
SF PT
Société Française de Photogrammétrie et de Télédétection
Colloque Télédétection Radar
2 Juin 2017
esa
ESA's Earth Observation Programmes
Henri Laur
ESA Directorate of Earth Observation Programmes
ESA UNCLASSIFIED - For Official Use
European Space Agency

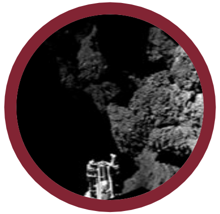
ESA facts and figures

- Over 50 years of experience
- Over 80 satellites designed, tested and operated in flight
- About 2300 staff
- Eight sites/facilities in Europe
- 22 Member States

Activities

ESA is one of the few space agencies in the world to combine responsibility in nearly all areas of space activity.

* Space science is a Mandatory programme, all Member States contribute to it according to GNP. All other programmes are Optional, funded ‘a la carte’ by Participating States.



space science

human spaceflight

exploration

earth observation

launchers

navigation

operations

technology

telecommunications

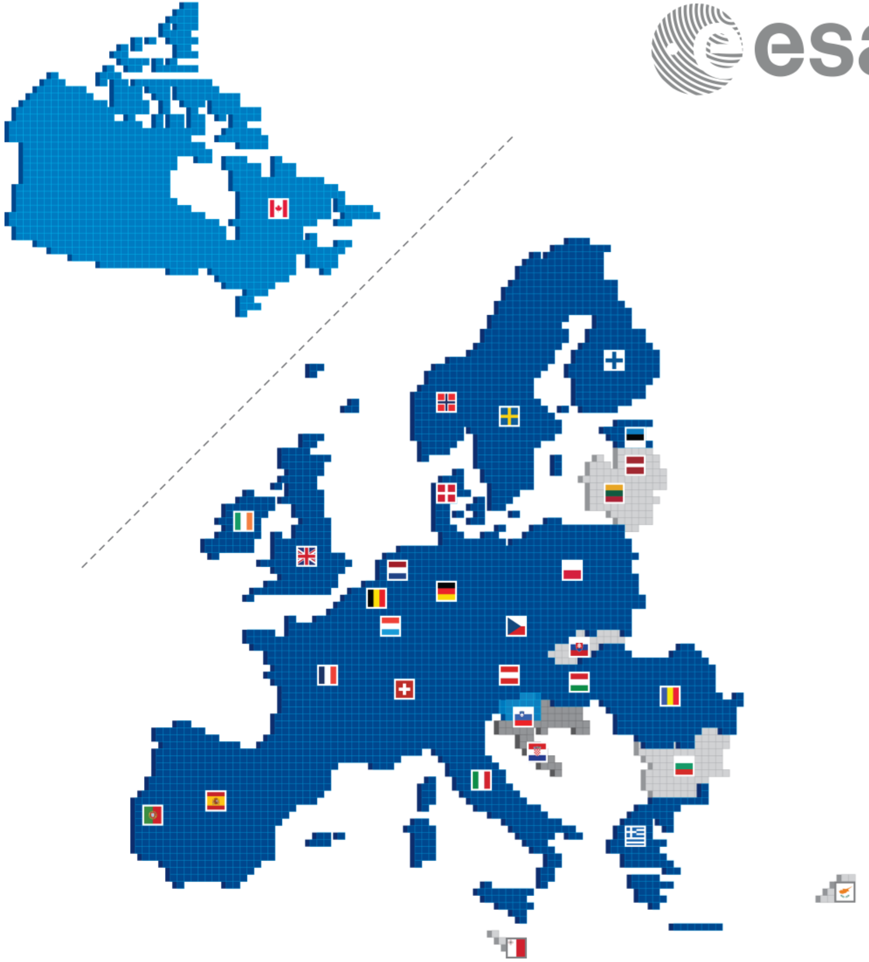
ESA Member States

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.

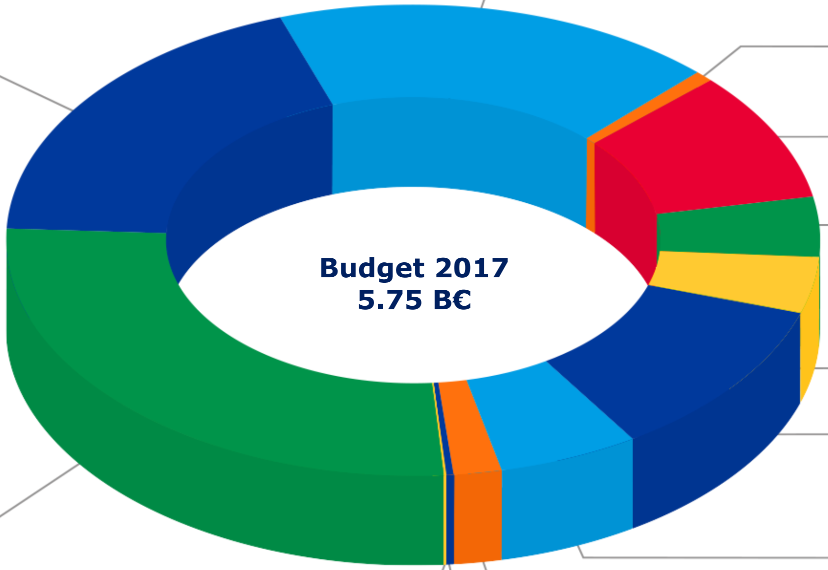
Seven other EU states have Cooperation Agreements with ESA: Bulgaria, Cyprus, Latvia, Lithuania, Malta and Slovakia. Discussions are ongoing with Croatia.

Slovenia is an Associate Member.

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



ESA budget for 2017: by domain



B€: Billion Euro

M€: Million Euro

***includes programmes implemented for other institutional partners**

A substantial part of EO budget comes from EU and from Eumetsat

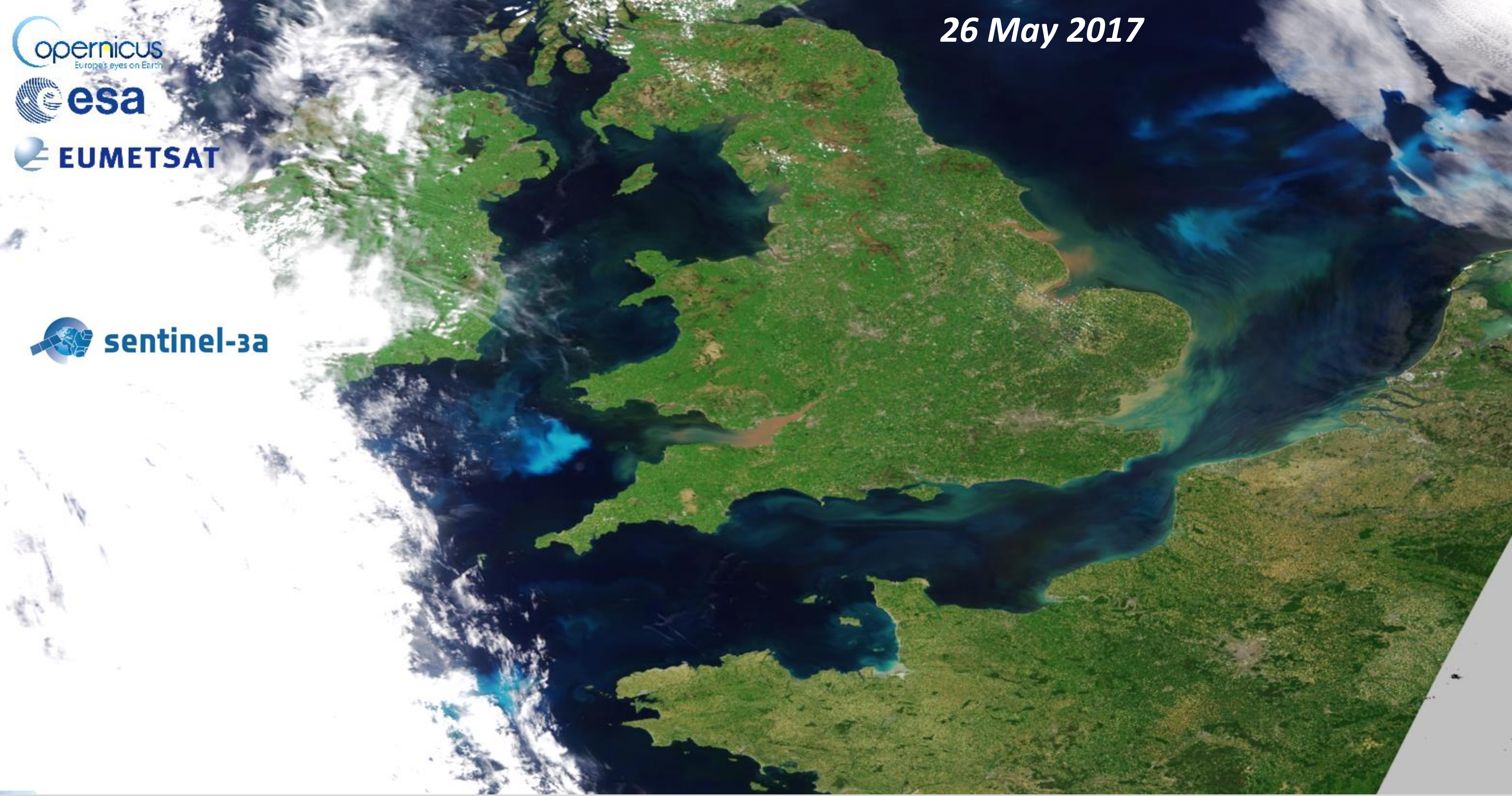
ESA Earth Observation Strategy

The prime objective of ESA Earth Observation Strategy is **to help society** to:

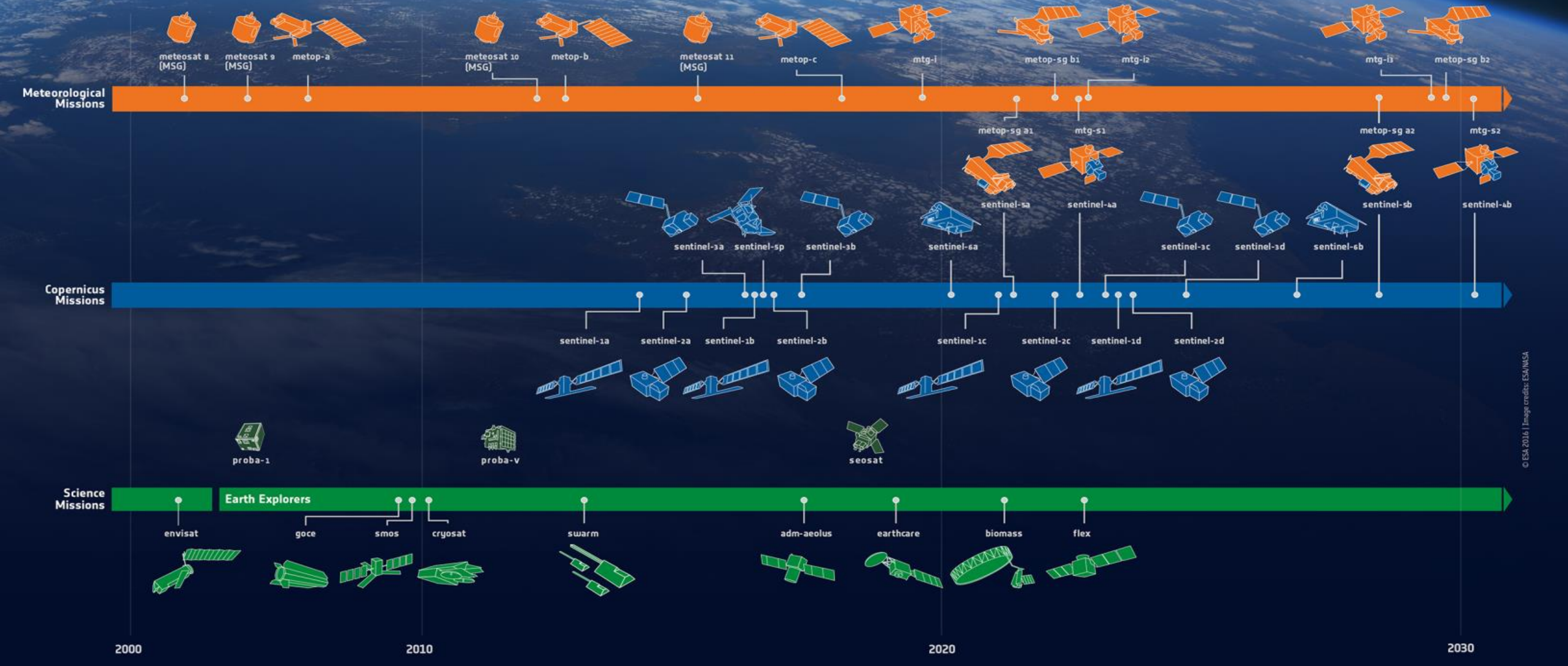
- ✓ **Observe**: develop and provide the observations to better understand the complexity of our planet and monitor its health;
- ✓ **Understand**: enable improved predictions of the physical interaction of society with the Earth system;
- ✓ **Decide**: inform decision makers and citizens on scenarios and consequences of political and economic decisions regarding our home planet.

The vision of ESA is to enable the maximum benefit of Earth observation for science, society and economic growth in Europe, served by European industry.

→ **Facilitating access to EO data is essential to reach above objectives**


26 May 2017

→ ESA–DEVELOPED EARTH OBSERVATION MISSIONS



ESA Third Party Missions

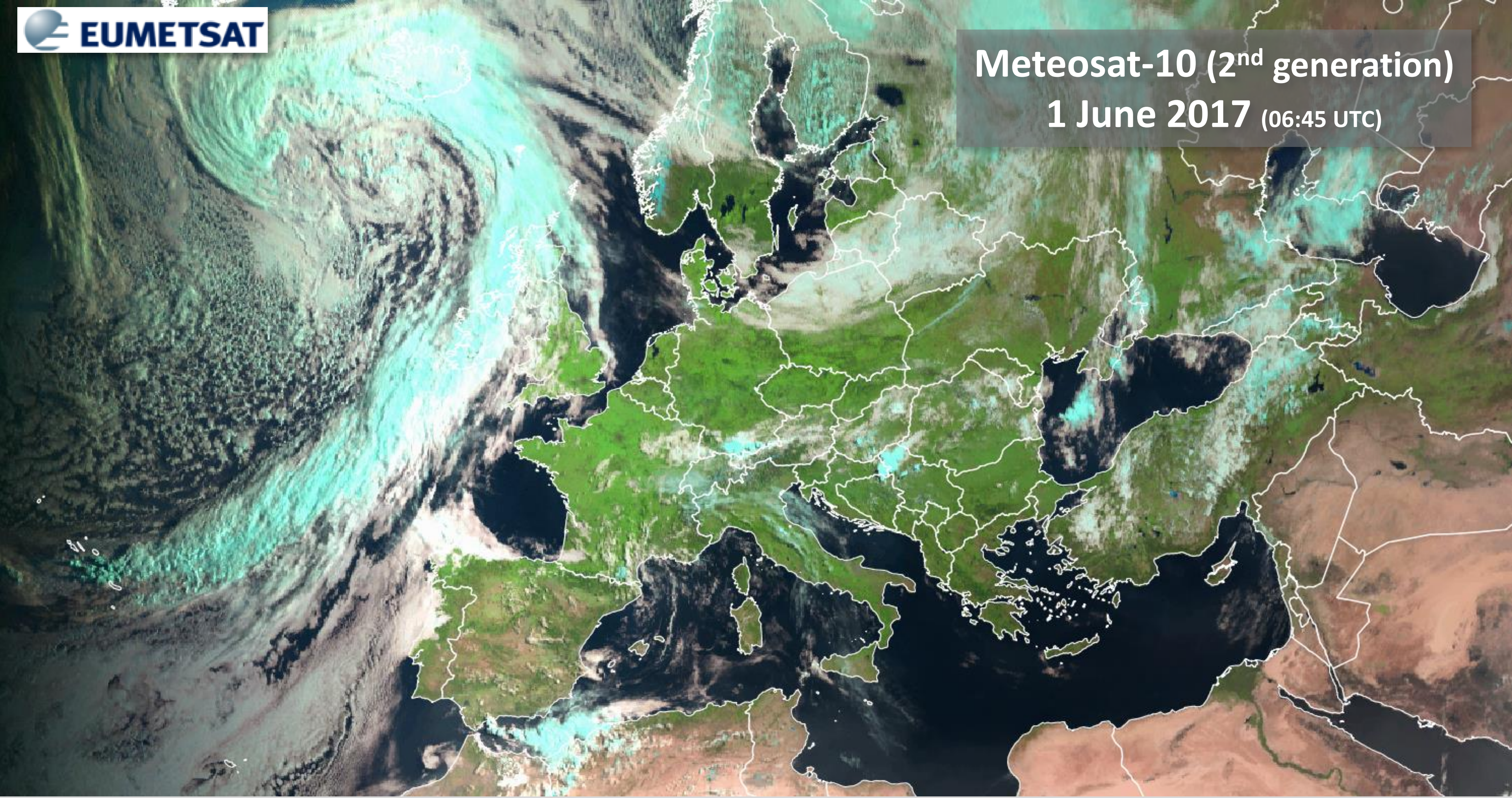
www.esa.int

European Space Agency

→ ESA–DEVELOPED EARTH OBSERVATION MISSIONS

in operation

The **MetOp-C** weather satellite is currently being tested inside Europe's largest vacuum chamber at ESTEC

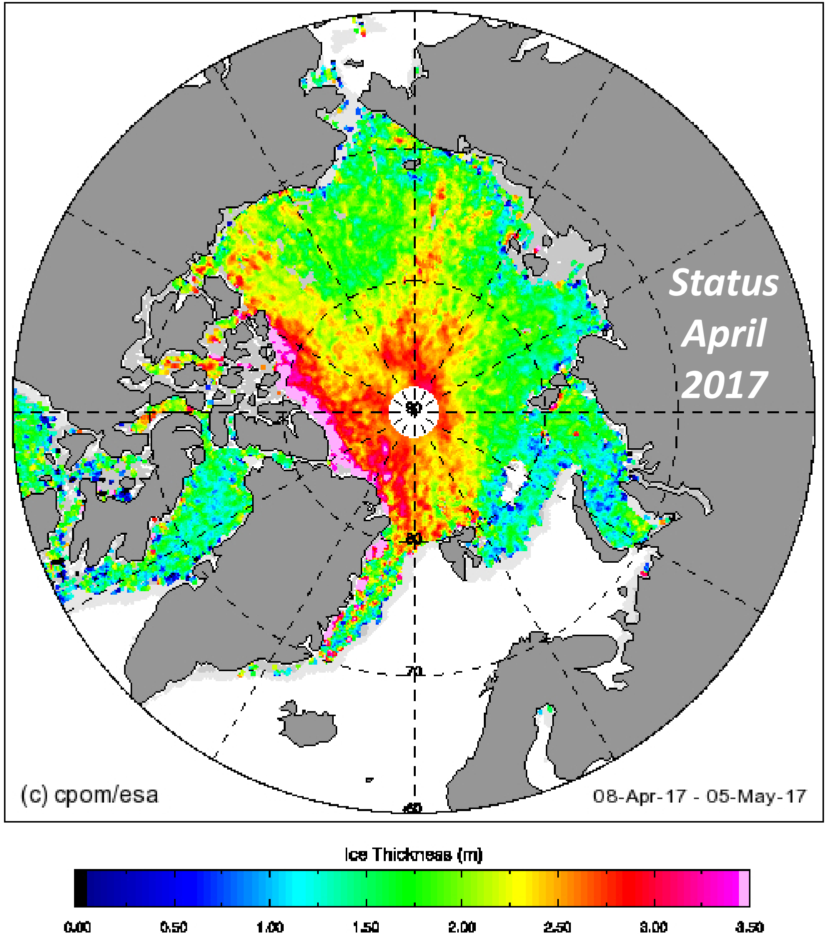


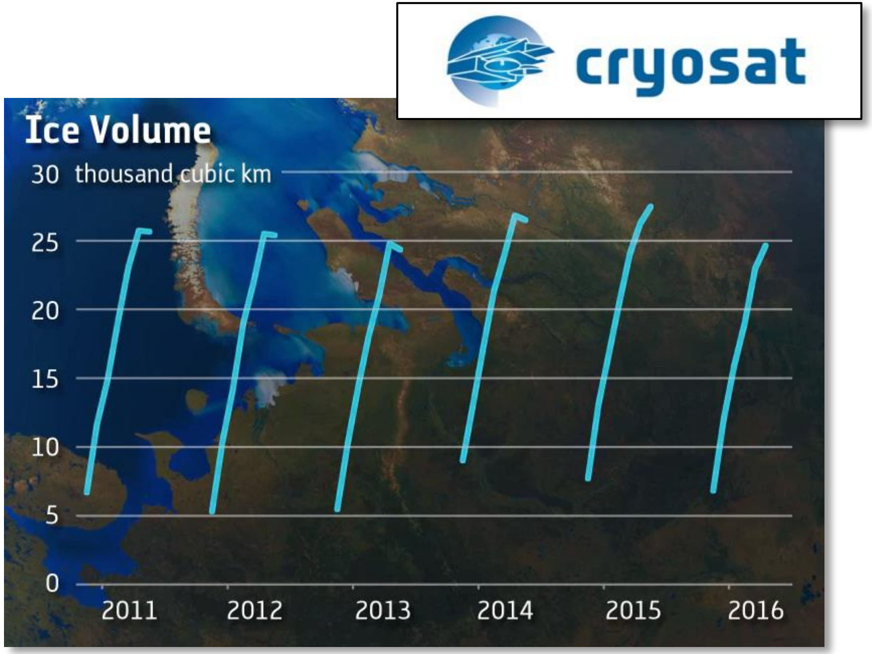
European Space Agency

→ ESA–DEVELOPED EARTH OBSERVATION MISSIONS

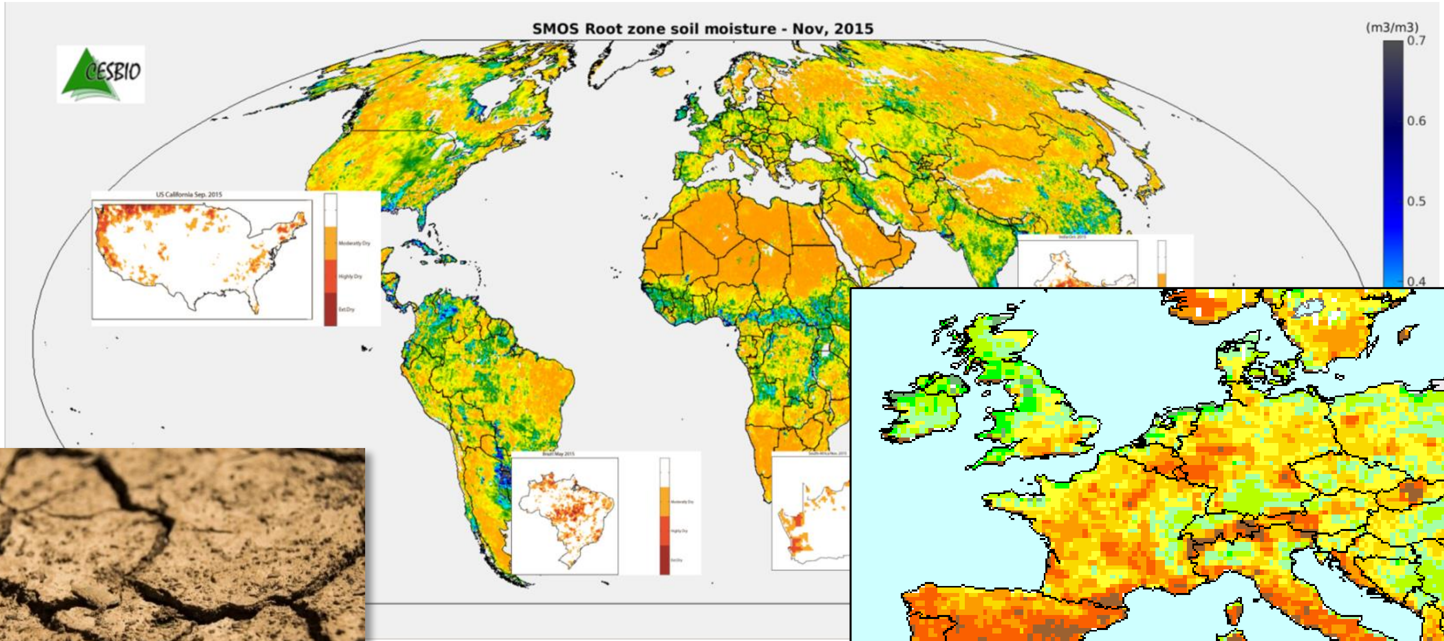
Arctic sea ice

→ *an historical minimum*

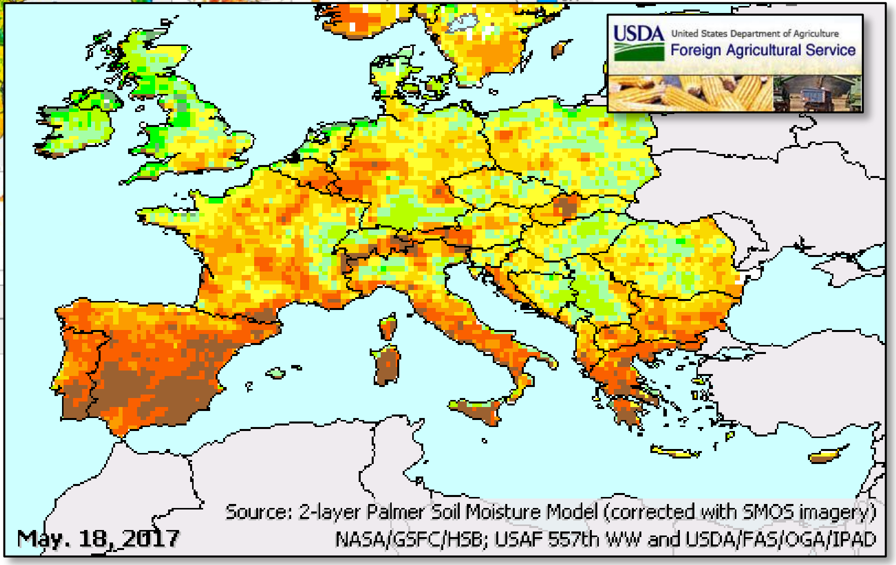




Soil moisture



Subsurface soil moisture (mid-May 2017)



Changes in strength of Earth's magnetic field

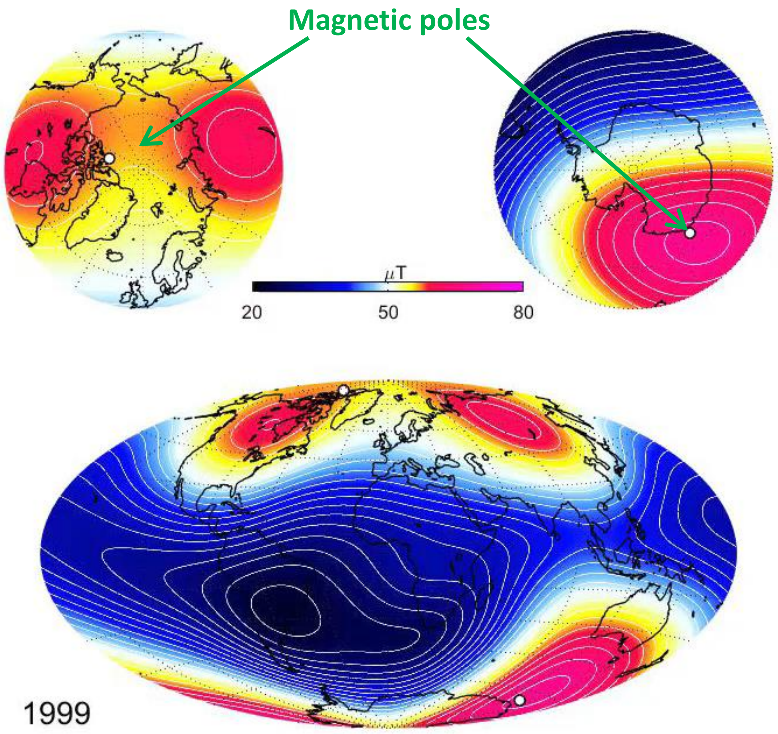
Swarm witnessing the changes in strength of Earth's magnetic field

Changes of the strength of Earth's magnetic field between 1999 and 2016:

Blue → weak field
Red → strong field

The field has weakened by 3.5% at high latitudes over North America, while it has grown about 2% stronger over Asia.

The South Atlantic Anomaly (region with the weakest magnetic field) has moved westward and further weakened by ~2%.

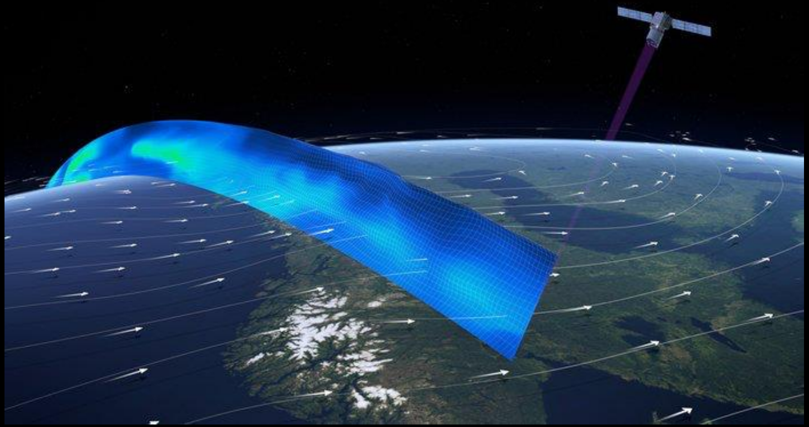


Animation courtesy of DTU Space (Swarm, CHAMP and Ørsted data

Upcoming missions

Aeolus

- Global observations of wind profiles for analysis of global 3D wind field
- *Launch planned for January 2018*



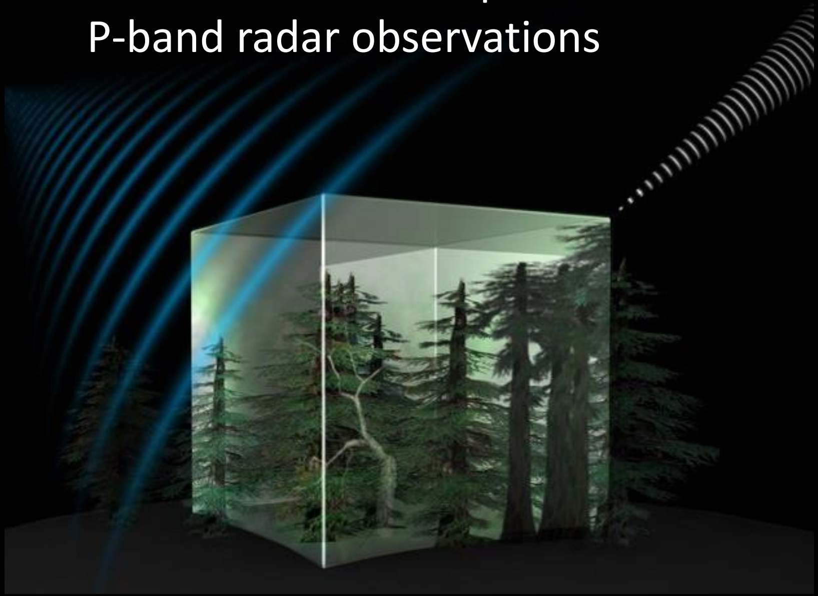
EarthCARE

- Global observations of clouds, aerosols and radiation
- *Launch planned for 2019*

Further missions

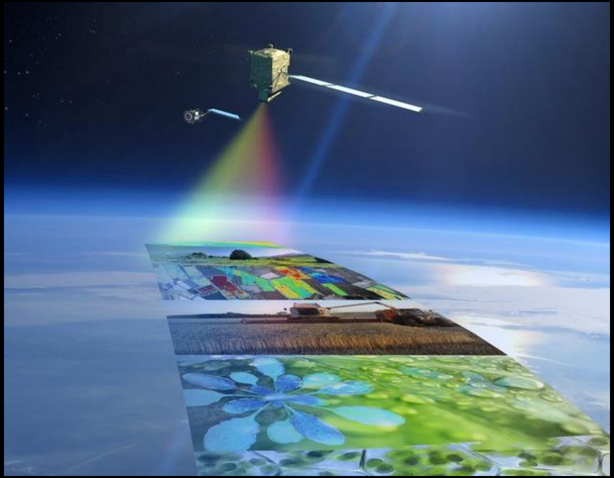
Biomass

Biomass estimates based on interferometric and polarimetric P-band radar observations



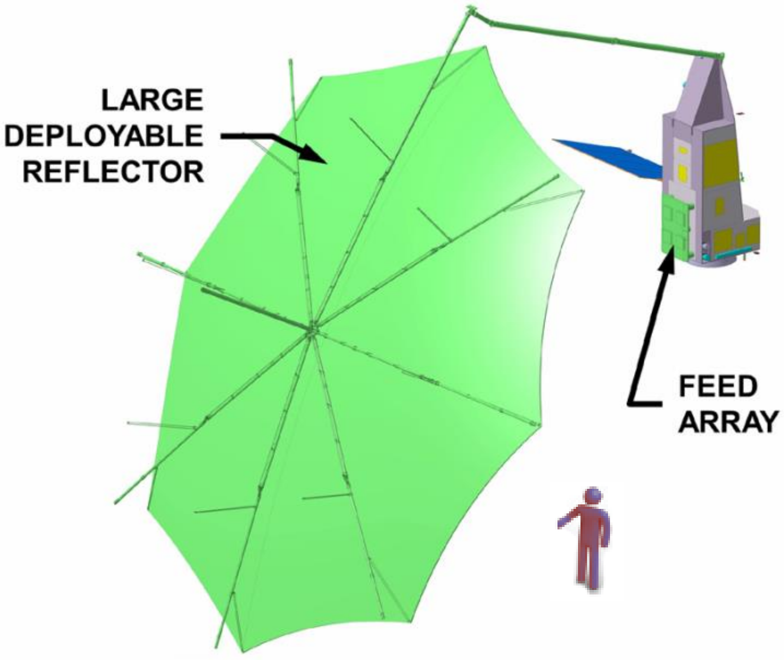
FLEX

Global maps of vegetation fluorescence, which can be converted into an indicator of photosynthetic activity



An innovative instrument

- ✓ First P-band (435 MHz) SAR in space
- ✓ Full polarimetric (HH, HV, VV)
- ✓ 6 MHz bandwidth
- ✓ Level 1: 50 x 50 m^2 resolution
- ✓ Multi-pass interferometry with a 3 days repeat cycle
- ✓ Two mission phases: Tomography (year 1), Interferometry (year 2-5)
- ✓ Currently estimated launch: end-2021



BIOMASS mission

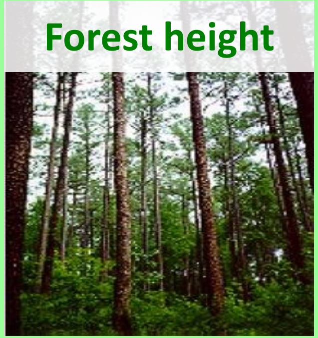
Level 2 products to be delivered

Forest biomass

Above-ground biomass (tons/hectare)

- 200 m resolution
- **1 map every 7 months**
- global coverage of forested areas
- accuracy of 20%,
  or 10 t ha^{-1} for biomass < 50 t ha^{-1}

Forest height



Upper canopy height (meter)

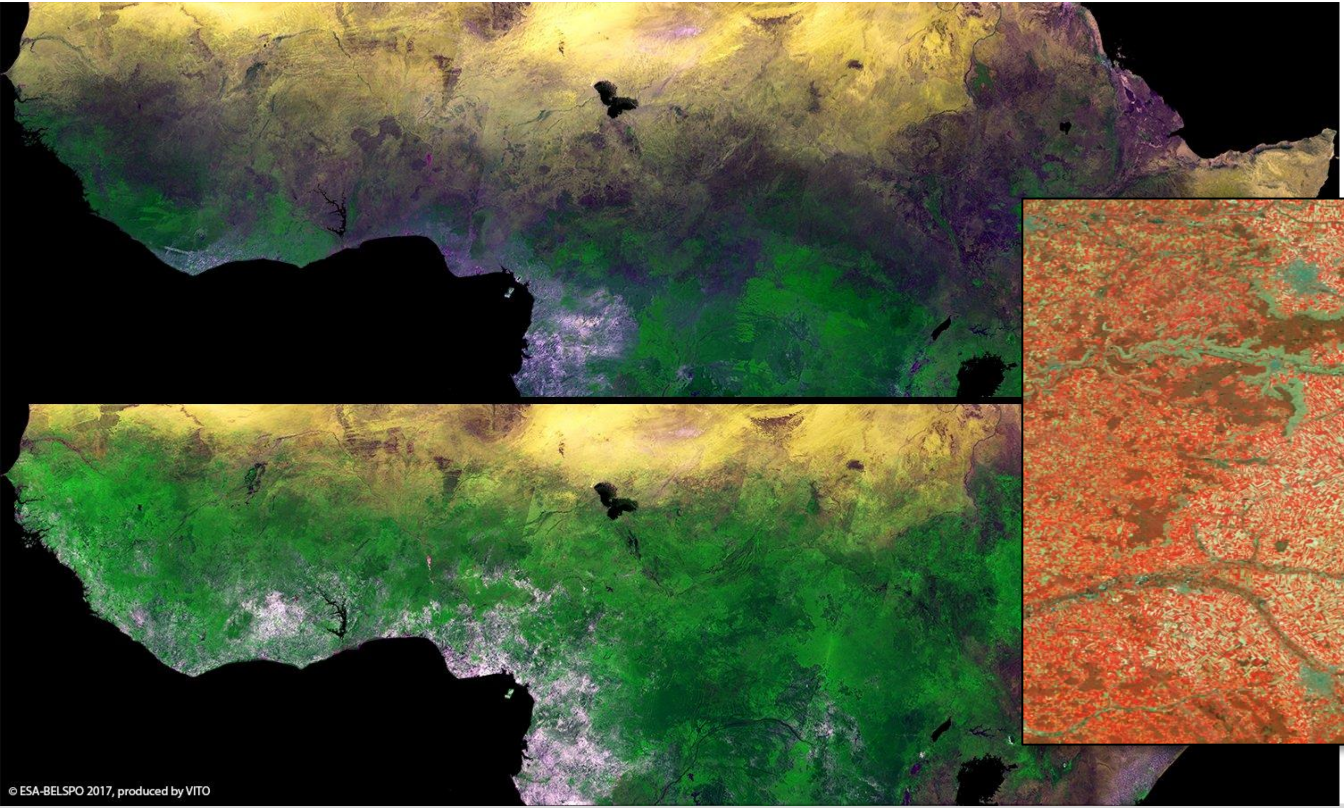
- 200 m resolution
- **1 map every 7 months**
- global coverage of forested areas
- accuracy of 20-30%

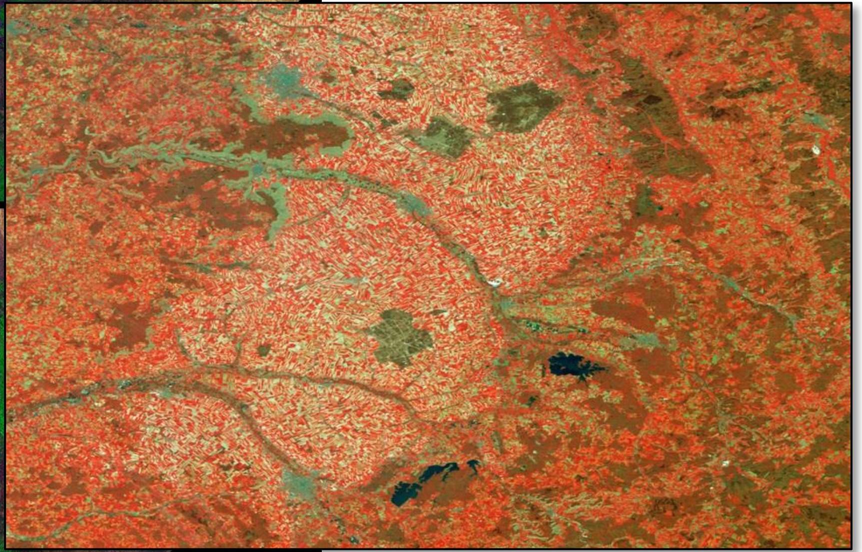
Disturbances

Areas of forest clearing (hectare)

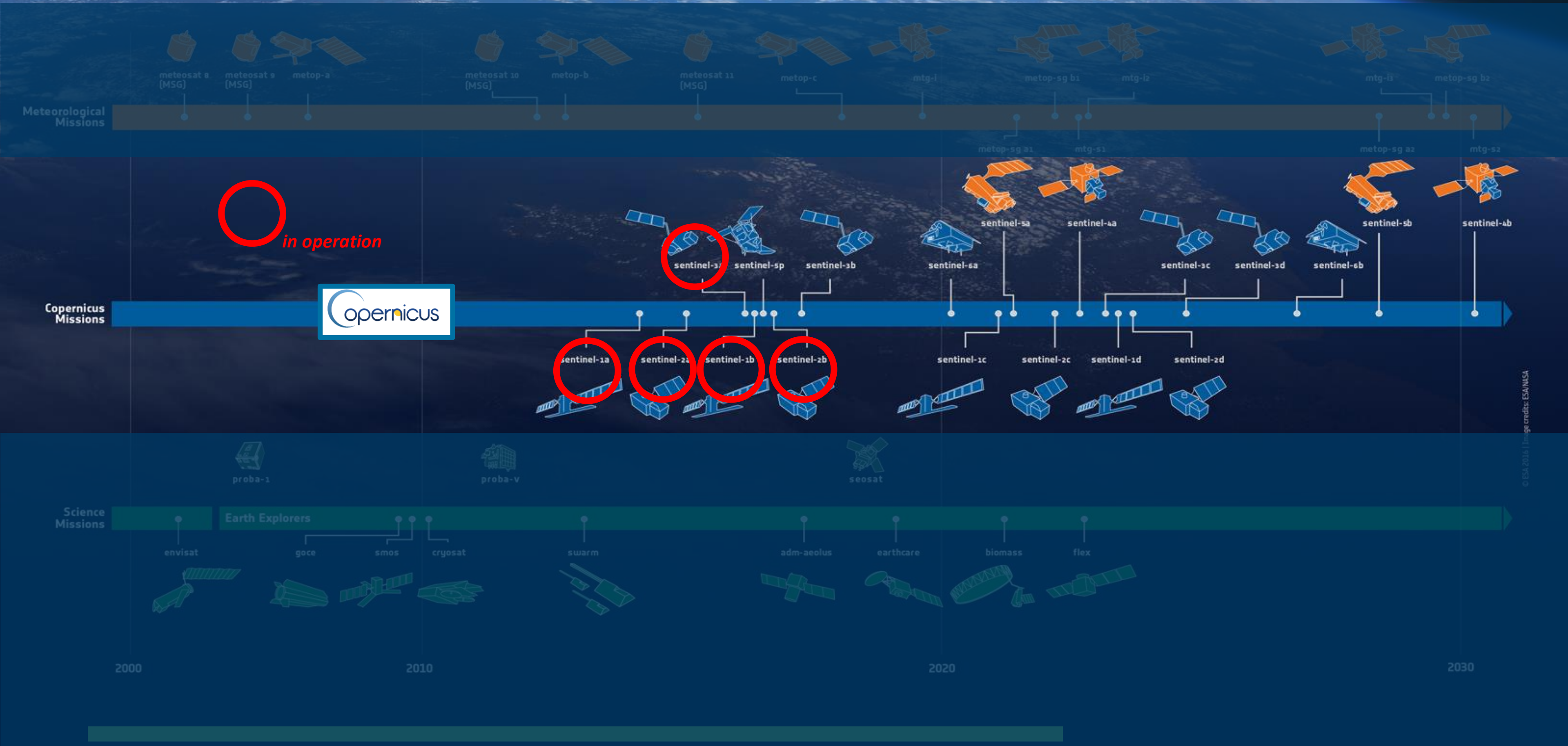
- 50 m resolution
- **1 map every 7 months**
- global coverage of forested areas
- 90% classification accuracy

Proba-Vegetation was specifically designed for global environmental and agricultural monitoring. It extends the dataset of the long-established Vegetation instrument carried on the French Spot-4 and Spot-5 satellites, launched in 1998 and 2002 respectively.

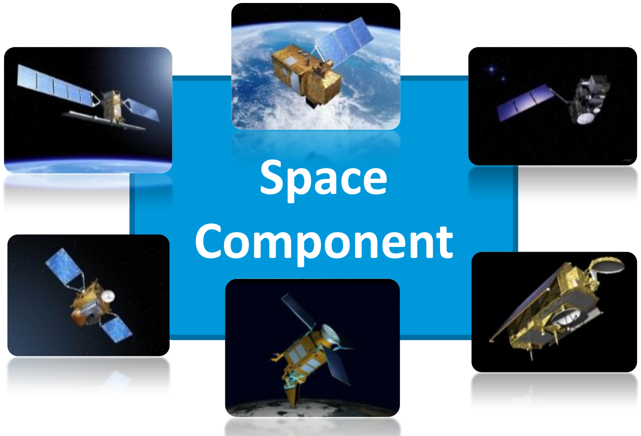


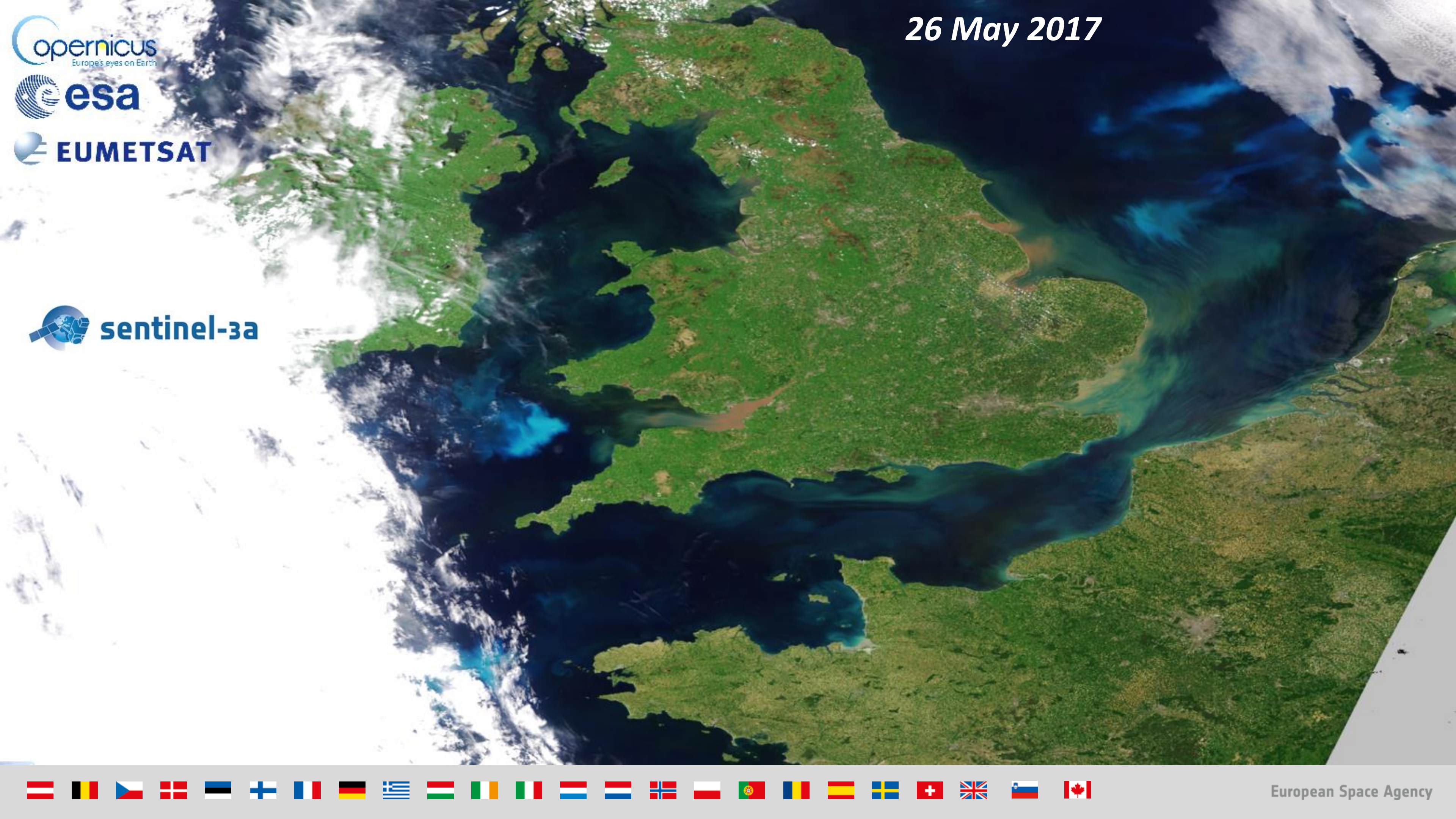


➔ ESA–DEVELOPED EARTH OBSERVATION MISSIONS

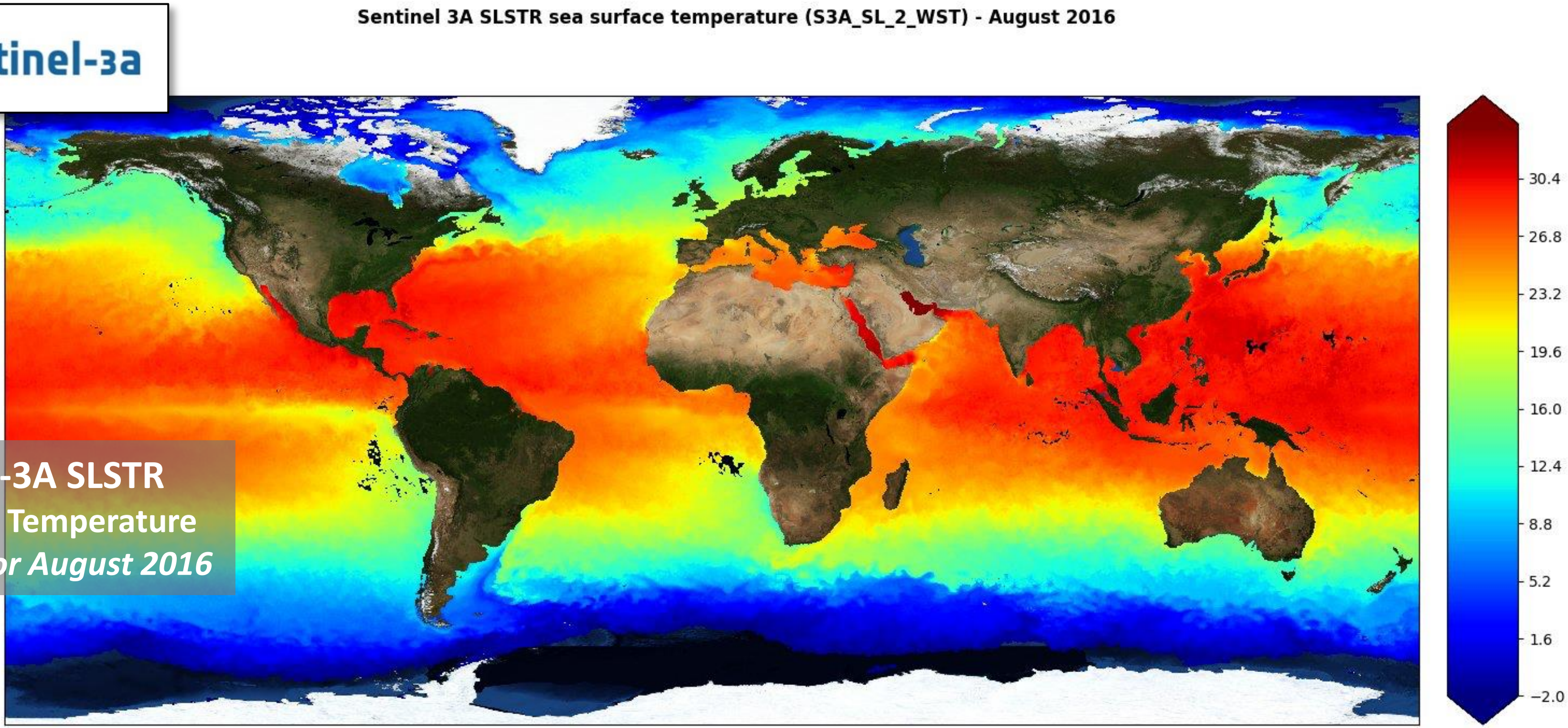


Overall programme coordination:




26 May 2017
copernicus
Europe's eyes on Earth
esa
EUMETSAT
sentinel-3a
European Space Agency

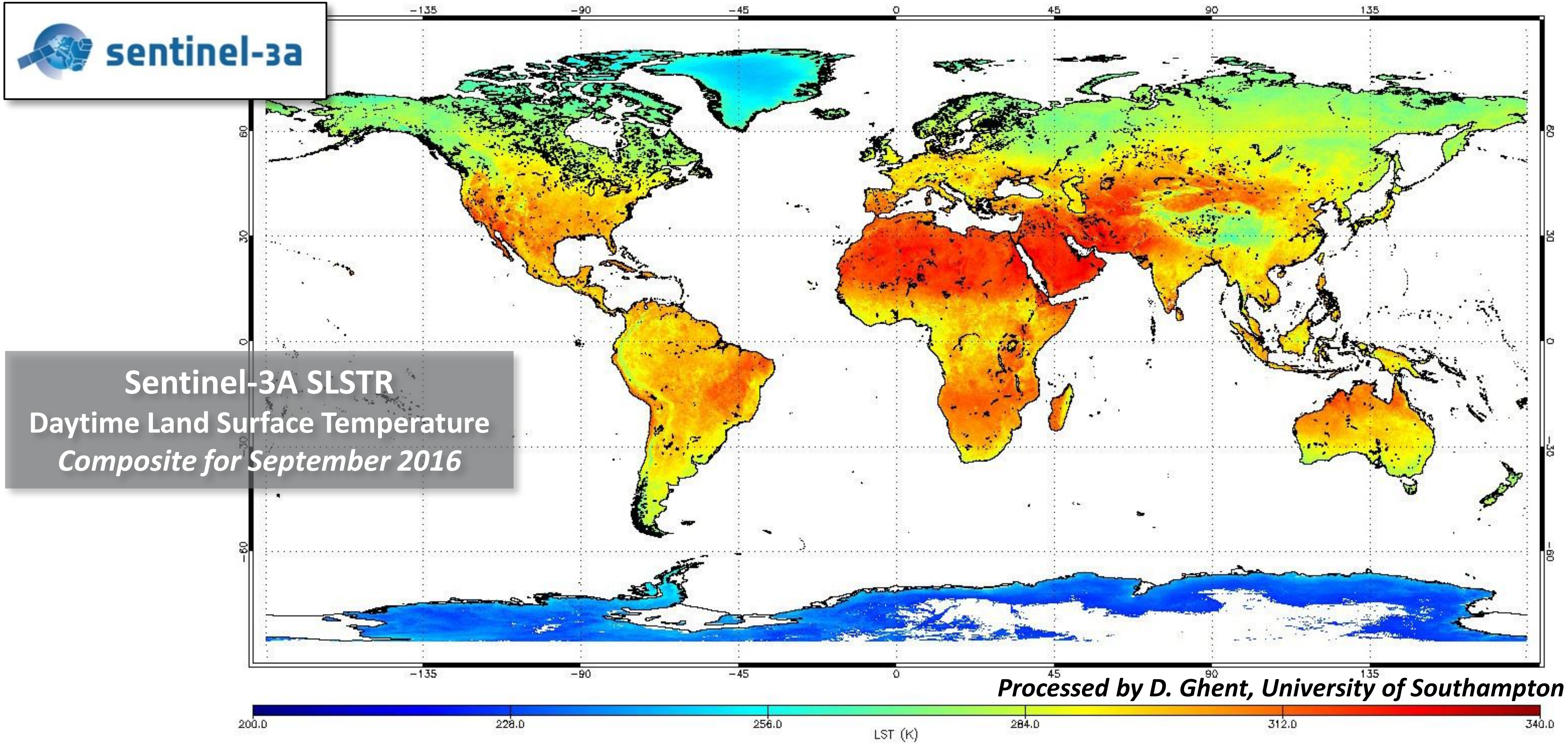
Sea Surface Temperature



Sentinel-3A SLSTR
Sea Surface Temperature
Composite for August 2016

Land Surface Temperature

sentinel-3a



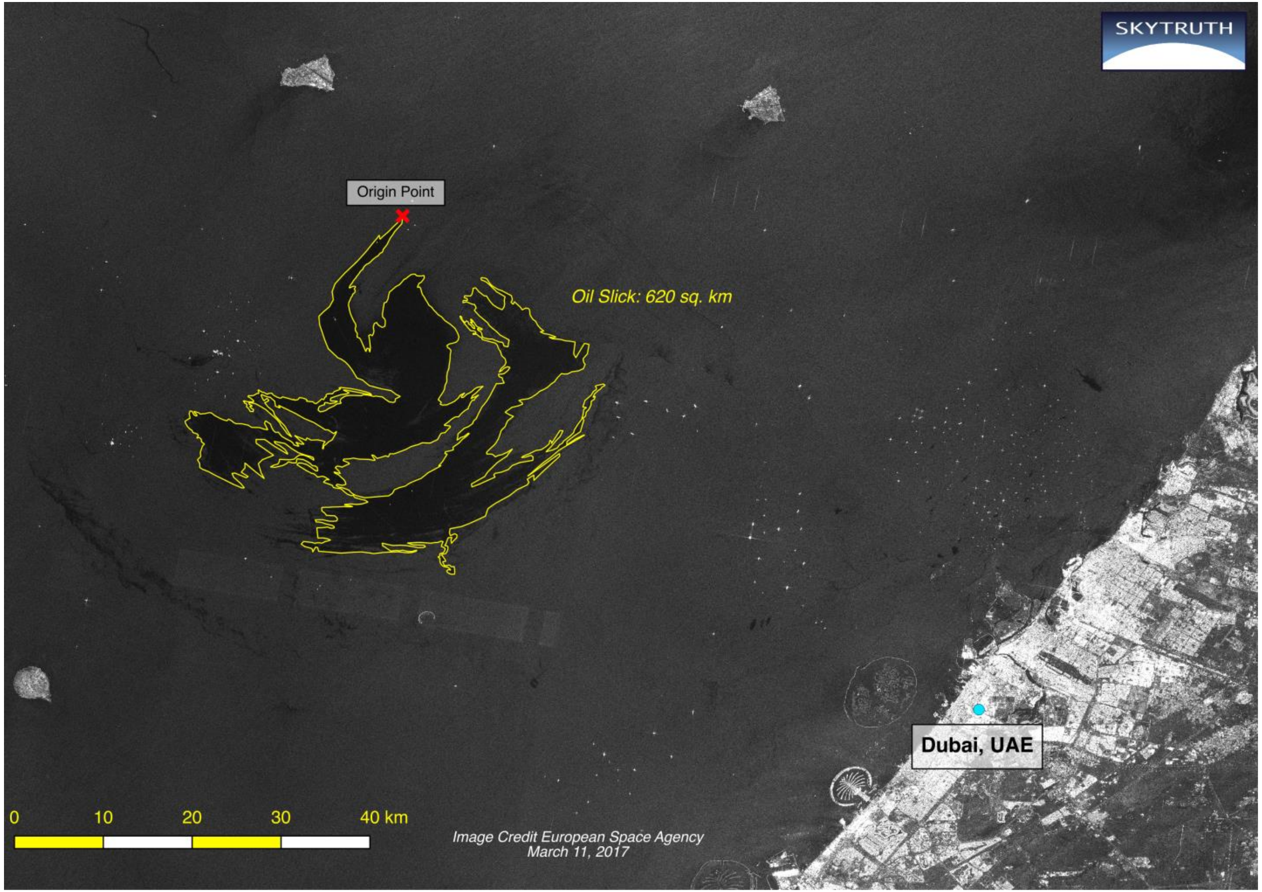
European Space Agency

On-going Etna eruption

8 April 2017


26 May 2017, Interferometric Wide Swath, VV/VH

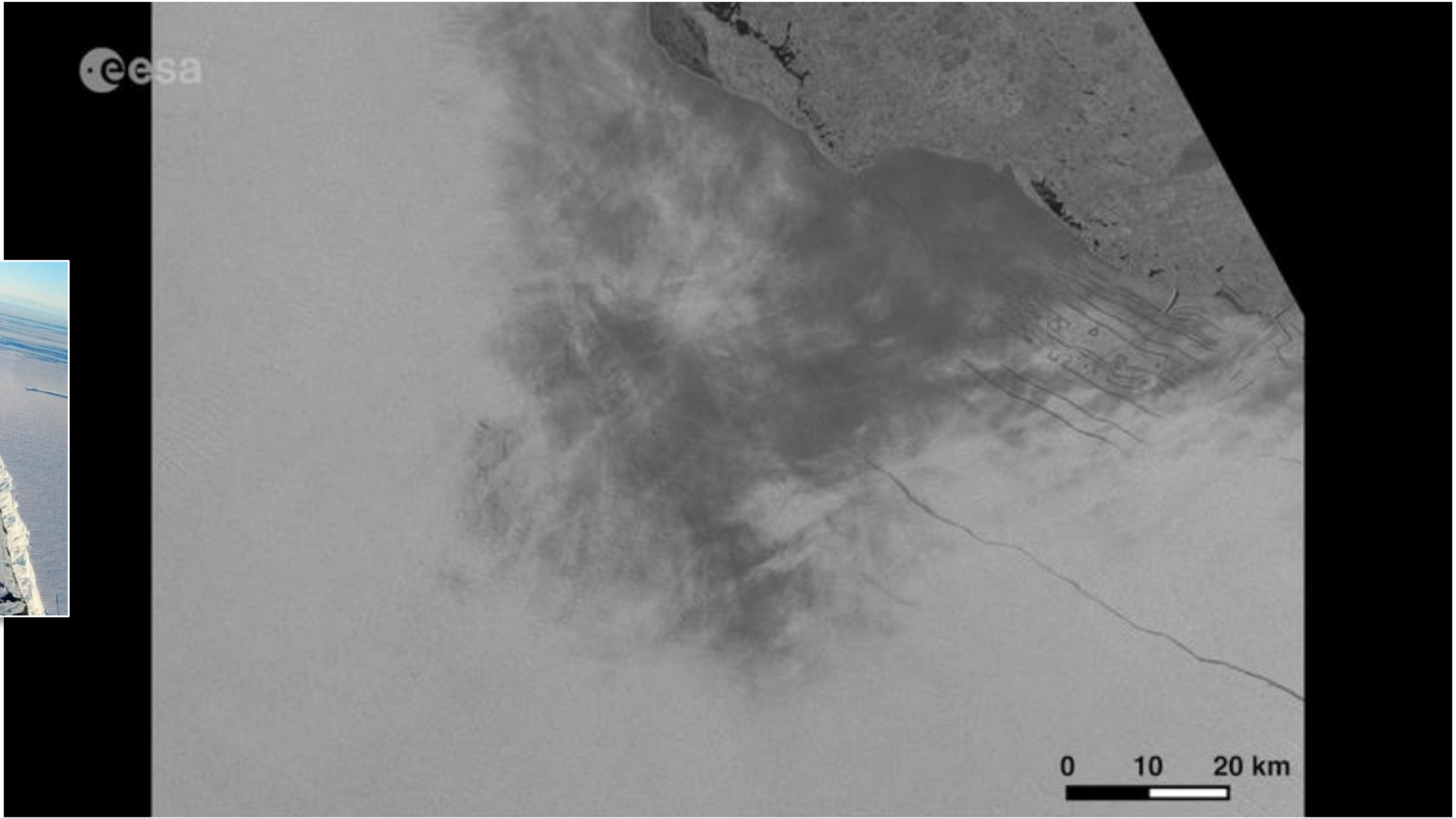
Oil spill monitoring



Larsen-C Ice Shelf *(Antarctica)*

sentinel-1a

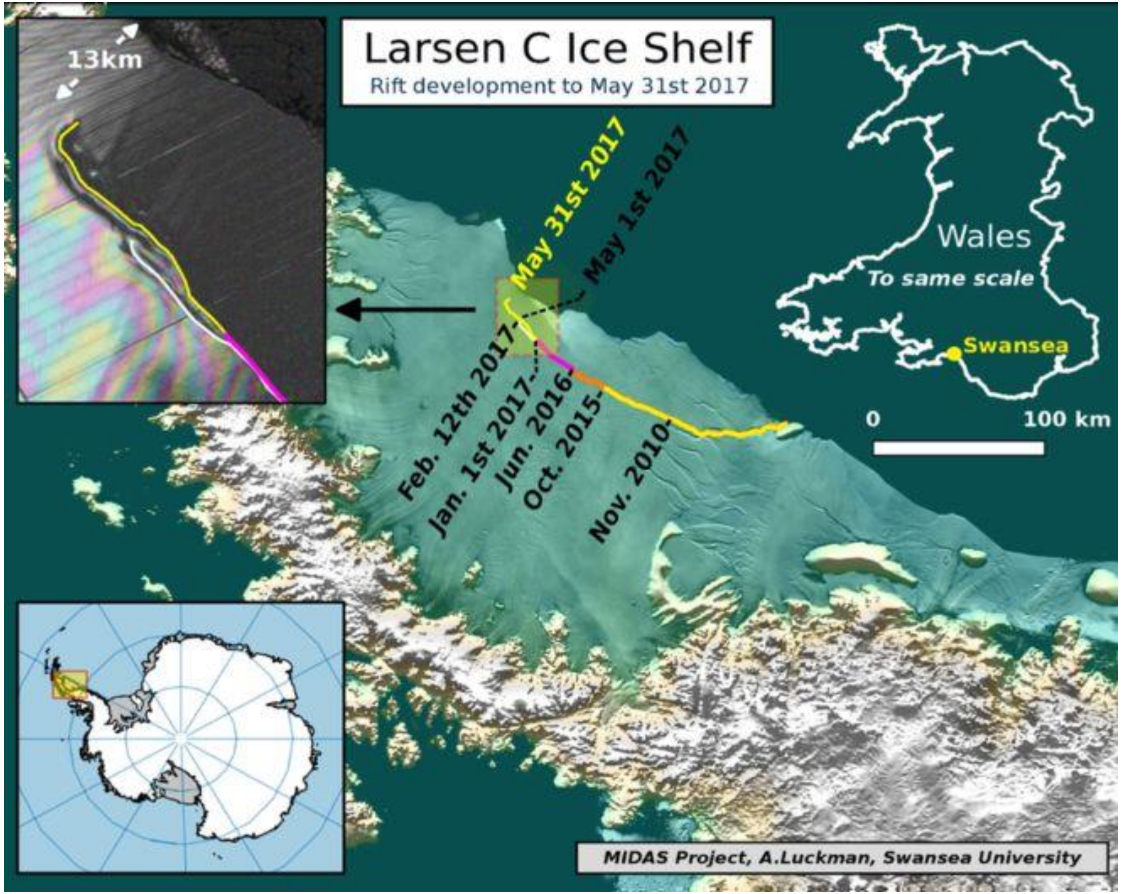
sentinel-1b



Larsen-C Ice Shelf *(Antarctica)*

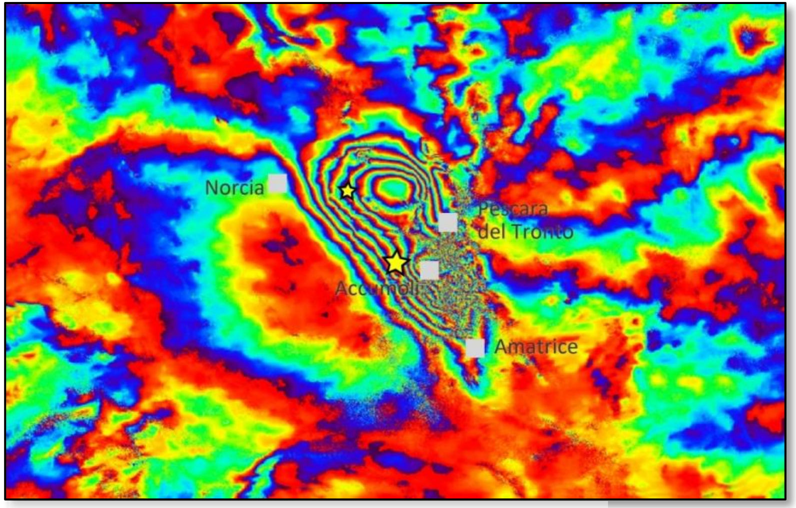
sentinel-1a

sentinel-1b



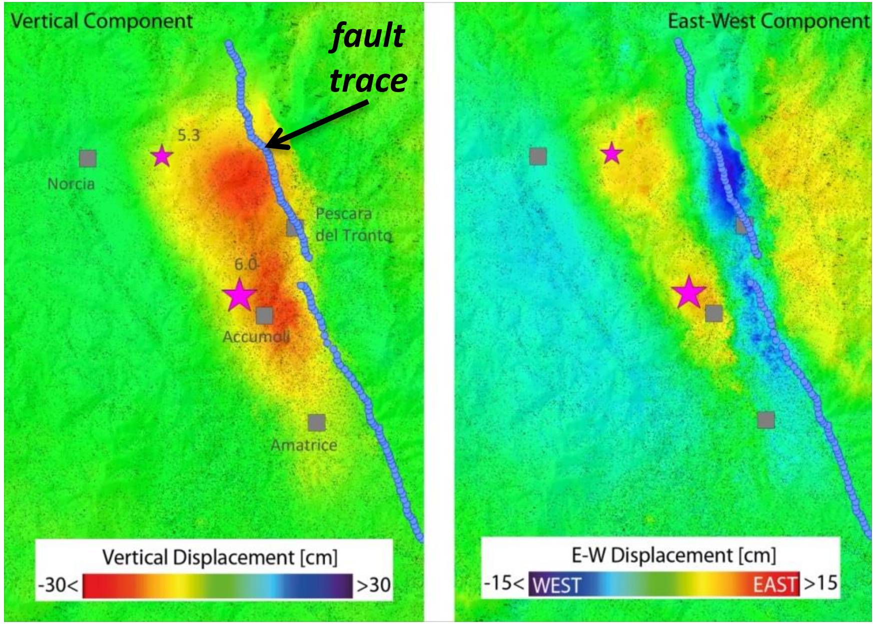
Central Italy Earthquake
(24 August 2016)

sentinel-1a sentinel-1b



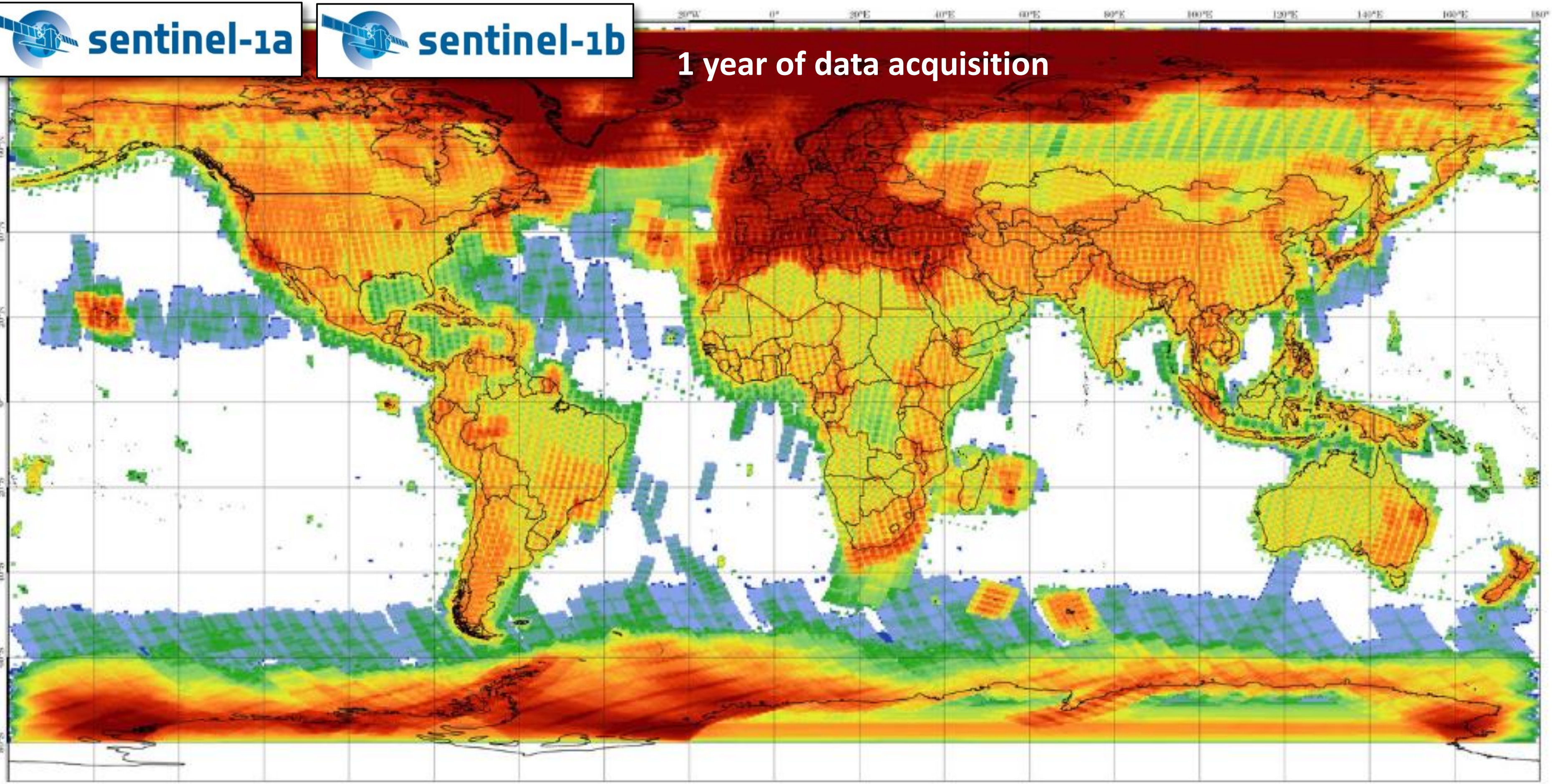
Each interferometric fringe of the above interferogramme represents about 3 cm of deformation.

Scientists from Italy's CNR-IREA combined Sentinel-1 radar acquisitions over central Italy from before and after the earthquake: 15 August, 21 August and 27 August 2016. The result shows **vertical** ground subsidence, reaching ~**20 cm** in correspondence to the Accumoli area, and **lateral** movement of up to **16 cm**.



sentinel-1a sentinel-1b

1 year of data acquisition



Sentinel-1A and Sentinel-1B constellation products overview
- 31. 03. 2016 - 31. 03. 2017 -

Sensoroperationalmode: EW, IW, WV, SM
Producttype: All
Polarisationmode: All

Legend

All Sentinel-1 Products

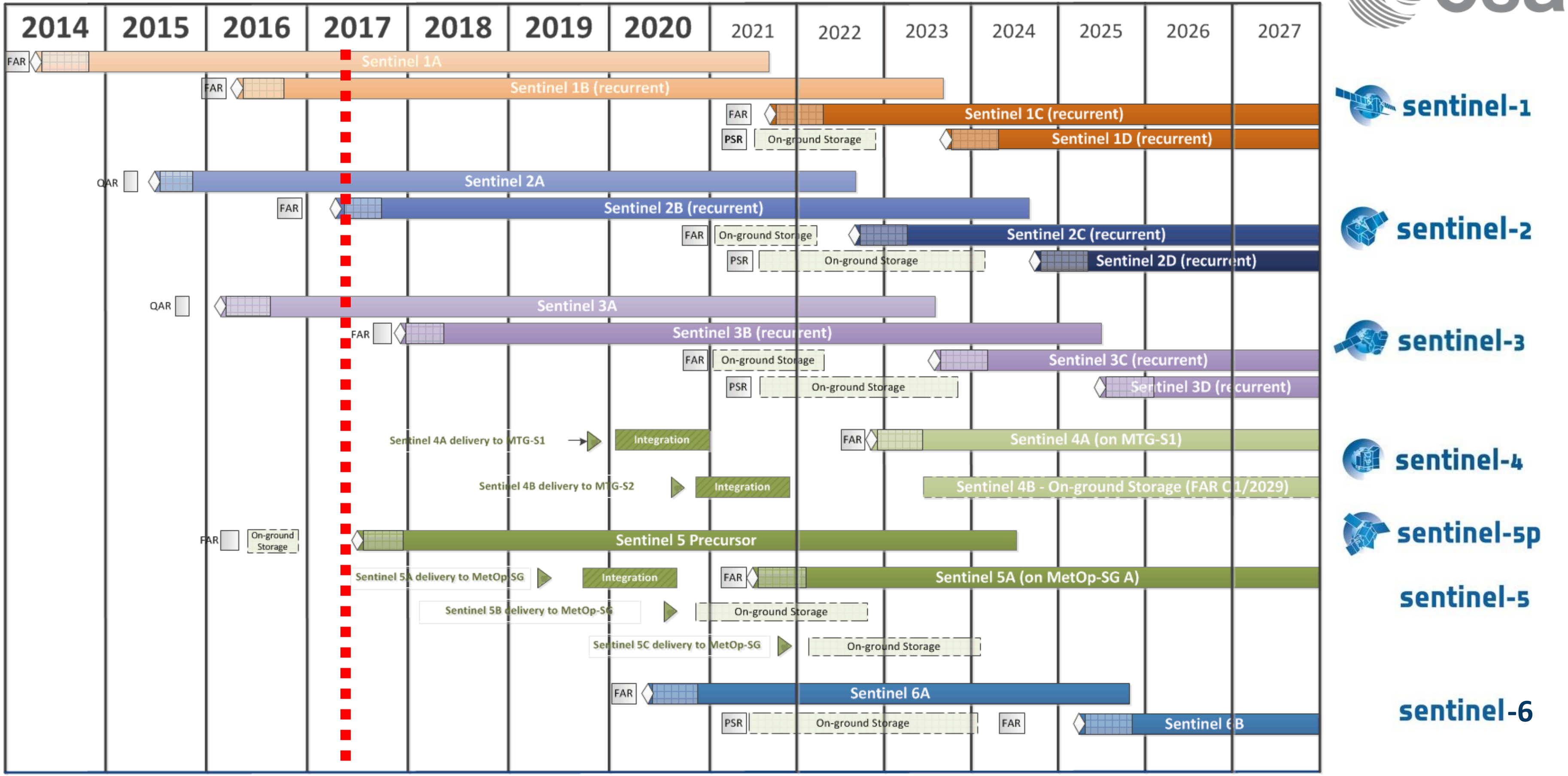
Borders of countries

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

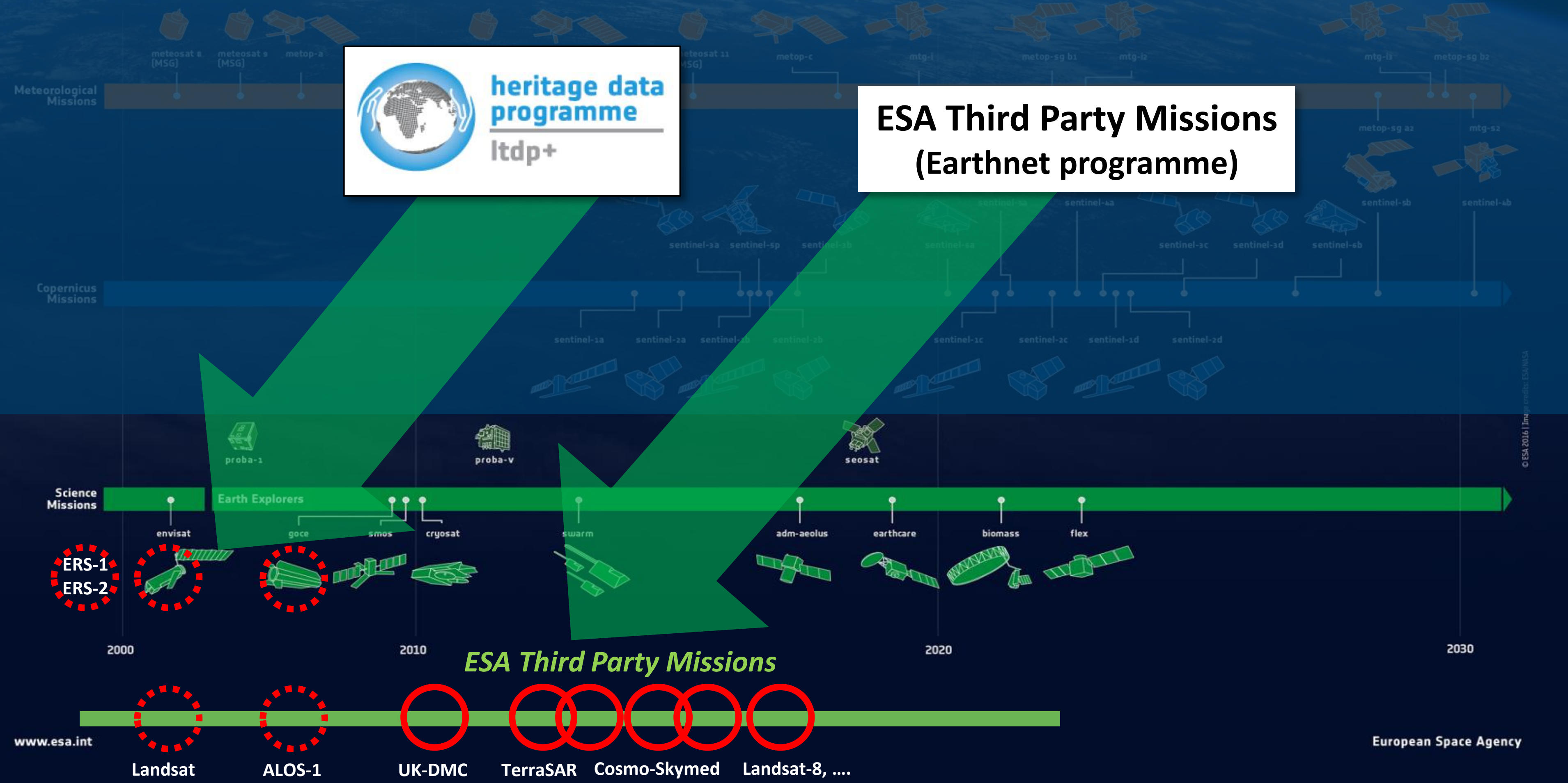
Sentinel-1 Constellation Observation Scenario: Revisit & Coverage Frequency

This map presents a density of Sentinel-1 acquisitions over a course of one year in a 0.5x0.5[degree] resolution grid.

Sentinel - Tentative Launch Schedule



→ ESA–DEVELOPED EARTH OBSERVATION MISSIONS

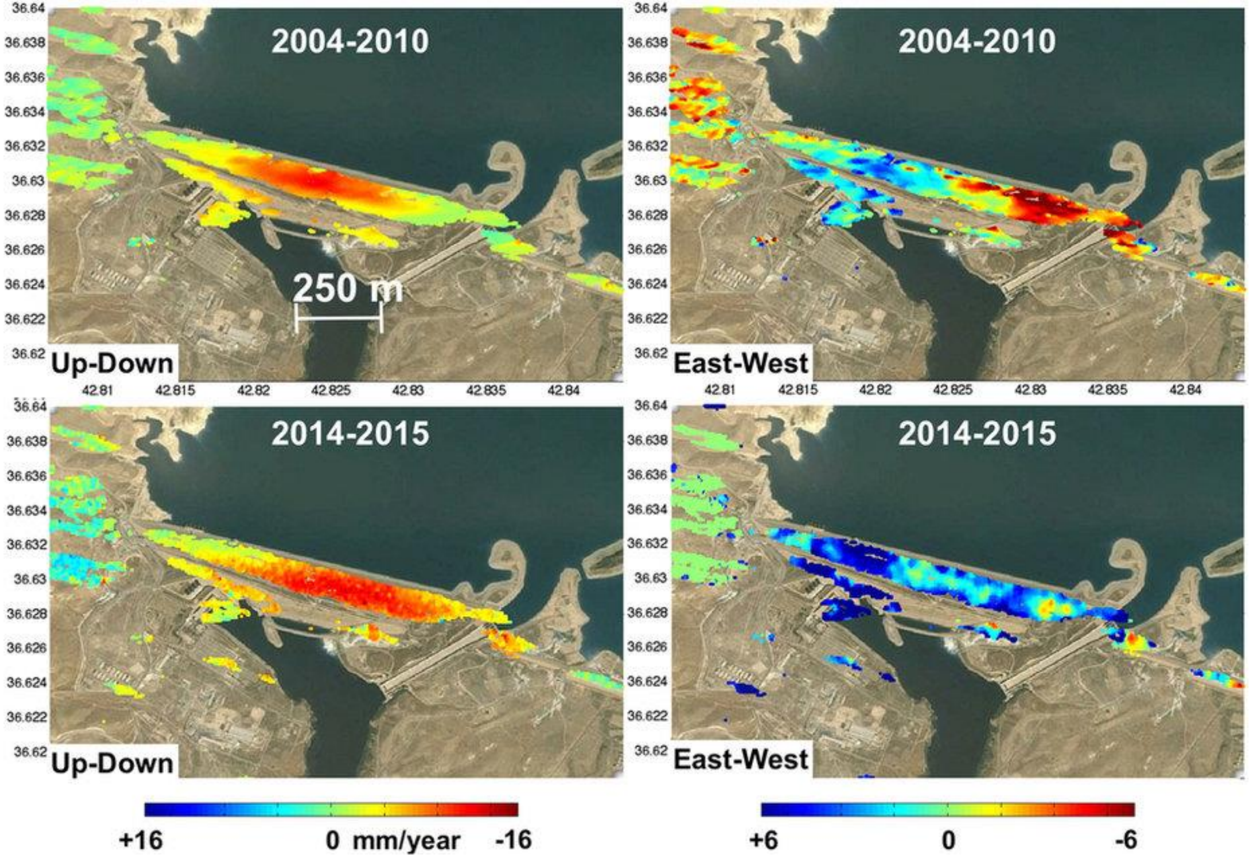


Importance of heritage data for long-term analysis

Example with the ongoing destabilization of the Mosul dam, Iraq

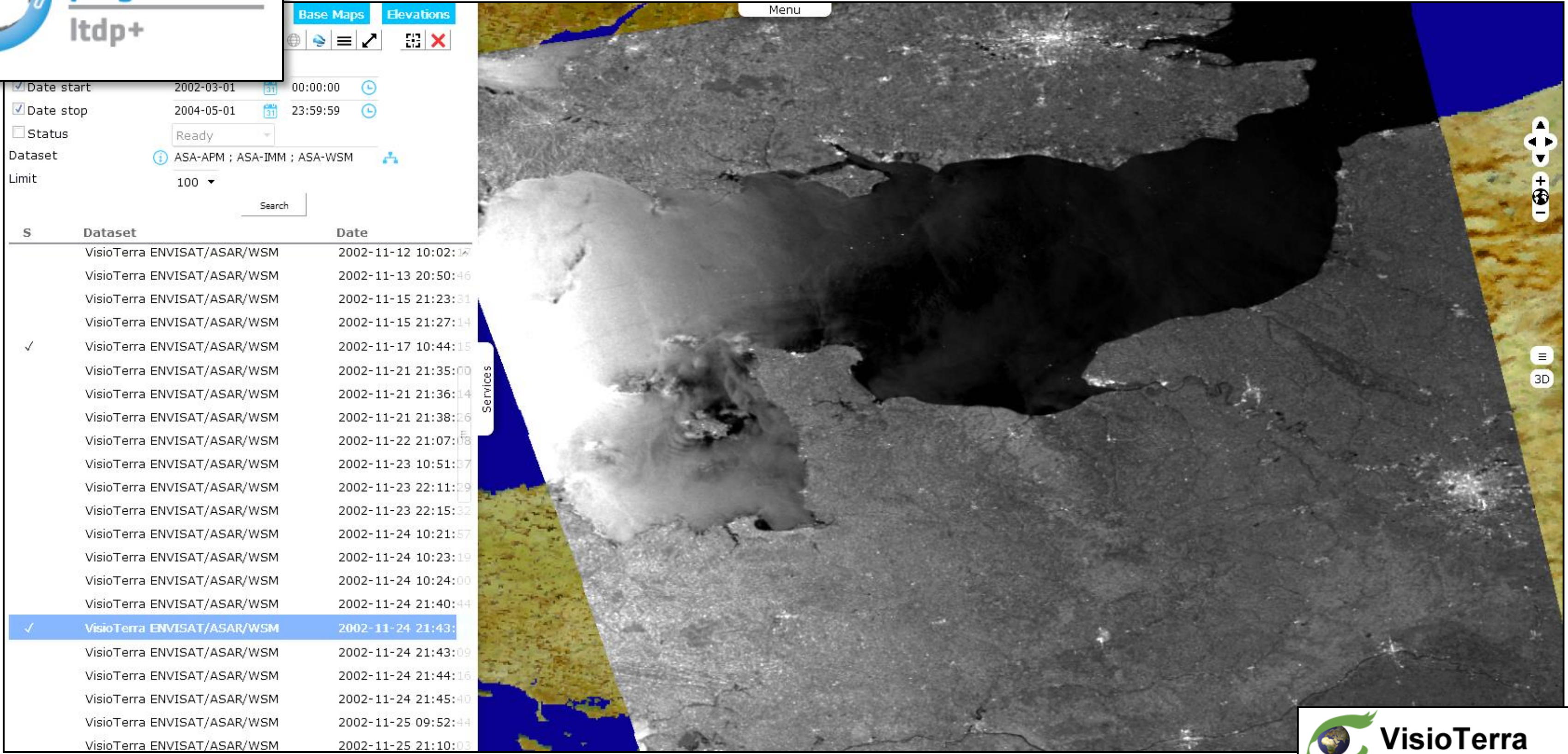
Negative values indicate downward and westward motion respectively. The results are derived from Envisat data (2004-2010) and from Cosmo-Skymed and Sentinel-1a data.

Figure extracted from "Space geodetic monitoring of engineered structures: The ongoing destabilization of the Mosul dam, Iraq",
P. Milillo et al., Nature Scientific Reports 6 (2016)



heritage data programme
ltdp+

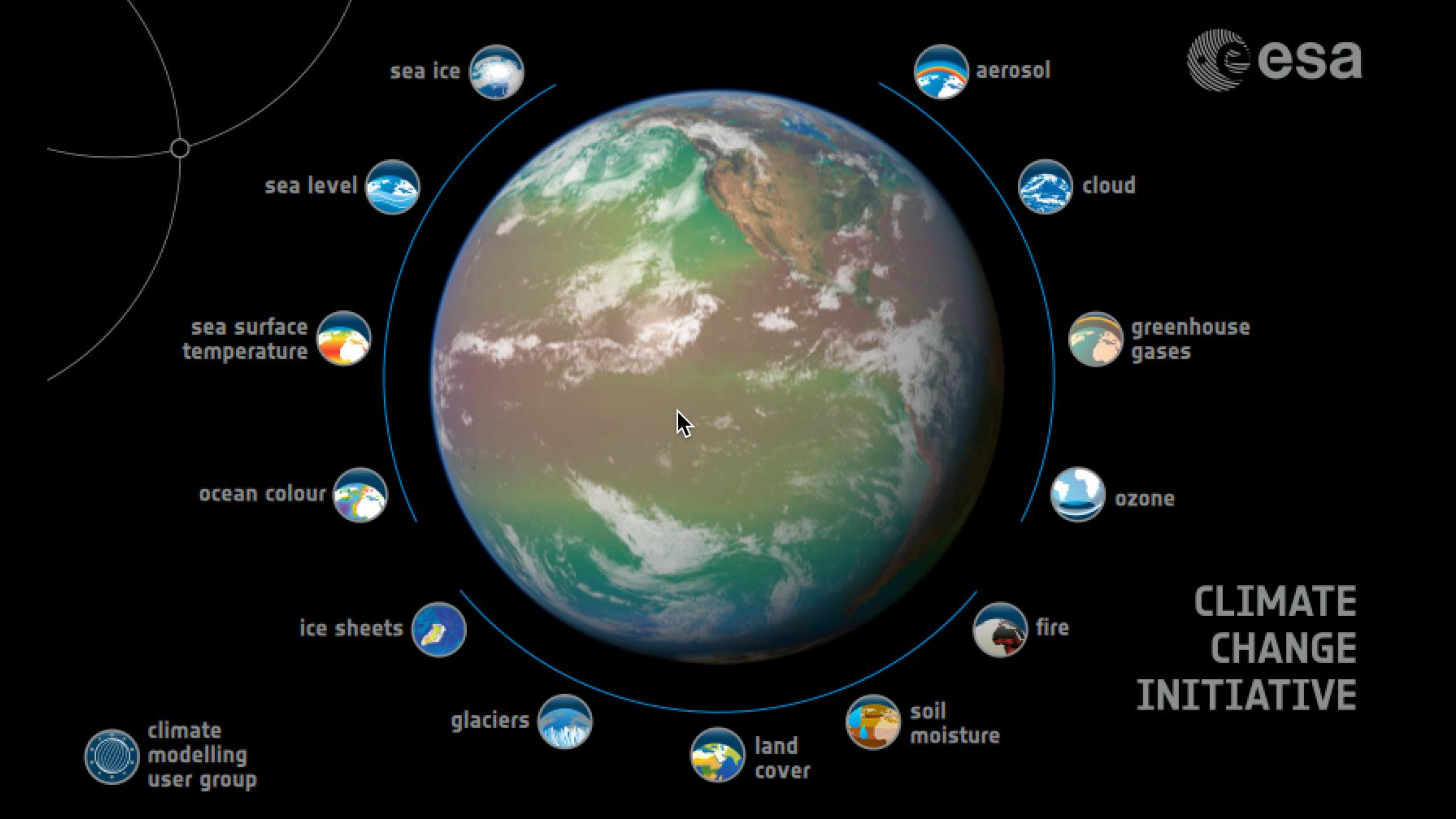
hedavi : heritage data visualisation



VisioTerra
Scientific Consulting for Earth Observations

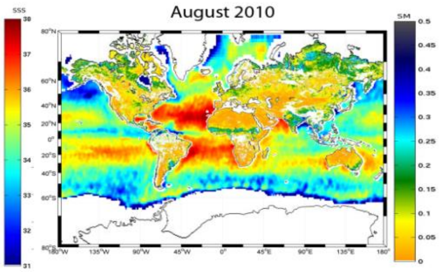
http://hedavi.esa.int

European Space Agency

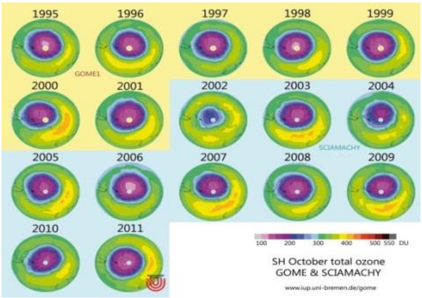


esa
sea ice
aerosol
sea level
cloud
sea surface temperature
greenhouse gases
ocean colour
ozone
ice sheets
fire
CLIMATE CHANGE INITIATIVE
glaciers
soil moisture
land cover
climate modelling user group

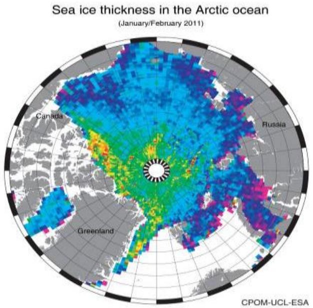
Data challenges for EO missions at ESA



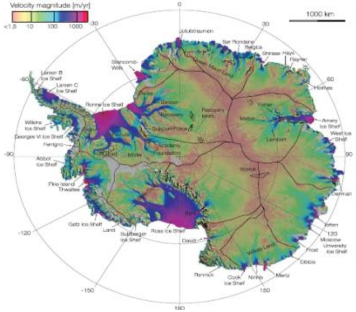
Data volume



Data continuity

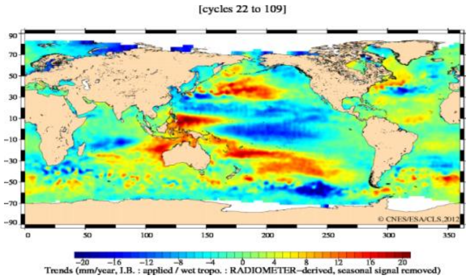


Data quality

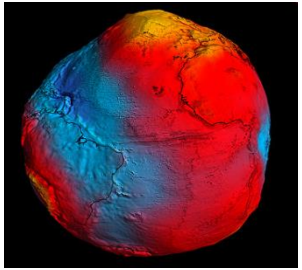


Data diversity

Timeliness



Synergy between EO missions



Uniqueness

Innovation

→ Facilitating access to (quality) EO data

esa

- EO data policy at ESA (ESA policy and Copernicus policy)
  → free of charge, open (and as full as possible)

- For all missions, operations concept based on systematicity:
  → all data are systematically acquired, downlinked & processed to generate and disseminate core products

- Focus on data quality (calibration, validation, product evolution)

→ *Need to anticipate the way users will use EO data in future, e.g.:*

- *toolboxes in virtual research environment,*
- *collaborative exploitation platforms,*
- *merging of EO and non-EO data, etc.*

Which EO data are available at ESA?

ESA missions

Earth Explorer missions

swarm
smos
cryosat
goce

Heritage missions

envisat
ers-1
ers-2

Proba missions

proba-v
proba-1

ESA Third Party missions

e.g. Landsat, ALOS…

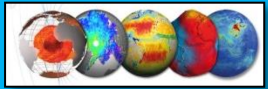
+ ESA EO campaigns data

Copernicus Space Component

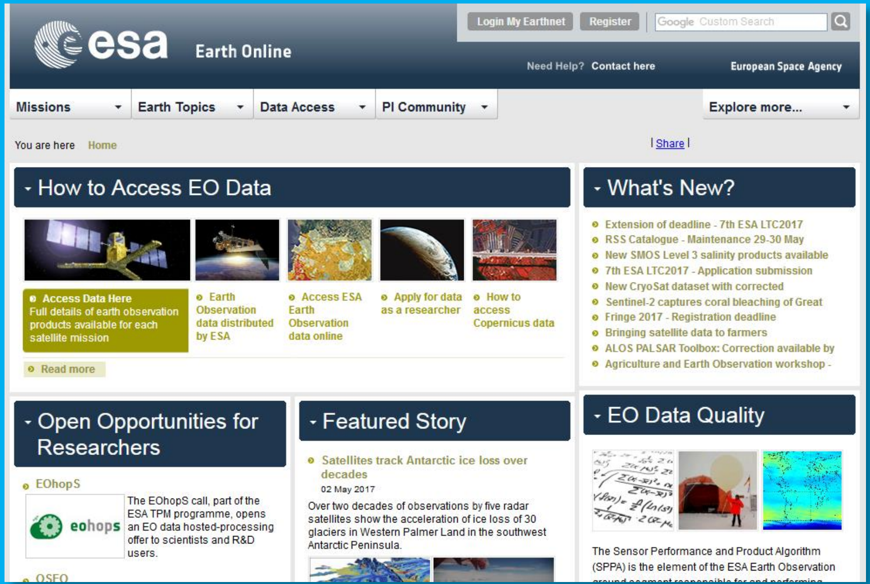
Sentinel missions

sentinel-1a
sentinel-1b
sentinel-2a
sentinel-2b
sentinel-3a

Copernicus Contributing Missions

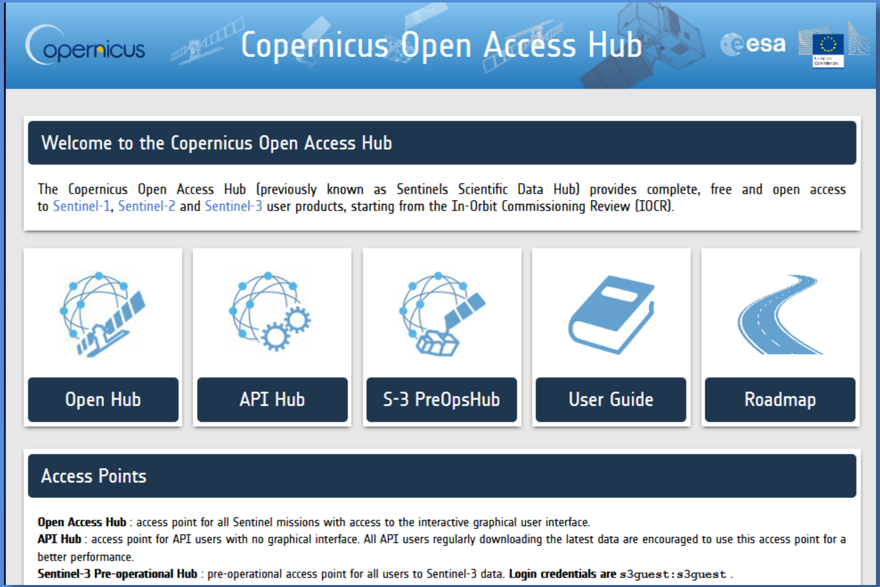


Access to ESA missions



https://earth.esa.int

Access to Sentinel missions



https://scihub.copernicus.eu

Copernicus data access & redistribution

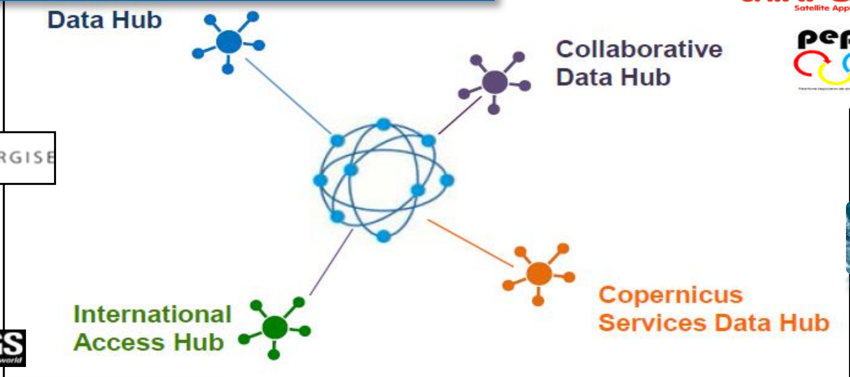
→ *Sentinel Data Hubs operated by ESA*

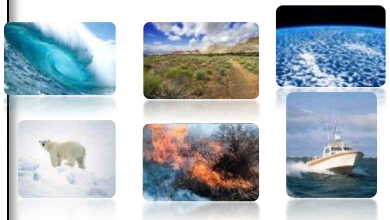
The Copernicus Ground Segment features **dedicated data access infrastructure solutions,** tailored to the needs of the **various use typologies**:

Large and small private companies are re-distributing Sentinel products/images via free and pay-per-use schemes

The open access Data Hub, for *anyone (82,000 users)*

***Collaborative mirror sites directly serve <u>600+ users</u>** (status end 2015)*





As of spring 2016, international partners mirror sites have started disseminating towards own national communities

Copernicus services are providing their higher level products to ~10,000 users (status Q1 2016)

Sentinel open access Data Hub

Statistics on 1 June 2017

Registered Users
81,797

Published Products
2,803,928

Volume of User Downloads
26 PB

Open Access Hub Availability in the past month
96.7%

Last month | Last 3 months

Europe

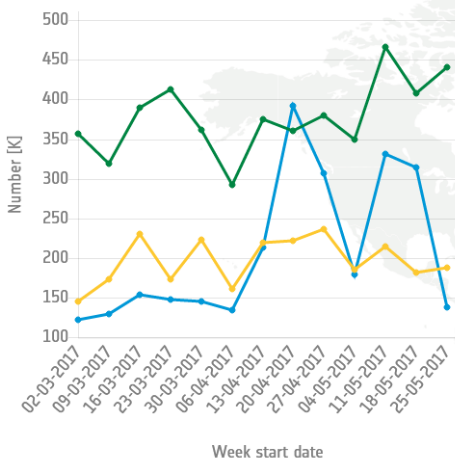
Active Users
5,800

Increase/decrease (last 3 months)

Last 3 months

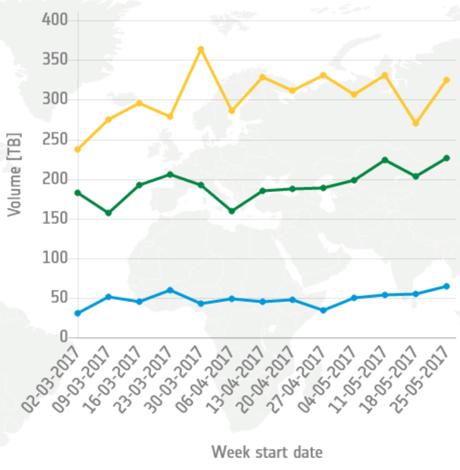
Total number of downloads
10,419,356

Number of products downloaded per Sentinel



Total volume of downloads (PB)
6.91

Volume of products downloaded per Sentinel



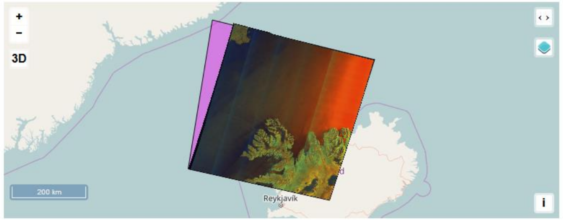
CENTRE NATIONAL D'ÉTUDES SPATIALES

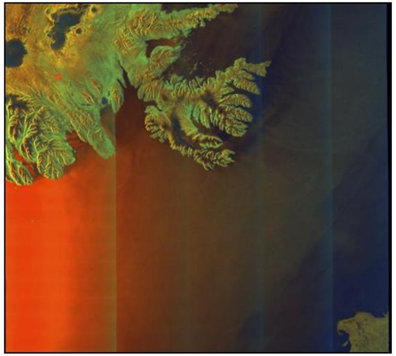
FRENCH ACCESS TO THE **SENTINEL PRODUCTS**

Collaborative ground segment

HOME EXPLORE RSS MORE SIGN IN REGISTER

S1B_EW_GRDM_1SDH_20170601T080441_20170601T080541_005854_00A437_8AC3





Iceland

Main

Collection

Product identifier

Published date

Storage mode

Satellite

Platform

Instrument

Product type

Processing level

Sensor mode EW

Characteristics

Start date	2017-06-01T08:04:41.917Z
Snow cover	0 %
Cloud cover	0 %
Polarization	HH HV
Orbit direction	Ascending
Orbit number	585453
Nrt product	Yes
Real time	Sentinel-1_NRT
Swath	EW

ACQUIRED PRODUCTS NUMBER

990618	SENTINEL-1 PRODUCTS
353469	SENTINEL-2 PRODUCTS
687766	SENTINEL-2 SINGLE TILE PRODUCTS
272618	SENTINEL-3 PRODUCTS

→ **how will EO data be used in 5 years and 10 years from now ?**

→ **how can Europe maximise the benefits on its public investments with EO satellites (e.g. in terms of knowledge/information creation, of socio-economic benefits) ?**

How can ESA address the above questions within the ground segment(s) with the other EO stakeholders in Europe and worldwide:
- European Commission
- Public agencies in Europe (national space agencies, Eumetsat, others…)
- Industry in Europe

ESA EO Ground Segment evolution strategy [September 2015]

EO data user point of view

"Am I using the latest version of the dataset?"

"My computation takes too much time!"

"I don't like the official dataset but I have a good idea for improving it."

"I cannot do all what I want with the tool box."

"I don't have enough space to store all my TB data."

"How to share my results (few GB of data) with my peers?"

"Where do I find in-situ data to validate my results?"

The concept of Data Exploitation Platform remains central in ESA GS evolution strategy

"Move User activities to the Data"

What is an Exploitation platform

=

Virtual open and collaborative environment

bringing together:

- data centre (EO and non-EO data)
- computing resources and hosted processing
- collaborative tools (processing tools, data mining tools, user tools, …)
- concurrent design and test bench functions
- communication tools (social network) and documentation
- accounting tools to manage resource utilisation

What is EO-Innovation Europe ?

→ concept of networking of exploitation platforms with the following objectives:

- ***Enabling large scale exploitation of EO data***
- ***Stimulating the innovation with EO data***
- ***Maximising impact of European EO assets and preserving European independence***

EO Innovation Europe → *an important step forward: DIAS*

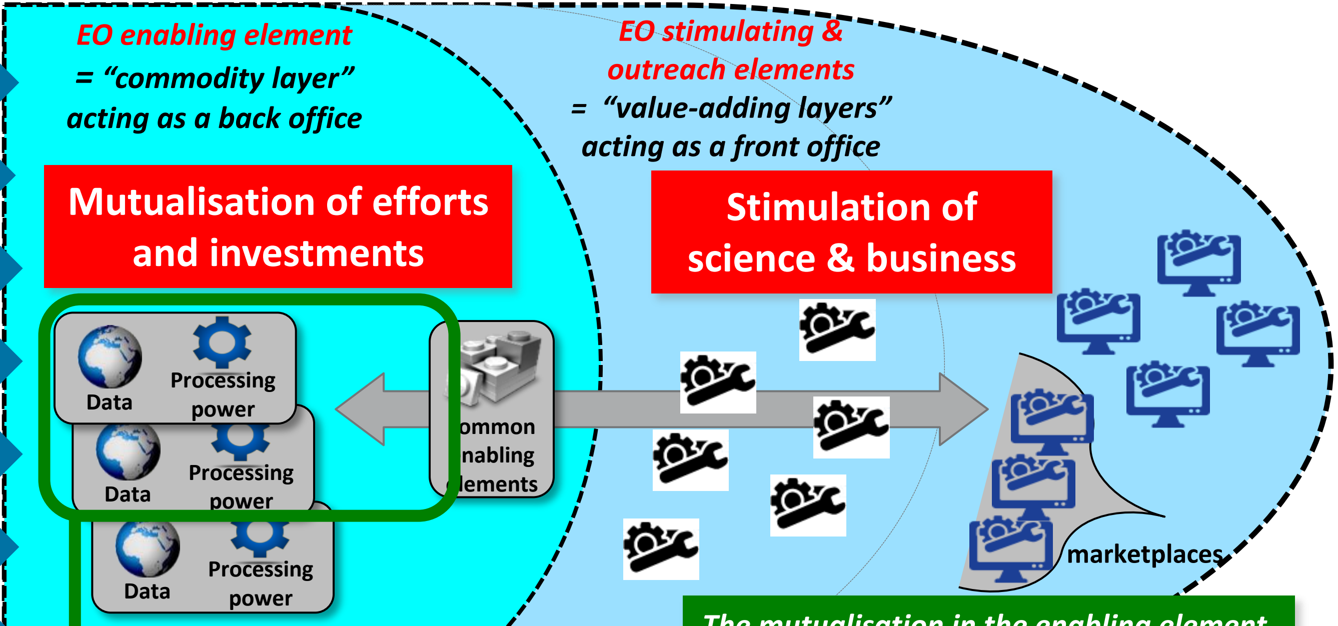
DIAS: a structuring element of the overall concept

Data hosted processing

Data pull
Data push

European EO dataset

- **ESA** missions data
- **Copernicus** missions data
- **Meteo** missions data
- **National** missions data
- **Commercial** missions data
- **Heritage** missions data
- **Airborne &** in-situ data



DIAS **(Data and Information Access Service)**
funded by EC Copernicus

The mutualisation in the enabling element will stimulate the existence of many platforms funded by different public and private entities in the outreach element

Some Exploitation Platforms at ESA

esa

Thematic** Exploitation Platform (TEP)* → ***focusing on a geophysical theme (e.g. forestry)

tep
thematic exploitation platform

https://tep.eo.esa.int

geohazards tep
hydrology tep
coastal tep
forestry tep
polar tep
urban tep
food security tep

***Regional** (multi-thematic) exploitation platform*:

→ ***focusing on a regional theme*** (e.g. Baltic, Black Sea, Alpine, Arctic …)

To be initiated in 2018

***Mission/Sensor** exploitation platform (MEP)*:

→ ***tailored** to a particular mission/sensor community (e.g. an Earth Explorer user community)*

e.g. →

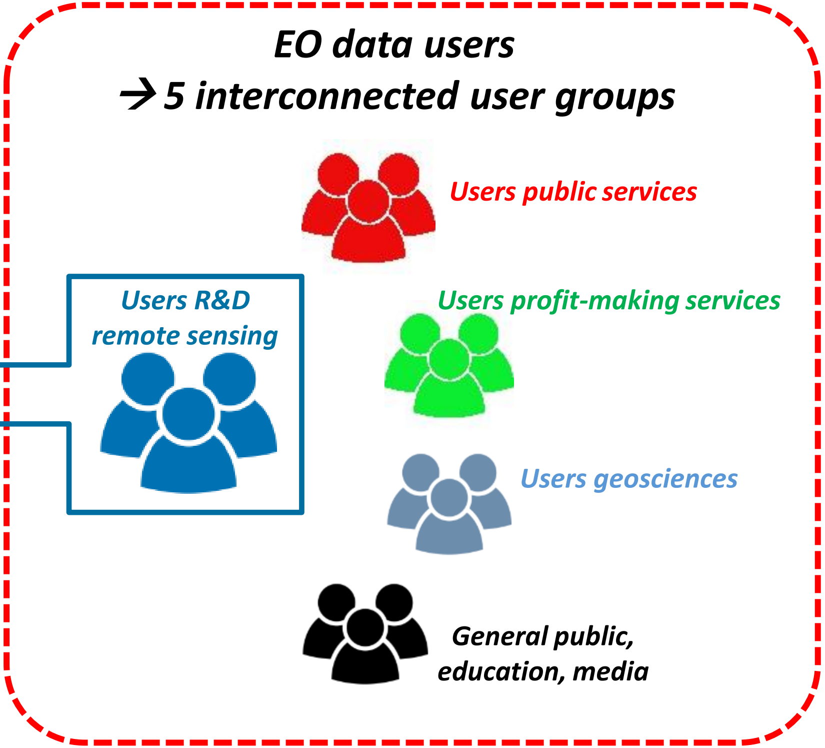
Proba-V mission exploitation platform
SMOS pilot mission exploitation platform
BIOMASS mission exploitation platform

Mission exploitation platforms:
→ addressing which user group ?

Remote sensing scientists,

i.e. those users developing the methods to transform raw data into L1/L2/L3 products

- *traditionally the closest group to ESA*
- *70% of the Earth Explorer data users*
- *10 % of Sentinel data users*



Need of new services adapted to remote sensing scientists

How to increase flexibility for (and collaboration with) remote sensing scientists ?

→ through **new services to remote sensing scientists**, e.g. possibility for users:

- to access/edit/modify the (L2) processing algorithms source codes
- to perform large reprocessing with modified processing algorithms
- to self-validate the results of a processing algorithm modification
- to propose new processing algorithms

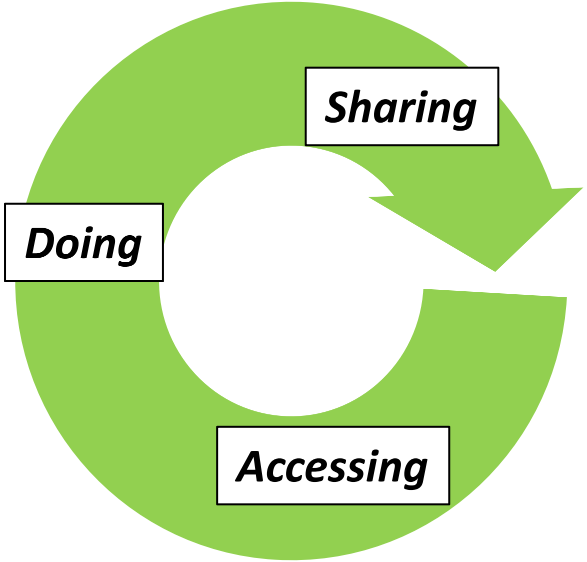
Product Algorithm Laboratory (PAL)

How to provide the above new services to remote sensing scientists (and to regroup existing services to users) ?

→ use of virtual research environment ("eo data do not travel")

→ **an (Earth Explorer) "Mission Exploitation Platform"**

Earth Explorer Mission Exploitation Platform (MEP)
→ *better addressing remote sensing scientists needs*



- ✓ ***Ease of data access***
  - Remote sensing data from ESA science missions (and complementary/similar missions)
  - Ground data from ESA campaigns (field data and cal/val)
- ✓ ***Ease of data sharing***
  - For both ESA and from communities/projects that may have complementary data
- ✓ ***Ease of data transport***
- ✓ ***Joint code/algorithm development***, addressing intellectual property rights issues
- ✓ *Enable **interoperability** of data/code/algorithms*
- ✓ *Supported **transparency** in research, development and validation*

Product Algorithm Laboratory (PAL)

Algorithm initial definition

First algorithm implementation

- *Processing algorithms evolution is easier as the development and implementation are made within the same environment*
- *Allow to arrive faster to stable algorithms for R&D missions on a user cooperative approach*
- *People outside the core science team can contribute to the product improvement cycle*
- *Approach breaks the wall between science and operations*

PAL concept

Algorithm improvement by MEP users:
1- modify processing algorithm/code
2- generate the corresponding new dataset

3- Self Validation by MEP users
using validation data available in MEP

4- ESA verification and approval of new official dataset

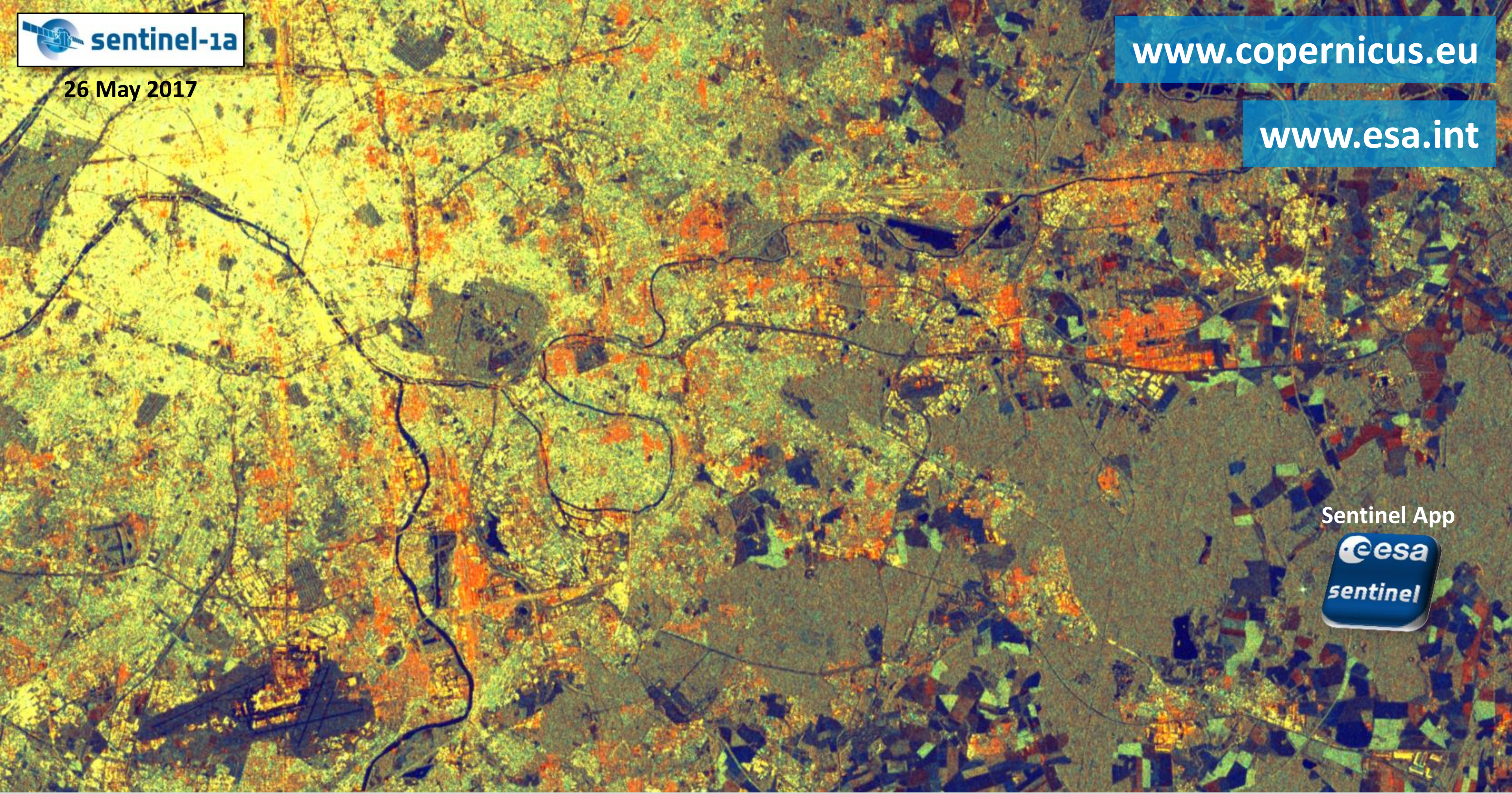
Mission Exploitation Platform (MEP)

ESA toolboxes

Sentinel-1A mosaic over Europe, generated using 400 ascending scenes from May to July 2015. Processing involved radiometric calibration, multi-looking, terrain correction at 120 m resolution, and spatial mosaicking using ESA's SNAP/Sentinel-1 Toolbox.

** Download the course flyer **

** Application deadline extended to Mon. 05 June 2017 23:59 CEST **



European Space Agency