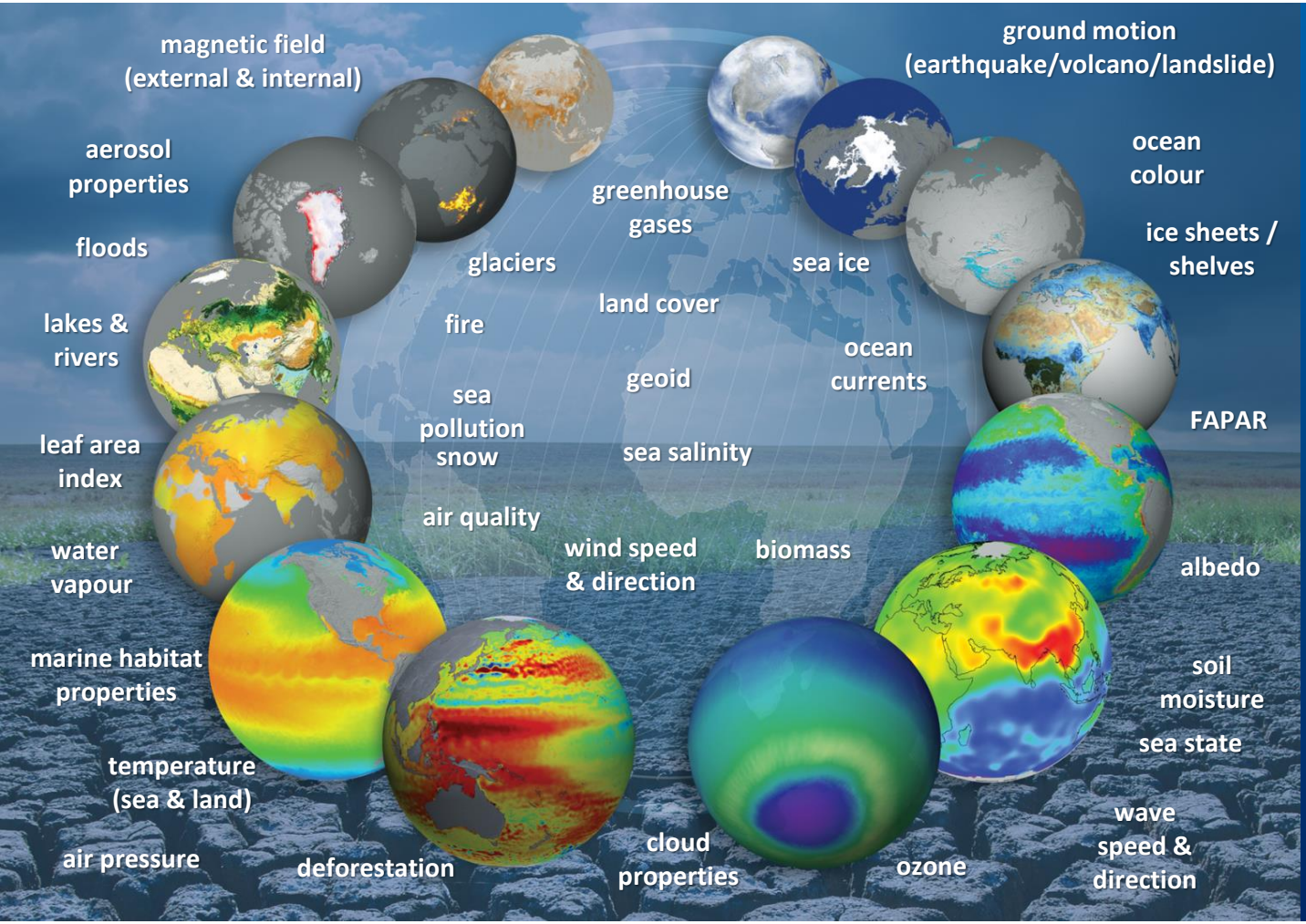
Envisat (2002–12) the largest satellite ever built to monitor the environment, provided continuous observation of Earth's surface, atmosphere, oceans and ice caps.



ESA-DEVELOPED EARTH OBSERVATION MISSIONS



Satellites
25 under development
14 in operation



ESA provides EO mission data addressing almost **all** parameters retrievable by EO satellites

➔ **Extreme user diversity**

Copernicus

Copernicus – a new Phase in EO

European Earth Observation System, led by the EU

European response to global needs:

- to manage the environment
- to mitigate the effects of climate change
- to ensure civil security

European independence, contribution to global system (GEOSS)

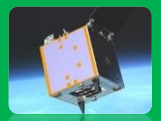
CSC: Sentinel Satellites

	Sentinel 1 (A/B/C/D) **SAR Imaging**	All weather, day/night applications, interferometry
	Sentinel 2 (A/B/C/D) **Multispectral Imaging**	Land applications: urban, forest, agriculture, … Continuity of Landsat, SPOT
	Sentinel 3 (A/B/C/D) **Ocean & Global Land Monitoring**	Wide-swath ocean colour, vegetation, sea/land surface temperature, altimetry
	Sentinel 4 (A/B) **Geostationary Atmospheric**	Atmospheric composition monitoring, pollution; instrument on MTG satellites
	Sentinel 5 (A/B/C) & Precursor **Low-Orbit Atmospheric**	Atmospheric composition monitoring; instrument on MetOp-SG satellites
	Sentinel 6 **Jason CS (A/B)**	Altimetry reference mission

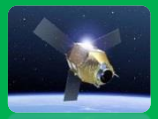
Contributing Missions

Optical High & Very High Resolution

DMC



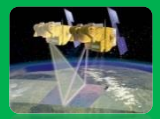
Pléiades



RapidEye

Deimos-2

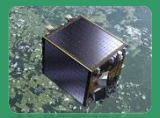
SPOT (HRS)



Optical Medium & Low Resolution

SPOT

PROBA-V



Synthetic Aperture Radar

Cosmo SkyMed

Radarsat

TerraSAR-X Tandem-X

Altimetry

Cryosat

Jason

Atmosphere

MetOp

MSG

and many more …

Sentinel Status

S-1

Radar

- **A** 3 Apr. 2014
- **B** 25 Apr. 2016
- **C** 2022/23
- **D** > 2022/23

S-2

High Res. Optical

- **A** 23 Jun. 2015
- **B** 6 Mar. 2017
- **C** 2022/23
- **D** > 2022/23

S-3

Medium Res. Optical & Altimetry

- **A** 16 Feb. 2016
- **B** 25 Apr. 2018
- **C** 2023
- **D** > 2023

S-4

Atmospheric Chemistry (GEO)

- **A** 2021
- **B** 2027

S-5P

Atmospheric Chemistry (LEO)

- **A** 13 Oct. 2017

S-5

Atmospheric Chemistry (LEO)

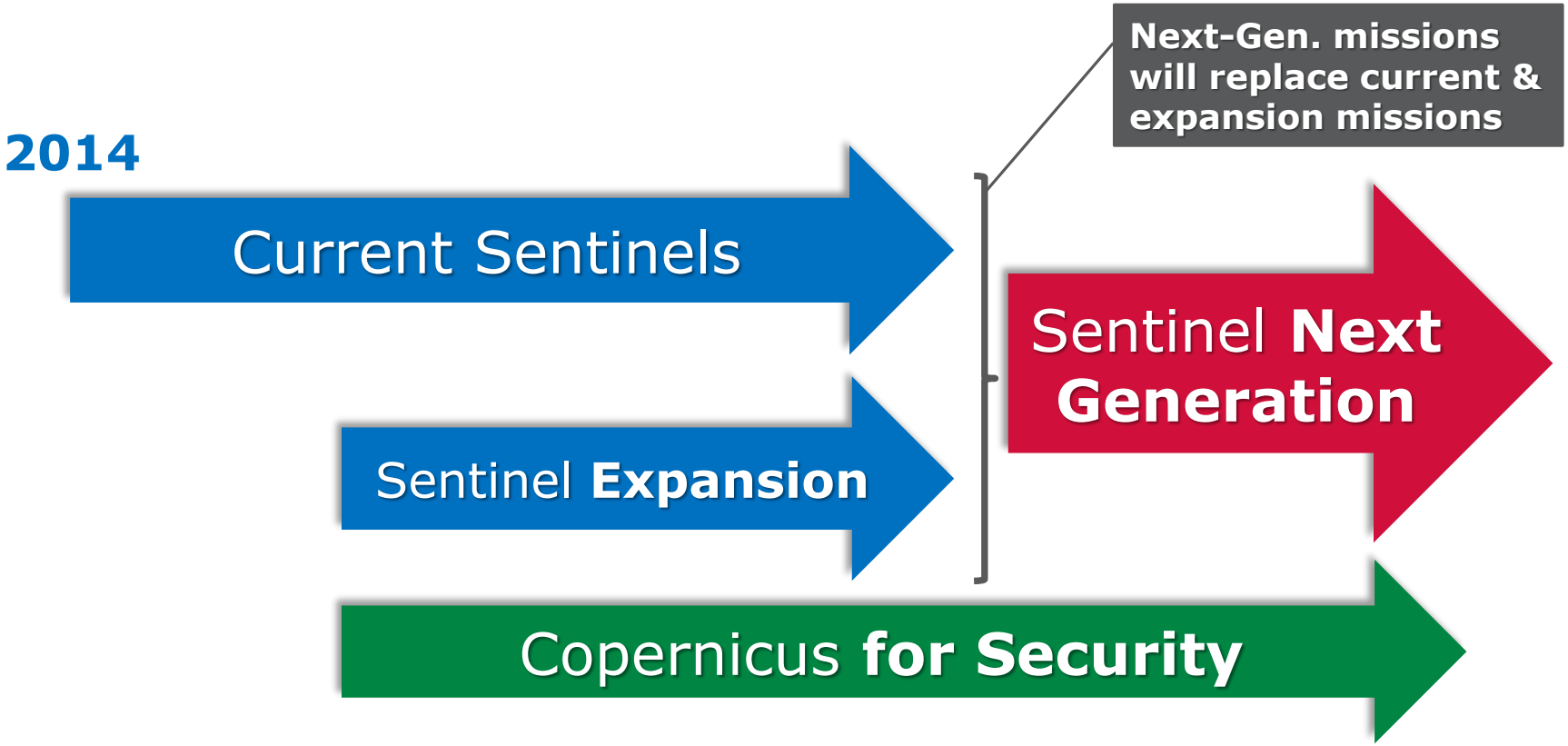
- **A** 2021
- **B** 2027
- **C** > 2027

S-6

Altimetry

- **A** 2020
- **B** 2025

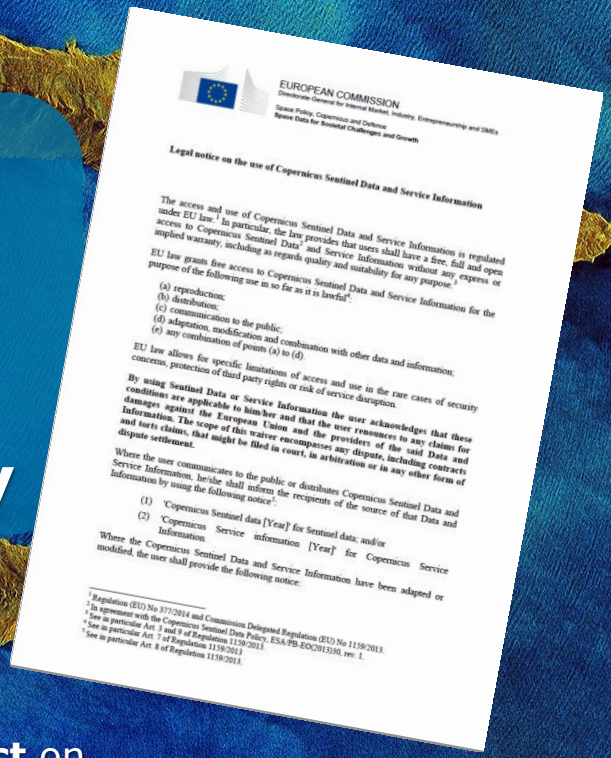
Copernicus Space Component Evolution



Copernicus Sentinel Data Policy

Sentinel data are available:

- ✓ **Free, Full and Open***
- ✓ **Over very long term**
- ✓ **Systematically, Operationally**



EUROPEAN COMMISSION
Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
Space Policy, Copernicus and Defence
Space Data for Societal Challenges and Growth

Legal notice on the use of Copernicus Sentinel Data and Service Information

The access and use of Copernicus Sentinel Data and Service Information is regulated under EU law.[1] In particular, the law provides that users shall have a free, full and open access to Copernicus Sentinel Data[2] and Service Information without any, express or implied warranty, including as regards quality and suitability for any purpose.[3]

EU law grants free access to Copernicus Sentinel Data and Service Information for the purpose of the following use in so far as it is lawful[4]:

(a) reproduction;
(b) distribution;
(c) communication to the public;
(d) adaptation, modification and combination with other data and information;
(e) any combination of points (a) to (d).

EU law allows for specific limitations of access and use in the rare cases of security concerns, protection of third party rights or risk of service disruption.

By using Sentinel Data or Service Information the user acknowledges that these conditions are applicable to him/her and that the user renounces to any claims for damages against the European Union and the providers of the said Data and Information. The scope of this waiver encompasses any dispute, including contracts and torts claims, that might be filed in court, in arbitration or in any other form of dispute settlement.

Where the user communicates to the public or distributes Copernicus Sentinel Data and Service Information, he/she shall inform the recipients of the source of that Data and Information by using the following notice[5]:

(1) 'Copernicus Sentinel data [Year]' for Sentinel data; and/or
(2) 'Copernicus Service information [Year]' for Copernicus Service Information.

Where the Copernicus Sentinel Data and Service Information have been adapted or modified, the user shall provide the following notice:

[1] Regulation (EU) No 377/2014 and Commission Delegated Regulation (EU) No 1159/2013.
[2] In agreement with the Copernicus Sentinel Data Policy, ESA/PB-EO(2013)30, rev. 1.
[3] See in particular Art. 3 and 9 of Regulation 1159/2013.
[4] See in particular Art. 7 of Regulation 1159/2013.
[5] See in particular Art. 8 of Regulation 1159/2013.

*** ESA Sentinel Data Policy** (Sep 2013) and **EU Delegated Act** on Copernicus Data and Information Policy (Dec 2013)

European Space Agency

DIAS – Creating an EO Data Ecosystem

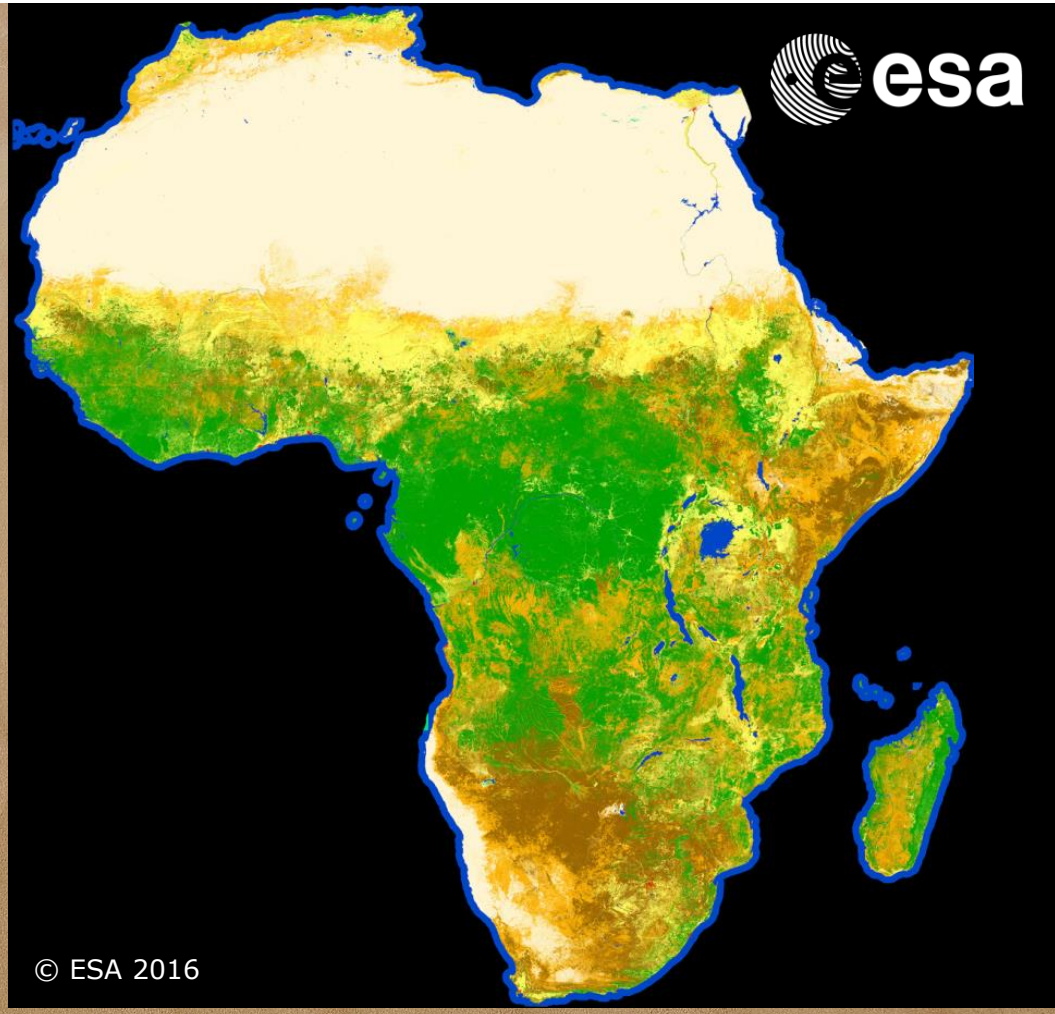
- Copernicus **D**ata and **I**nformation **A**ccess **S**ervices
- Common DG-GROW-ESA approach to EO data exploitation with Copernicus at its core
- Create & enable European EO Data ecosystem for research & business
- Starts in June 2018

Copernicus' Land Applications

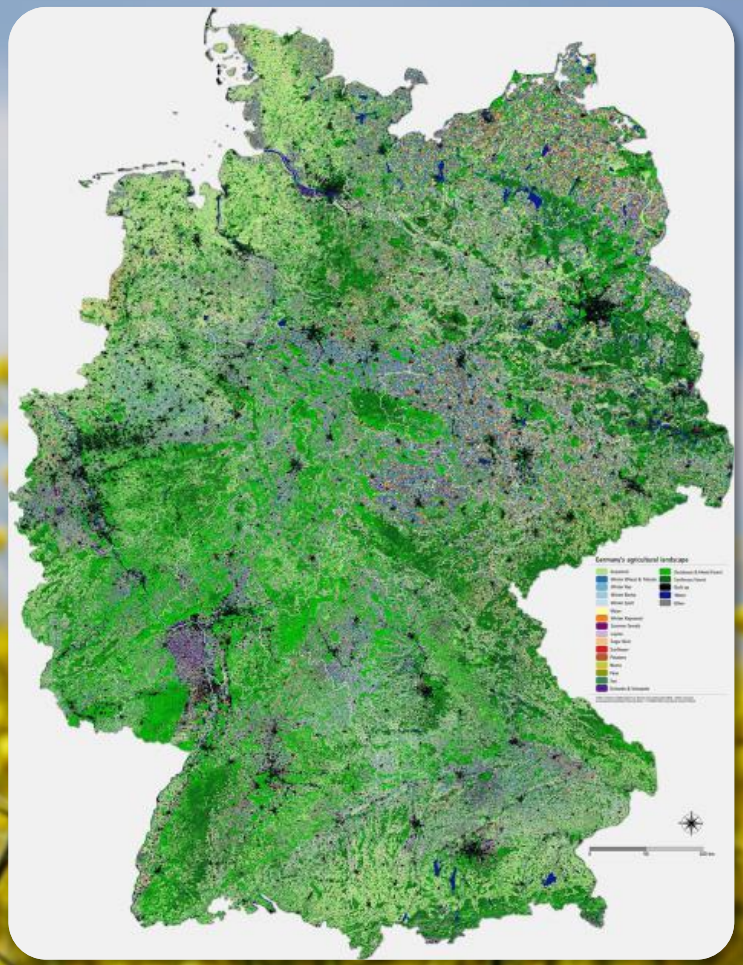
Land Cover Typology

180.000 Sentinel-2A images
Dec. 2015 – Dec. 2016

- no data
- Trees cover areas
- Shrubs cover areas
- Grassland
- Cropland
- Vegetation aquatic or regularly flooded
- Lichen Mosses / Sparse vegetation
- Bare areas
- Built up areas
- Snow and/or Ice
- Open water



Agricultural Land Use

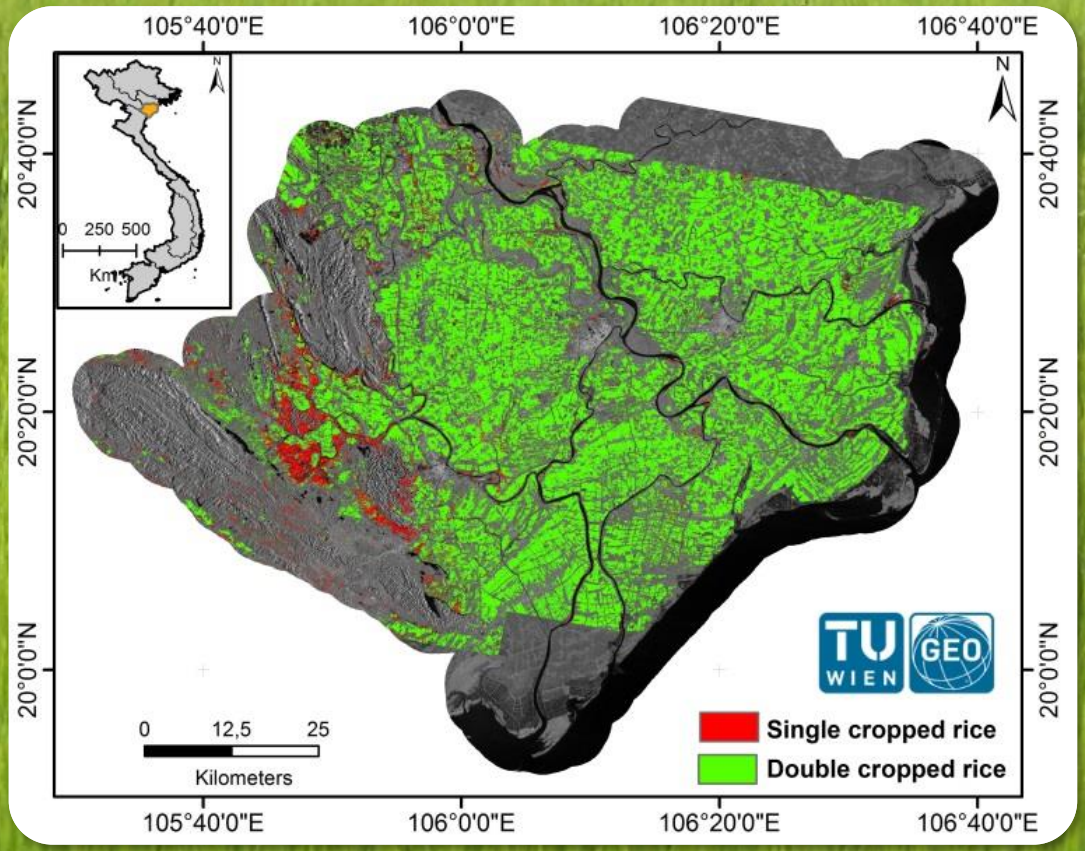


Distinguishing 15 crop types
Germany

Mixed Sentinel-2 and Landsat-8 Data

© Humboldt
University Berlin
P. Griffiths

Monitoring Rice Yields

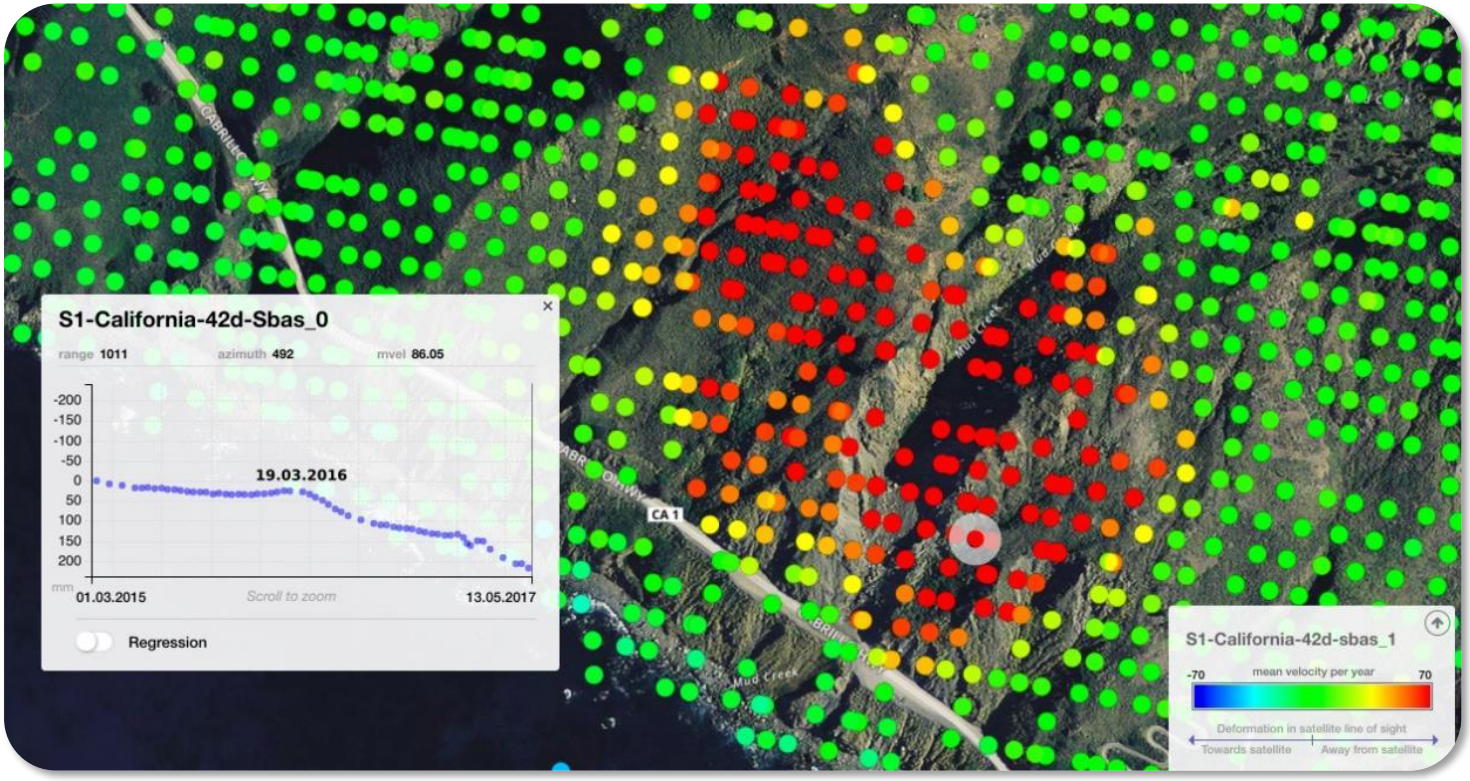


Duong Delta
Nothern Vietnam

Based on Sentinel-1 Data

© TU Wien, GEO

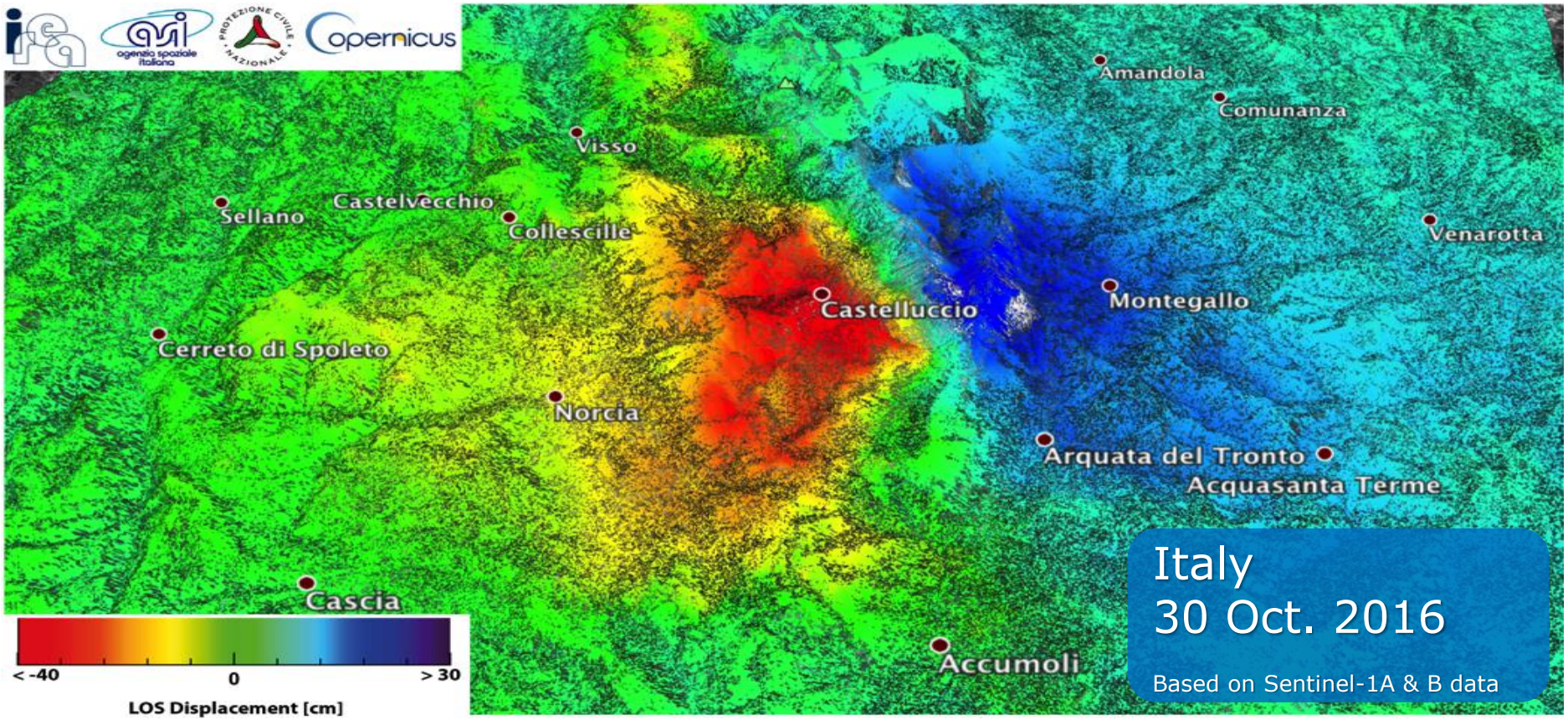
Landslides



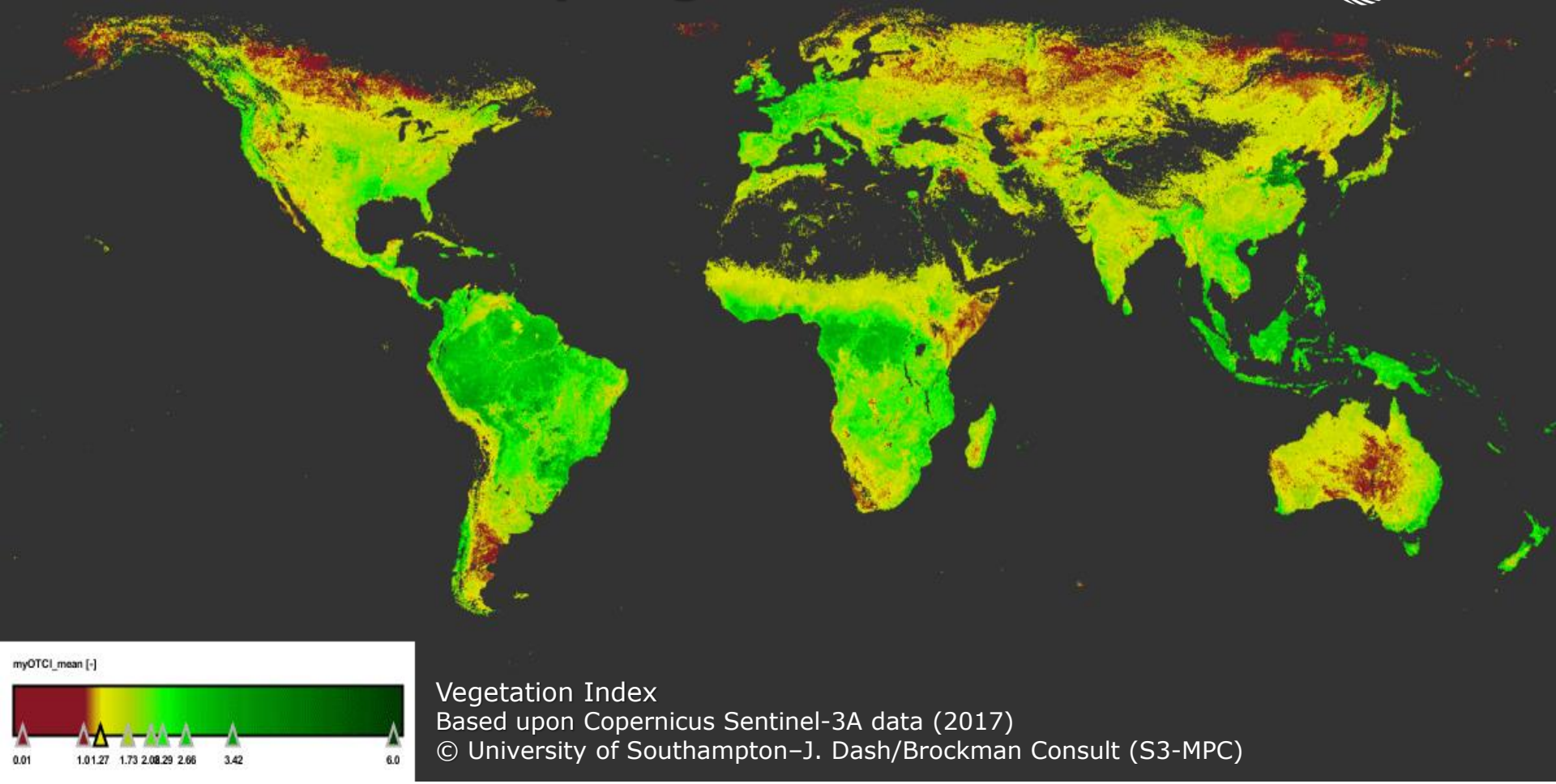
Highway 1
California
U.S.

Based on Sentinel-1 data (2015–17), processed by Norut

Earthquakes

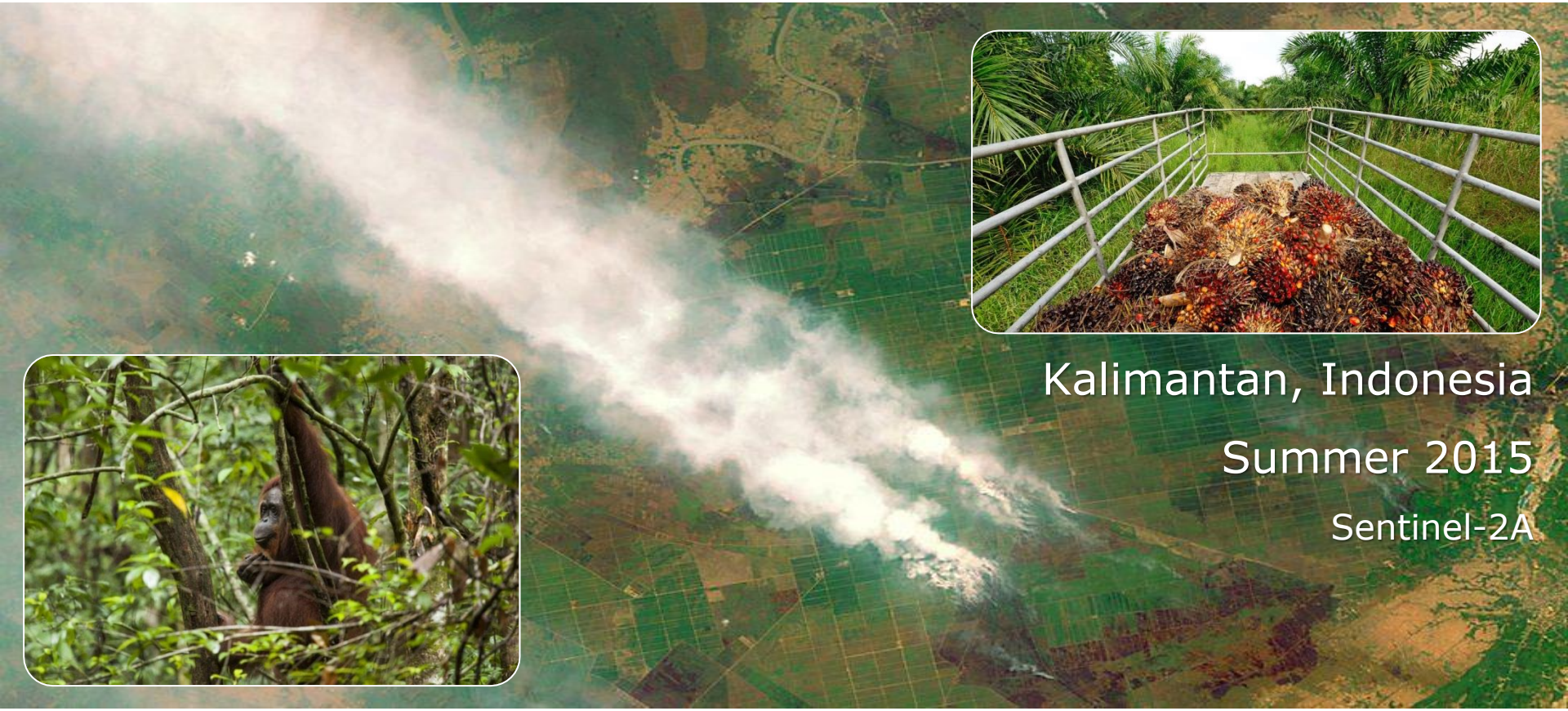


Plant Growth in Spring

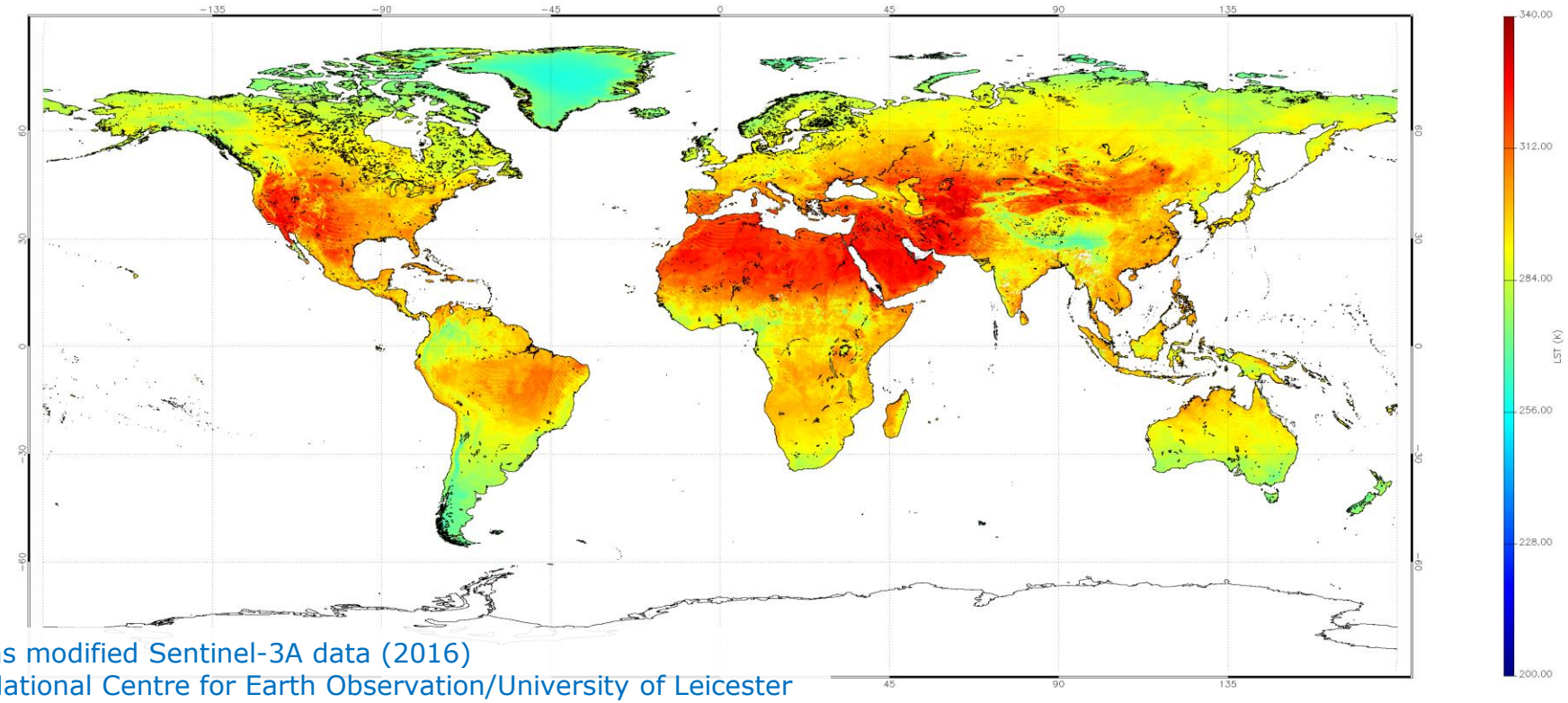


Vegetation Index
Based upon Copernicus Sentinel-3A data (2017)
© University of Southampton–J. Dash/Brockman Consult (S3-MPC)

Ecosystem Destruction



Earth Surface Heat



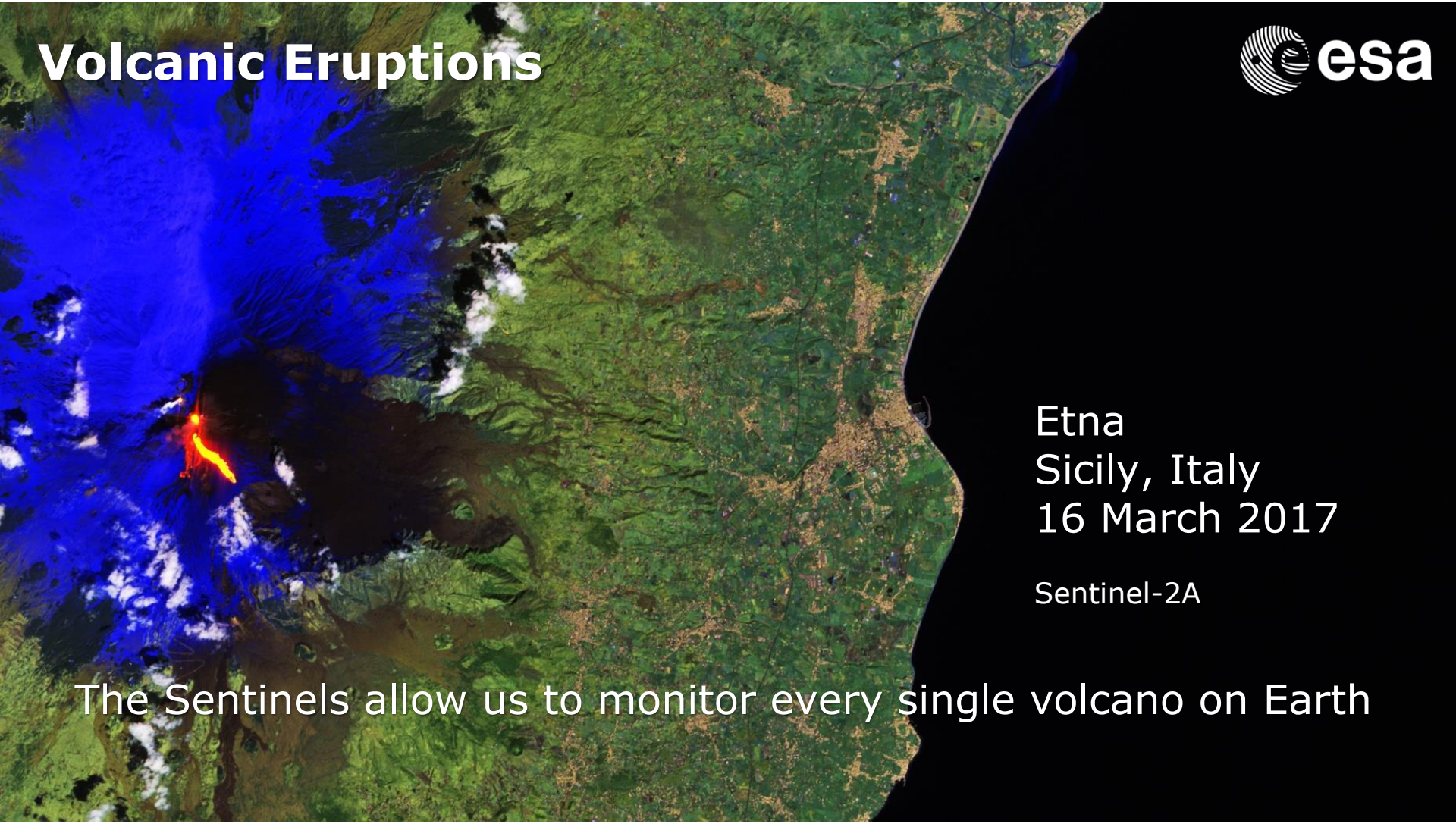
Contains modified Sentinel-3A data (2016)
© UK National Centre for Earth Observation/University of Leicester

Water Level Changes

Lake Bracciano, Italy
Summer 2017 Drought

Based upon Sentinel-2
© BY-SA 3.0 IGO

Volcanic Eruptions

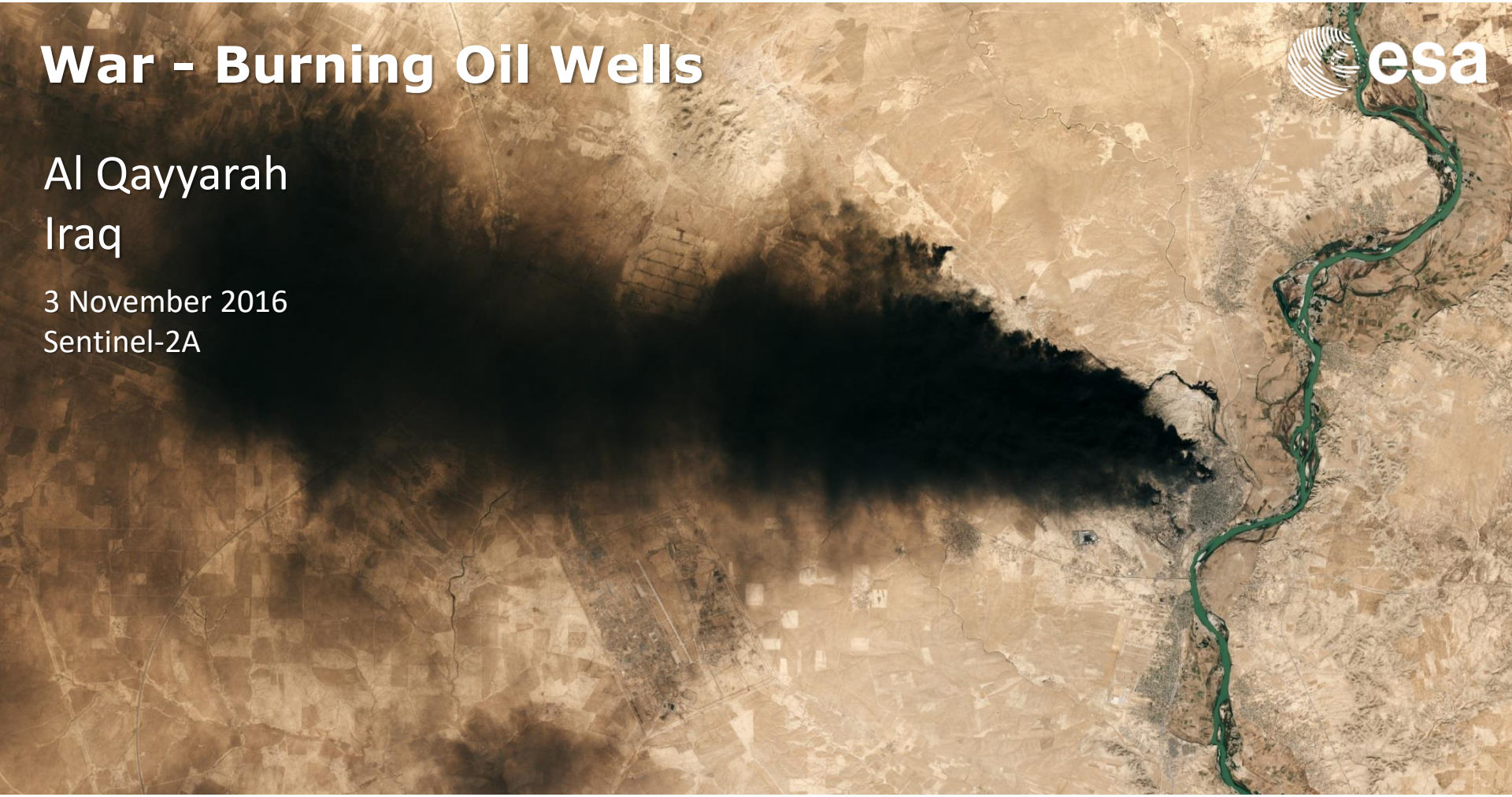


The Sentinels allow us to monitor every single volcano on Earth

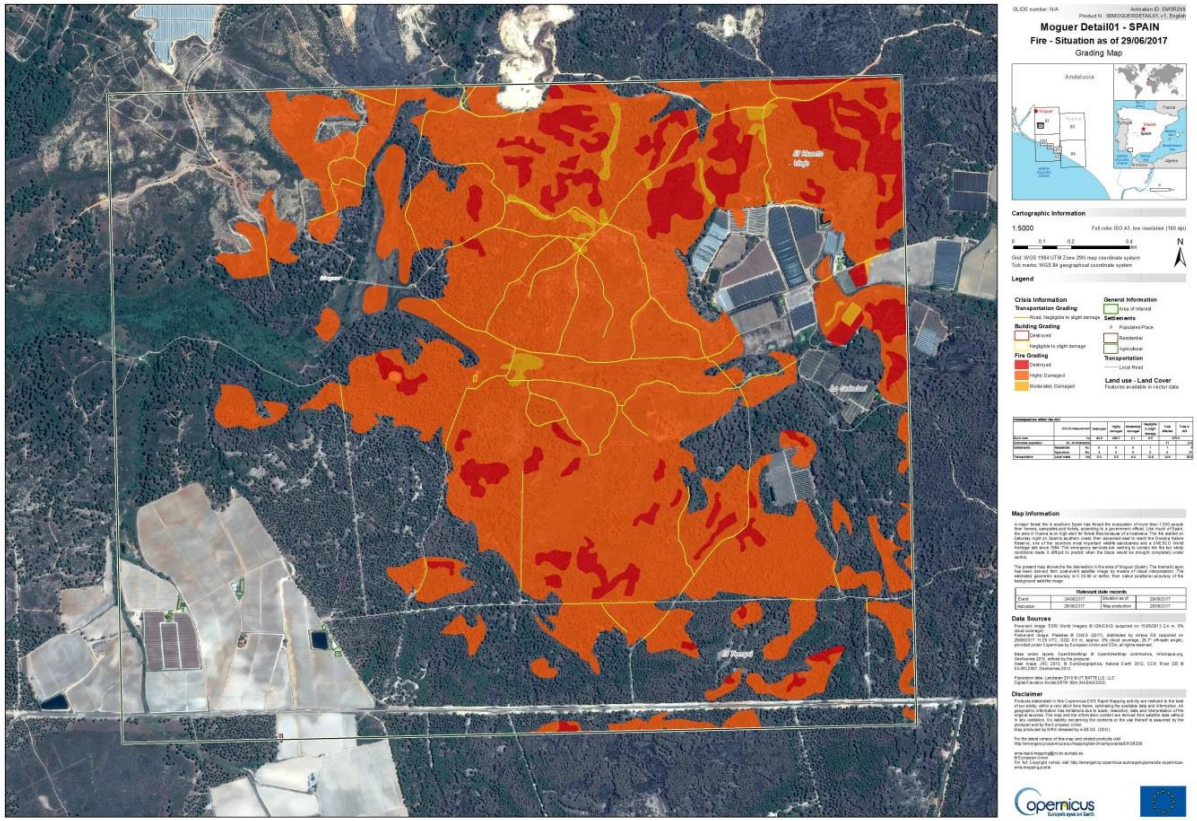
War - Burning Oil Wells

Al Qayyarah
Iraq

3 November 2016
Sentinel-2A



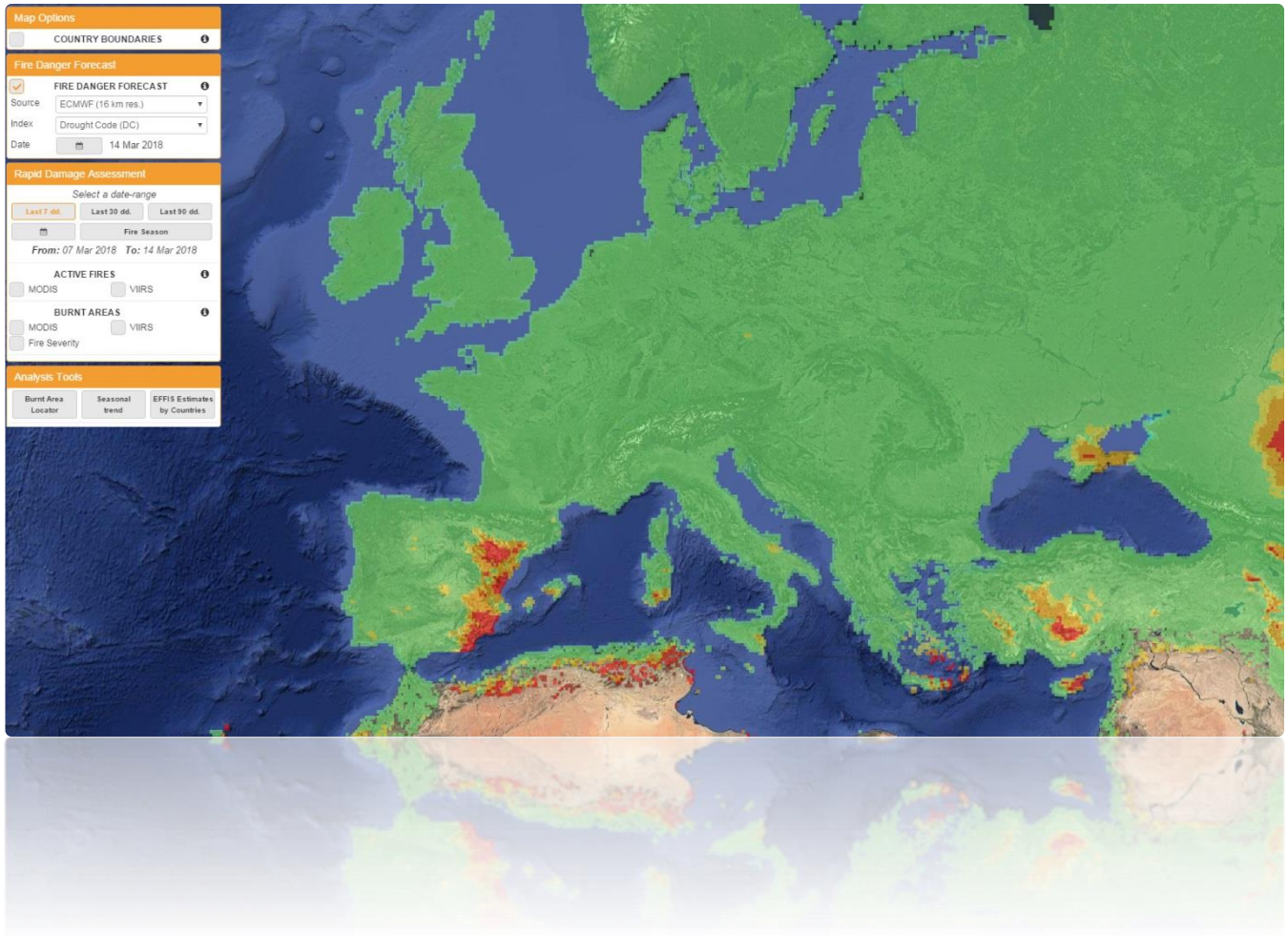
Wildfires - Monitoring



< Moguer, Spain
29 June 2017

Copernicus Emergency Management Service Rapid Mapping

Wildfires – Prevention



< Fire Danger Forecast (based upon the Drought Code)

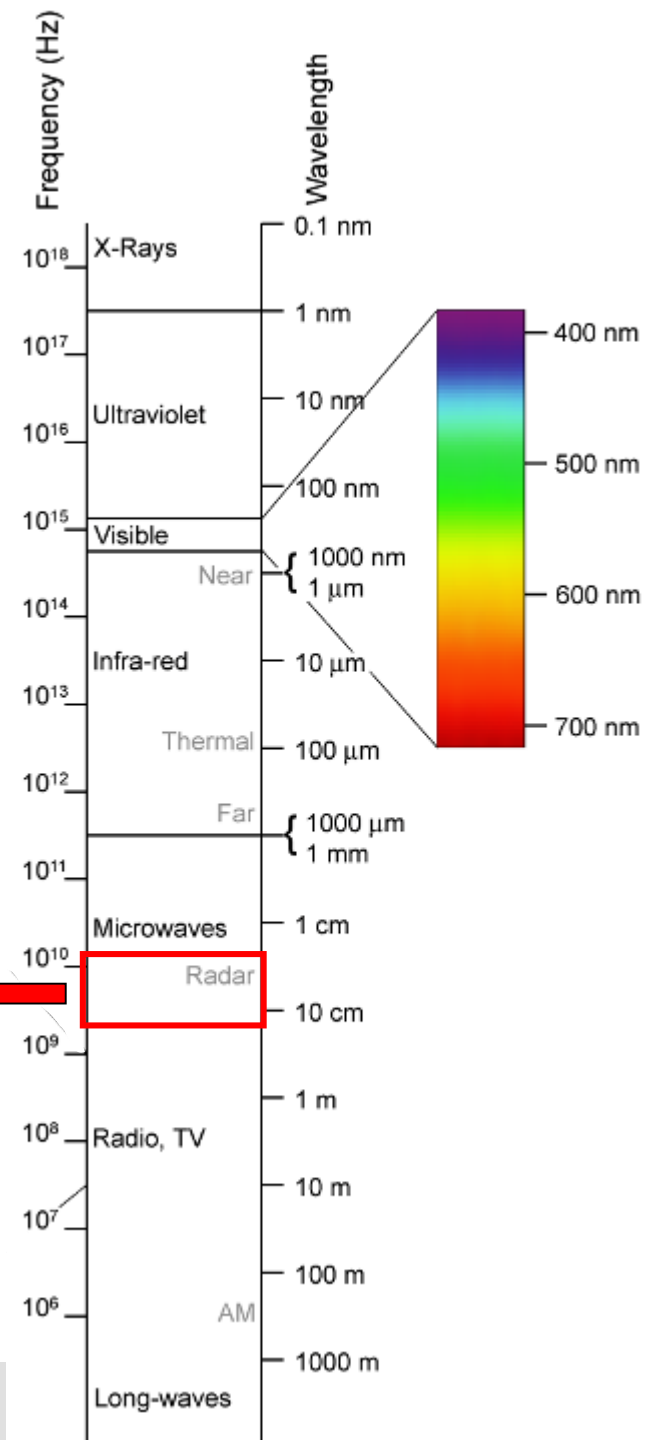
14 March 2018

Copernicus Emergency Management Service

SENTINEL-1

The electromagnetic spectrum

Synthetic Aperture Radar (SAR)



ESA Heritage SAR missions: ERS and ENVISAT

For the last 25 years, ESA has been constantly supporting the SAR Interferometry (InSAR) communities with:

- the **provision of InSAR data**, through:
  - the development and operations of SAR satellites (ERS-1, ERS-2, Envisat)
  - a precise satellite orbital maintenance including InSAR tandem campaigns (ERS-1/ERS-2 tandem, ERS-2/Envisat tandem)
  - the development of a large and consistent InSAR data archive
  - a constant effort in facilitating the use of SAR data
- the **development of InSAR science and InSAR applications**,
- bringing together the InSAR communities through **Fringe & Living Planet workshops**.

Launch of Sentinel-1A

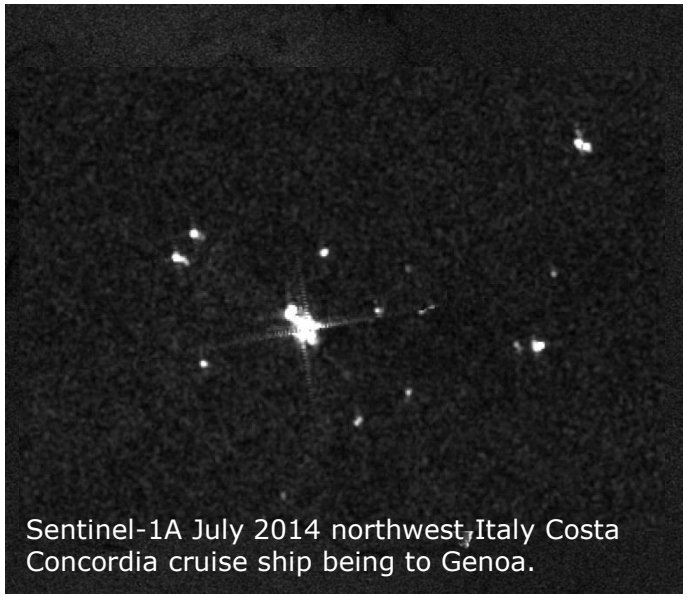
- April 3, 2014
- Launch from French Guiana Space Base
- Soyuz-2 rocket
- New era in Earth Observation

Sentinel-1
Mission objectives

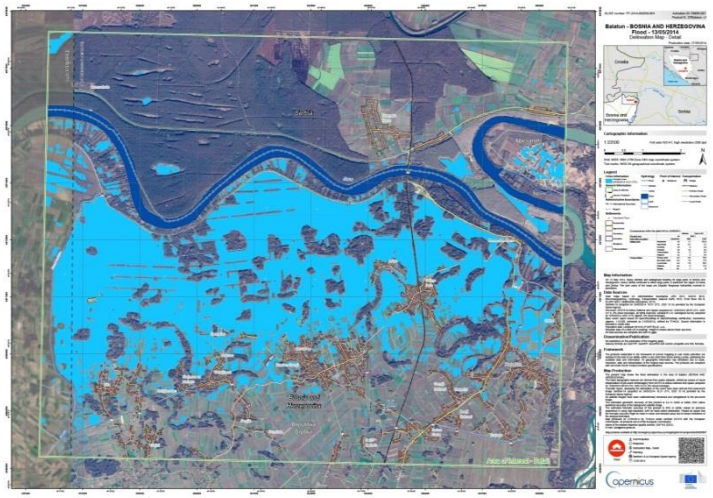
✓**Data continuity of ERS and ENVISAT missions**

✓ **Copernicus imaging radar mission for ocean, land, emergency applications:**

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



Sentinel-1A July 2014 northwest Italy Costa Concordia cruise ship being to Genoa.



Flood delineation map over Balatun Bosnia and Herzegovina

Sentinel-1 observation scenario
Main thematic domains & components

Land cover: agriculture, forestry, hydrology, etc.

Maritime surveillance

European coverage

Sea-ice, icebergs, lake-ice

Emergency

Calibration/validation

Ground deformation: Tectonic, volcanoes, landslides, subsidence… (InSAR applications)

Security

Global land mapping

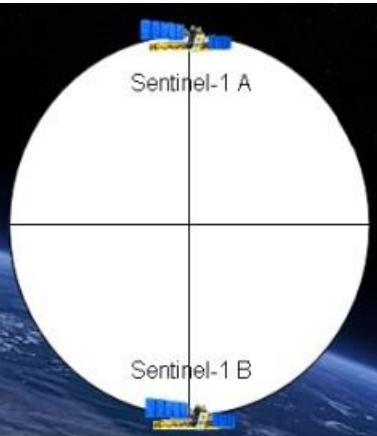
PR actions (infrequent)

Sea state

Ice sheets, glaciers, permafrost, snow, etc

Sentinel-1
Mission Overview

- Two satellites
- C-band Radar instrument
- Sun-synchronous orbit at 693 km altitude
- Inclination: 98.18°
- 7 years lifetime
- Consumables for 12 years
- Mean LST: 18:00h at ascending node
- 12-day repeat cycle at Equator (with 1 satellite)

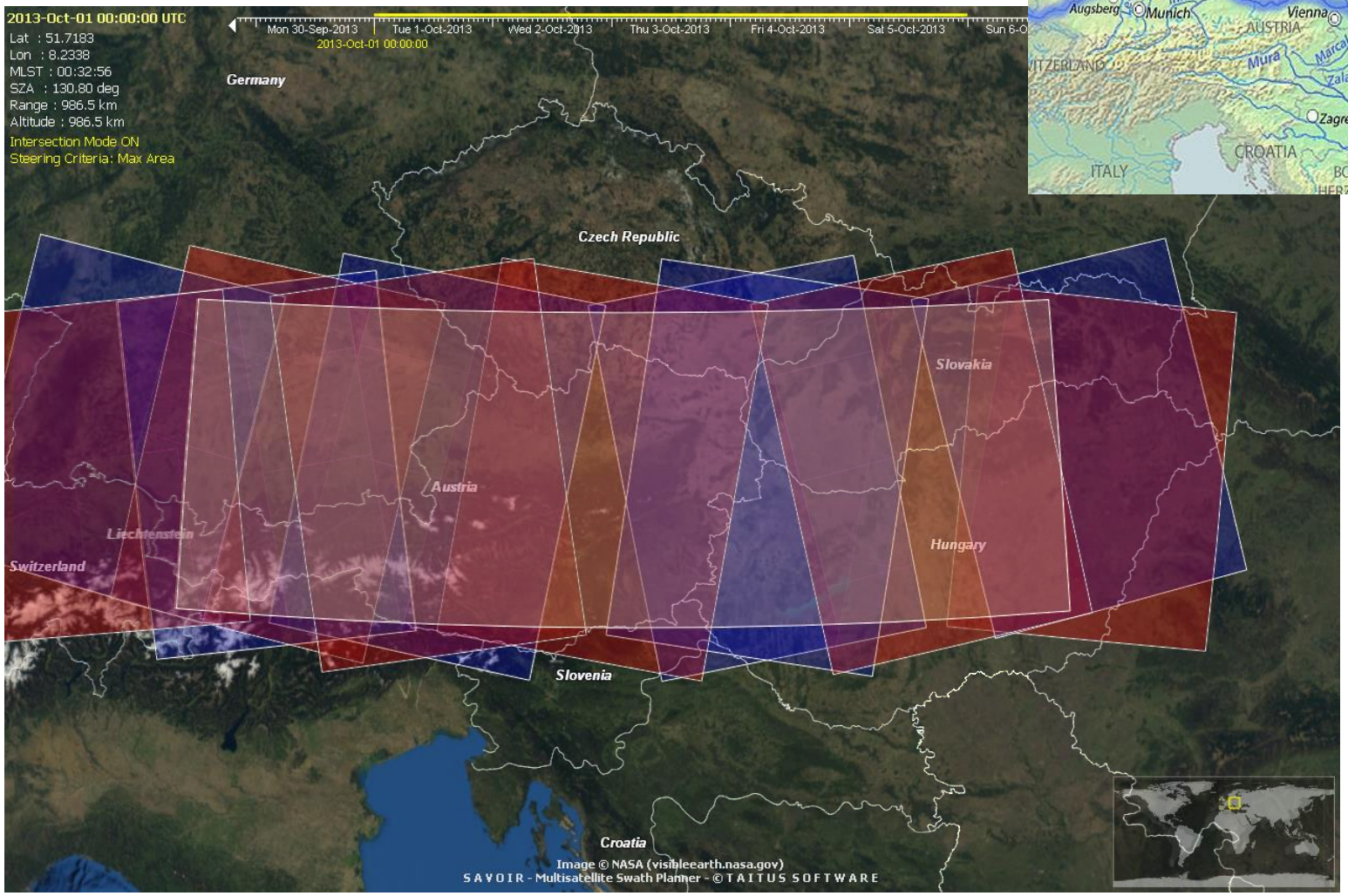


Laser data transmission via the geostationary data relay system EDRS was demonstrated for S-1

Now 6-day repeat cycle at Equator (with 2 satellites). Sentinel 1-B data distributed since 26 Sept 2016

Sentinel-1: Improved Spatial Coverage

Sentinel-1 vs ENVISAT 5-day coverage



Until 2012: ENVISAT

2014+: Sentinel1A

2016+: Sentinel1A/B

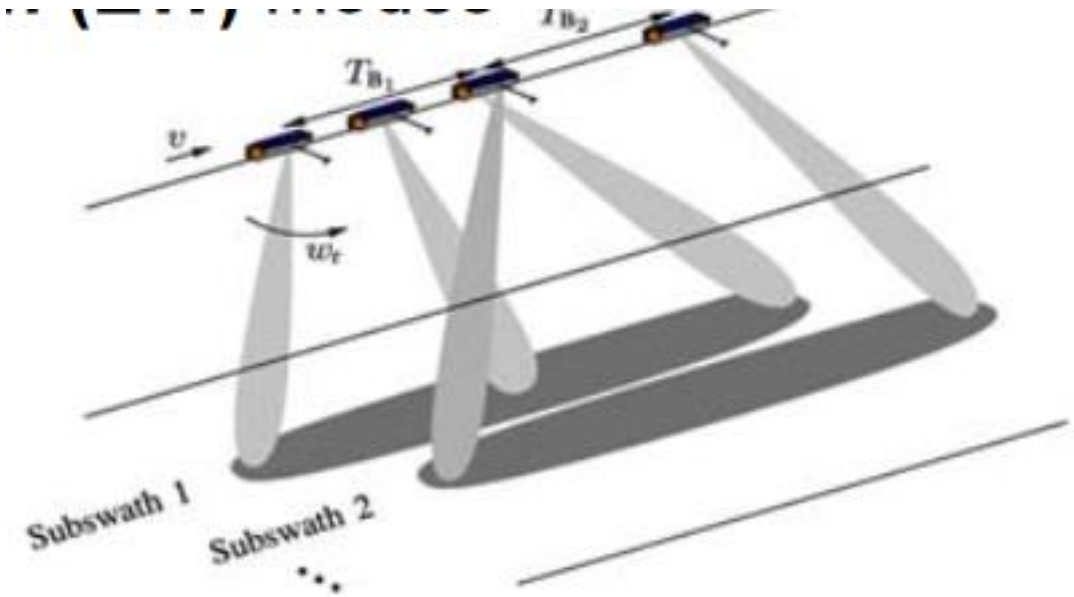
Image Acquisition in TOPS

Interferometric Wide Swath mode (IW)

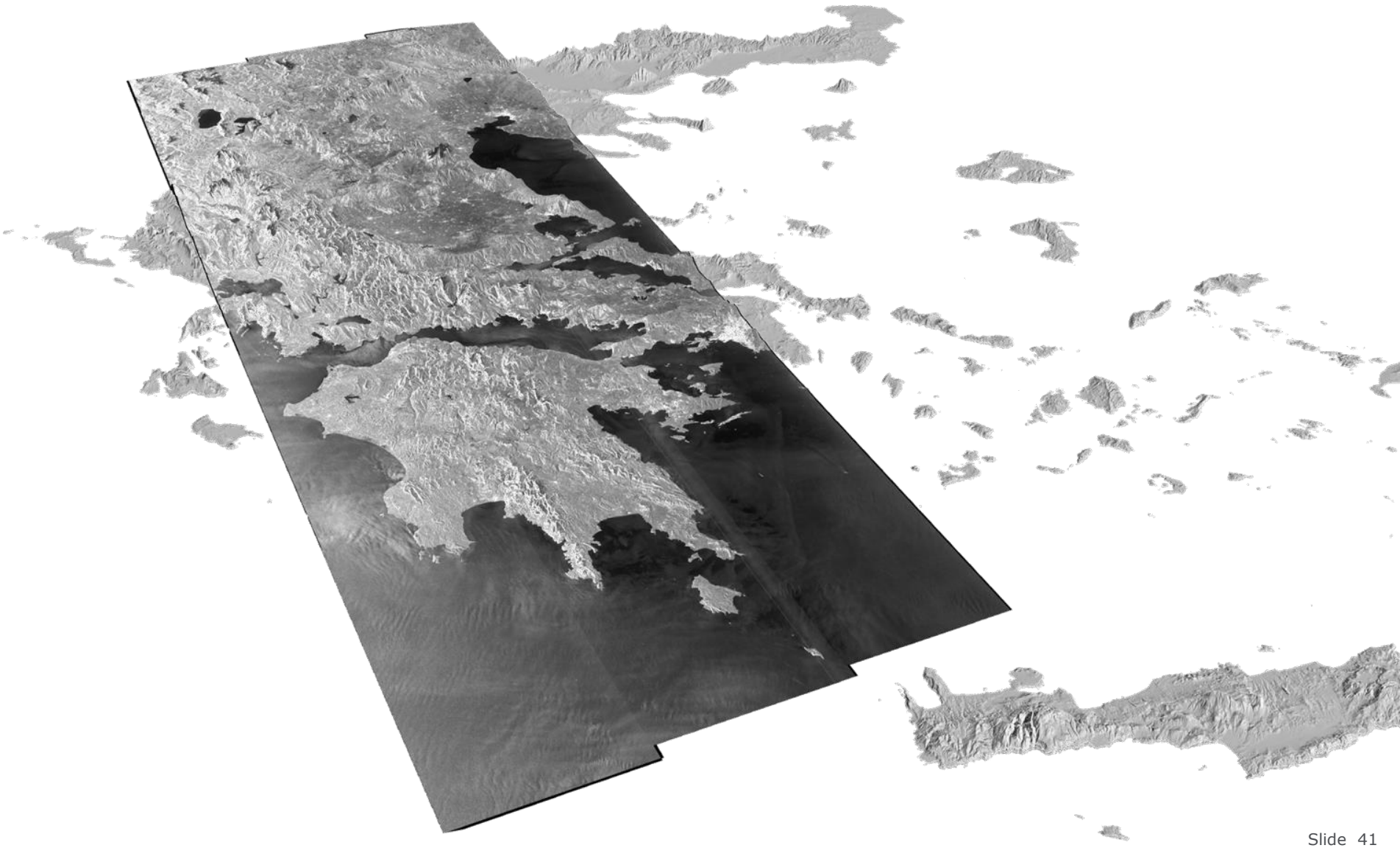
S-1 SAR TOPS Mode for IW and EW

TOPS = Terrain Observation with Progressive Scans in azimuth. Used for Sentinel-1 Interferometric Wide Swath (IW) and Extended Wide Swath (EW) modes

It provides large swath width (ScanSAR) & and enhanced radiometric performance

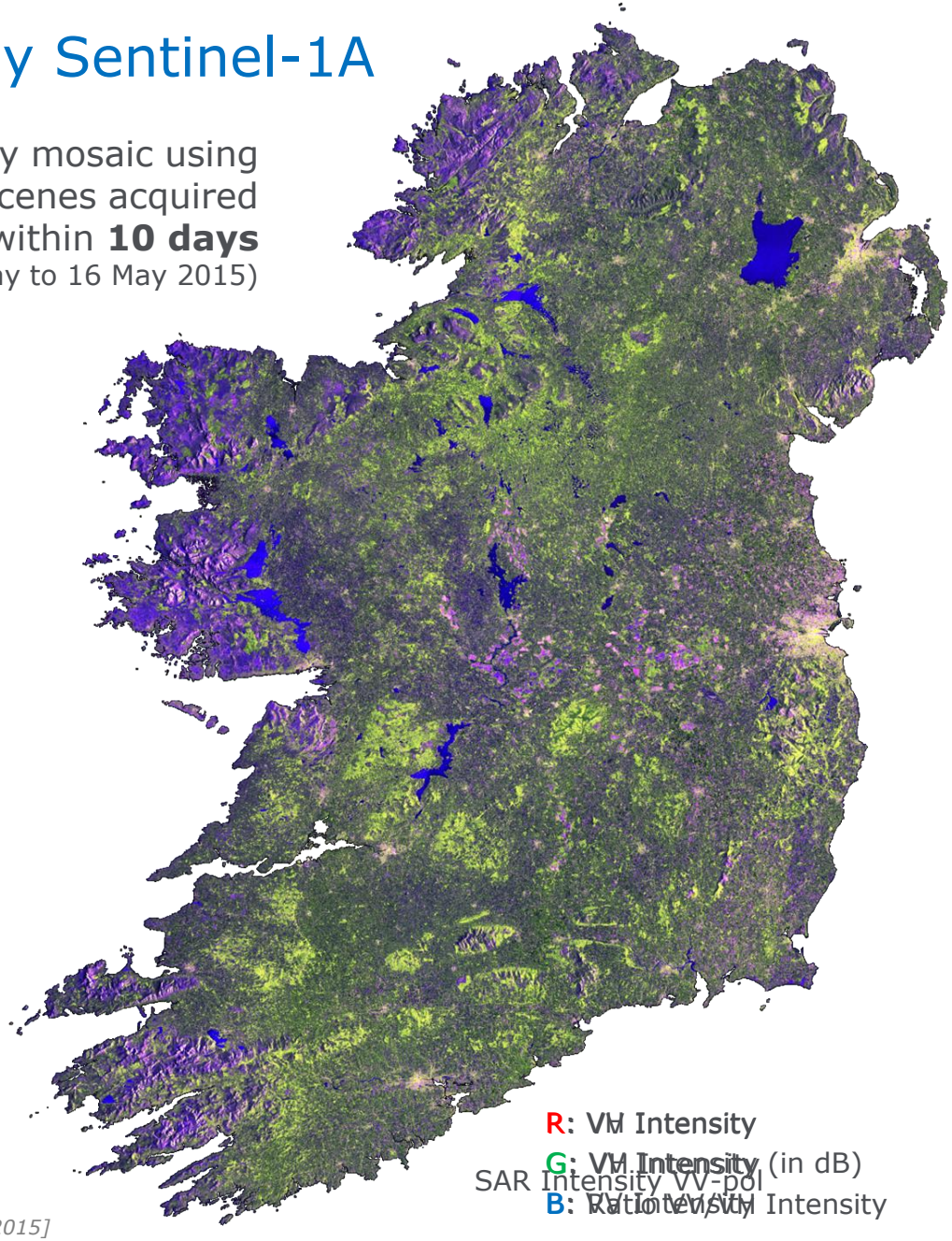


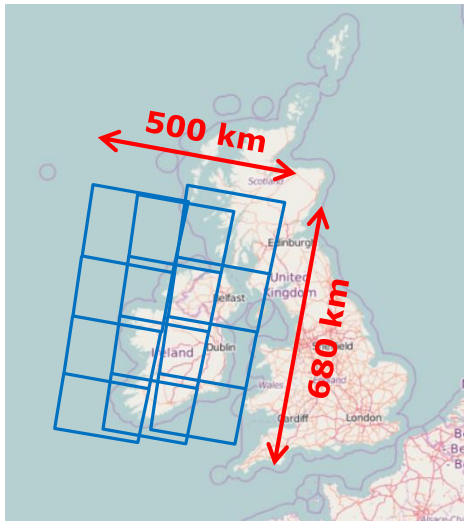
Sentinel-1A TOPS over Greece (First Acquisitions)



Ireland by Sentinel-1A

Country mosaic using
12 scenes acquired
within **10 days**
(from 06 May to 16 May 2015)





Data accessed via the Sentinels Scientific Data Hub (scihub.copernicus.eu)

Processed by SNAP/S1TBX (step.esa.int)

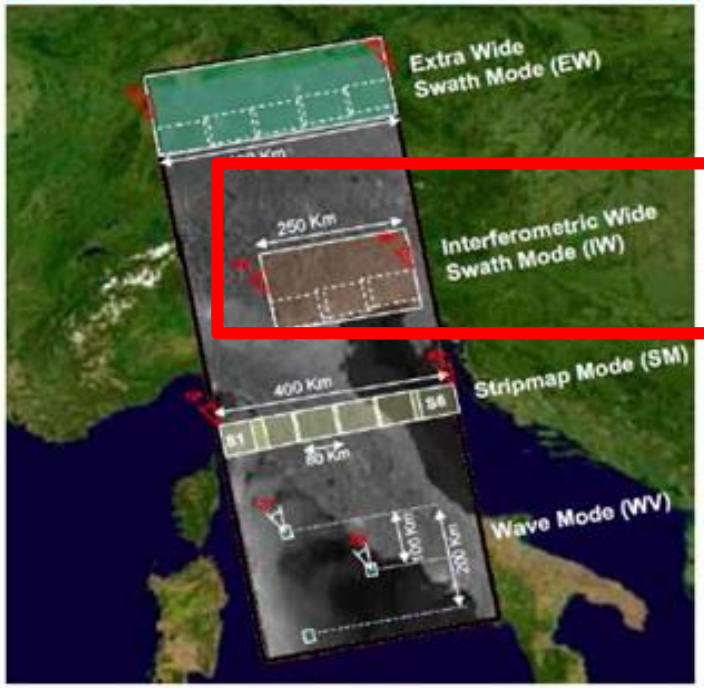
Contains modified Copernicus Sentinel data [2015]

Building Sentinel-1A Mosaic of EUROPE

Contains modified Copernicus Sentinel data [2014]

Sentinel-1
SAR Operational Modes

Operational Modes	Resolution	Swath Width	Polarisation
Extra Wide Swath Mode (EW)	20 x 40 m²	> 400 km	HH+HV or VV+VH
Interferometric Wide Swath Mode (IW)	5 x 20 m²	> 250 km	HH+HV or VV+VH
Stripmap Mode (SM)	5 x 5 m²	> 80 km	HH+HV or VV+VH
Wave Mode (WV)	5 x 5 m²	20 x 20 km² at 100 km spacing	HH or VV



- **Daily coverage of high priority areas, e.g. Europe, Canada, shipping routes**

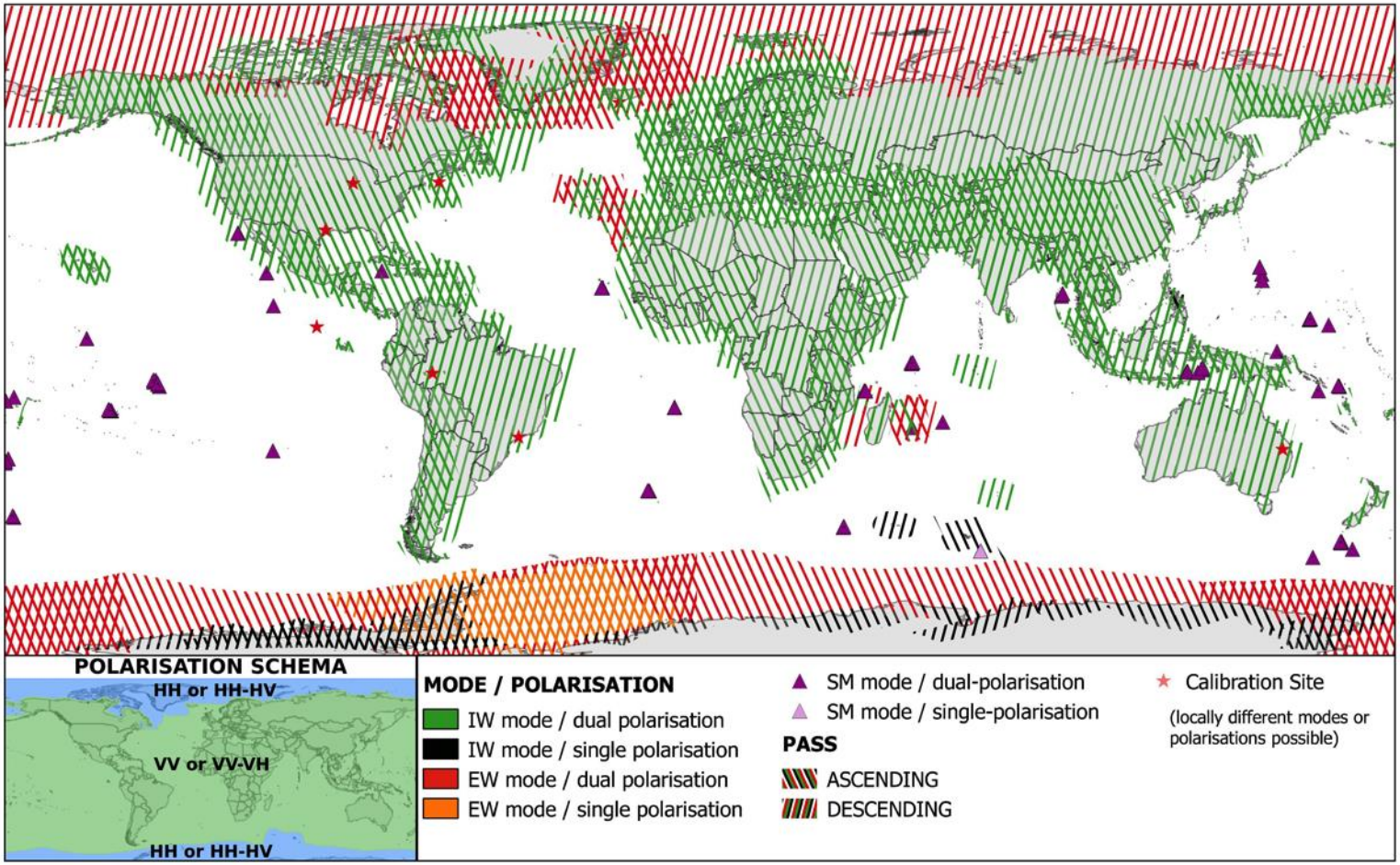
Main modes of operations:

- **IW over land and coastal waters (normally VV or VV-VH polarization)**
- **EW over extended sea (VV or VV-VH) and sea-ice (HH or HH-HV) areas**
- **WV over open oceans**

Sentinel-1 Constellation Observation Scenario: Mode - Polarisation - Observation Geometry

sentinel-1

validity start: 02/2018



Updated Map

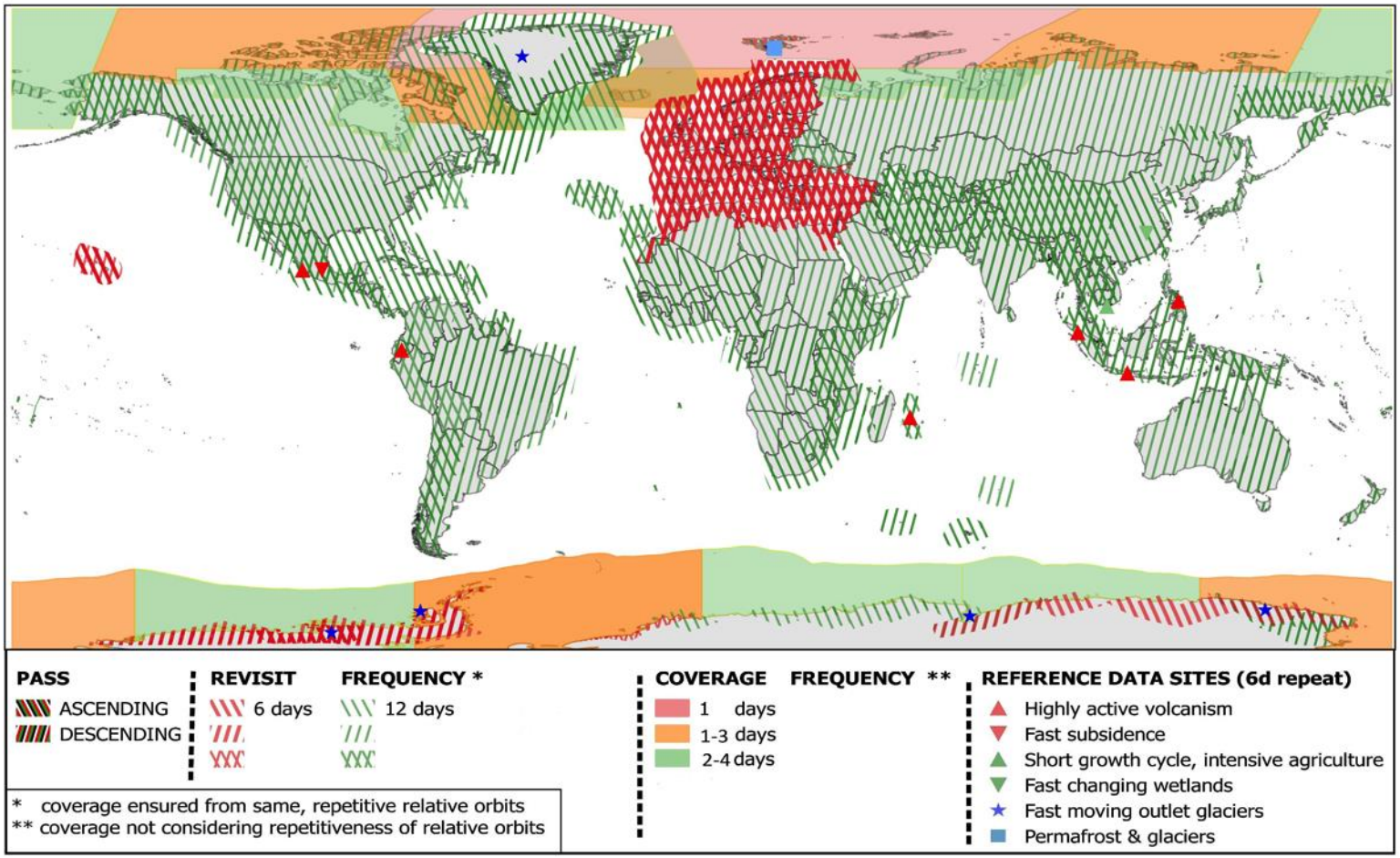
Baseline starting Feb 2018

This map is related to SAR High Rate modes only. Wave mode operated by default over open oceans (not shown)

Sentinel-1 Constellation Observation Scenario: Revisit & Coverage Frequency

sentinel-1

validity start: 02/2018



Updated Map

Baseline starting Feb 2018

This map is related to SAR High Rate modes only. Wave mode operated by default over open oceans (not shown)

Sentinel-1
Operational Products available to users

LEVEL-0 PRODUCTS

Compressed, unprocessed instrument source packets, with additional annotations and auxiliary information to support the processing.

LEVEL-1 PRODUCTS

Level-1 Slant-Range Single-Look Complex Products (SLC):
Focused data in slant-range geometry, single look, containing phase and amplitude information.

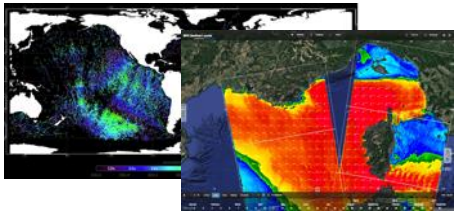
Level-1 Ground Range Detected Geo-referenced Products (GRD):
Focused data projected to ground range, detected and multi-looked.
Data is projected to ground range using an Earth ellipsoid model, maintaining the original satellite path direction and including complete geo-reference information.

LEVEL-2 PRODUCTS

Level-2 Ocean products
Ocean wind field, swell wave spectra and surface radial velocity information as derived from SAR data.

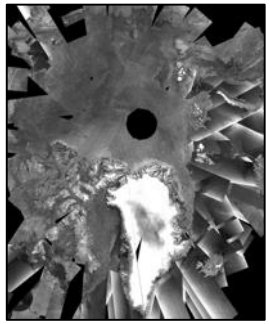
Sentinel-1 applications → ever increasing

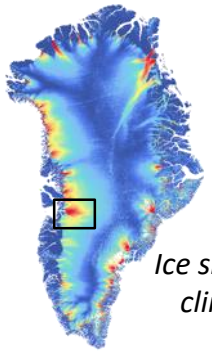
Maritime surveillance: oil spill monitoring, ship detection, illegal fisheries, etc.



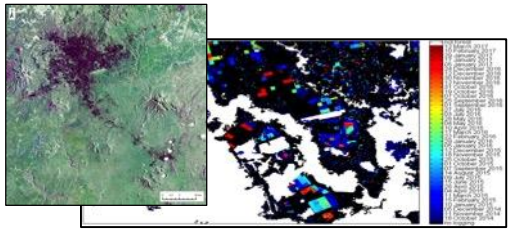
Sea state: wind, wave

Sea ice and iceberg monitoring

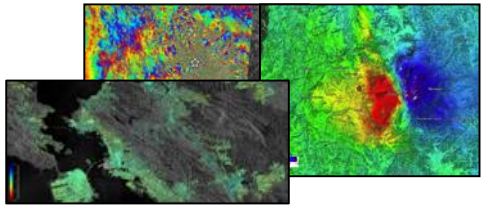




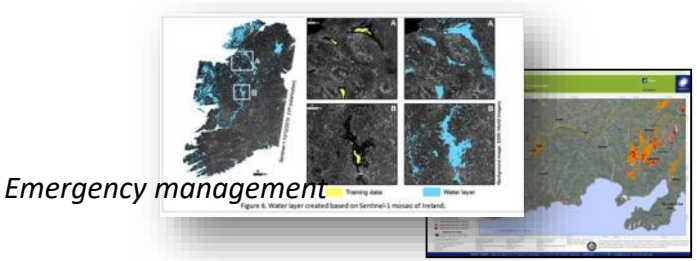
Ice sheets, glaciers, climate change



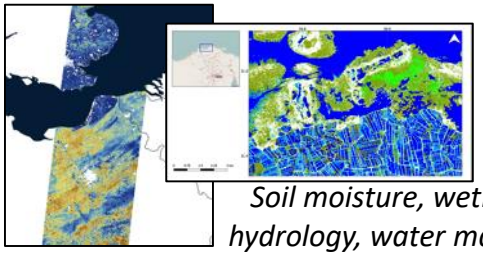
Land use, agriculture, forestry, logging, land classification, urban planning



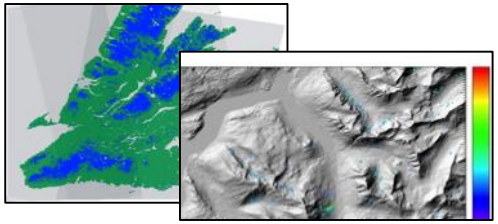
Ground deformation: subsidence, landslides, earthquakes, volcanoes, infrastructure monitoring



Emergency management



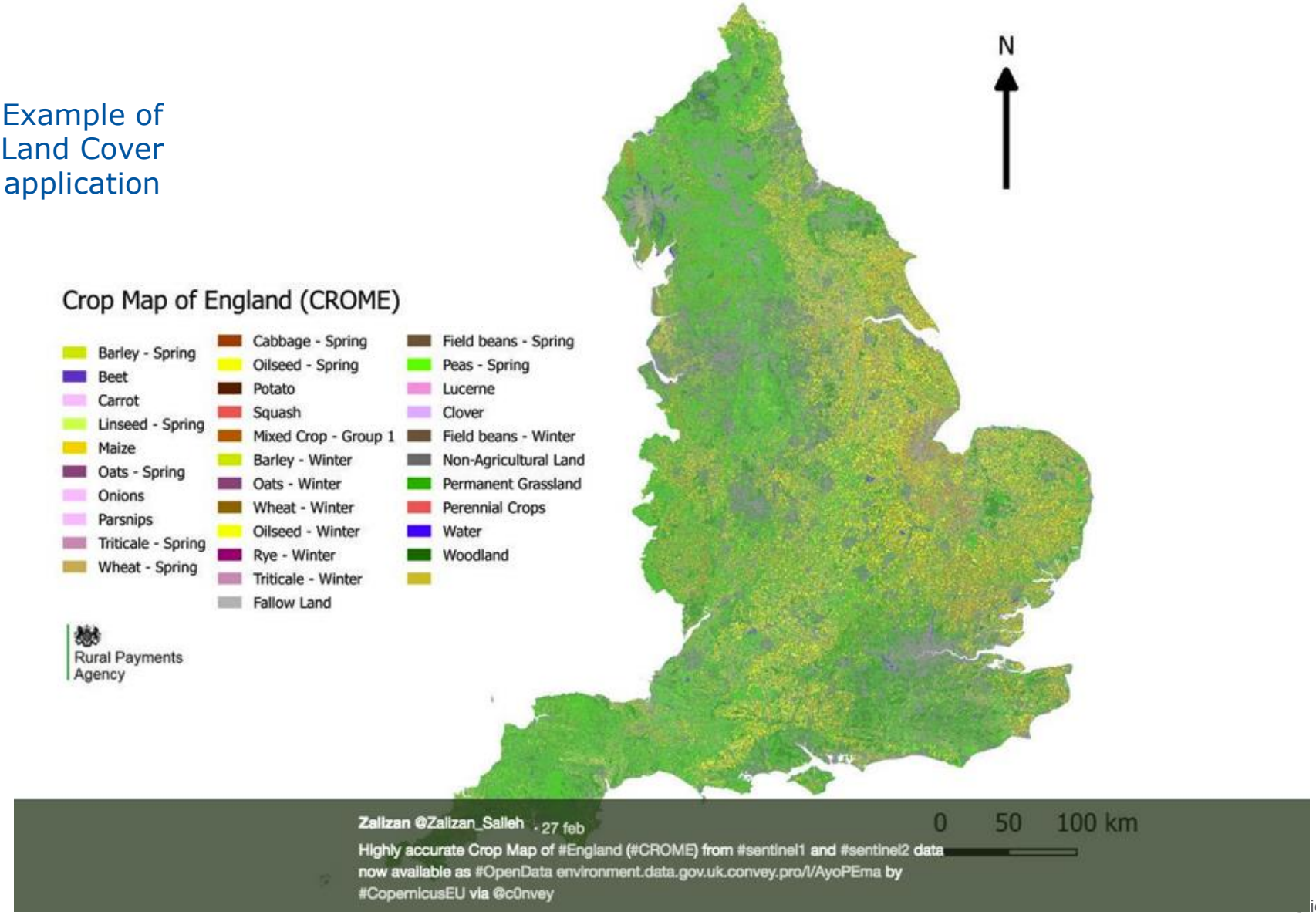
Soil moisture, wetland, hydrology, water mapping



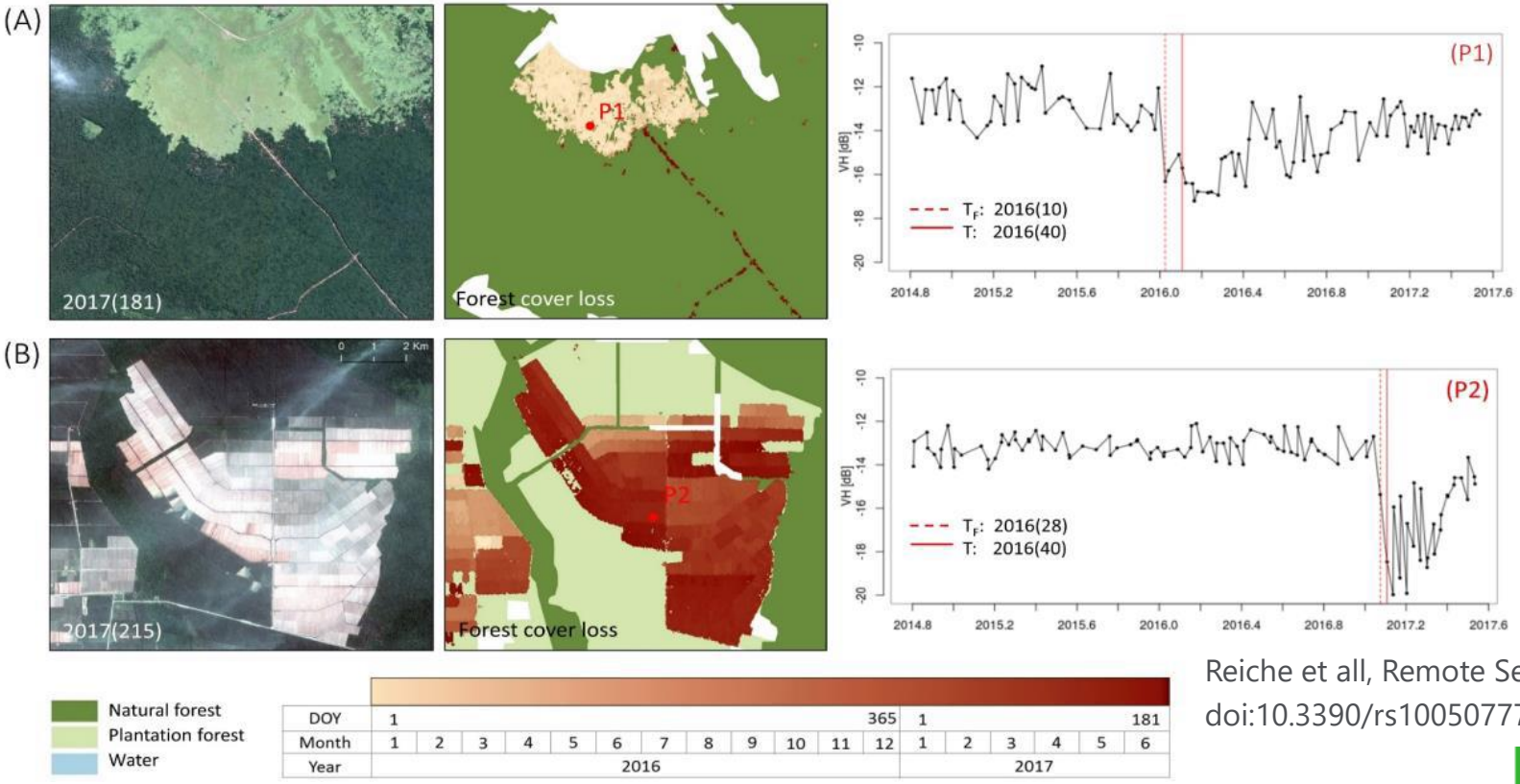
Snow, permafrost, avalanches,…

Example of UK map of crop classification

Example of Land Cover application



Tropical Forest Cover Loss by dense S-1 Time Series



Forest-cover loss map in Province Riau, Indonesia, based on dense S-1 time series (VH channel):

(A) encroachment into natural forest

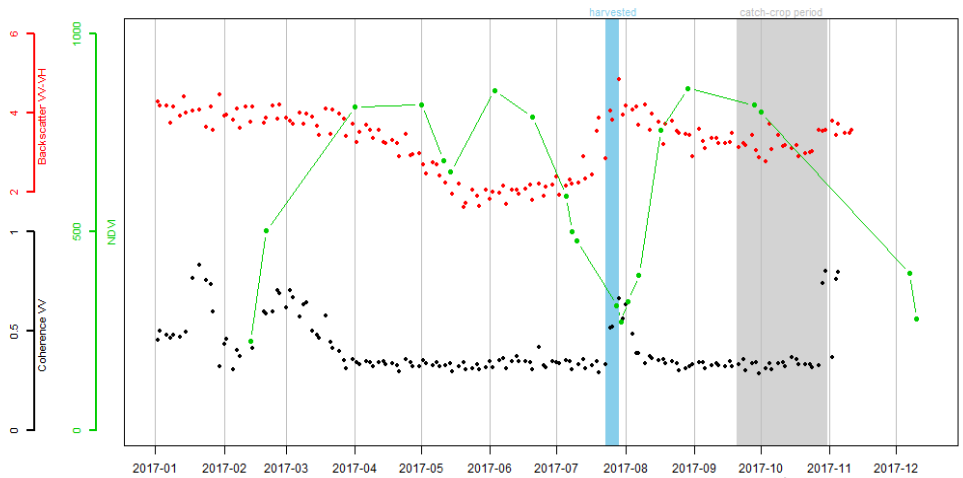
(B) large-scale plantation

Reiche et all, Remote Sensing. 2018, 10, 777; doi:10.3390/rs10050777

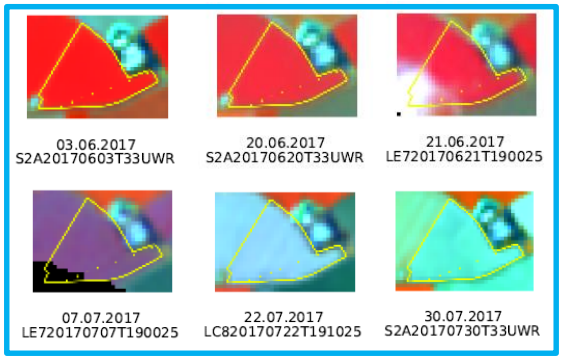
EU Common Agricultural Policy Monitoring
First Evidence of Sentinels Benefit

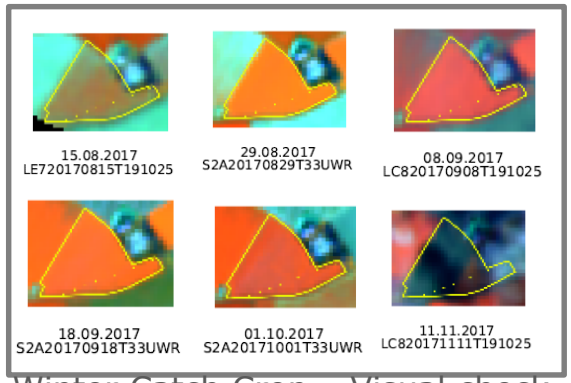
EFA Catch crop assessment – Czech Republic

RULE: Winter Catch Crop must be sown before 20 Sept. and must not be harvested before 31 Oct. During this period, crop coverage must not be mechanically or chemically removed or limited in growth.



Harvest – Visual check





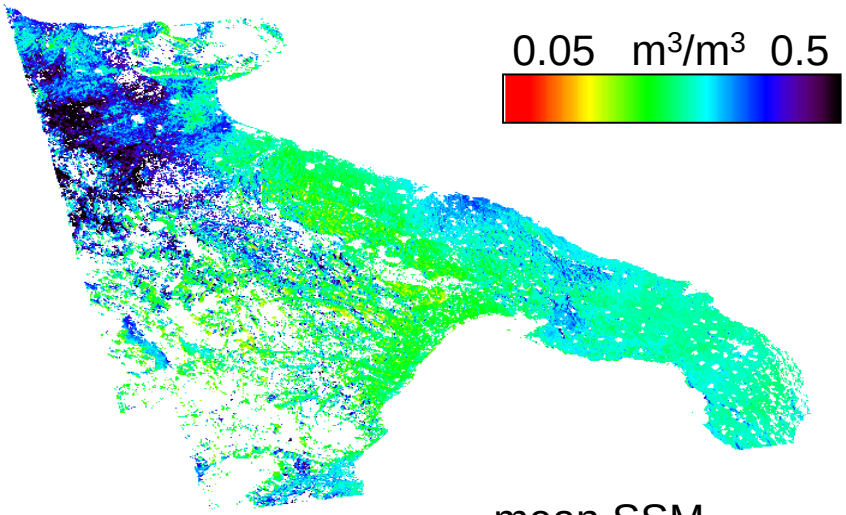
Winter Catch Crop – Visual check

Sentinel-1 Surface Soil Moisture

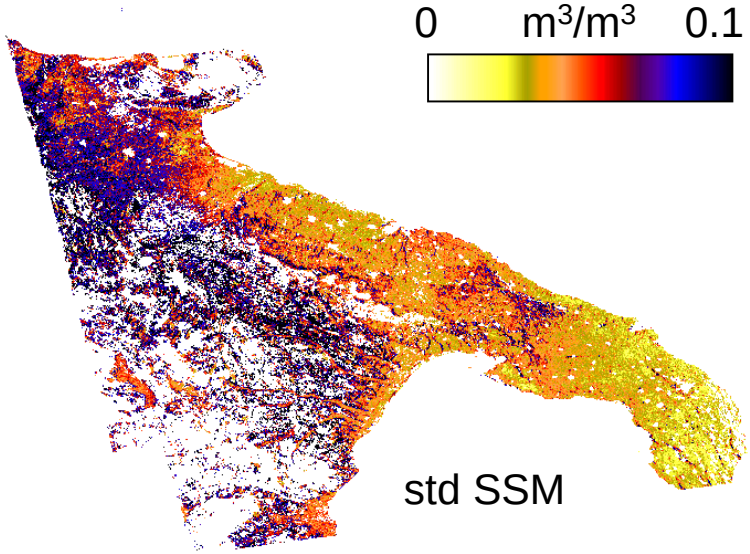
Example of 1km SSM resolution over in Southern Italy

S-1 SSM product includes mean & std at 520m pixels size (≈1 km res)

December 04, 2017



mean SSM



std SSM

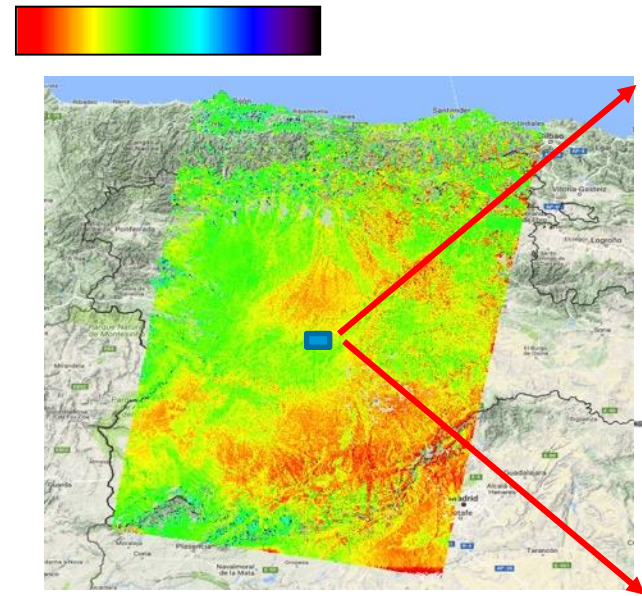
Exploit-S-1

Courtesy: Francesco Mattia, CNR - ISSIA

Sentinel-1 Surface Soil Moisture

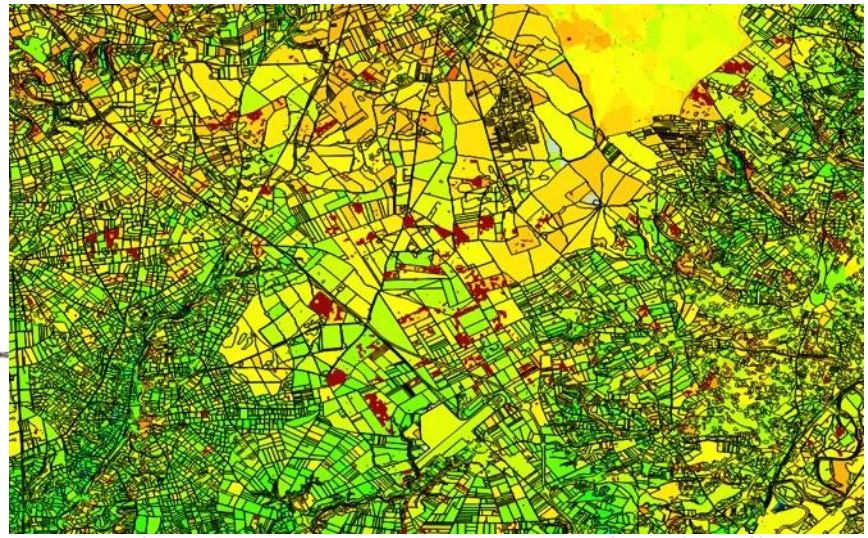
Example of SMOSAR S-1 SSM at field scale

0.05 m^3/m^3 0.5



Overview of S-1 SSM map on 20/06/2017

Castilla y León region (Spain)



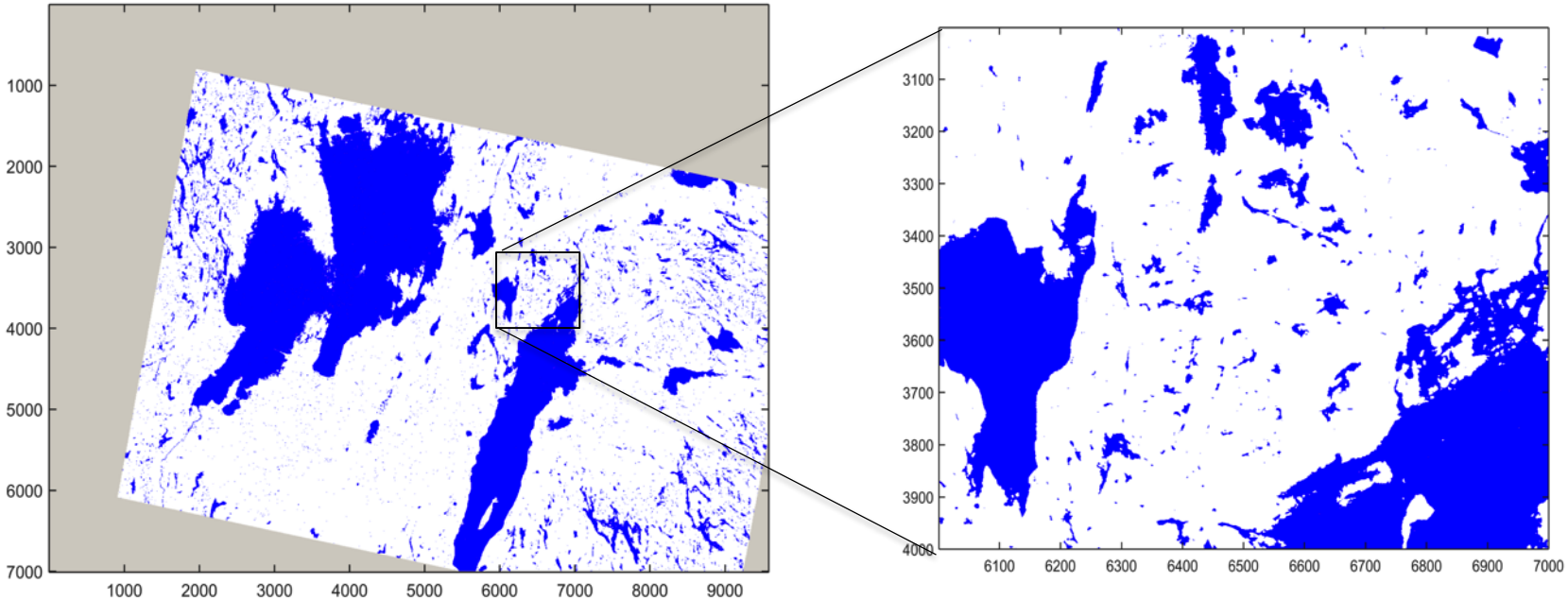
Tillage / vegetation changes

Zoom the S-1 SSM image overimposed to the tillage or vegetation abrupt changes derived from VH S-1 changes (12-20/06/2017) at 40m (details close to the Valladolid city).

Exploit-S-1

Courtesy: Francesco Mattia, CNR - ISSIA

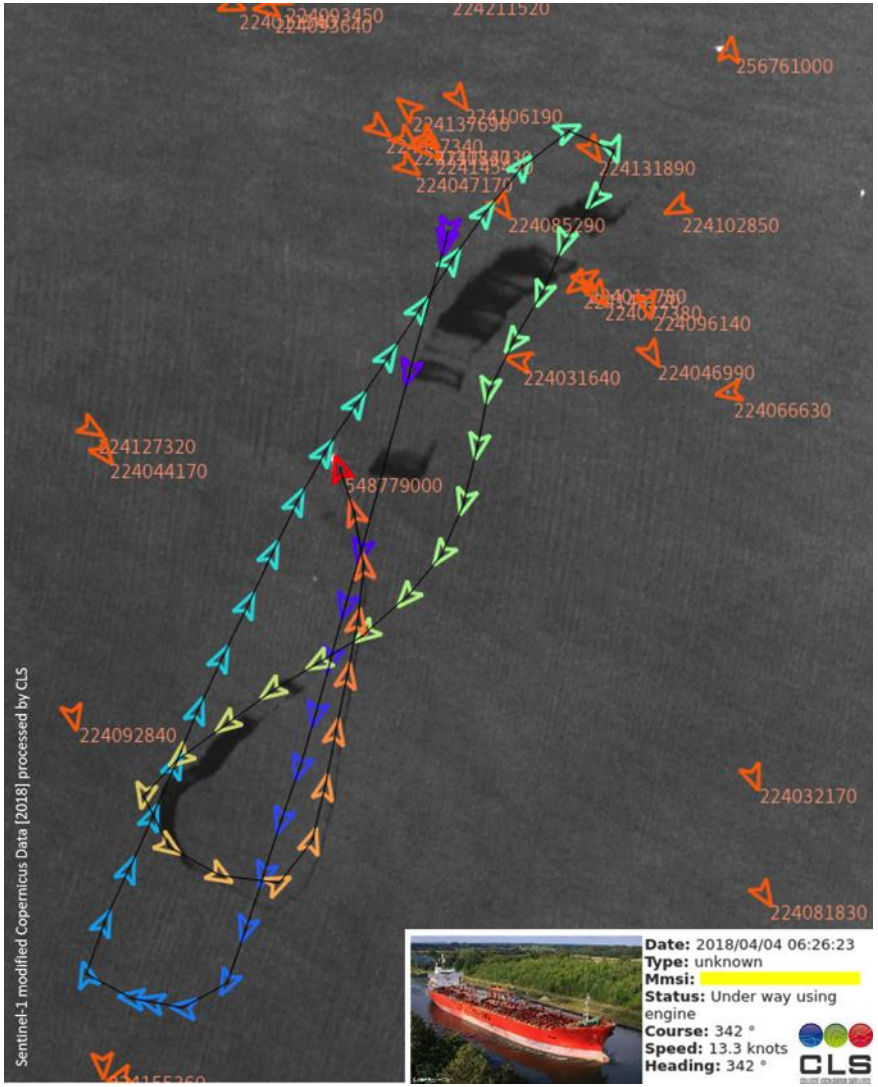
Sentinel-1 water body map of Southern Sweden



Sentinel-1 classification based on average VH-pol backscatter of August 2015 (3 images)

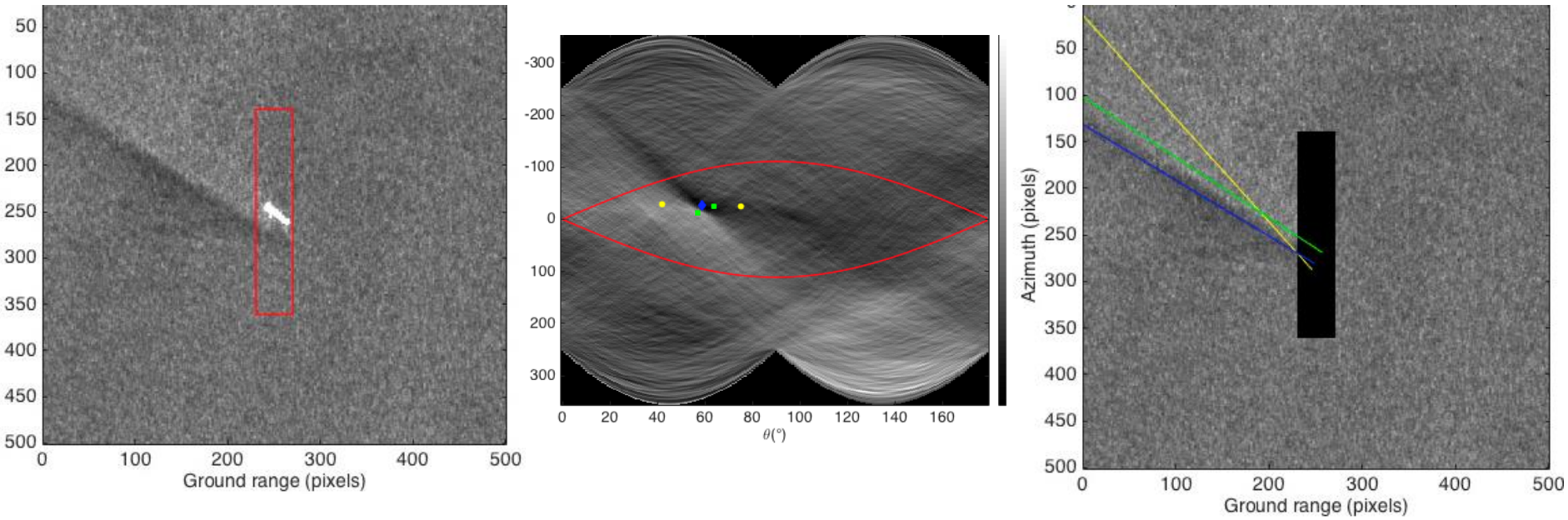
Courtesy: M. Santoro, GAMMA Remote Sensing

Oil spill detected by Sentinel-1B on 4th April 2018 in Spain, Huelva

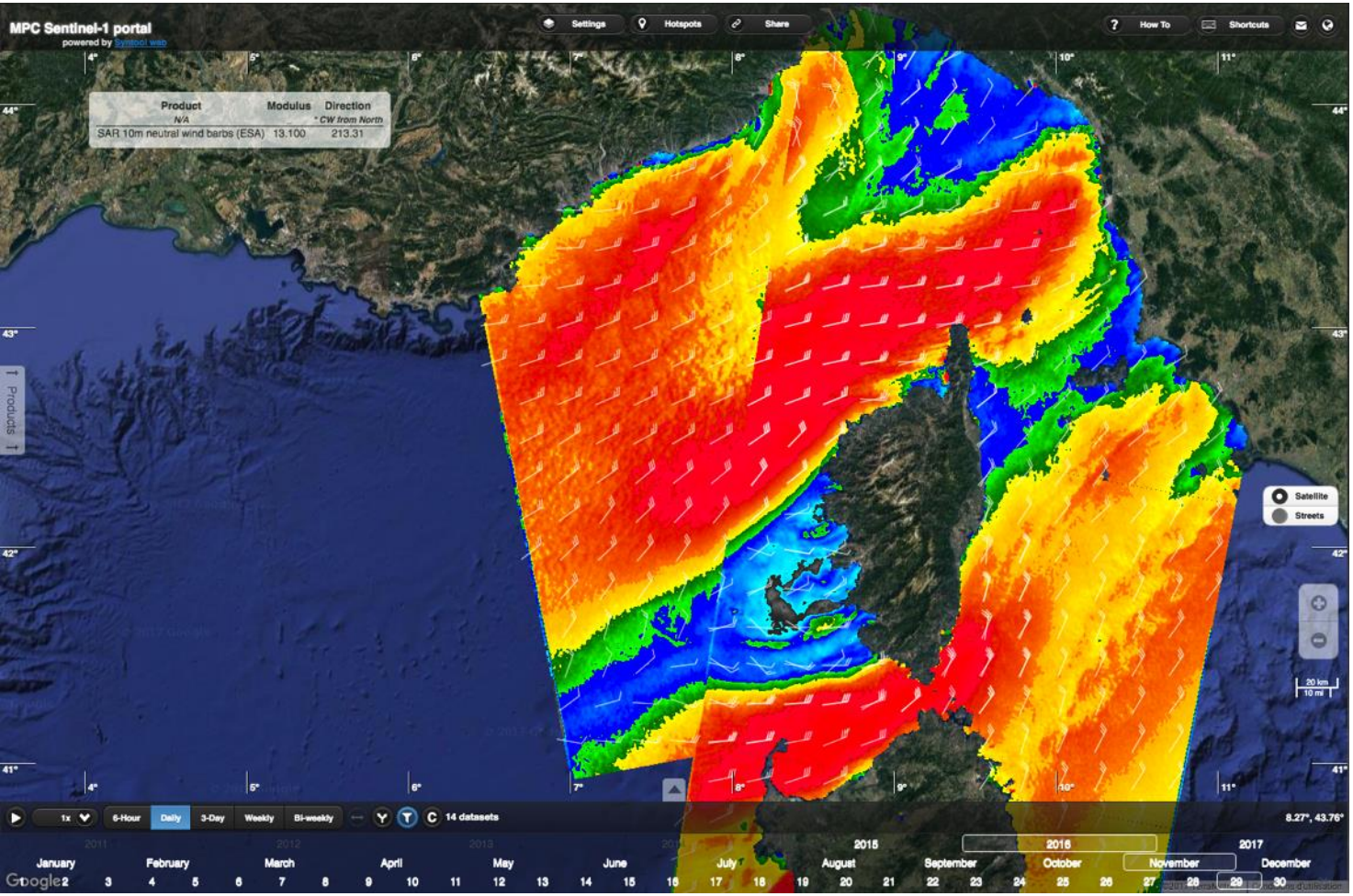


Wake Detection

"The most assessed algorithms for wake detection (Sentinel 1)"



[Graziano et al., 2017]



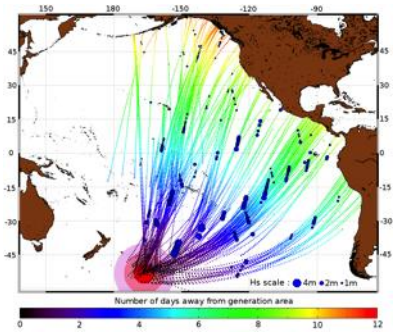
Wind fields

S1A morning pass S1B evening pass

oceandatalab

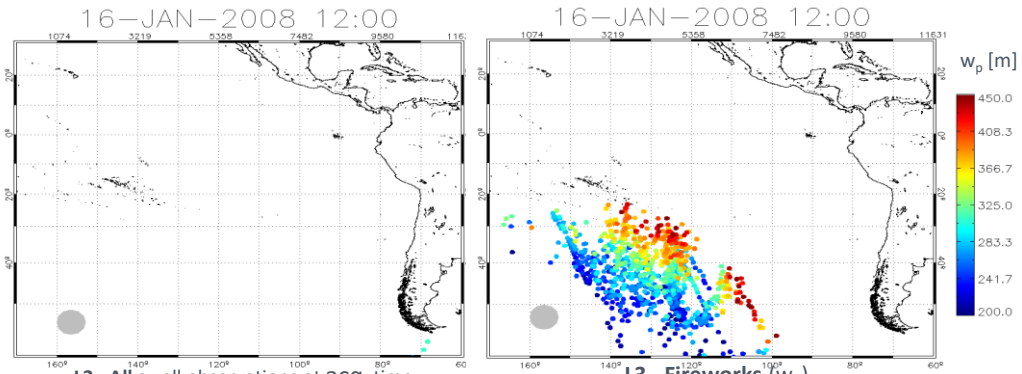
Operational generation of SAR Wave products recently implemented by CMEMS

Systematic generation of Level 3 products since end 2017, derived from the Sentinel-1A/B Level 2 Wave/OCN



SAR-derived swell measurement trajectories from the source to the coast. Measured H_s shown by blue dots

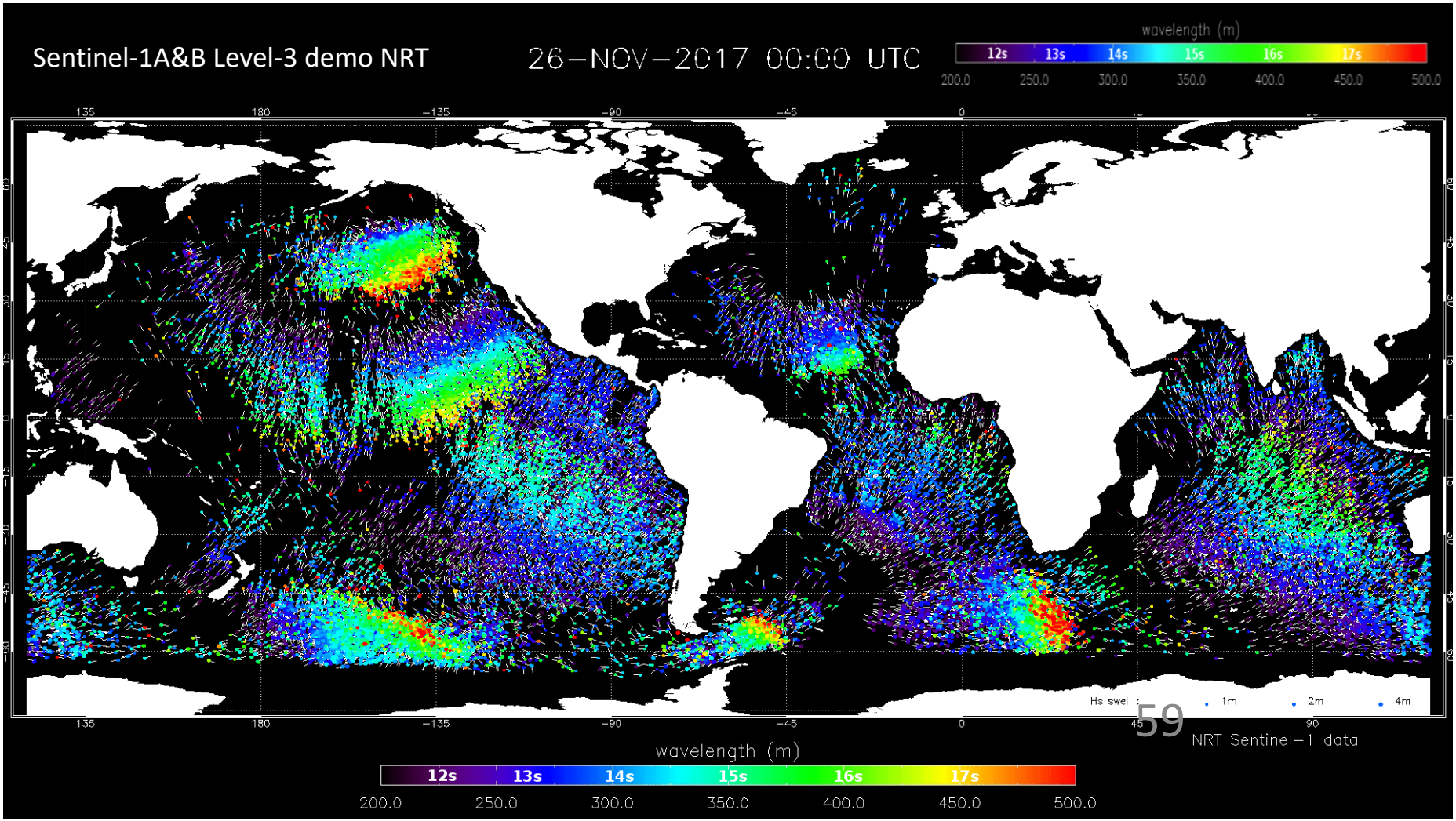
Courtesy:



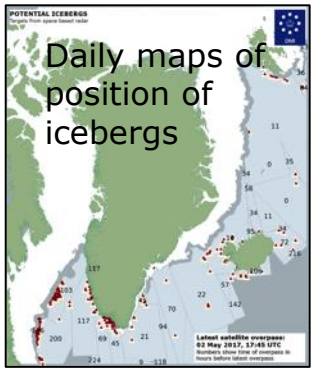
L2 - All swell observations at acq. time
Heterogeneous in quality/space/time – poor sampling

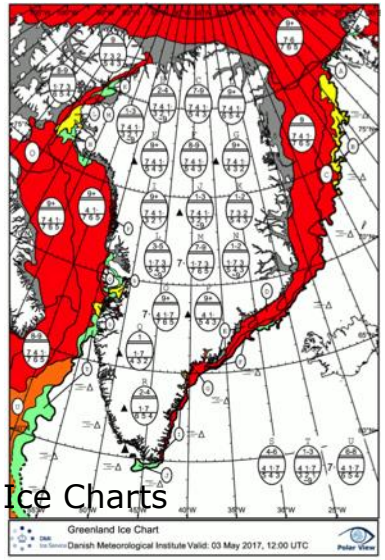
L3 - Fireworks (w_p)
Heterogeneous in quality/space/time

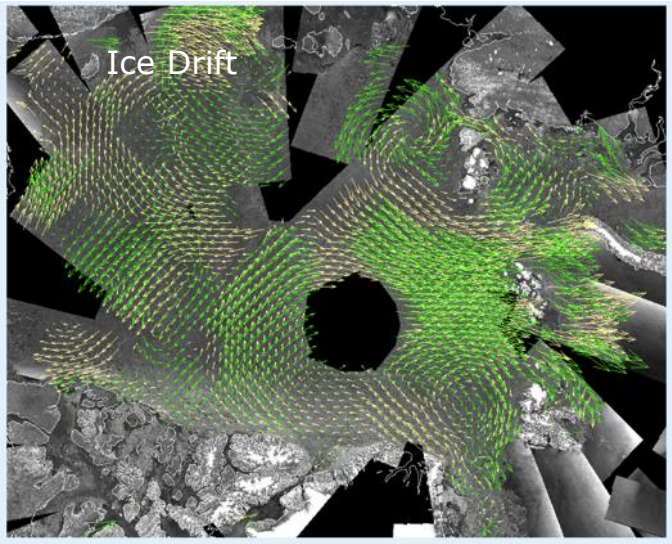
CMEMS Waves product content from SAR



Operational support to the Copernicus Marine Environment Monitoring Service (CMEMS) on-going, since start of Sentinel-1A operations



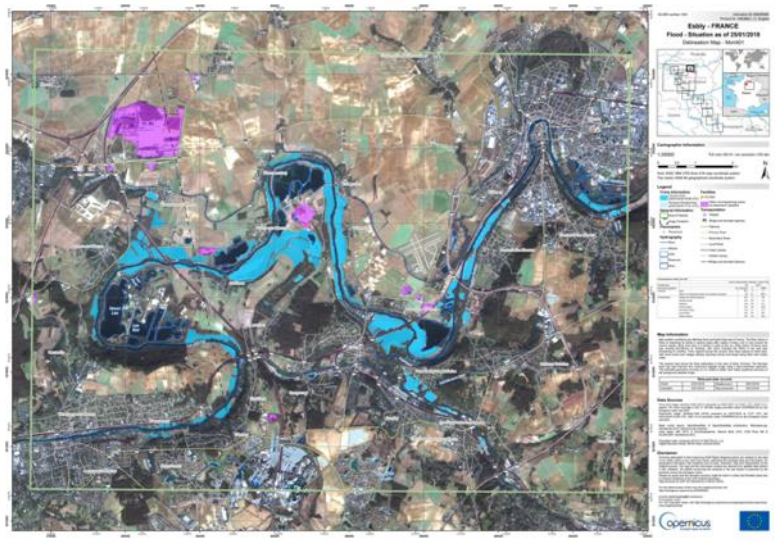


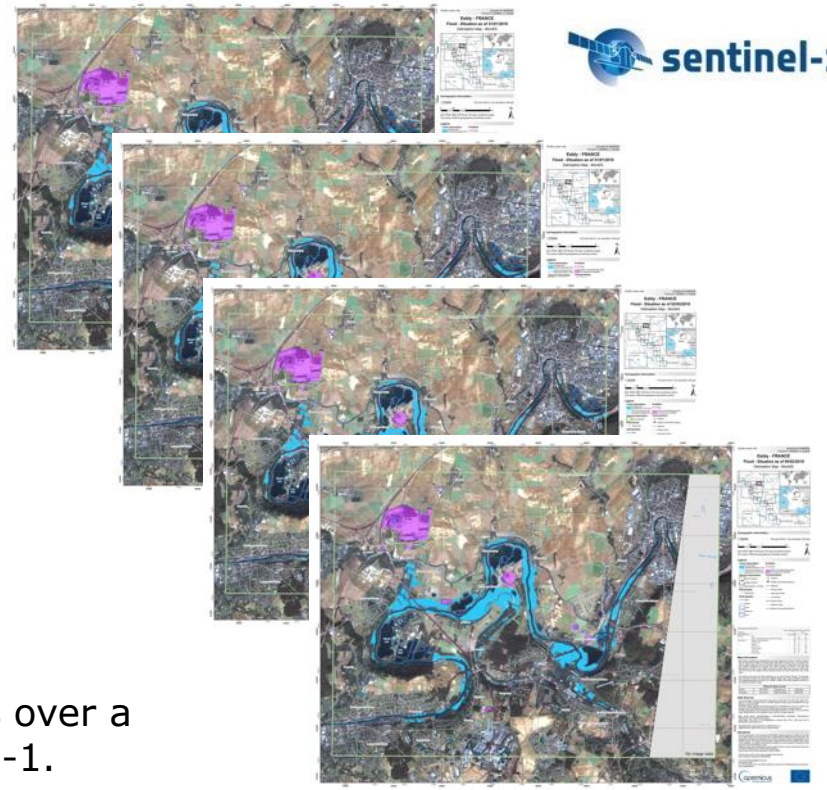


3-day Mosaic 2-3-4 June 2018
http://www.seaice.dk/

Strong increase of the Sentinel-1 contribution to the Copernicus Emergency Management Service

Example of Sentinel-1A/-1B contribution to the exceptional floods that occurred in Jan/Feb 2018 in Northern France

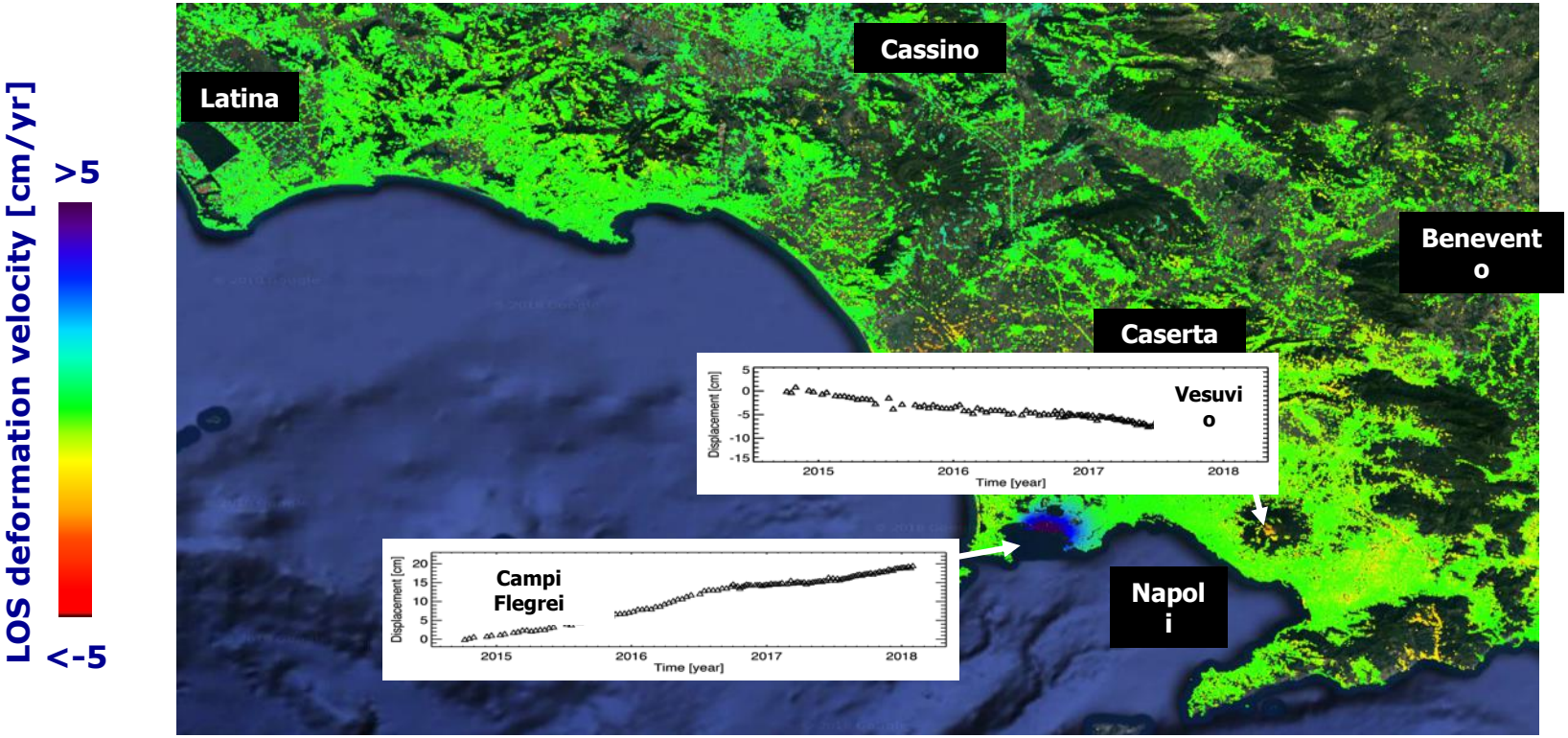




Same area (here Esbly) could be imaged several times over a long period thanks to the systematic revisit of Sentinel-1.

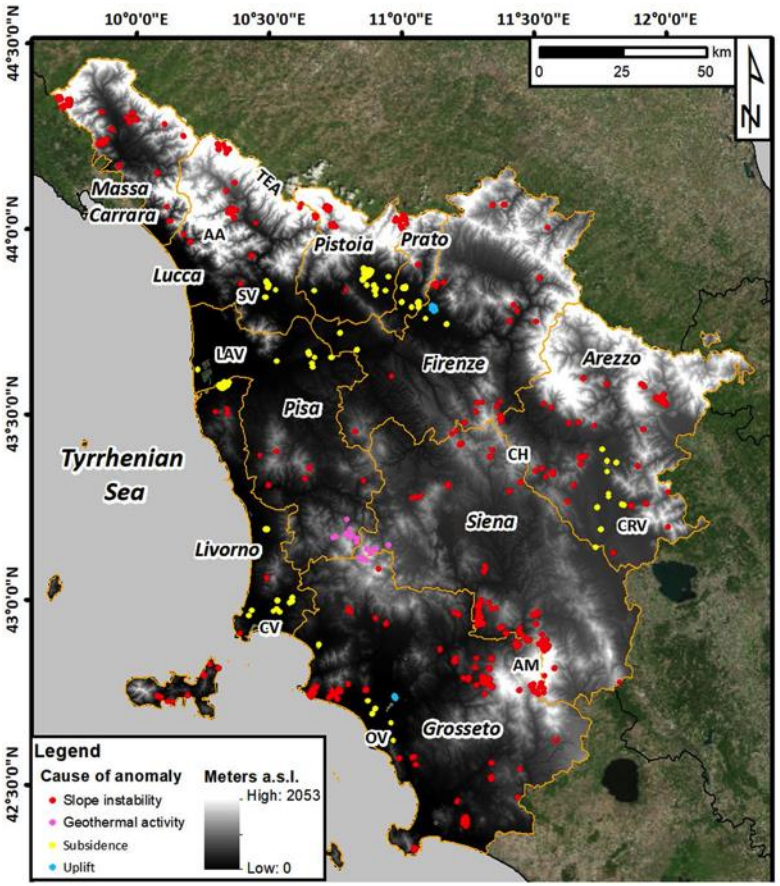
© *Contains modified Copernicus Service information [2018], processed by CEMS*

SBAS-DInSAR analysis: Sentinel-1 regional scale



IW Sentinel-1: 131 SAR images (October 2014-January 2018)

Routine use of Sentinel-1 time series for ground deformation – Tuscany



Update	Last acqusition (track 117)	# of Anomalies	# of ghost anomalies
2	07/11/2016	70	133
3	19/11/2016	90	104
4	01/12/2016	60	72
5	13/12/2016	95	76
6	25/12/2016	121	86
7	06/01/2017	130	55
8	18/01/2017	84	57
9	30/01/2017	94	86
10	11/02/2017	195	154
11	23/02/2017	304	86
12	07/03/2017	341	56
13	19/03/2017	803	109
14	31/03/2017	1.233	83
15	12/04/2017	1.024	68
16	24/04/2017	907	57
17	06/05/2017	2.314	174
18	18/05/2017	2.119	497
19	30/05/2017	2.034	642
Total	07/11/2016 - 30/05/2017	12.018	2.597

Province	Area (km^2)	Total anomalies	Anomalies/10 km^2			
			Slope instability	Subsidence	Uplift	Geothermal activity
Massa Carrara	1.159	79	0.68	0	0	0
Lucca	177	75	3.56	0.68	0	0
Pistoia	966	8.001	1.12	81.71	0	0
Prato	365	997	0.14	27.18	0	0
Firenze	3.520	103	0.25	0.01	0.03	0
Pisa	2.451	52	0.09	0.07	0	0.05
Livorno	1.218	71	0.24	0.34	0	0
Siena	3.820	618	1.60	0	0	0.01
Arezzo	3.235	338	0.90	0.15	0	0
Grosseto	4.510	1.684	2.43	0.04	1.25	0.02
Tuscany	21.412	12.018	1.12	4.21	0.27	0.01

TS **anomalies** classified according to the driving force as at Update #19. Anomalies related to **slope instabilities** are widespread in most of the mountain areas of the region. Anomalies related to **subsidence phenomena** are identified in the alluvial plains, along with two **uplifting areas** within the province of Grosseto and Firenze. Anomalies linked to **geothermal activities** straddle the provinces of Pisa, Siena and Grosseto.

TEA (Tuscan-Emilian Apennines); AA (Apuan Alps); SV (Serchio Valley); LAV (Lower Arno Valley); CH (Chianti Hills); CRV (Chiana River valley); AM (Amiata Mountain); CV (Cornia Valley); OV (Ombrone Valley).

University of Firenze,
TRE ALTAMIRA
University of Pisa

Results from UK wide ground motion map based on Sentinel-1 data

https://www.telegraph.co.uk/science/2018/04/12/devon-village-rising-2cm-year-scientists-have-no-idea/

The Telegraph

HOME | NEWS | SPORT | BUSINESS | ALL SECTIONS

News | Science

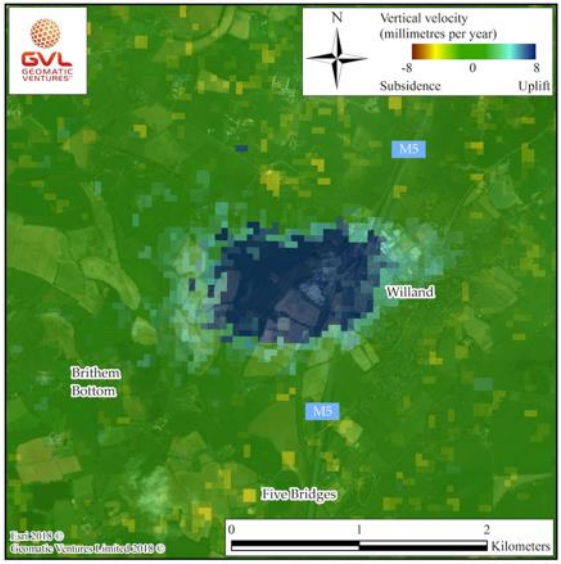
News › Science

Devon village is rising 2cm a year, and scientists have no idea why

FOLLOW THE TELEGRAPH

[The map] "*offers the most detailed look ever at the UK's shifting topography and highlights areas of hazards due to coal mining, soil compaction, landslides, coastal erosion, landfill subsidence and tunnelling for the London Underground*."

Dr Stephen Grebby, Assistant Professor in Earth Observation, at Nottingham University said, "***With the new map we are able to better understand how the entire UK landscape is being affected by various natural and anthropogenic processes. Whilst providing us with detailed information to study the individual mechanisms of these processes, the technique also offers a means of identifying and mitigating any potential risk that these may also pose to infrastructure, society and the environment***."

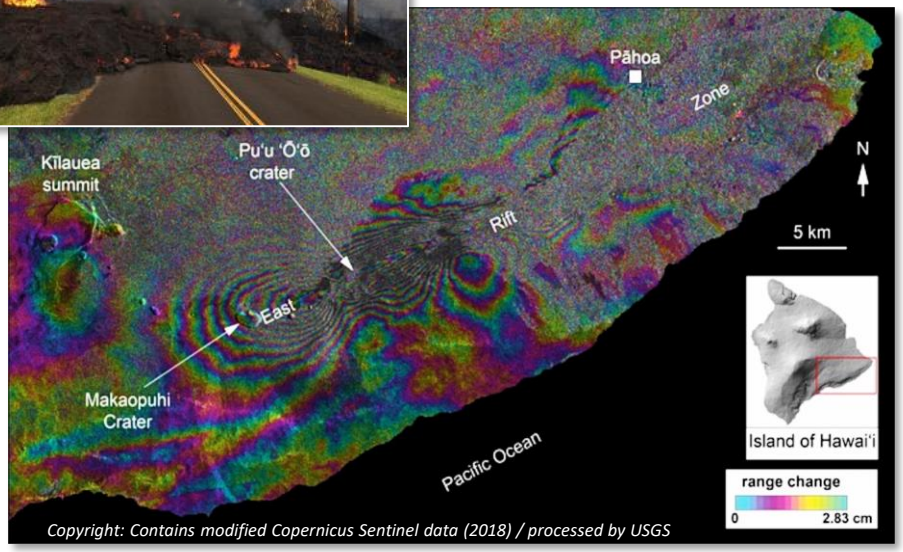


The area of Willand which is rising up Credit: GVL

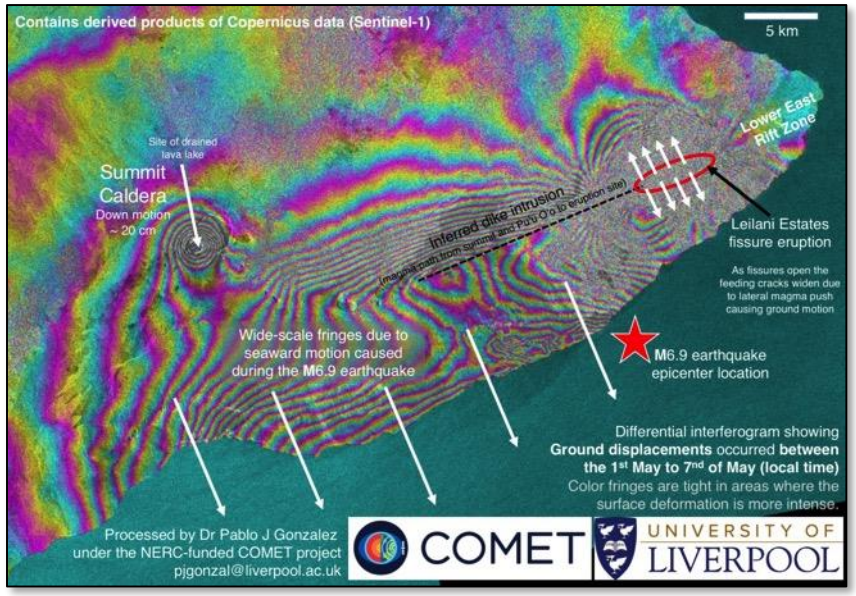
The team hope the map will be useful for policymakers and a wide range of industries, including onshore oil and gas, civil engineering, insurance, mining and carbon trading.

Sentinel-1: a major tool for geophysicists

Eruption and earthquake near Kilauea volcano, Hawaii (3 May 2018)



*Sentinel-1 interferogram (19 April – **1 May 2018**)*



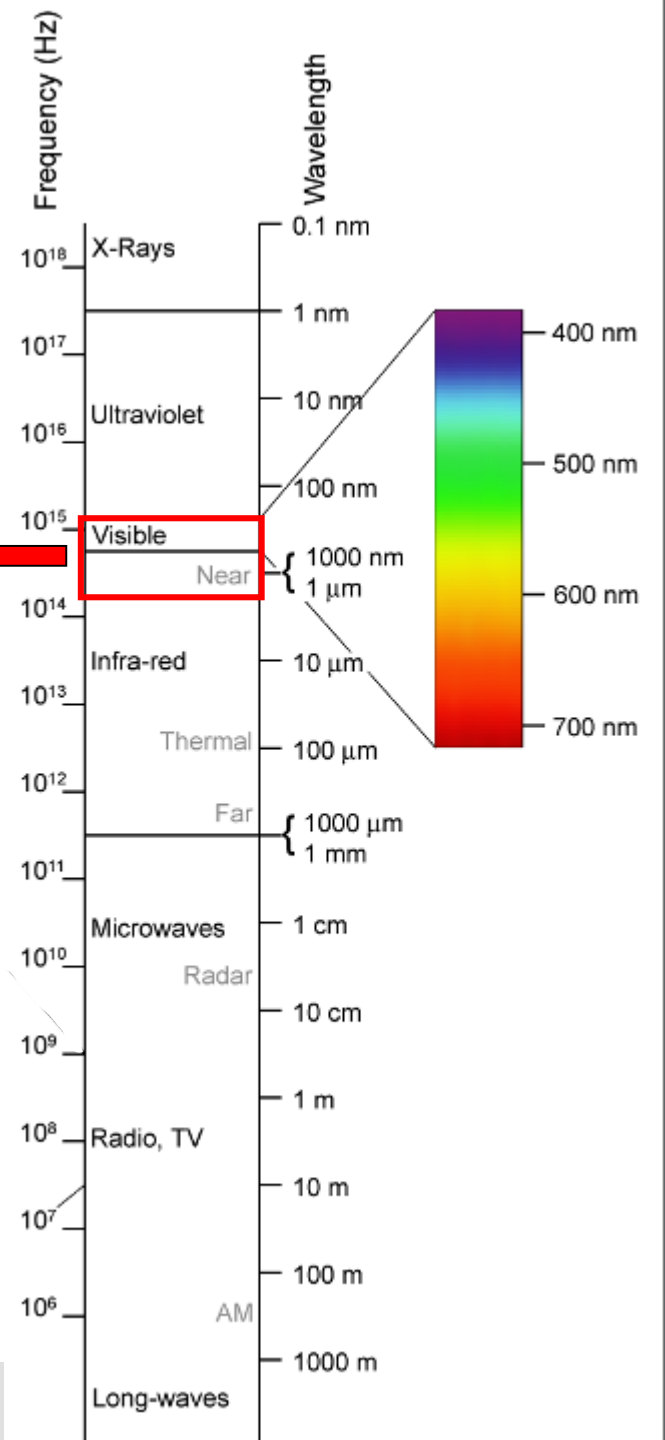
*Sentinel-1 interferogram (**1 May – 7 May 2018**)*

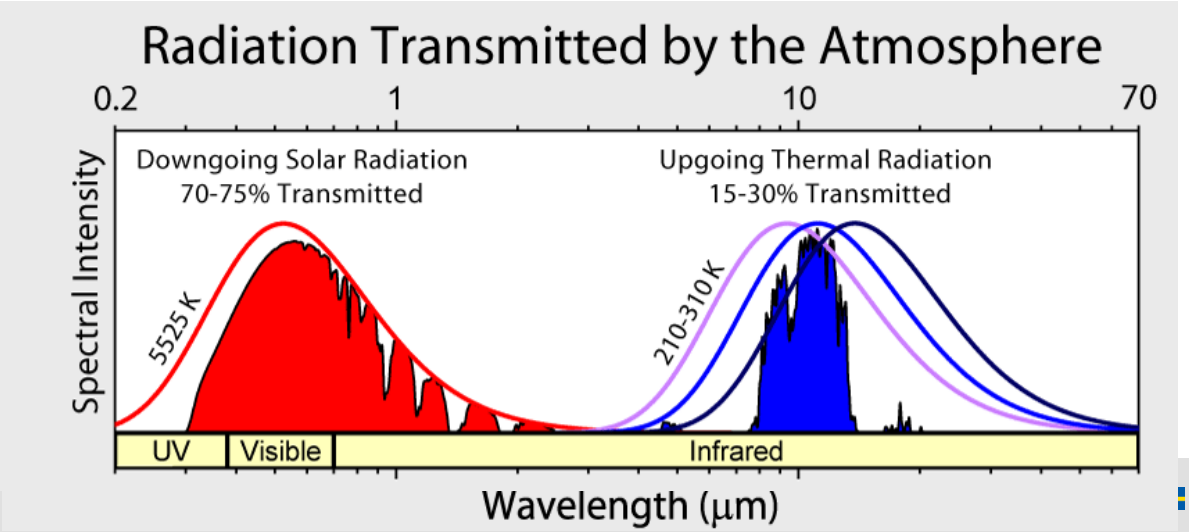
Deformation due to magmatic intrusion → magma withdrawn from middle East Rift Zone and intruded beneath lower East Rift Zone.

SENTINEL-2

The electromagnetic spectrum

Visible (VIS) + Near Infrared (NIR)= Optical





Launch of Sentinel-2A

- June 23, 2015
- Launch from French Guiana Space Base
- Vega rocket

Sentinel-2 Superspectral imaging mission

Mission profile

- Multispectral instrument with **13** spectral bands (VIS, NIR & SWIR)
- Sun synchronous orbit at **786 km** mean altitude and 98.5° inclinaison
- **290 km** swath width
- **5 days** repeat cycle at Equator (cloud free) with 2 satellites
- **7 years** design life time, consumables for 12 years
- **10 m**, **20 m** and **60 m** spatial resolution (depending on the band) (1)

Mission objectives :

- Generic land cover maps
- Risk mapping and disaster relief

Sentinel-2
The European "Super Landsat"

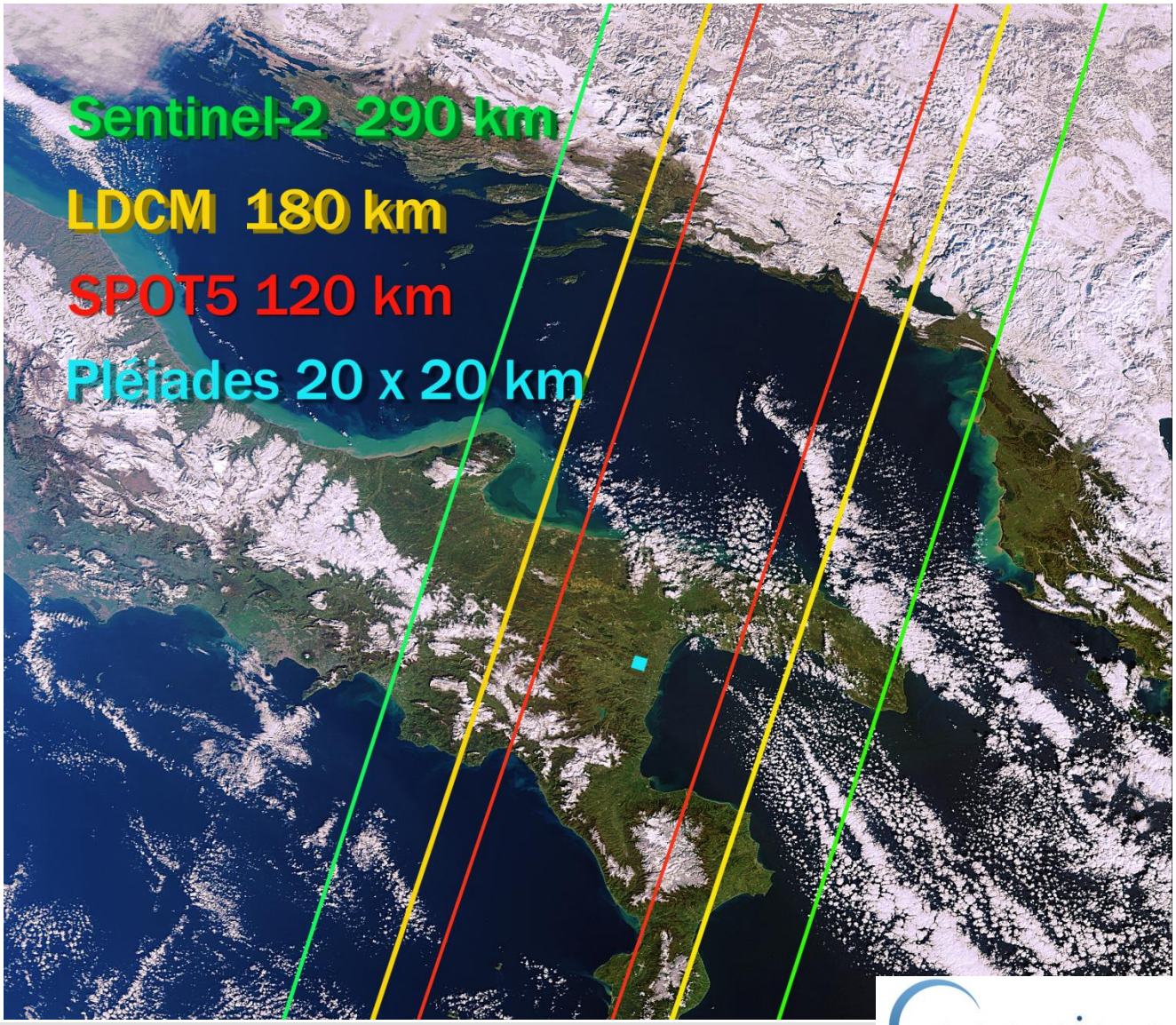
Coverage (d)	26	16	**5 (2 satellites)**
Swath (km)	60	185	**290**
Spectral bands	4+1	8+1	**13**
Resolution (m)	2.5	30,(15)	**10,20,(60)**

Sentinel-2
Imaging System : Multi Spectral Instrument (MSI)

Band name	Resolution (m)	Central wavelength (nm)	Band width (nm)	Purpose
B01	60	443	20	Aerosol detection
B02	10	490	65	Blue
B03	10	560	35	Green
B04	10	665	30	Red
B05	20	705	15	Vegetation classification
B06	20	740	15	Vegetation classification
B07	20	783	20	Vegetation classification
B08	10	842	115	Near infrared
B08A	20	865	20	Vegetation classification
B09	60	945	20	Water vapour
B10	60	1375	30	Cirrus
B11	20	1610	90	Snow / ice / cloud discrimination
B12	20	2190	180	Snow / ice / cloud discrimination

Sentinel-2
Swath width

Sentinels are complementary to High-Res commercial and national missions



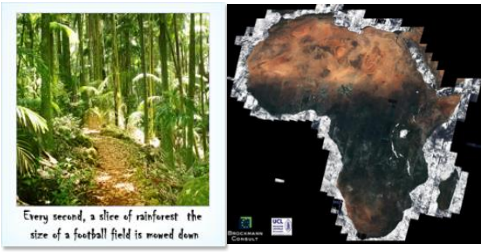
Sentinel-2
User Product List

Name	High-level Description	Intended Users
Level-1A	Sensor raw image data	Not distributed to external users
Level-1B	Sensor calibrated image data Top-of-Atmosphere Reflectance in sensor geometry	Expert End Users
Level-1C	Ortho-rectified and UTM geocoded Top-of-Atmosphere Reflectance	General End-Users
Level-2A	Ortho-rectified and UTM geocoded Bottom-of-Atmosphere Reflectance	General End-Users

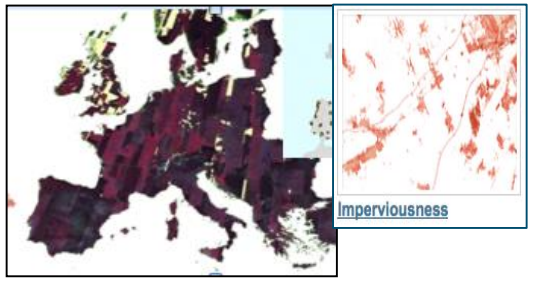
The Uniquess of Sentinel-2...

- ✓ Systematic acquisition of all land surfaces and coastal waters.
- ✓ High revisit frequency (5 days periodicity, same viewing direction).
- ✓ Large swath (290km).
- ✓ High spatial resolution (10m / 20m / 60m).
- ✓ Large number of spectral bands (13 in VNIR-SWIR domain).
- ✓ Free and open products for feeding a large range of applications.

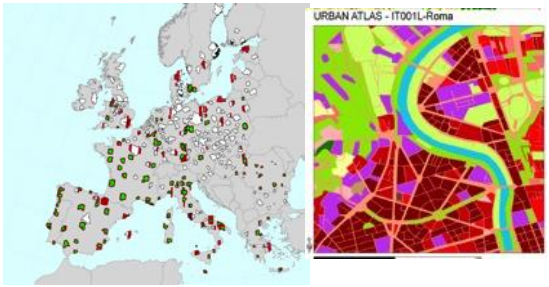
S-2: Large range of applications...



Agriculture, Forests & Carbon, Vegetation monitoring

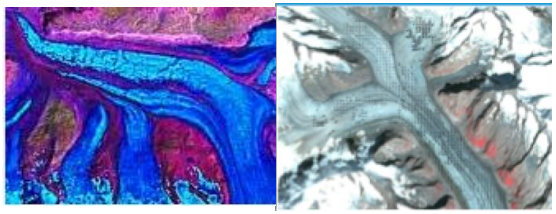


Land cover classification, high resolution layers & change.



Regional to Urban Applications

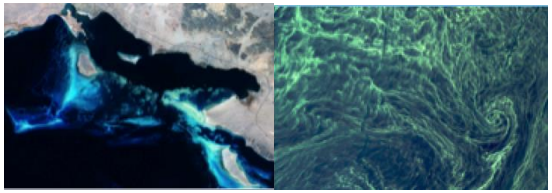
Emergency management



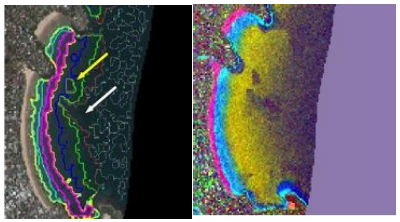
Glaciers & Ice

Global Land use & change

Geology



Water quality

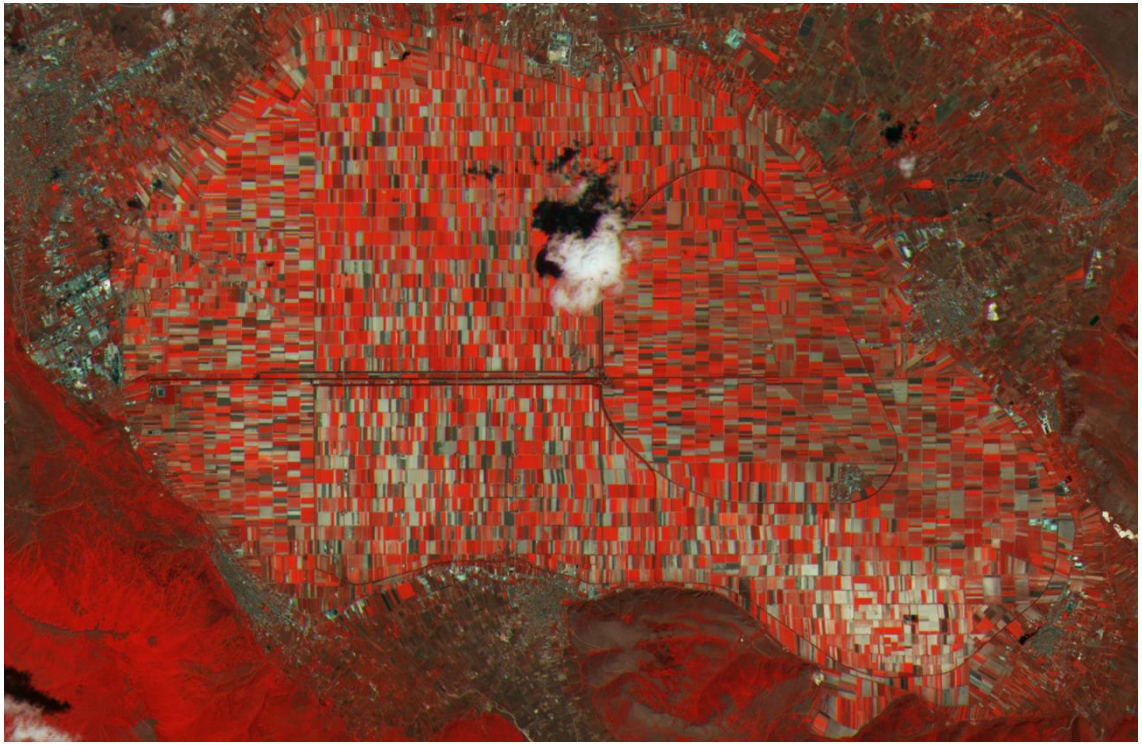


Coastal zones/bathymetry

Sentinel-2: Agriculture

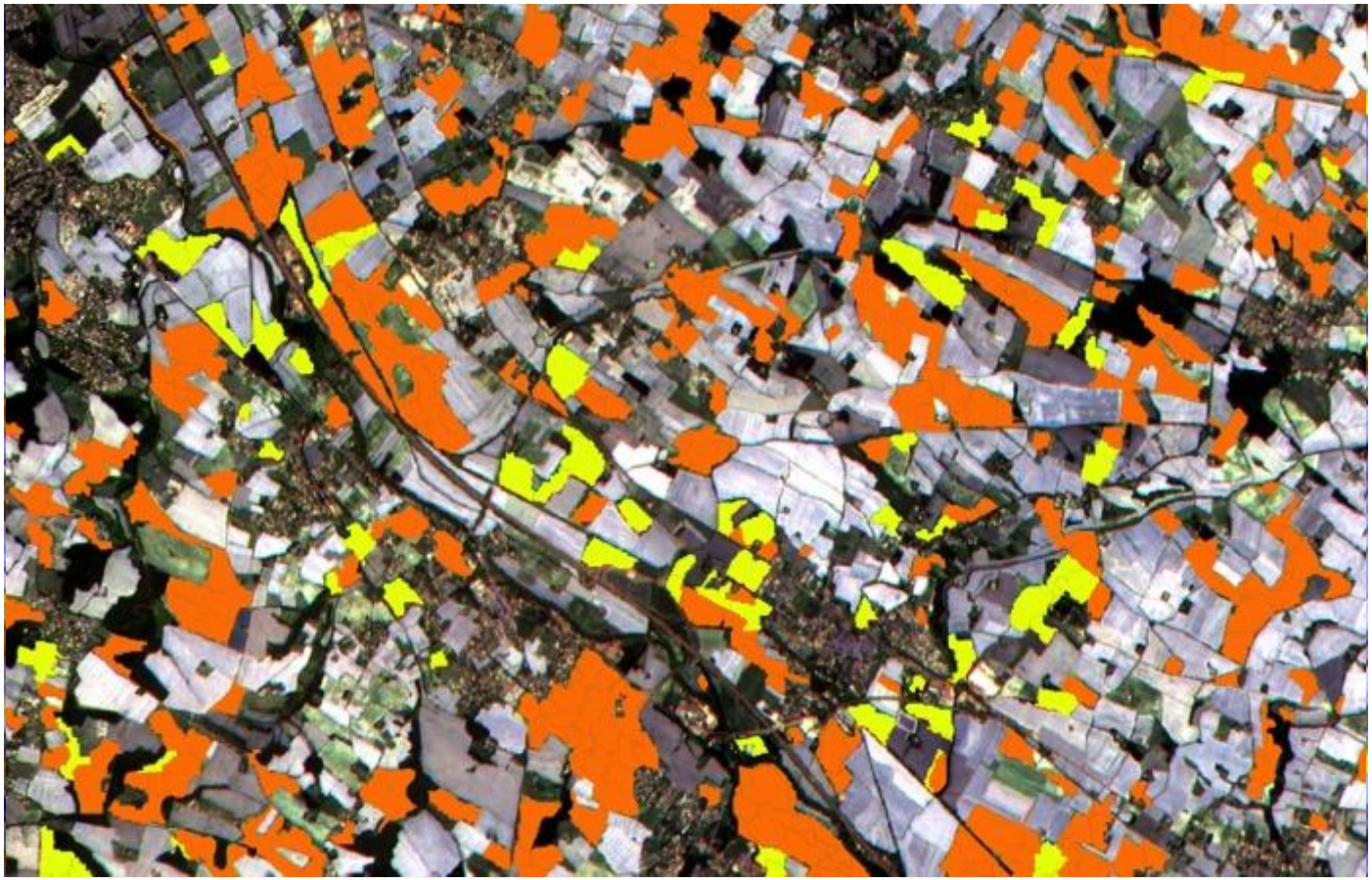
Sentinel-2 is the first optical mission to include 3 bands in the '**red edge**', providing information on the state of vegetation

Sentinel-2 for agriculture :
esa-sen2agri.org



Usage of red-edge bands

Toulouse area (France) - Sentinel-2 – 06 July 2015



Summer Crops Map – 6 July 2015

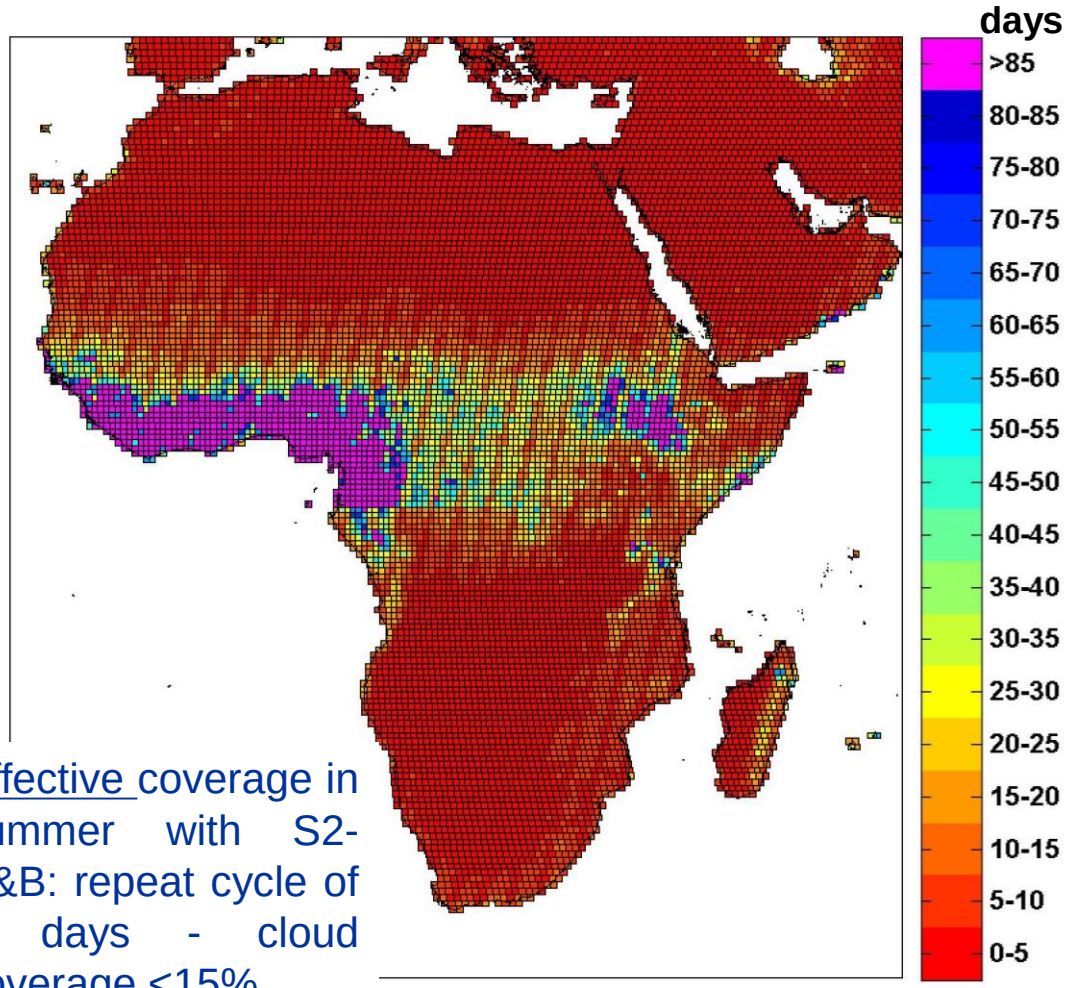
- Sunflower
- Maize

Courtesy: S2AGri, UCL, Cesbio, ESA

Vegetation monitoring

Sentinel-2: Agriculture

Sentinel-2 Revisit Time Capability
5 days revisit for crop dynamics



Effective coverage in summer with S2-A&B: repeat cycle of 5 days - cloud coverage <15%

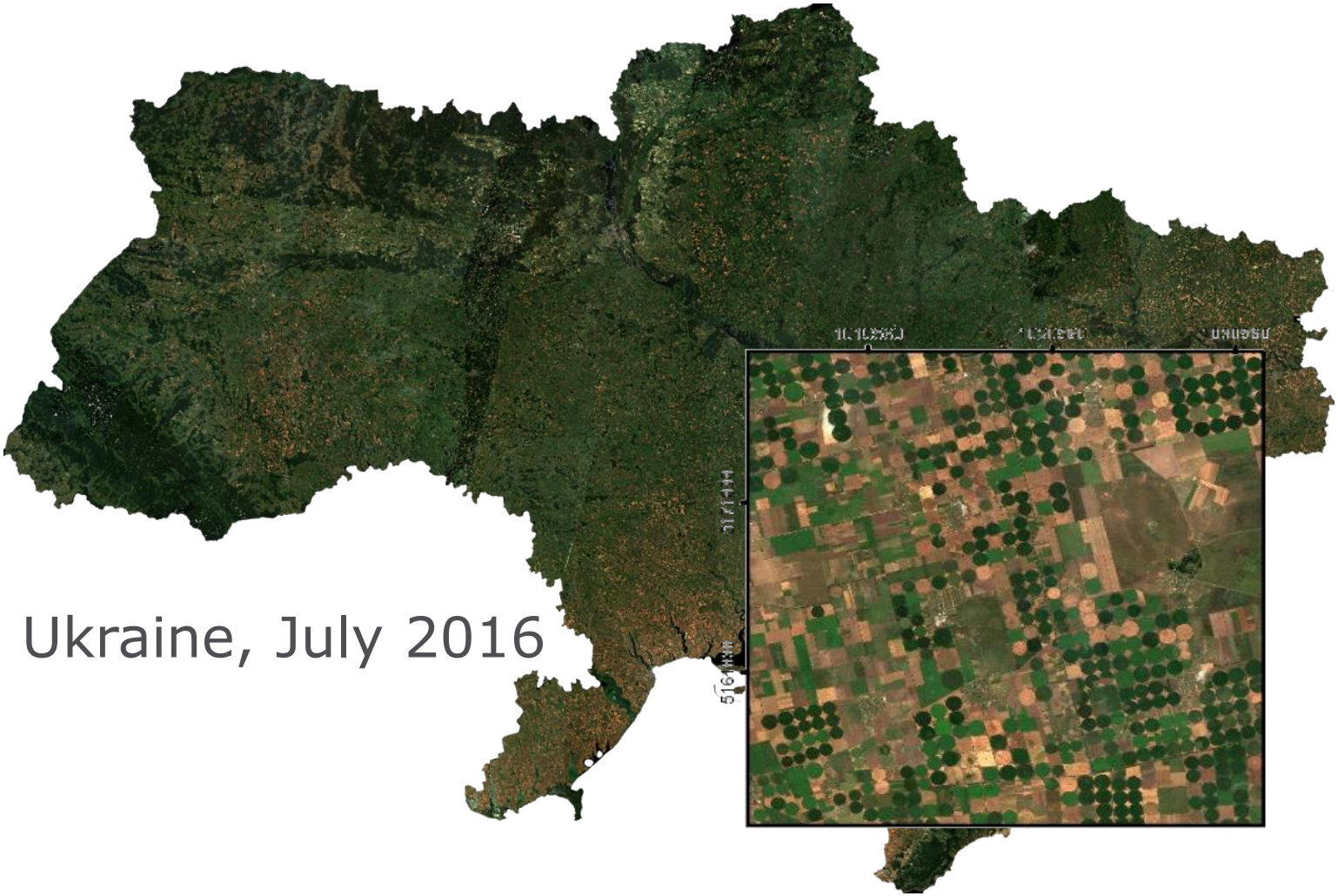
South Africa JECAM site: 5 days revisit, February-June 2013 - RapidEye

Monthly cloud free composites possible for most areas

Sentinel-2: Agriculture

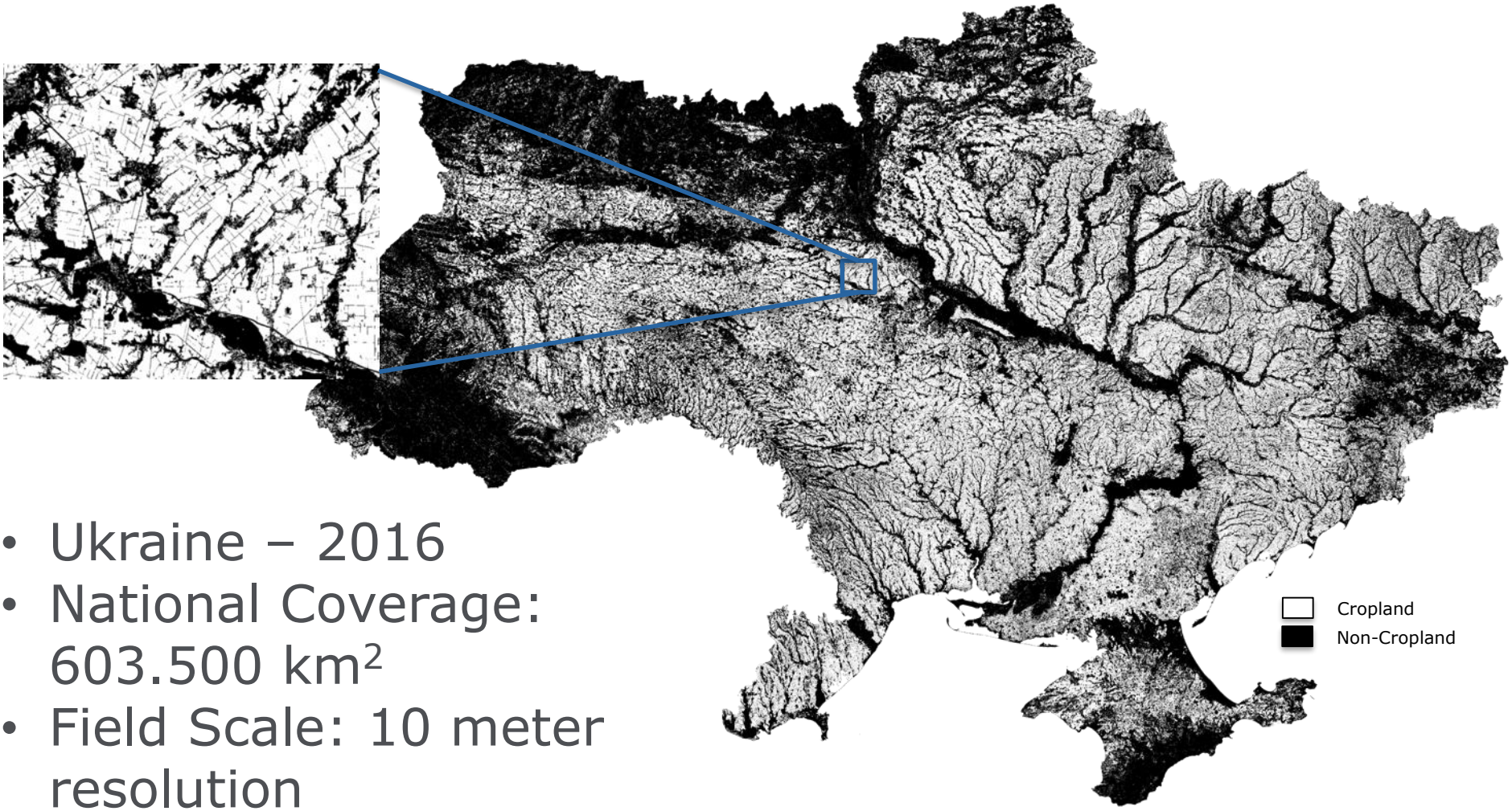
Sustainable use of agricultural land

S2 cloud free composite



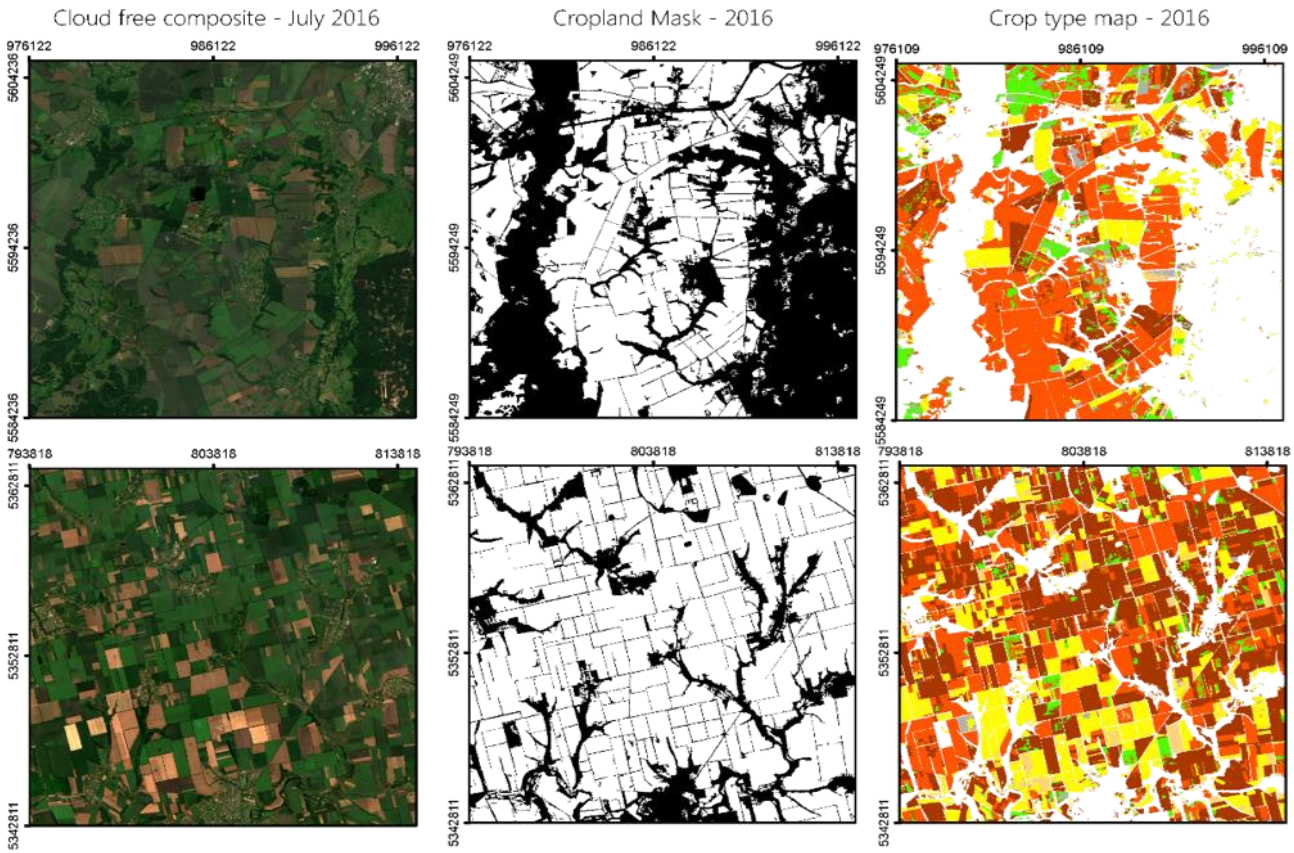
Ukraine, July 2016

S2 Crop mask



- Ukraine – 2016
- National Coverage: 603.500 km^2
- Field Scale: 10 meter resolution
- Overall Accuracy: 96%

S2 crop mask and type mapping at field scale



Ukraine 2016

S2 crop status monitoring over the season

18 Feb. 16

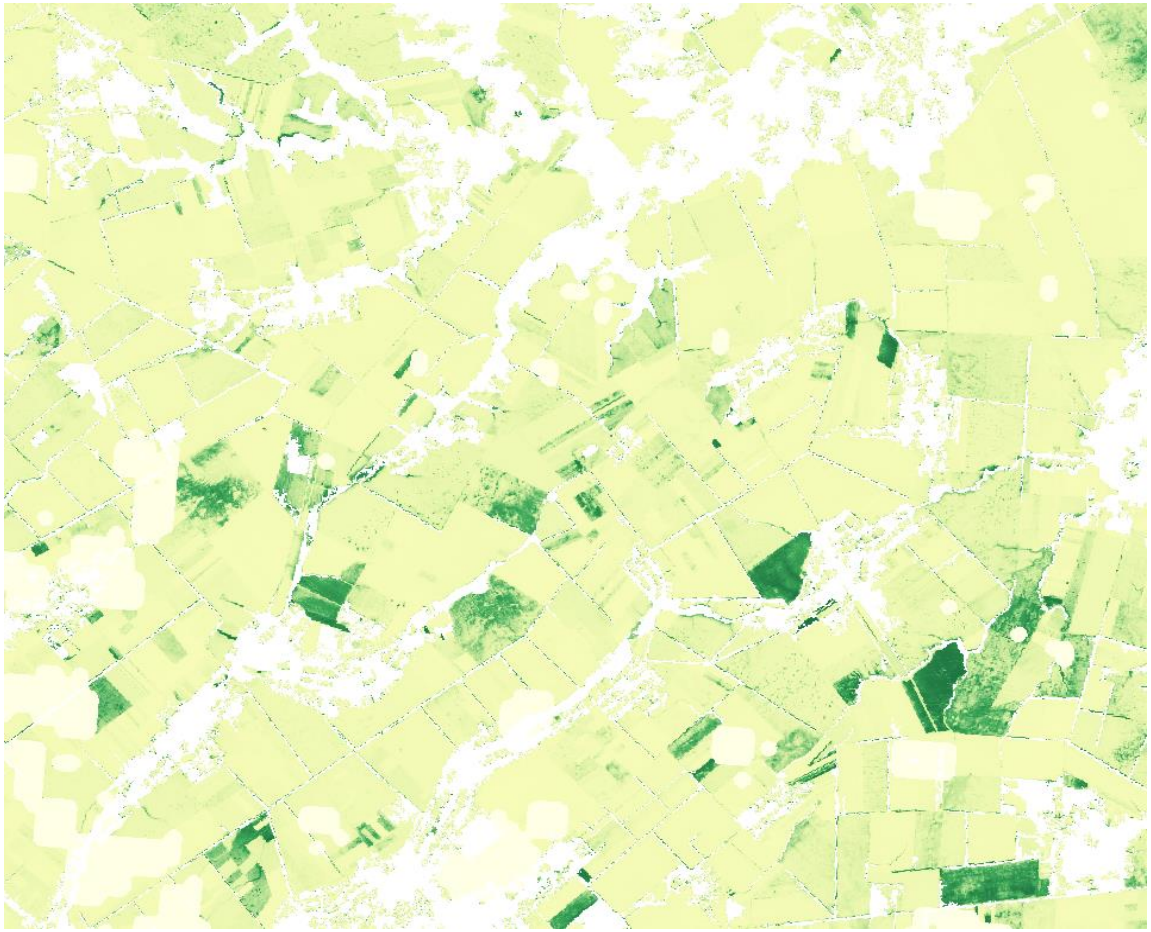
18 Apr. 16

28 Apr. 16

17 Jun. 16

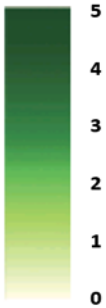
17 Jul. 16

8 Sept. 16



Ukraine 2016

Leaf Area Index



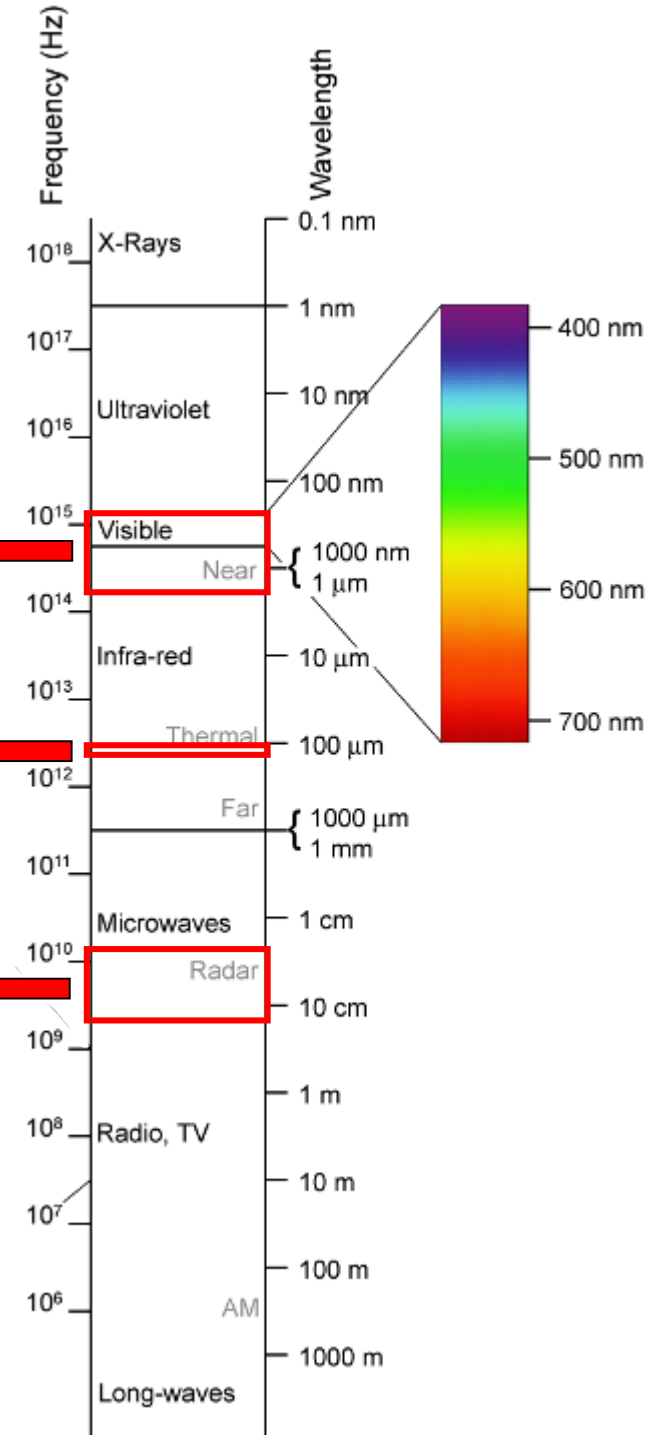
SENTINEL-3

The electromagnetic spectrum

Visible (VIS) + Near Infrared (NIR)= Optical

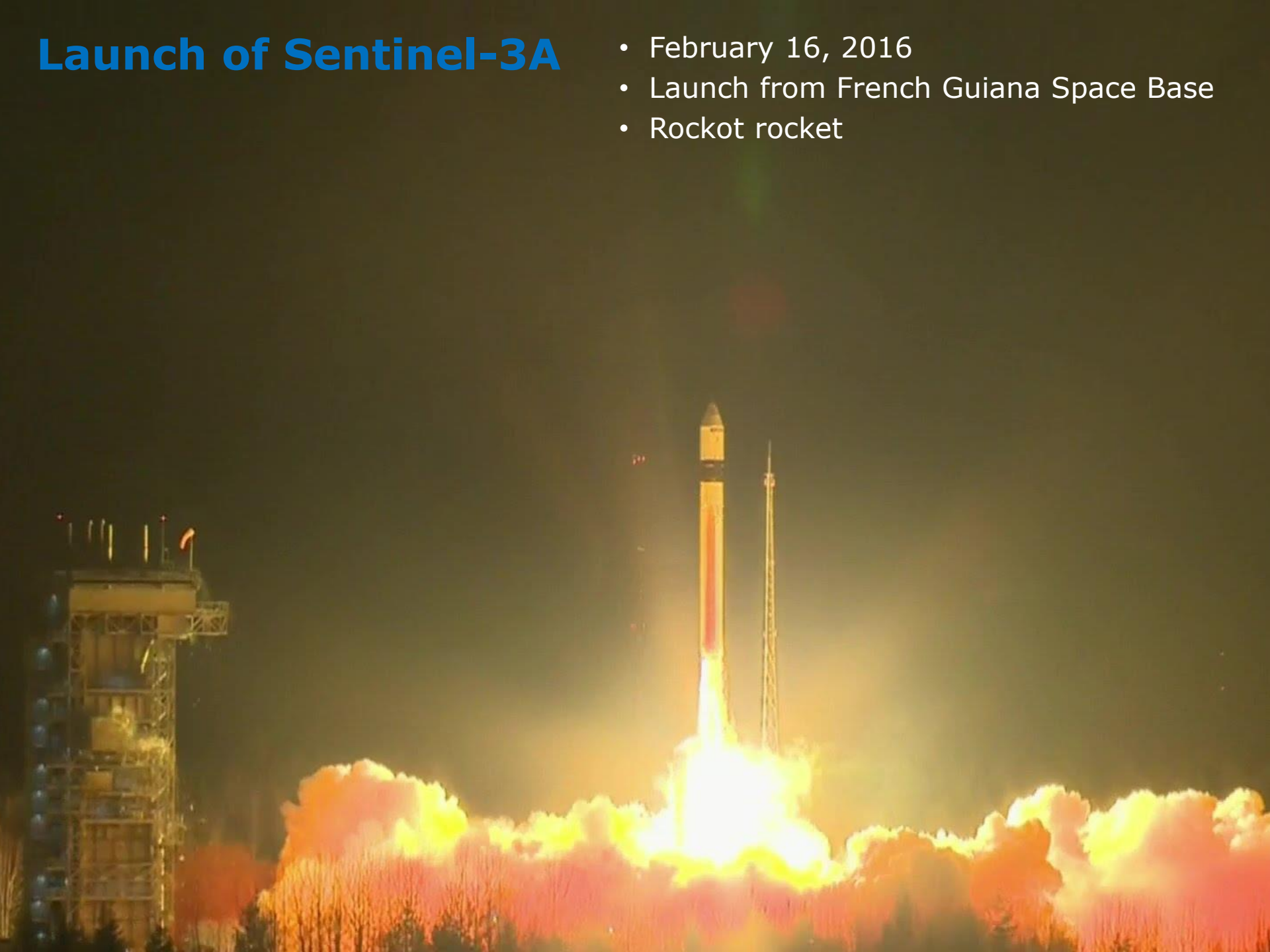
Thermal Infrared (TIR)

Synthetic Aperture Radar (SAR)



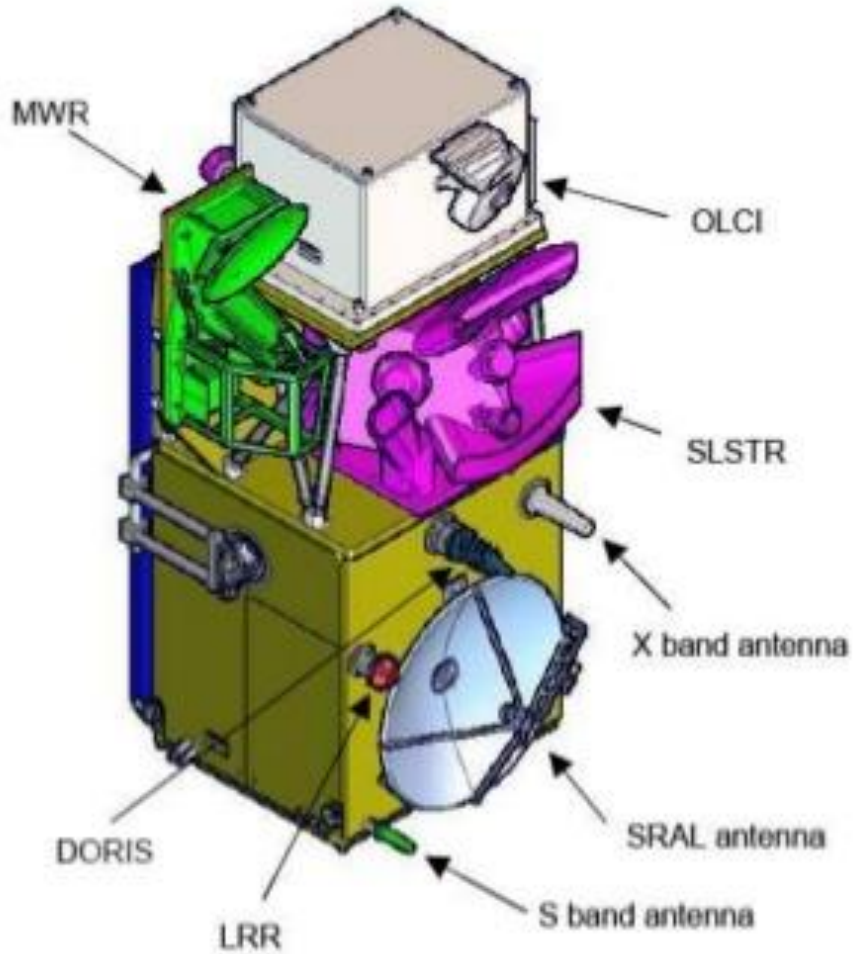
Launch of Sentinel-3A

- February 16, 2016
- Launch from French Guiana Space Base
- Rockot rocket



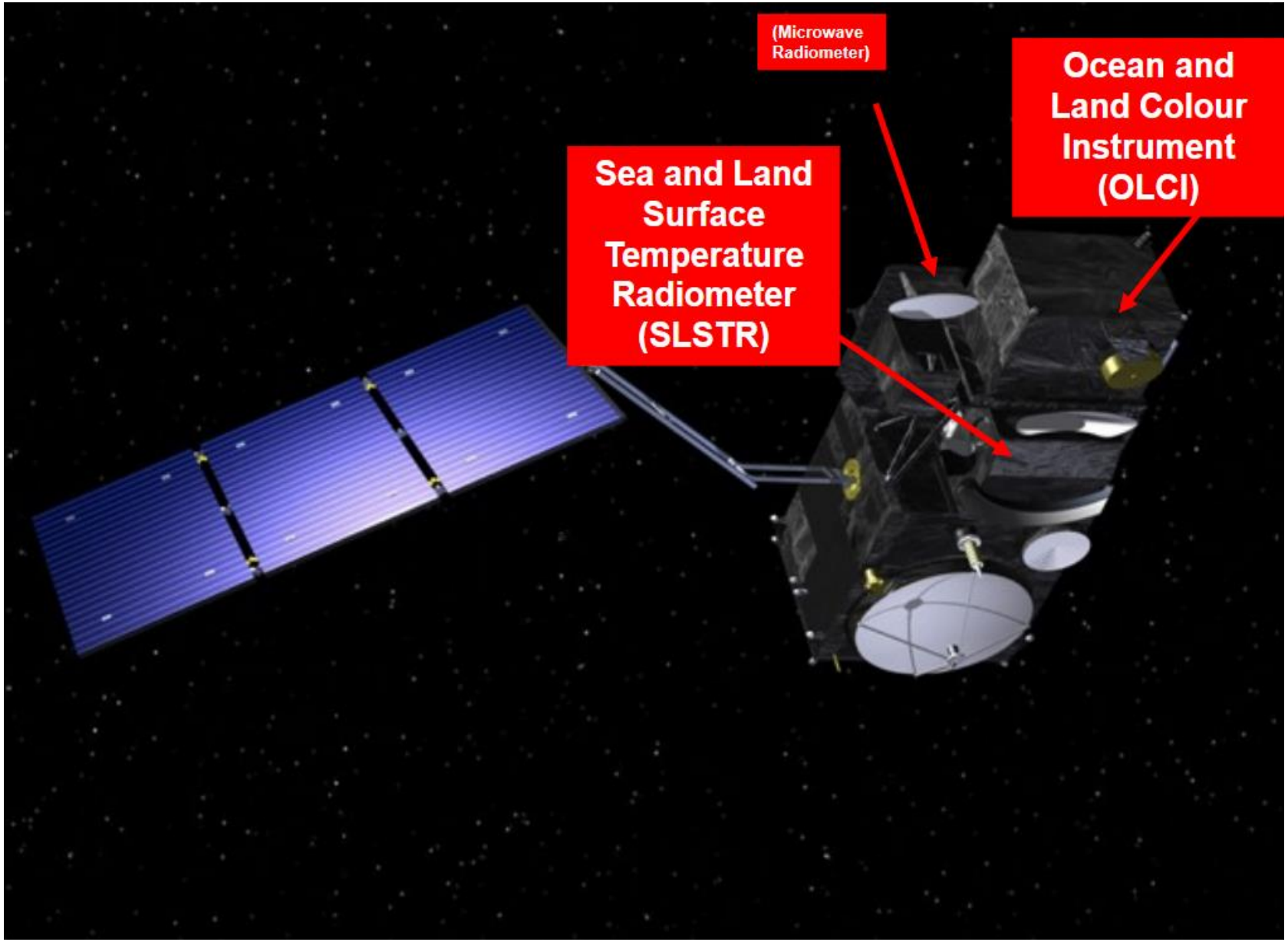
Sentinel-3 Mission requirements
Satellite and Payload

- **Copernicus requirement :**
  Operational and near-real-time monitoring of ocean, land and ice surfaces over a period of 20 years.



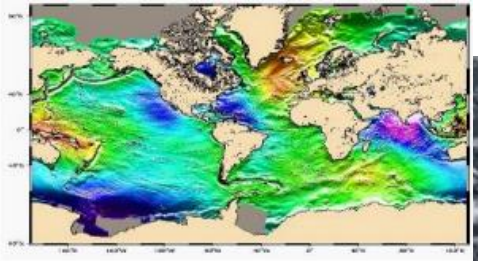
- SLSTR: Sea and Land Surface Temperature Radiometer
- SRAL: Synthetic Aperture Radar Altimeter
- OLCI: Ocean and Land Colour Instrument
- MWR: Micro-Wave Radiometer
- LRR: Laser Retro-Reflector
- DORIS: Doppler Orbitography and Radiopositionning Integrated by Satellite
- STM: Surface Topography Mission = SRAL + MWR

Sentinel-3: *Optical Payload*



Sentinel-3
Mission overview

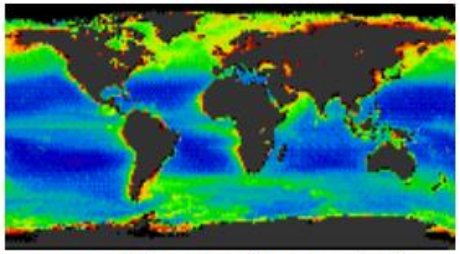
- **Operational mission in high-inclination, low Earth orbit**
- **Full performance achieved with 2 satellites in orbit (S-3A,-3B)**



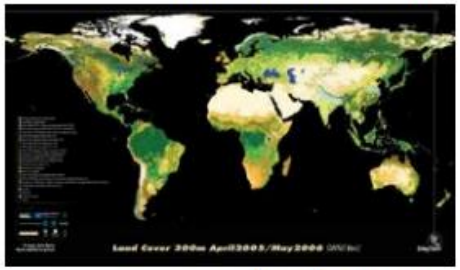
Sea Surface Height products
(Credit: CLS)

Optical Mission Payload providing

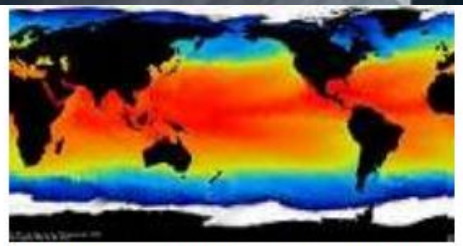
- **Sea and land color data**, through **OLCI (Ocean and Land Color Instrument)**
- **Sea and land surface temperature**, through the **SLSTR (Sea and Land Surface Temperature Radiometer)**



Ocean colour products
(Credit: MyOcean)



Land cover products
(Credit: ESA)



Sea Surface Temperature products
(Credit: Met Office)

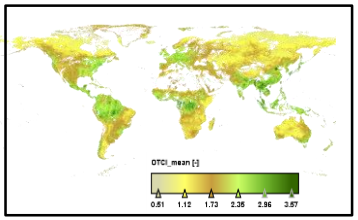
Topography Mission Payload providing

- **Sea surface topography data**, through a **Ku-/C-band Synthetic Aperture Radar Altimeter (SRAL)**, a bi-frequency **MicroWave Radiometer (MWR)**, and a **Precise Orbit Determination (POD)** including
  - **GNSS Receiver**
  - **DORIS**
  - **Laser Retro-Reflector**

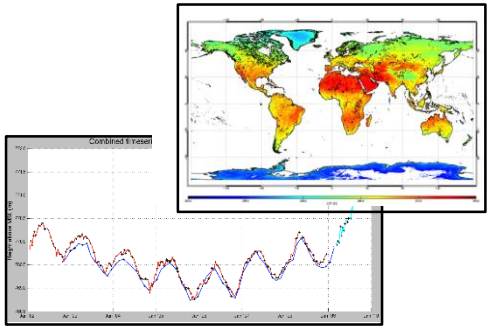
In addition, the payload design will allow

- **Data continuity of the Vegetation instrument (on SPOT4/5),**
- **Enhanced fire monitoring capabilities, river and lake height, atmospheric products**

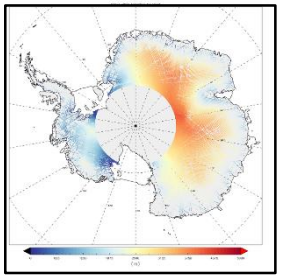
Sentinel-3 applications → ever increasing



Agriculture, vegetation monitoring

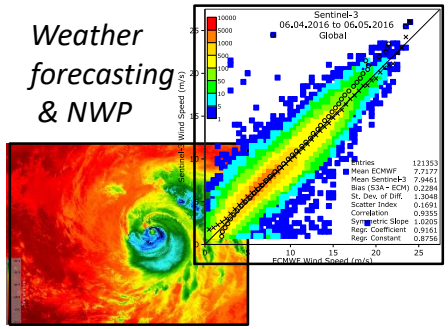


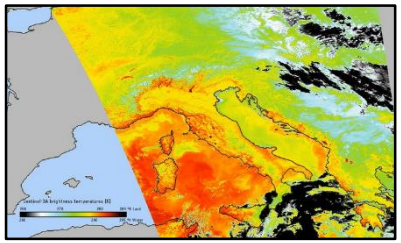
Water resource management



Climate research

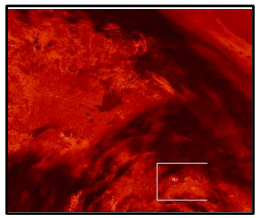
Weather forecasting & NWP





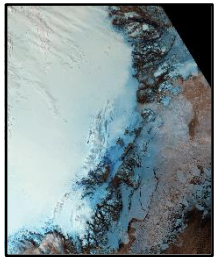
Climate monitoring, numerical modelling and mesoscale analysis

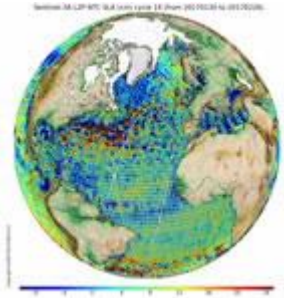
Inland water quality



Fire monitoring

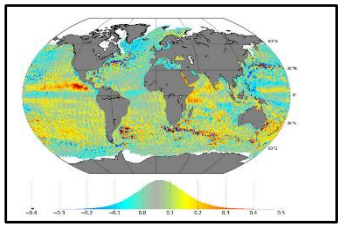
Snow and Ice





Mesoscale ocean circulation, currents, tides

Ship routing: maritime safety

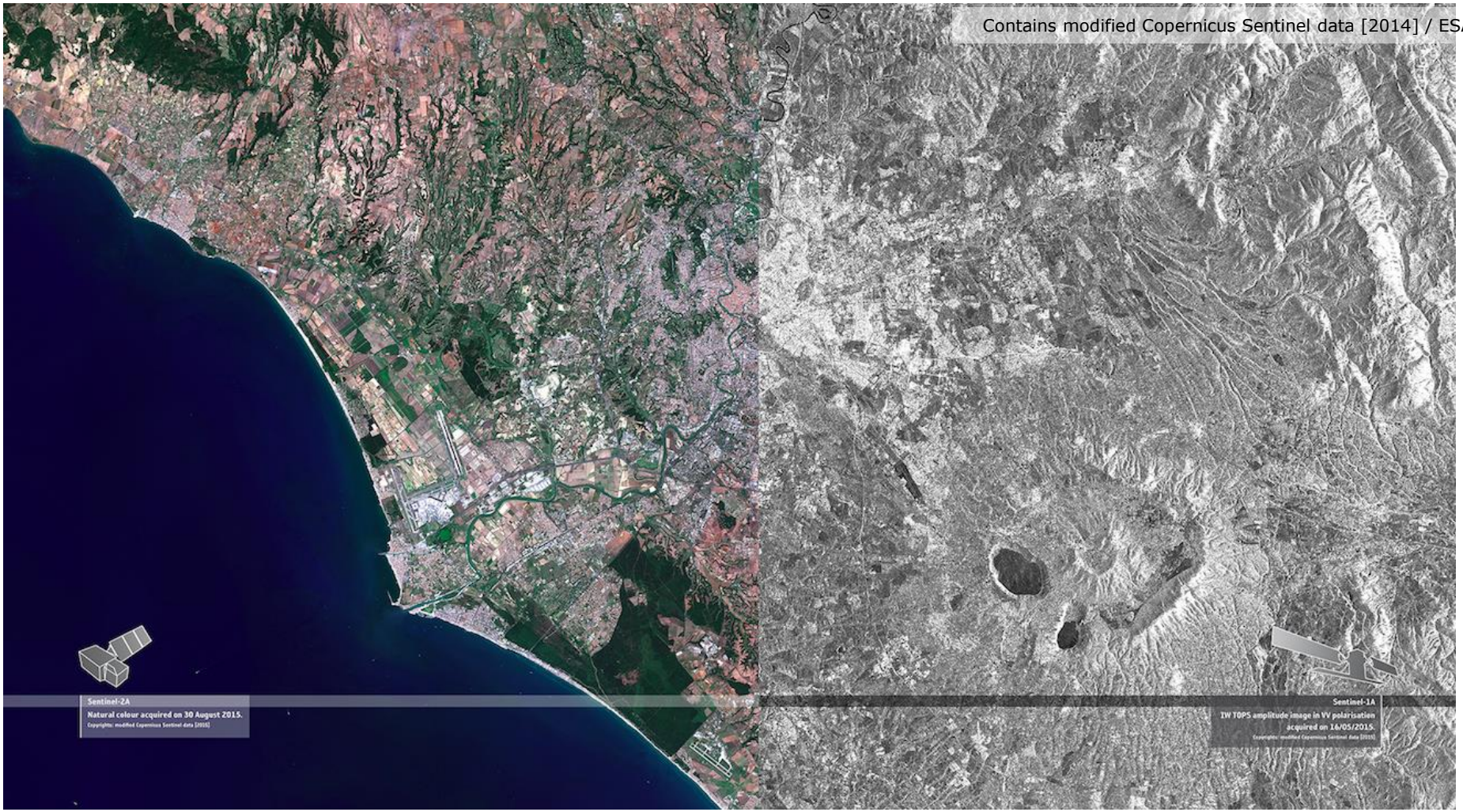


Fisheries: Harmful algal bloom/marine biology/global ocean primary production

Sentinel-1, -2 and -3 Synergy

Contains modified Copernicus Sentinel data [2014] / ESA

Sentinel-1 & -2 **Synergy**



Contains modified Copernicus Sentinel data [2014] / ESA
Synergy of
Sentinel-1 & -2

Sentinels in Co-Operation

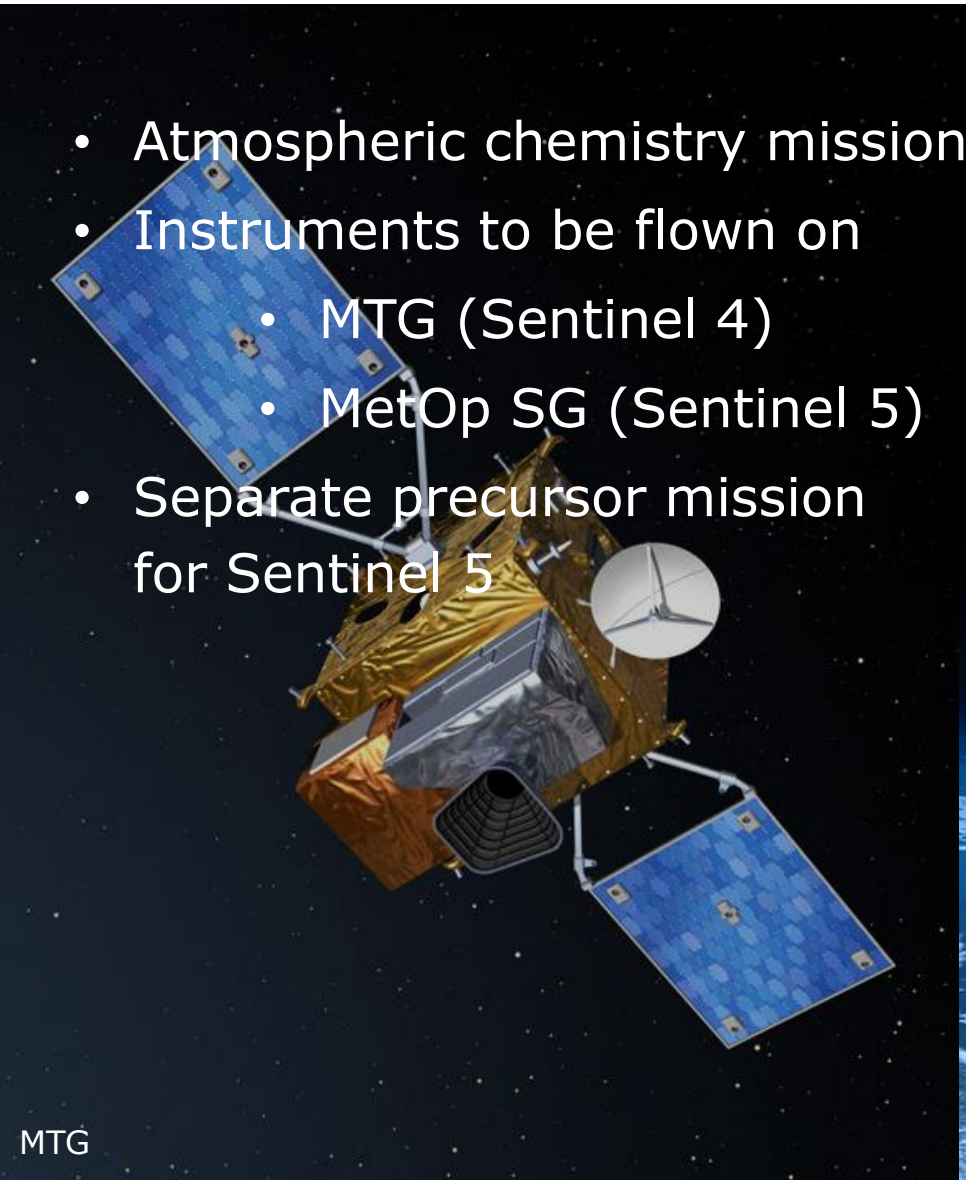
Using both S1 and S2 data (and Landsat-8).

Innovative crop type map at national scale: pilot project for potential future Copernicus service agricultural components

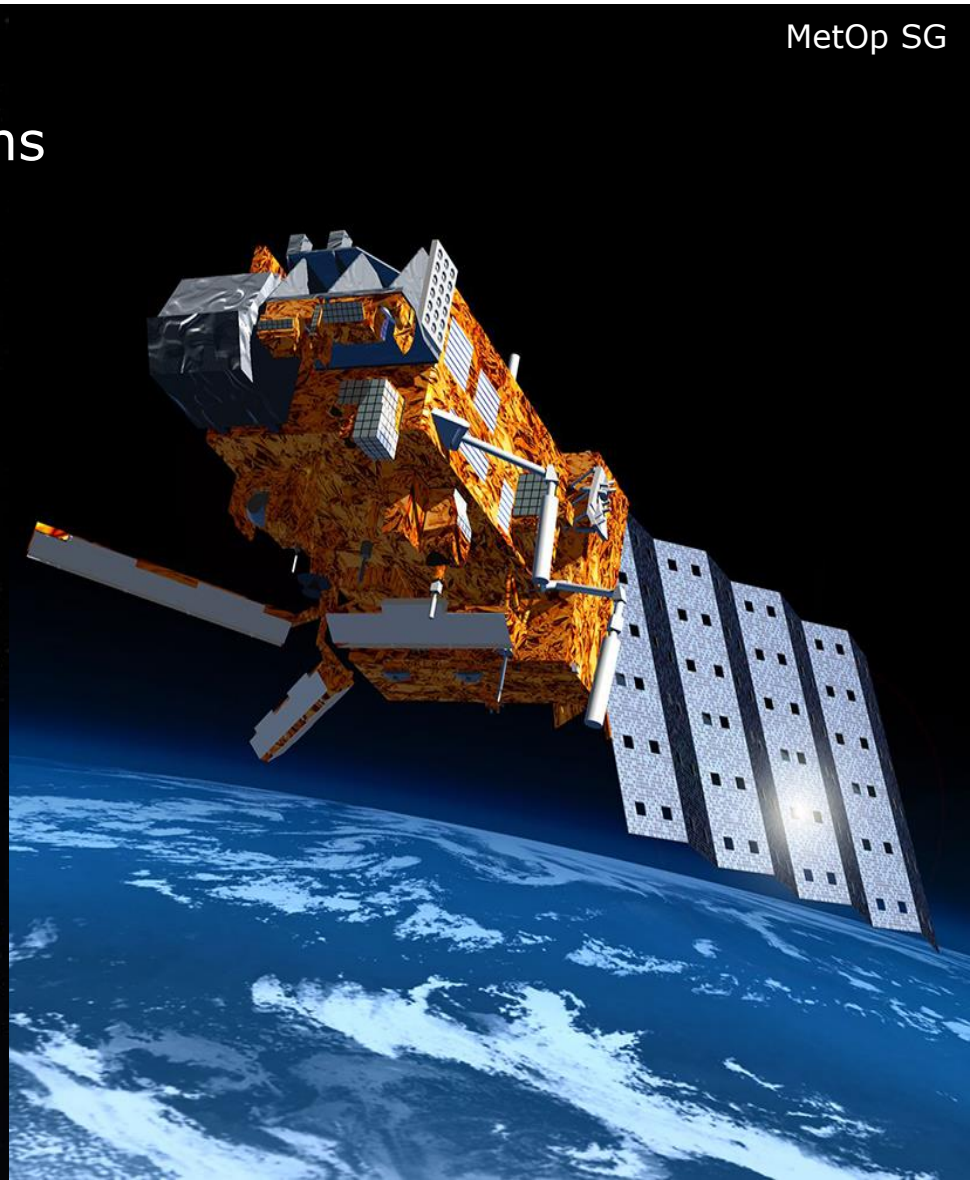
Sentinel-1A und -2A: Traffic Jam on the Danube

Sentinel-4/5/5p

- Atmospheric chemistry missions
- Instruments to be flown on
  - MTG (Sentinel 4)
  - MetOp SG (Sentinel 5)
- Separate precursor mission for Sentinel 5



MTG



MetOp SG

Sentinel-5 Precursor

COPERNICUS ATMOSPHERE MISSION IN POLAR ORBIT

The ESA Sentinel-5 Precursor (S-5P) is a pre-operational mission focusing on global observations of the atmospheric composition for **air quality** and **climate**.

The TROPOspheric Monitoring Instrument (**TROPOMI**) is the payload of the S-5P mission and is jointly developed by **The Netherlands and ESA**.

S-5P will be provide **enhanced radiometric sensitivity & spatial resolution** enabling sampling of small-scale variabilities specifically in the lower troposphere.

The troposphere is the lowest portion of the atmosphere, where nearly all weather "takes place"

The mission was launched in October 2017

7 year design lifetime.

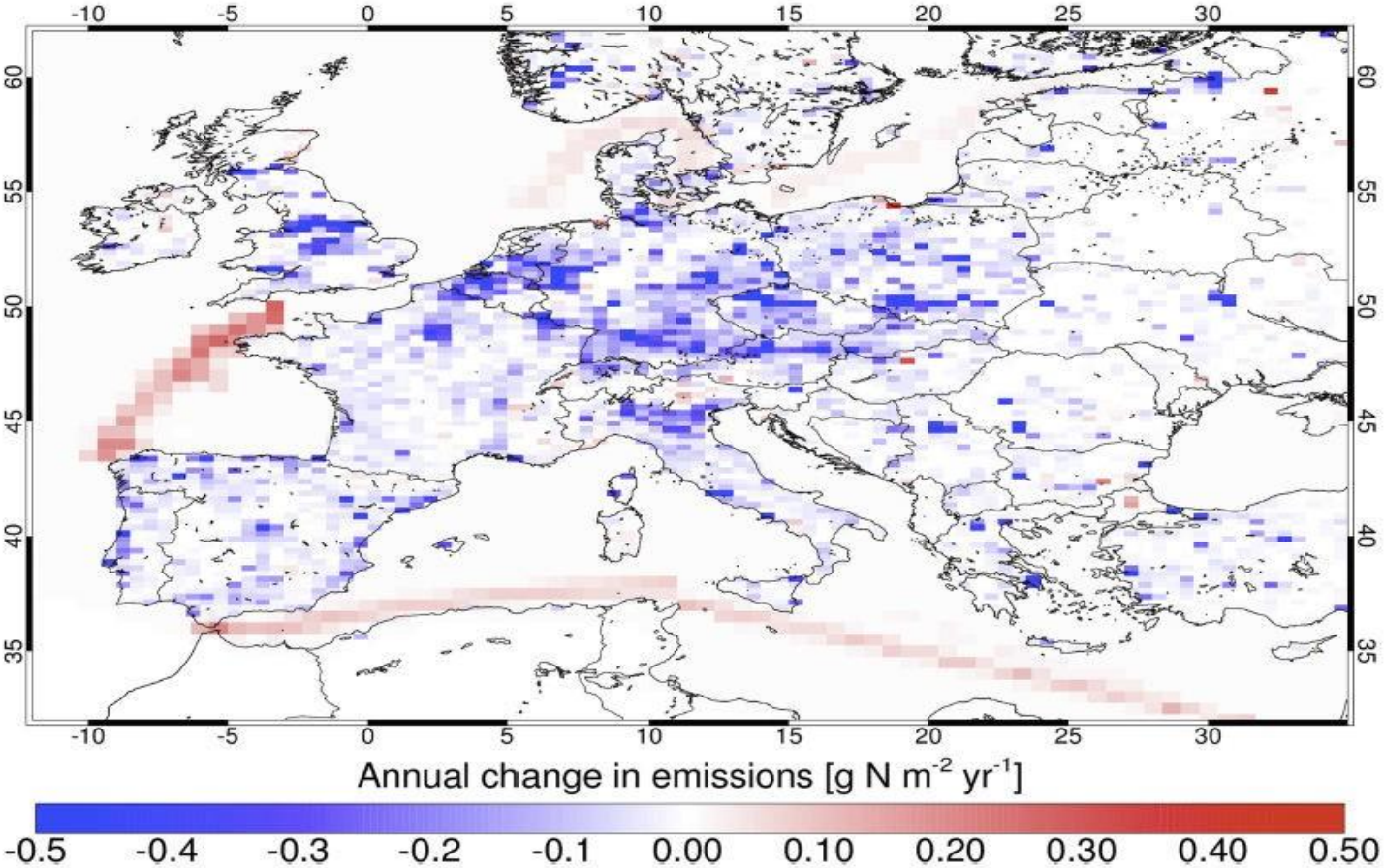
TROPOMI is continuity of SCIAMACHY (ENVISAT), OMI (NASA AURA satellite) and the Global Ozone Monitoring Experiment (GOME/GOME2) on ERS-2 and the METOP series. Its observations will be continued by SENTINEL-5

TROPOMI

- UV-VIS-NIR-SWIR nadir view grating spectrometer.
- Spectral range: 270-500, 675-775, 2305-2385 nm
- Spectral Resolution: 0.25-1.1 nm
- Spatial Resolution: 3.5x7km^2
- Global daily coverage at 13:30 local solar time.

NO_x Pollution over Europe - OMI Data

Annual changes in OMI NO_x emissions (2005-2008)



Quality Assurance for Essential Climate Variables (EU FP7 project QA4ECV, lead by KNMI (F. Boersma), www.qa4ecv.eu

nitrogen oxide (NOx) pollution

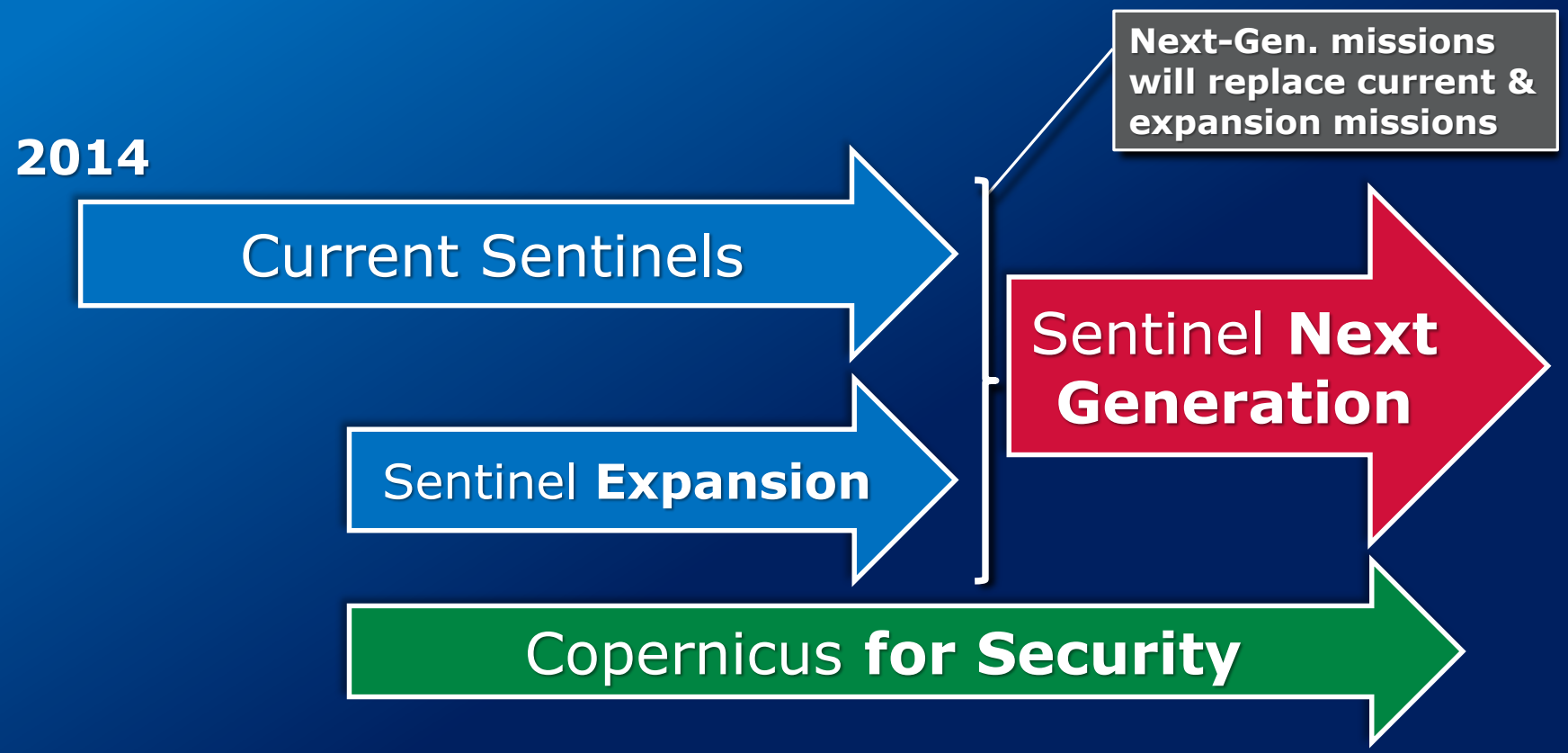
https://aura.gsfc.nasa.gov/science/feature-102009c.html

Nitrogen Oxides are a family of poisonous gases, forming when fuel is burned at high temperatures (automobiles, industrial sources, power plants).

Some countries have adopted regulations to reduce NOx emissions (either by modifying the combustion process or by installing air pollution control equipment)

https://www3.epa.gov/region1/airquality/nox.html

Copernicus Space Component Evolution



Current Sentinels

Copernicus is the largest producer of EO data in the world

Sentinel Expansion: Status & Progress

Present
(Sept. 2018)

- Potential Sentinel expansion system study activities initiated
- End-to-end performance simulation campaigns
- Scientific studies in support of mission requirements definition
- Pre-developments of most critical technologies

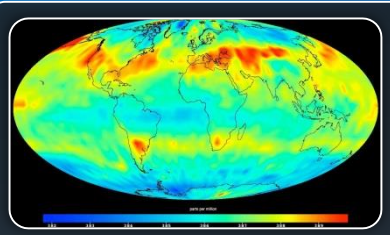
CM19

Will cover the ESA MS co-funding to the EU Copernicus programme for the space component, as outlined in (evolving) Long-Term Scenario:

- Development of prototype missions for new Sentinels in response to EU policy priorities
- Development of prototype missions for the continuation of observations of the current Sentinel-1–6 series
- Development of Ground Segment for future Sentinels

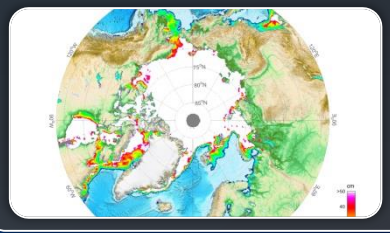
Operational EO: Copernicus 2.0

Addressing current and future user and policy needs: 6 High Priority Candidate Missions & Next Generation Sentinels 1, 2 and 3

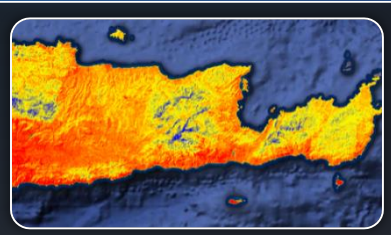


Monitor causes of Climate Change (CO_2 emissions)

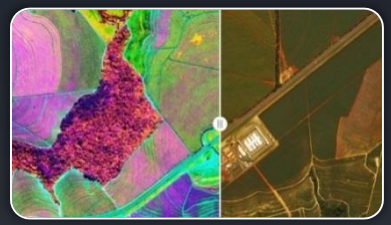
Monitor effects of Climate Change (Arctic/Polar ice volume)



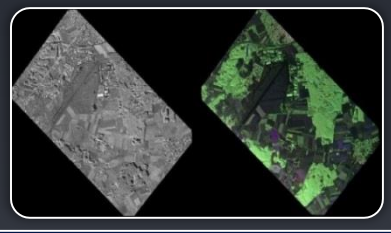
Sea Ice Conc. & SST (Arctic situational awareness)



Agriculture & Water Productivity



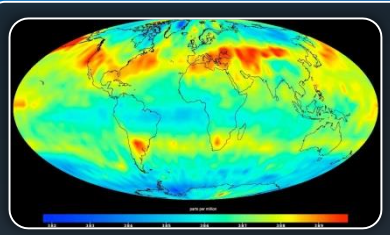
Food Security, Soil & Minerals, Forestry, Biodiversity



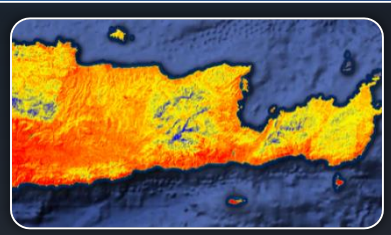
Soil Moisture, Vegetation & Ground Motion

Operational EO: Copernicus 2.0

Addressing current and future user and policy needs: 6 High Priority Candidate Missions & Next Generation Sentinels 1, 2 and 3

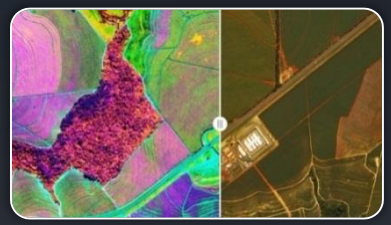


Anthropogenic CO_2 Imaging Spectrometer

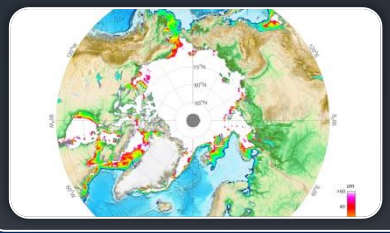


High Resolution Surface Temp.

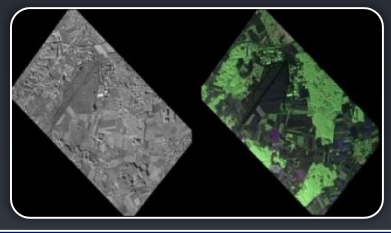
Polar Ice & Snow Topography



Hyperspectral Imaging



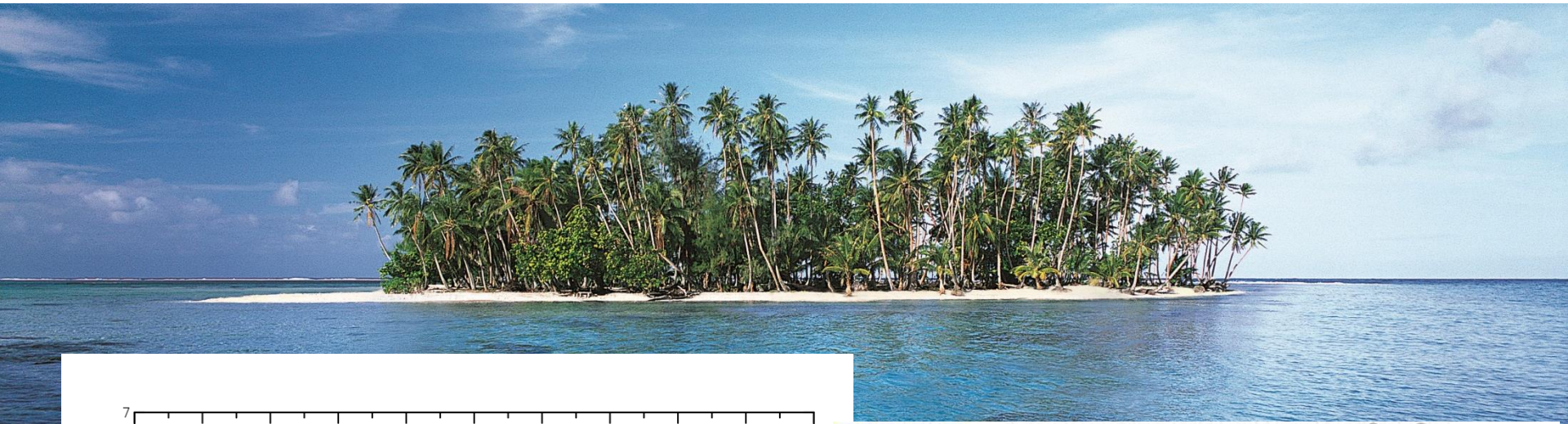
Passive Microwave Imaging

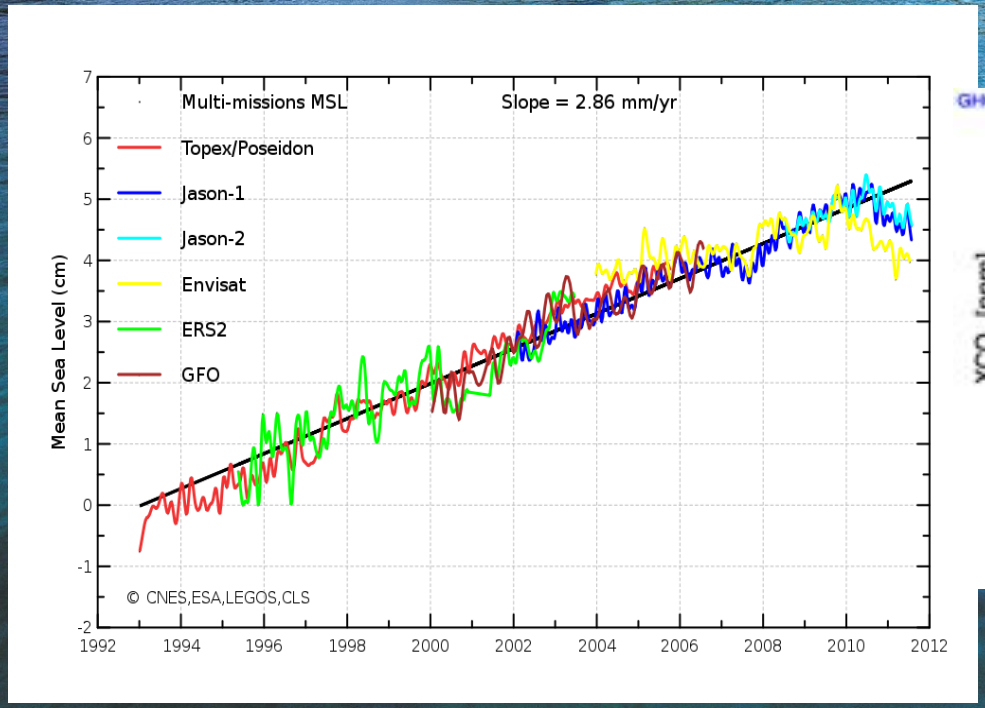


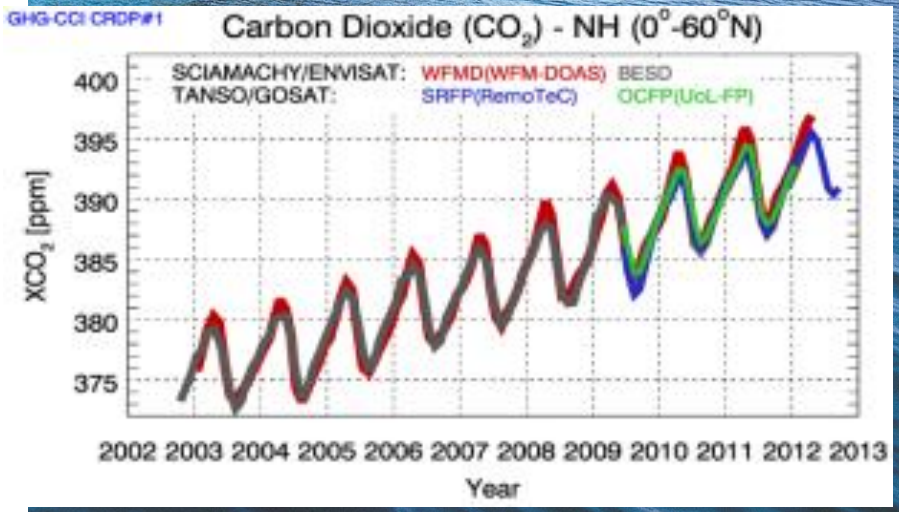
L-band SAR

European Space Agency

The ESA Climate Change Initiative (CCI)



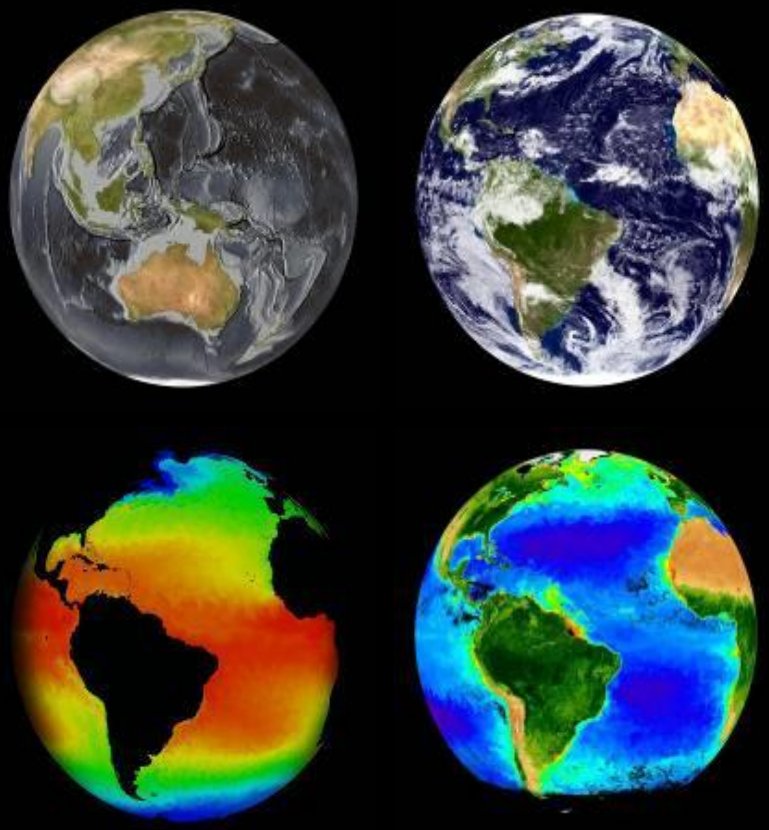




© Thinkstock by Getty Images

CCI: Essential Climate Variables

- Cloud Properties
- Carbon Dioxide, Methane & other GHGs
- Ozone
- Aerosol properties
- Sea Surface Temperature
- Sea Level; Sea Ice
- Ocean Colour
- Glaciers and ice caps
- Land cover
- Fire disturbance
- Soil moisture



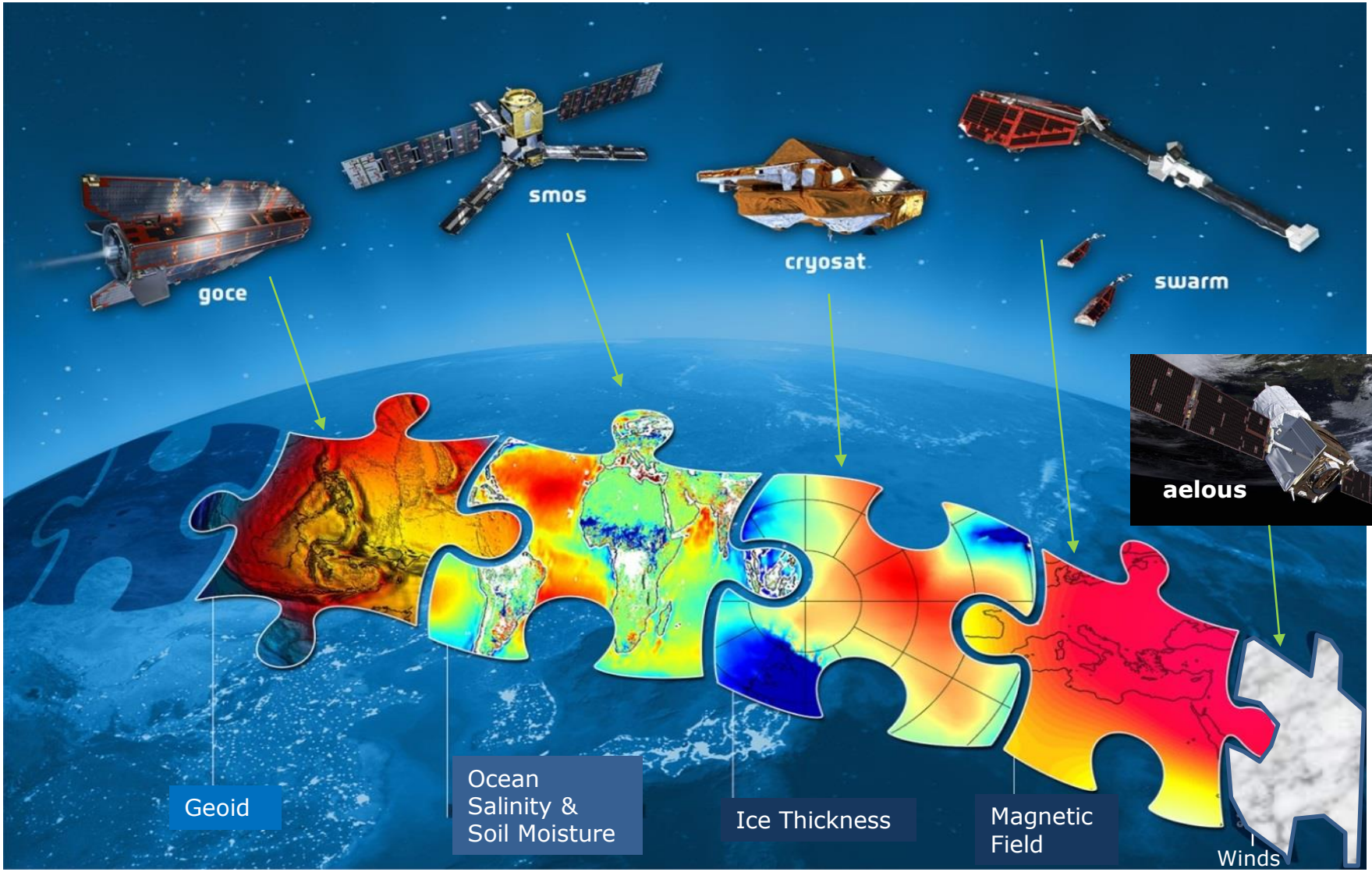
Earth Explorers

These missions address critical and specific issues raised by the science community, while demonstrating the latest observing techniques.

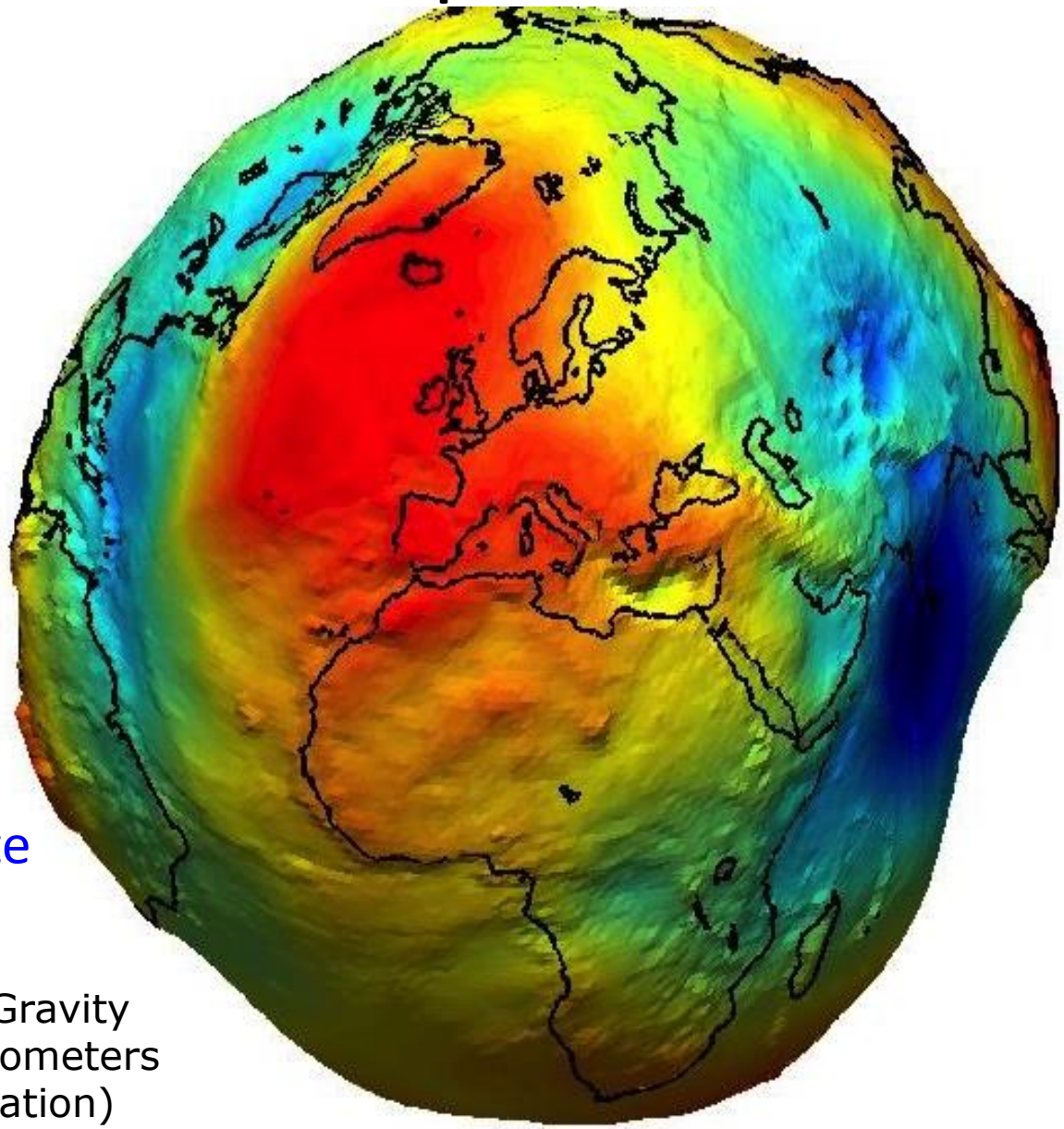
- **GOCE** (2009–13) studying Earth's gravity field
- **SMOS** (2009–) studying Earth's water cycle
- **CryoSat-2** (2010–) studying Earth's ice cover
- **Swarm** (2013–) three satellites studying Earth's magnetic field
- **ADM-Aeolus** (2018) studying global winds

- **EarthCARE** (2021) studying Earth's clouds, aerosols and radiation (ESA/JAXA)
- **Biomass** (2022) studying Earth's carbon cycle
- **FLEX** (2022) studying photosynthesis
- Earth Explorers 9 & 10 to be selected

Earth Explorers launched so far



GOCE: Mission accomplished



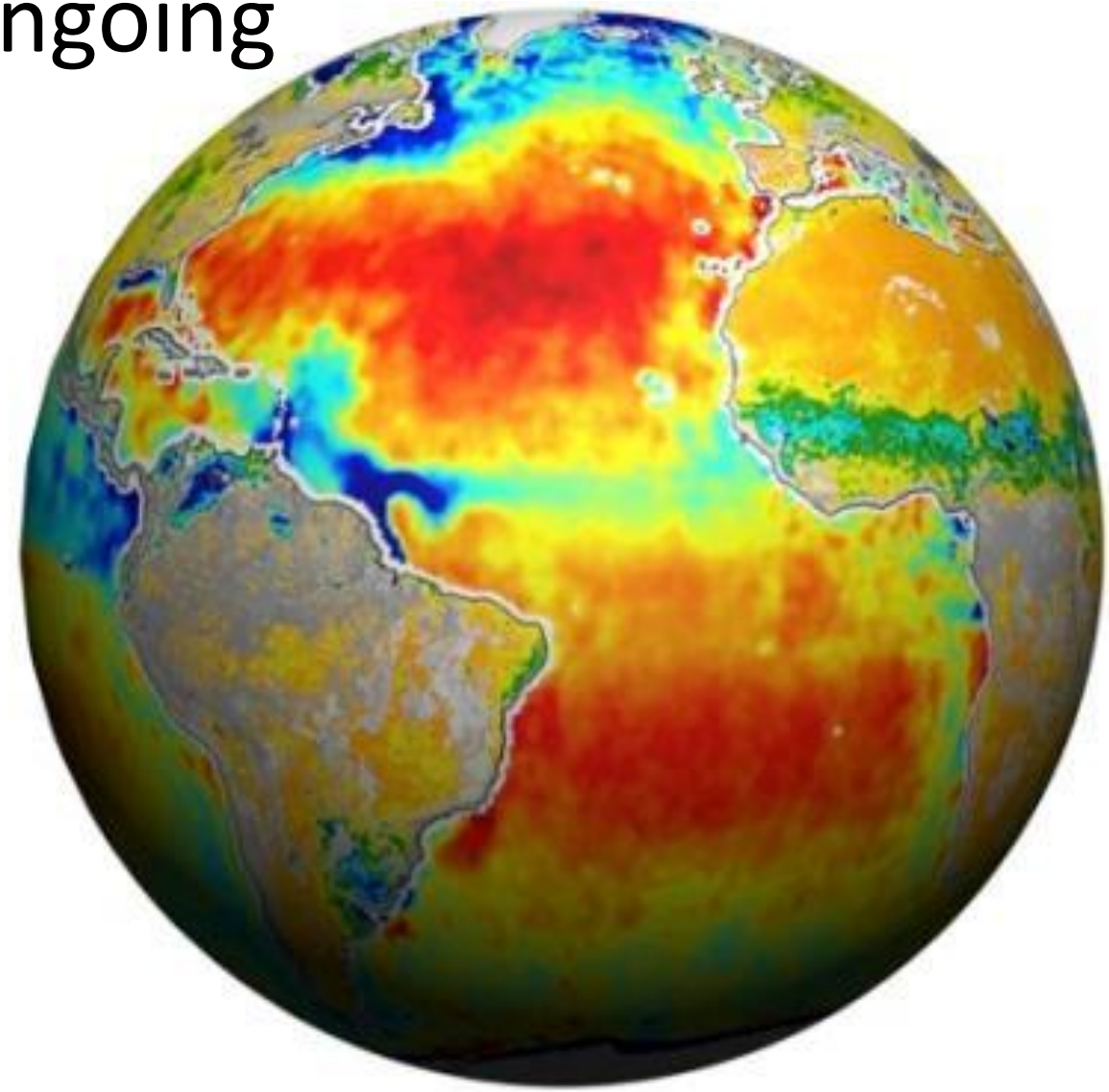
Most precise geoid to date

Main instrument: Electrostatic Gravity Gradiometer (six 3-axis accelerometers mounted in a diamond configuration)

SMOS: Mission accomplished and ongoing

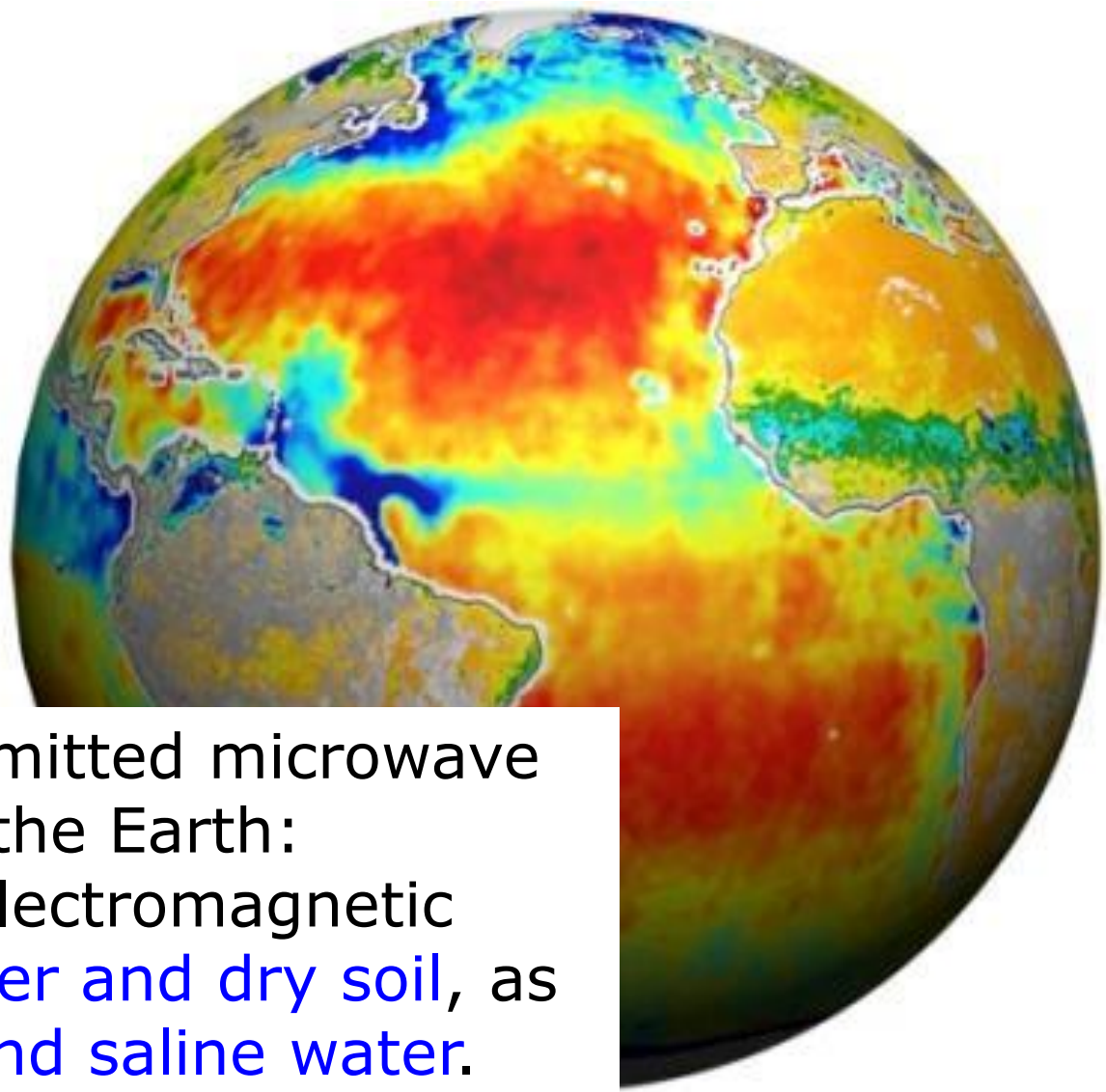
Monitoring soil moisture and ocean salinity. Globally.

One single instrument: the 2D Microwave Imaging Radiometer with Aperture Synthesis (MIRAS), a passive microwave sensor in L-band



SMOS: Mission accomplished and c

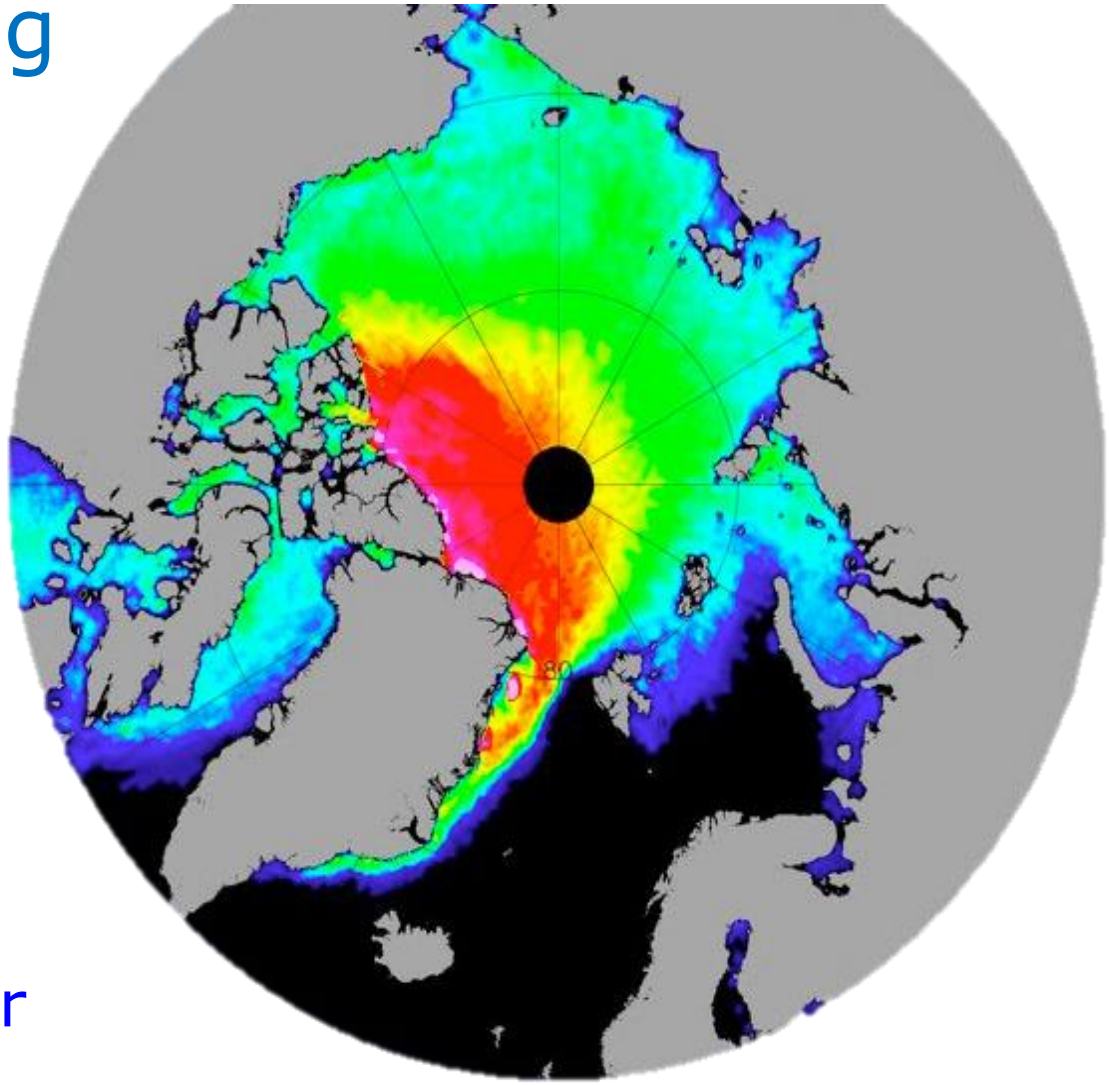
Monitoring soil moisture and ocean salinity. Globally.



MIRAS measures the emitted microwave radiation coming from the Earth: contrast between the electromagnetic properties of liquid water and dry soil, as well as of pure water and saline water.

Cryosat: Mission accomplished and ongoing

Surveyed sea ice thickness



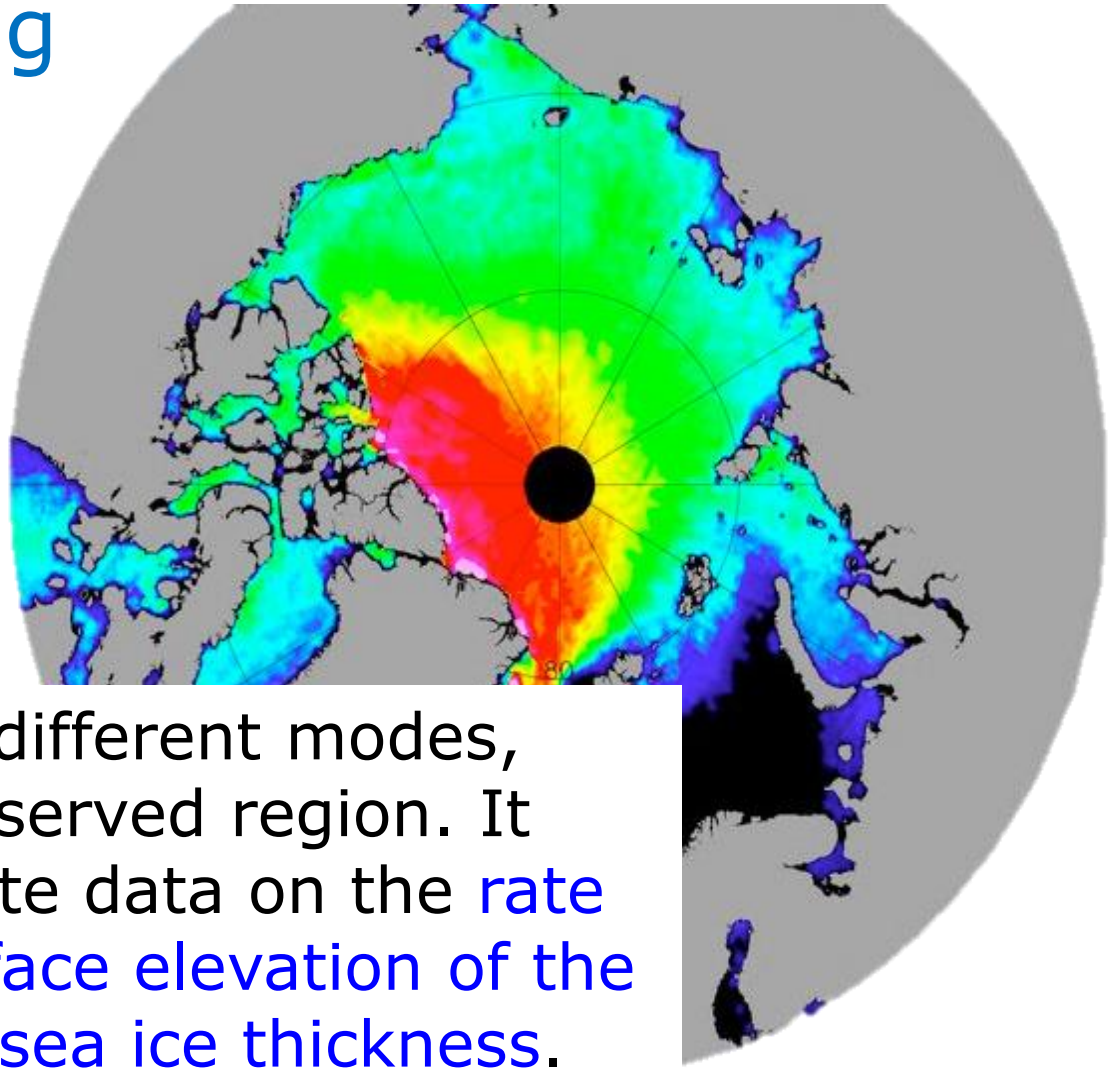
Average spring sea ice thickness 2010-2015

0 3.5m

Primary instrument: Synthetic Aperture Interferometric Radar Altimeter (SIRAL)

Cryosat: Mission accomplished and ongoing

Surveyed sea ice thickness



SIRAL operates in 3 different modes, depending on the observed region. It provides very accurate data on the rate of change of the surface elevation of the polar ice sheets and sea ice thickness.

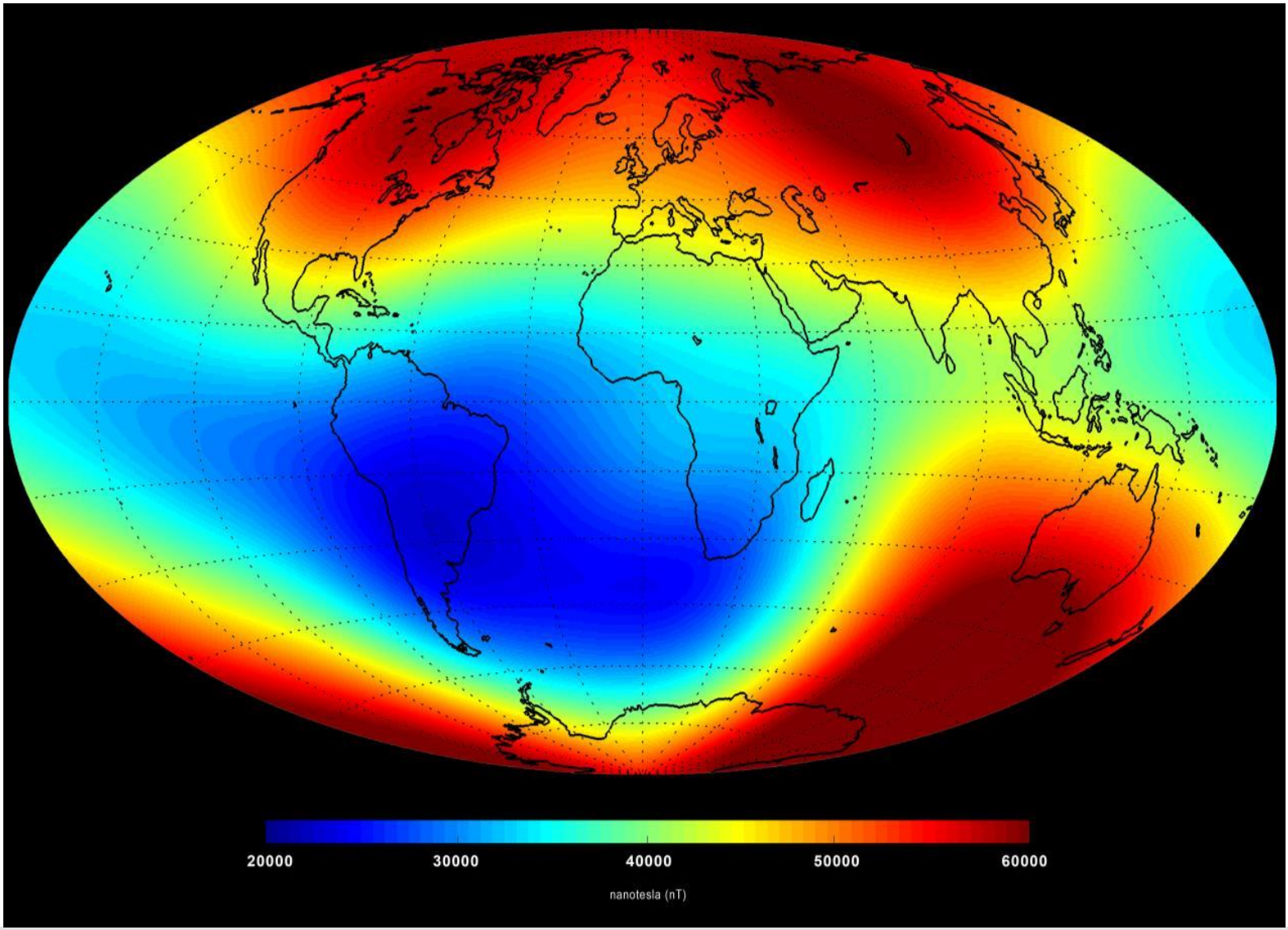
Average spring sea ice thickness 2010-2015

0 3.5m

Swarm: Mission accomplished and ongoing

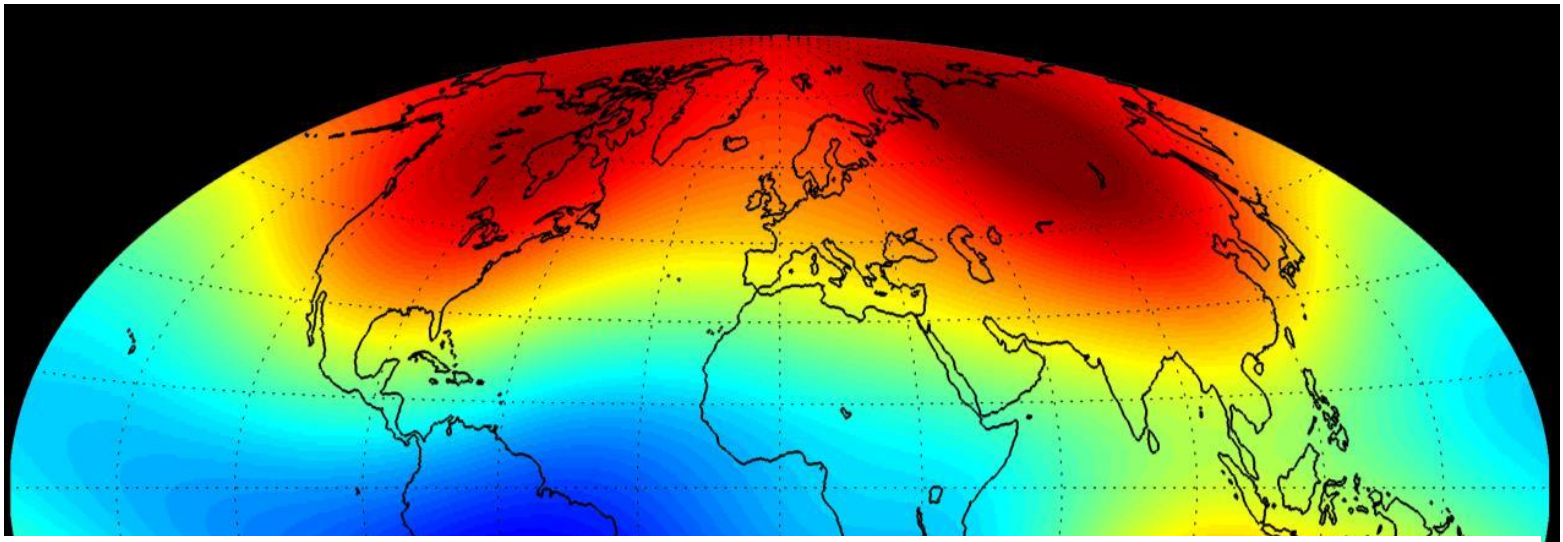
Tracking Earth's dynamic magnetic field.

Three satellites carry several new-generation instruments



Swarm: Mission accomplished and ongoing

Tracking Earth's dynamic magnetic field.



Magnetometers
are the mission's core instruments, measuring the magnitude and direction of the magnetic field

Accelerometer
measures the satellite's non-gravitational acceleration and provides information about air drag and solar wind

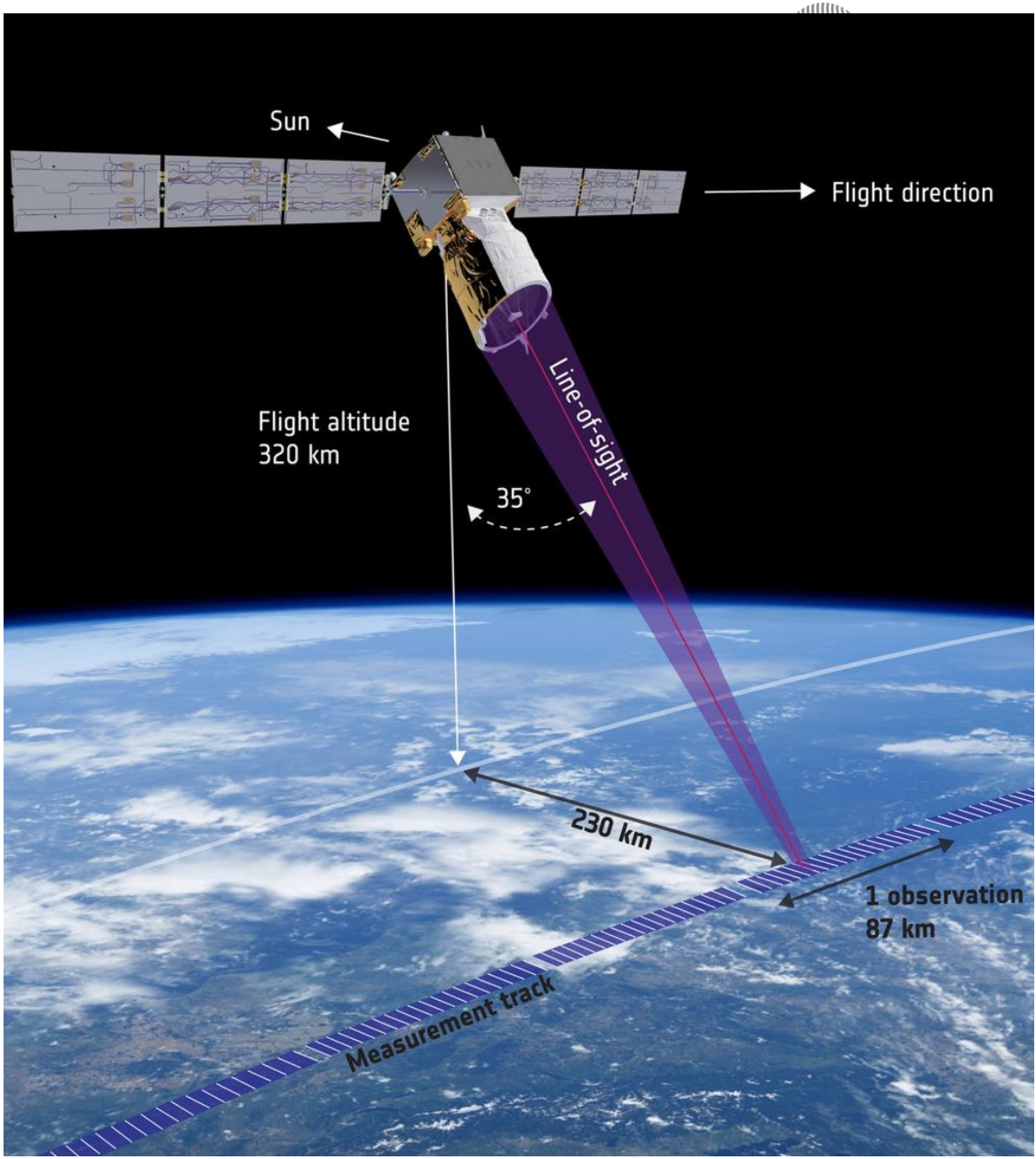
Electrical Field Instrument
allows to characterize the electric field around Earth

Aeolus

Launched 22 August 2018

Wind Profiling
First ever UV LIDAR in Space

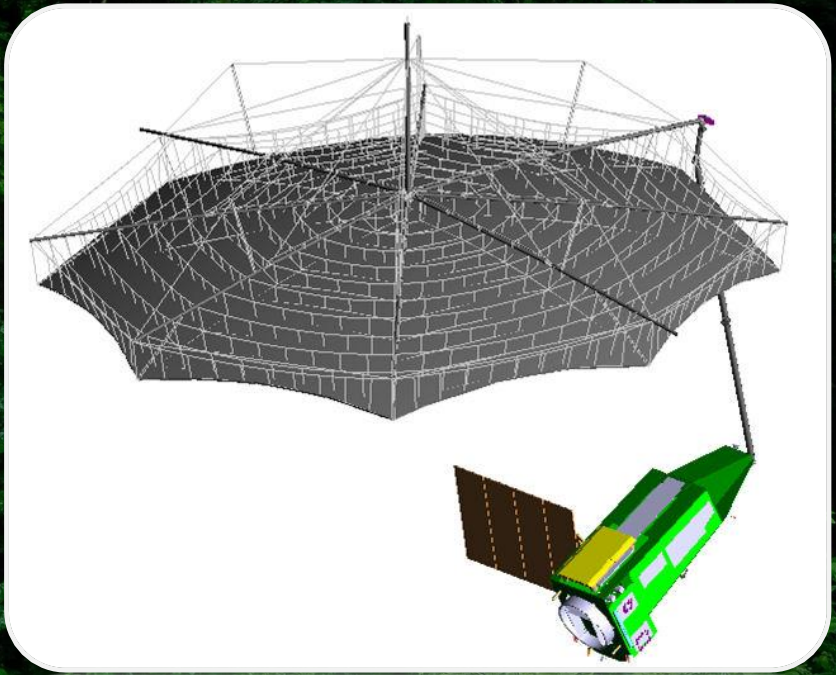
Lidar uses light scattering and Doppler Effect. It emits short pulses of light from a laser through the atmosphere and collects the light that is backscattered from particles of gas, dust & water in the atmosphere. As the scattering particles are moving in the wind, the wavelength of the scattered light is shifted as a function of speed. Thus, the Doppler wind lidar measures this change and thus the wind speed. Measurement are done along the LoS.



Future Earth Explorers

BIOMASS

Mission	Measure of forest biomass and height (200 m. pixel resolution)
Payload	P-Band radar
Orbit	SSO, alt: 666 km; LTAN: 6h00
Satellite	1250 Kg
Consortium	Prime: ADS-UK, Instrument: ADS-DE
Launch date	2022
Lifetime	5.5 years



Biomass, what information will we get

Above-ground biomass (tons/hectare)

- 200 m resolution
- 1 map every 6 months
- global coverage of forested areas
- accuracy of 20%, or 10 t ha^{-1} for biomass < 50 t ha^{-1}

Upper canopy height (meter)

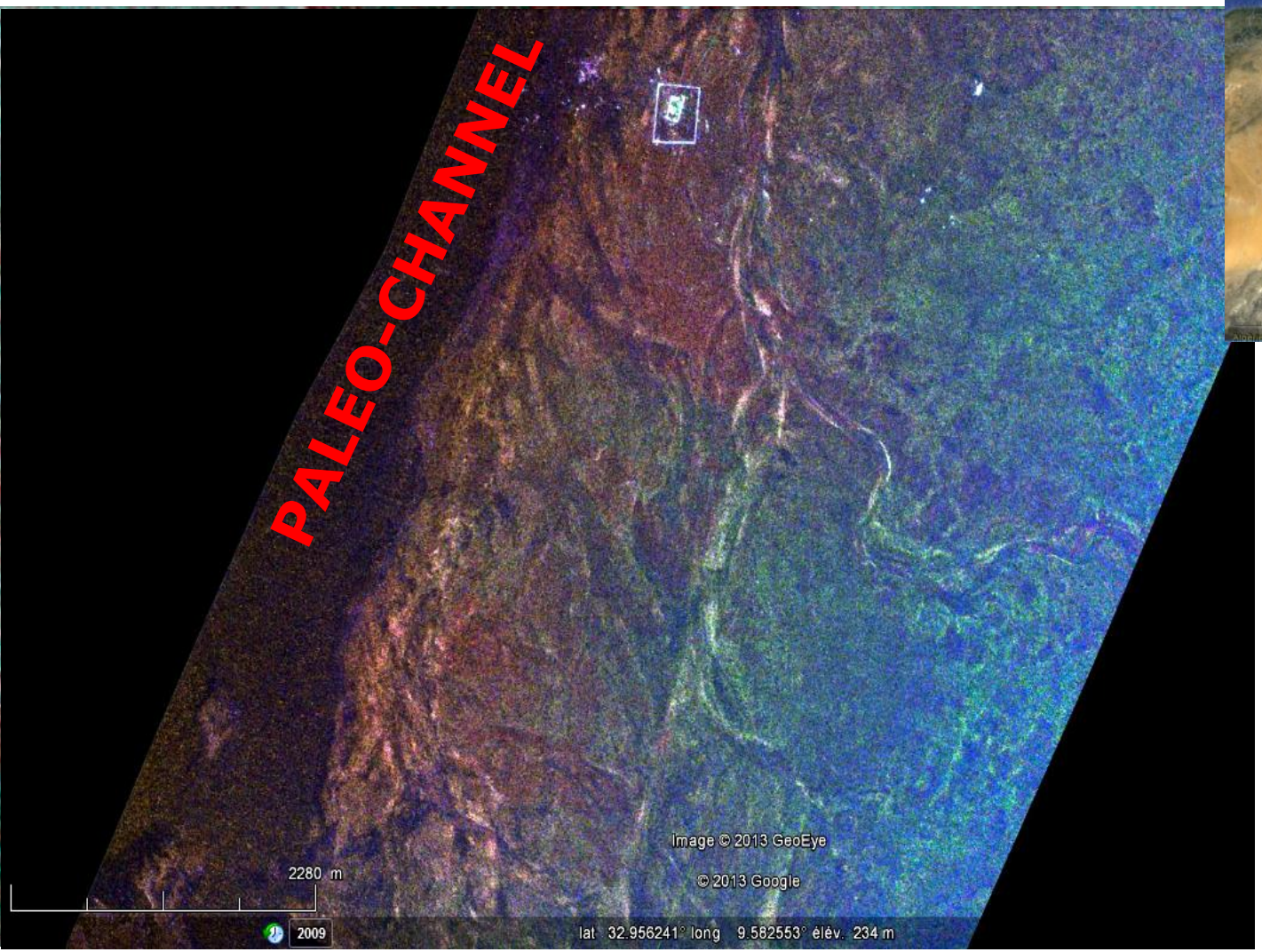
- 200 m resolution
- 1 map every 6 months
- global coverage of forested areas
- accuracy of 20-30%

Areas of forest clearing (hectare)

- 50 m resolution
- 1 map every 6 months
- global coverage of forested areas
- 90% classification accuracy

P-band enhances subsurface imaging in arid zones

P-band SAR



FLEX

Mission	Study & monitoring of fluorescence signal linked to vegetation stress; pixel 300m.
Swath	150 km
Payload	FLORIS, 2 channels spectrometers (O_2 lines)
Orbit	SSO, alt: 814 km; LTDN: 10h00
Satellite	470 Kg
Consortium	Prime: TAS Instrument: Leonardo
Launch date	end 2022
Lifetime	3.5 years

ESA EO DATA ACCESS & RESOURCES

Sentinel Online | The Official Sentinel Website

https://sentinel.esa.int/web/sentinel/home

esa Sentinel Online

Need Help? FAQ Contact Us About Sentinel Online

Google™ Custom Search

Missions | User Guides | Technical Guides | Thematic Areas | Data Access | Toolboxes

You are here Home › Missions

Share |

SENTINEL Overview

ESA is developing a series of next-generation Earth observation missions, on behalf of the joint ESA/European Commission initiative GMES (Global Monitoring for Environment and Security).

The goal of the SENTINEL program is to replace the current older Earth observation missions which have reached retirement, such as the ERS mission, or are currently nearing the end of their operational life span. This will ensure a continuity of data so that there are no gaps in ongoing studies.

Each mission will focus on a different aspect of Earth observation; Atmospheric, Oceanic, and Land monitoring, and the data will be of use in many applications.

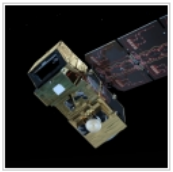
For mission planning information, see the Copernicus Mission pages.

SENTINEL Missions

SENTINEL-1

With the objectives of Land and Ocean monitoring, SENTINEL-1 will be composed of two polar-orbiting satellites operating day and night, and will perform Radar imaging, enabling them to acquire imagery regardless of the weather. The first SENTINEL-1 satellite was launched in April 2014.

Read more



SENTINEL-2

The objective of SENTINEL-2 is land monitoring, and the mission will be composed of two polar-orbiting satellites providing high-resolution optical imagery. Vegetation, soil and coastal areas are among the monitoring objectives. The first SENTINEL-2 satellite was launched in June 2015.

Missions

- Missions Home
- Sentinel-1
- Sentinel-2
- Sentinel-3
- Sentinel-4
- Sentinel-5
- Sentinel-5P
- Collaborative Ground Segment
- International cooperation

Latest Sentinel News

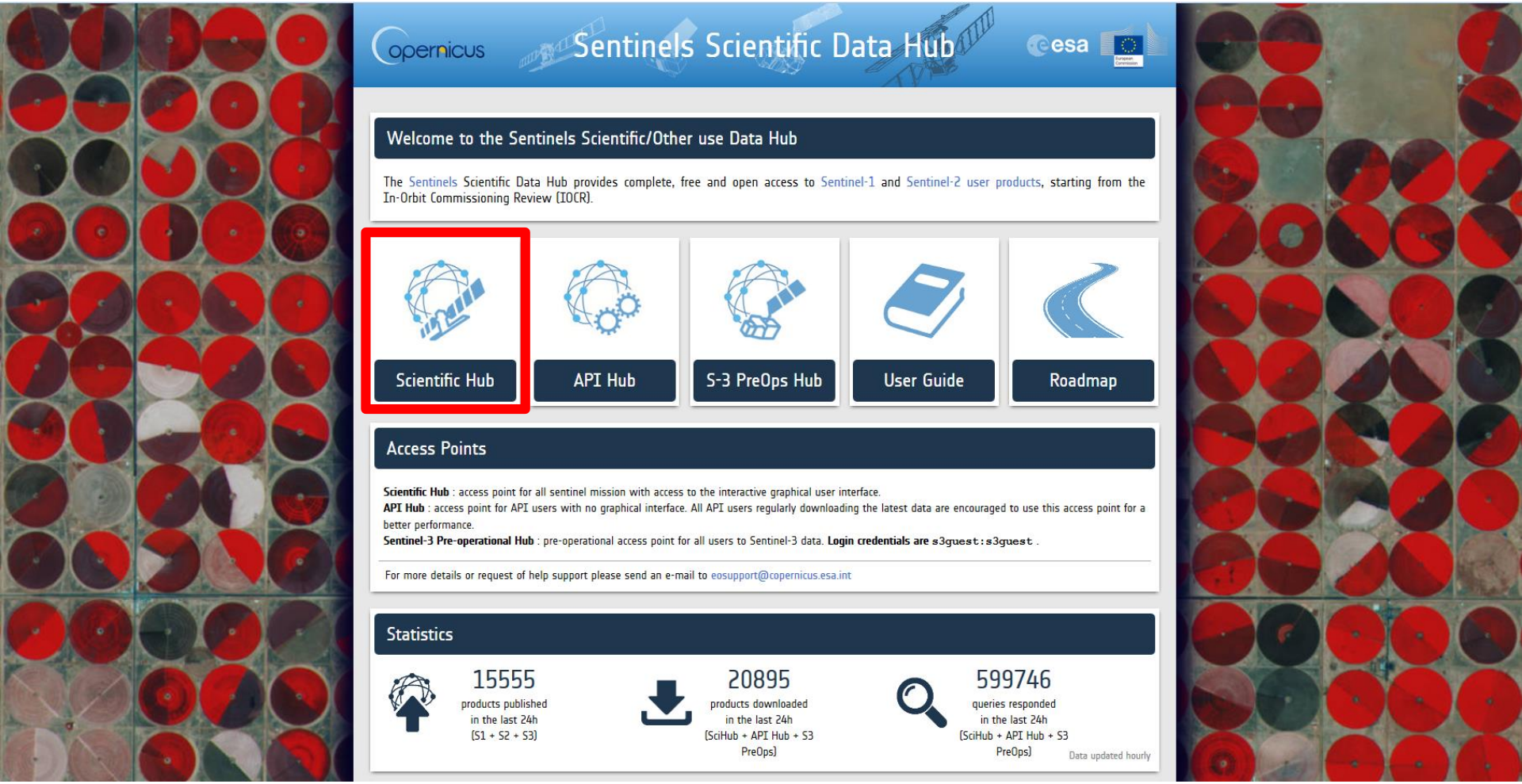
- SciHub products publication delay:
- SciHub maintenance on 30 September 2016
- Sentinel-1B products available from 26
- Call for Sentinel-2 Validation Team (S2VT)
- Sentinels International Access Hub

Browse to Other Sites

- ESA Copernicus website
- European Commission
- Astrium
- EUMETSAT
- European Space Operations Centre (ESOC)
- Thales Alenia Space

Sentinel-1 Data Access | Scientific Data Hub

https://scihub.copernicus.eu/



- open and free on-line access to Sentinel-1 products | Access through self-registration

ESA Third Party Mission **SAR** Sensors

ESA uses its multi-mission ground systems to acquire, process, archive and distribute data from other (non-ESA) satellites - so called Third Party Missions. The data from these missions are distributed under specific agreements with the owners or operators of the mission, following the ESA Data Policy.

- **TerraSAR-X**
  - Staring SpotLight (basic + Inteferometric pack)
  - High Resolution SpotLight (basic and Ineterferometry pack)
  - SpotLight (basic + Inteferometric pack)
  - StripMap (basic + Inteferometric pack + Maritime pack)
  - ScanSAR (basic + Maritime pack)
  - Wide ScanSAR (basic + Maritime pack)
- **Radarsat 1/2**
  - ScanSAR Wide and Narrow (Single or Dual Pol)
  - Wide (Single or Dual Pol)
  - Fine (Single or Dual Pol)
  - Standard (Single or Dual Pol)
  - Extended High and Low (Single Pol)
- **COSMO-SkyMed**
  - ScanSAR Huge
  - ScanSAR Wide
  - StripMap HIMAGE
  - StripMap PINGPONG
- **ALOS PALSAR**
  - ALOS PALSAR PLR (Polarimetric 4 polarization)
  - ALOS PALSAR FBD (Fine Beam Double polarization)
  - ALOS PALSAR FBS (Fine Beam Single polarization)
- **SEASAT**
  - SAR Precision Image (SEA_PRI_1P)
  - SAR Single Look Complex Image Product (SEA_SLC_1P)
  - SAR Ellipsoid Geocoded Precision Image (SEA_GEC_1P)

Earth Explorers Data Access:
Earth Observation data distribution services improvement

ESA has started a process to improve the Earth Observation data distribution services, aiming at facilitating access to data and information for the end users.

The **Earth Explorers** GOCE, SMOS, CryoSat, Swarm (not yet AELOS) data can be accessed since June 2018 via a simplified procedure **leading the users straight to the product repository**

GOCE:http://eo-virtual-archive1.esa.int/Index.html

SMOS:https://smos-ds-02.eo.esa.int/oads/access/

SWARM:https://swarm-diss.eo.esa.int/

CRYOSAT:http://science-pds.cryosat.esa.int/

Earth Explorers Data Access: virtual archive example for GOCE (data access without registration)

eo-virtual-archive1.esa.int/Index.html

ESA GOCE Virtual Archive

- Home
- GOCE Gravity Models
- Full Gravity Gradients and GRIDS
- GOCE Level 1b products
- GOCE Level 2 products
- GOCE Commissioning products
- GOCE De-orbiting data
- Thermospheric Data
- VTGoce Data
- Changelog

Available Global GOCE Gravity Models

Product	Description
EGM_GOC_2	GOCE Gravity solution. Solutions are available up to Third Generation, with three different processing techniques: direct numerical solution, time-wise and space-wise solutions.
EGM_GVC_2	Variance/covariance matrices associated to the Gravity solutions. Available only through the Virtual Online Archive.
EGM_GCF_2	Gravity Coefficients (ICGEM format)

Available L1b and L2 GOCE single Products

Instrument	Level	Product	Description
EGG	L1b	EGG_NOM_1b	Nominal Gradiometer Instrument data
	L2	EGG_NOM_2	Calibrated and corrected gravity gradients in the gradiometer reference frame
		EGG_TRF_2	Calibrated and corrected gravity gradients in the terrestrial reference frame
		EGG_QLK_2i	Gradiometer error Power Spectral Density estimated from Quick-Look gravity solutions

SNAP

- The common architecture for all **Sentinel Toolboxes** and **SMOS Toolbox** is called Sentinel Application Platform (SNAP).
- SNAP architecture is ideal for Earth Observation processing and analysis due the following technological innovations: Extensibility, Portability, Modular Rich Client Platform, Generic EO Data Abstraction, Tiled Memory Management and a Graph Processing Framework.

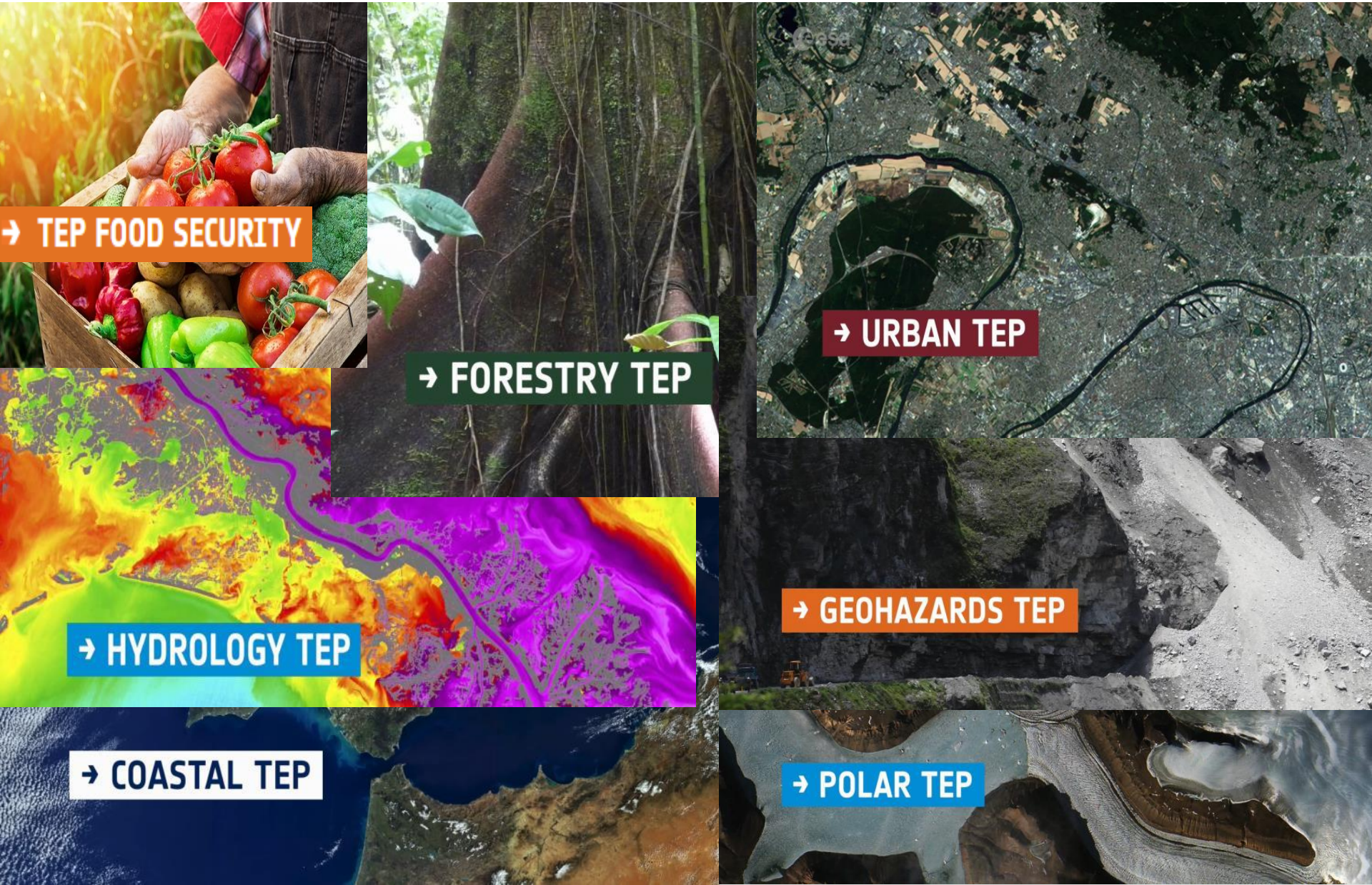
Activity funded through SEOM element of ESA's EOEP-4 (www.seom.esa.int)

Sentinel Application Platform | SNAP

- **SAR Toolbox (S1TBX)**
  - Scientific toolbox for the handling and post-processing of data products from Sentinel-1 SAR mission
- **High Resolution Optical Toolbox (S2TBX)**
  - Toolbox for the visualisation, analysis and post-processing of data products from Sentinel-2 multi-spectral optical data
- **Medium Resolution Optical Toolbox (S3TBX)**
  - Toolbox for the processing and analysis of Sentinel 3 OLCI and SLSTR
- Developer forum
  - Requirements addressing a common platform issues
  - Define the platform roadmap
  - Coordinate horizontal activities across the three toolboxes

scientific exploitation of operational missions

#EO4society results –
Thematic Exploitation Platforms



Opportunities – Open call

EO Science for Society Open call for proposals
EOEP-5 Block 4

- Permanently open call
- Framework to rapidly respond to new innovative ideas from bidders.
- Submission deadline for the first batch of proposals:

  1st December 2017
- Applications:

  http://emits.sso.esa.int/

Opportunities for EO data processing and access:

- **EO Science IPT Cloud (https://rus-copernicus.eu/portal/)**
- **RUS (https://rus-copernicus.eu/portal/)**
- **… and soon DIAS**

Open Science Earth Observation (OSEO) Cloud

- Open to scientists from ESA, EU and Africa* for access to dedicated cloud computing infrastructure.
- Offers the opportunity to exploit at no cost a full archive of EO data for science: Sentinel-1, -2 and 3.
- Application: https://rus-copernicus.eu/portal/

*until the ESA allocated resources are exhausted.

Opportunities for EO training

Central page for EO education and training:

https://earth.esa.int/web/guest/eo-education-and-training

esa Earth Online

Need Help

Missions | Earth Topics | Data Access | PI Community

You are here Home › EO Education and Training

EO Education and Training

Overview of Earth Observation Training at ESA

ESA undertakes a wide range of activities in the field of Earth Observation education, training and capacity building. The scope of these activities ranges from high level training in state-of-the-art processing for the next generation of Principal Investigators to more general outreach activities and Earth Observation education for schools.

The aim of this website is to provide a single portal that supplies information about these activities, and enables access to resources produced in their framework.

Training courses at University level in Europe:
Innovative Training for Next generation EO Scientists, in MS

seom
scientific exploitation of operational missions

seom
scientific exploitation of operational missions

esa

ESA | SEOM | OBJECTIVES | ACTION LINES | CONFERENCES | NEWS | TOOLBOX | TRAININGS

ESA EO

COPERNICUS

SENTINEL

NEW OPPORTUNITIES

Invitations to Tender

PARTNERS

PROJECTS

CONTACTS

SEOM > Trainings

http://seom.esa.int/

As part of the Scientific Exploitation of Operational Missions (SEOM) programme element, the European Space Agency (ESA) is regularly organising a series of advanced thematic training courses devoted to train the next generation of Earth Observation (EO) scientists to exploit data from ESA and operational EO Missions for Land, Ocean and Atmospheric science and applications development.

These training courses are open to early career scientists (i.e. Ph.D. students, young post-doctoral scientists) and users from European countries and Canada .The training courses are hosted by Universities and Research institutions, with the venues rotating among the ESA Member States.

The training courses include formal lectures by leading scientists from theory to advanced concepts as well as hands-on computing exercises exposing students to scientific EO data exploitation. Practicals will use EO data from ESA, Third Party and national missions as well as data from the upcoming Sentinels missions.

2018

EO Summer School 2018
30 July - 10 August 2018, ESA ESRIN, Frascati (Rome), Italy

- For further information please click here

8th Advanced Training Course on Land Remote Sensing
10-14 Semptember 2018, University of Leicester (UK)

- For further information please click here

seom
scientific exploitation of operational missions

MUAS 18

Φ-week 2018

LTC 18

Training courses at University level in Europe:
Earth Observation Summer Schools in ESRIN

Usually organized every 2 years, open to students from worldwide, free tuition

https://rus-copernicus.eu/portal/the-rus-offer/training/

RUS Copernicus Research and User Support

Login / Register

The RUS Service | The RUS Offer | The RUS Library | The RUS Community

You are here: Home > The RUS Offer > Training

Training

A key pillar of the RUS service is the provision of **free training** aiming to bridge knowledge gaps which may limit the use of Copernicus data.

The RUS training offer includes:

- **Face-to-face sessions** which focus on remote sensing applications and are dedicated to different user categories, from beginners to trainers.These events are generally split in a **theory** part and a **hands-on** one, the latter being carried out within the RUS working environment each attendee is delivered at the beginning of the session.
  The number of such events is limited to a few each year, collocated as far as possible with large Earth observation events to facilitate user attendance.
  You can check at any time the list of **forthcoming face-to-face sessions**.

- **Webinars** aiming to demonstrate in a concrete way how the RUS working environment can help you to process data and derive results. Their typical duration is **90 minutes.**
  Upcoming webinars are generally advertised a few weeks in advance to allow registration.
  However, if you miss one of them, you can re-play it on the **RUS Copernicus Training channel** available on YouTube or consult the synthesis of questions and answers discussed at the event time in the section **Training past events**.
  You can also repeat step by step the exercise corresponding to each webinar in a RUS working environment using the tutorial available in our **Training Library**.

Search

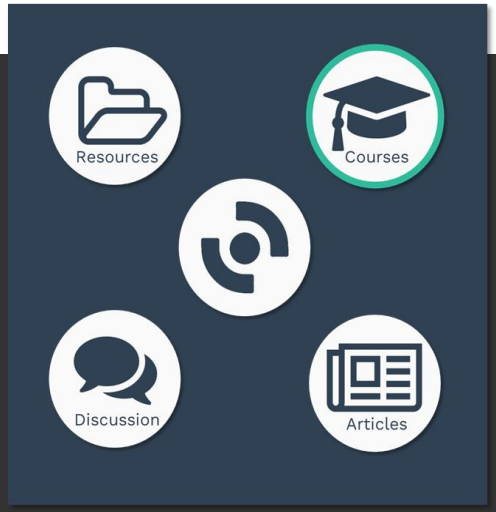
News from RUS

- GEO Blue Planet – Toulouse – 4-6 July 2018
- Access to the RUS chat
- RUS Training Session – Valencia – 22 July 2018
- IGARSS 2018 – Valencia – 22-27 July 2018
- RUS Training Session – Chamonix – 27 June 2018
- GeOBIA 2018 – Montpellier – 18-19 June 2018
- RUS Training Session – Sozopol – 21 June 2018
- Copernicus Info Session – Bratislava – 12 June 2018

The RUS agenda

- Conferences & Workshops
- Training sessions

MOOC – First Radar Remote Sensing Course



HISTORY GEOMETRY

LAND WATER HAZARD

12	5700	15%	Φιναλ Χερτιφιχατε
Τυτοριαλσ	Στυδεντσ	Χομπλετιον ρατε	

esa FRIEDRICH-SCHILLER-UNIVERSITÄT JENA EOS eo college

http://eo-college.org

Previous ESA EO MOOCs

Monitoring Climate from Space

Explore our planet from space and learn how Earth observation is used to monitor climate change, with this free online course.

Earth Observation from Space: the Optical View

Discover how optical Earth observation data is gathered and used in this free online course from the European Space Agency (ESA).

- **3rd ESA MOOC on Climate from Space "Greenland special"**

https://www.futurelearn.com/courses/climate-from-space

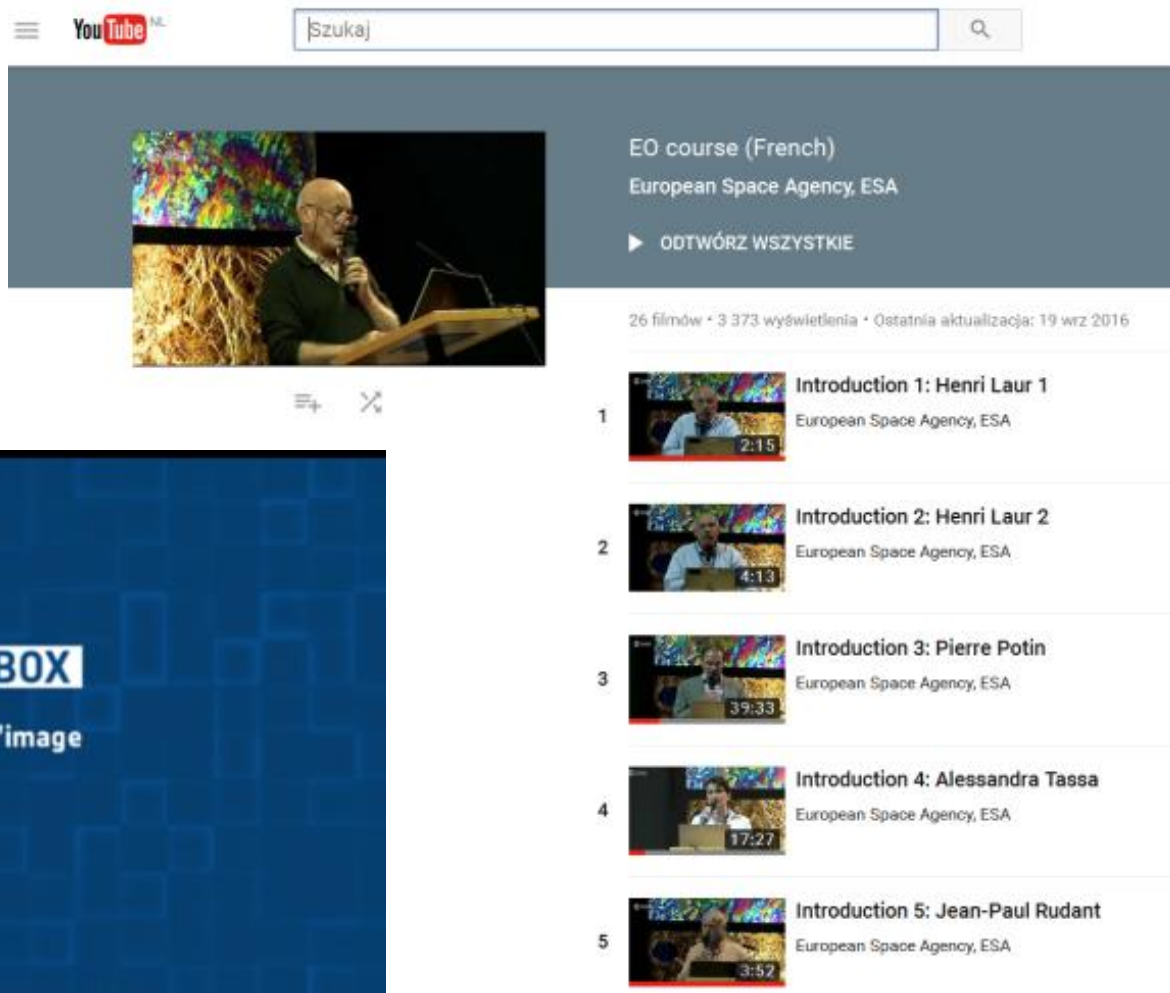
- **1st ESA MOOC on "EO from Space: The Optical View"**

https://www.futurelearn.com/courses/optical-earth-observation

- **1st ESA MOOC on "EO from Space: The Radar View"**
  Foreseen launch in October 2017

Recent SAR video lectures and SNAP tutorials (French, with Spanish / English Subtitles)

- SAR basic theory and practical exercises with SNAP (French version)
- Subtitles (Spanish, English) published in July 2017



Sentinel App

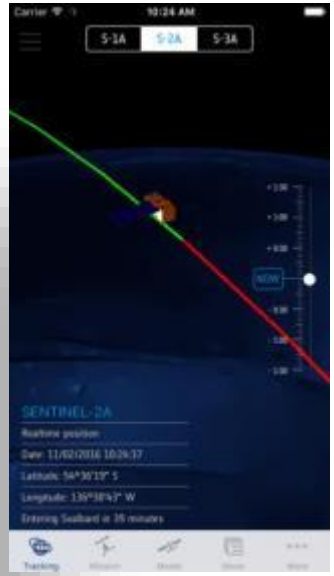
esa sentinel

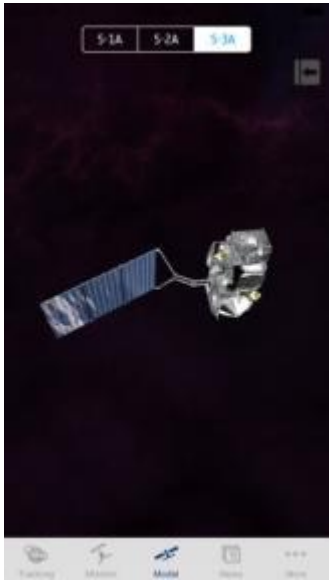
Available on the App Store

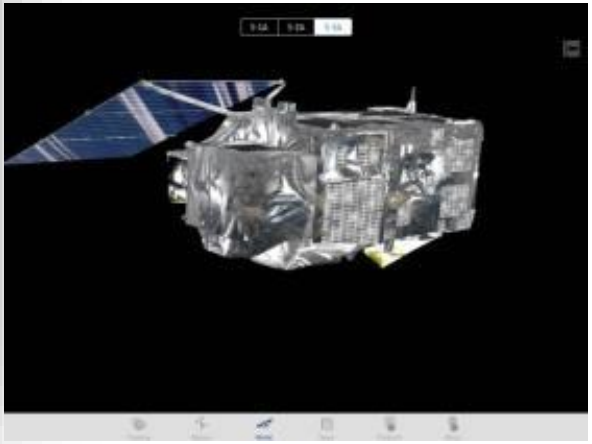
ANDROID APP ON Google play

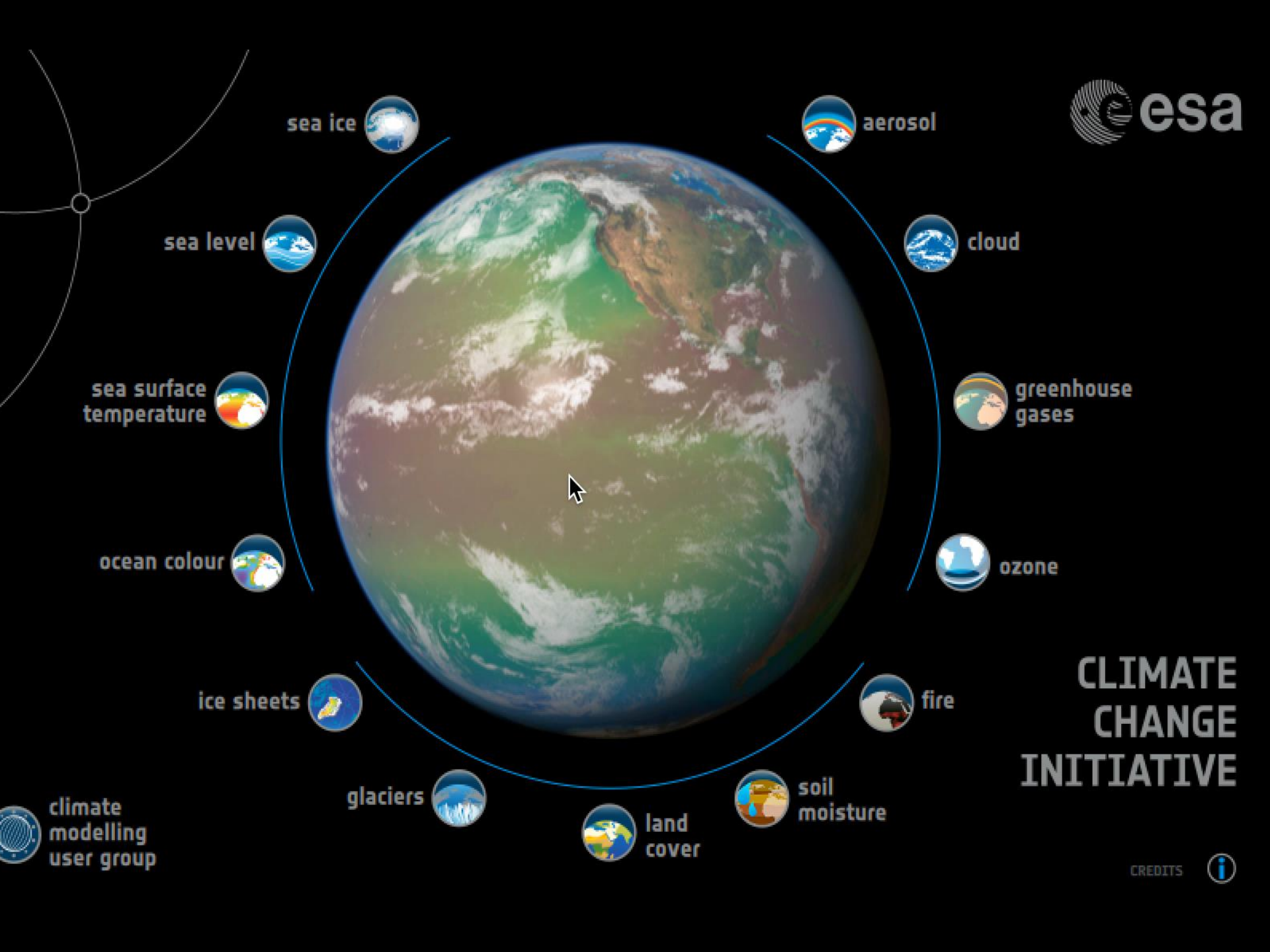
For iPhone

- See where the Sentinel satellites are in real-time
- See the last and next time they have been and will be over your location; Move them to the time of the last data transmission and smoothly move them back to their current location over the 3D globe
- Explore the Sentinel satellite 3D models
- Get information and news about the Copernicus Programme
- Get information about access to Sentinel data
- Set Notifications to be warned when satellites are flying by
- Stay tuned with the latest mission information



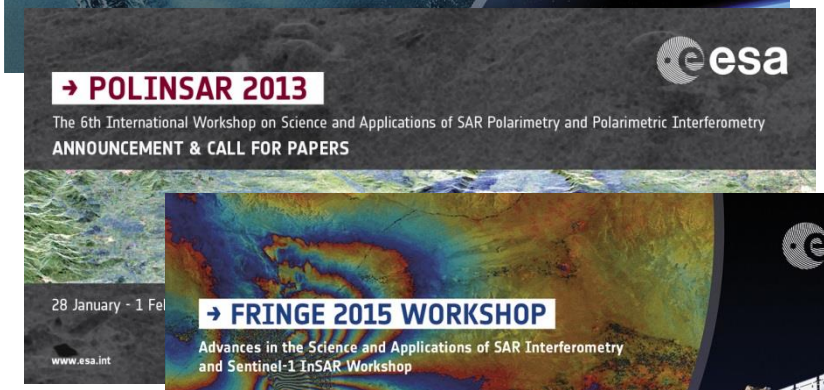


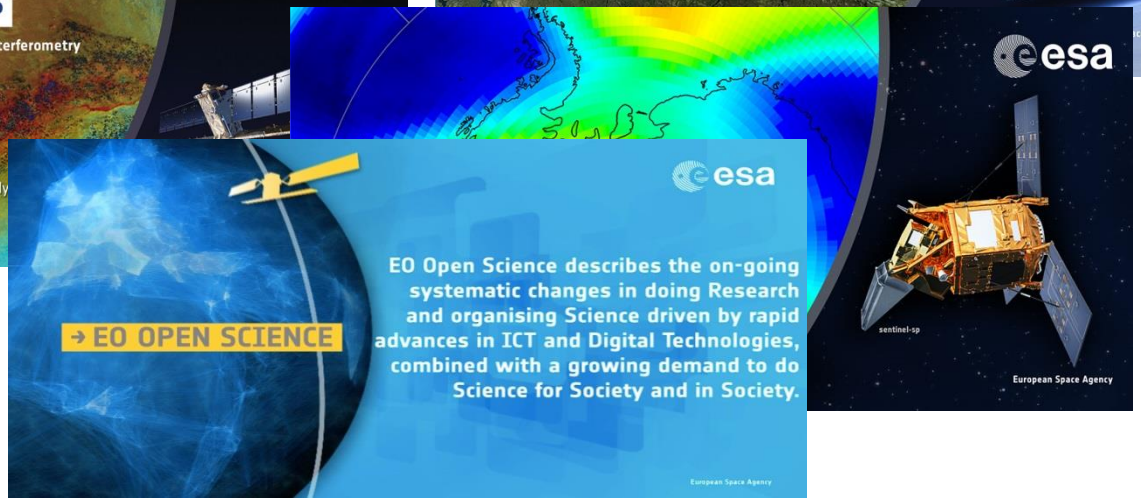



esa
sea ice
aerosol
sea level
cloud
sea surface temperature
greenhouse gases
ocean colour
ozone
ice sheets
fire
glaciers
soil moisture
land cover
climate modelling user group
CLIMATE CHANGE INITIATIVE
CREDITS

Sentinels

and Contribute to the EO Open Science Concept





esa

living planet symposium

MILAN
13–17 May
2019

UNDERSTANDING THE EARTH SYSTEM

SPACE 4.0 AND EARTH OBSERVATION

BENEFITS FOR A RESILIENT SOCIETY

PUBLIC AND PRIVATE SECTOR INTERACTIONS

Deadlines

Session Proposals	Abstracts	Registration	
17 June 2018	11 November 2018	April 2019	lps19.esa.int

European Space Agency

	Monday 17/09	Tuesday 18/09	Wednesday 19/09	Thursday 20/09	Friday 21/09
08:08:30	Registration				
08:30 – 08:45	Welcome Representatives of the Slovak Centre of Scientific and Technical Information	Radar imagery for nature conservation S1 for vegetation monitoring Theory P.L. Frison	Combination of S1/S2 for Land Cover Change detection Theory P.L. Frison	Flood monitoring with S1/S2 Theory and Practical (SNAP) L.Pipia., A.Castro, R.Rigoli	S1/2 Snow and ice G. Schwaizer
08:45 – 10:00	Introduction to ESA EO Missions Data access, platforms F. Sarti, R. Rigoli				
10:00 – 10:30	S1 Theory Introduction N. Salepci				
10:30 – 10:45	*Coffee Break*				
10:45 – 12:30	Theory continuation	Theory continuation	Theory continuation	Exercises continuation	Theory continuation
12:30 – 13:30	*Lunch Break*				
13:30 – 15:00	S1 applications for forestry Practical exercises (SNAP) N. Salepci, A. Castro, R.Rigoli	Integration of S1, ALOS PALSAR and S2 for vegetation monitoring Practical exercises(SNAP, QGIS/OTB) P.L. Frison, A.Castro, R.Rigoli	Applications to nature conservation Combination of S2/Landsat-8 for Land Cover Change Detection (Bark Beetle case study) Practical (SNAP, Rstudio) P.L. Frison, A. Castro, R.Rigoli	Wildfire mapping from S1/S2 Theory and practical (SNAP) J. Verrelst, A. Castro, R.Rigoli	S1/2 Snow and ice Practical (SNAP) G.Schwaizer, A. Castro, R.Rigoli
15:00 – 15:15	*Coffee Break*				
15:15 – 17:30	Exercises continuation	Exercises continuation	Exercises continuation	Exercises continuation	Exercises continuation
17:00-17:30					Feedback and Presentation of certificates
	Ice Breaker (time tbd)				

Slovak University of Technology

Department of Theoretical Geodesy

Available courses and expertise in Earth Observation:

- Global Navigation Satellite Systems (GNSS)
- Satellite geodesy (GOCE, Grace, Champ)
- Remote Sensing (Optical + **InSAR**)

More info here https://www.svf.stuba.sk/

or at juraj.papco@stuba.sk

Retrieval of Motions and Potential Deformation Threats using Sentinel-1 (remotIO)

Contractor: insar.sk s.r.o.				**ESA Budget:** **Co-funded Budget:**	**197 k€** **0 k€**
Contract No.: 4000123625/18/NL/SC			**Year of Contract: 2018**	**TO: Maite Trujillo (IPL-IPS)**	
TRL	**Initial: 2**	**Achieved: N/A**	**Target TRL: 4 Date: April 2020**		

Background and justification:
The remotIO project focuses on the operational exploitation of Sentinel-1 mission for detection of potential deformation threats from Multi-Temporal InSAR (MTI) deformation maps. Our vision is to provide easy-to-interpret outputs intended for non-expert users by improving and automating some of the routine procedures involved in professional InSAR expertise, what we see as the key step towards widespread usage of InSAR data.

Objective(s):
The visual inspection of millions of scatters with wide area coverage capabilities of Sentinel-1 is not more sufficient in providing useful insights into the actual nature of undergoing processes. Our ambition is to examine data mining tools in order to improve the clarity of InSAR products, highlighting the full potential of Sentinel-1 mission.

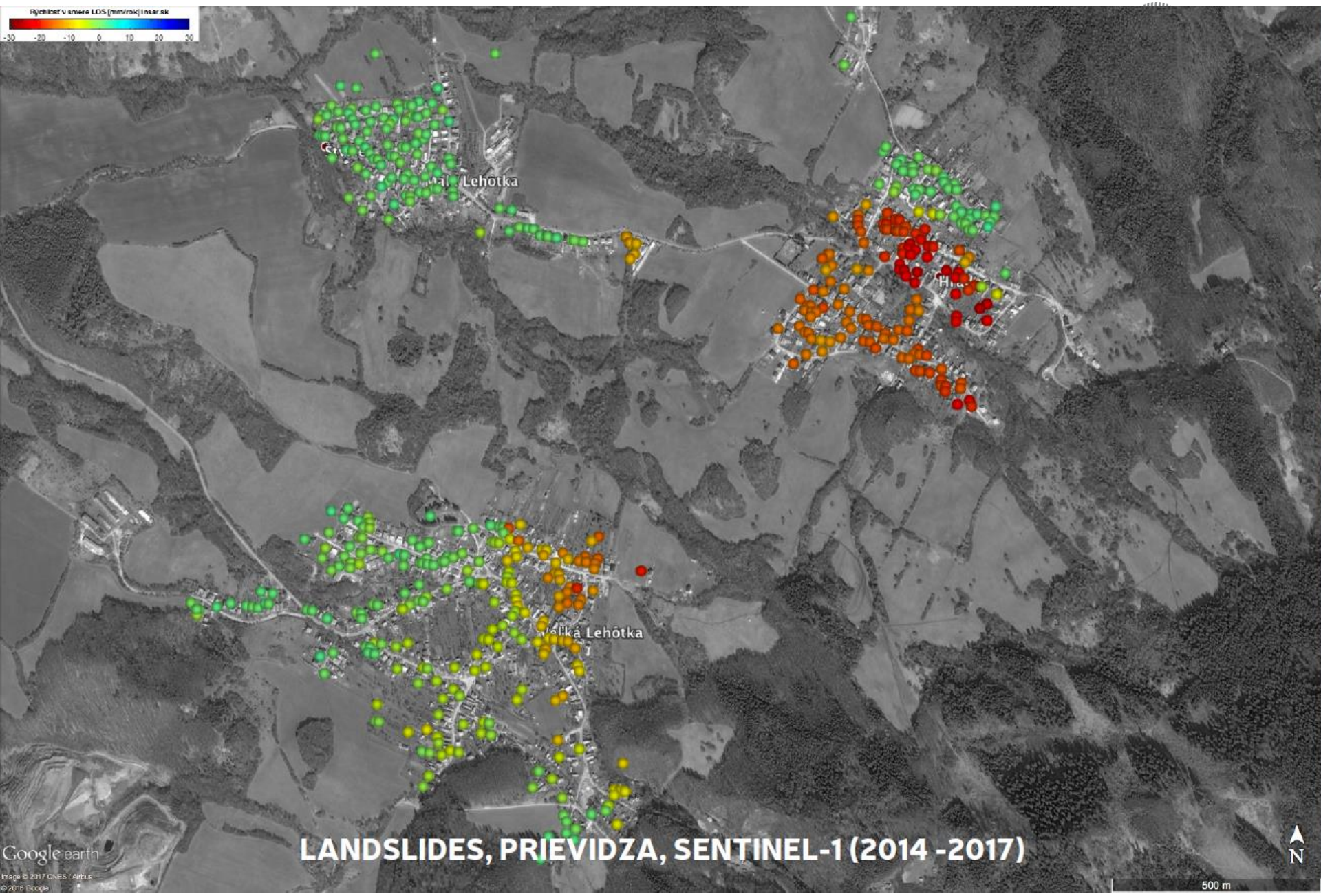
Achievements and status:
Designing algorithms that search for anomalies and indicate specific phenomenon will help professionals to adopt advanced processing strategies in order to mitigate violating effects. On the other hand, providing add-on information about potential deformation threats in monitored area is crucial for end-user in order to establish intervening or preventing actions.
remotIO project is in its initial phase since April 2018

Benefits:
Aiming at improving the understanding of kinematical behaviour of our changing environment, we are challenged to make the interpretation of InSAR results easier for key target audiences: industrial service providers, decision and policy makers, scientific and technical communities.

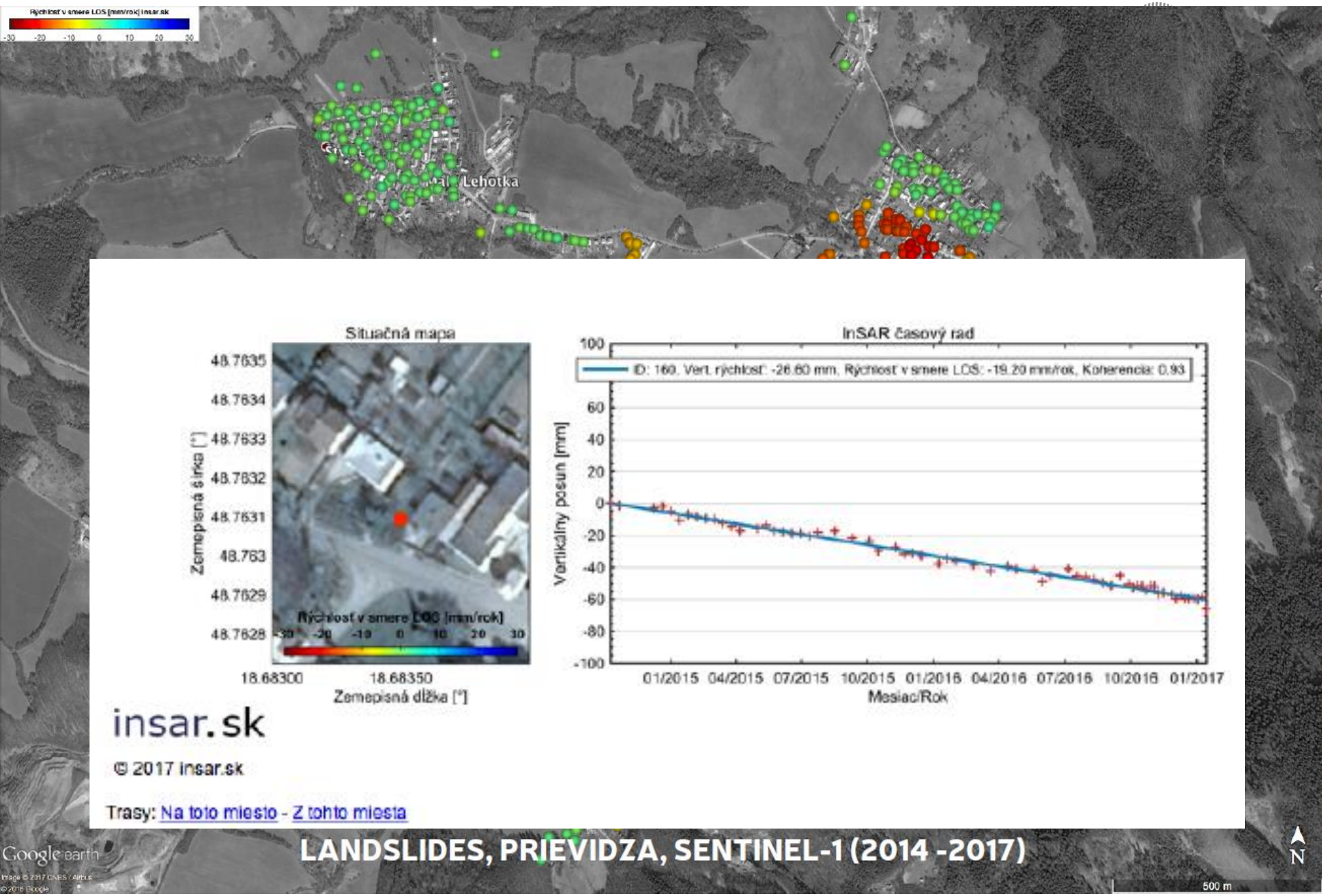
Next steps:
The projects aims to design a portfolio of higher level data products tailored according to demands of a wide variety of expert and non-expert InSAR users.

remotIO

European Space Agency

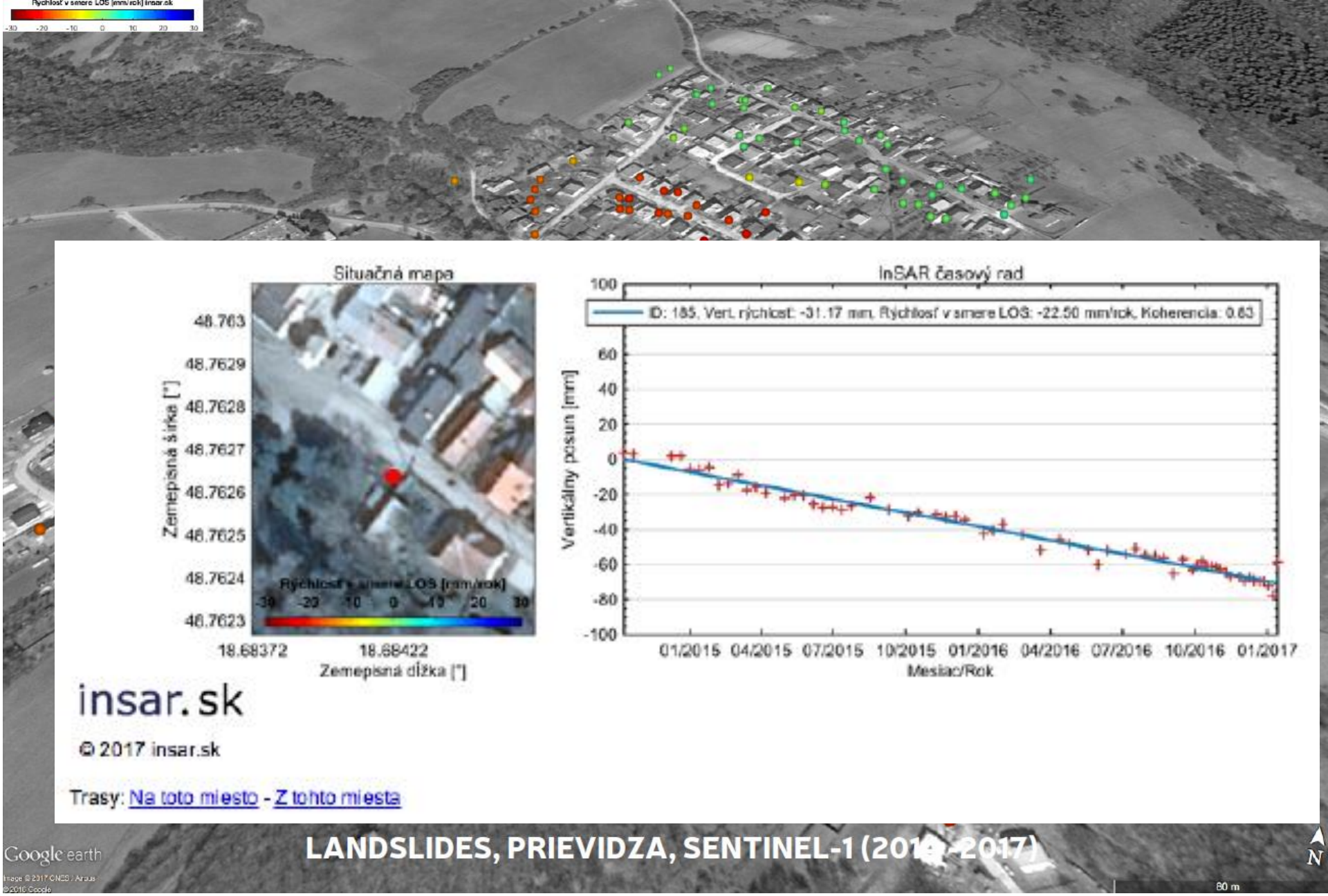


LANDSLIDES, PRIEVIDZA, SENTINEL-1 (2014 -2017)

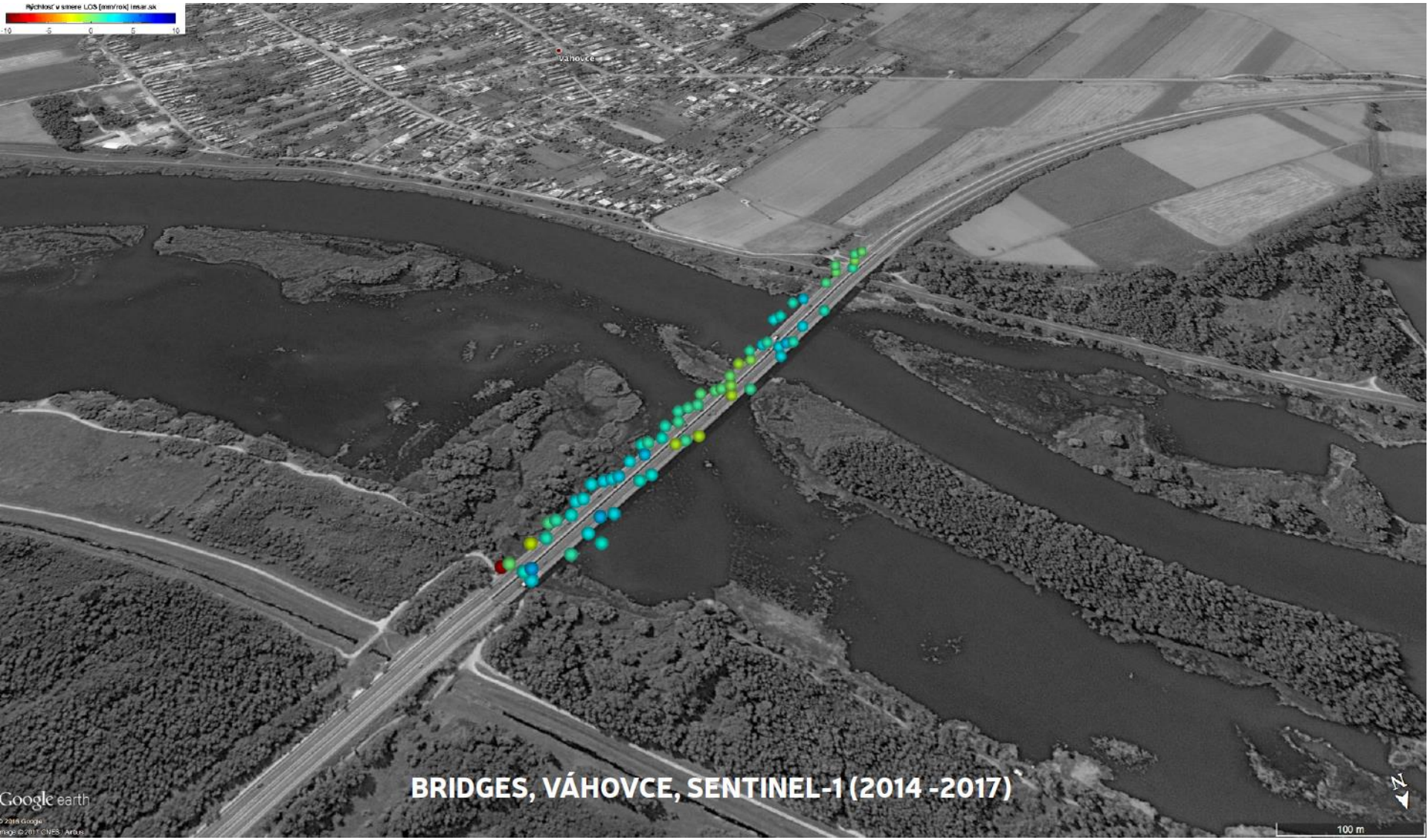


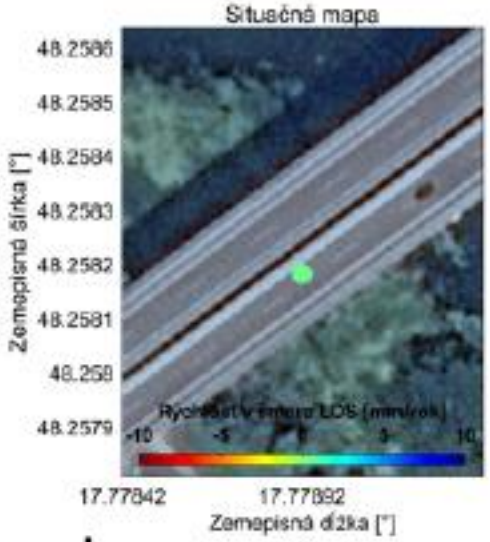
LANDSLIDES, PRIEVIDZA, SENTINEL-1 (2014 -2017)

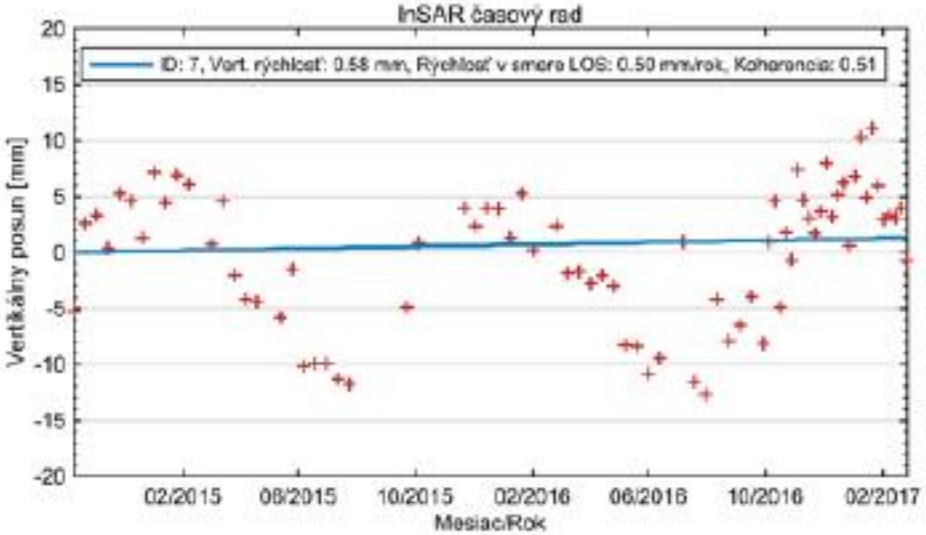
Rychlost v smere LOS [mm/rok] linear.sk
-30 -20 -10 0 10 20 30
LANDSLIDES, PRIEVIDZA, SENTINEL-1 (2016 -2017)
Google earth
Image © 2017 CNES / Airbus
©2016 Google
N
80 m



LANDSLIDES, PRIEVIDZA, SENTINEL-1 (2016 -2017)


Rýchlosť v smere LOS [mm/rok] insar.sk
-10
-5
0
5
10
Váhovce
BRIDGES, VÁHOVCE, SENTINEL-1 (2014 -2017)
Google earth
100 m
N

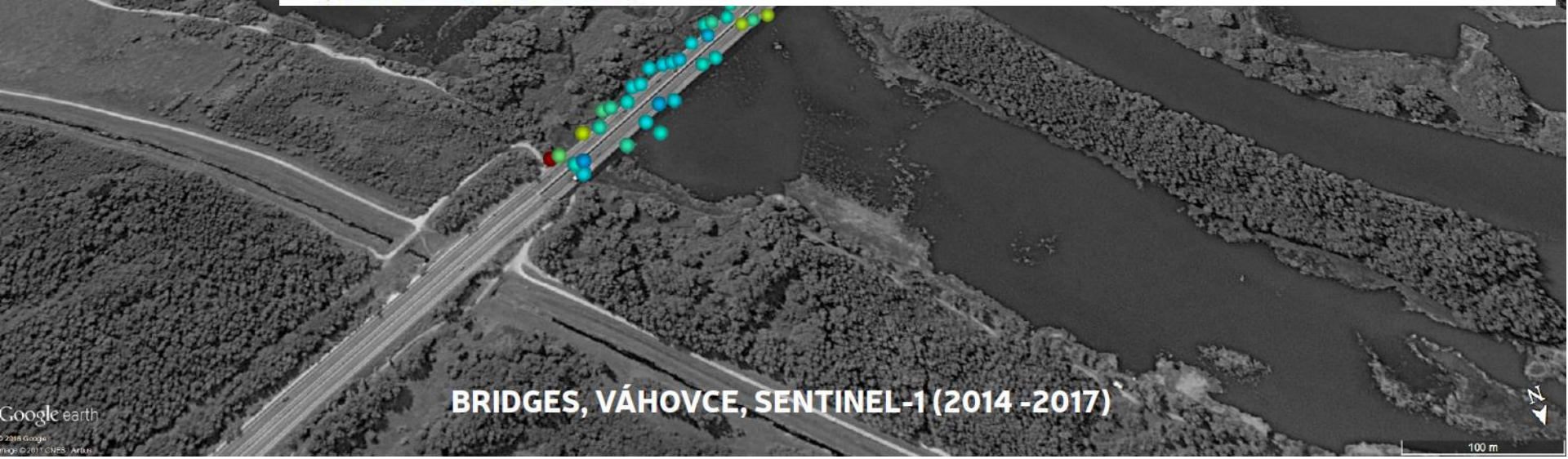




insar.sk

© 2017 insar.sk

Trasy: Na toto miesto - Z tohto miesta



BRIDGES, VÁHOVCE, SENTINEL-1 (2014 -2017)