Welcome to the 9th TAT Course on Earth Observation, with focus on Land Cover

Jointly organised by ESA, NASA, Charles University

05 Sept 2022

F. Sarti, A. Castro Gomez
ESA Earth Observation Programme Data Applications EOP-SD

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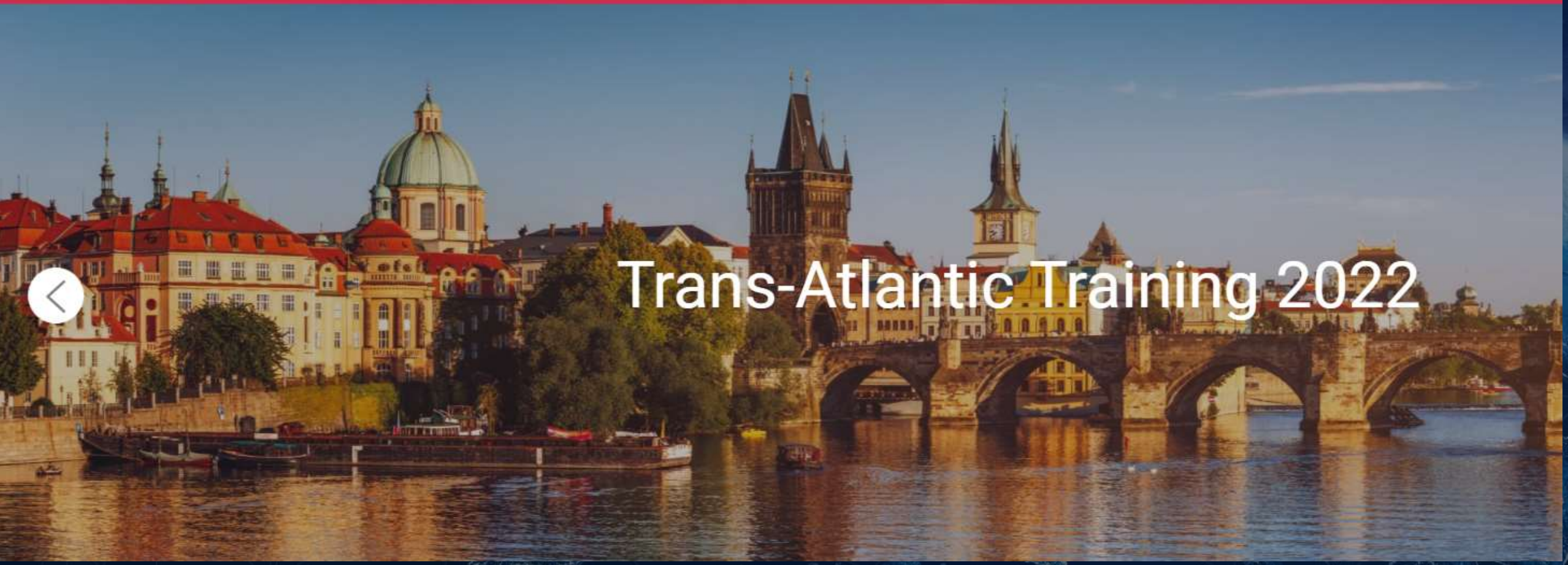
TRANS-ATLANTIC TRAINING – PRAGUE 2022

A Changing Eastern Europe: New Challenges for Science and Capacity Building in Land Remote Sensing

INTRODUCTION | REGISTRATION | PROGRAMME & TEACHERS ▼ | PRACTICAL INFO ▼ | PREVIOUS TATS ▼



day1	day2	day3	day4	day5
EO intro (ESA, NASA, Euspa)	RS for Agriculture (Uni Ljubljana)	Free morning	RS for Land dynamics, forestry, fires, etc (NASA speakers and Uni Jena)	Additional RS applications to Land Cover (NASA and ESA speakers)
RS for Land Cover (Uni Paris)		Vegetation spectroscopy (NASA speakers)		Feedback, certificates, end of course
Ice-breaker		Social Dinner		

The course includes Theory and practice (different tools)

35 participants from more than 10 countries

European Space Agency

EUROPE'S GATEWAY TO SPACE

WHAT	22 Member States, 5000 employees
WHY	Exploration and use of space for exclusively peaceful purposes
WHERE	HQ in Paris, 7 sites across Europe and a spaceport in French Guiana
HOW MUCH	€6.68 billion = €12 per European per year

ESA Activities and Achievements

All of this is possible thanks to the collaboration of Member States

ESA is active across **every area** of the **space sector**

World leader in **science** and **technology**

Over 80 satellites developed, tested, and operated **since 1975**

More than 220 launches from Europe's Spaceport in Kourou

ESA Membership

22 Member States

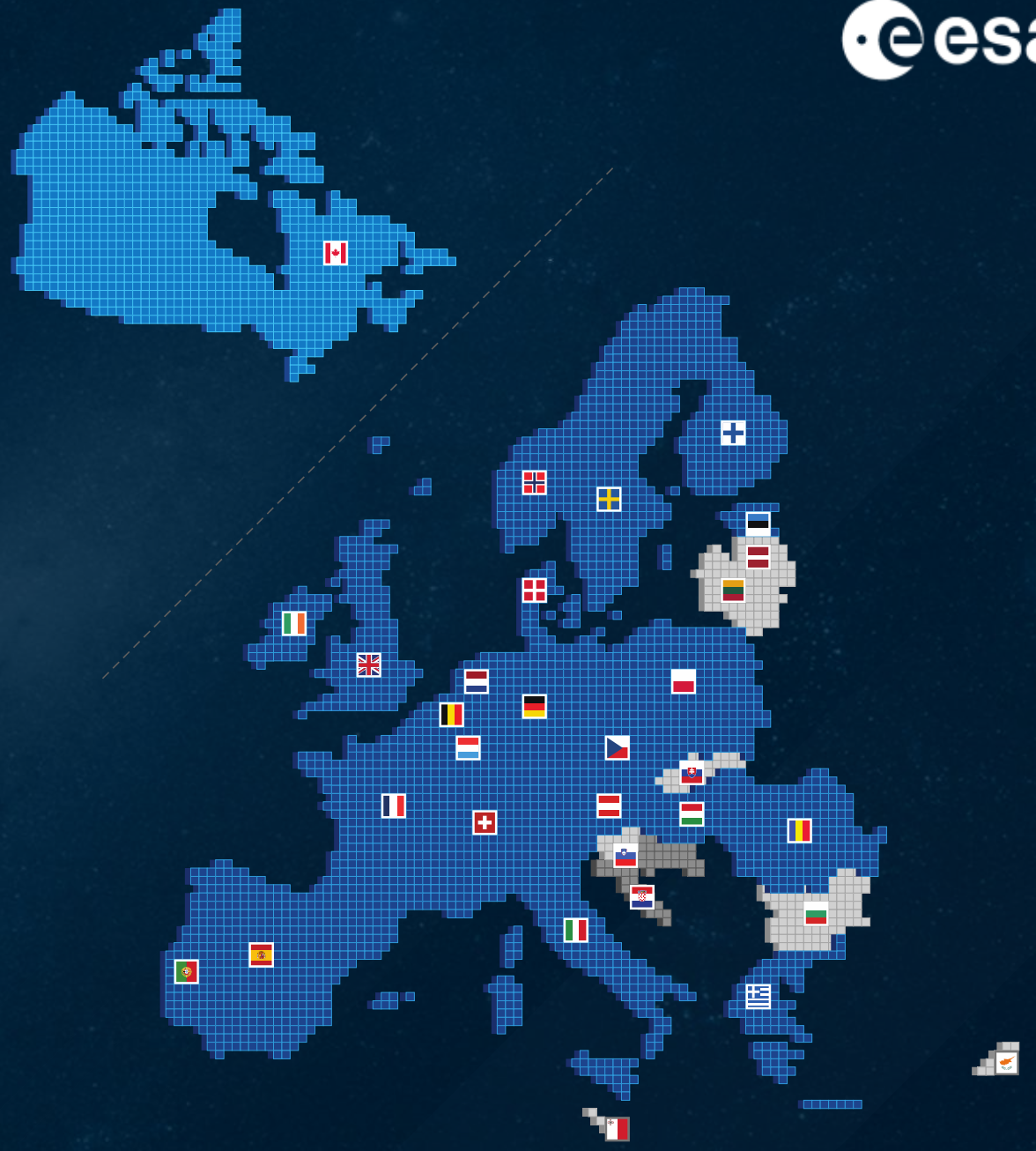
Austria	Italy
Belgium	Luxembourg
Czech Republic	Netherlands
Denmark	Norway
Estonia	Poland
Finland	Portugal
France	Romania
Germany	Spain
Greece	Sweden
Hungary	Switzerland
Ireland	United Kingdom

3 Associate Members

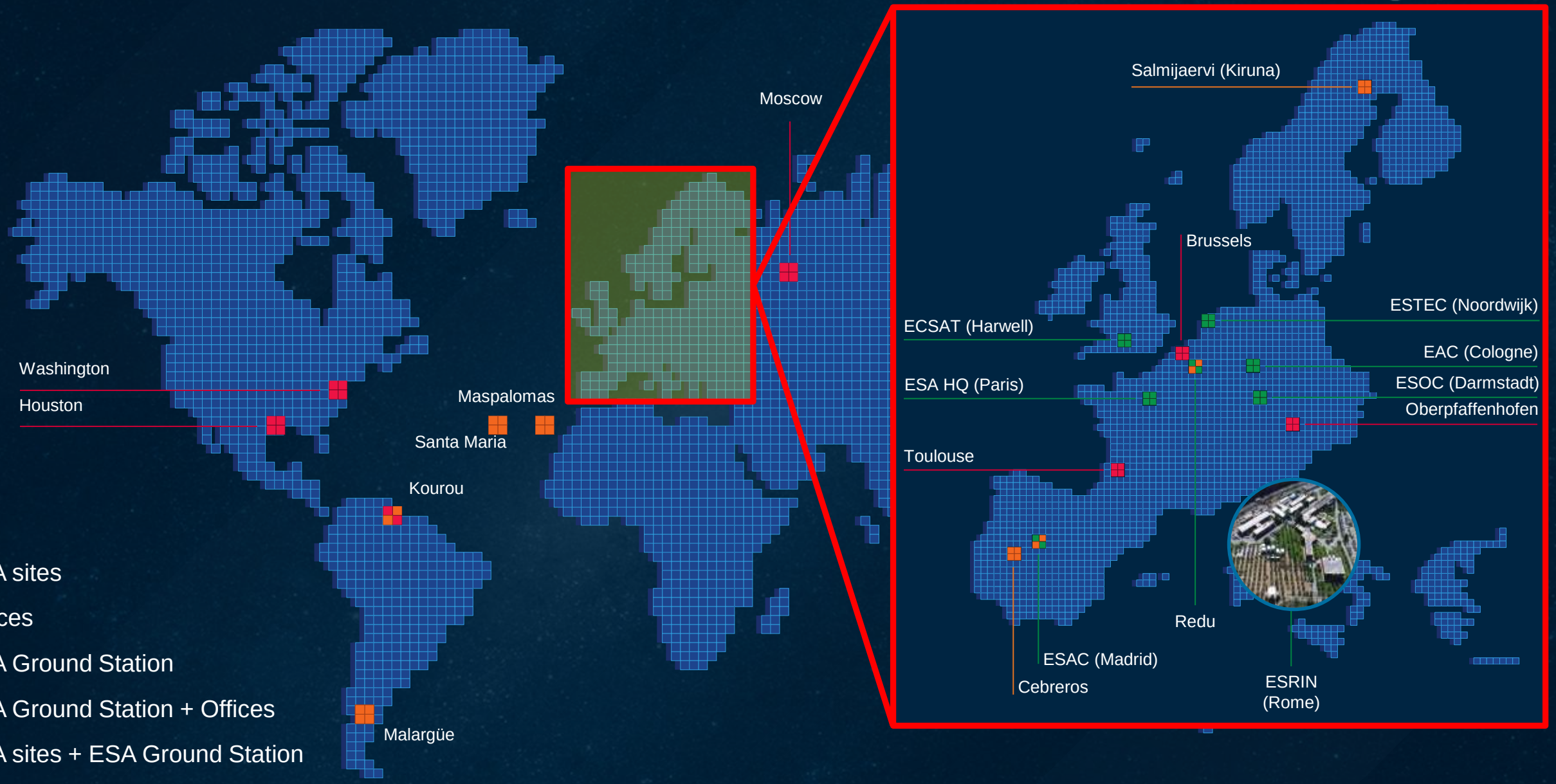
Slovenia, Latvia, Lithuania

Cooperation Agreements

6 other European States + Canada



ESA Locations



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

ESRIN – ESA's EO and European Small Launcher Programmes

Copernicus – Largest Global EO Provider

- Over 427.178 registered users
- 25 terabyte new EO data per day
- 365.23 PB of download volume

(Status 13 July 2021)

Earth Explorers

Groundbreaking Earth Science satellite missions

International Charter Space & Major Disasters

ESRIN hosts a 24-hour call operator to deal with requests for assistance from civil protection authorities

Home to ESA Φ-lab

Accelerate the future of EO

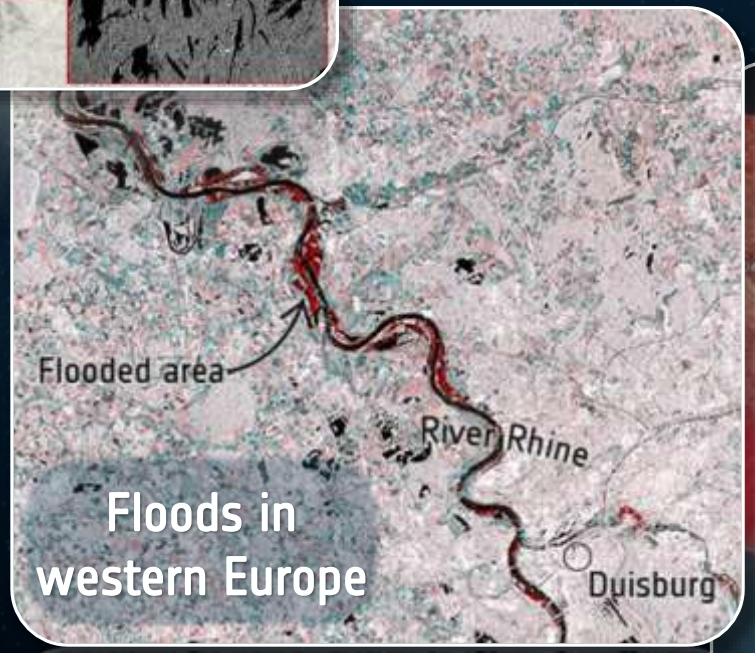
ESRIN hosts the VEGA European small Launcher Project Team

EO for Disaster Response and Management Support

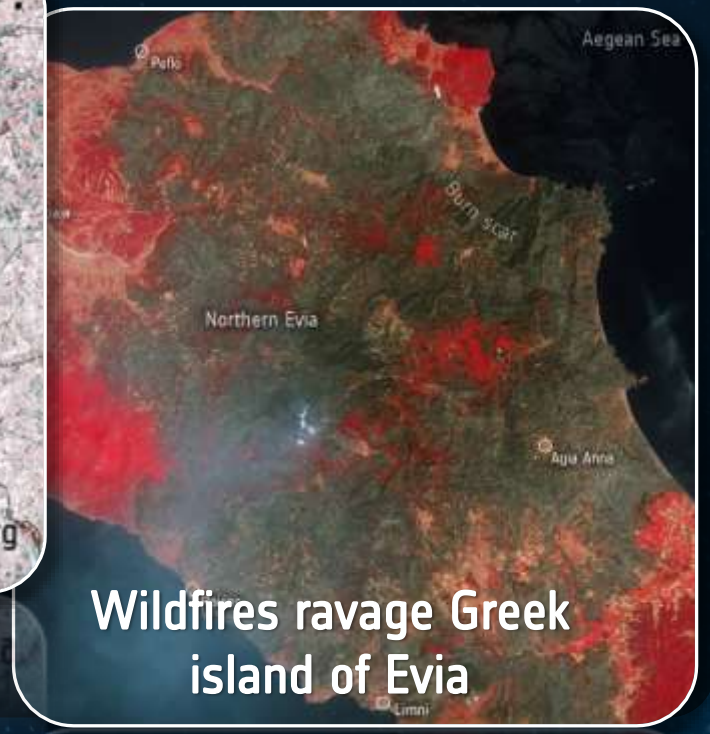
International Charter on Space and Major Disasters

Copernicus Emergency Management Service

Flood in Khabarovskiy Krai, Russia



Floods in western Europe



Wildfires ravage Greek island of Evia

ESA Directorate of EOP

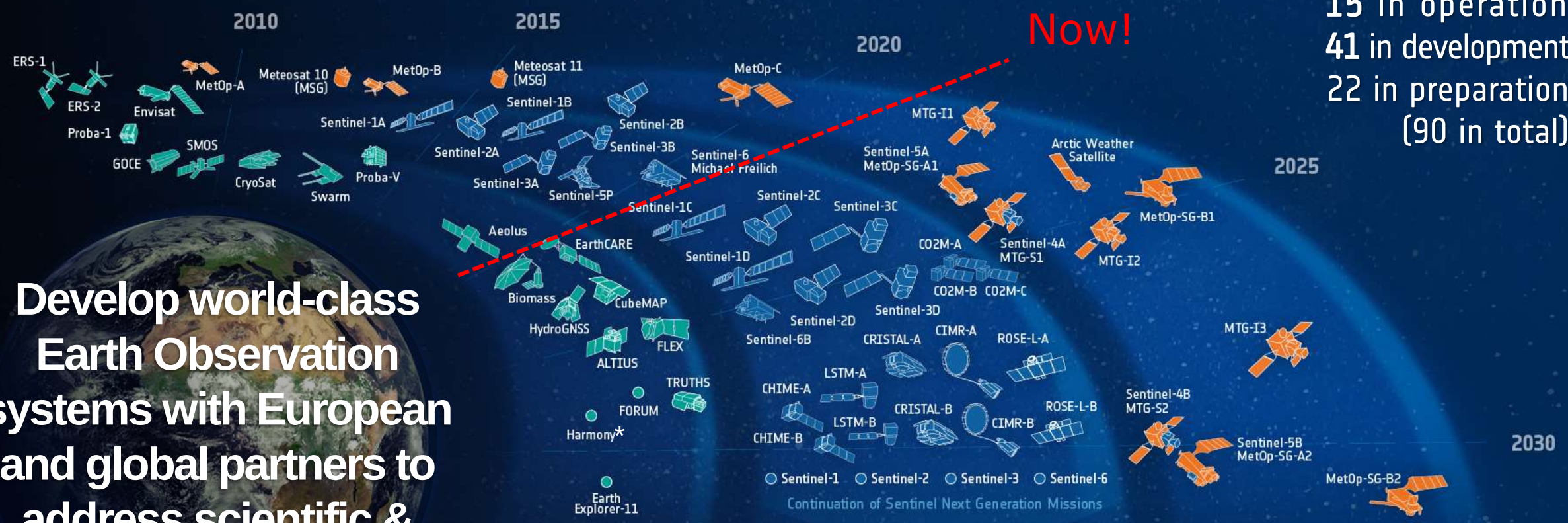
ESA’s Earth Observation Vision

Taking the Pulse of our Planet

ESA's Earth Observation Mission

Satellites

12 in heritage
15 in operation
41 in development
22 in preparation
(90 in total)



Develop world-class Earth Observation systems with European and global partners to address scientific & societal challenges

Science | Copernicus | Meteorology

*Pending final mission selection

→ THE EUROPEAN SPACE AGENCY

Copernicus Dashboard

> 425.000
registered users
= tip of the iceberg

6 operational services

Land | Atmosphere | Ocean | Climate | Disaster | Security

250 TB satellite data distributed per day

full, free & open data policy

8 Copernicus Sentinels flying

S1	S2	S3	S4	S5P	S5	S6
~~●●~~	●●	●●		●		●

preparing Copernicus 4.0

S1B end of mission, after a failure on 23 Dec 2021

Sentinel-1B experienced an anomaly related to the instrument electronics power supply, leaving it unable to deliver radar data.

Thanks to the successful inaugural flight of the Vega-C rocket (13 July), we are targeting to launch Sentinel-1C as soon as possible (second quarter of 2023)

FutureEO – Earth Explorers

Flying Missions

GOCE	SMOS	Cryosat	Swarm	Aeolus
2009-2013	2009	2010	2013	2018

Future Missions

EarthCARE	Biomass	FLEX	FORUM	Harmony*
2023	2023	2024	2027	2029

Science & Innovation

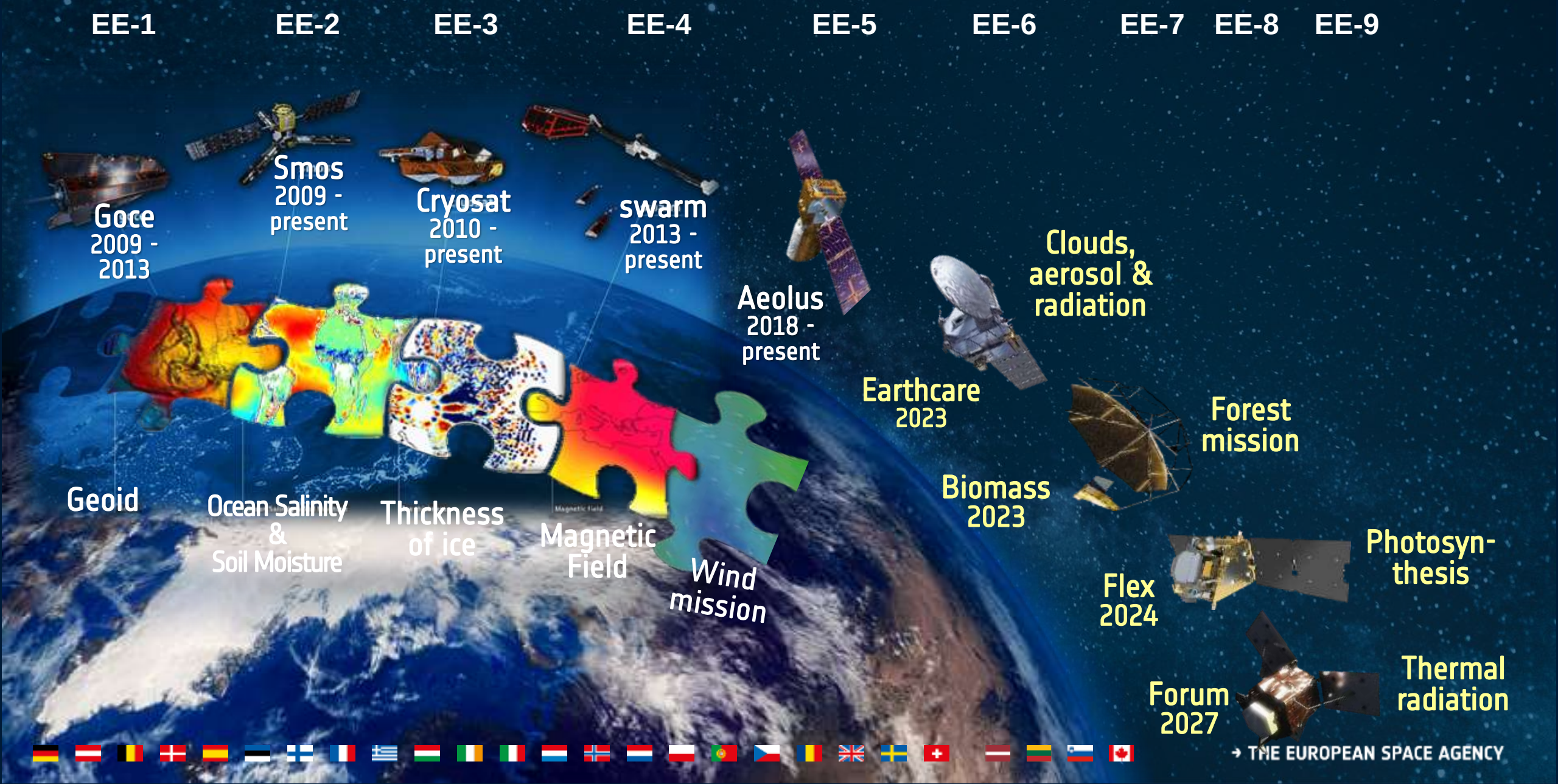
1.200+ Active Users

400+ Publ. per Year

High Risks for Great Rewards

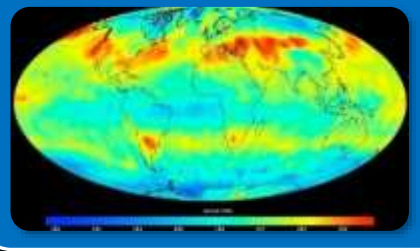
*Pending final mission selection

Earth Explorers Putting together the puzzle Earth Since 2009



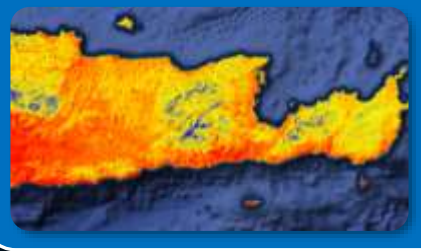
Sentinel Expansion Missions

CO2M - Anthropogenic CO_2 Monitoring



Causes of Climate Change

LST – Land Surface Temperature Mission



Agriculture & Urban Management

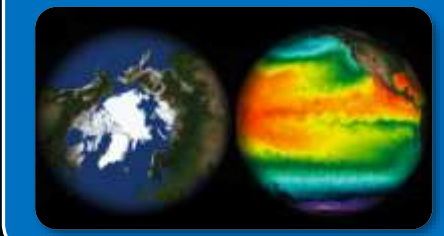
CRISTAL – Polar Ice & Snow Topography

Effects of Climate Change

CHIME – Hyperspectral Imaging Mission

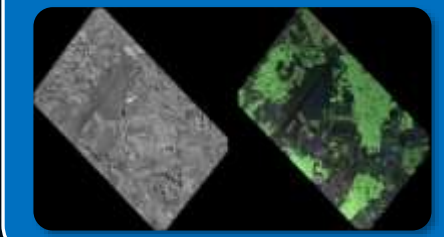
Food Security, Soil, Minerals, Biodiversity

CIMR – Passive Microwave Radiometer



Sea: Surface Temp. & Ice Concentration

ROSE-L – L-band SAR Mission



Vegetation & Ground Motion & Moisture

Scientific Advances & Impact

Building on Europe's EO ecosystem to address societal needs and global challenges;

LPS 2022 Bonn May 2022

https://www.esa.int/ESA_Multimedia/Videos/2022/05/Living_Planet_Symposium_opens_LPS_2022

Climate: Sentinels add to 3 decades of ice sheet & sea level data

11 satellites including ESA's ERS-1, ERS-2, Envisat and CryoSat, S-1 and S-2

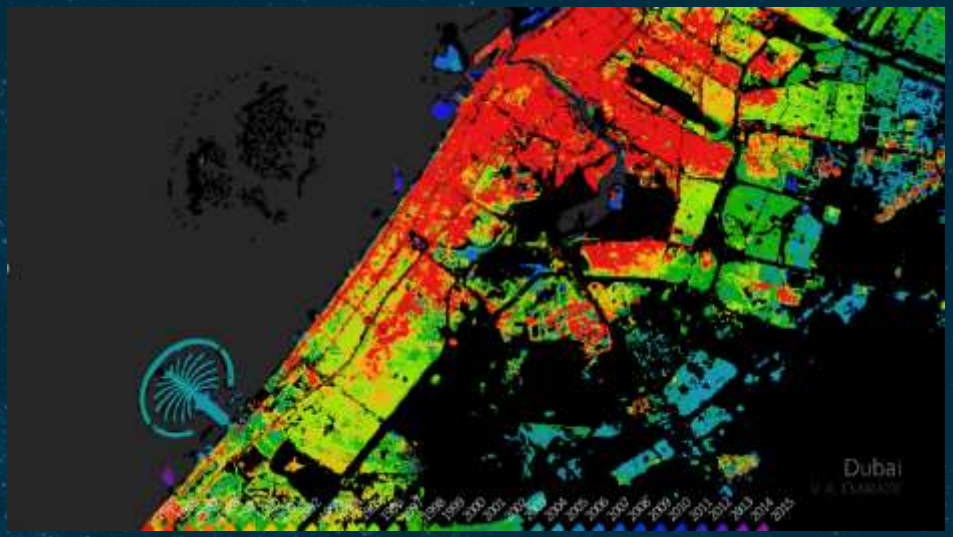
Mass balance of the Greenland Ice Sheet from 1992 to 2018 (2019) Nature doi:10.1038/s41586-019-1855-2
Mass balance of the Antarctic Ice Sheet from 1992 to 2017 (2020) Nature doi:10.1038/s41586-018-0179-y

Greenland and Antarctica are losing ice six times faster than in the 1990s.

Polar ice sheets are now responsible for a third of all sea level rise.

Losses are on track with the IPCC's worst-case climate warming scenario.

CRYOSAT Swath Altimetry to monitor World Glaciers



Earth Science for Society – Applications

Extending Europe's World-leading EO expertise and competitive advantage
Support international responses to global societal challenges

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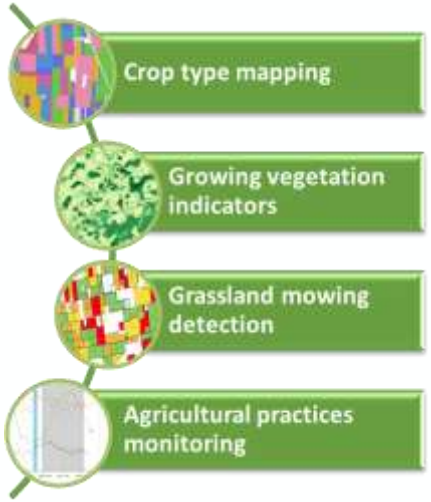
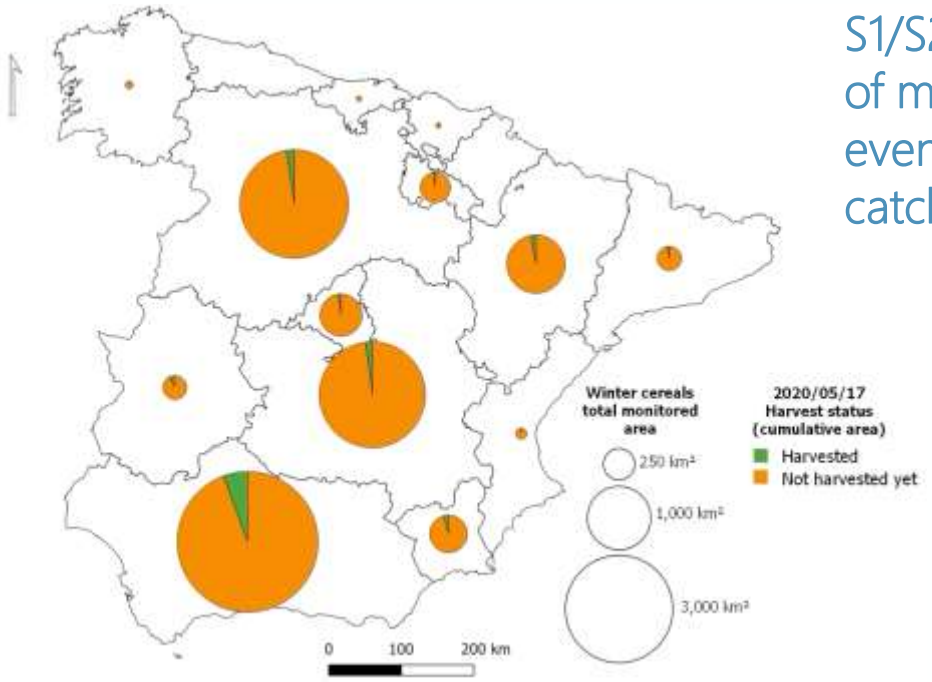
Enabling Agriculture monitoring and policies

sen4cap
common agricultural policy

Sen4Stat
Sentinels for Agricultural Statistics





S1/S2 Detection of mowing events, harvest & catch crops

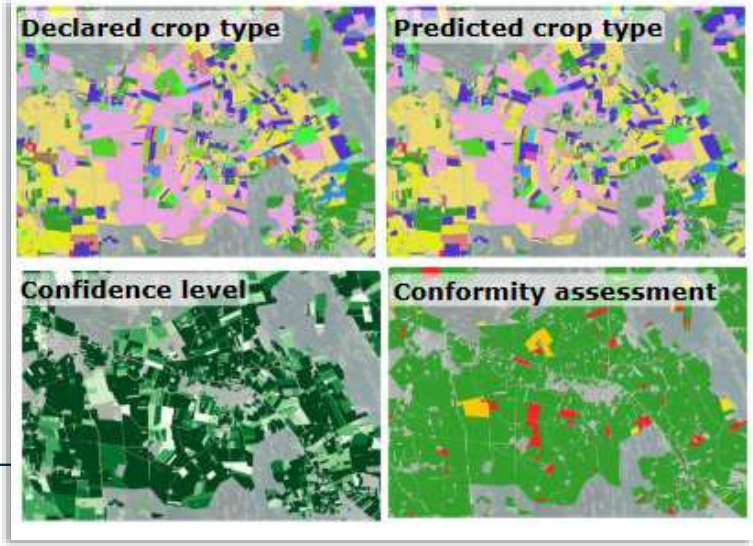
Involved stakeholders

Sen4CAP > 20 Paying Agencies are early adopters and integrating these EO-based solutions for monitoring. Sen4Stat four National Statistical Offices involved as early adopters.

International stakeholders are collaborating:

World Food Programme, IFAD, THE WORLD BANK, FAO, GEOGLAM Global Agricultural Monitoring

UCL Université catholique de Louvain, SINERGISE, gisat, e-geos, CS ROMÂNIA, CLS

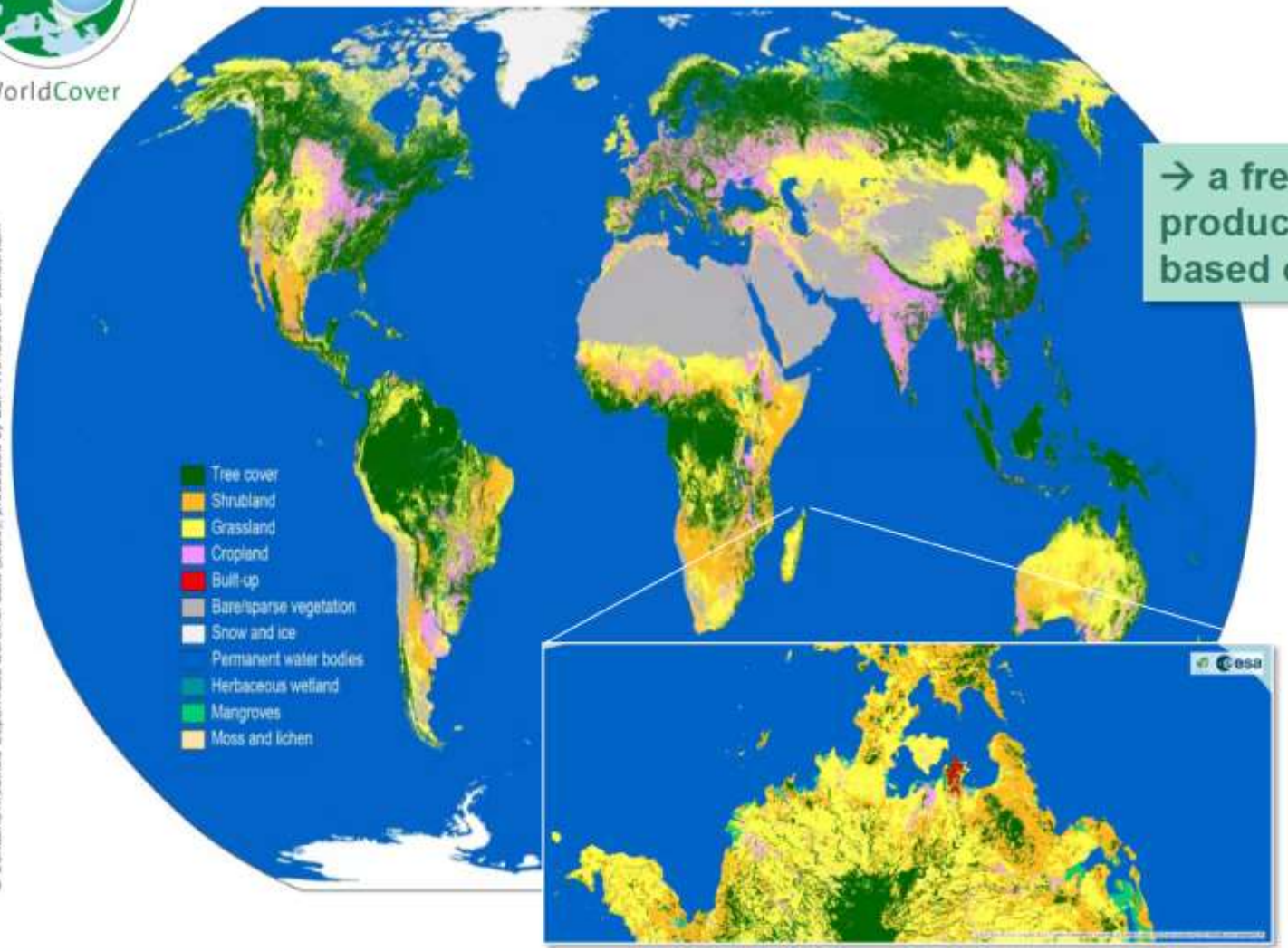


Accuracy:
80% (crop type) &
88% crop group

Worldwide Land Cover Mapping at 10m

WorldCover

sentinel-1 sentinel-2



WorldCover

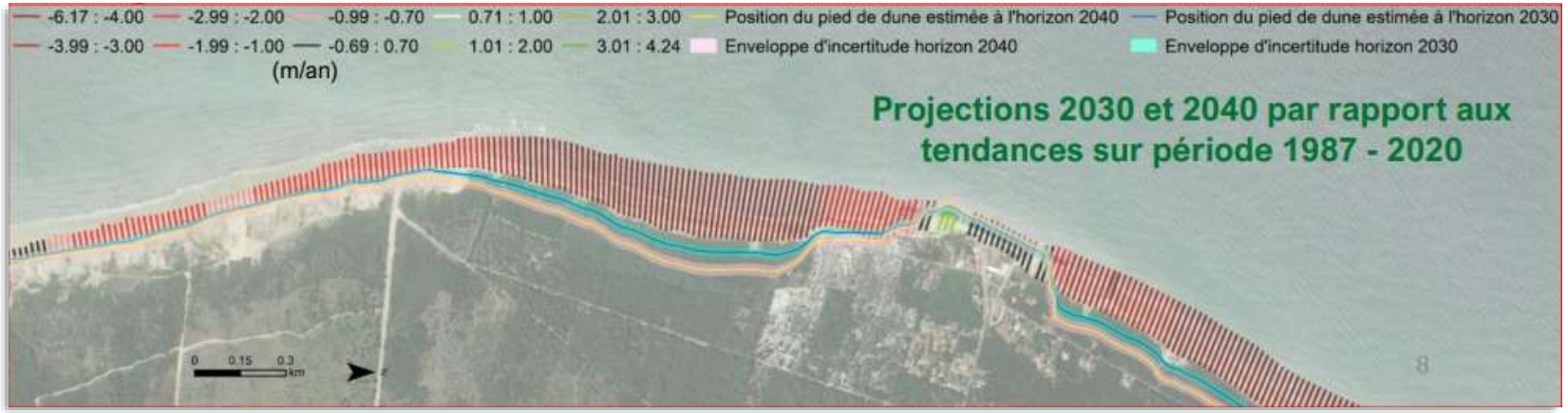
→ a freely accessible global land cover product at 10 m resolution for 2020, based on Sentinel-1 and Sentinel-2 data

- ✓ Released on 20th October 2021
- ✓ **11 classes, ≈74%** overall accuracy
- ✓ Independent data validation, highly robust for phenology, Copernicus DEM used as auxiliary data
- ✓ **Part of ESA EOEP-5** (Block 4 – EO Science for Society)

https://esa-worldcover.org/

Enabling Coastal Charting and Erosion monitoring

Monitoring of shoreline indicators and coastal erosion estimation.



Historical Erosion and Accretion monitoring.
Future projections of erosion evolutoin.
Major cliff events.

Involved stakeholders

National governmental agencies, regional authorities, intermunicipal cooperation and municipalities, as well as natural site managers, research centers and coastal observatories

Two parallel projects

ARGANS FRANCE i-Sea

Thousands of km over France, UK, Ireland, Spain Canada, Italy, Germany, Portugal, Greece, Romania, Norway

Earth Science for Society - Digital Platforms

Access and utilization of EO data shall be massively enhanced and democratized by accelerated use of ICT, bringing users to data and scalable hosted processing

RACE Dashboard

The Rapid Action on coronavirus and EO

The Rapid Action coronavirus Earth observation dashboard presents the results of the Joint cooperation between ESA and the European Commission on Covid 19 and EO.

The **platform** demonstrates how the use of **Earth observation** data can help shed new light on societal and economic changes currently taking place owing to the coronavirus pandemic.

RACE Project Summary

race.esa.int

532
INDICATORS

39
COUNTRIES
(EUROPE)

WEEKLY
UPDATES

- CHL-A & TOTAL SUSPENDED MATTER
- NO2, CO, PM2.5, PM10, O3
- TEMPERATURE, HUMIDITY, WIND
- PRODUCTION, HARVESTING
- WORKERS AVAILABILITY
- FREIGHT TRANSPORT
- PORTS & SHIPPING
- MANUFACTURING, MATERIALS
- AIR TRAVEL
- URBAN MOBILITY
- HEALTH

OPEN
SOURCE

114.710
VISITS

40
COMPANIES

REPRODUCIBLE
SCIENCE

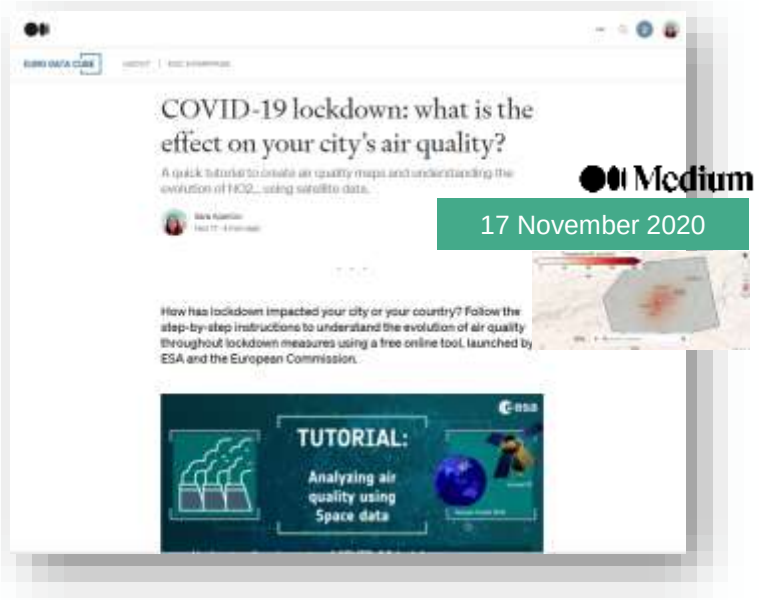
EDUCATIONAL
RESOURCES

3 COMMUNITY
CONTRIBUTIONS

How to use race.esa.int?

COVID-19 lockdown: What is the effect on your city's air pollution?

Step-by-step tutorial with simple and visual instructions on how to analyse (through graphs and EO image multitemporal comparison) the evolution of NO2 concentrations throughout lockdown periods.

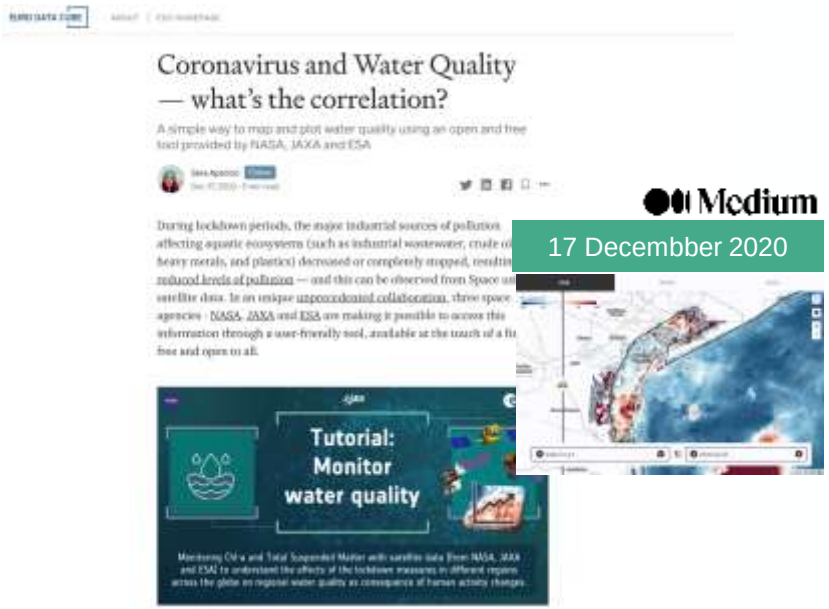


Building traffic maps with Space data

Step-by-step tutorial with simple and visual instructions to retrieve average number of trucks on motorways and primary roads on a location of choice.

Coronavirus and Water Quality - what's the correlation?

Step-by-step tutorial with simple and visual instructions to inspect water quality maps and water quality time series and combine and compare multi-mission data.



EURO DATA CUBE

Sentinel Hub – the world–leading operational Data Cube Platform

esa

Cloud API

170 k
registered users

500 M
processed requests

50+ PB
of satellite imagery

700 TB
added every month

4 Sentinel missions

7 Landsat missions, MODIS

Envisat, Airbus, Maxar, Planet

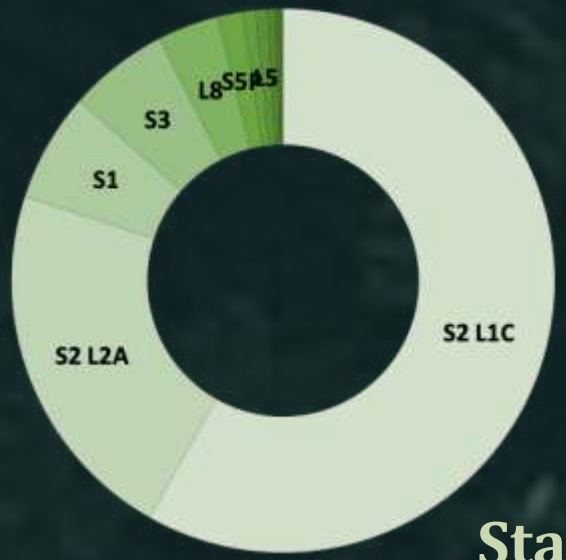
Copernicus Services

EO Browser

60 k
monthly visitors

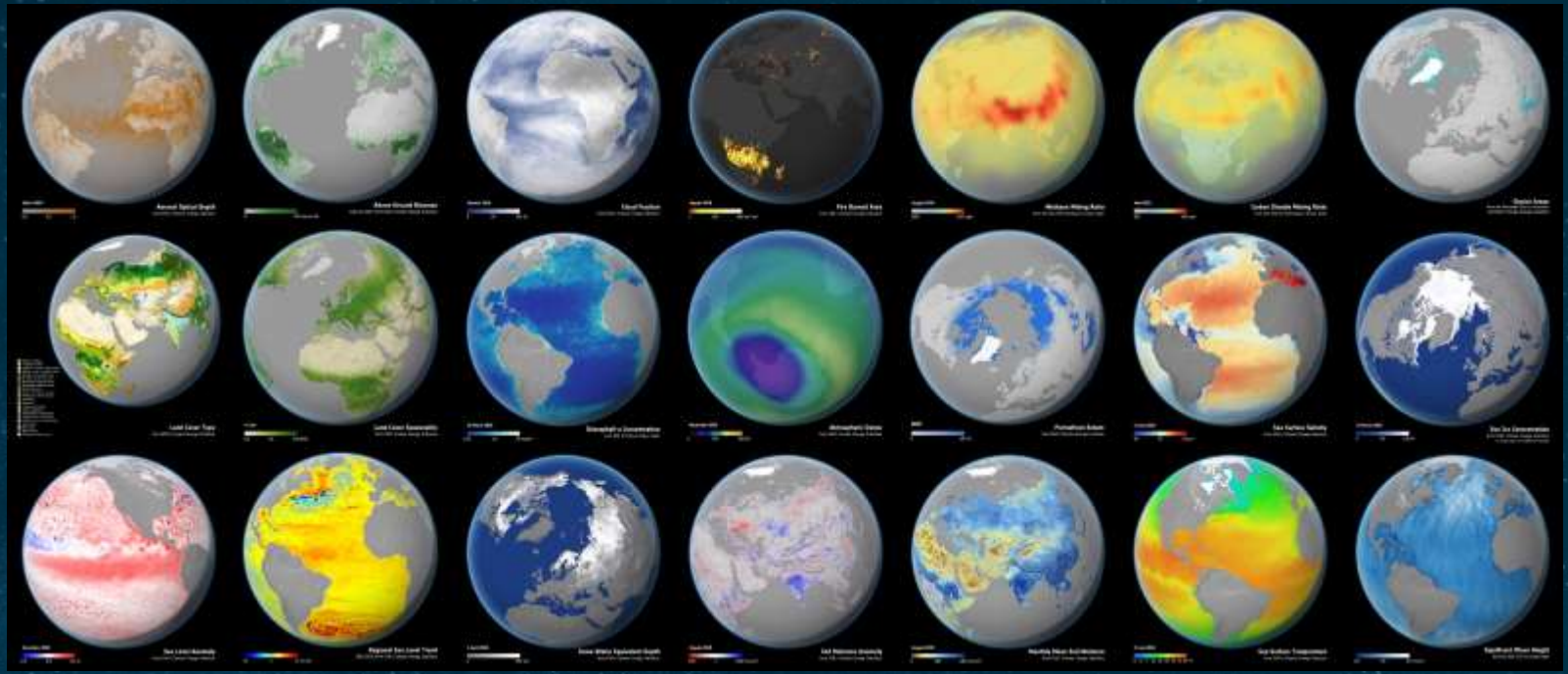
60 M
processed requests

Open-source and free to use



Statistics – September 2021

Visitors from 200 countries



Climate Change Initiative

The ESA CCI develops robust, global long term satellite datasets for 21 Essential Climate Variables as defined by the Global Climate Observing System.

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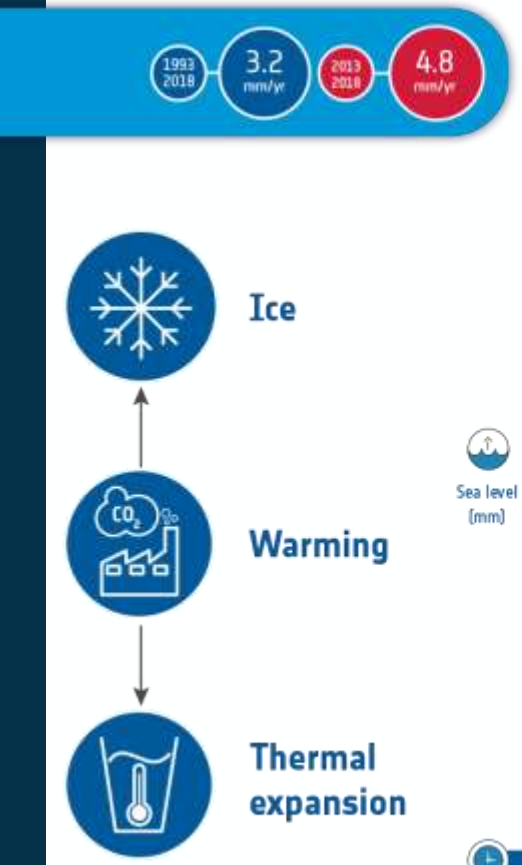
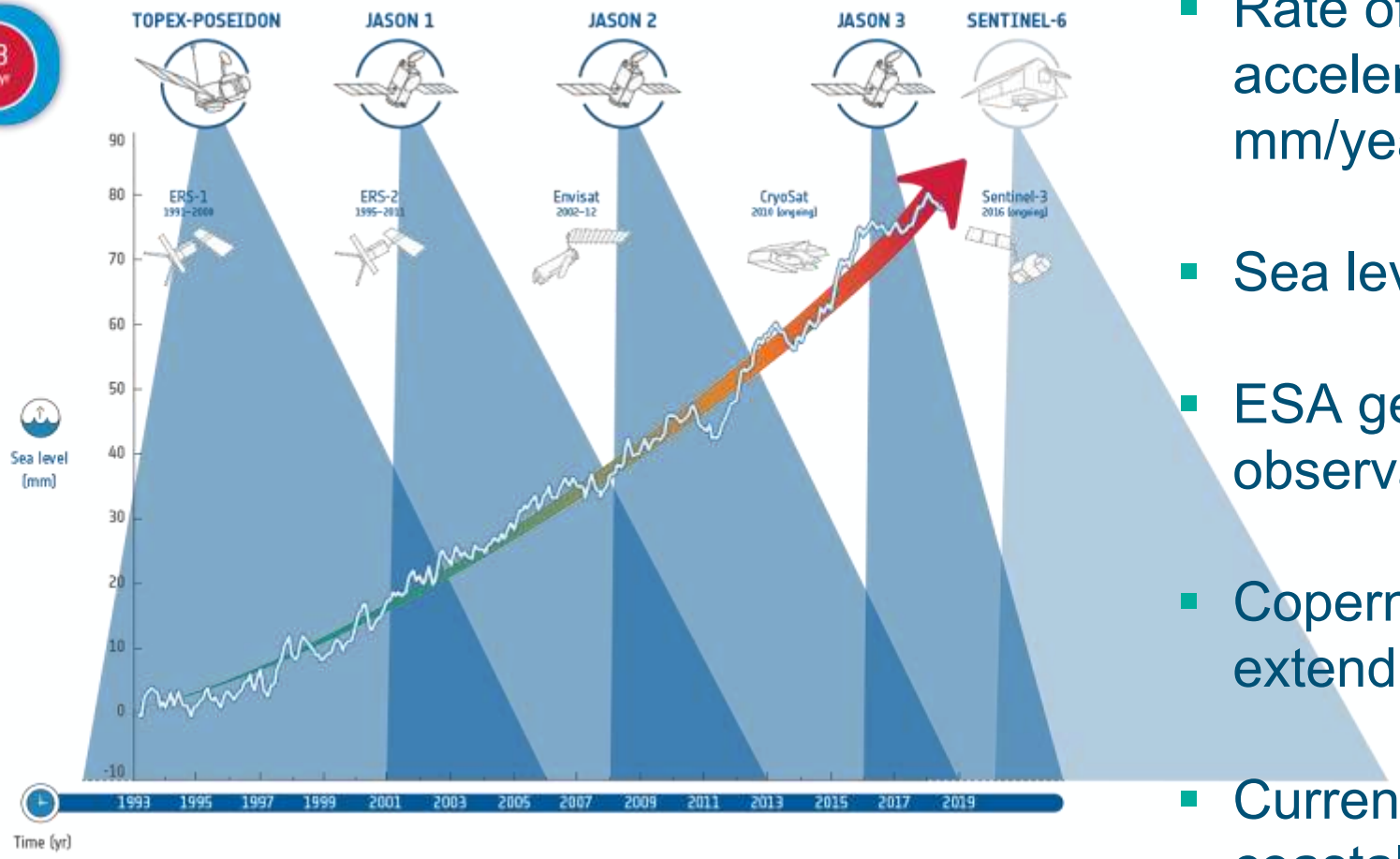
OBSERVING SEA LEVEL FROM SPACE





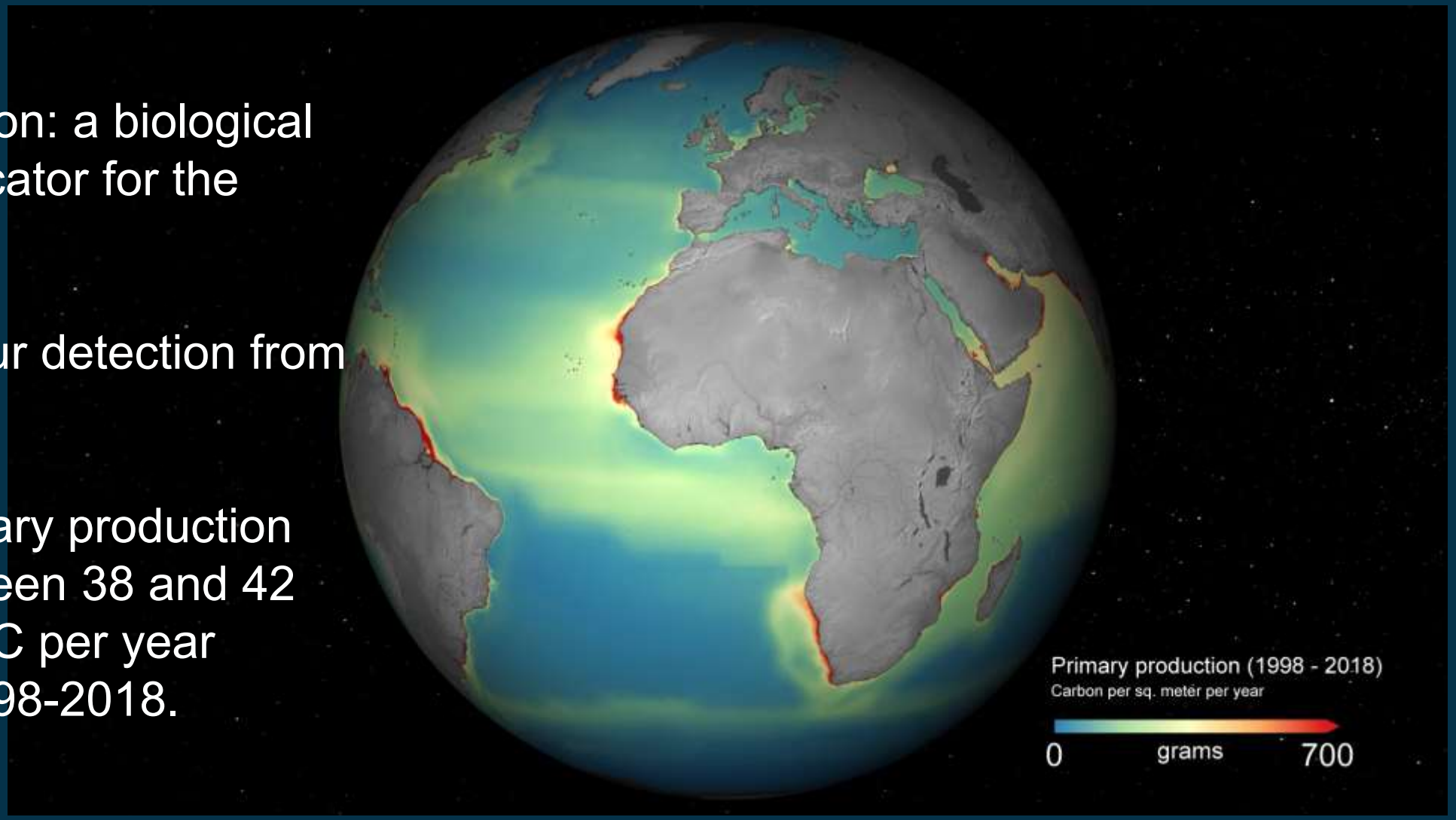
- Rate of sea level rise is accelerating (towards 4.5 mm/year)
- Sea level rise is not uniform
- ESA generating long term observation record
- Copernicus Sentinel-6, extending record
- Current area of focus on coastal sea level

TRACKING THE OCEAN'S LIVING CARBON PUMP

Phytoplankton: a biological climate indicator for the oceans.

Ocean colour detection from space

Global primary production varied between 38 and 42 gigatonnes C per year between 1998-2018.



OBSERVER: Mapping ground motion at European Scale: from dream to reality

https://www.copernicus.eu/en/news/news/observer-mapping-ground-motion-european-scale-dream-reality

Thu, 02/06/2022 - 12:00

Print to pdf

https://egms.land.copernicus.eu/

In May 2022 the Copernicus Land Monitoring Service launched the European Ground Motion Service. In this article we look at the making of the service and its significance to users.

Left image: landslide and subsidence in mountainous area east of Lyon, France - Basic Product; central image: bradyseism in Campi Flegrei, Naples – Basic product; right image: metropolitan area of Rome- Basic product; credits: EEA/Copernicus Land Monitoring Service/EGMS

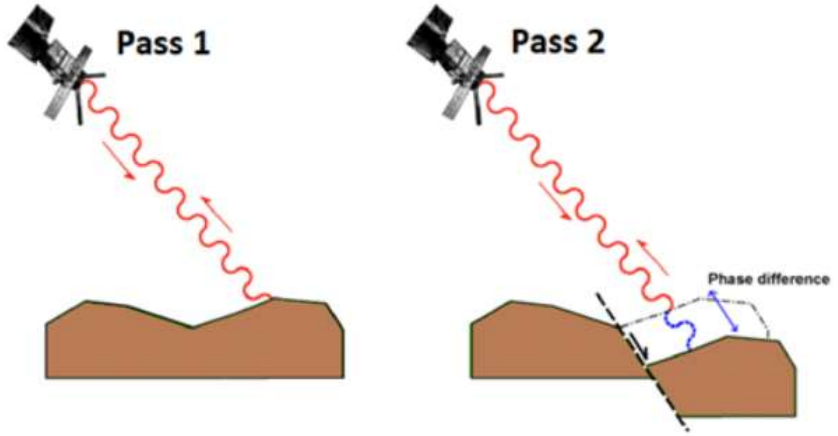
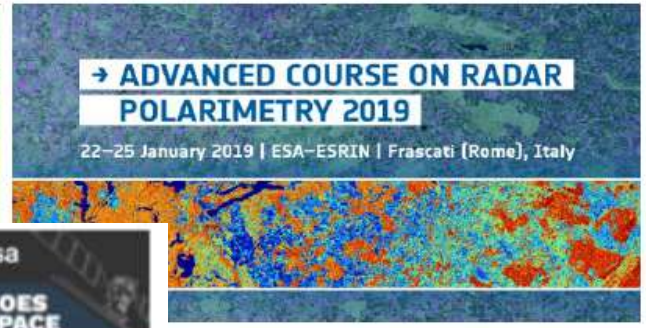


Figure 6: Principle of the InSAR techniques: sketch of phase-shift (Δr) detection by comparing two SAR images, produced by a ground deformation.

ESA EO Education/Training activities: opportunities and tools

Training & Education https://eo4society.esa.int/training-education/



A NEW ONE: Impact of COVID-19 measures on Atmospheric Composition

How did COVID-19 affect the atmosphere? Learn about the ICOVAC project and its findings

MORE INFO

A NEW ONE... EO from Space: The Cryosphere

Learn about the role of satellite Earth observation (EO) technology in monitoring the Earth's Cryosphere and the data it produces

MORE INFO

A NEW ONE... Land in Focus

A series of online learning materials suitable for anybody interested in the potential of remote sensing technologies for applications over land surfaces.

MORE INFO

AN ONGOING MOOC: Echoes in Space

Echoes in Space is suitable for anybody interested in getting an introduction to Radar images or looking to dive into the topic

MORE INFO

Earth Observation from Space: the Optical View

An introduction to optical Earth observation: monitoring our planet from satellites, using photography, imaging in various wavelengths, lidar and other optical sensing technologies

MORE INFO

Earth Observation: Disruptive Technology and New Space

A series of interviews with leading experts across Earth Observation and related technologies

MORE INFO

Monitoring Climate from Space

How does EO work, and how can it achieve the essential detail and comprehensive worldwide view that we need for climate monitoring

MORE INFO

The Frozen Frontier: Monitoring the Greenland Ice Sheet from Space

You'll look at the measurements made possible by Earth Observation (EO) satellites like Cryosat, the technologies and techniques involved, the data generated, and its uses and challenges

ESA EO training & educational Courses (in-presence and/or virtual), Webinars, Videos, MOOCs, Exercises, Tools, SW and GIS resources. From school level to universities and young-scientists
https://eo4society.esa.int/training-education/

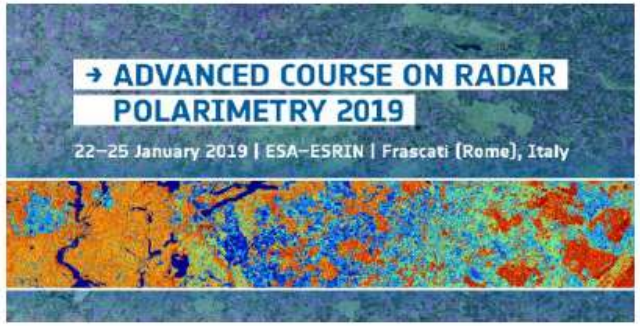
Links to some educational resources from ESA partners/partnerships, such as CEOS WG CapD, DLR/Jena, NASA/ARSET

Links to recent ESA EO MOOCs

- SAR MOOC (including CSA mini-MOOC)
- Land MOOC
- Atmo MOOC
- Cryo MOOC
- collaborative (Zero-Hunger, Jena/Germany coordination)

Online Courses and webinars on EO Applications

- Past ESA courses (eg Land course in Slovenia, Polarimetry in Toulouse …)
- Two ARSET / ESA webinars on SAR & Optical RS for Agriculture and Food Security
- RUS courses / webinars



Educational Toolboxes:

Demos/Tutorials/Exercises based on:

- SNAP
- PolSARpro
- EO Browser Edu Mode
- Hybrid ESA School Atlas (in preparation)

Future opportunities:

- Forthcoming courses (Land, Carbon permafrost & methane emissions in the Arctic…)
- ESA Earth System Science Hub; PHI Lab
- PUMAS training (such as: C/L/X/P band synergy, optical/SAR synergy, PolInSAR techniques and applications…)
- Training activities in preparation for future missions (Biomass, Rose-L ..)
- Potential for training offered by new tools such as ESA EO Open Platform (cloud environment for Jupyter processing), EO Dashboard, new AI developments

Thanks for your attention!

https://eo4society.esa.int/training-education/