Accessing Copernicus data and processing tools

BALTIC SAT APPS

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FINNISH METEOROLOGICAL INSTITUTE

Interreg Baltic Sea Region
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

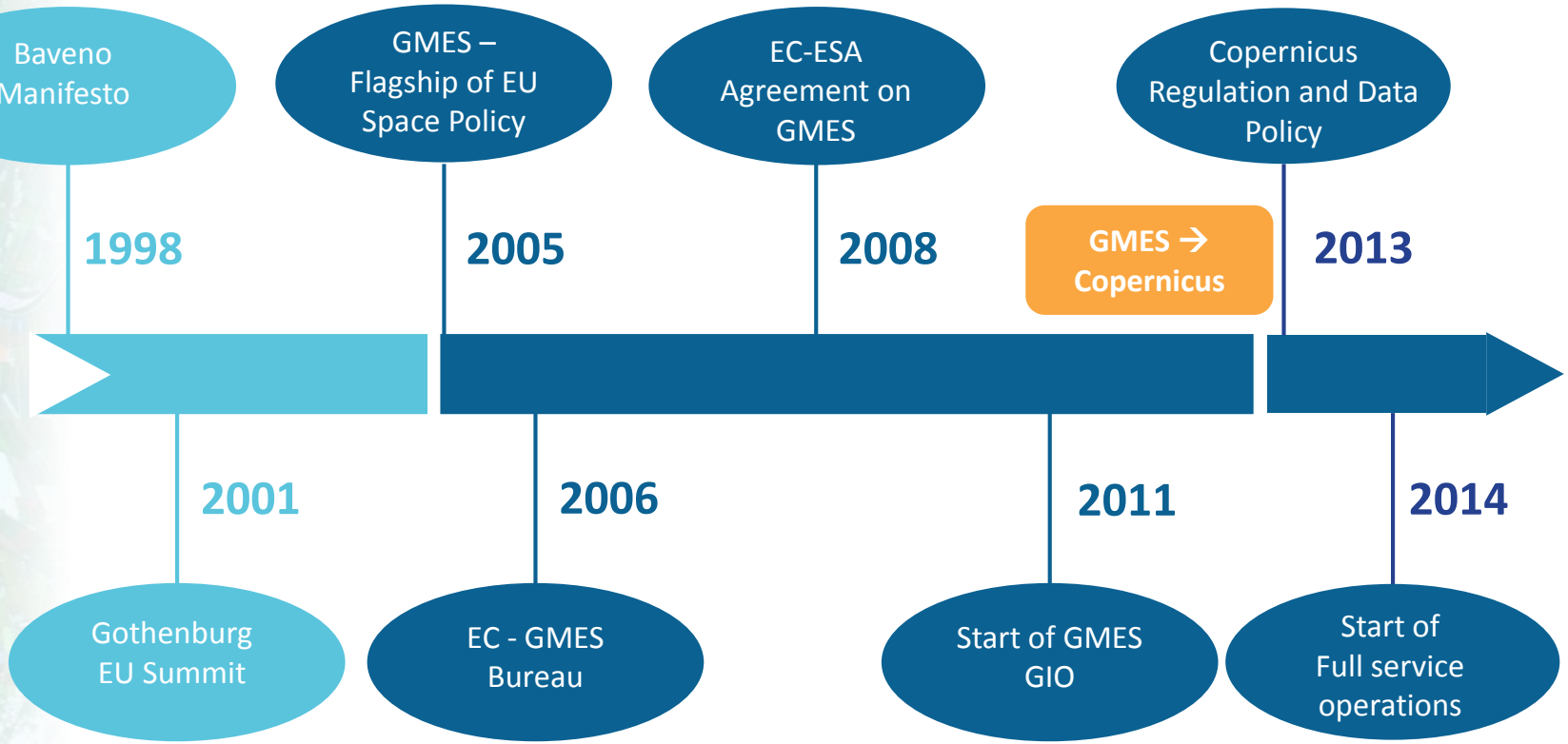
CONTENTS

- General overview of Copernicus
- Copernicus Sentinels
- Copernicus Data Access
- Some use cases
- Sentinel data toolbox and processing

COPERNICUS IN BRIEF

- **Copernicus, a flagship programme** of the European Union:
  - Monitors **the Earth,** its environment and ecosystems
  - Prepares for **crises, security risks** and **natural or man-made disasters**
  - Contributes to the **EU's role as a global soft power**
- Adopts a **full, free and open data policy**
- Is a tool for **economic development** and a driver for the **digital economy**

COPERNICUS HISTORY



GIO = GMES Initial Operation

Nicolaus Copernicus, Polish **Mikołaj Kopernik**, German **Nikolaus Kopernikus**, (born February 19, 1473, Toruń, Royal Prussia, Poland—died May 24, 1543, Frauenburg, East Prussia [now Frombork, Poland]), Polish astronomer who proposed that the planets have the Sun as the fixed point to which their motions are to be referred; that Earth is a planet which, besides orbiting the Sun annually, also turns once daily on its own axis; and that very slow, long-term changes in the direction of this axis account for the precession of the equinoxes. This representation of the heavens is usually called the heliocentric, or "Sun-centred," system—derived from the Greek *helios*, meaning "Sun." Copernicus's theory had important consequences for later thinkers of the scientific revolution, including such major figures as Galileo, Kepler, Descartes, and Newton. Copernicus probably hit upon his main idea sometime between 1508 and 1514, and during those years he wrote a manuscript usually called the *Commentariolus* ("Little Commentary").

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Nicolaus Copernicus / Quotes

To know that we know what we know, and to know that we do not know what we do not know, that is true knowledge.

Copernicus – the European EO programme

esa

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

FULL, FREE AND OPEN ACCESS TO DATA

- ATMOSPHERE MONITORING
- MARINE ENVIRONMENT MONITORING
- LAND MONITORING
- CLIMATE CHANGE
- EMERGENCY MANAGEMENT
- SECURITY

opernicus
Europe's eyes on Earth

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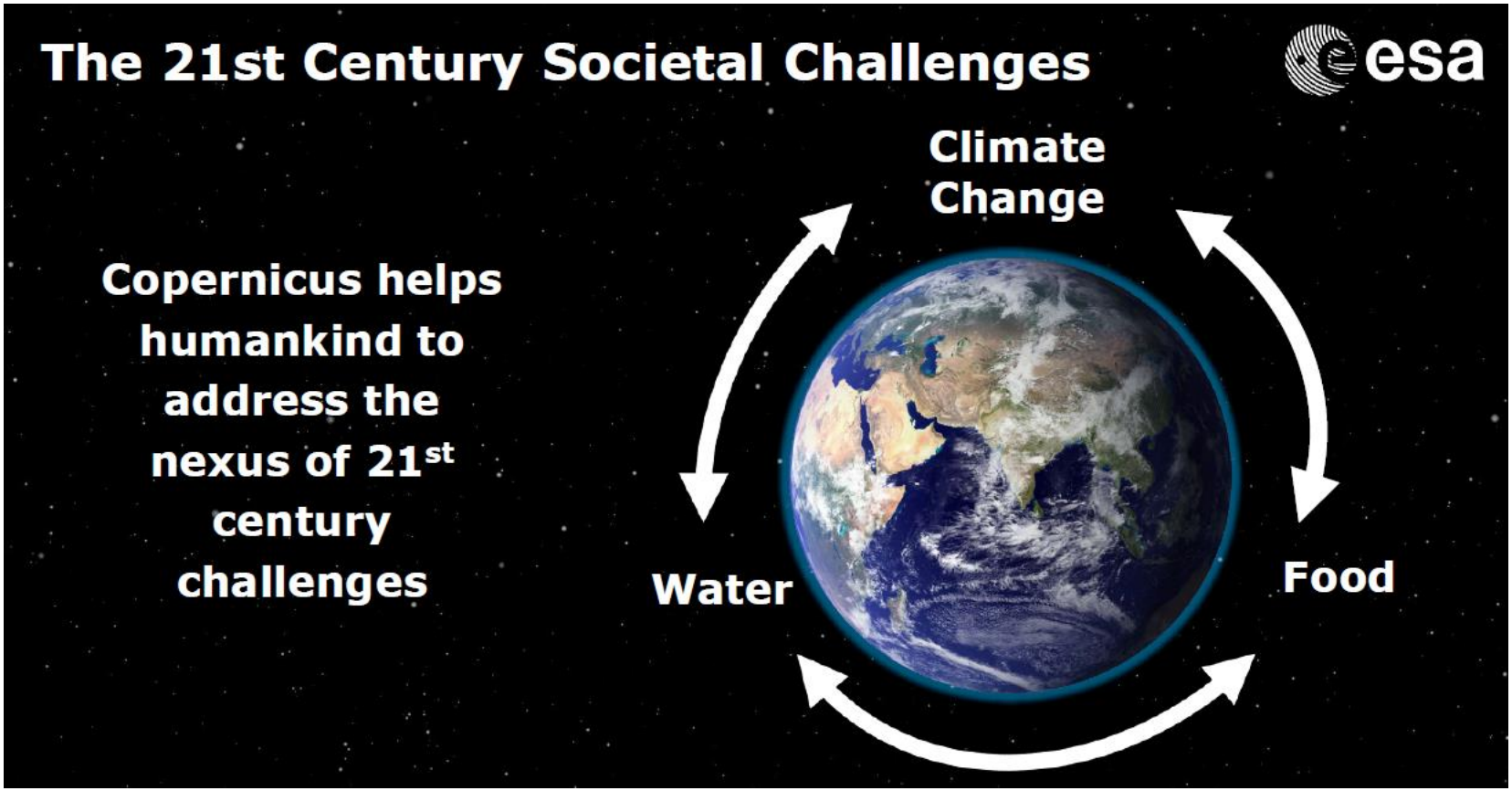

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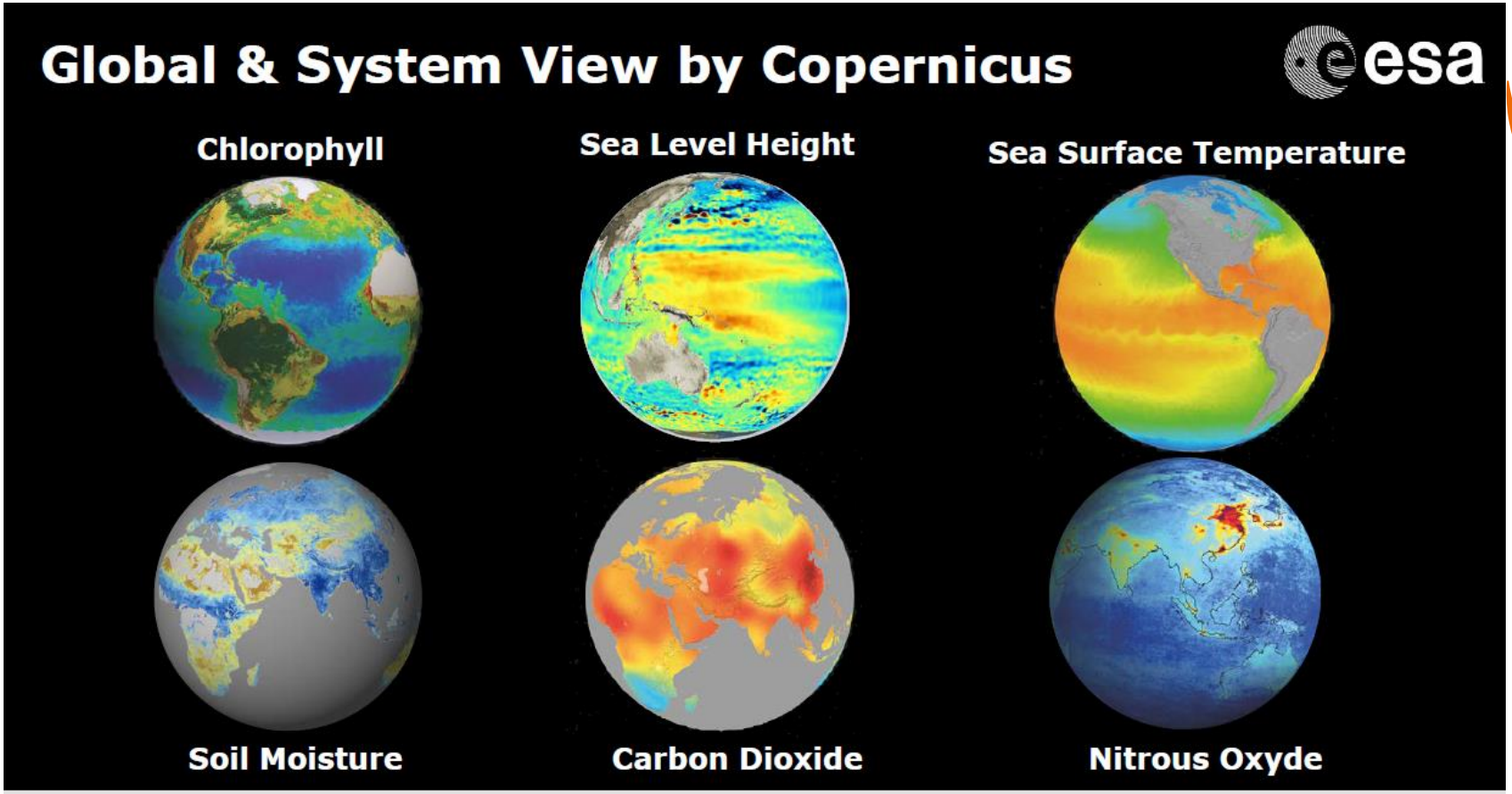

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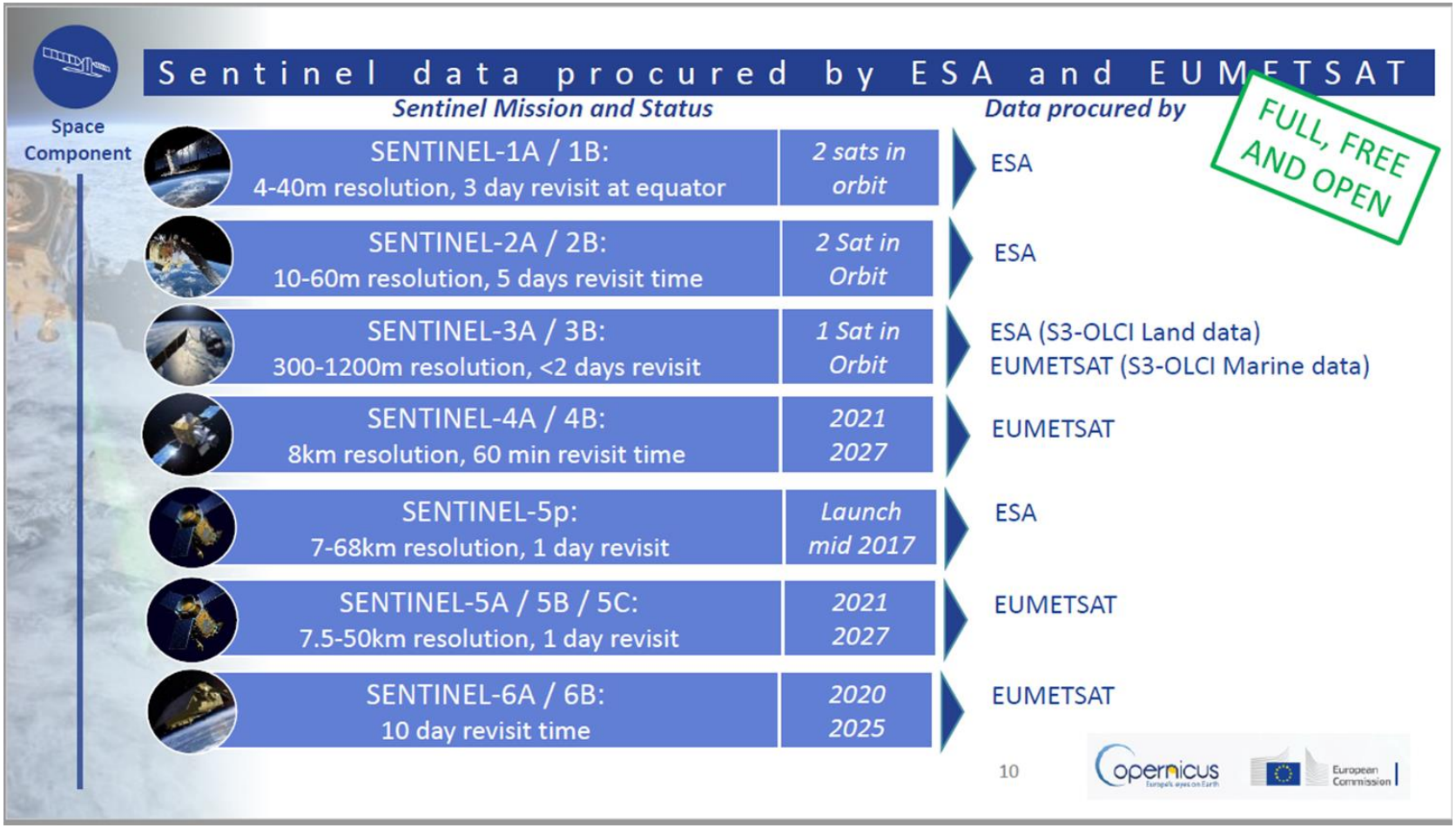

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The Copernicus Sentinels Explained

	**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

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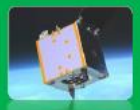
Copernicus Contributing Missions

Optical High & Very High Resolution

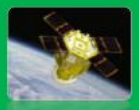
DMC



Pléiades

RapidEye

Deimos-2

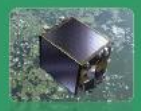


SPOT (HRS)

Optical Medium & Low Resolution

SPOT

PROBA-V



Synthetic Aperture Radar

Cosmo SkyMed

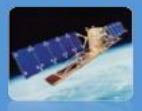
Radarsat

TerraSAR-X Tandem-X

Altimetry

Cryosat

Jason



Atmosphere

MetOp

MSG

and many more ...

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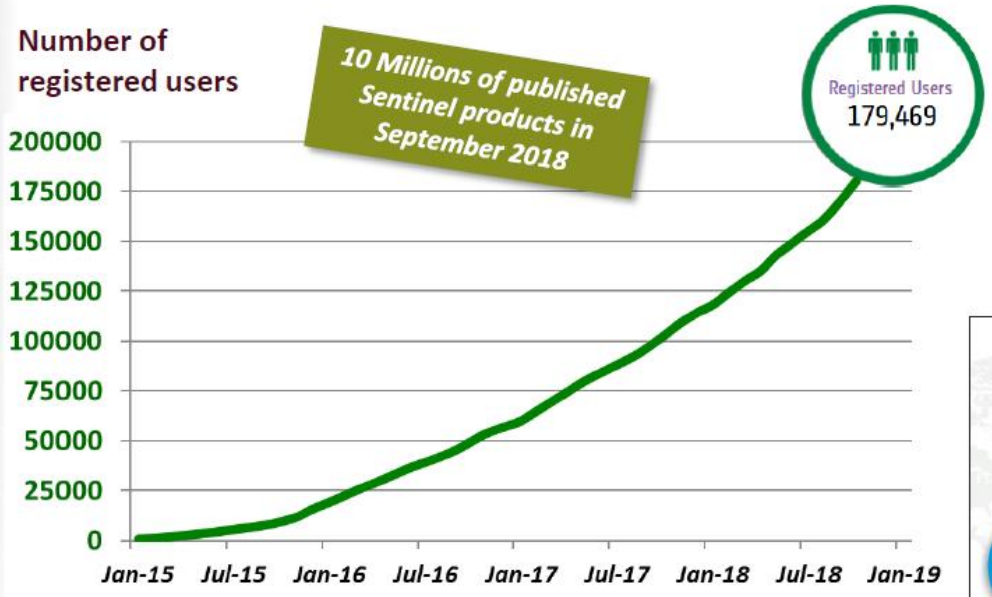
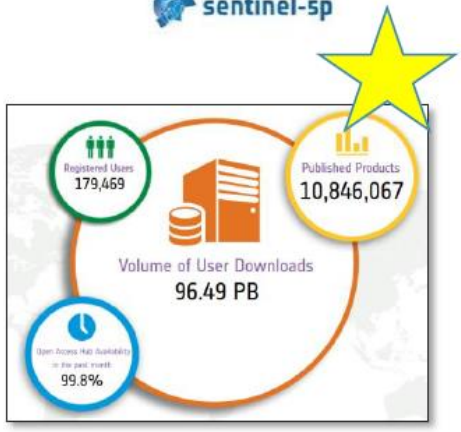
Data Access

Evolution of registered users on Sentinel Open Access Hub



sentinel-1a
sentinel-1b
sentinel-2a
sentinel-2b
sentinel-3a
sentinel-5p



Statistics at end-October 2018

Copernicus Europe's eyes on Earth

European Commission

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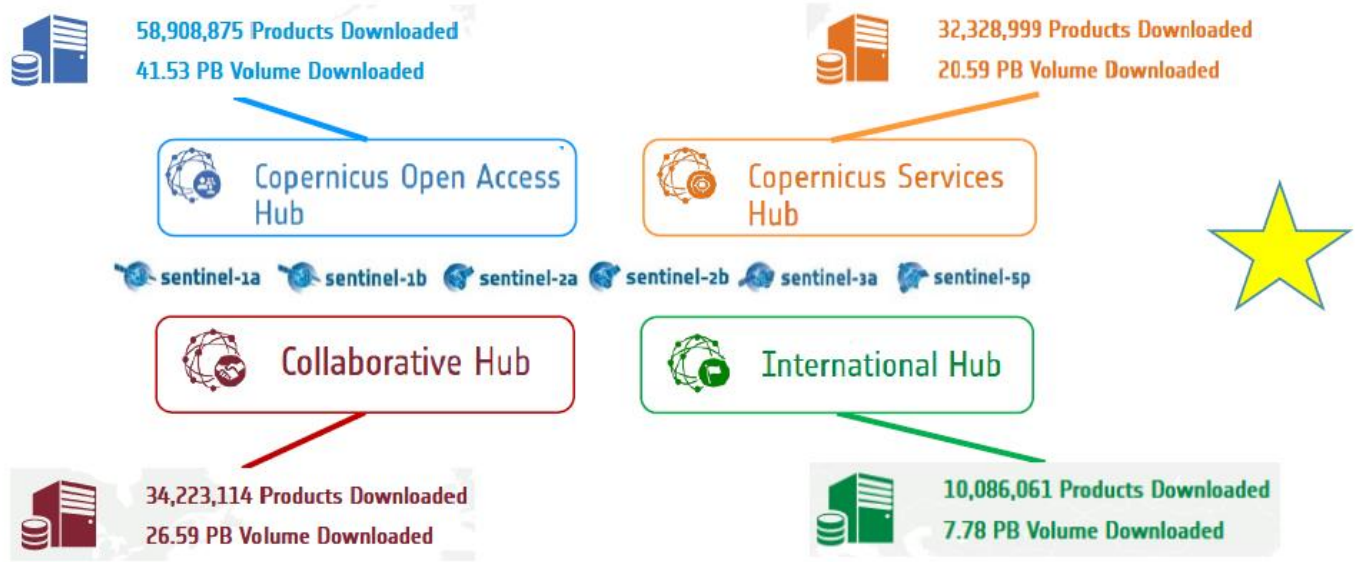
Sentinels Data Access – Four Access Hubs

Data Access

The four Copernicus Sentinel data access hubs operated by ESA

→ *the enabler of a wide distribution to users*



Statistics at end-October 2018

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Data & Information Access Services (DIAS)

Data Access

e.copernicus.eu/DIAS

THE DIAS & WHERE TO REACH THEM

CREODIAS

WWW.CREODIAS.EU

sobloo

WWW.SOBLOO.EU

mundi WEB SERVICES

WWW.MUNDIWEBSERVICES.COM

ONDA

WWW.ONDA-DIAS.EU

WEkEO

WWW.WEKEO.EU

EUMETSAT

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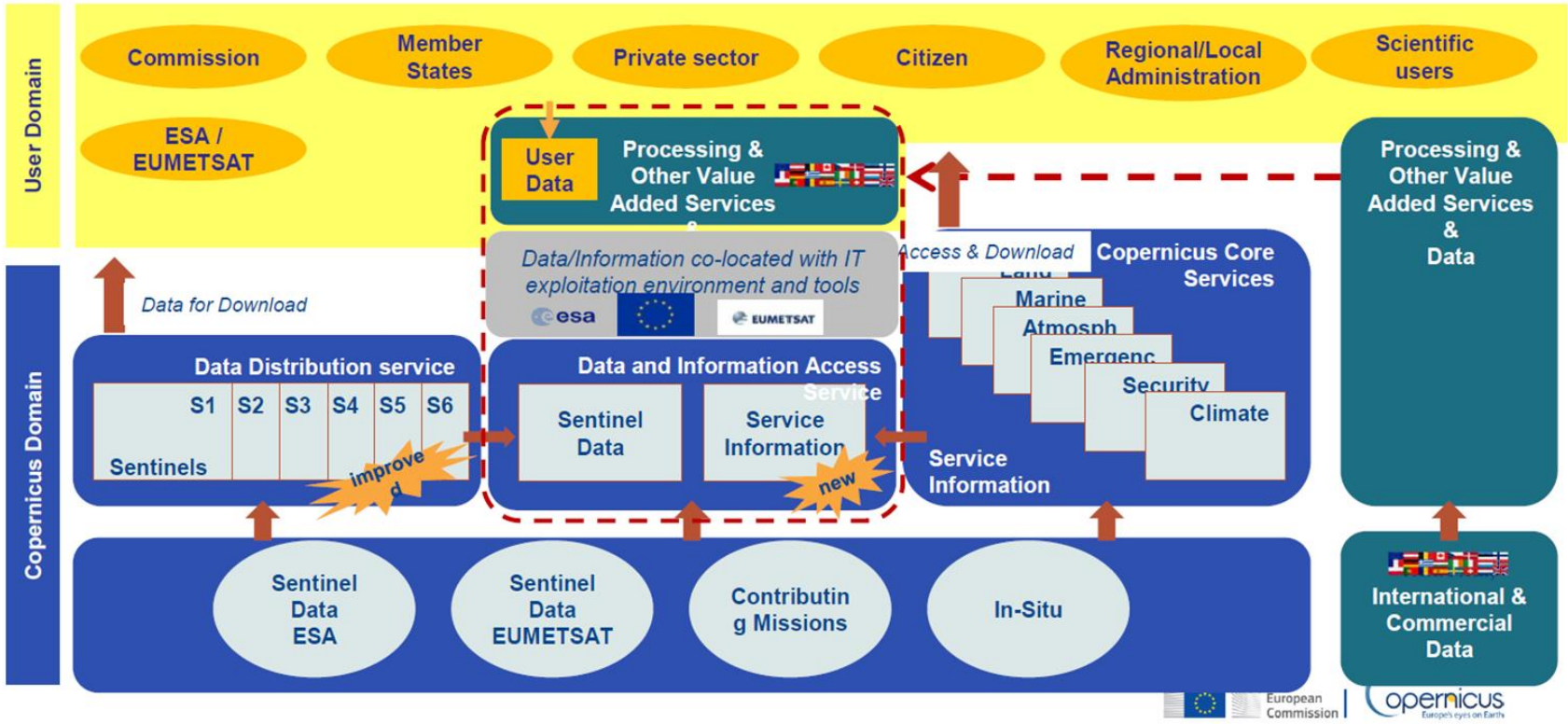
European Commission

Overview Distribution and DIAS



OTHER DATA ACCESS PUBLIC INITIATIVES

National Initiatives- Collaborative Ground Segment

Initiative Name	Initiative Leader	Website and Target User Group
SWEA	SNSB, Spacemetric	• URL: expected in the coming months • Scientific communities, public authorities, private industry players
NOA Hellenic National Sentinel Data Mirror Site	NOA, IAASARS	• URL: sentinels.space.noa.fr • Scientific communities, public authorities, private industry players
CATAPULT Satellite Applications and CEDA	UK Space Agency	• URL: sa.catapult.org.uk • Scientific communities, public authorities, private industry players
ESA Thematic Exploitation Platforms	ESA	• URL: tep.eo.esa.int • All user types
Platform for Exploiting Products from Sentinels (PEPS1)	CNES	• URL: peps.cnes.fr • Scientific communities and public authorities

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Data Access

OTHER DATA ACCESS PRIVATE INITIATIVES

Private Initiatives

Initiative Name	Initiative Leader	Website and Target User Group
CLOUDEO	CloudEO	• URL: cloudeo-ag.com • Users and developers of geo services, providers of geo data, services, applications and tools
Earth Observation Data Centre (EODC) for water resources monitoring	Vienna University of Technology Department of Geodesy and Geo-info	• URL: eodc.eu • Regional public authorities and private users
GEOPEDIA platform	Sinergise	• URL: geopedia.world • National, regional public authorities and private users
GEOSTORM platform	CS-SI	• URL: geostorm.eu • Regional authorities and private users
Sentinel-2 on AWS	Amazon	• URL: sentinel-pds.s3-website.eu-central-1.amazonaws.com • Developers, private/public downstream players
Google Earth Engine	Google	• URL: earthengine.google.com • Regional authorities and private users

* The European Commission does not endorse any particular commercial solution

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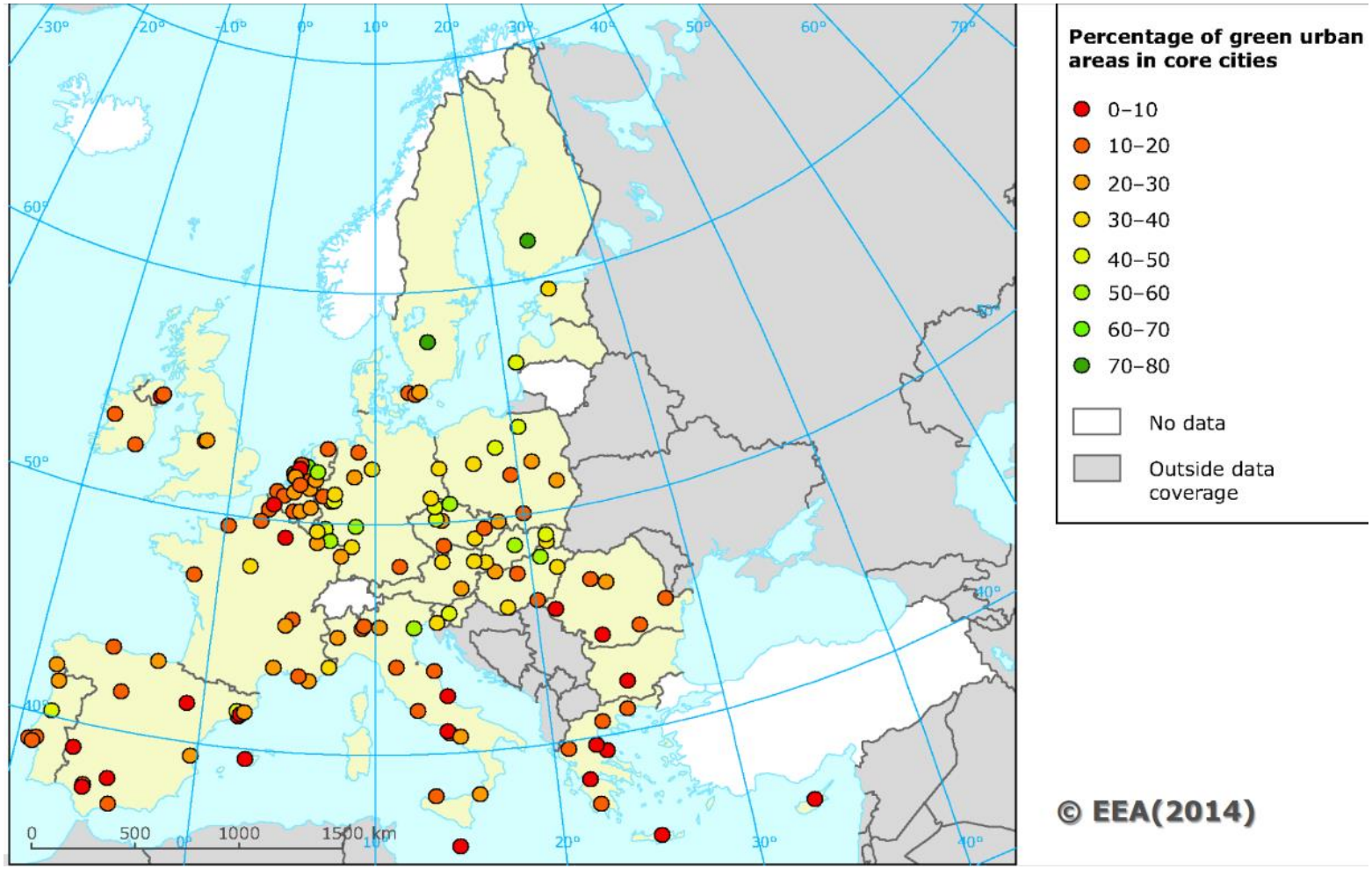
Copernicus Services Component

Copernicus-services

- Six thematic services (http://copernicus.eu/main/services), with products
  - **Atmosphere** (Copernicus Atmosphere Monitoring Service, CAMS) https://atmosphere.copernicus.eu/ (Europe's air quality forecast etc.)
  - **Marine** (Copernicus Marine Environment Monitoring Service, CMEMS) http://marine.copernicus.eu/ (marine products, trends etc.)
  - **Land** (Copernicus Land Monitoring Service, CLMS) https://land.copernicus.eu/ (Global, Pan European and local; landcover/usage, urban atlas, CLC 2012, tree cover density 2015, hotspots)
  - **Climate** (Copernicus Climate Change Service, C3S) https://climate.copernicus.eu/ (monthly maps to tell about the state of climate at that moment etc.)
  - **Emergency** (Copernicus Emergency Management Service, EMS) http://emergency.copernicus.eu/ (EMS-map showing flooding, forest fires etc.)
  - **Security** (Copernicus service for security applications) http://copernicus.eu/main/security (preventing and preparing for crises)



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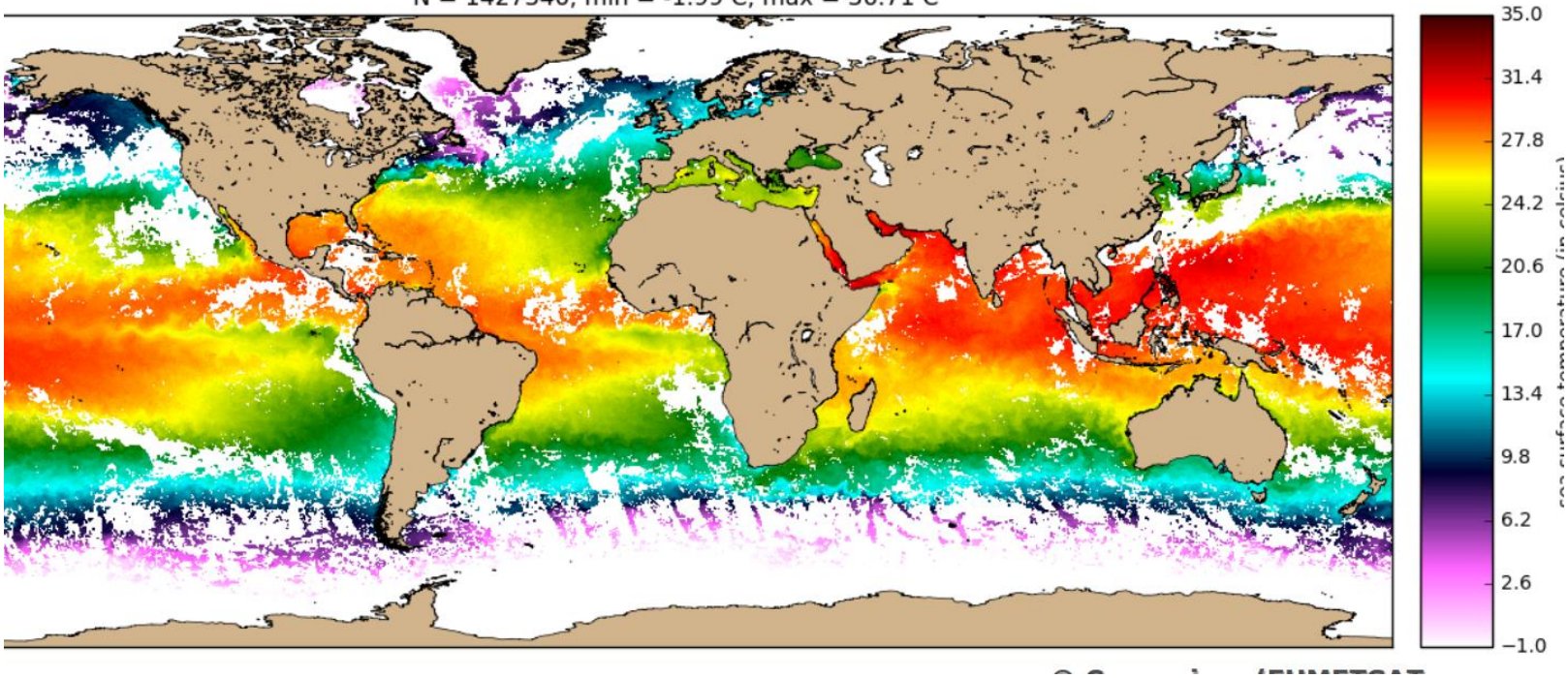
Sea Surface Temperature

15-19 Jun 2017 composite - Sentinel-3A / SLSTR WST NR [PB2.16]-
N = 1427346, min = -1.99 C, max = 36.71 C



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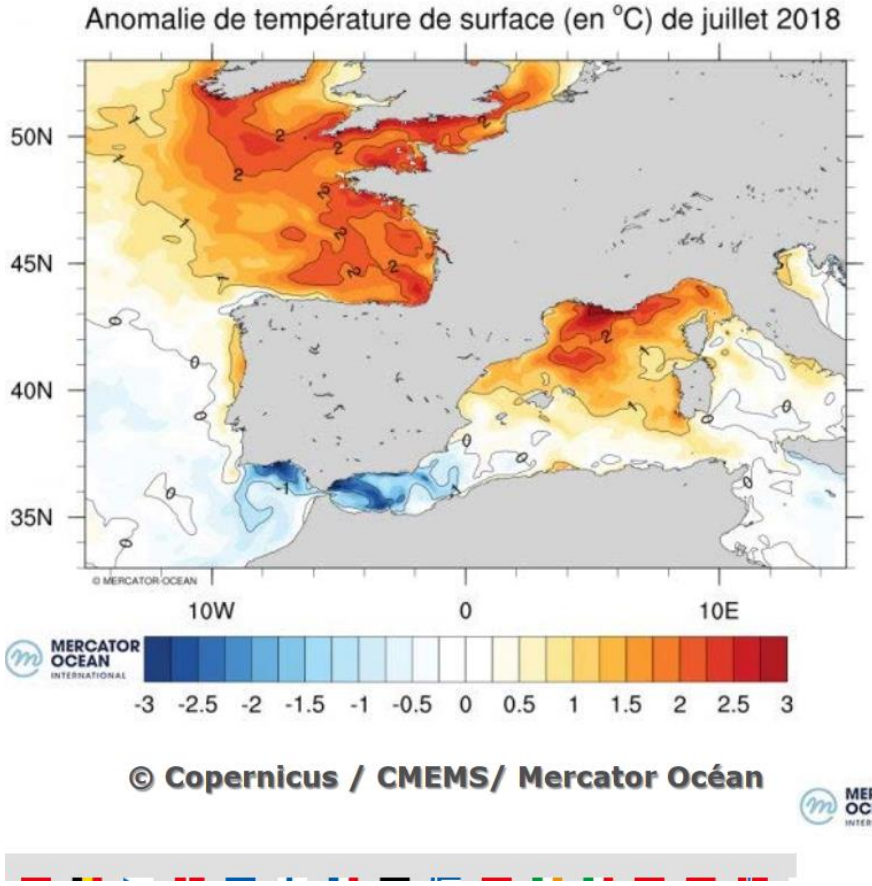
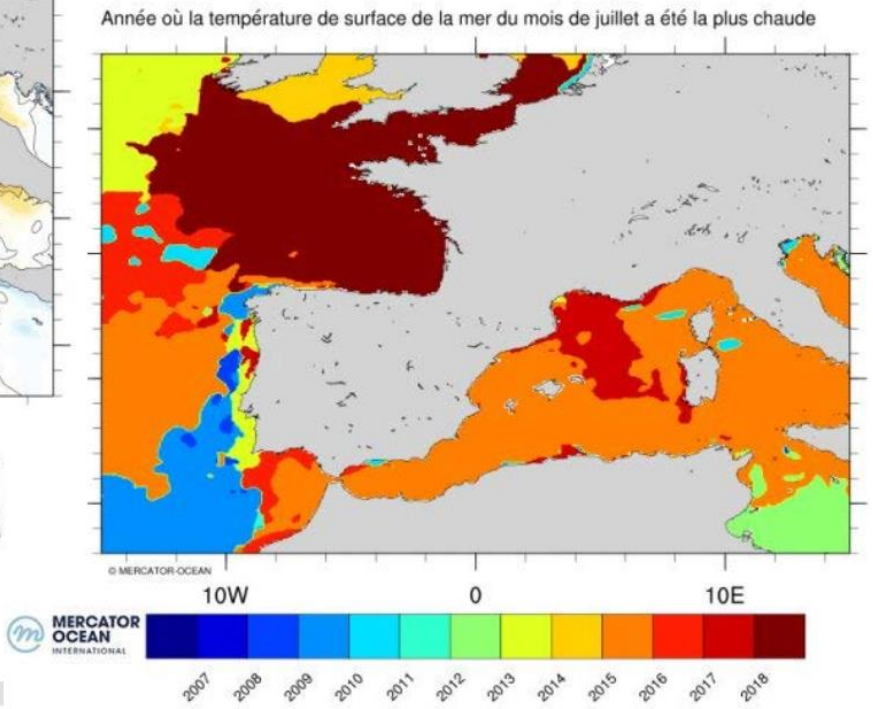
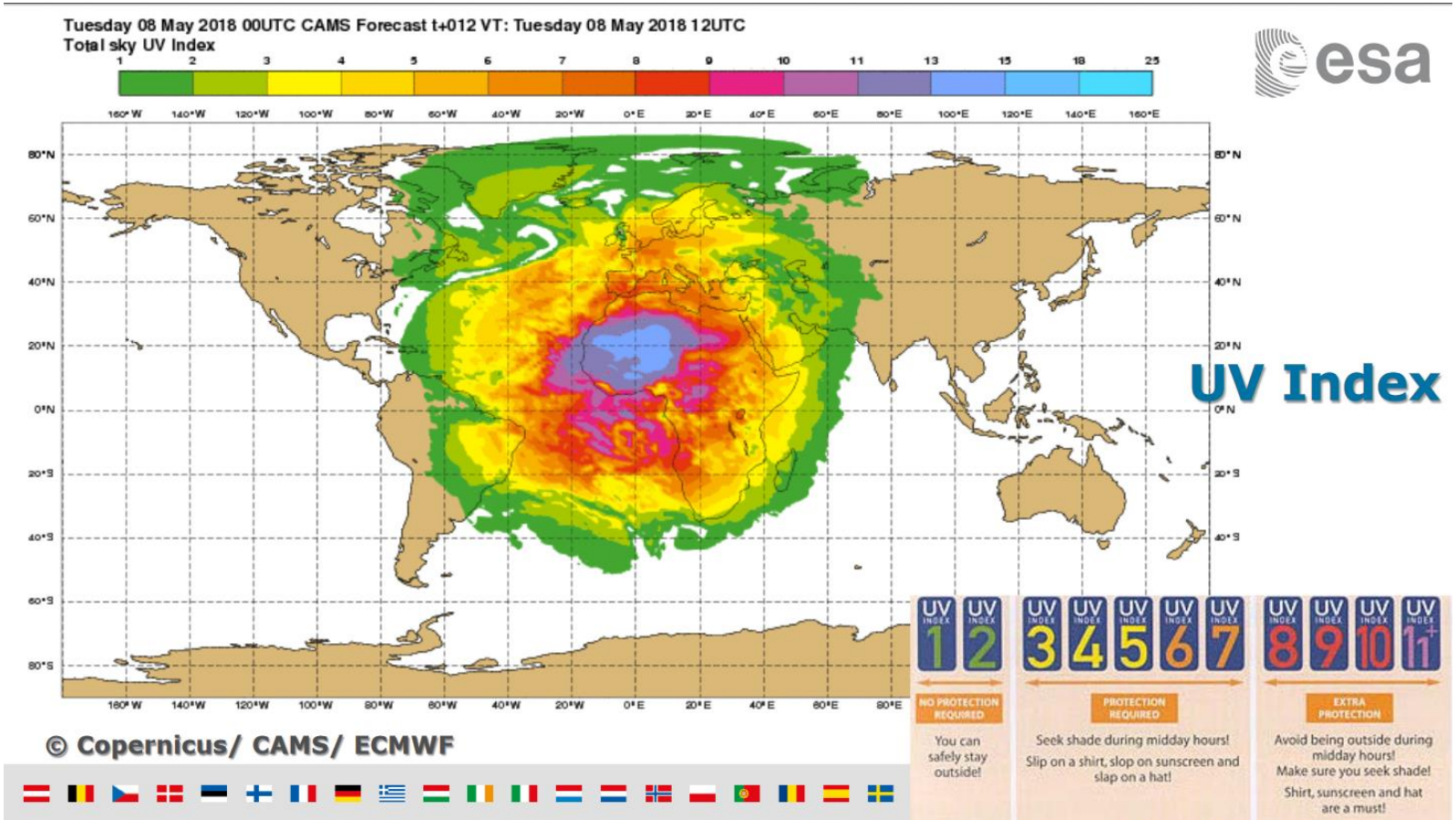

Anomalie de température de surface (en °C) de juillet 2018
50N
45N
40N
35N
10W
0
10E
© MERCATOR-OCEAN
MERCATOR OCEAN INTERNATIONAL
-3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3
© Copernicus / CMEMS/ Mercator Océan


Année où la température de surface de la mer du mois de juillet a été la plus chaude
© MERCATOR-OCEAN
10W
0
10E
MERCATOR OCEAN INTERNATIONAL
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018


Tuesday 08 May 2018 00UTC CAMS Forecast t+012 VT: Tuesday 08 May 2018 12UTC
Total sky UV Index
1 2 3 4 5 6 7 8 9 10 11 13 15 18 25
© Copernicus/ CAMS/ ECMWF
UV Index
UV INDEX 1 2
NO PROTECTION REQUIRED
You can safely stay outside!
UV INDEX 3 4 5 6 7
PROTECTION REQUIRED
Seek shade during midday hours!
Slip on a shirt, slop on sunscreen and slap on a hat!
UV INDEX 8 9 10 11+
EXTRA PROTECTION
Avoid being outside during midday hours!
Make sure you seek shade!
Shirt, sunscreen and hat are a must!

Monitoring ice caps melting

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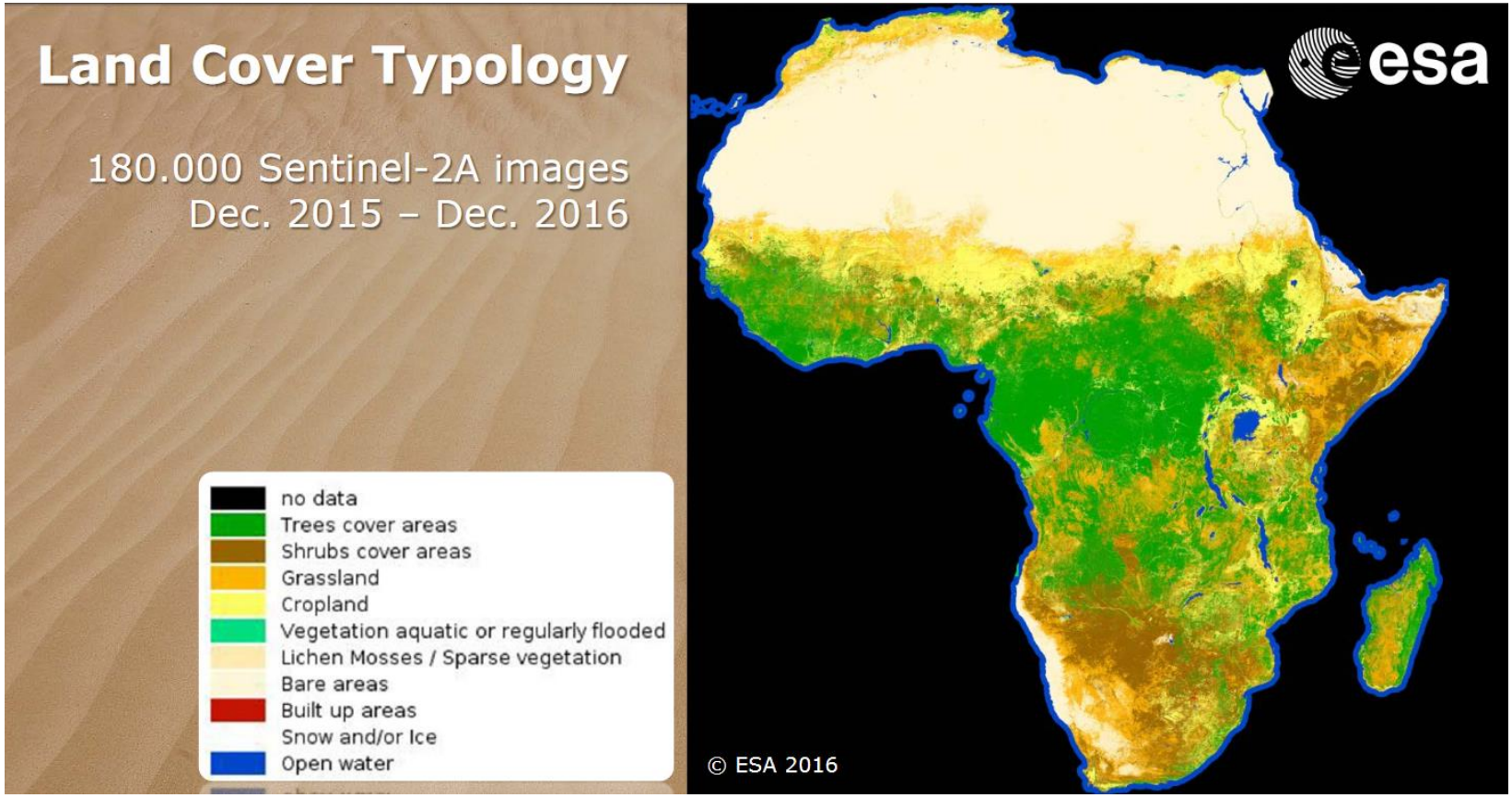

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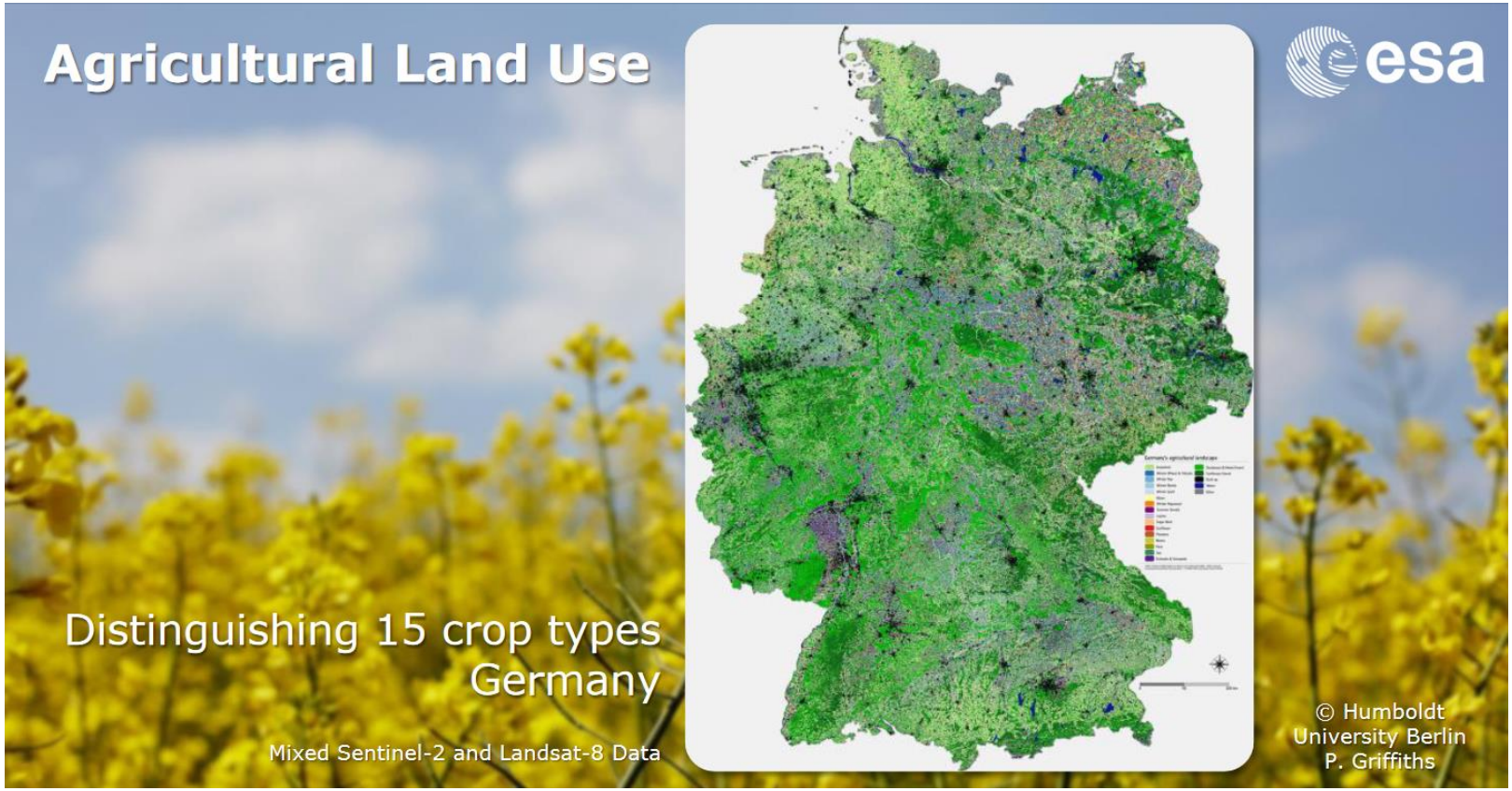

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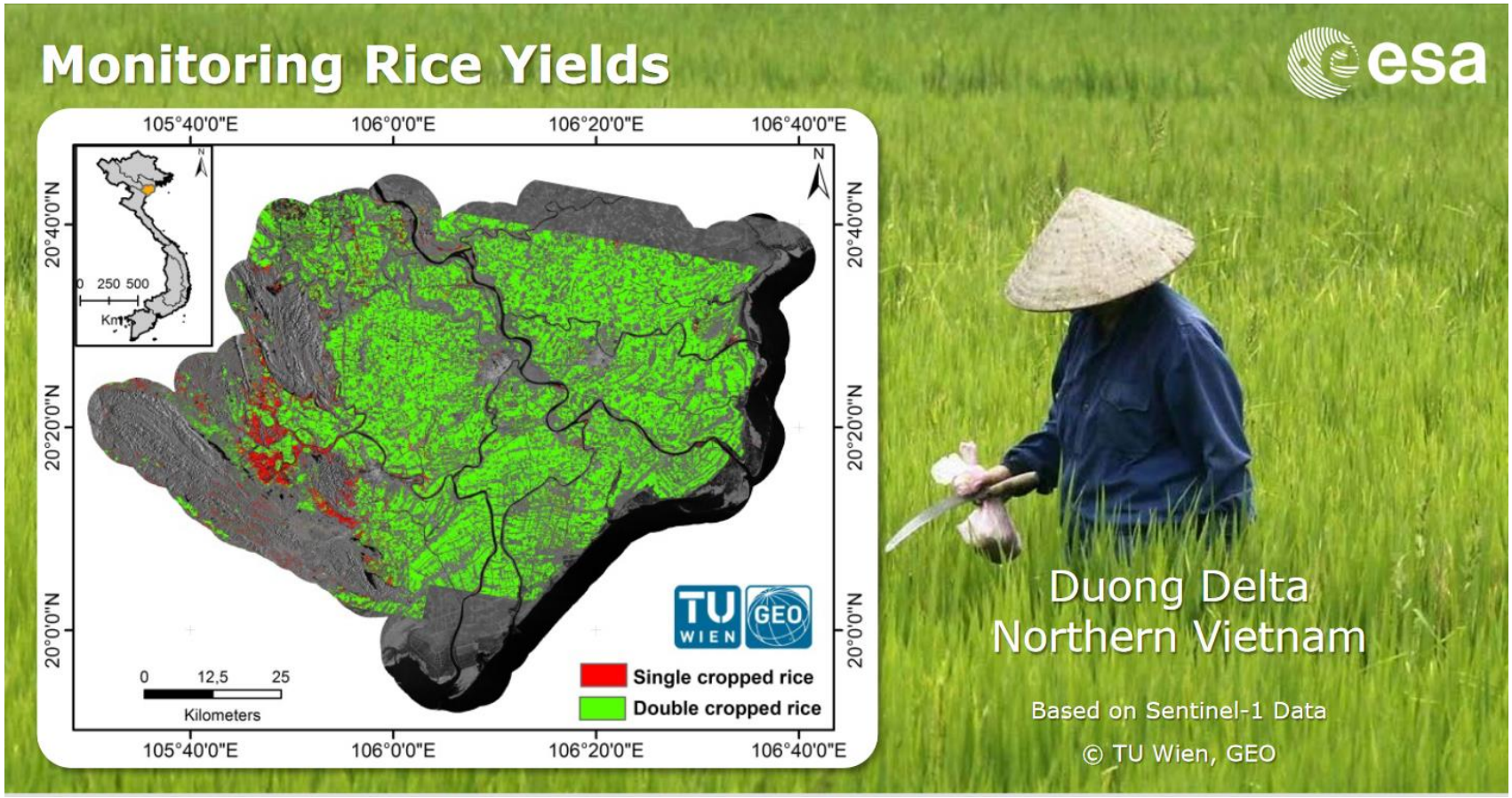

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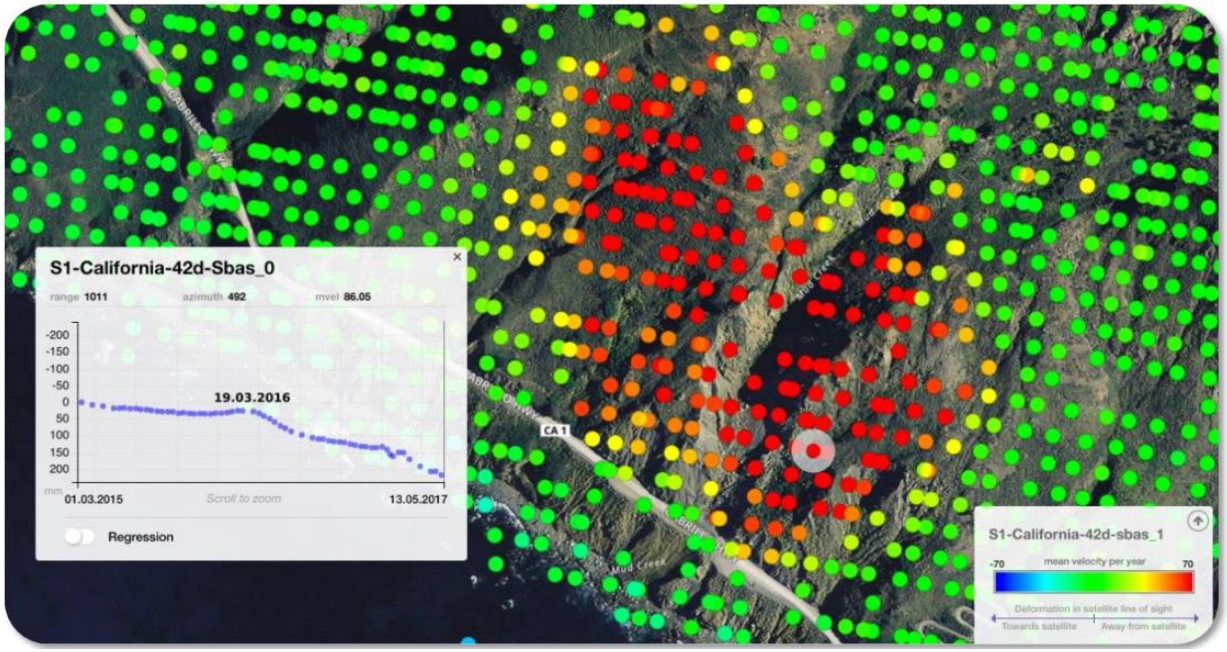
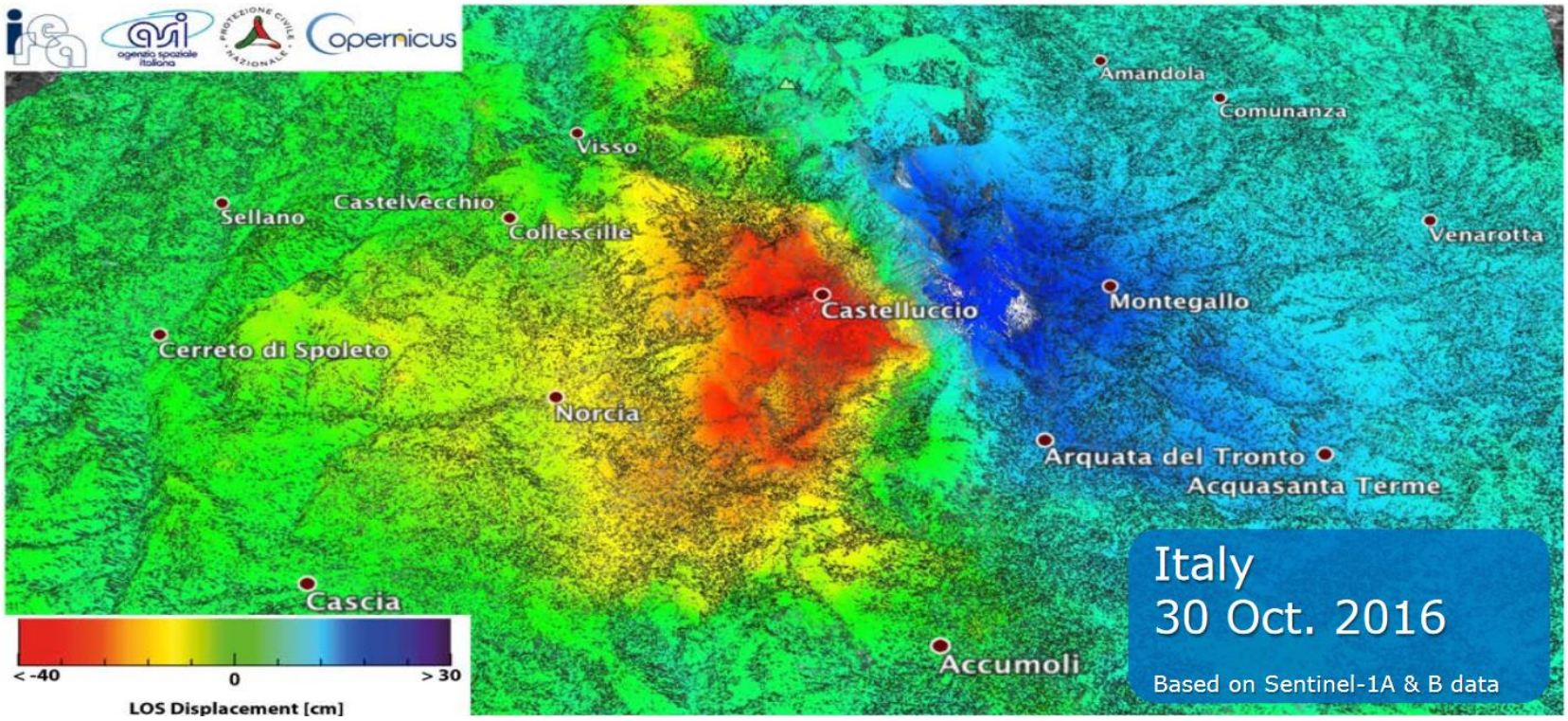
Land Slides



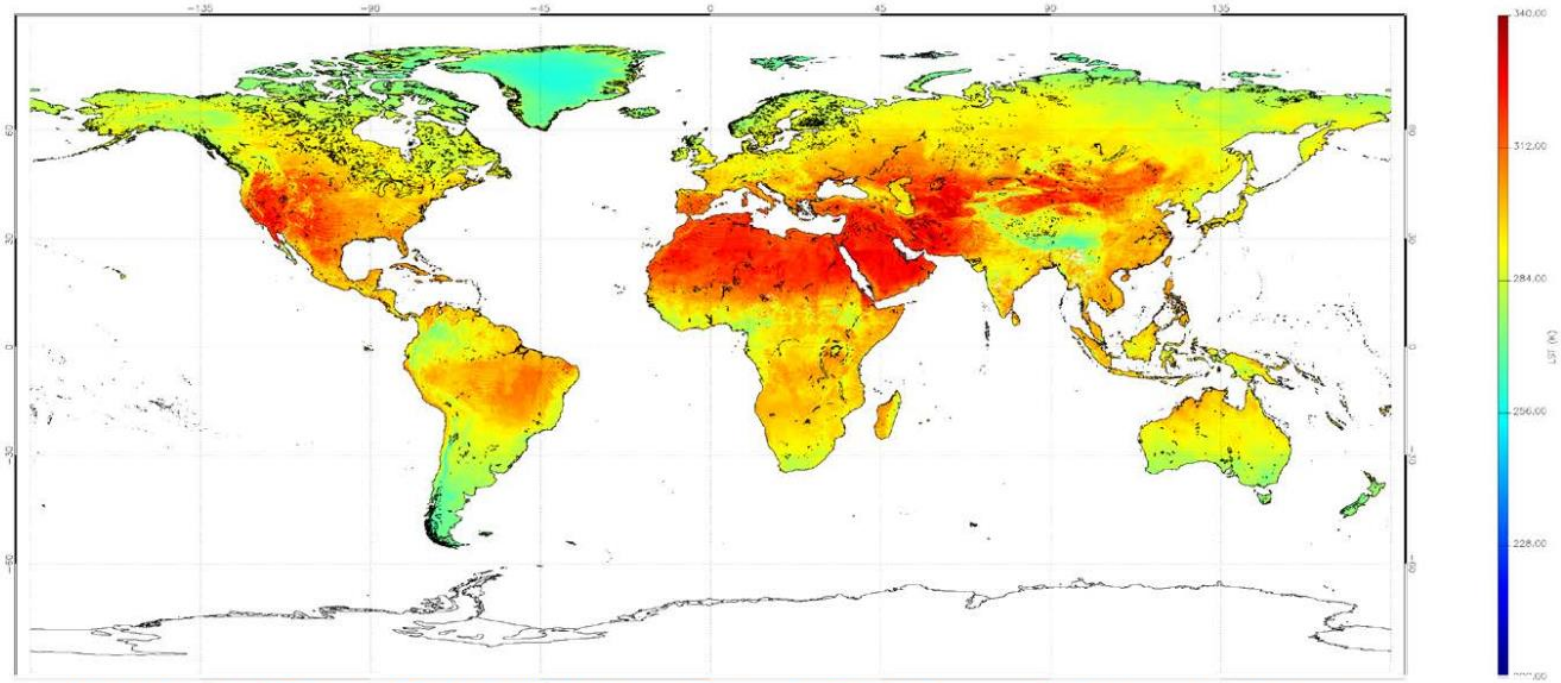
Highway 1
California
U.S.

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

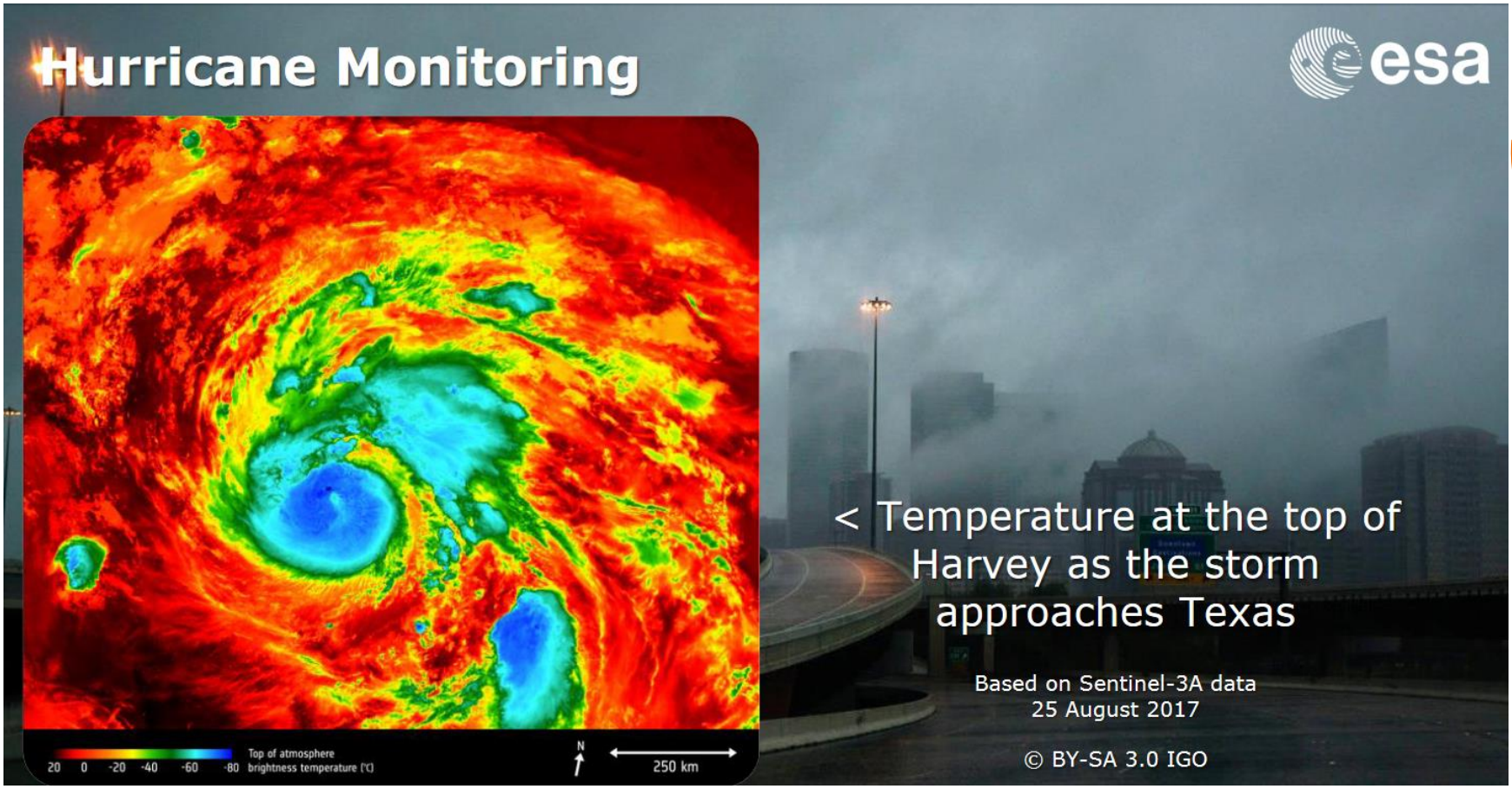
Earthquakes



Earth Surface Heat



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



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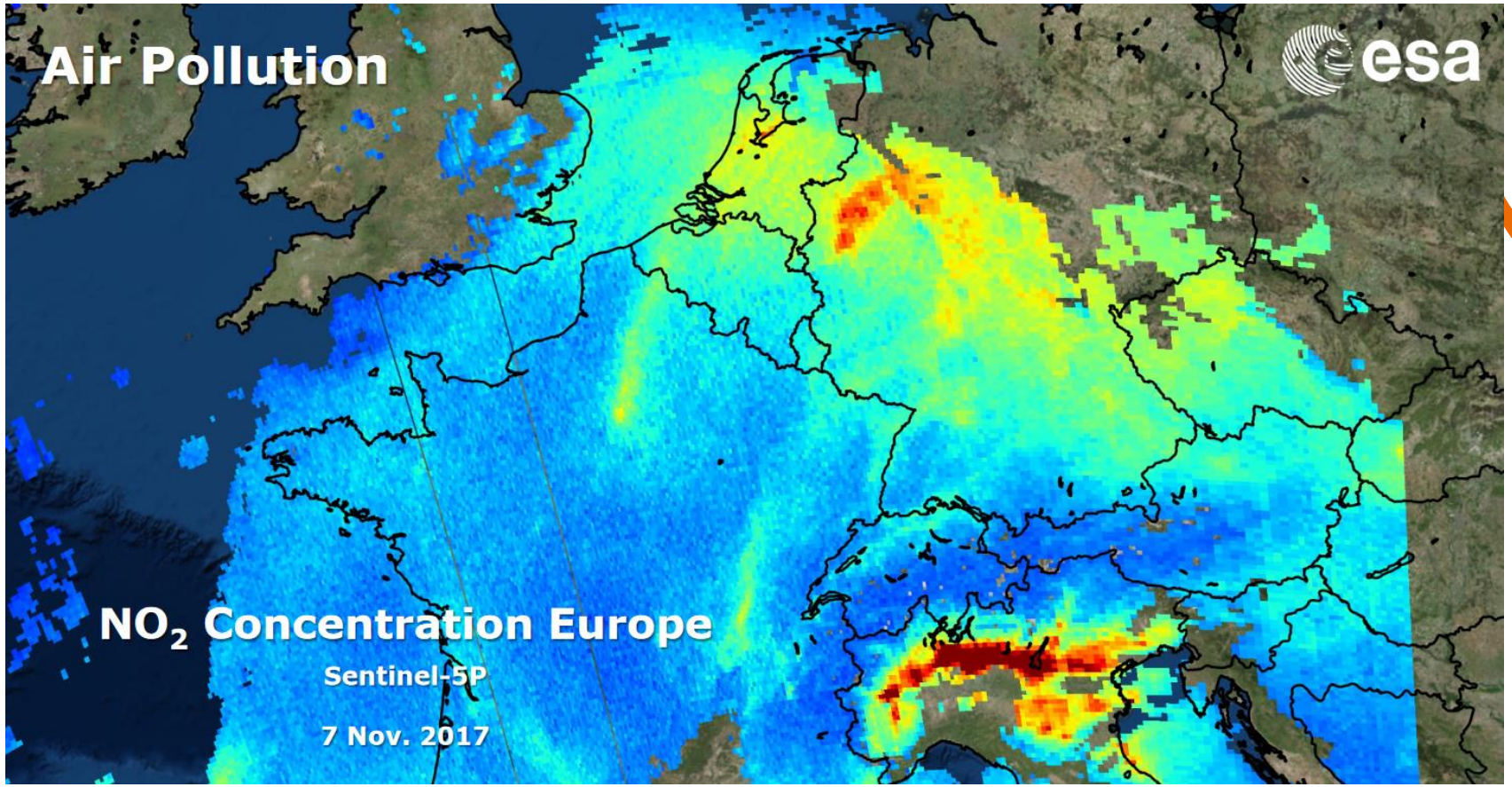

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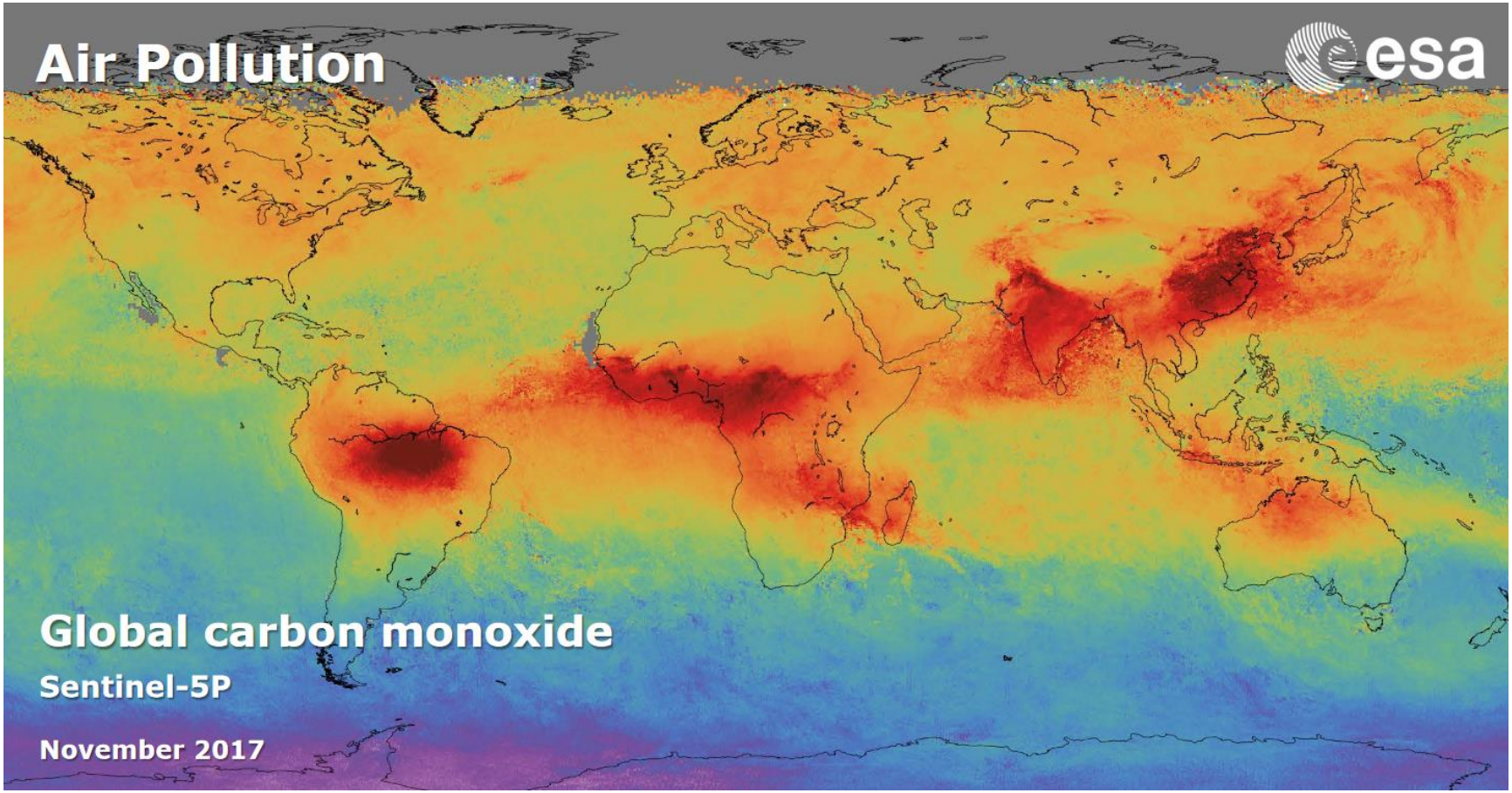

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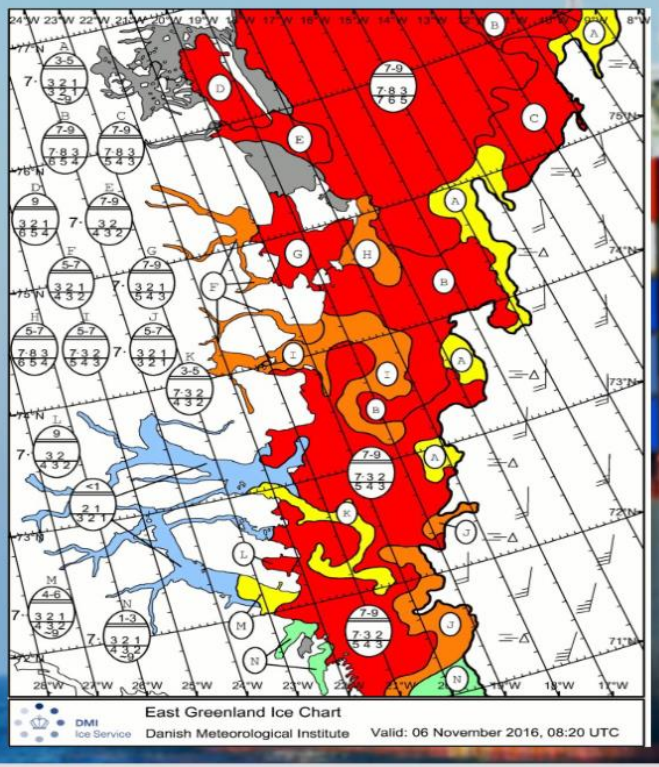
Safe & Efficient Shipping



East Greenland Ice Chart

Based upon Sentinel-1 A & B data

© DMI

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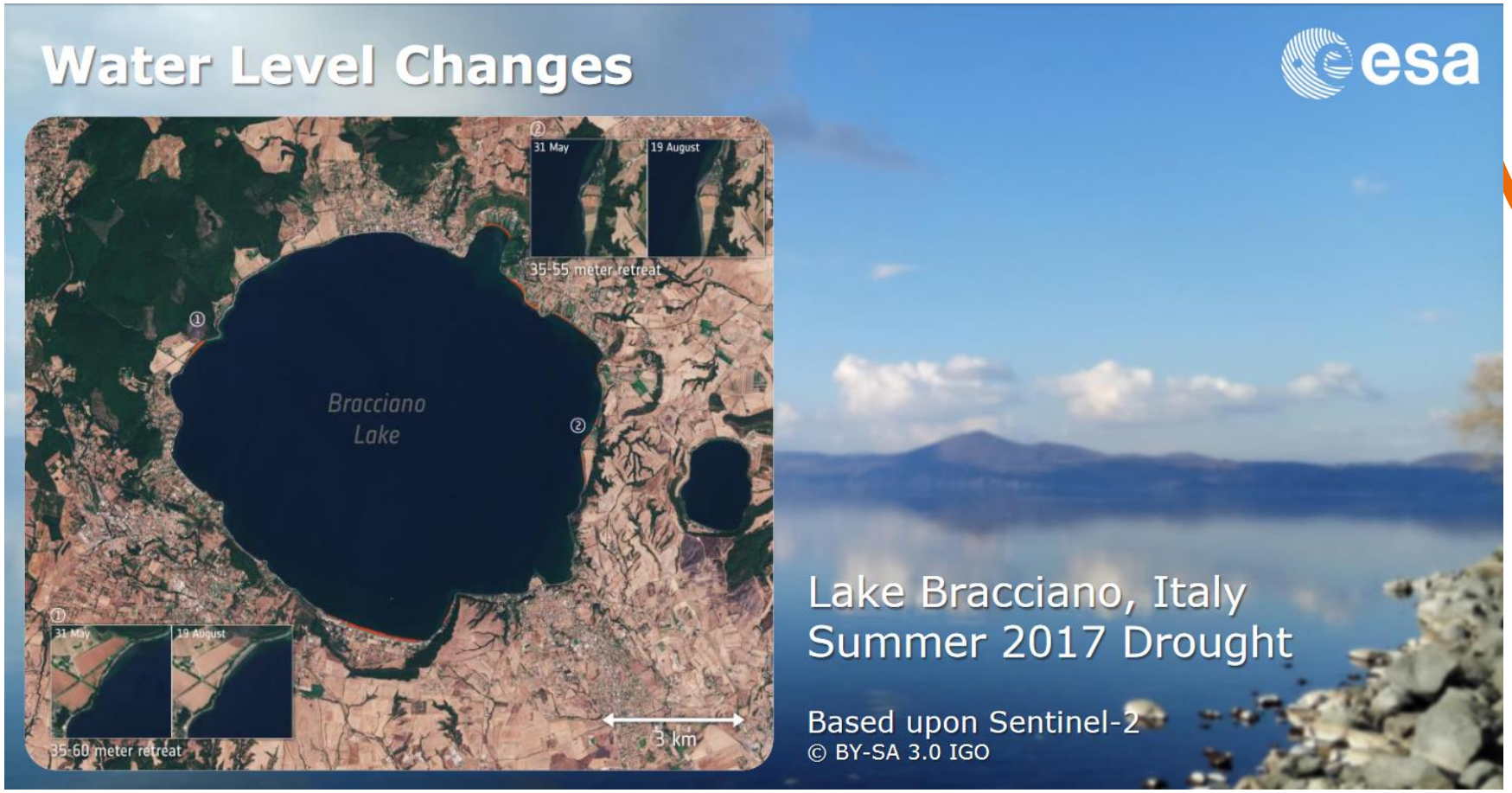

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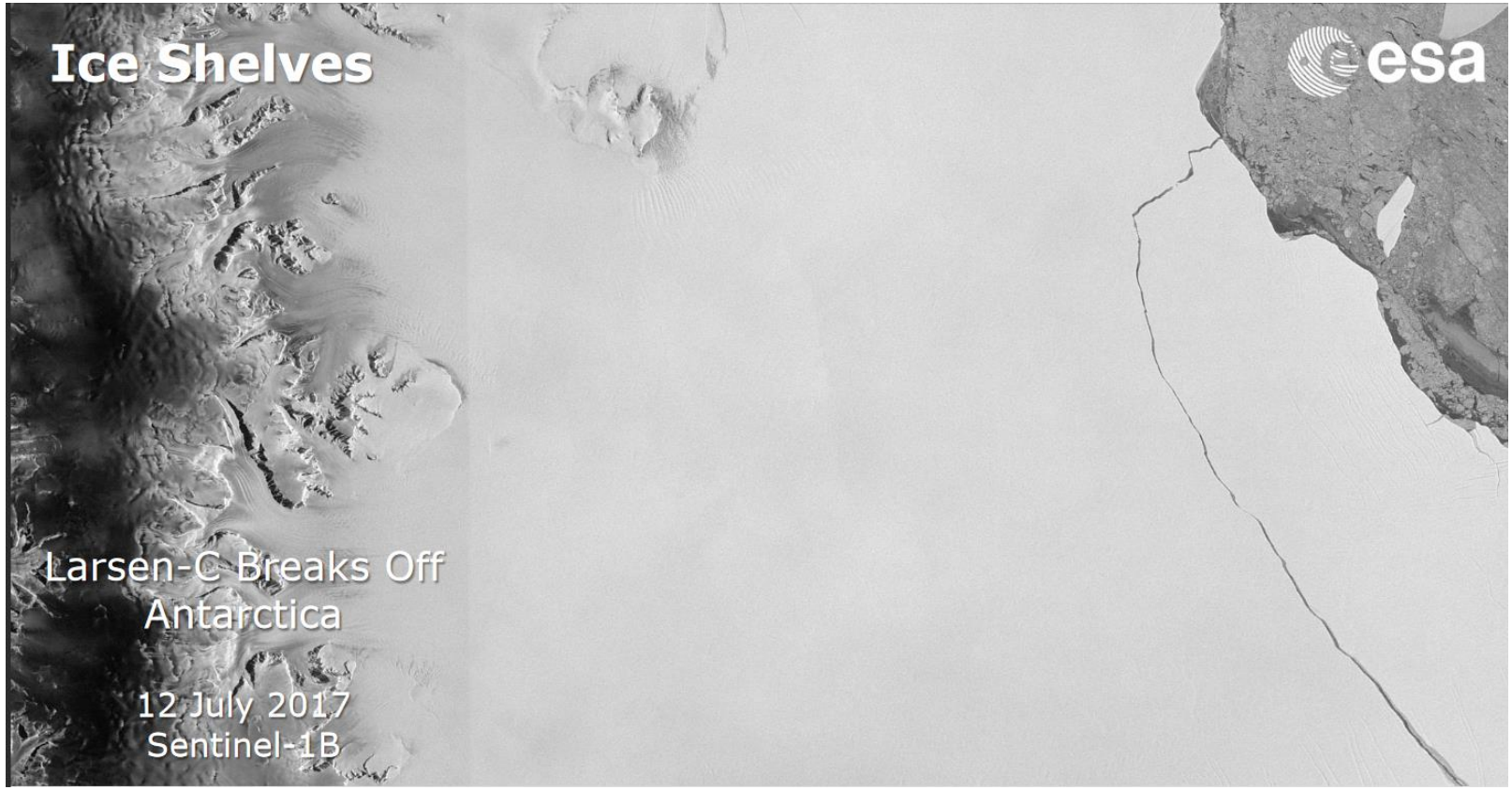

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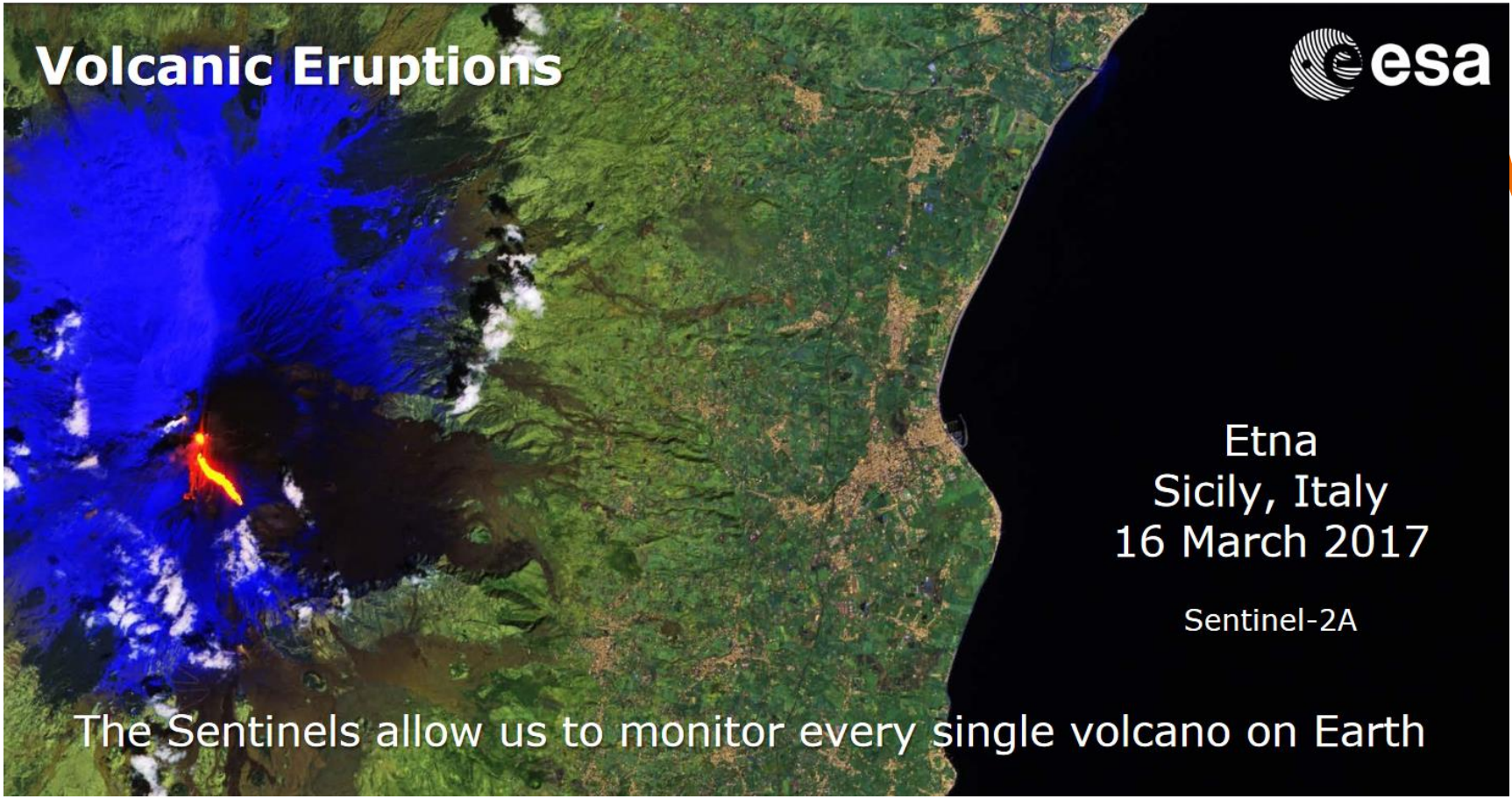

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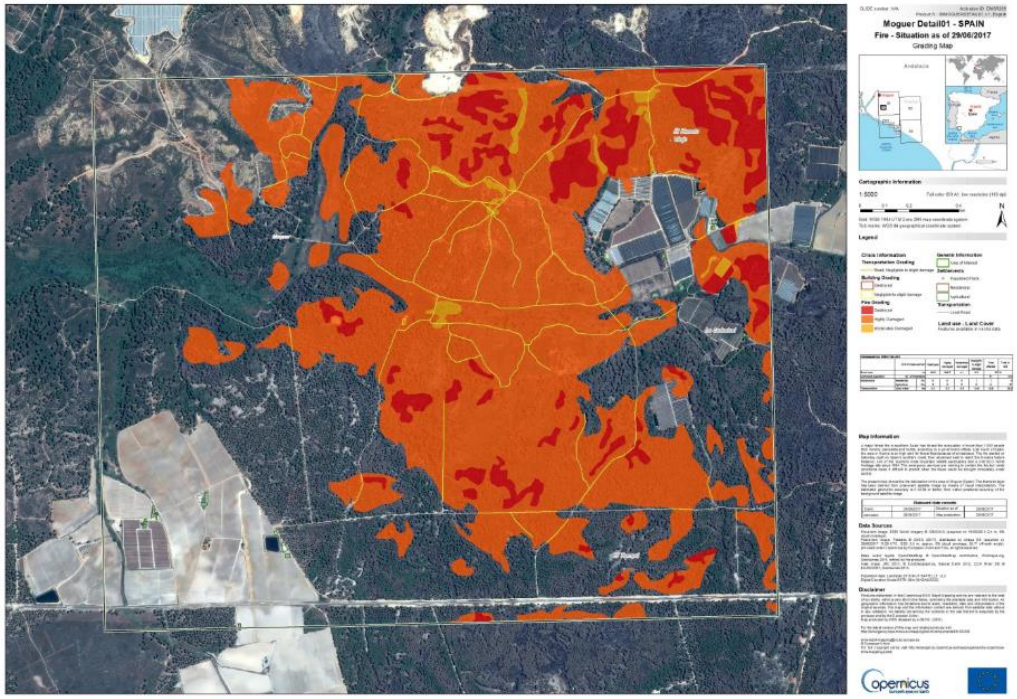
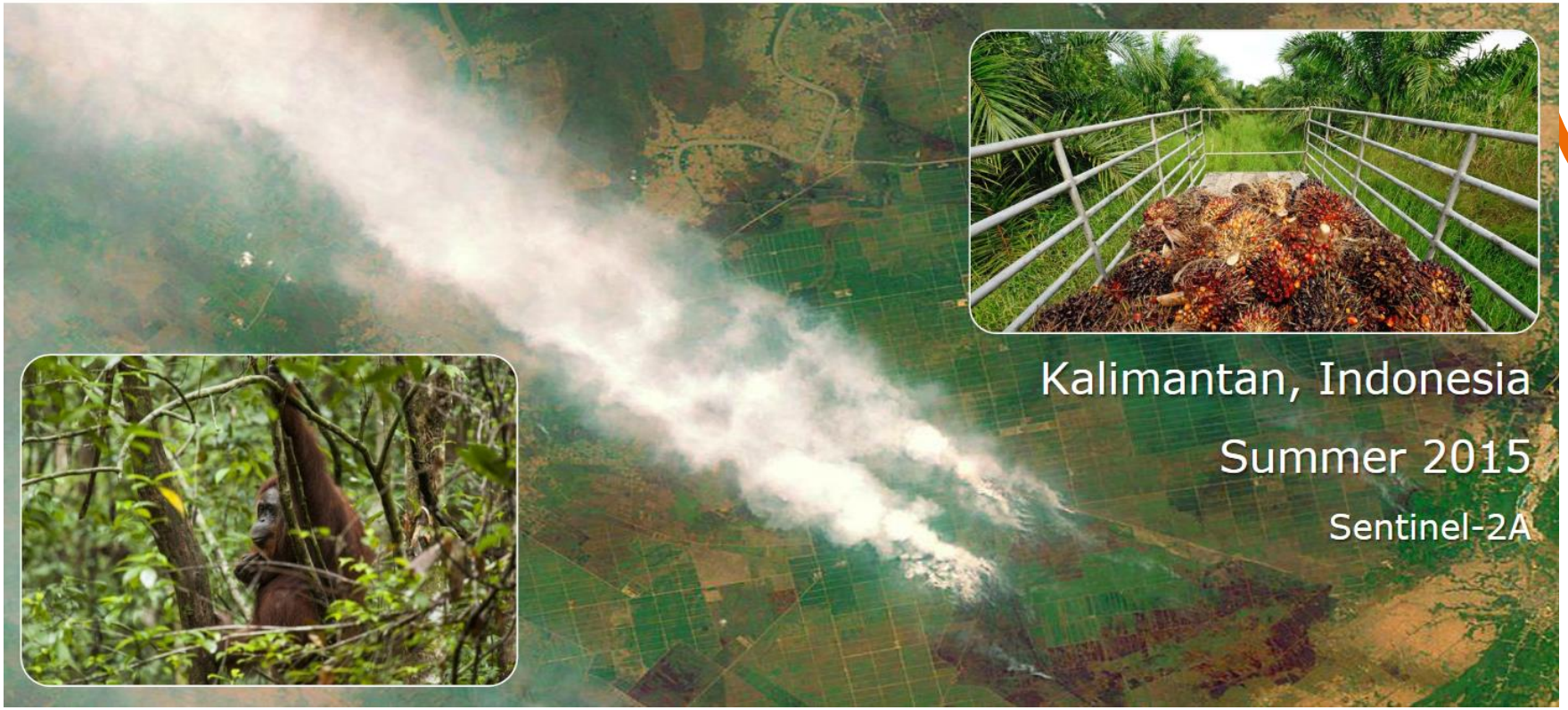
Wildfires



Moguer, Spain
29 June 2017

Copernicus Emergency Management Service Rapid Mapping

Ecosystem Destruction



Marine Monitoring

SUCCESS USE CASE BOOKS PER EU-MEMBER STATE

USE CASE BOOKS showcasing how the Copernicus Marine Service supports EU Member States.

First USE CASE BOOKS published in **November 2018** for the following countries:

- **ITALY**
- **GERMANY**
- **SPAIN**
- **PORTUGAL**
- **DENMARK**
- **NORWAY**
- **ESTONIA**
- **FRANCE**

All EU Member State Use Case Books to come later in 2019.

Please, help us to promote user uptake in YOUR country!

SUBMIT USE CASE HERE:

http://marine.copernicus.eu/markets/submit-your-use-case/

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ESA Scientific Toolbox Exploitation Platform

ESA is developing free open source toolboxes for the scientific exploitation of Earth Observation missions under the the Scientific Exploitation of Operational Missions (SEOM) programme element. STEP is the ESA community platform for accessing the software and its documentation, communicating with the developers, dialoguing within the science community, promoting results and achievements as well as providing tutorials and material for training scientists using the Toolboxes.

The ESA toolboxes support the scientific exploitation for the ERS-ENVISAT missions, the Sentinels 1/2/3 missions and a range of National and Third Party missions. The three toolboxes are called respectively Sentinel 1, 2 and 3 Toolboxes and share a common architecture called SNAP. They contain some functionalities of historical toolboxes such as BEAM, NEST and Orfeo Toolbox that were developed over the last years.

http://step.esa.int/main/

SNAP

A common architecture for all Sentinel Toolboxes is being jointly developed by Brockmann Consult, Array Systems Computing and C-S called the Sentinel Application Platform (SNAP).

The SNAP architecture is ideal for Earth Observation processing and analysis due to the following technological innovations: Extensibility, Portability, Modular Rich Client Platform, Generic EO Data Abstraction, Tiled Memory Management, and a Graph Processing Framework.

SNAP is using the following technologies

- NetBeans platform – desktop application framework
- Install4J – multi-platform installation builder
- GeoTools – geospatial tools library
- GDAL – reading/writing raster and vector geospatial data formats
- Jira – issue tracker
- Git – version control system, hosted by GitHub

Feature Highlights

- Common architecture for all Toolboxes
- Very **fast image display and navigation** even of giga-pixel images
- Graph Processing Framework (GPF): for creating user-defined processing chains
- Advanced **layer management** allows adding and manipulation of new overlays such as images of other bands, images from WMS servers or ESRI shapefiles
- Rich **region-of-interest** definitions for **statistics** and various **plots**
- Easy **bitmask** definition and overlay
- Flexible **band arithmetic** using arbitrary mathematical expressions
- Accurate **reprojection** and **ortho-rectification** to common map projections,
- Geo-coding and rectification using **ground control points**
- Automatic SRTM DEM download and tile selection
- Product library for scanning and cataloguing large archives efficiently
- Multithreading and Multi-core processor support
- Integrated WorldWind visualisation

Sentinel 1 Toolbox

The Sentinel-1 Toolbox (S1TBX) consists of a collection of processing tools, data product readers and writers and a display and analysis application to support the large archive of data from ESA SAR missions including SENTINEL-1, ERS-1 & 2 and ENVISAT, as well as third party SAR data from ALOS PALSAR, TerraSAR-X, COSMO-SkyMed and RADARSAT-2. The various processing tools could be run independently from the command-line and also integrated within the graphical user interface. The Toolbox includes tools for calibration, speckle filtering, coregistration, orthorectification, mosaicking, data conversion, polarimetry and interferometry.

The Sentinel-1 Toolbox is being developed for ESA by Array Systems Computing in partnership with DLR, Brockmann Consult and OceanDataLab.

Sentinel 2 Toolbox

The Sentinel-2 Toolbox consists of a rich set of visualisation, analysis and processing tools for the exploitation of optical high-resolution products including the upcoming Sentinel-2 MSI sensor. As a multi-mission remote sensing toolbox, it also provides support for third party data from RapidEye, SPOT, MODIS (Aqua and Terra), Landsat (TM) and others.

The Sentinel-2 Toolbox is being developed for ESA by CS in partnership with Brockmann Consult, CS ROMANIA, Telespazio Vega Deutschland, INRA and UCL.

Sentinel-3 Toolbox

The Sentinel-3 Toolbox consists of a rich set of visualisation, analysis and processing tools for the exploitation of OLCI and SLSTR data from the upcoming Sentinel-3 mission. As a multi-mission remote sensing toolbox, it also supports the ESA missions Envisat (MERIS & AATSR), ERS (ATSR), SMOS as well as third party data from MODIS (Aqua and Terra), Landsat (TM), ALOS (AVNIR & PRISM) and others. The various tools can be run from an intuitive desktop application or via a command-line interface. A rich application programming interface allows for development of plugins using Java or Python.

The Sentinel-3 Toolbox is being developed for ESA by Brockmann Consult in partnership with the University of Reading, C-S France, ACRI-ST and Array.

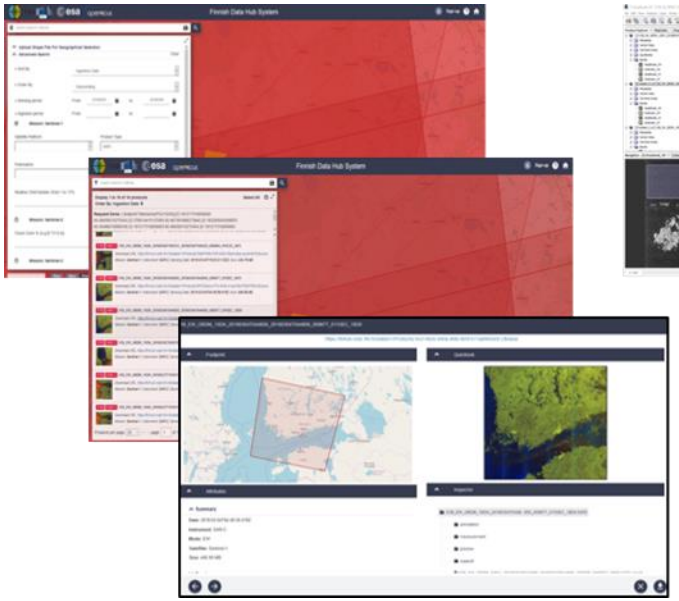
Third Party Plugins

- Sen2Cor: Atmospheric correction for Sentinel-2 images (level 2A)
- Sen2Three: Spatio-Temporal synthesis of Sentinel-2 level 2A images
- Sen2Res: Resolution enhancement of Sentinel-2 images (all bands at 10m)
- SNAPHU: Recover unambiguous phase data from a 2-D array of phase values

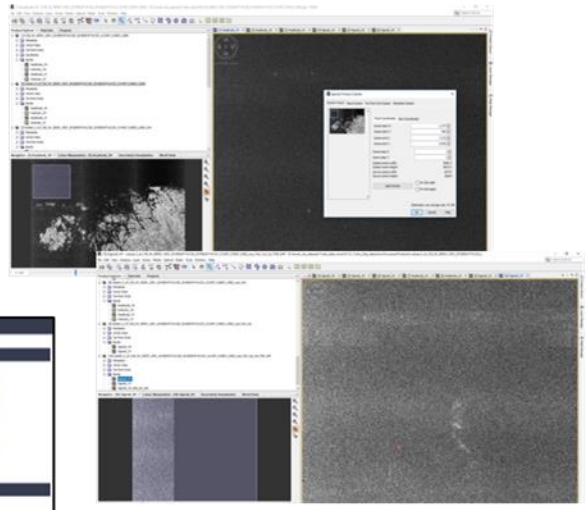
- QGIS
  - One way to view and process Sentinel data is to use QGIS (https://qgis.org/). It is a free and open source software.
  - There is also a plugin for QGIS https://qgis.org/ (SCP Semi-Automatic Classification Plugin) that can be used to download and process satellite images https://fromgistors.blogspot.com/p/semi-automatic-classification-plugin.html .
  - After processing and exporting the satellite image from SNAP, it can be opened in QGIS to view and process further. It can be opened e.g. on top of Google maps or OpenStreetMap.
- ESRI
  - http://www.arcgis.com
- Pytroll
  - One way to process Sentinel data is to use Pytroll (http://pytroll.github.io/). It is a free and open source python framework to process Earth Observation (EO) satellite data. The packages, supported satellites, tutorials and examples can be found from the home page of Pytroll.
- SatPy
  - With SatPy package you can read many Level-1 and Level-2 products, resample, make RGB images and save e.g. as netcdf, GeoTIFF or png images. The documentation for SatPy can be found from http://satpy.readthedocs.io/en/latest/ .

Example of ship detection

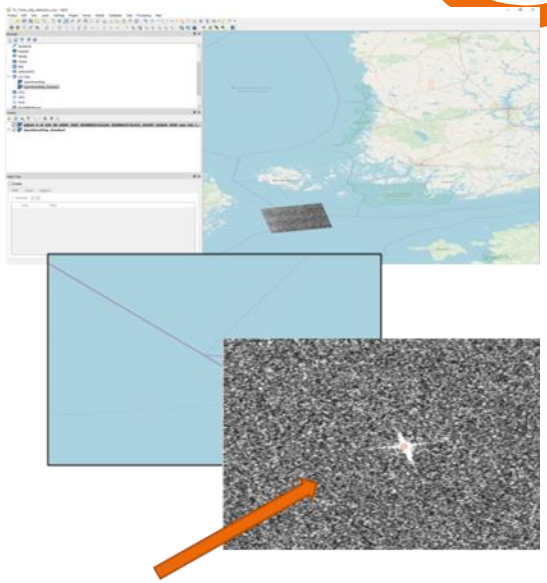
Finhub

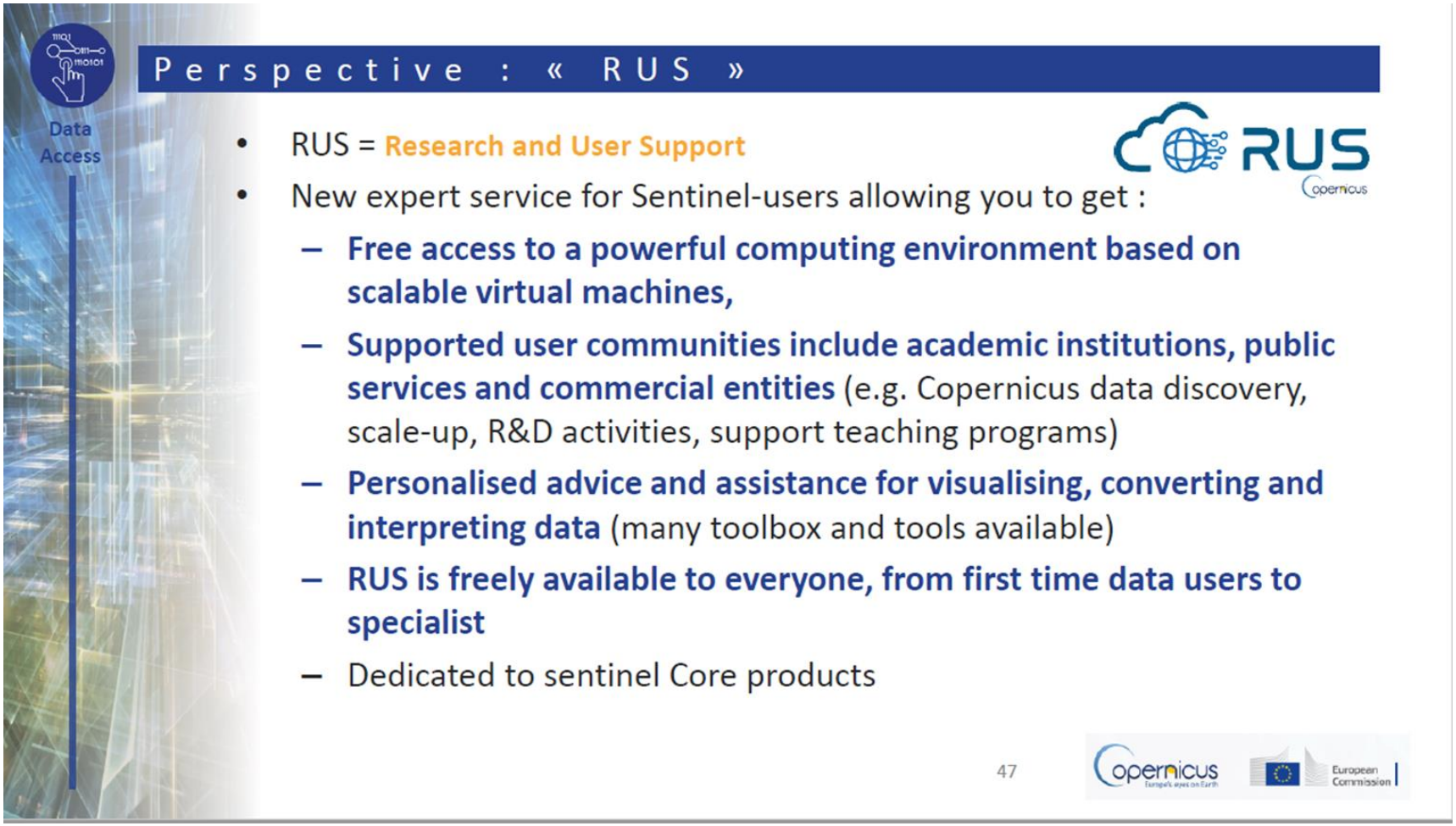


SNAP



QGIS



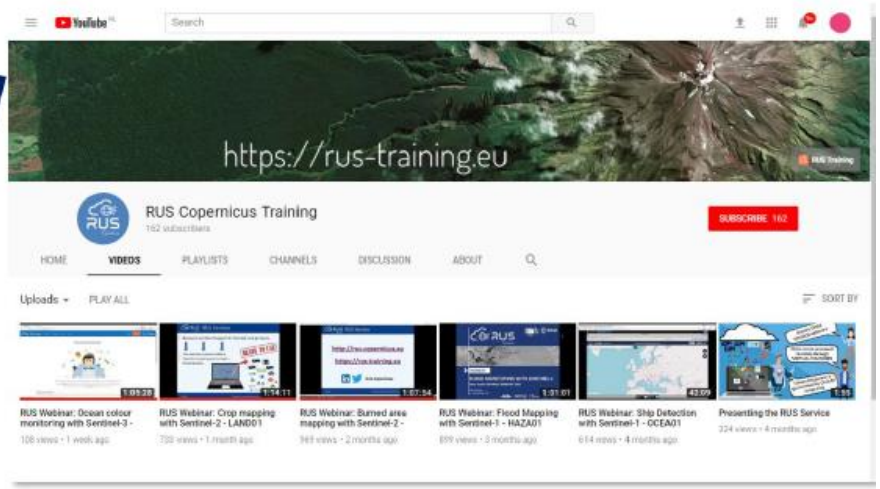


BALTIC SAT APPS

Pre-installed software / tools

Free materials available online

Training



Training kits to practice on exercises

All webinars available on YouTube

- **Download the Q&As of each webinar from the RUS Training portal**
- **Ask a RUS VM to replay the webinar on your own (with data set and materials)**

Sentinels Data Access – Image visualisation

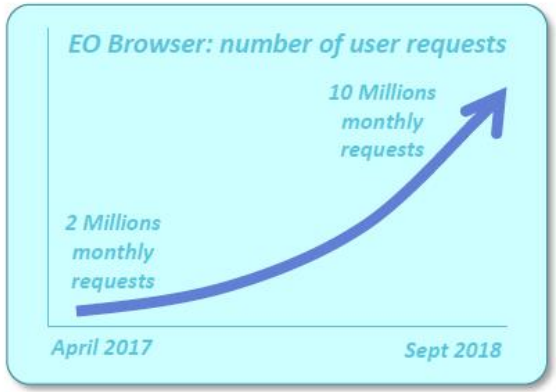
Data Access

Sintra-Cascais forest fire, Portugal (Sentinel-2, 5 and 7 October 2018)

Many Sentinel data users (in particular general public) only need basic image handling tools (i.e. not requiring data download):

→ EO Browser is a good example of such tool

http://apps.sentinel-hub.com/eo-browser



Copernicus Europe's eyes on Earth

European Commission

BALTIC SAT APPS

www.copernicus.eu

Access to Data

Copernicus builds on a constellations of satellites making millions an impressive number of of daily observations, as well as on a global network of thousands of land-, air- and marine-based sensors to create the most detailed pictures of Earth. The technological evolution, especially in terms of availability and accessibility, has made Copernicus the largest space data provider in the world, currently producing 12 terabytes per day.

The vast majority of data and information delivered by the Copernicus Space infrastructure and the Copernicus services are made available and accessible to any citizen and any organisation around the world on a **free, full and open access basis**. You can access Copernicus Data and Information Services through the DIAS or the Conventional Data Hubs.

Go to DIAS

Go to Access Hubs

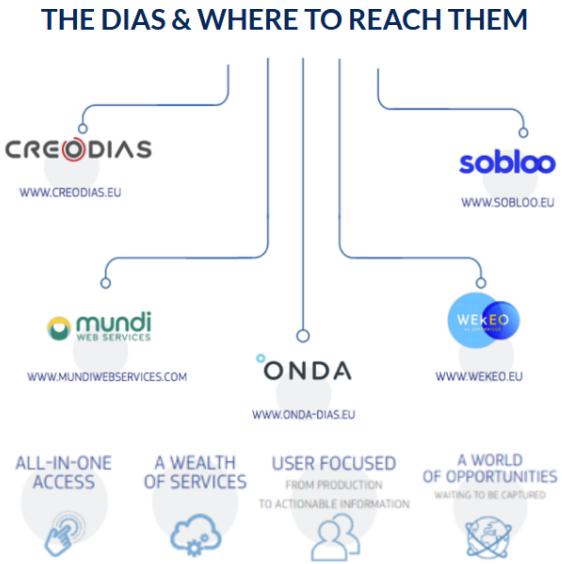
DIAS

To facilitate and standardise access to data, the European Commission has funded the deployment of five cloud-based platforms providing centralised access to Copernicus data and information, as well as to processing tools. These platforms are known as the DIAS, or Data and Information Access Services.

The five DIAS online platforms allow users to discover, manipulate, process and download Copernicus data and information. All DIAS platforms provide access to Copernicus Sentinel data, as well as to the information products from Copernicus' six operational services, together with cloud-based tools (open source and/or on a pay-per-use basis).

Each of the five competitive platforms also provides access to additional commercial satellite or non-space data sets as well as premium offers in terms of support or priority. Thanks to a single access point for the entire Copernicus data and information, DIAS allows the users to develop and host their own applications in the cloud, while removing the need to download bulky files from several access points and process them locally.

More info



Conventional Data Access Hubs

The vast majority of data and information delivered by the Copernicus space infrastructure and the Copernicus services are made freely available and accessible to any citizen and any organisation around the world.

Copernicus provides knowledge, but it all starts with data.

Satellite data

ESA

- SCI Hub
- CSCDA

EUMETSAT

- EUMETCast
- CODA

Services data and information

- Land - CLMS
- Marine - CMEMS
- Atmosphere - CAMS
- Climate - C3S
- Emergency - EMS
- Security

Land

Discover Land

The Copernicus Land Monitoring Service (CLMS) provides geographical information on land cover and its changes, land use, vegetation state, water cycle and earth surface energy variables to a broad range of users in Europe and across the World in the field of environmental terrestrial applications.

It supports applications in a variety of domains such as spatial and urban planning, forest management, water management, agriculture and food security, nature conservation and restoration, rural development, ecosystem accounting and mitigation/adaptation to climate change.

CLMS is jointly implemented by the European Environment Agency and the European Commission DG Joint Research Centre

Copernicus is a European system for monitoring the Earth. Data is collected by different sources, including Earth observation satellites and in-situ sensors. The data is processed and provides reliable and up-to-date information in six thematic areas: land, marine, atmosphere, climate change, emergency management and security. The land theme is divided into four main components:

Global
provides a series of bio-geophysical products on the status and evolution of the

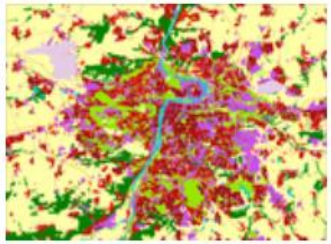
Pan-European
provides information about the land cover and land use (LC/LU), land cover and land

Local
focuses on different hotspots, i.e. areas that are prone to specific environmental

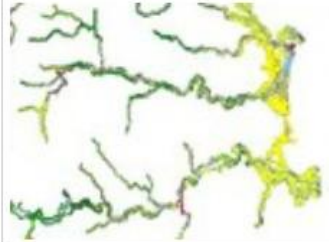
Imagery and reference data
satellite imagery forms the input for the creation of

Local

Print



Urban Atlas



Riparian Zones

Natura 2000 (N2K)

User corner

- How to access our data
- Technical library
- Factsheets
- Use cases

Contract opportunities

EAGLE

Use Cases

Publications

Technical library

Looking for national products?

USE CASES

See examples of how CMEMS data is used. You can read or download (pdf) **Use Case books** (by member states, by market...) here.

Geographical Area	Market	User type	Country	Mobile application
All	All	All	All	

Kiitos!