Earth Observation Programme of the European Space Agency (ESA)

Chris Stewart
RSAC c/o ESA
EARSeL SIG Education and Training Workshop
July 2017, Kaliningrad

ESA facts and figures

- Over 50 years of experience
- 22 Member States
- Eight sites/facilities in Europe, about 2200 staff
- 5.2 billion Euro (~350 billion Rubles) budget (2016)
- Over 80 satellites designed, tested and operated in flight

Purpose of ESA

"To provide for and promote, for exclusively peaceful purposes, cooperation among European states in **space research** and **technology** and their **space applications.**"

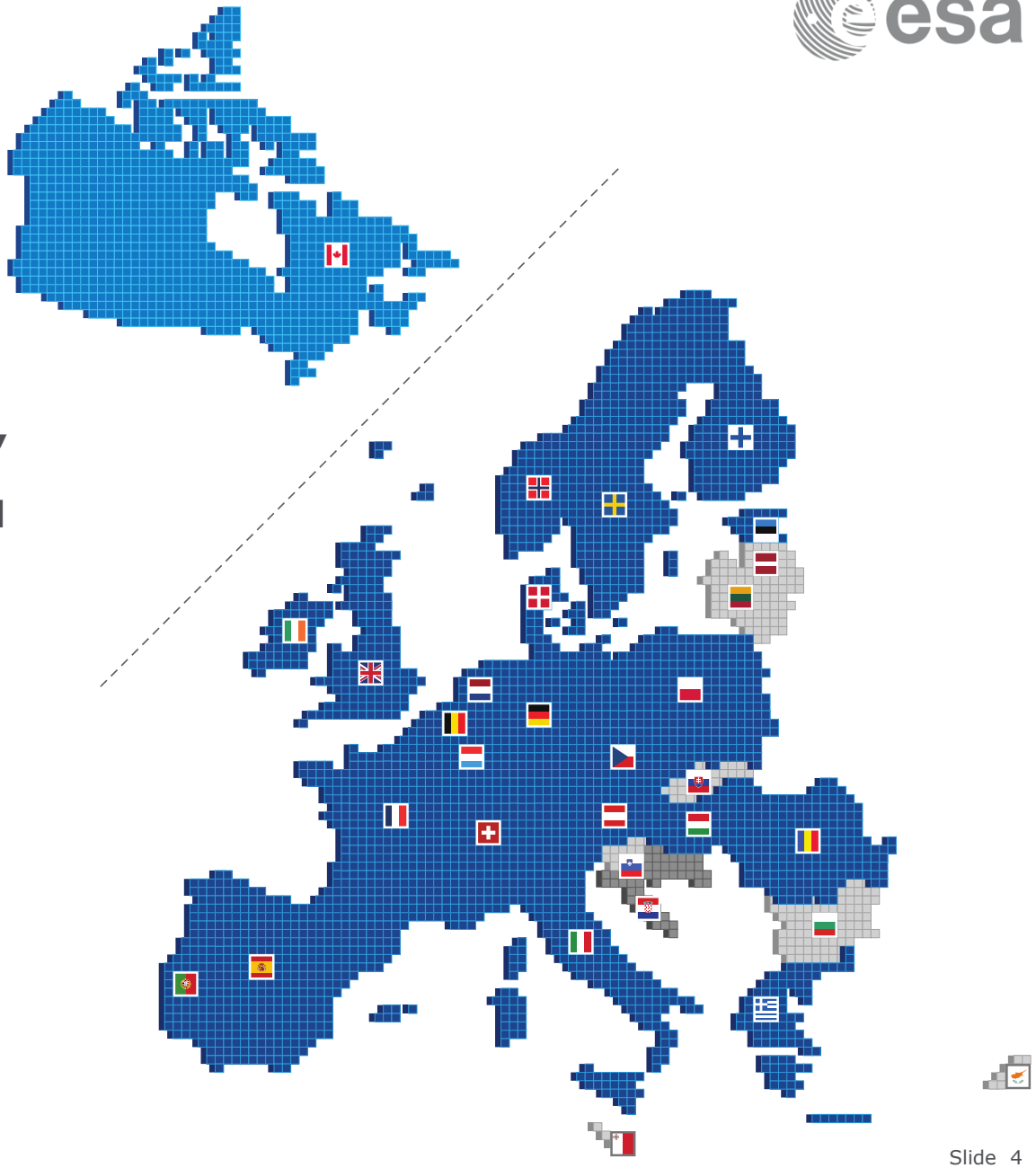
Article 2 of ESA Convention

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.

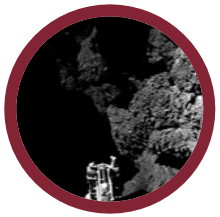
Seven other EU states have Cooperation Agreements with ESA: Bulgaria, Cyprus, Latvia, Lithuania, Malta, Slovakia and Slovenia. Discussions are ongoing with Croatia.

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



Activities

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



space science

human spaceflight

exploration

earth observation

launchers

navigation

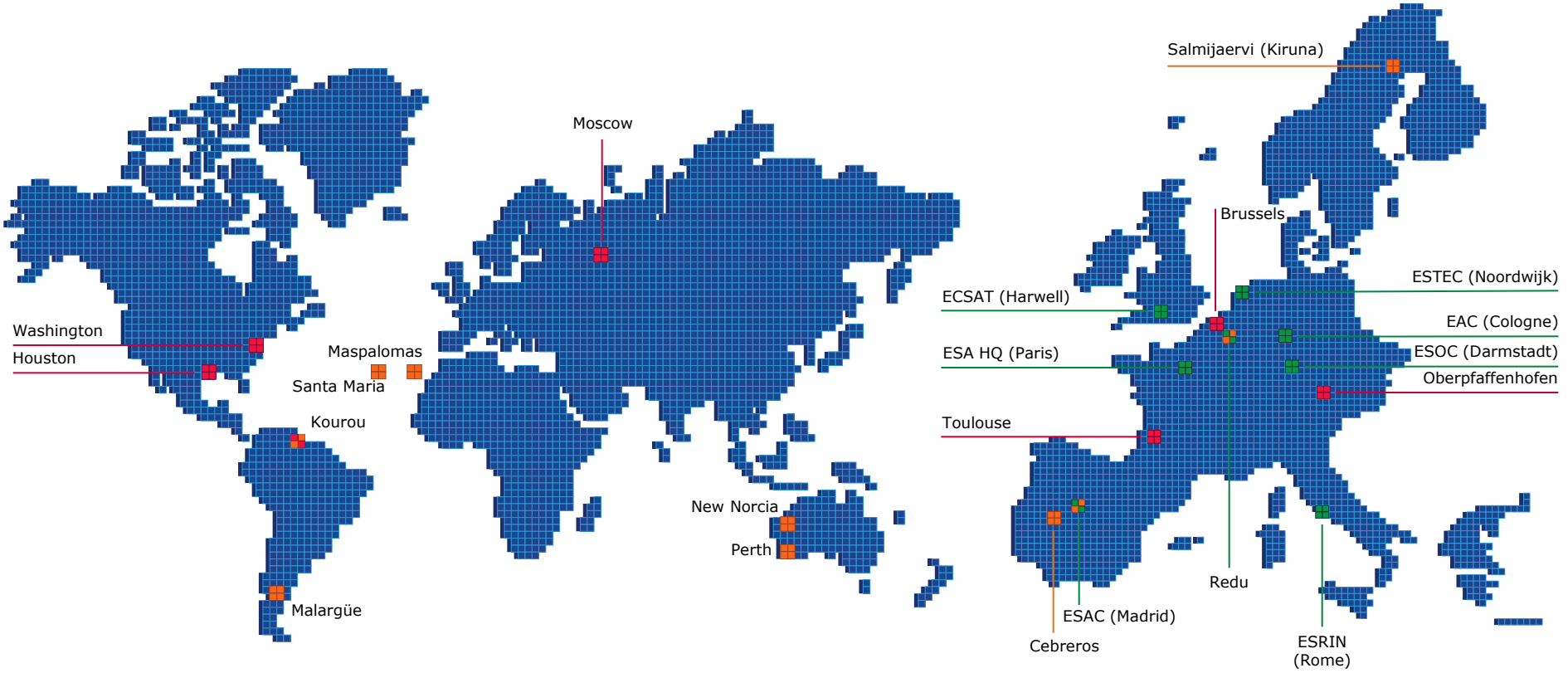
operations

technology

telecommunications

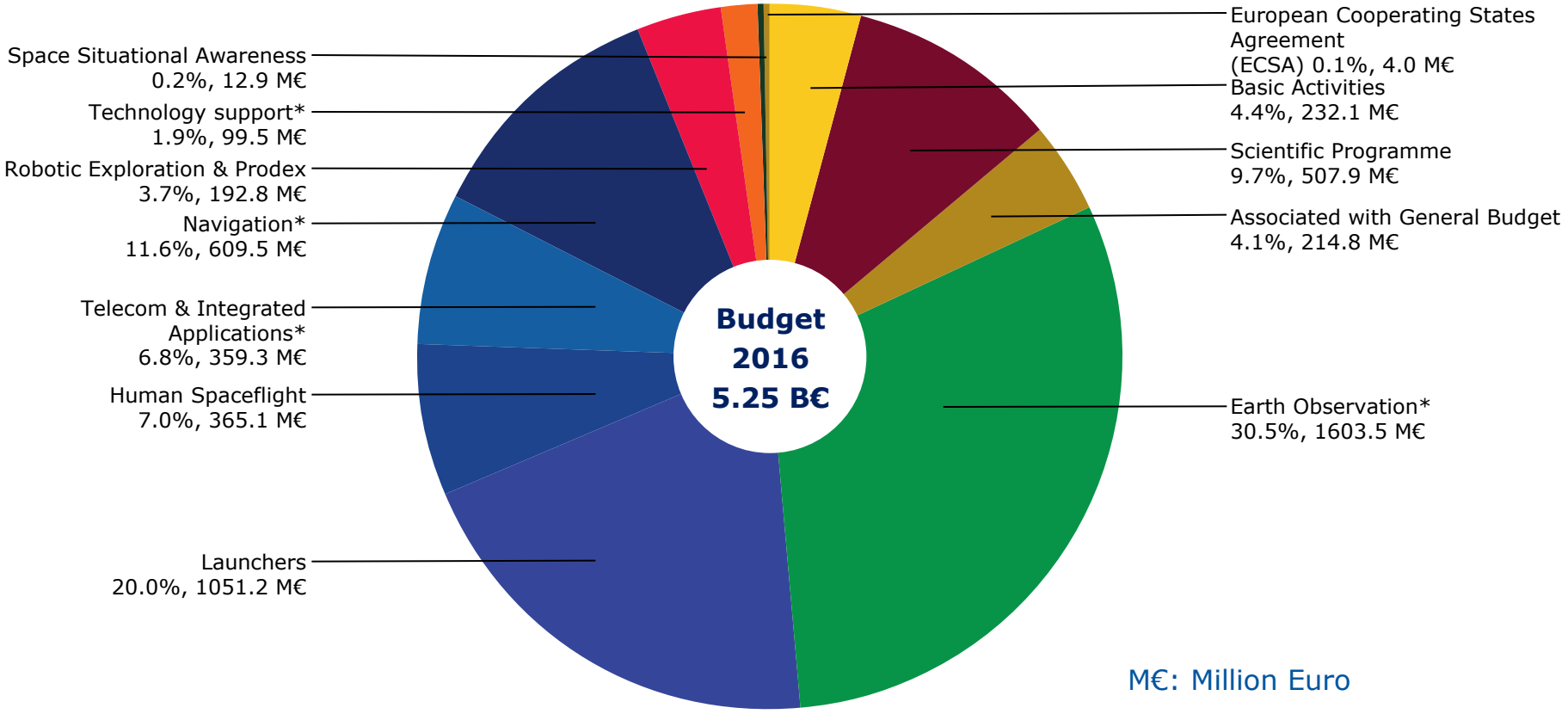
* Space science is a Mandatory programme, all Member States contribute to it according to GNP. All other programmes are Optional, funded 'a la carte' by Participating States.

ESA's locations



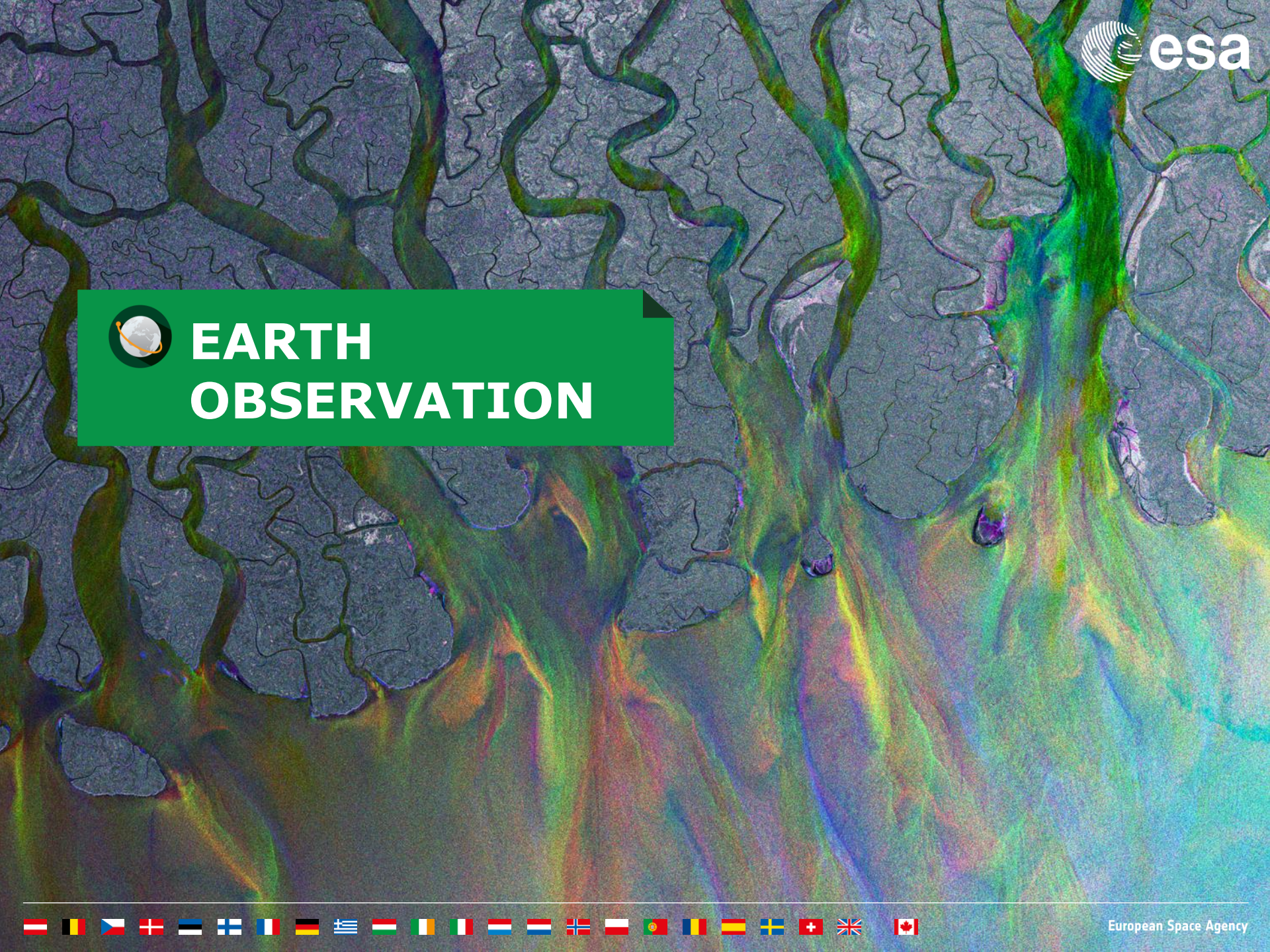
- ESA sites
- Offices
- ESA Ground Station
- ESA Ground Station + Offices
- ESA sites + ESA Ground Station

ESA 2016 budget by domain



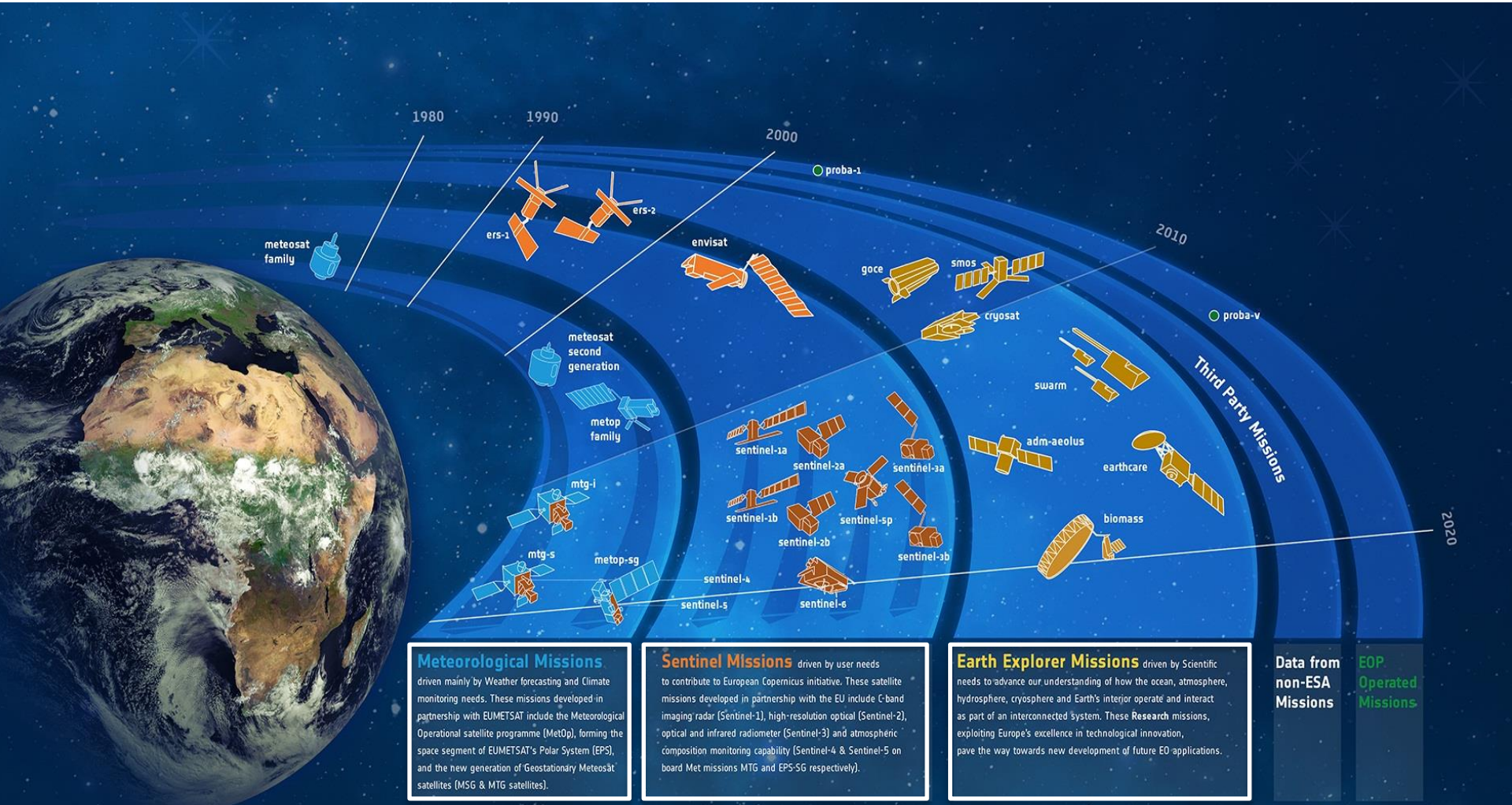
M€: Million Euro

*includes Programmes implemented for other Institutional Partners


esa
EARTH
OBSERVATION
European Space Agency

New Societal Boundary Conditions

ESA Earth Observation Programmes

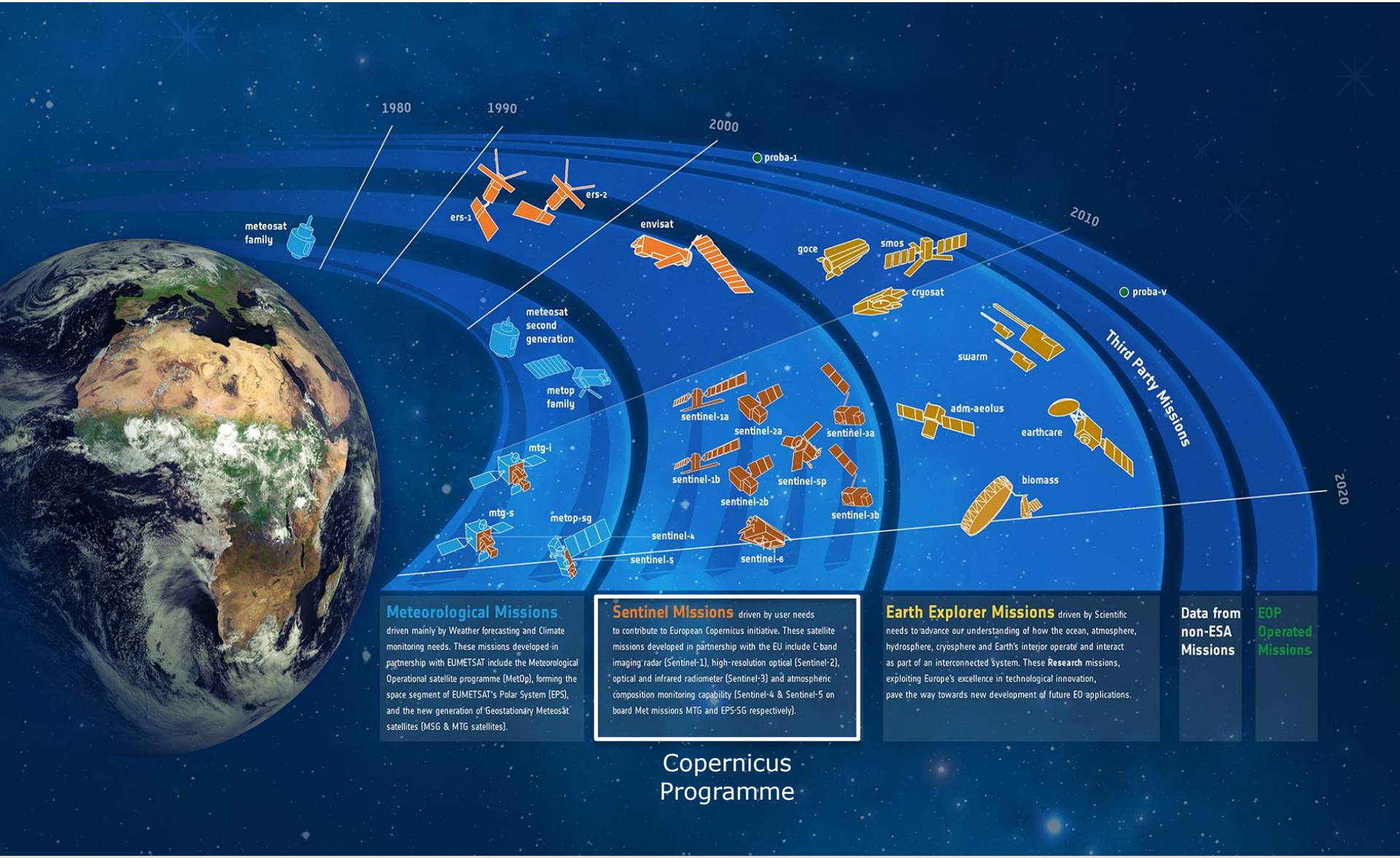


Meteorological Programme

Copernicus Programme

Earth Observation Envelope Programme

ESA Earth Observation Programmes

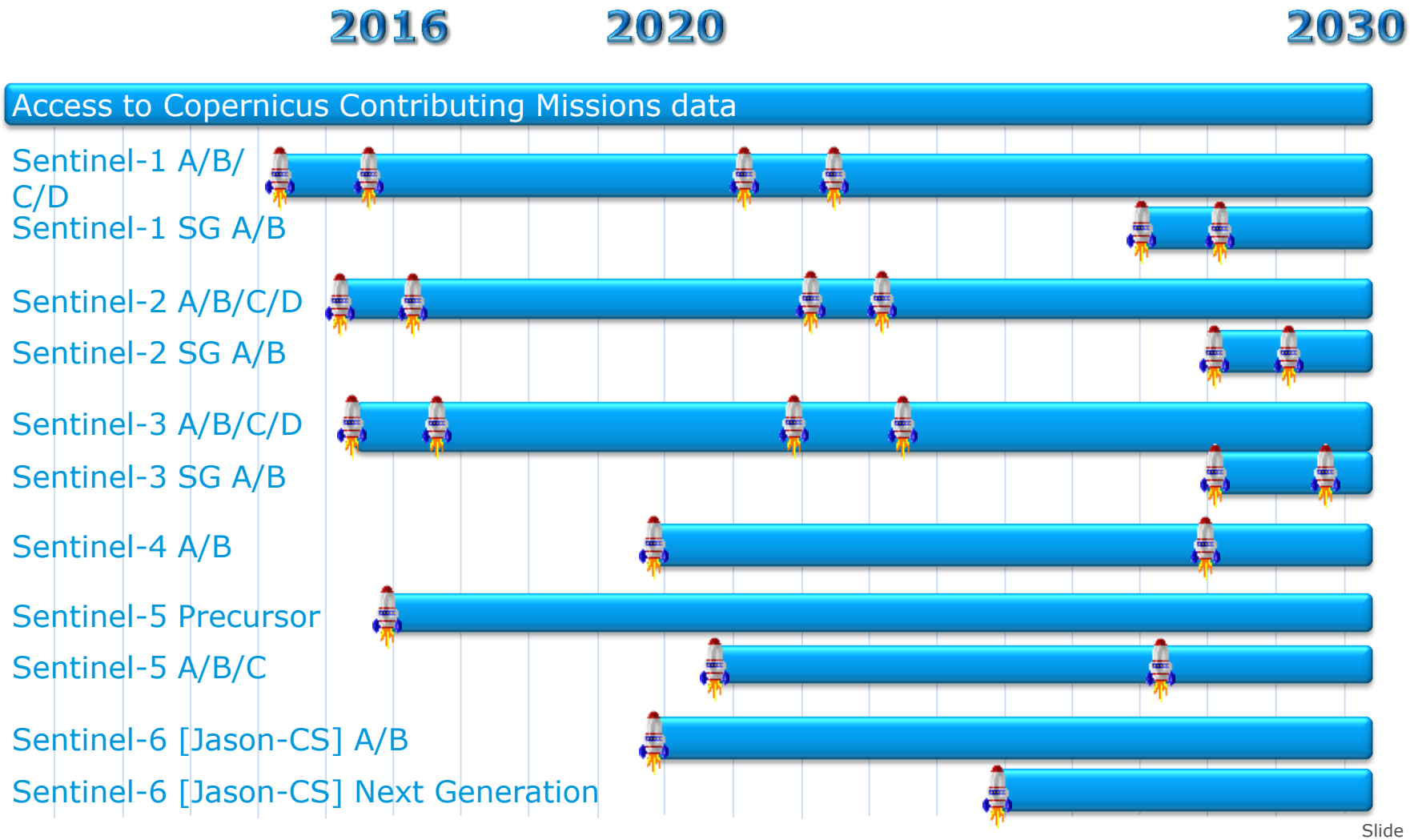



Policymakers
Decision Makers
Space Enthusiasts
Start-Up Companies
Large Institutional
User Organisations
Scientists
Students
Private Persons
Public Authorities
Value-Adding Companies

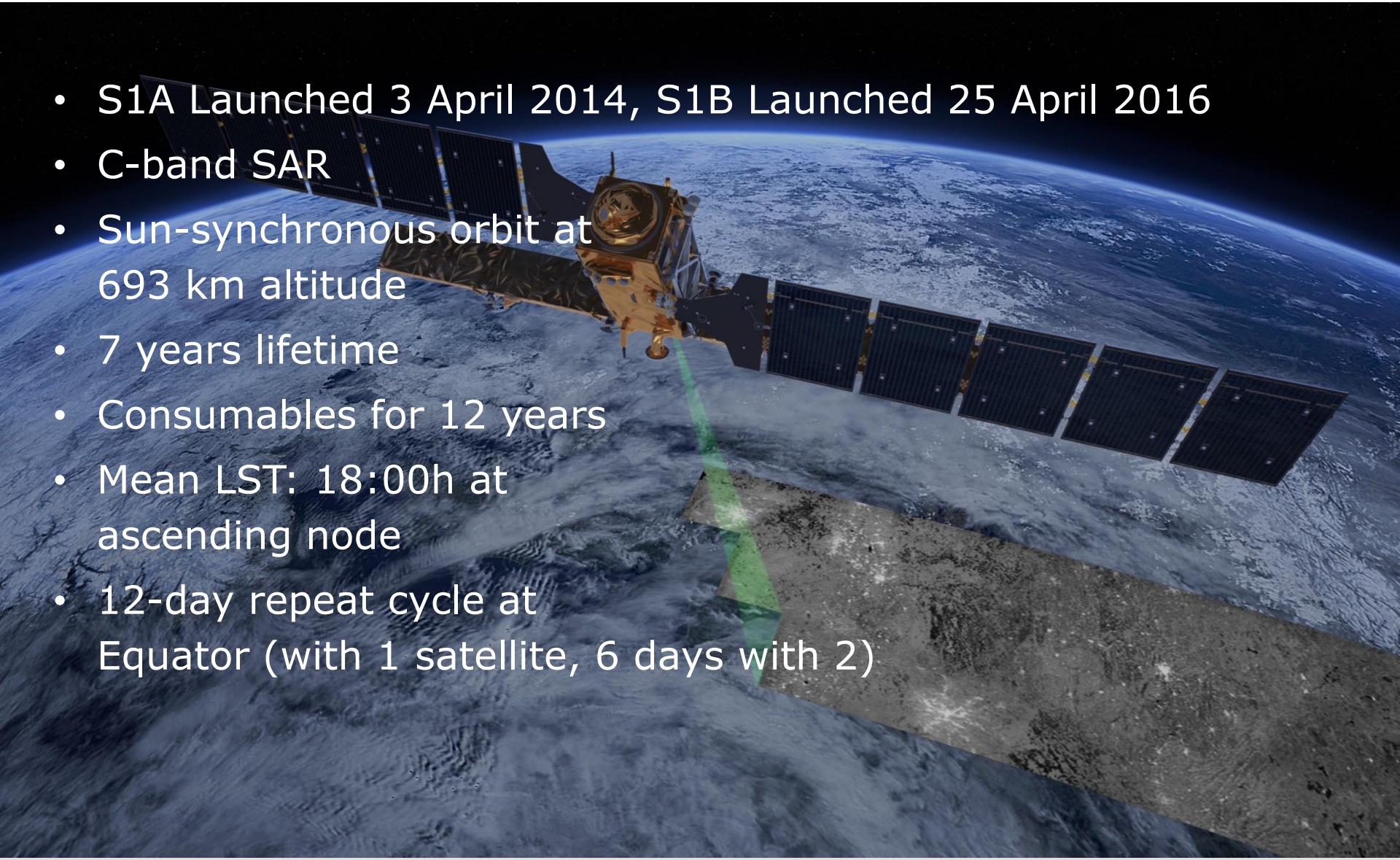
The Sentinel Family

- S1: Radar Mission
- S2: High Resolution Optical Mission
- S3: Medium Resolution Imaging and Altimetry Mission
- S4: GEO Atmospheric Chemistry Mission
- S5P/S5: LEO Atmospheric Chemistry Missions
- S6/Jason-CS: Altimetry Mission

Sentinel Deployment Schedule

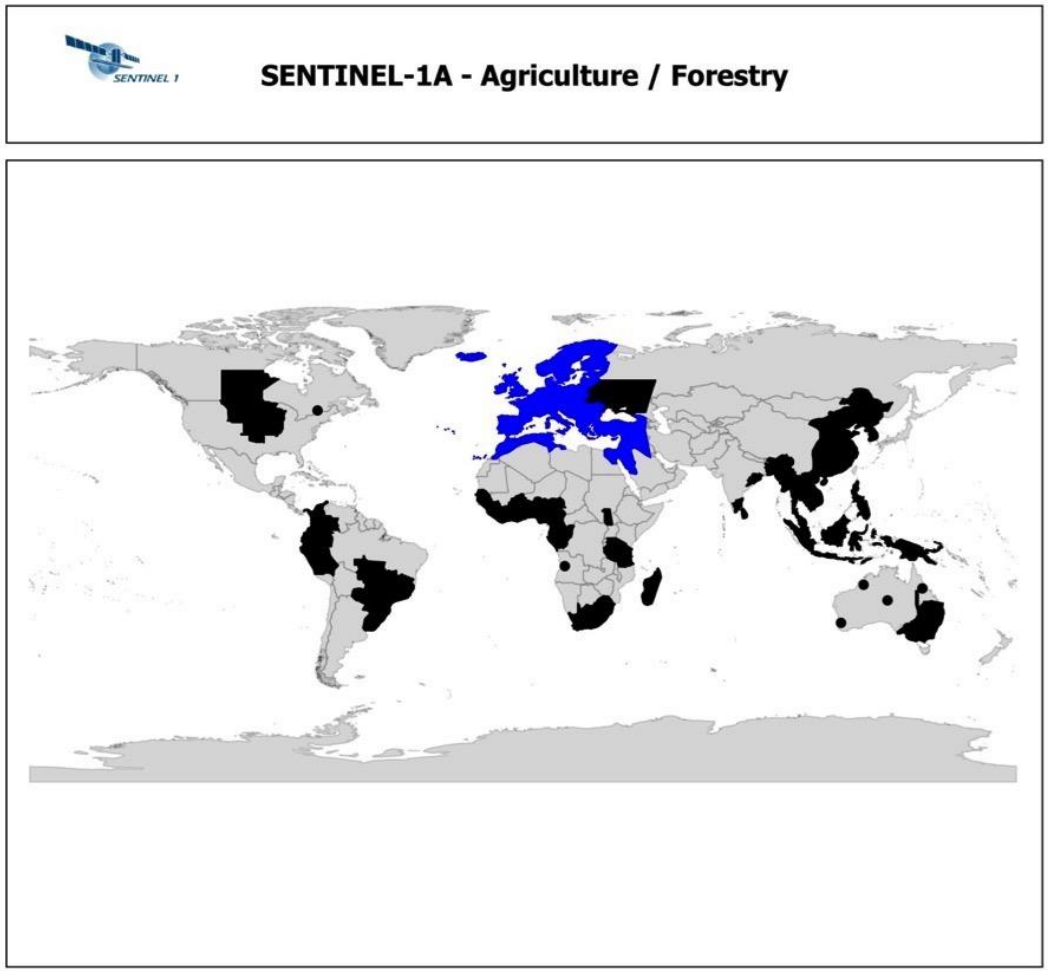


Sentinel-1: Mission Profile



- S1A Launched 3 April 2014, S1B Launched 25 April 2016
- C-band SAR
- Sun-synchronous orbit at 693 km altitude
- 7 years lifetime
- Consumables for 12 years
- Mean LST: 18:00h at ascending node
- 12-day repeat cycle at Equator (with 1 satellite, 6 days with 2)

Sentinel-1 observation scenario Agriculture and forestry priority areas



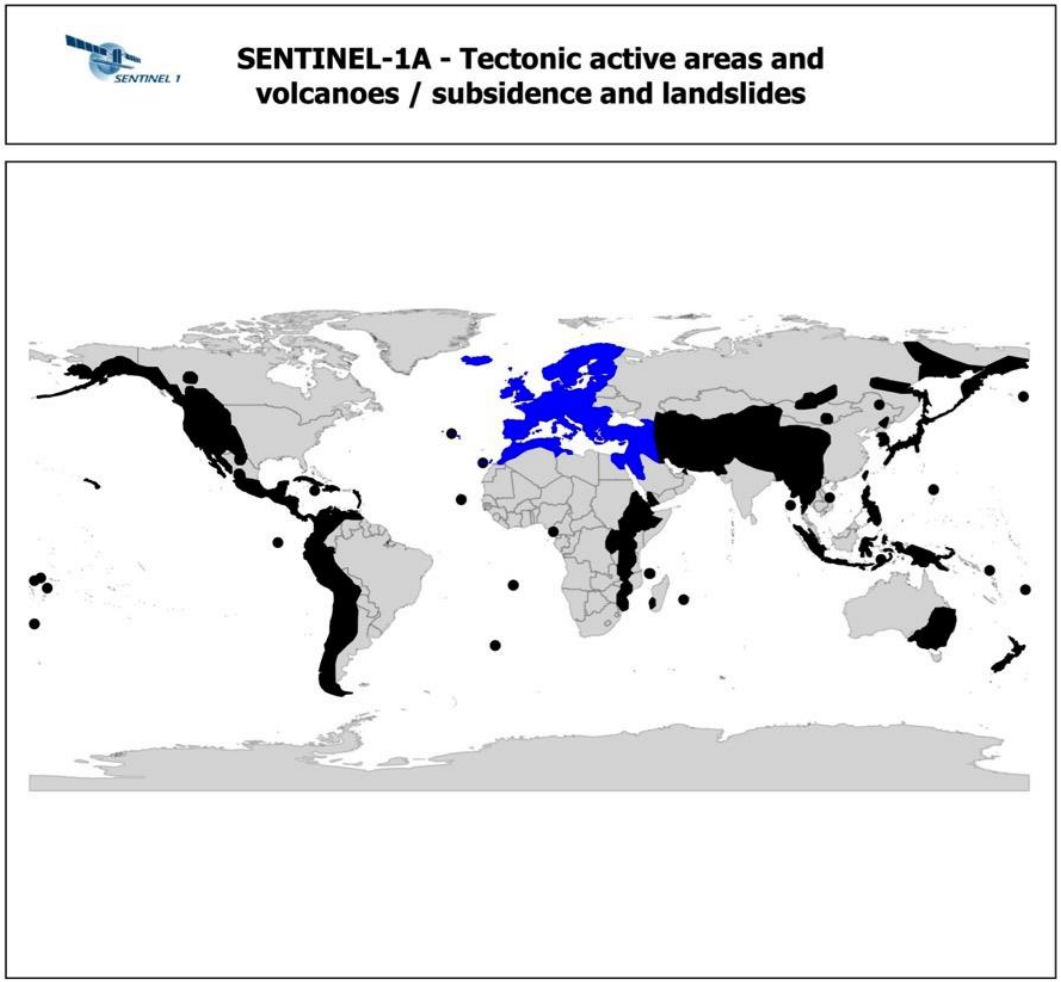
- **BLUE**: Acquisitions in IW mode, VV+VH polarisation, every 12 days ascending and descending

- **BLACK**: Acquisitions in IW mode, VV+VH polarisation, every 12 days in one pass
  - Repeat over parts of SE-Asia IW VV+VH currently every 24 days, plus complementary acquisitions in IW VV
  - North Andes and Tanzania covered with lower frequency (dedicated campaigns for forestry monitoring)

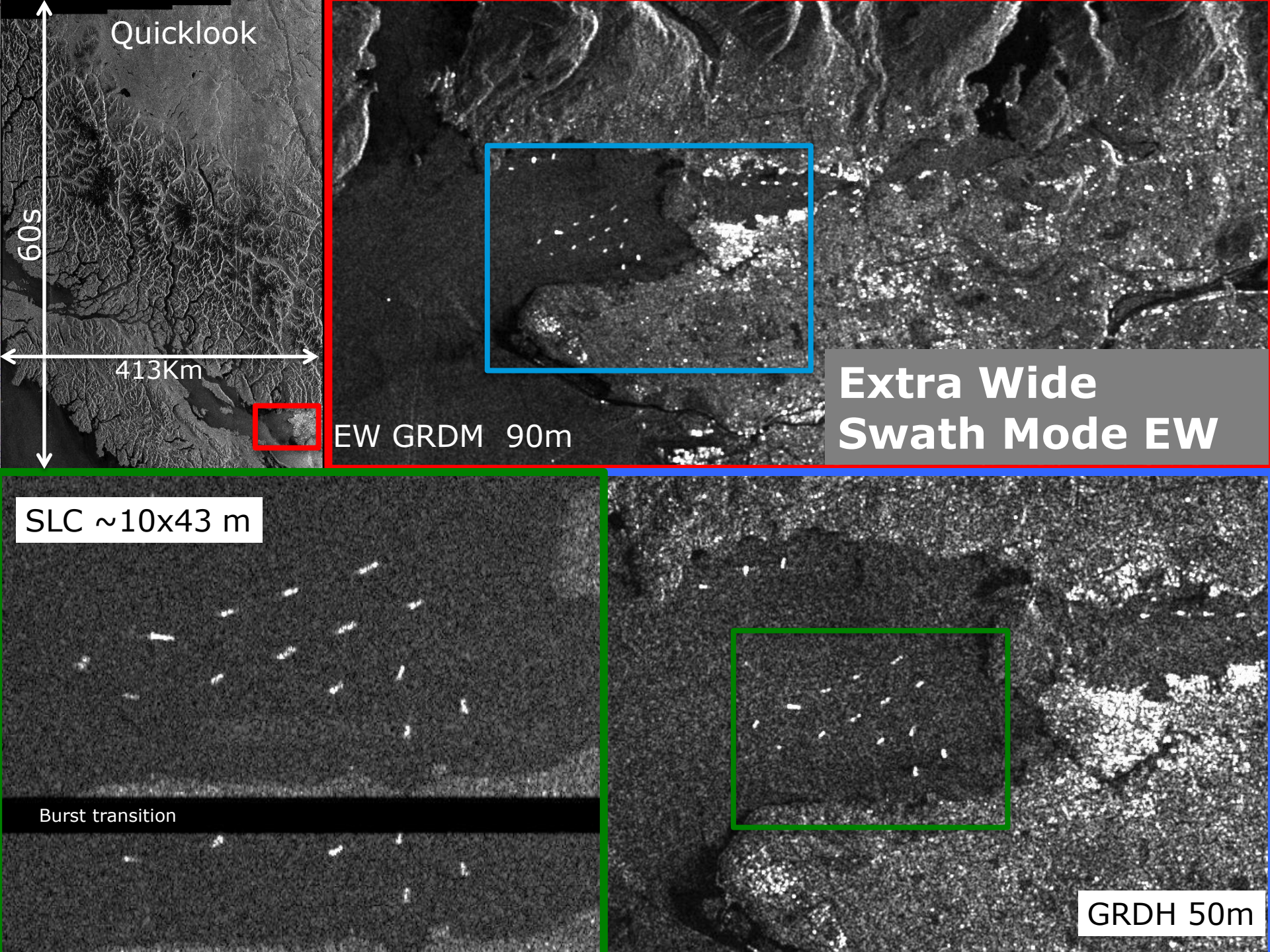
- **Agriculture focus**: mainly based on requirements from
  - wet rice crop monitoring (e.g. GEOGLAM)
  - soil moisture retrieval

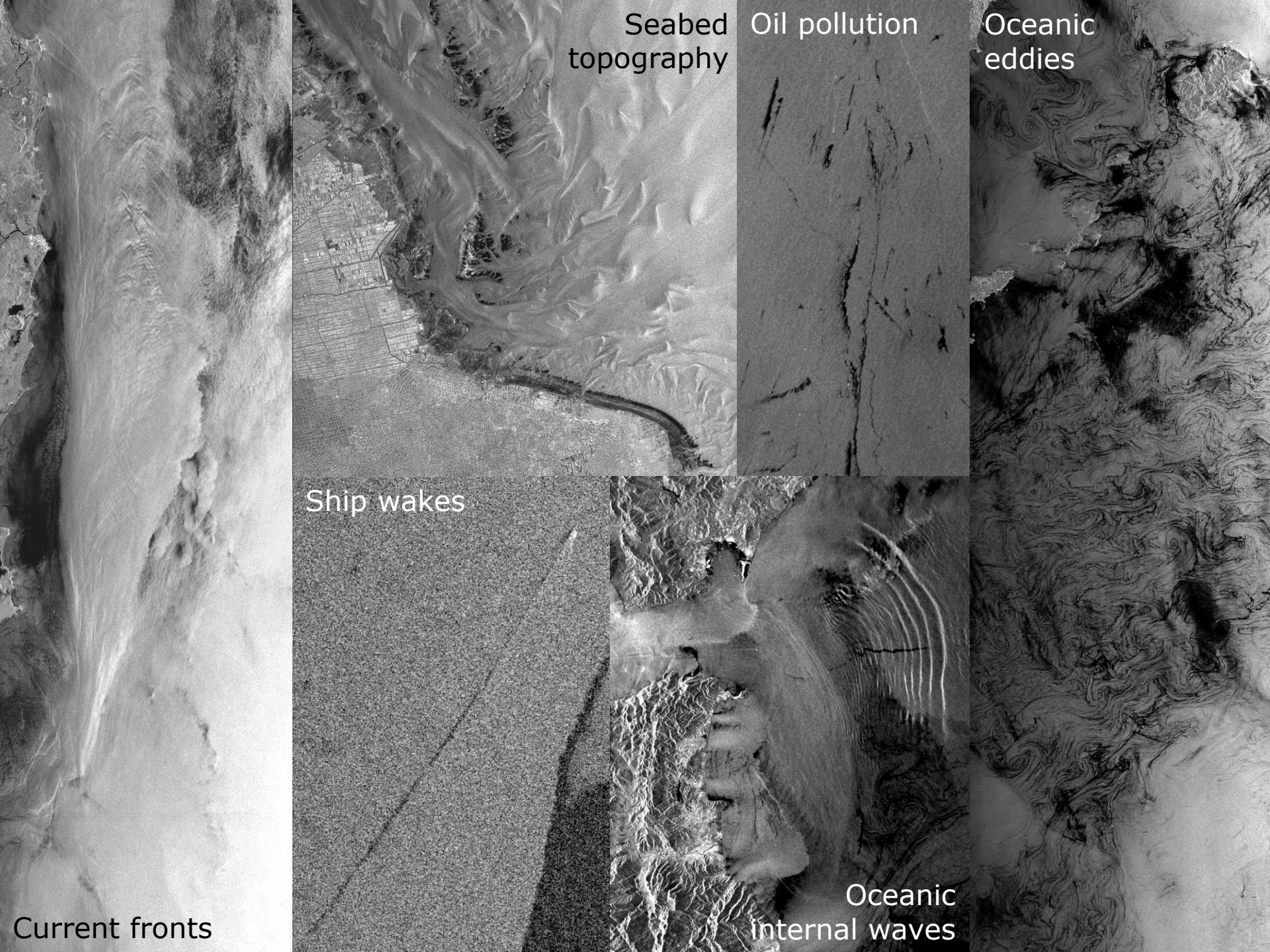
- **Forestry focus**: mainly based on requirements from
  - GFOI
  - regions with high risk for illegal logging
  - Mostly cloudy tropical rainforests

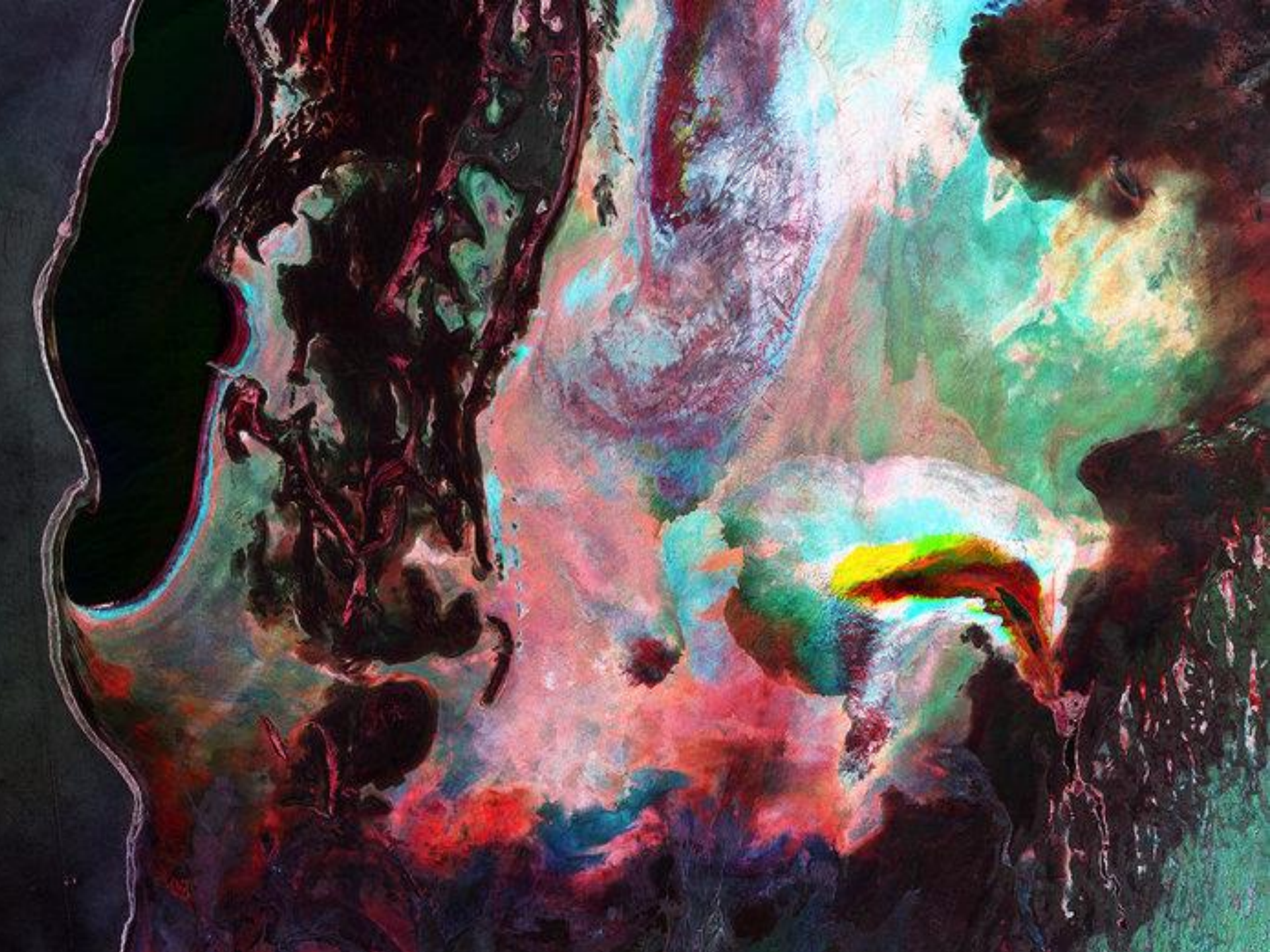
Sentinel-1 observation scenario Global tectonic and volcanic areas

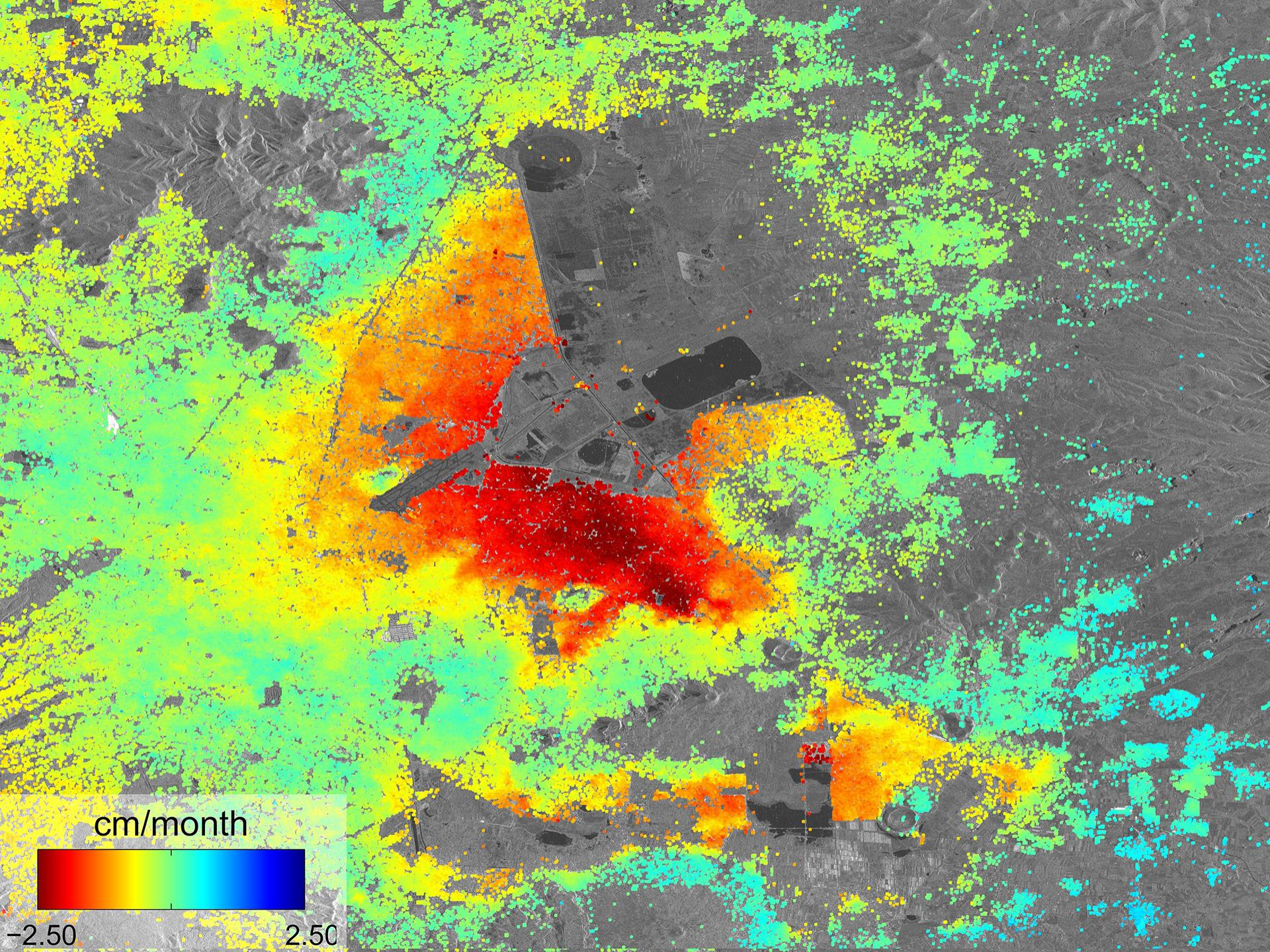


- **BLUE**: Acquisitions in IW mode, VV+VH polarisation, every 12 days ascending and descending
- **BLACK**: Acquisitions in IW mode, VV polarisation, every 24 days ascending and descending, alternating asc and desc passes every 12 days (i.e. repeat on the same track every 24 days)
- **Stripmap mode** (SM) acquisitions over selected small volcanic islands
- Increased sampling density over supersites outside Europe
- About one third of global landmass covered regularly under this frame


Quicklook
60s
413Km
EW GRDM 90m
Extra Wide
Swath Mode EW
SLC ~10x43 m
Burst transition
GRDH 50m


Seabed topography
Oil pollution
Oceanic eddies
Ship wakes
Oceanic internal waves
Current fronts

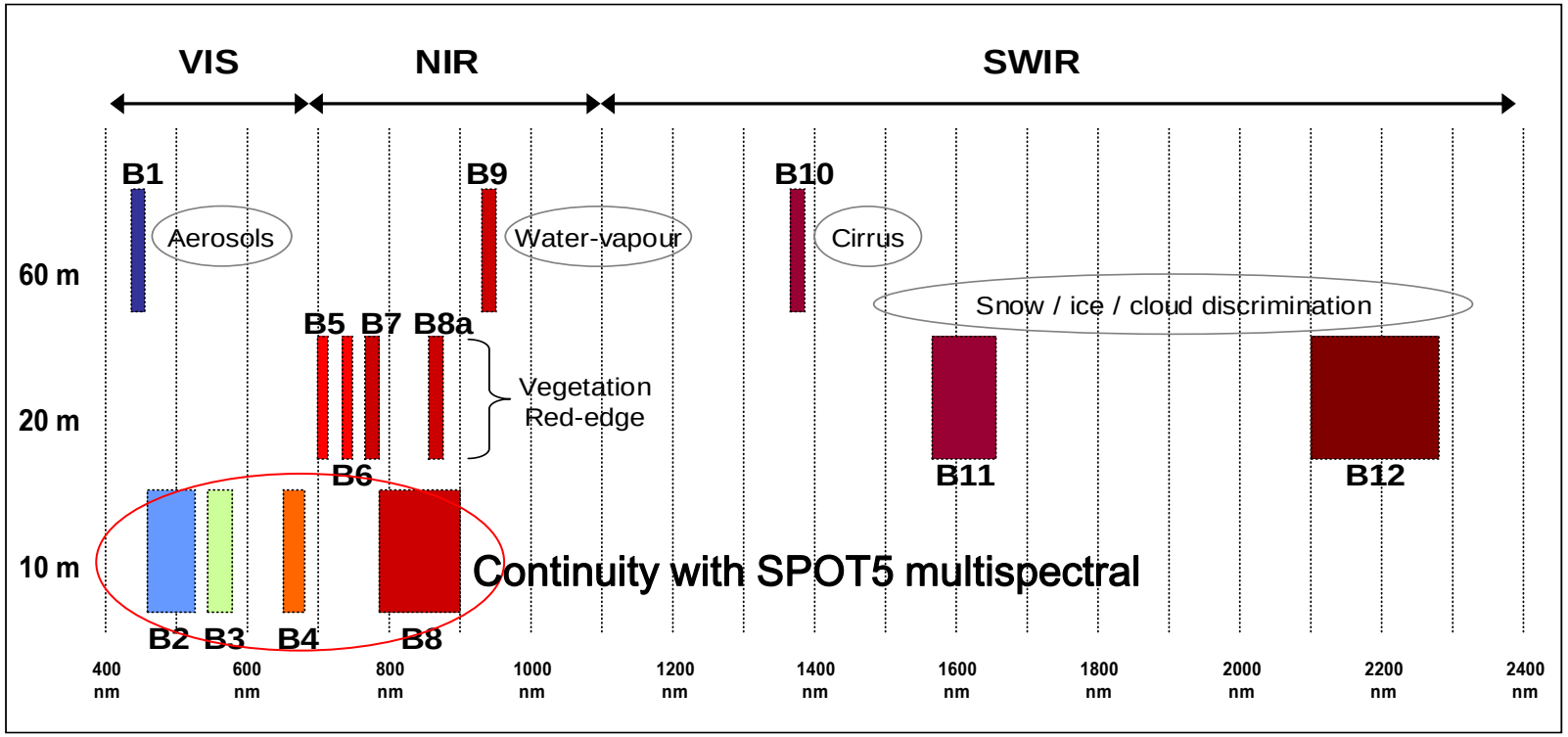



cm/month
−2.50
2.50

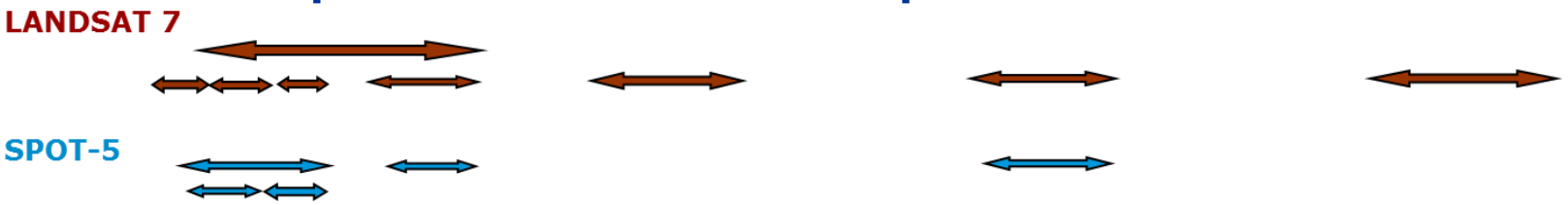
Sentinel-2: Mission Profile

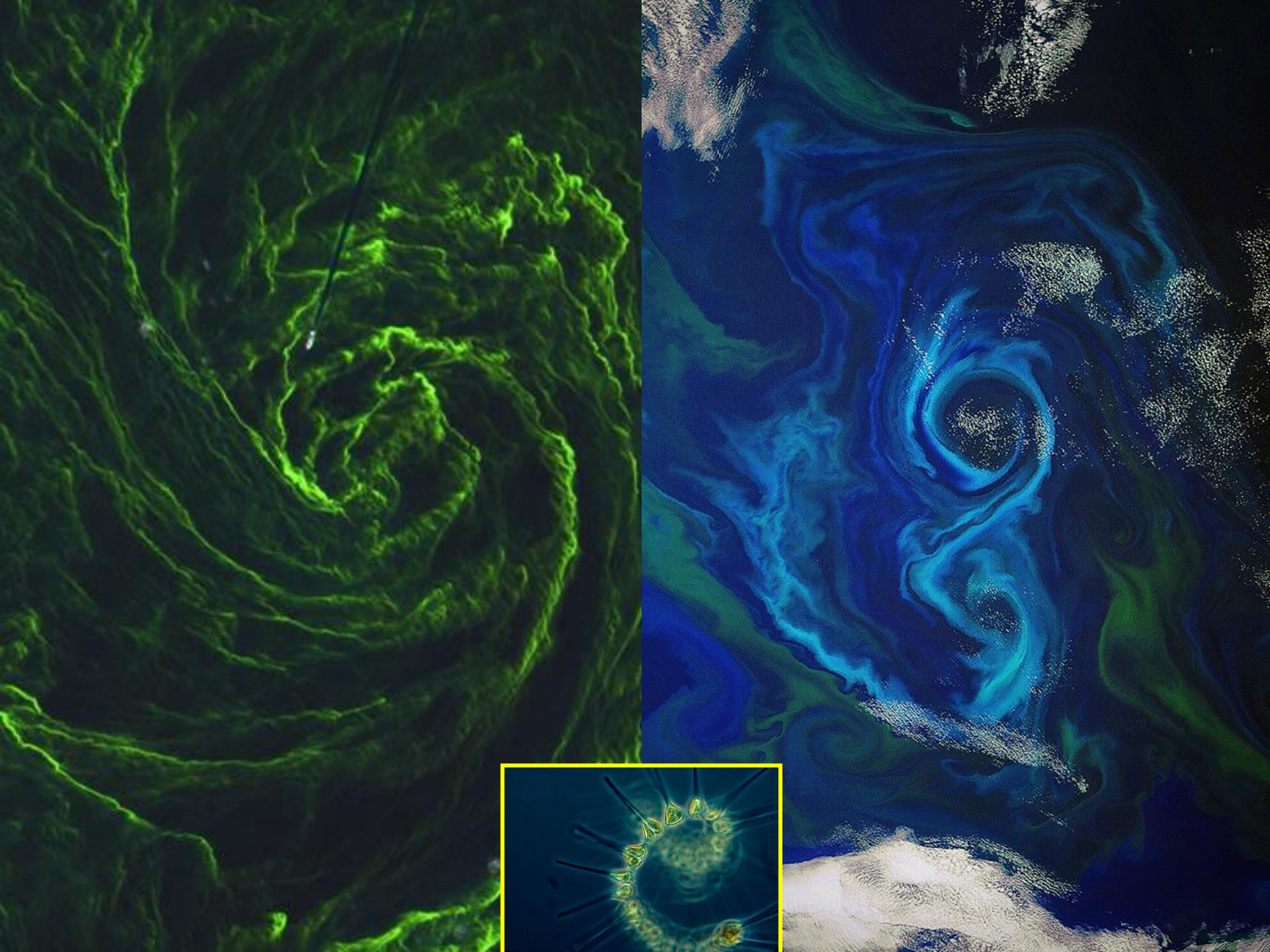
- S2A launched 23 June 2015, S2B launched 7 March 2017
- Sun-synchronous: 786 km altitude
- Wide swath high resolution super-spectral imaging mission
- Land and Security Services
- Data continuity Landsat and SPOT-type missions
- Repeat cycle:10 days (1 satellite, 5 days with 2)

Sentinel-2: 13 Spectral Bands

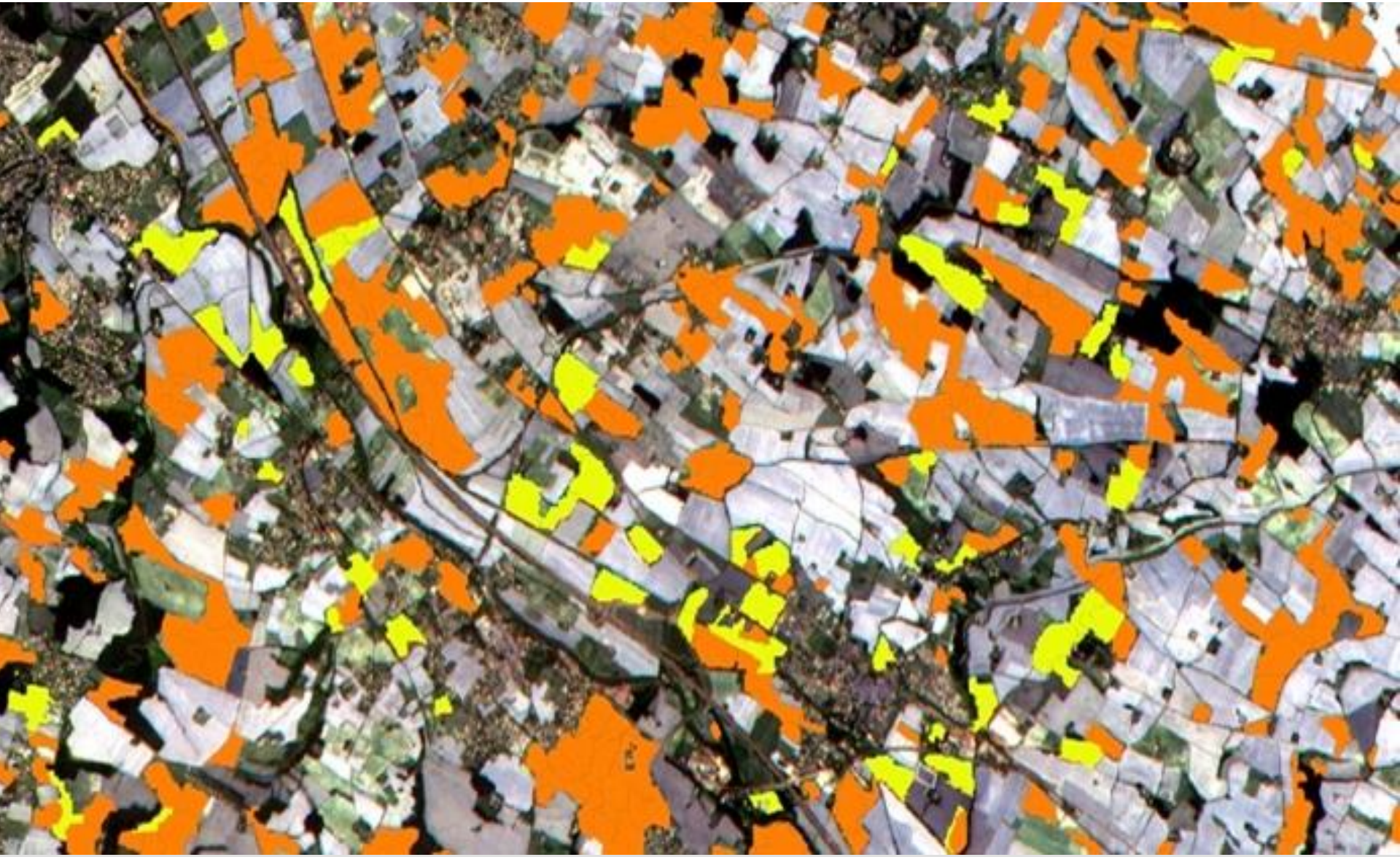


Spectral bands versus spatial resolution





Sentinel-2A: Agricultural Monitoring



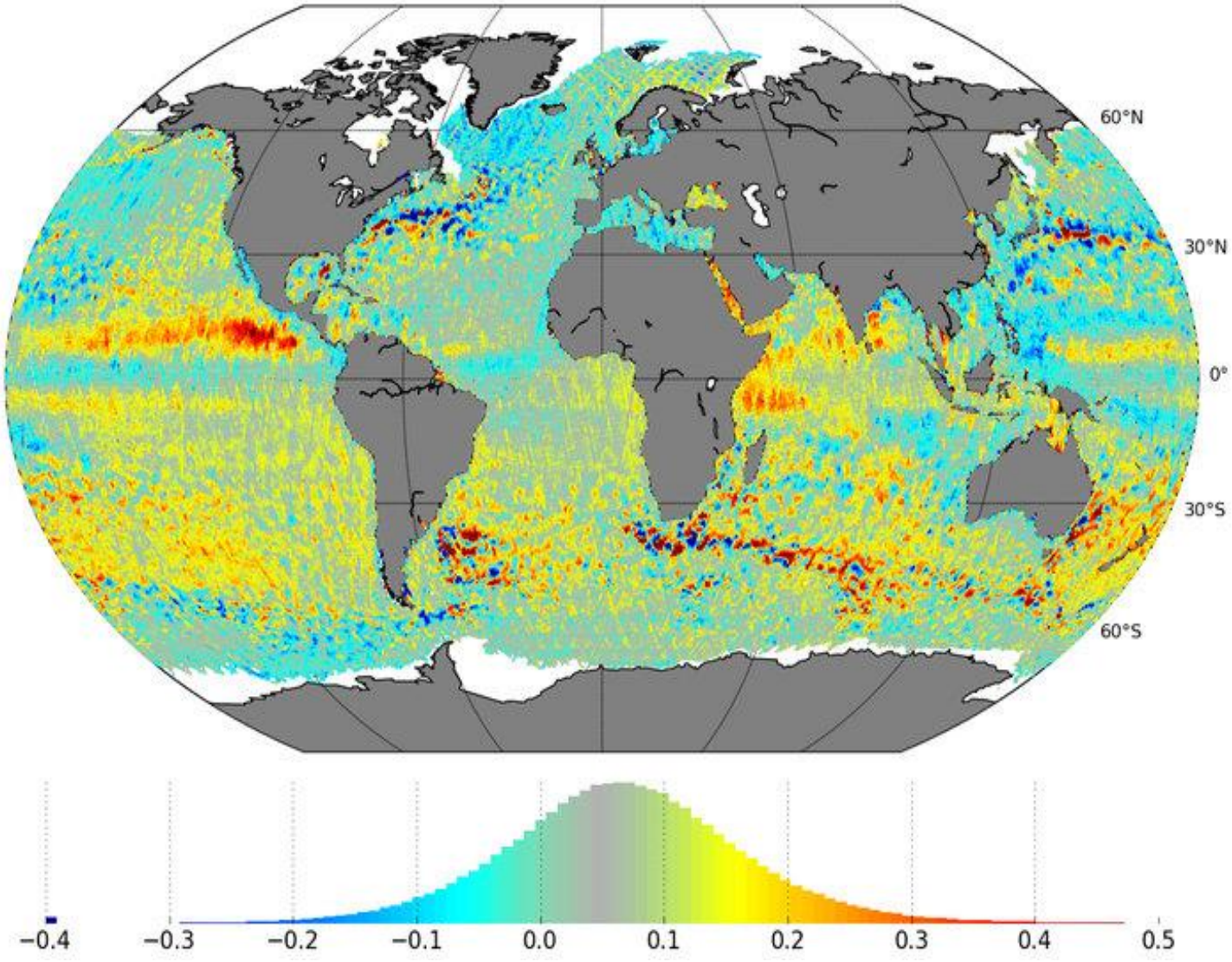
Sentinels in Co-Operation

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

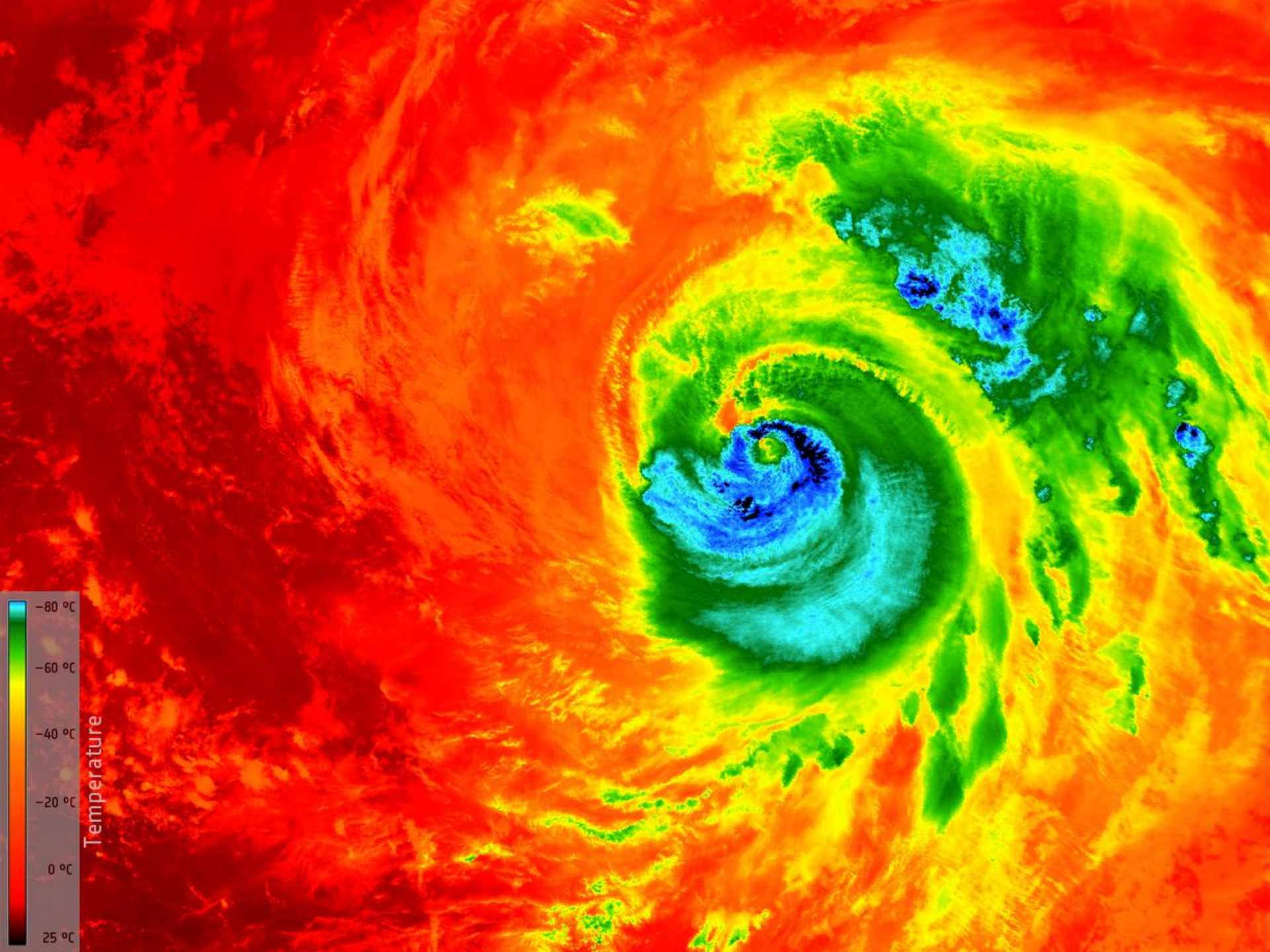
Sentinel-3: The Latest in Orbit

- Launch S3A 16 February 2016 *(S3B = early 2018)*
- Polar, Sun-synchronous at altitude of 815 km
- OLCI: 21 spectral bands (400–1020 nm) with a swath width of 1270 km
- SLSTR: 9 spectral bands (550–12 000 nm); dual-view scan with swath widths of 1420 km (nadir) and 750 km (backwards)
- Altimeter (SRAL) Ku-band (300 m after SAR processing) and C-band
- Microwave Radiometer (MWR) dual frequency at 23.8 & 36.5 GHz

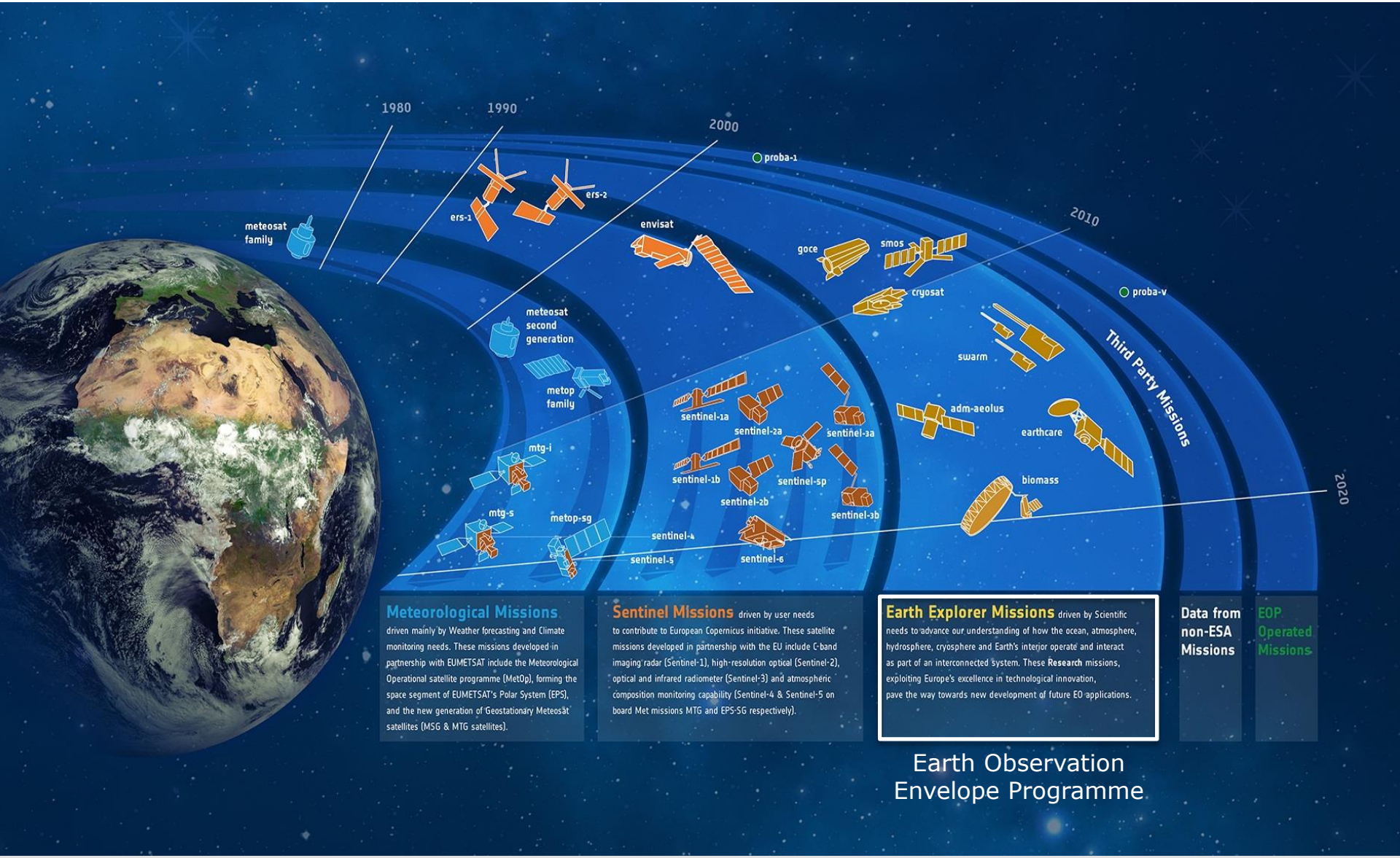
Sentinel-3A: Sea Level Anomaly



Contains modified Copernicus Sentinel data [2016], processed by ESA and CNES


−80 °C
−60 °C
−40 °C
−20 °C
0 °C
25 °C
Temperature

ESA Earth Observation Programmes

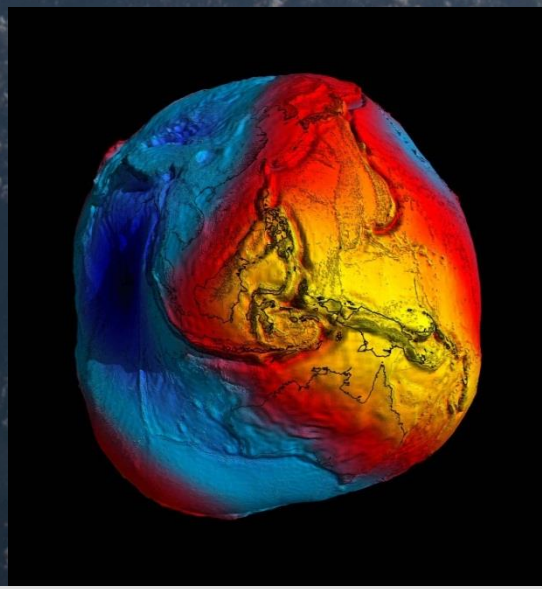


Earth Observation Envelope Programme

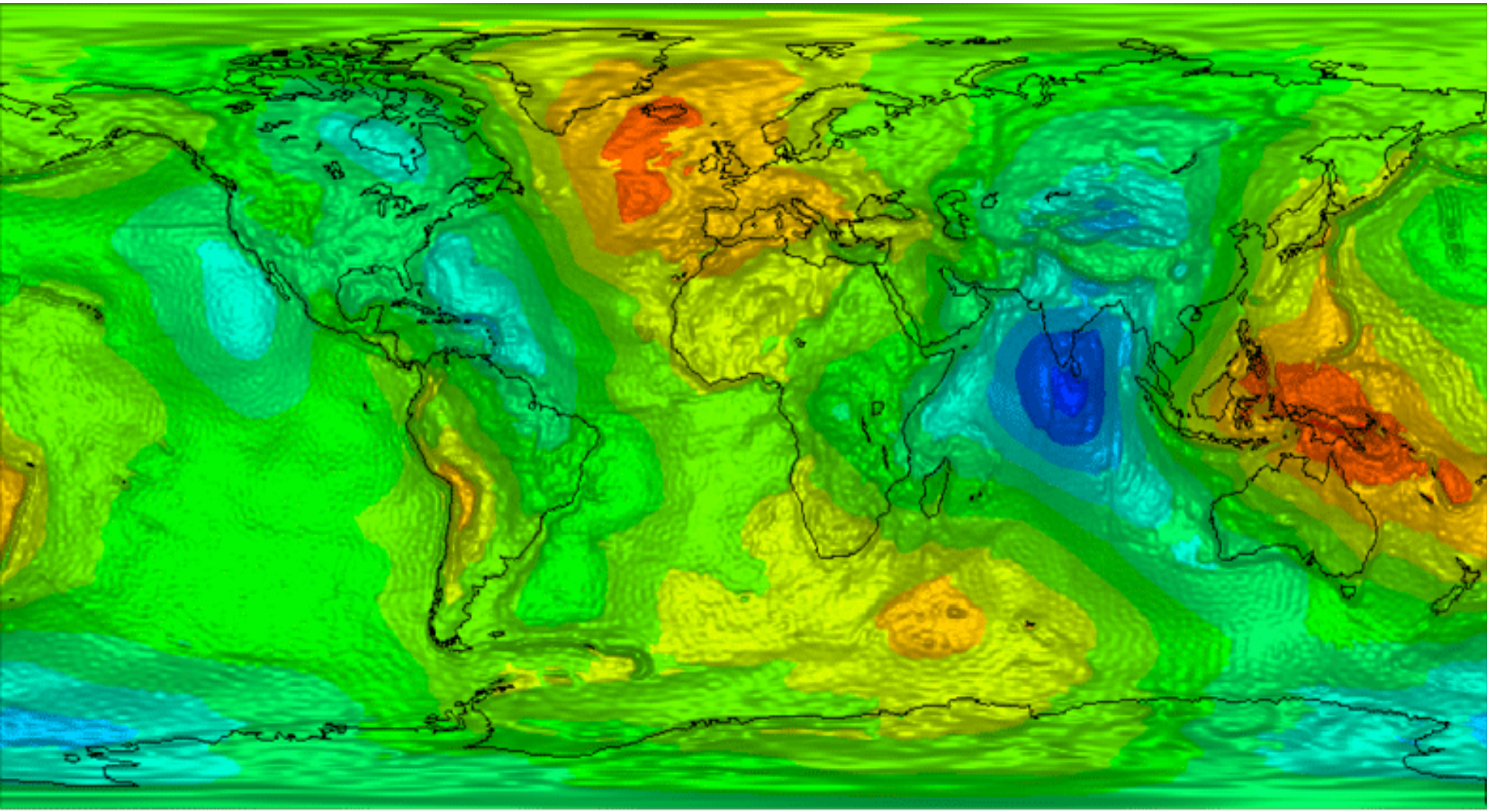
Science – the Earth Explorers

GOCE: Gravity and Ocean Circulation

- Launched 17 March 2009
- First gradiometer in space
- Best geoid ever
- 5th version of geoid released in July 2014, including all GOCE measurements
- End of mission declared 21 October 2013 following depletion of Xenon fuel
- Re-entry 11 November 2013



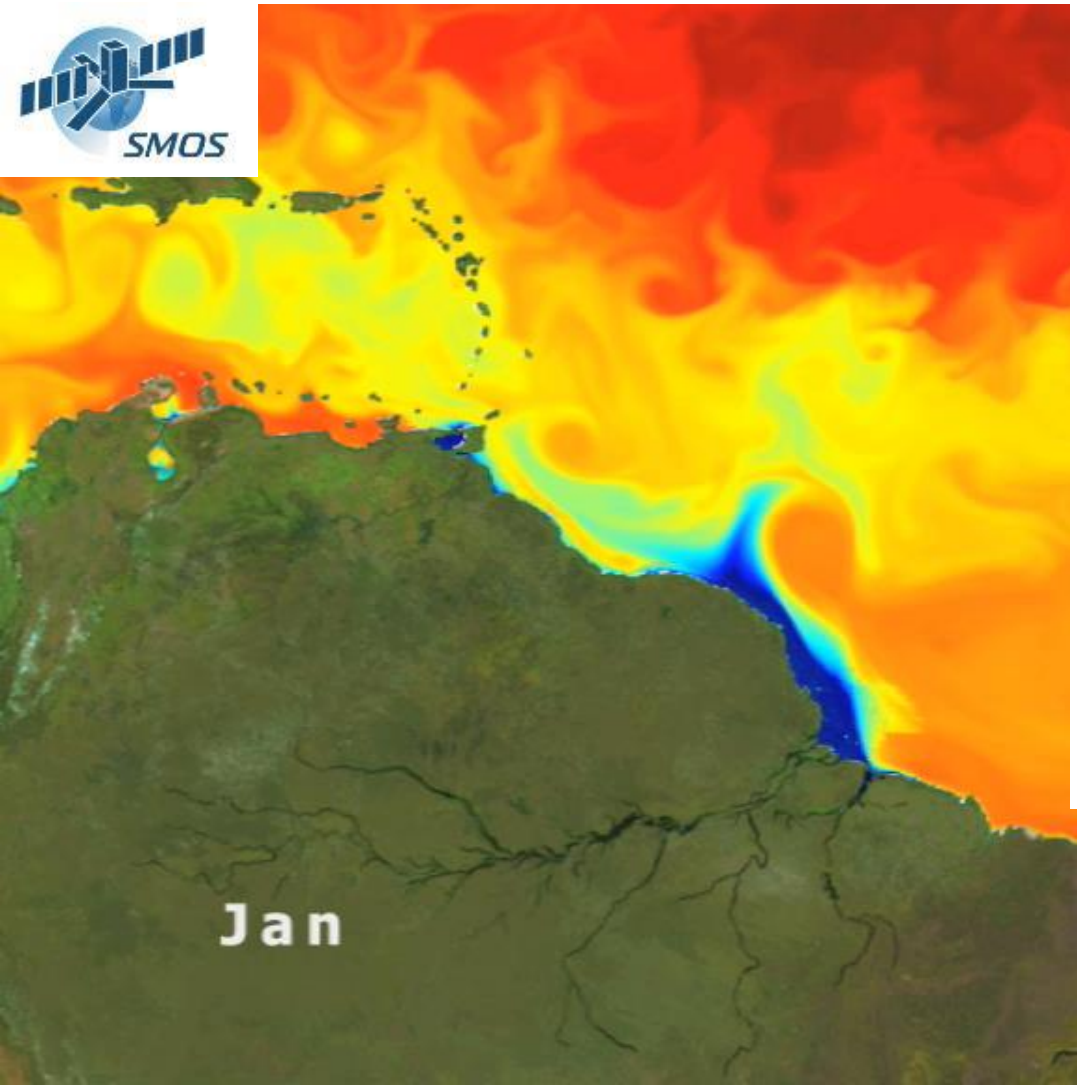
GOCE: Geoid in 2D

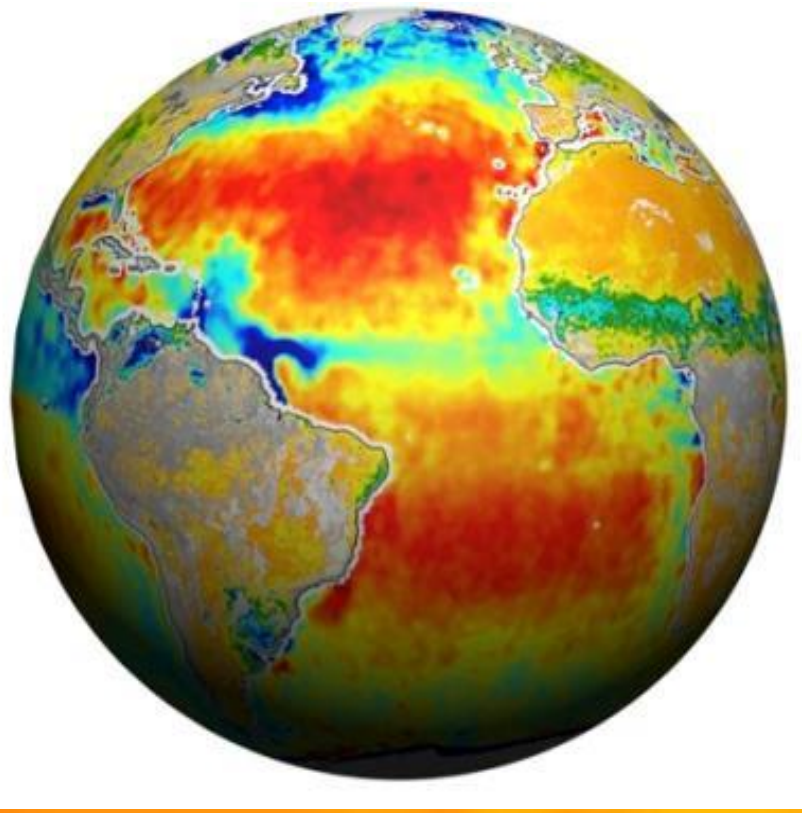


SMOS – Soil Moisture and Ocean Salinity

- Launched 2 Nov 2009 (data delivery since February 2010)
- Microwave Imaging Radiometer using Aperture Synthesis (MIRAS), 2D interferometric L-band radiometer operating at 1.4 GHz (21 cm wavelength)
- Complete Earth coverage within three days
- Mission extension until 2017

SMOS: Mission accomplished and ongoing

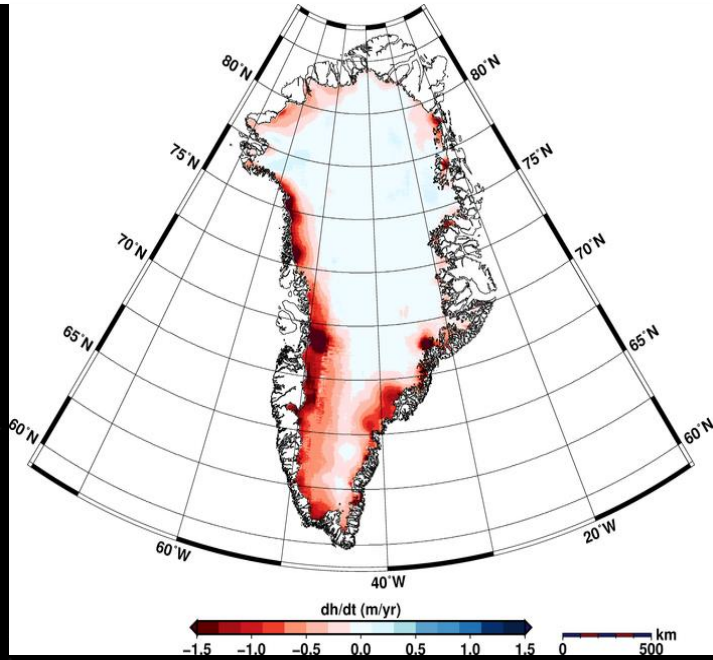




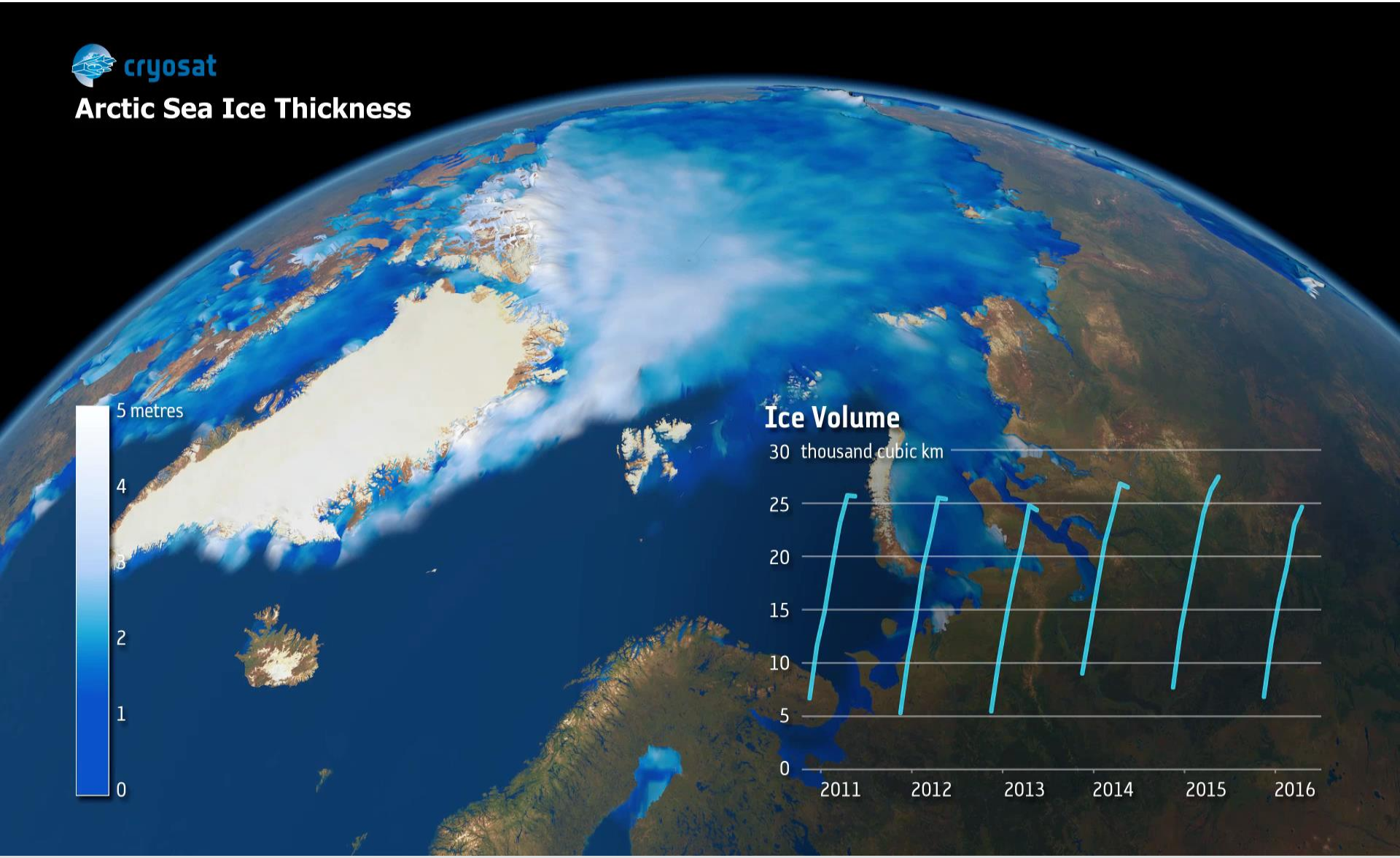
Monitoring soil moisture and ocean salinity. Globally.

CryoSat: The Ice Mission

- Launched 8 April 2010
- First interferometric altimeter in space
- Global sea ice thickness measurements
- Data used for ice research, but increasingly also for oceanography
- Mission extension until 2017

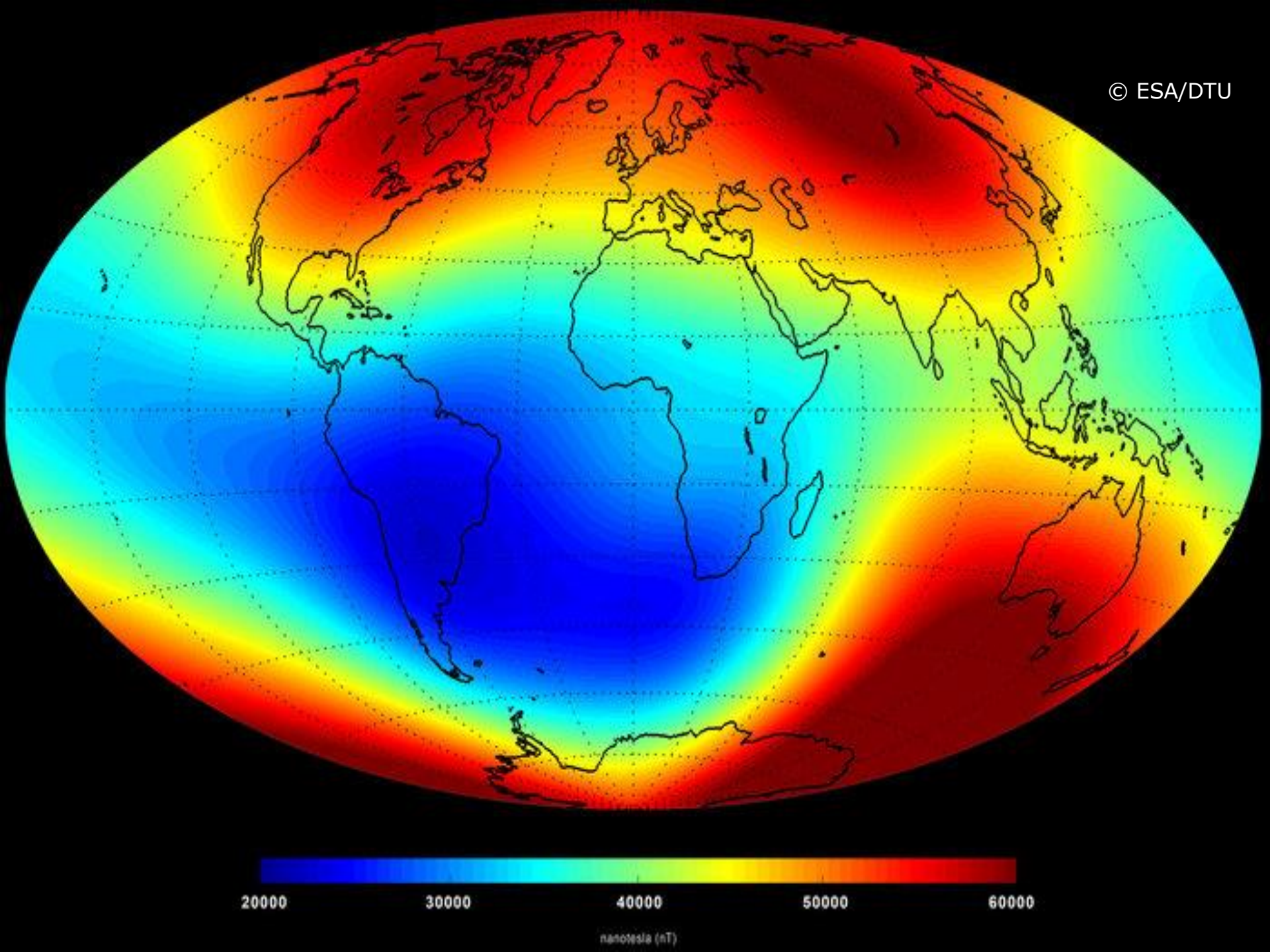


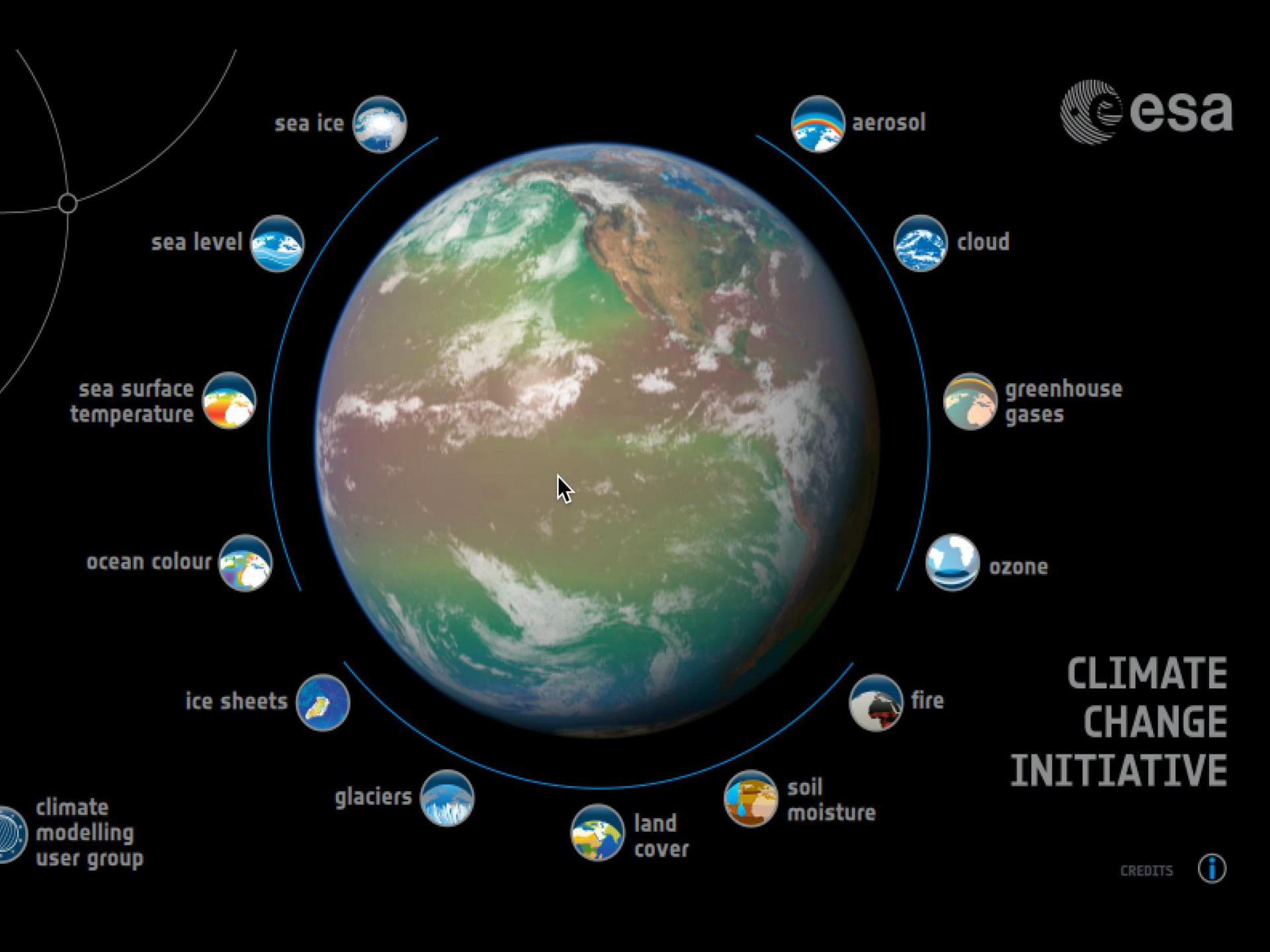
Cryosat and the Arctic



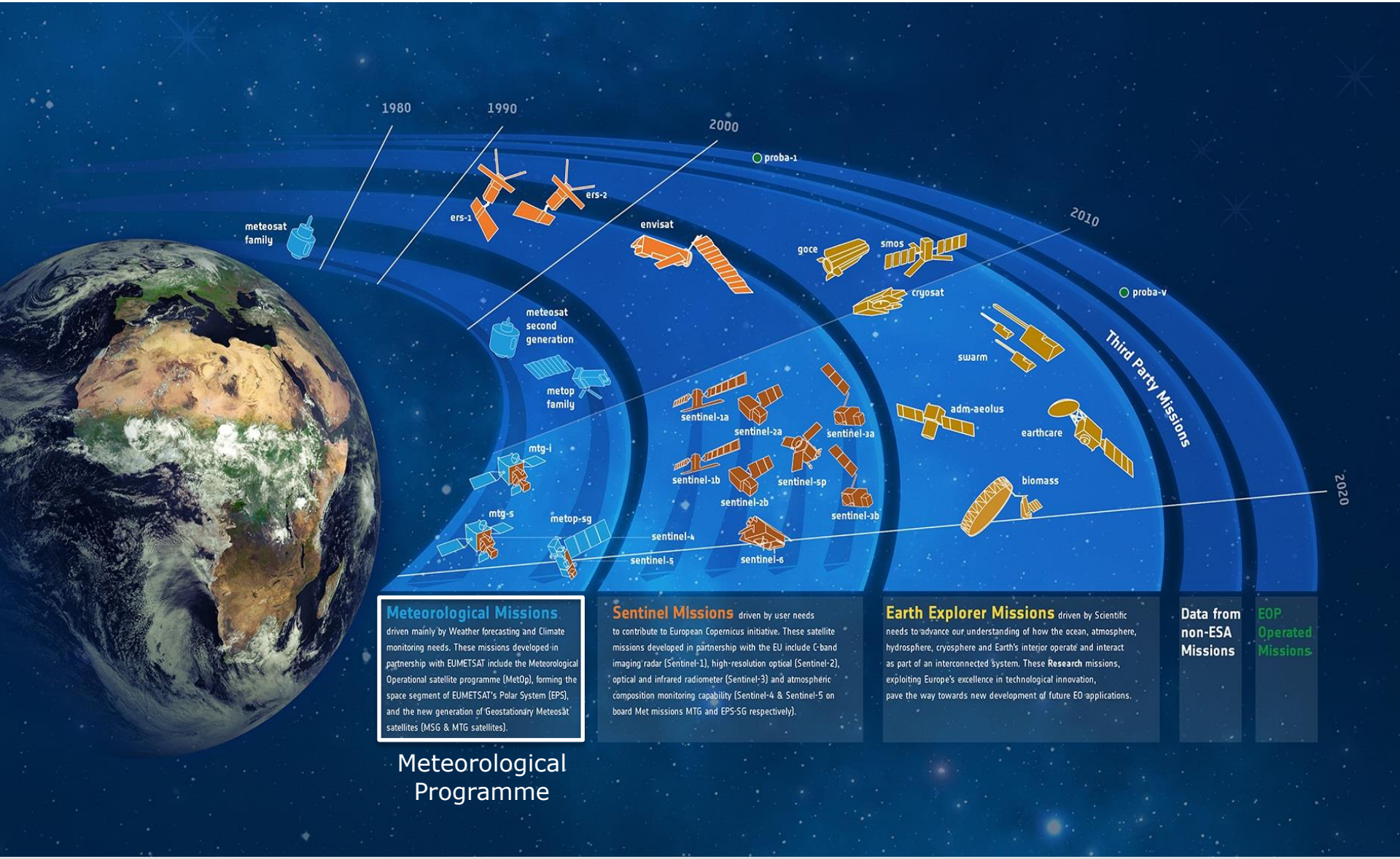
Swarm

- Three satellite constellation
- Launched 22 Nov 2013
- Providing the best-ever survey of the geomagnetic field and its variation in time
- Gaining new insights into the Earth's interior and climate


© ESA/DTU
20000
30000
40000
50000
60000
nanotesla (nT)


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

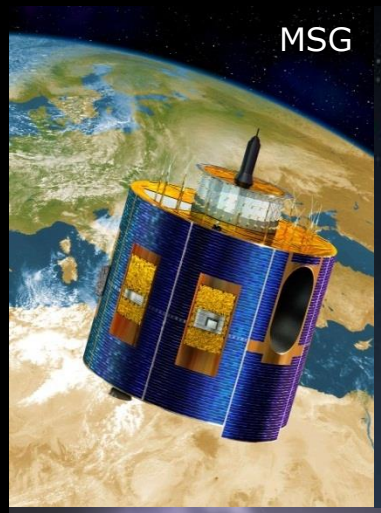
ESA Earth Observation Programmes

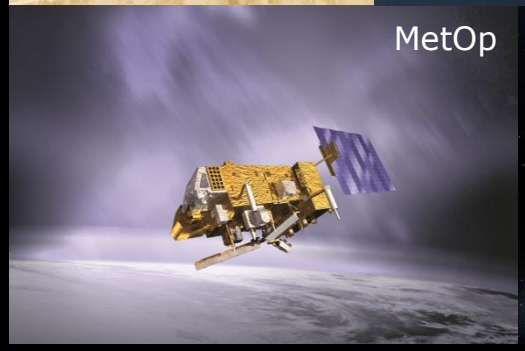


Meteorological Programme

Meteorological missions

- ESA develops prototype satellites and, on behalf of EUMETSAT, procures recurrent satellites
- EUMETSAT procures launchers and LEOP services
- EUMETSAT operates the satellites
- Launch of first meteorological mission, Meteosat-1 in 1977
- Currently Meteosat Second Generation (MSG) missions in GEO and MetOp missions in LEO
- MeteoSat Third Generation (MTG) and MetOp Second Generation under development



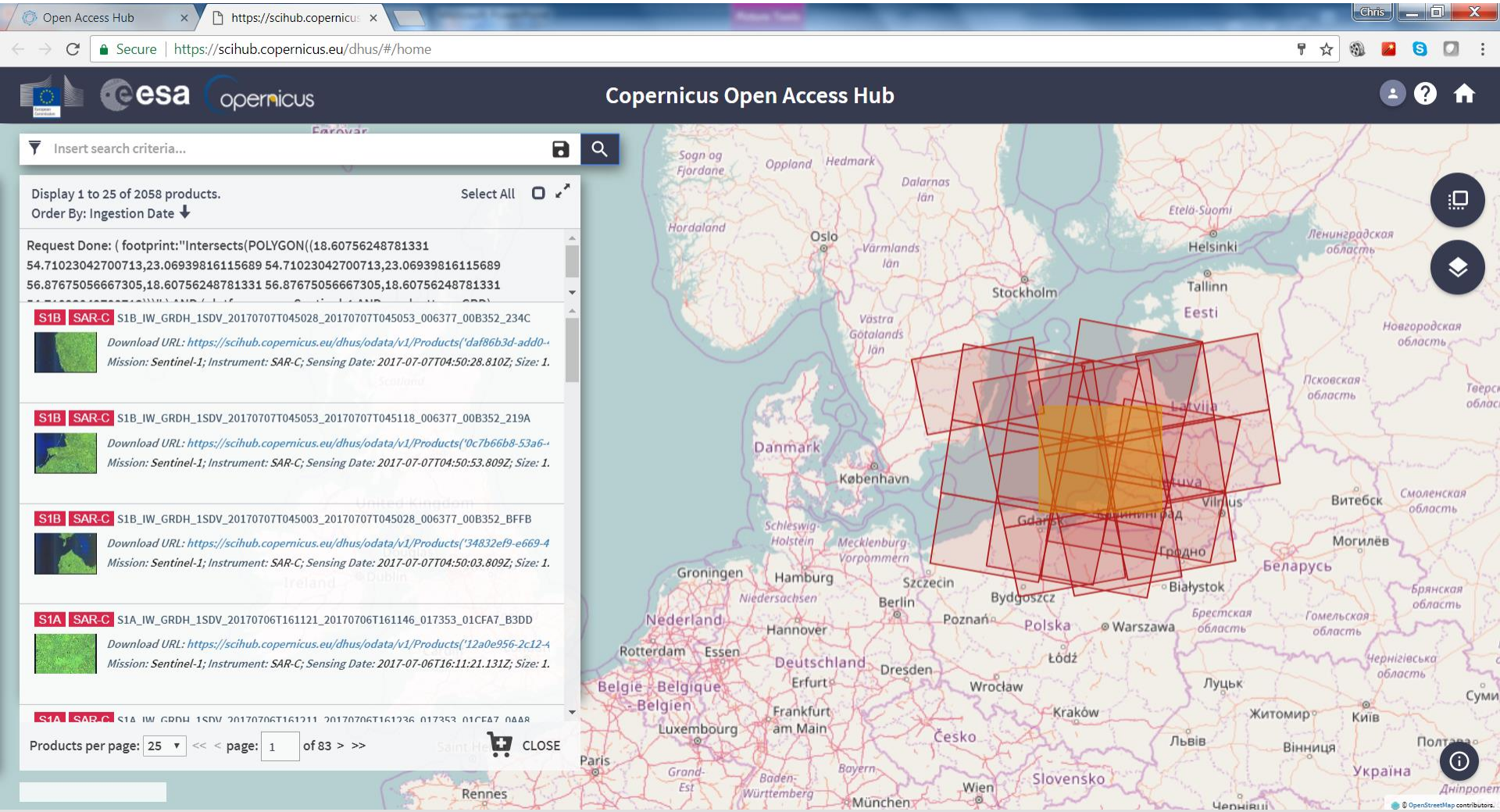


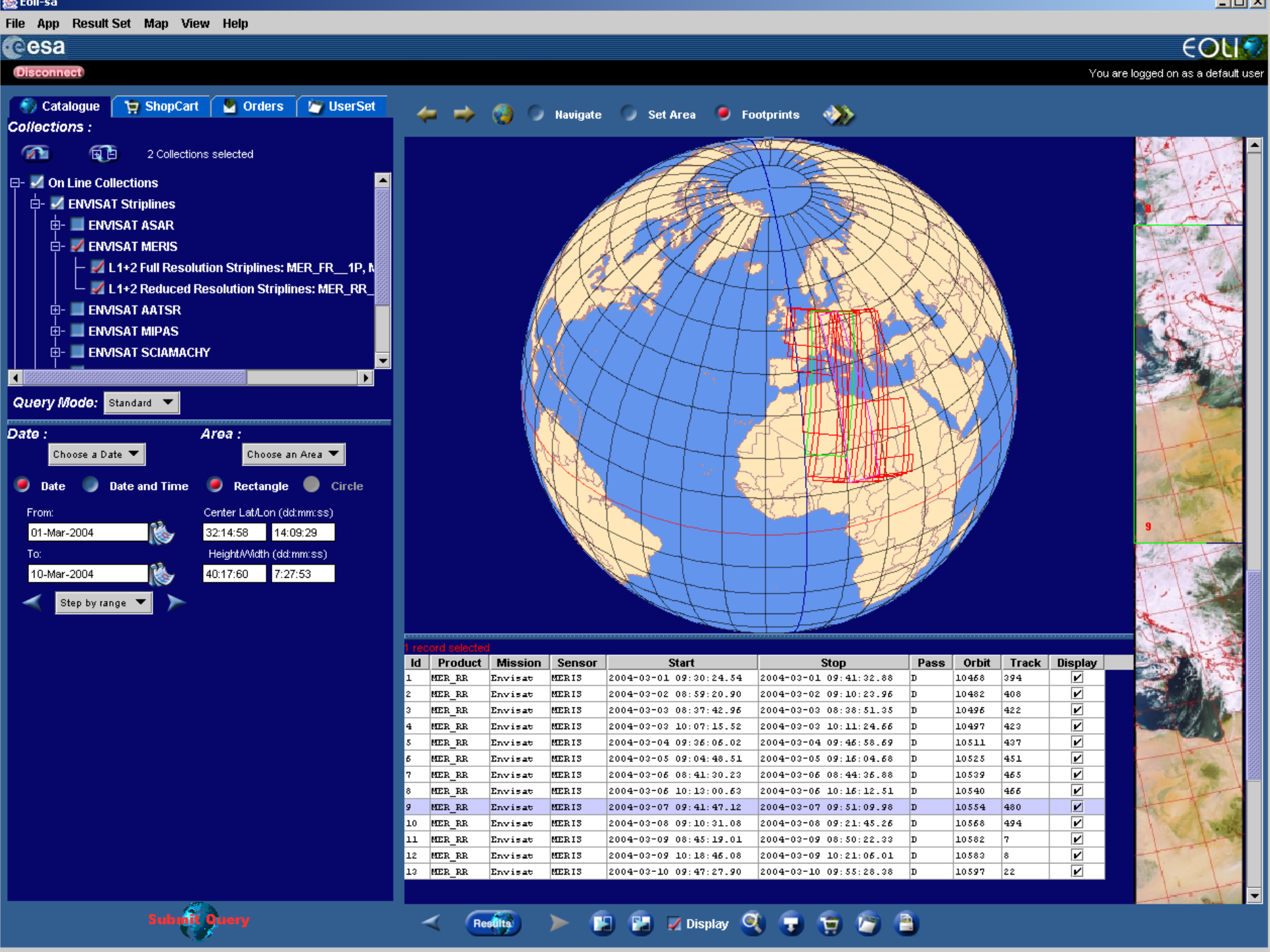
Sentinel Data Access

Free and open: https://scihub.copernicus.eu/

Sentinel Data Access

Free and open: https://scihub.copernicus.eu/




EOLI-SA
File App Result Set Map View Help
esa
EOLI
Disconnect
You are logged on as a default user
Catalogue ShopCart Orders UserSet
Collections :
2 Collections selected
On Line Collections
ENVISAT Striplines
ENVISAT ASAR
ENVISAT MERIS
L1+2 Full Resolution Striplines: MER_FR__1P, M
L1+2 Reduced Resolution Striplines: MER_RR_
ENVISAT AATSR
ENVISAT MIPAS
ENVISAT SCIAMACHY
Query Mode: Standard
Date :
Choose a Date
Area :
Choose an Area
Date
Date and Time
Rectangle
Circle
From:
01-Mar-2004
To:
10-Mar-2004
Center Lat/Lon (dd:mm:ss)
32:14:58
14:09:29
Height/Width (dd:mm:ss)
40:17:60
7:27:53
Step by range
Submit Query
Navigate
Set Area
Footprints
1 record selected
Id Product Mission Sensor Start Stop Pass Orbit Track Display
1 MER_RR Envisat MERIS 2004-03-01 09:30:24.54 2004-03-01 09:41:32.88 D 10468 394
2 MER_RR Envisat MERIS 2004-03-02 08:59:20.90 2004-03-02 09:10:23.96 D 10482 408
3 MER_RR Envisat MERIS 2004-03-03 08:37:42.96 2004-03-03 08:38:51.35 D 10496 422
4 MER_RR Envisat MERIS 2004-03-03 10:07:15.52 2004-03-03 10:11:24.66 D 10497 423
5 MER_RR Envisat MERIS 2004-03-04 09:36:06.02 2004-03-04 09:46:58.69 D 10511 437
6 MER_RR Envisat MERIS 2004-03-05 09:04:48.51 2004-03-05 09:16:04.68 D 10525 451
7 MER_RR Envisat MERIS 2004-03-06 08:41:30.23 2004-03-06 08:44:36.88 D 10539 465
8 MER_RR Envisat MERIS 2004-03-06 10:13:00.63 2004-03-06 10:16:12.51 D 10540 466
9 MER_RR Envisat MERIS 2004-03-07 09:41:47.12 2004-03-07 09:51:09.98 D 10554 480
10 MER_RR Envisat MERIS 2004-03-08 09:10:31.08 2004-03-08 09:21:45.26 D 10568 494
11 MER_RR Envisat MERIS 2004-03-09 08:45:19.01 2004-03-09 08:50:22.33 D 10582 7
12 MER_RR Envisat MERIS 2004-03-09 10:18:46.08 2004-03-09 10:21:06.01 D 10583 8
13 MER_RR Envisat MERIS 2004-03-10 09:47:27.90 2004-03-10 09:55:28.38 D 10597 22
Results
Display

Firefox | EO Education and Training Home - Eart... | https://earth.esa.int/web/guest/eo-education-and-training | Most Visited | Getting Started

esa Earthnet Online

Login My Earthnet | Register | Need Help? Contact here | European Space Agency

Data Access | Missions | Earth Topics | PI Community | Explore more...

You are here Home › EO Education and Training

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

EO Education News

Participate in the ESA LearnEO! competition
23 September 2013

EO Education and Training

EO Education and Training Home

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.

EO data

- EO data distributed by ESA
- Access data online
- Access GMES data
- How to apply for data
- EOLI Catalogue
- ESA Multimedia Gallery

EO training activities

- Education for Schools
- EO Summer Schools
- Dragon Programme
- Tiger Initiative
- Advanced Training
- Other EO Training
- Upcoming / Past Events

EO software

- NEST Training
- LEOWorks Download (19.5mb)
- Biliko
- ILWIS

LearnEO!

LearnEO! is an Earth observation education project funded by ESA. Its aim is to increase the understanding of satellite data from ESA missions and show how these can be used to tackle environmental problems in the real world.

Read more

Education for Schools

ESA has developed an EO educational website "Eduspace" that mainly targets secondary schools. In addition to this, ESA provides workshops for teachers and has funded the development of many tools for EO education.

Read more

Key Resources

- Sample data
- Auxiliary data
- Catalogue access
- Document Library
- Upcoming Events
- Events Catalogue
- Software Tools
- Online Archives
- EO Software Toolboxes

EO Summer Schools

TIGER Training

http://seom.esa.int

ESA EO

COPERNICUS

SENTINEL

NEW OPPORTUNITIES

Invitations to Tender

PARTNERS

PROJECTS

CONTACTS

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.

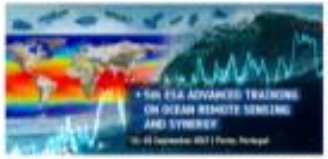
2017

7th ESA Advanced Land Training Course on Land Remote Sensing
4-9 September 2017, Gödöllő, Hungary

- For further information please visit the website.

Ocean Training Course 2017
11 - 15 September 2017, Porto, Portugal

EO OPEN SCIENCE



Ocean Training Course 2017

Land Training Course 2017

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

1-12 August 2016 Summer School ESRIN
70 early career scientists have taken part.

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

Topics :
Global Observing Systems, Earth System Modelling, Data Assimilation, Global Change

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"**

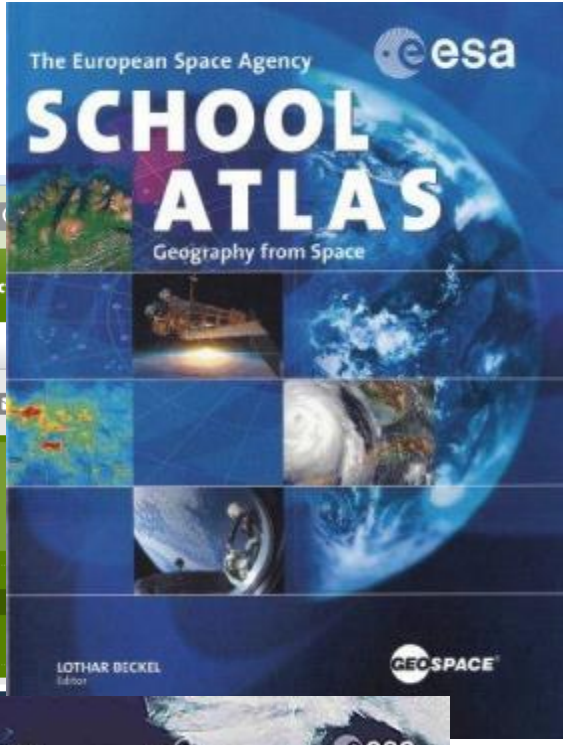
https://www.futurelearn.com/courses/climate-from-space

- **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

Atlases, apps, ebooks, …



esa Earth Online

Login My Earthnet | Register | Google™ Custom Search

Need Help? Contact here | European Space Agenc

Data Access | Missions | Earth Topics | PI Community | Explore more...

You are here Home › EO Education and Training › EO Education for Schools

Follow | Share

ESA School Atlas

ESA and Geospace launched an educational resource in the form of the ESA School Atlas. As a complement to the more conventional atlas, this represents an evolutionary leap in teaching resources, using satellite data to show the Earth *as it really is*.

The Atlas is built on satellite imagery and is packed with the most current and visually stunning results of Earth Observation. It displays in a clear and novel way all the fundamental processes affecting the Earth system, and demonstrates the techniques of the future for monitoring and understanding our planet.

This Educational resource is an invaluable tool for the classroom, finally providing a very affordable exposure to costly satellite imagery from a wide variety of sensors. Wide swath imagery providing continental and global overview is included, together with satellite imagery of the highest spatial resolution available today, with images of 0.6m resolution.

The production of the School Atlas was funded by ESA's Earth Observation programme specifically to convert this kind of Earth Observation material into an educational resource affordable to schools, and the atlas is available at a much reduced cost!

Earth Observation exploits our understanding of physics and computer science to observe a great many features and processes taking place on the Earth's surface and atmosphere. Some examples include the monitoring of plants, oceans, atmospheric gas concentrations, geological features and changing cities. As such, while the methods of Earth Observation are primarily relevant to the study of physics and computer science, the applications are significant to an extremely wide variety of disciplines, including among others: geography, biology, chemistry, environmental sciences, art and history.

The ESA School Atlas kit is a very valuable resource also for students of Geographic Information Systems (GIS). There are many ready made digital exercises on DVDs provided with the Atlas that can be used with the free software packages LEOWorks and ArcExplorer.

The Atlas is accompanied by a Teacher's Handbook and a digital version on two DVDs. It is available in both English and German.

Alternatively, select the links below to download freely the DVDs and Teacher's Handbook:

- ESA School Atlas DVD 1 (4.69 Gb)
- ESA School Atlas DVD 2 (3.20 Gb)
- Teacher's Handbook (English)
- Teacher's Handbook (German)

The Atlas contains the following content:

EO Education and Training

- EO Education and Training Home
- EO Education for Schools
- Advanced EO Training for PIs
- Other EO Training

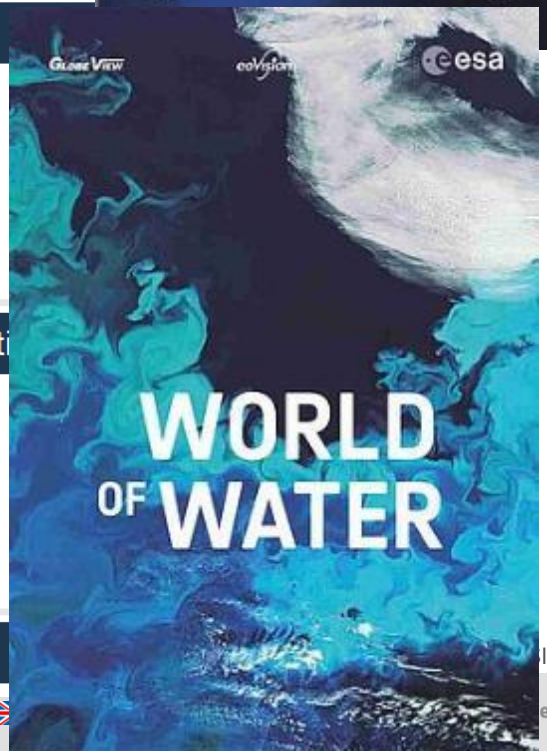
EO data

- EO data distributed by ESA
- Online Archives
- Catalogue access
- Sample data
- Sentinel-1 Data Hub
- Eoli Catalogue
- ESA Multimedia Gallery

EO training activiti

- Education for Schools
- EO Summer Schools
- Dragon Programme
- Tiger Initiative
- Advanced Training
- Other EO Training
- Upcoming / Past Events

EO software



Useful Websites

- **European Space Agency (ESA):**

  www.esa.int

- **ESA Earth Observation (EO) Scientific Portal:**

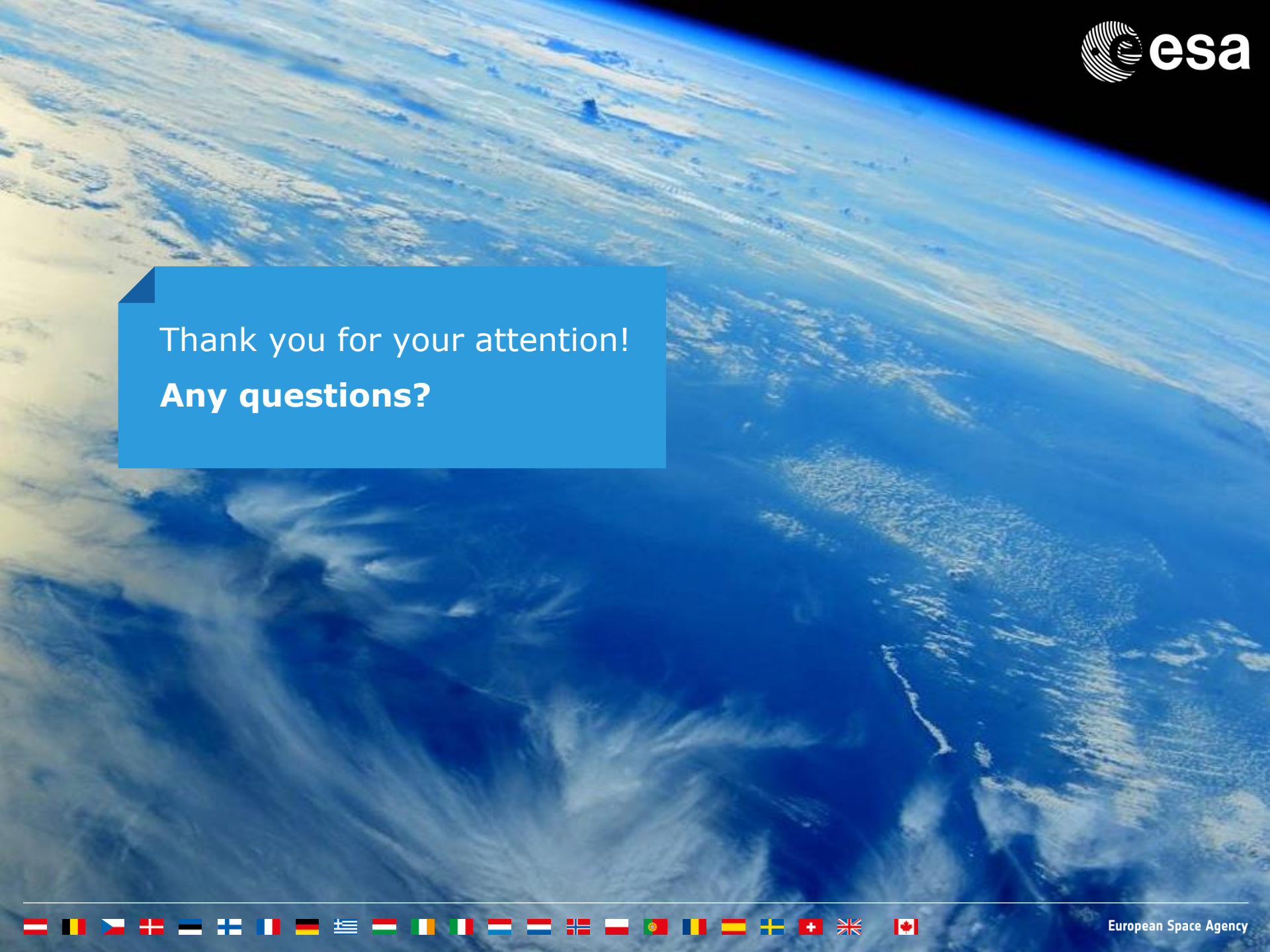
  earth.esa.int

- **ESA EO Education and Training:**

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

- **Sentinel Data Hub:**

  https://scihub.copernicus.eu


esa
Thank you for your attention!
Any questions?
European Space Agency