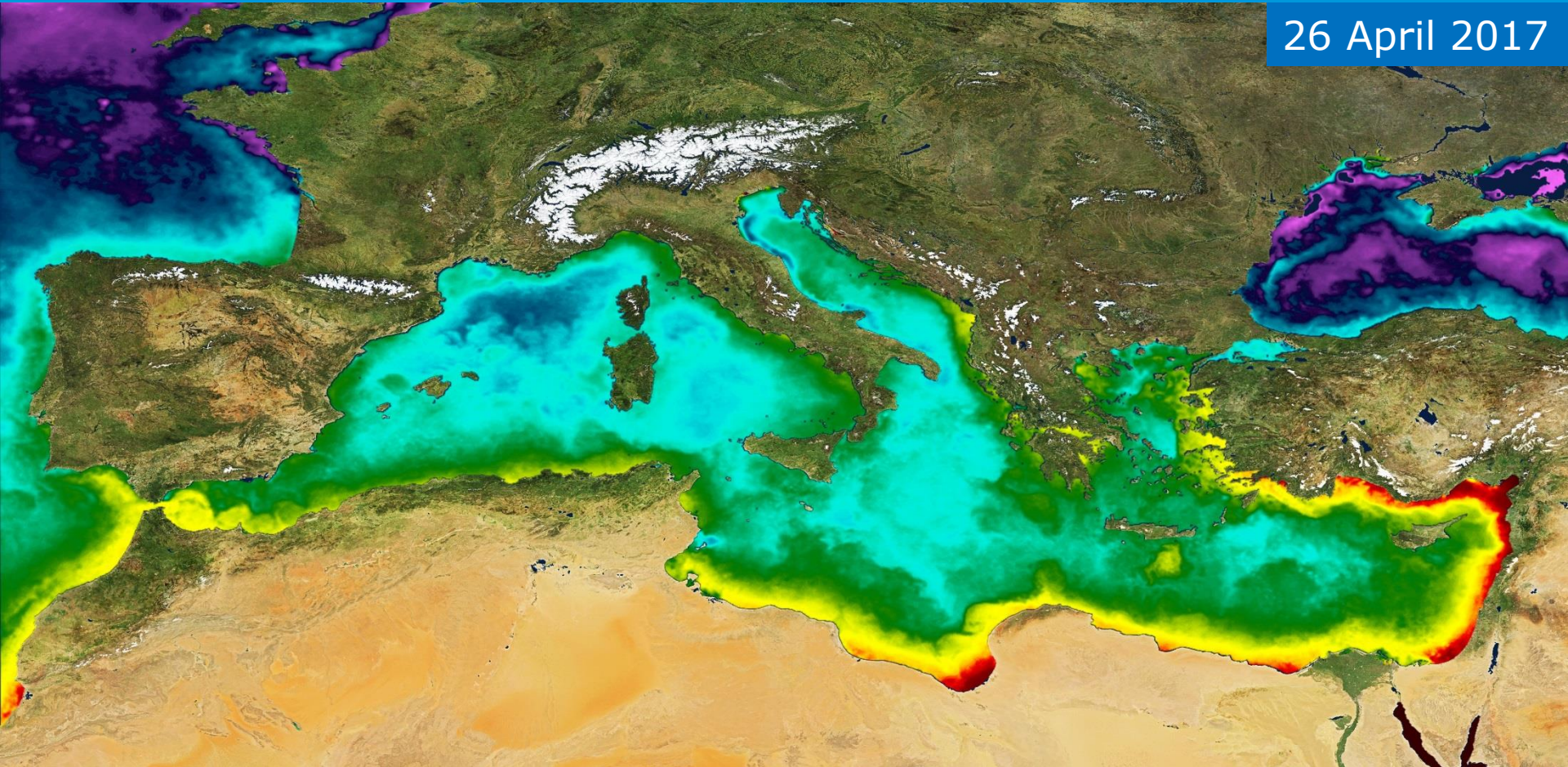


# Mediterranean from Space



26 April 2017



Speaker: **Francesco Sarti**, ESA/ESRIN, Frascati, Italy

Co-authors: **Georgia Karadimou**, ESA trainee, ESA/ESRIN, Frascati, Italy

**Antonios Mouratidis**, ESA Consultant, Aristotle University of  
Thessaloniki, Greece

- Tectonic evolution
- Dynamics of lithosphere / mantle interaction
  - Seismicity
- Volcanism & Campi Flegrei

- Endangered biodiversity



- History / evolution of Mediterranean sea level

- Mediterranean climate
  - Climate change
  - Atmospheric pollution

# Mediterranean from Space



Gibraltar Strait



Italy



Messina Strait



Bonaficio Strait



Greece



Libyan Coast



Nile Delta



Crete

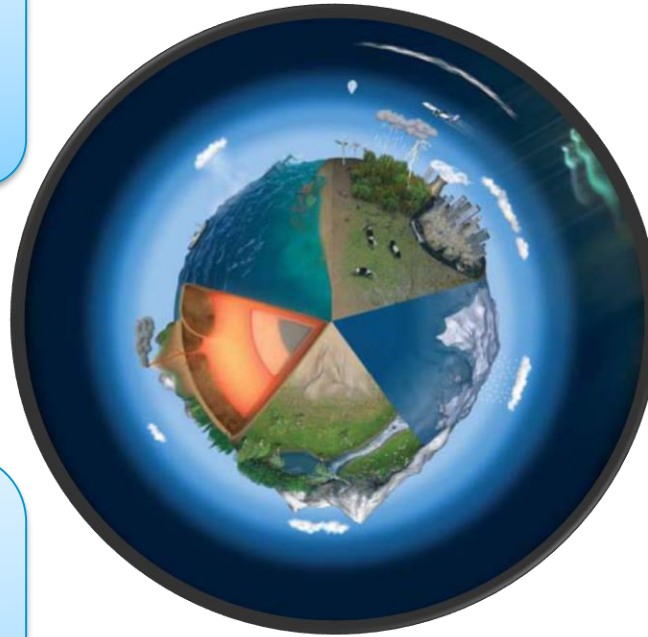


Cyprus

# Earth Observation from Space: Mediterranean



Seismic / Volcanic /  
Subsidence monitoring  
Geohazards  
Geodesy

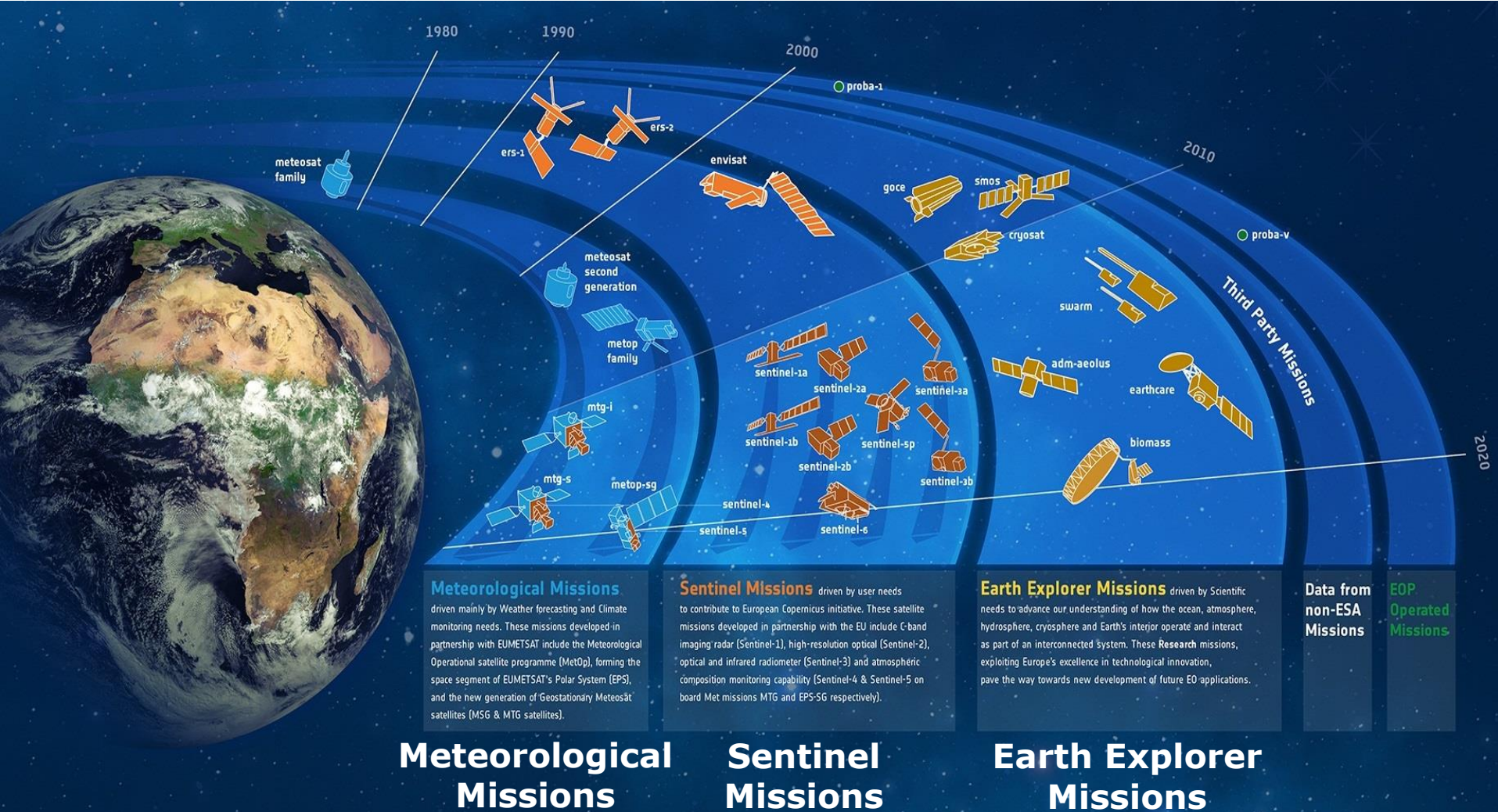


Land and Vegetation  
monitoring  
(deforestation, fires,  
land cover, soil  
moisture, urban  
monitoring,  
archaeology...)

Marine Applications  
(ship detection, oil  
spills, sea surface  
temperature & height,  
wind, currents and  
waves, chlorophyll...)

Atmospheric  
monitoring (air  
quality, greenhouse  
gases)

# ESA Earth Observation Programmes



# Copernicus dedicated missions

## A New Generation of Data Sources



### **Sentinel-1 (A/B) – SAR imaging**

All weather, day/night applications, interferometry



### **Sentinel-2 (A/B) – Multi-spectral imaging**

Land applications: urban, forest, agriculture, ...  
Continuity of Landsat, SPOT



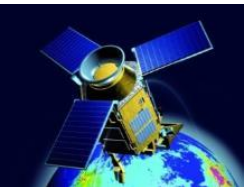
### **Sentinel-3 (A/B) – Ocean and global land monitoring**

Wide-swath ocean color, vegetation, sea/land  
surface temperature, altimetry



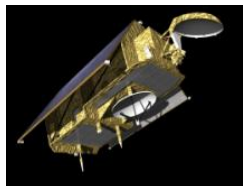
### **Sentinel-4 (A/B) – Geostationary atmospheric**

Atmospheric composition monitoring, trans-  
boundary pollution



### **Sentinel-5 precursor/ Sentinel-5 (A/B) – Low-orbit atmospheric**

Atmospheric composition monitoring



### **Sentinel-6 [Jason-CS] (A/B) – Low inclination Altimetry**

Sea-level, wave height and marine wind speed



# Sentinel Deployment Schedule



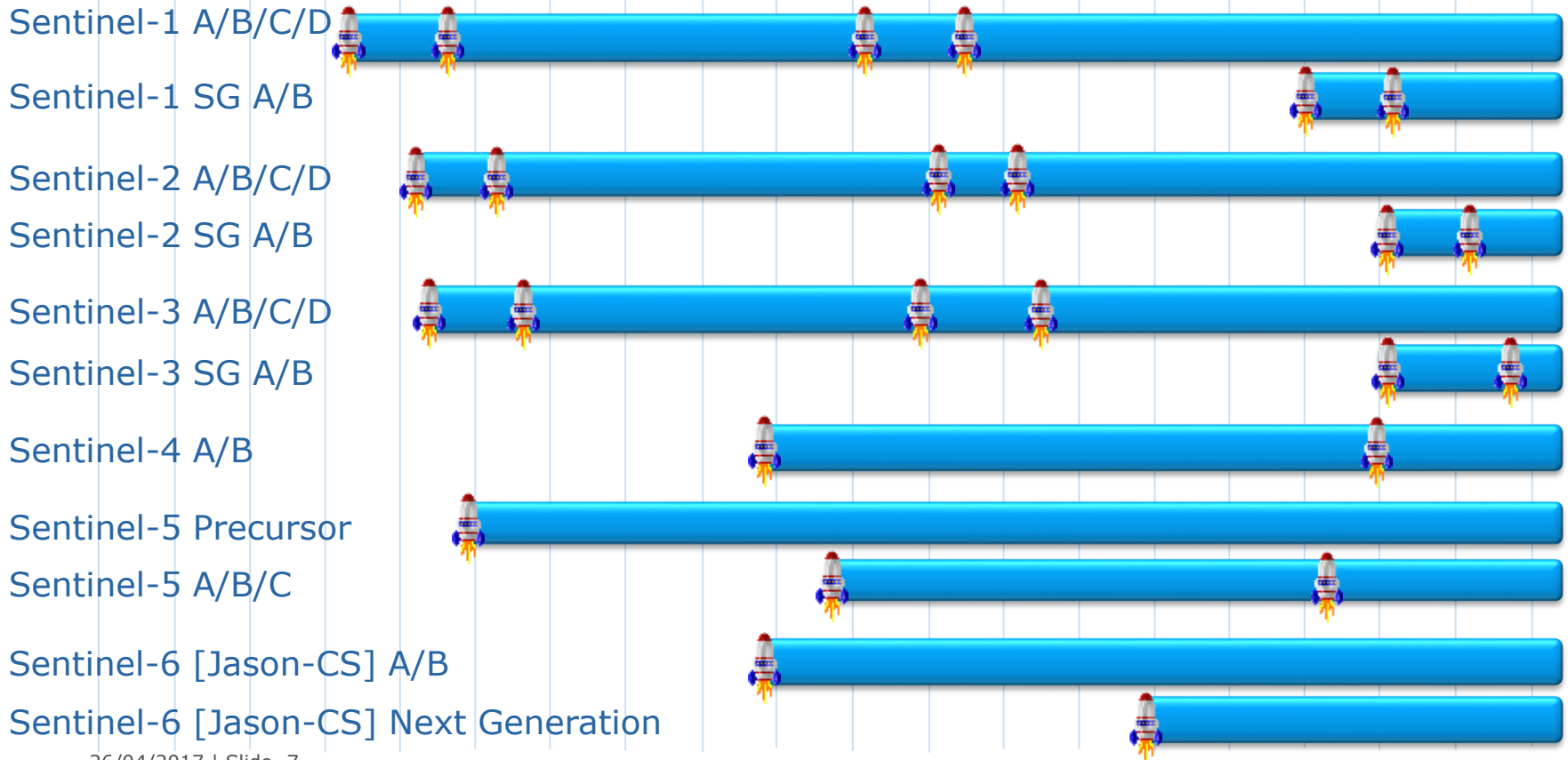
2011

2014

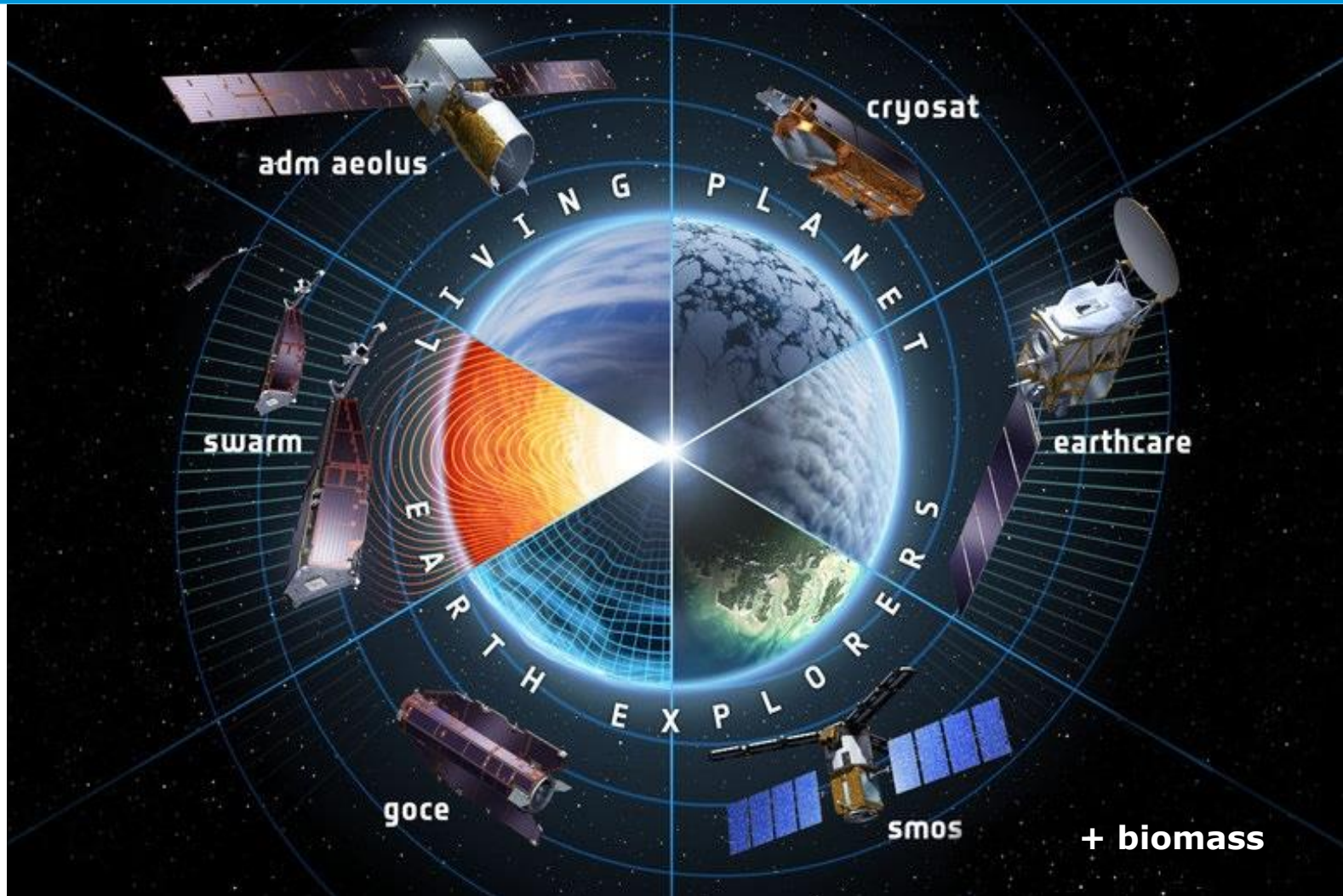
2020

2030

Access to Copernicus Contributing Missions data



# The Earth Explorers

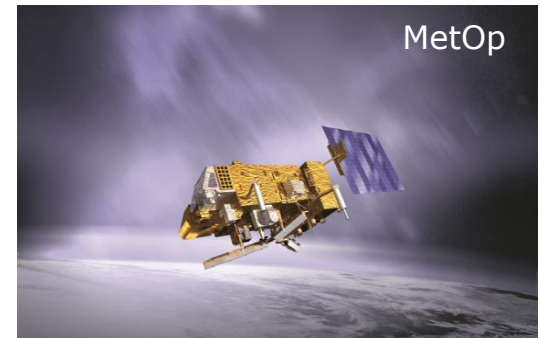
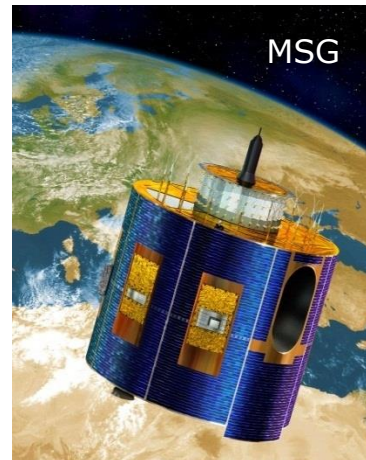




# Meteorological missions

- ESA: develops prototype satellites and, on behalf of EUMETSAT, procures recurrent satellites
- EUMETSAT: procures launchers and LEOP services, operates the satellites

- **Meteosat Second Generation** (MSG) missions in GEO and MetOp missions in LEO

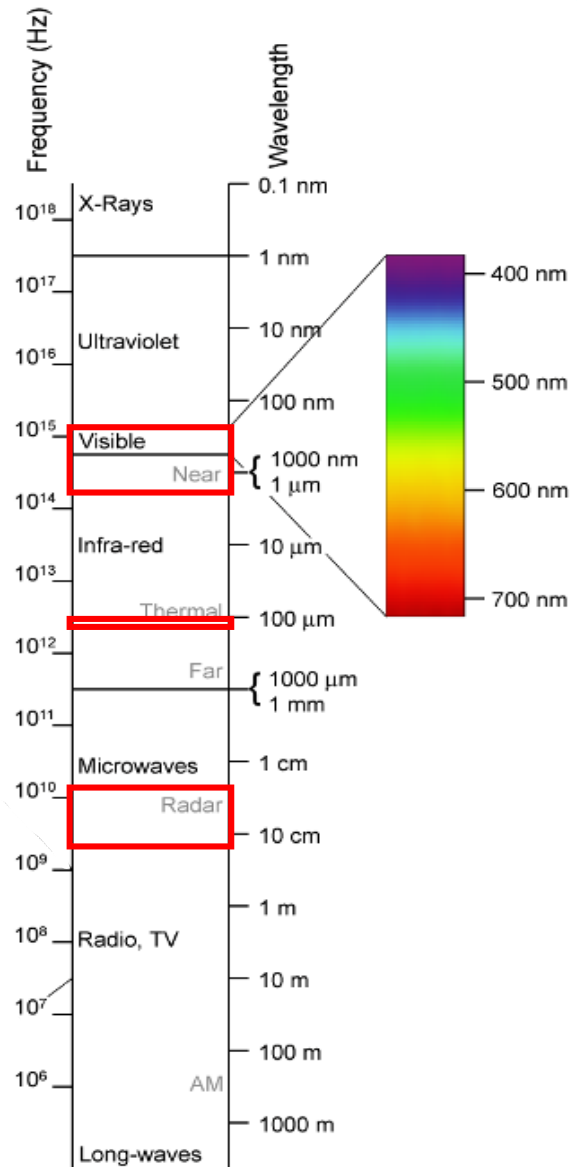
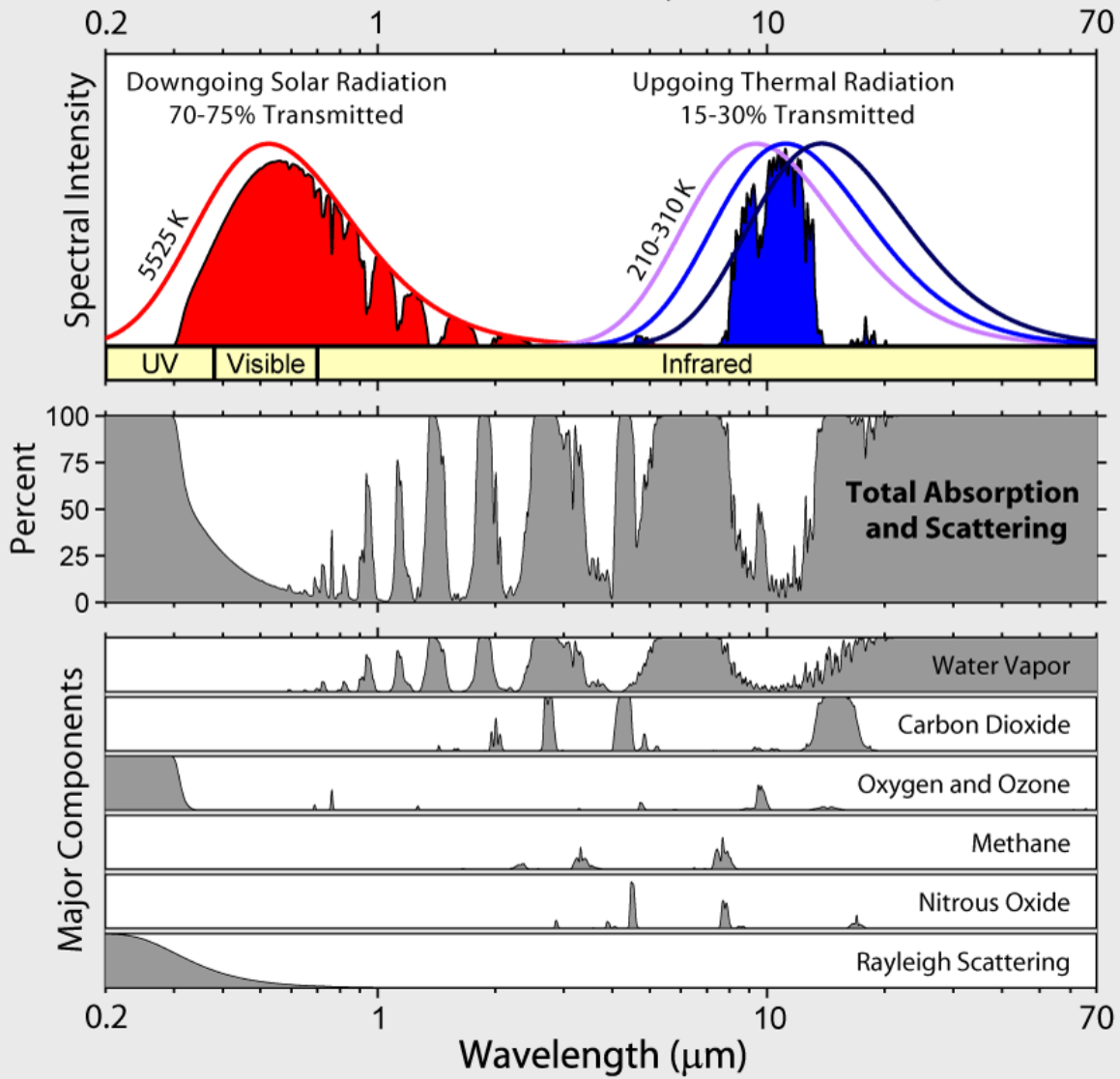


- **MeteoSat Third Generation** (MTG) missions and MetOp **Second Generation** (SG) under development



# Electromagnetic Spectrum

## Radiation Transmitted by the Atmosphere



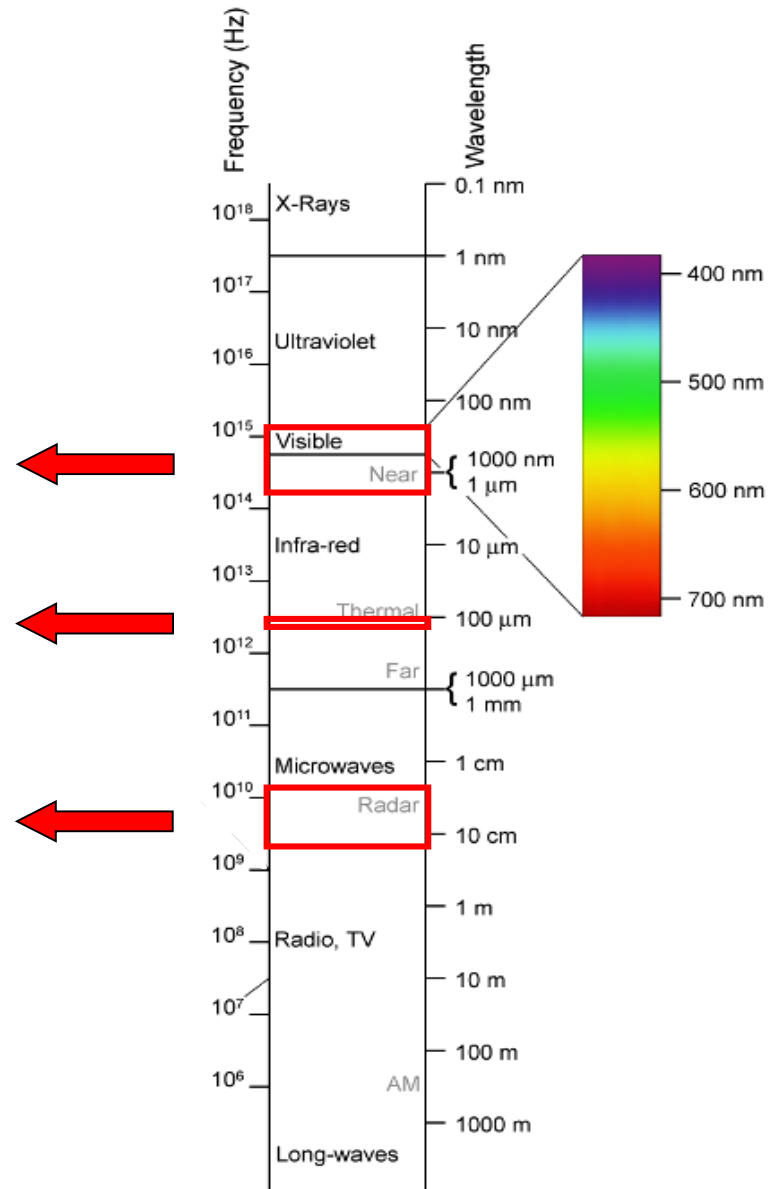
# Electromagnetic Spectrum



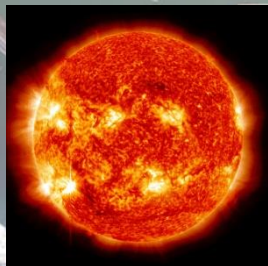
**Visible (VIS) + Near Infrared (NIR) =  
Optical**

**Thermal Infrared (TIR)**

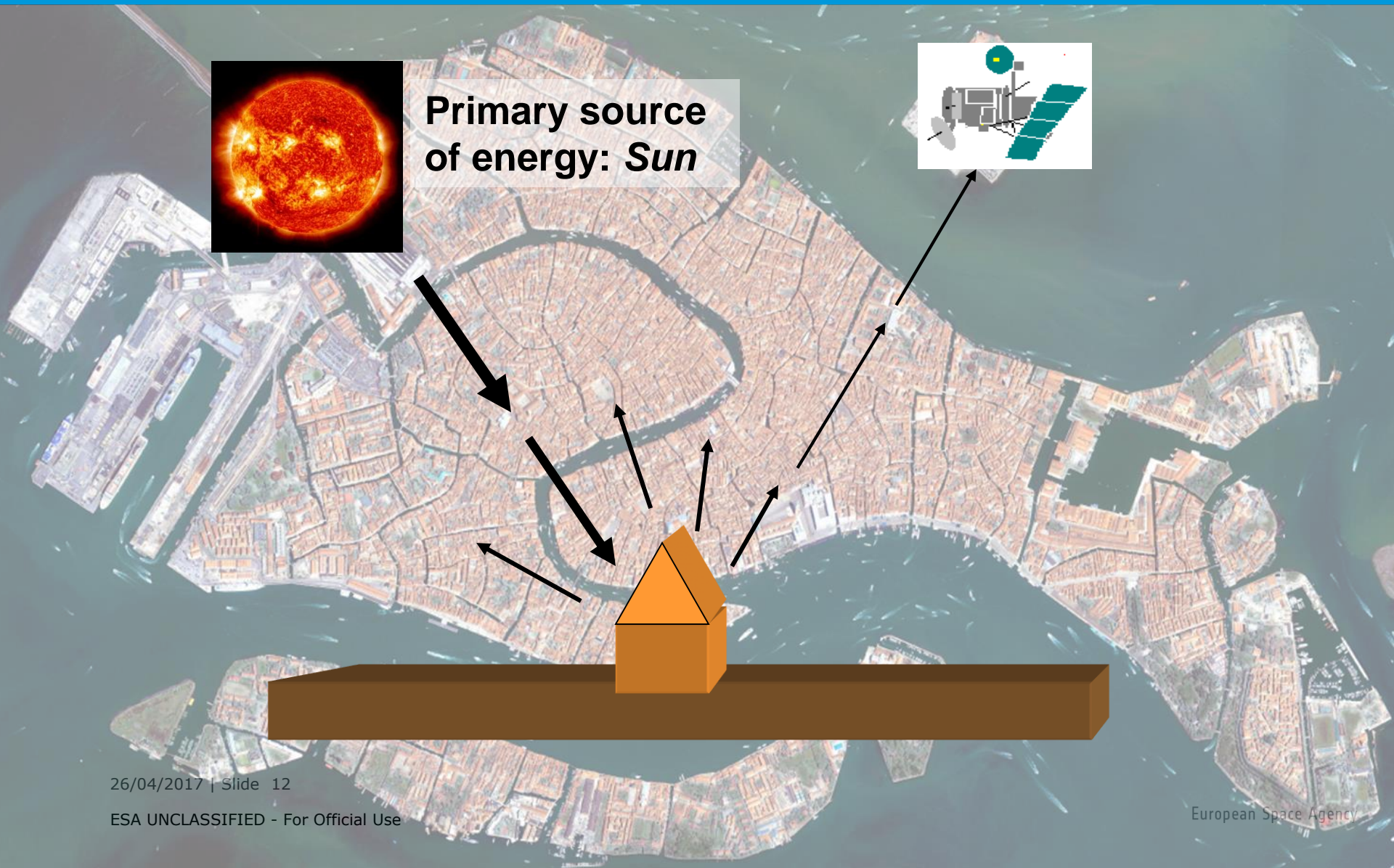
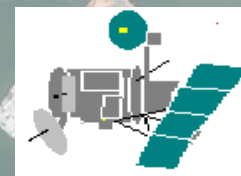
**Synthetic Aperture Radar (SAR)**



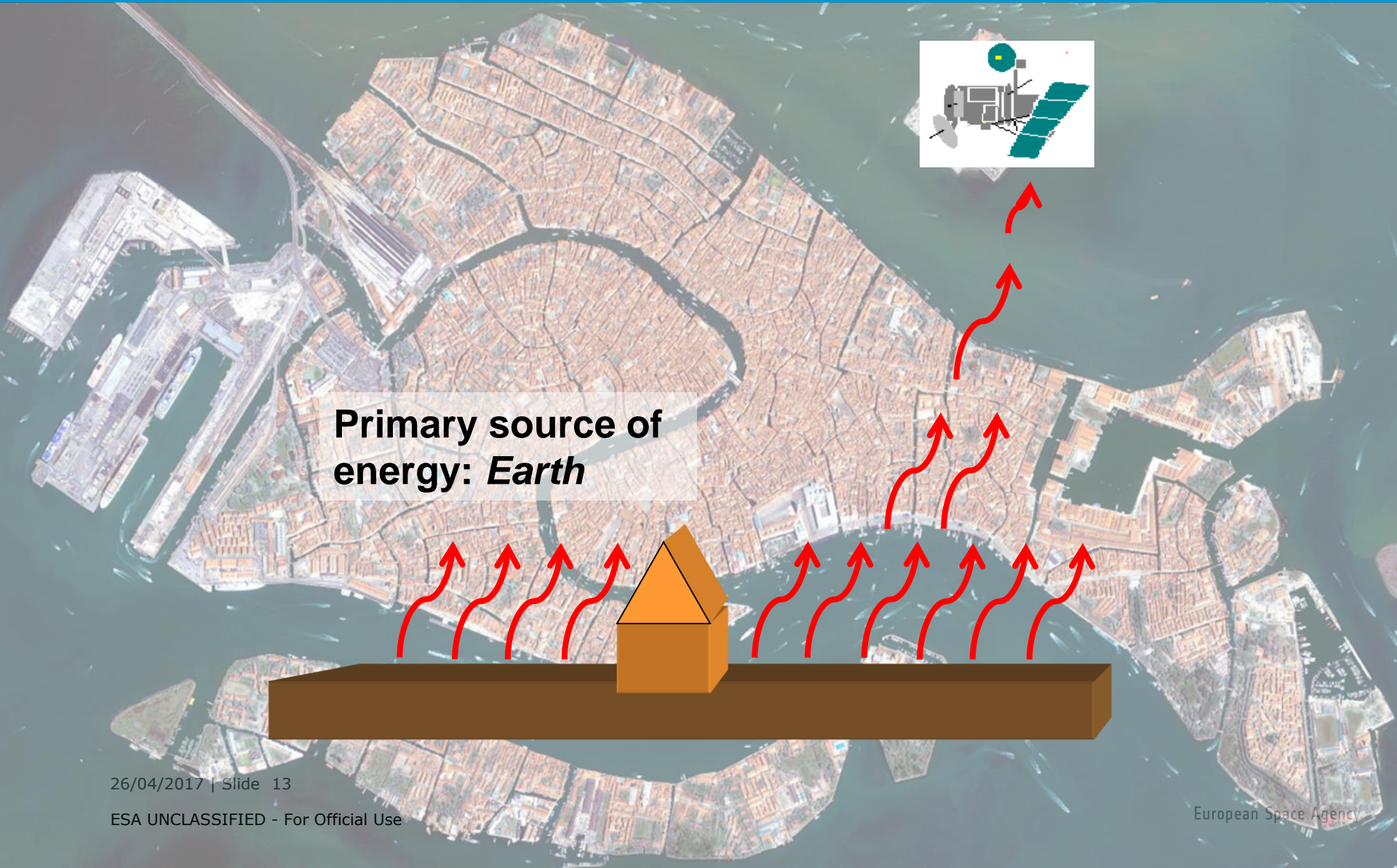
# Passive Sensors



Primary source  
of energy: *Sun*

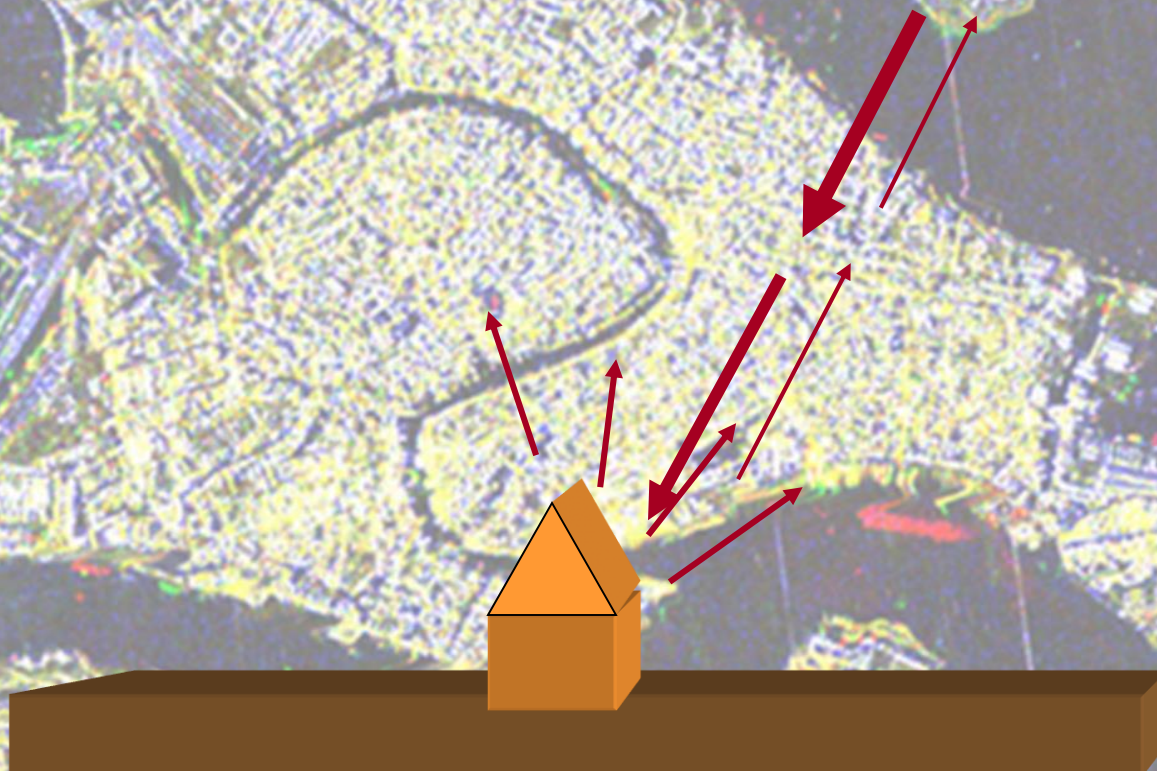


# Passive Sensors

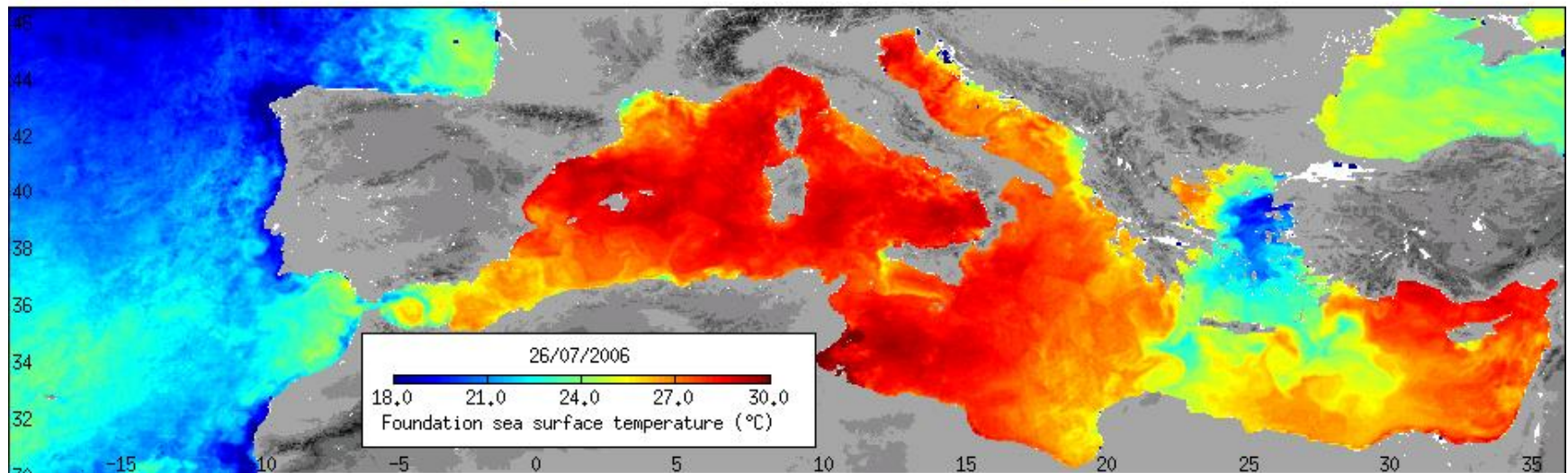
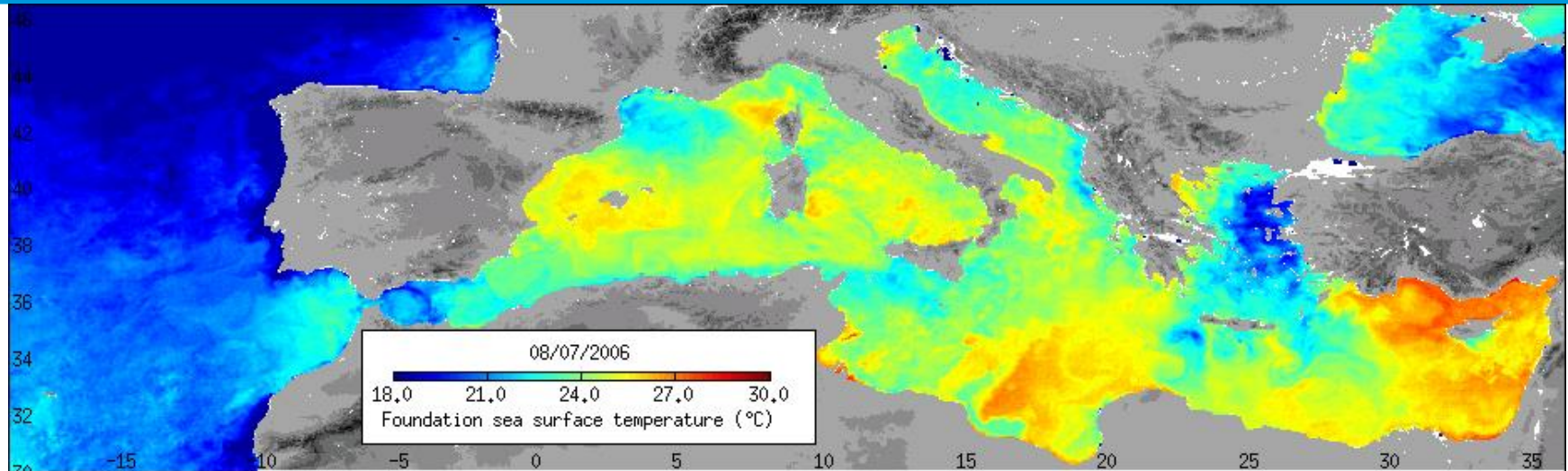


Primary source of energy: *Earth*

Source of energy:  
*Satellite*



# Heat Maps of Mediterranean 8 & 26 July 2006 ESA



26/04/2017 | Slide 15

# Mediterranean Sea Currents (video)





# Today's phytoplankton estimate (forecast)



MEDSEA\_ANALYSIS\_FO  
RECAST\_BIO\_006\_006

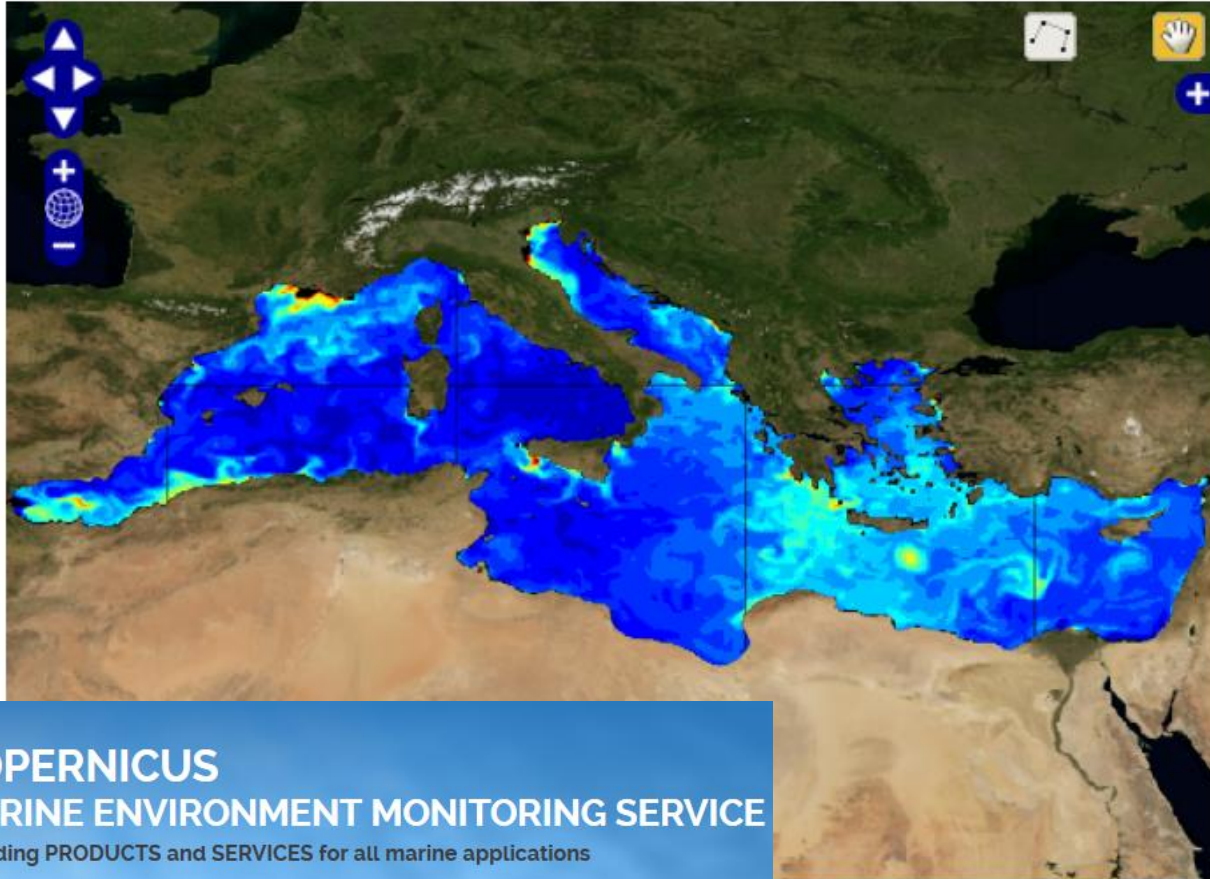
Product id: MEDSEA\_ANALYSIS\_FORECAST\_BIO\_006\_006

Dataset: Carbon and Chlorophyll content of phytoplankton functional type(3D) - Daily Mean

Variable: mole\_concentration\_of\_phytoplankton\_expressed\_as\_carbon\_in\_sea\_water

Units: mol m-3    Time: 2017-04-26 12:00:00.000Z    Depth (m): -1.47

[http://marine.copernicus.eu/services-portfolio/access-to-products/?option=com\\_csw&task=results&advancedsearch-geographical\\_area\[\]=advancedsearch-geographical\\_area-mediterranean-sea](http://marine.copernicus.eu/services-portfolio/access-to-products/?option=com_csw&task=results&advancedsearch-geographical_area[]=advancedsearch-geographical_area-mediterranean-sea)



**COPERNICUS**  
**MARINE ENVIRONMENT MONITORING SERVICE**  
Providing PRODUCTS and SERVICES for all marine applications

# Today's salinity estimate (forecast)



MY CART

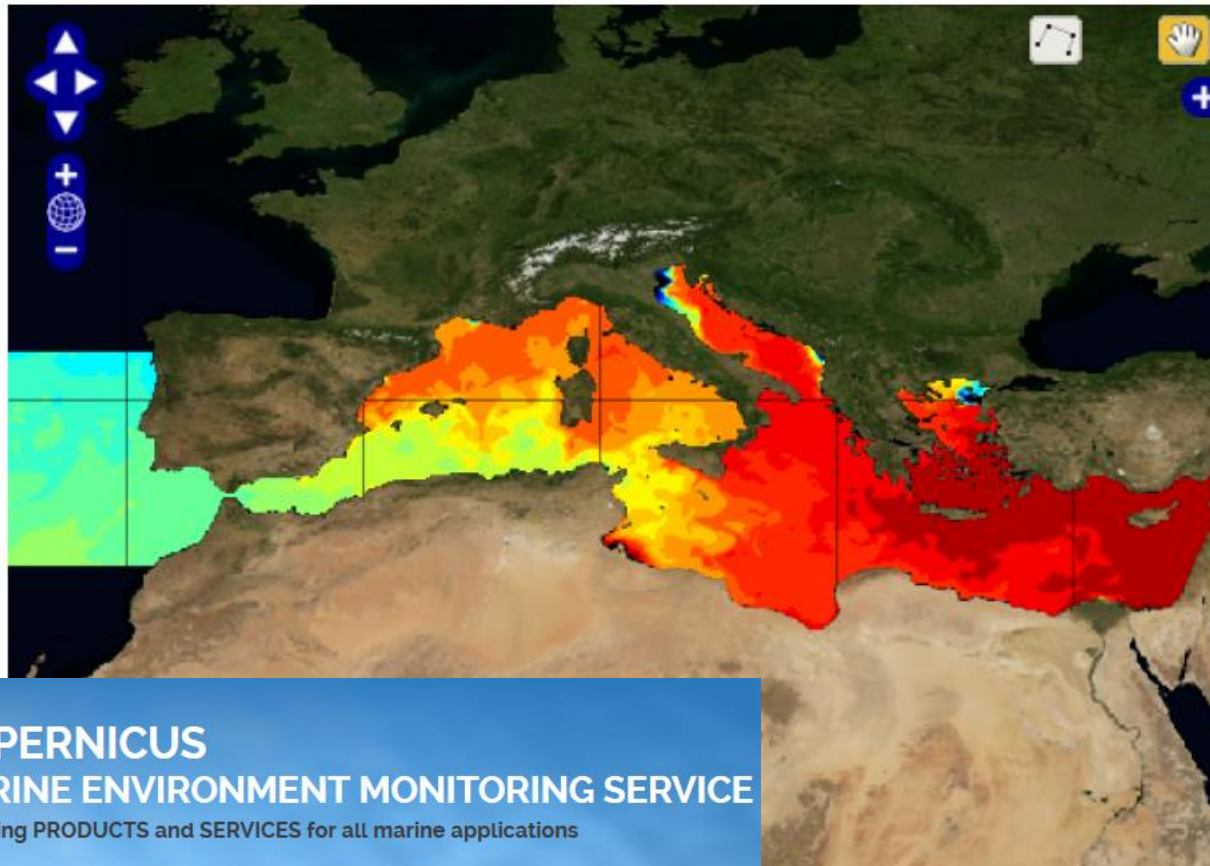
## Mediterranean Sea Physics Analysis and Forecast

Product id: MEDSEA\_ANALYSIS\_FORECAST\_WAV\_006\_011

Dataset: Salinity (3D) - Daily Mean

Variable: sea\_water\_salinity

Units: 1e-3 Time: 2017-04-26 00:00:00.000Z Depth (m): -1.47



MEDSEA\_ANALYSIS\_FORECAST\_WAV\_006\_011

MEDSEA\_ANALYSIS\_FORECAST\_PHYS\_006\_001

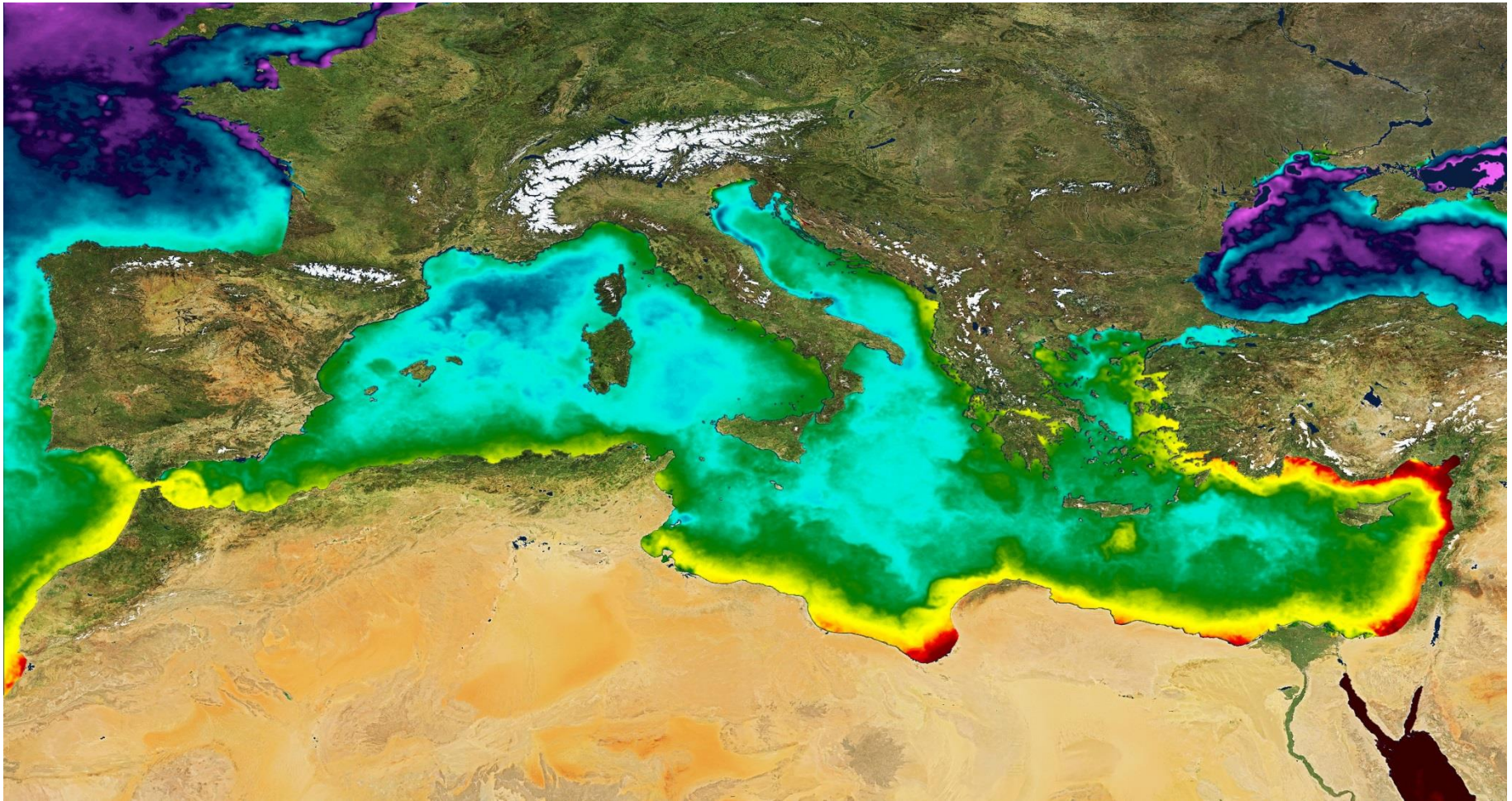
[http://marine.copernicus.eu/services-portfolio/access-to-products/?option=com\\_csw&task=results&advancedsearch-geographical\\_area\[\]=advancedsearch-geographical\\_area-mediterranean-sea](http://marine.copernicus.eu/services-portfolio/access-to-products/?option=com_csw&task=results&advancedsearch-geographical_area[]=advancedsearch-geographical_area-mediterranean-sea)



**COPERNICUS  
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Providing PRODUCTS and SERVICES for all marine applications

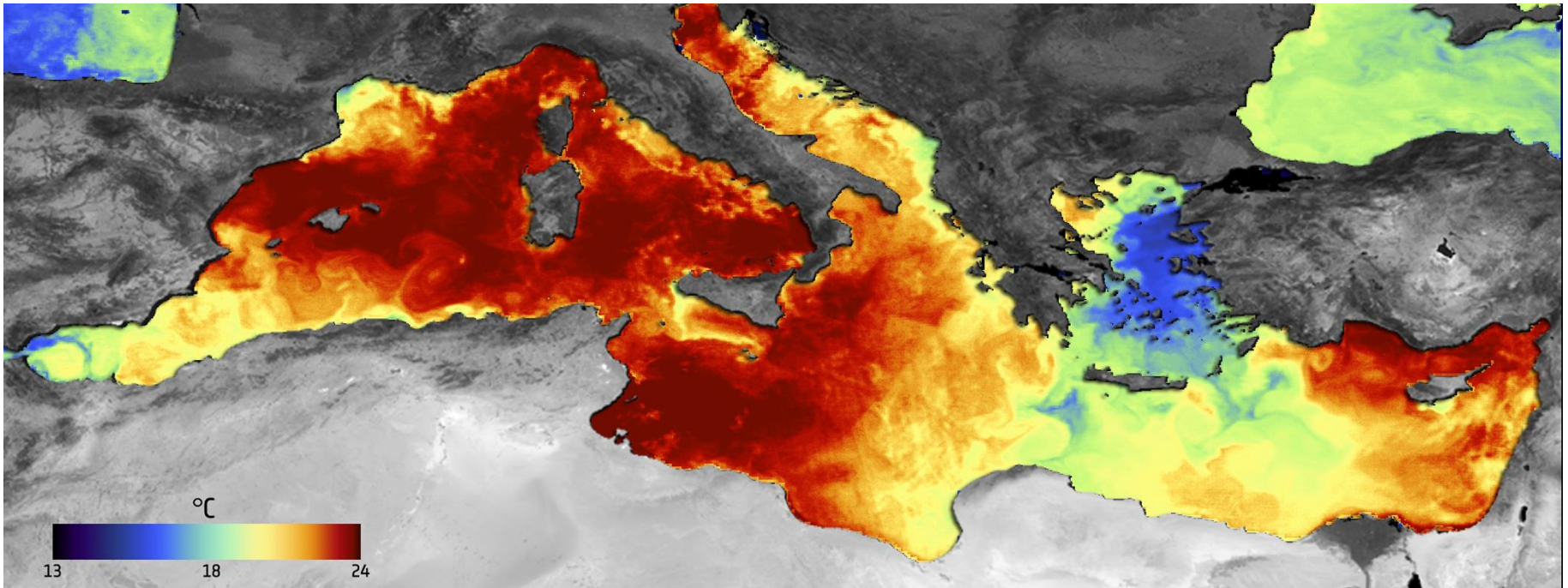
# Combination of Globcover (land) & Sea Surface Temperature (water) over the Mediterranean



# Mediterranean Sea Surface Temperature



WATER: Colours are associated to sea surface temperature values - processed under the Medspiration project that used a variety of thermal sensors including the AATSR radiometer on board ENVISAT (ESA)



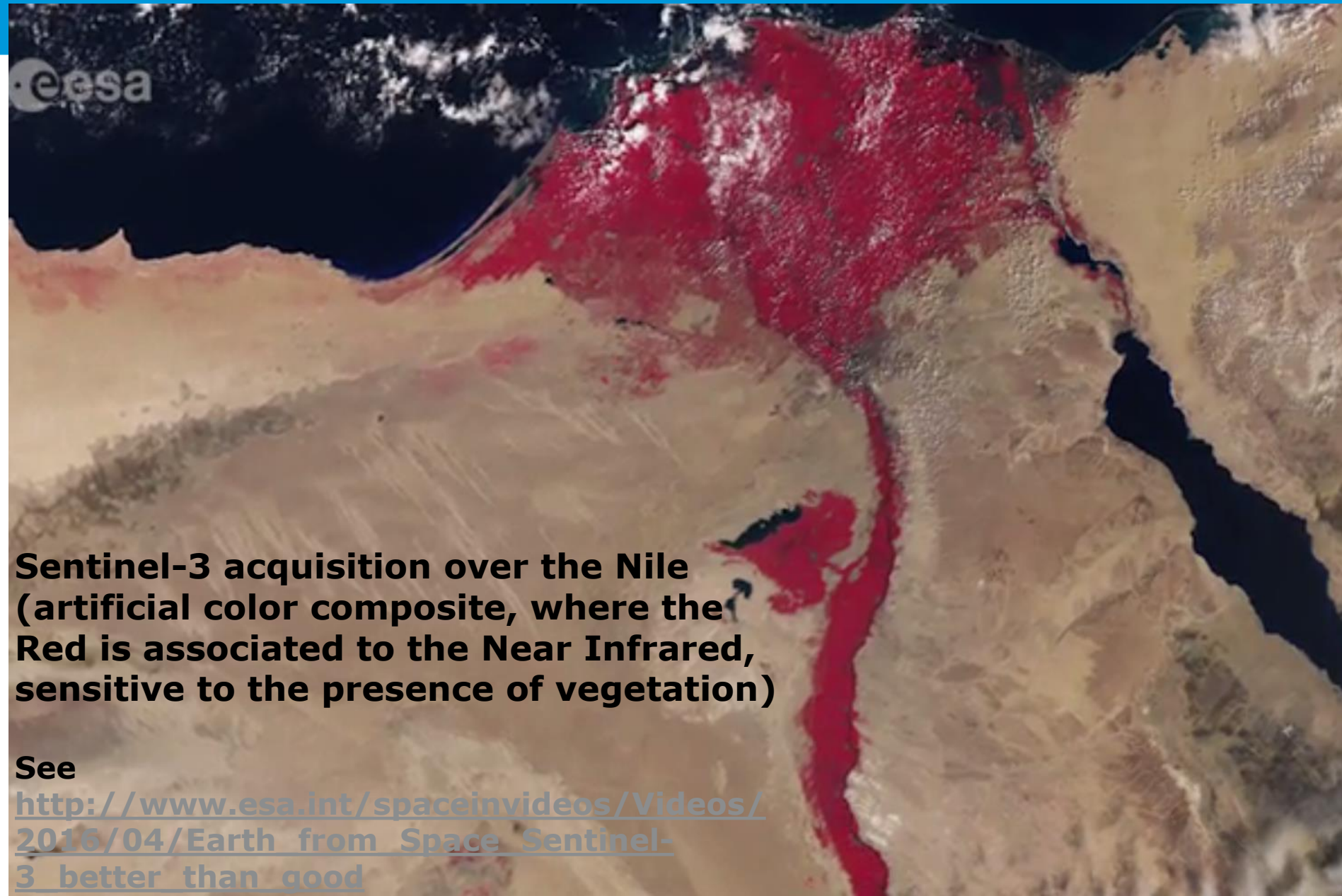
# Mediterranean Globcover



LAND: ESA GlobCover product (bi-month mosaic), an automated global classification based on the MERIS instrument (300 m resolution)/ENVISAT



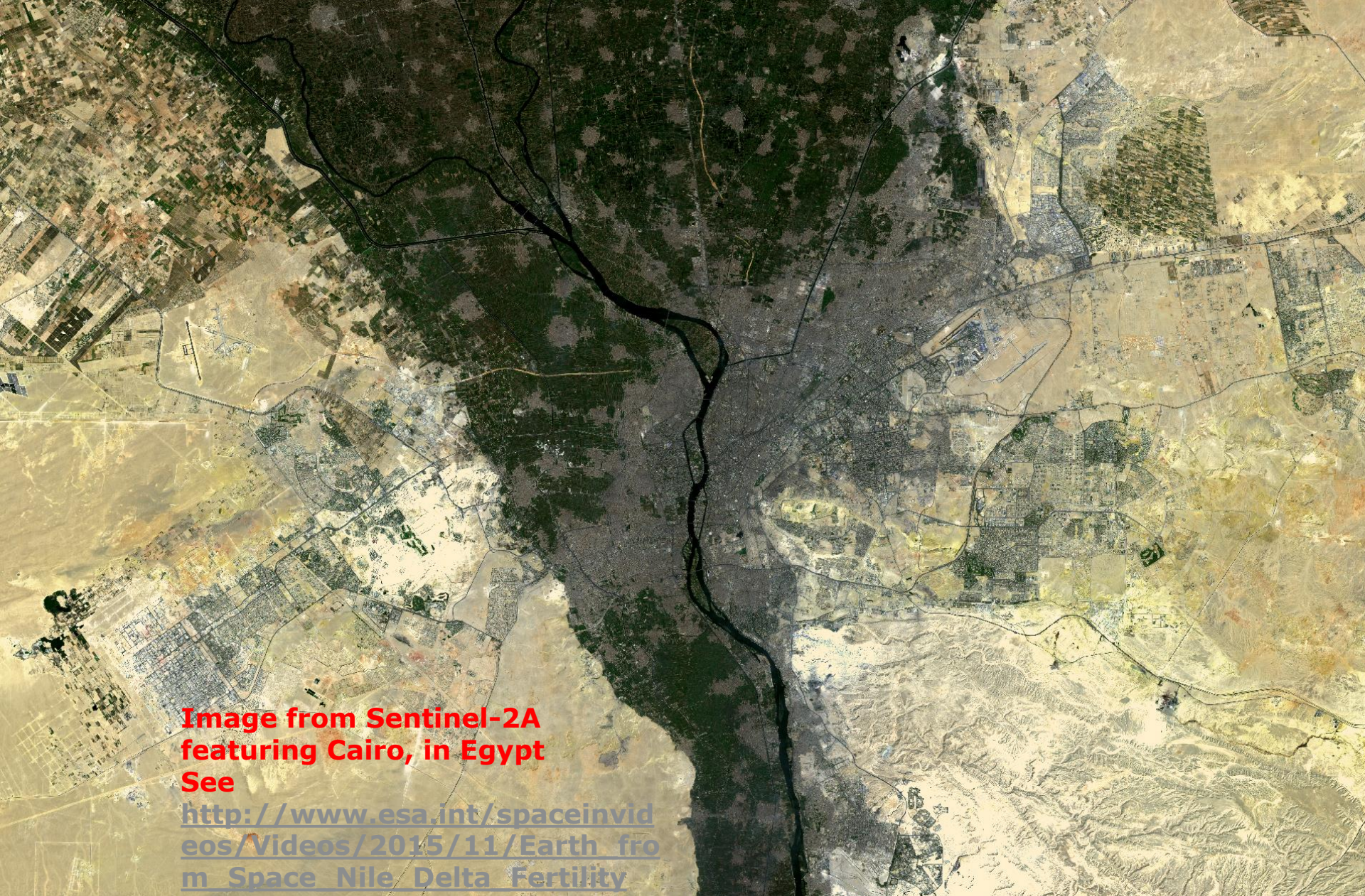
# Vegetation along the Nile from S-3



**Sentinel-3 acquisition over the Nile  
(artificial color composite, where the  
Red is associated to the Near Infrared,  
sensitive to the presence of vegetation)**

See  
[http://www.esa.int/spaceinvideos/Videos/  
2016/04/Earth\\_from\\_Space\\_Sentinel-  
3\\_better\\_than\\_good](http://www.esa.int/spaceinvideos/Videos/2016/04/Earth_from_Space_Sentinel-3_better_than_good)

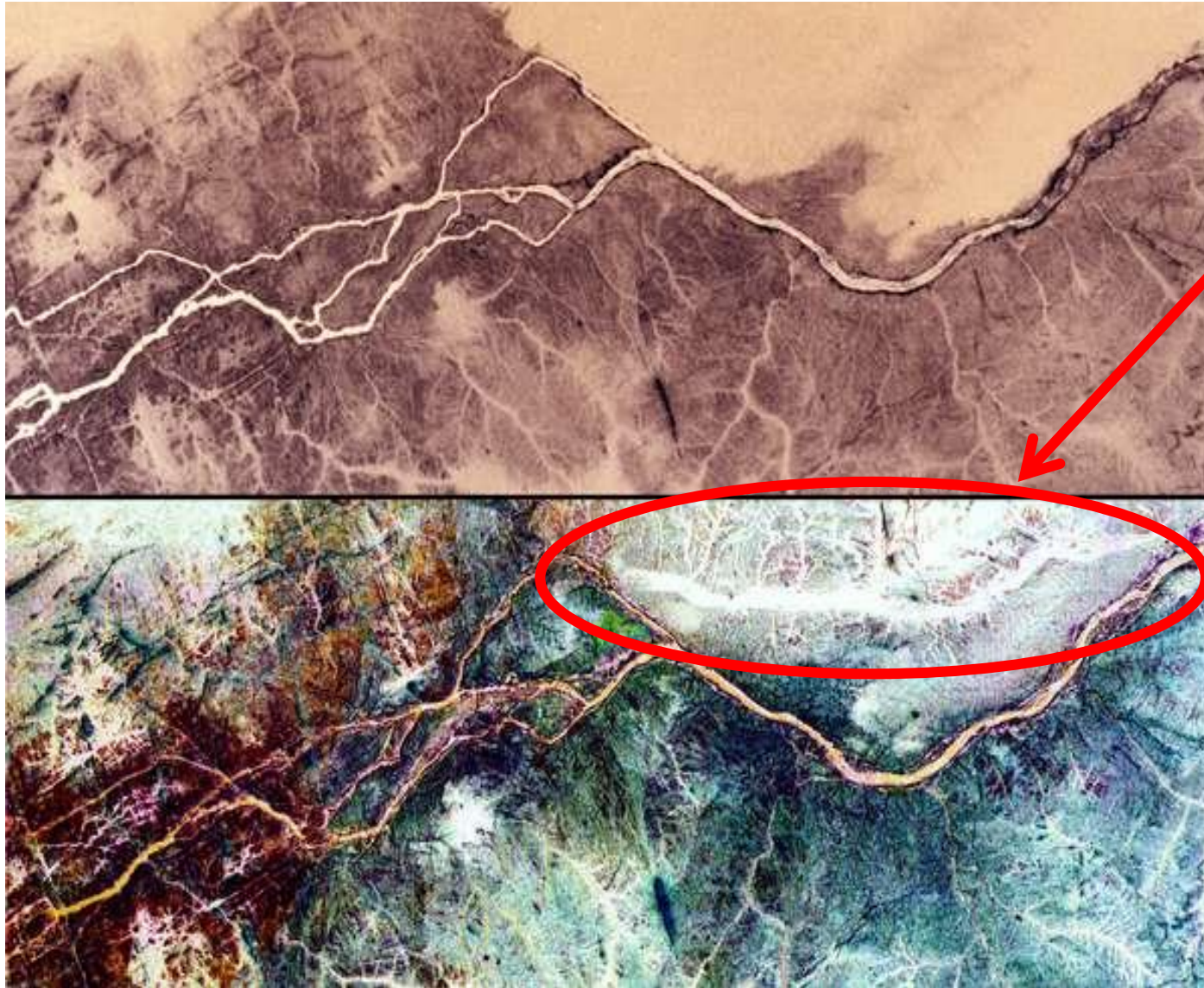
# Vegetation: Nile delta fertility from S-2



**Image from Sentinel-2A  
featuring Cairo, in Egypt  
See**

**[http://www.esa.int/spaceinvideo/Videos/2015/11/Earth\\_from\\_Space\\_Nile\\_Delta\\_Fertility](http://www.esa.int/spaceinvideo/Videos/2015/11/Earth_from_Space_Nile_Delta_Fertility)**

# Archaeological Prospection with SAR Remote Sensing through Sand: palaeorivers



**Old course of the Nile River, near Sudan.**

Top: photograph taken from Space Shuttle.

Bottom: radar image acquired by the Spaceborne Imaging Radar C/X-Band SAR (SIR-C/X-SAR) aboard Space Shuttle April 1994



# Etna 28/10/2002 (MERIS)



26/04/2017 | Slide 25

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# Mount Etna

Twin volcanic plumes:

- one ash
- one gas

26/10/2013

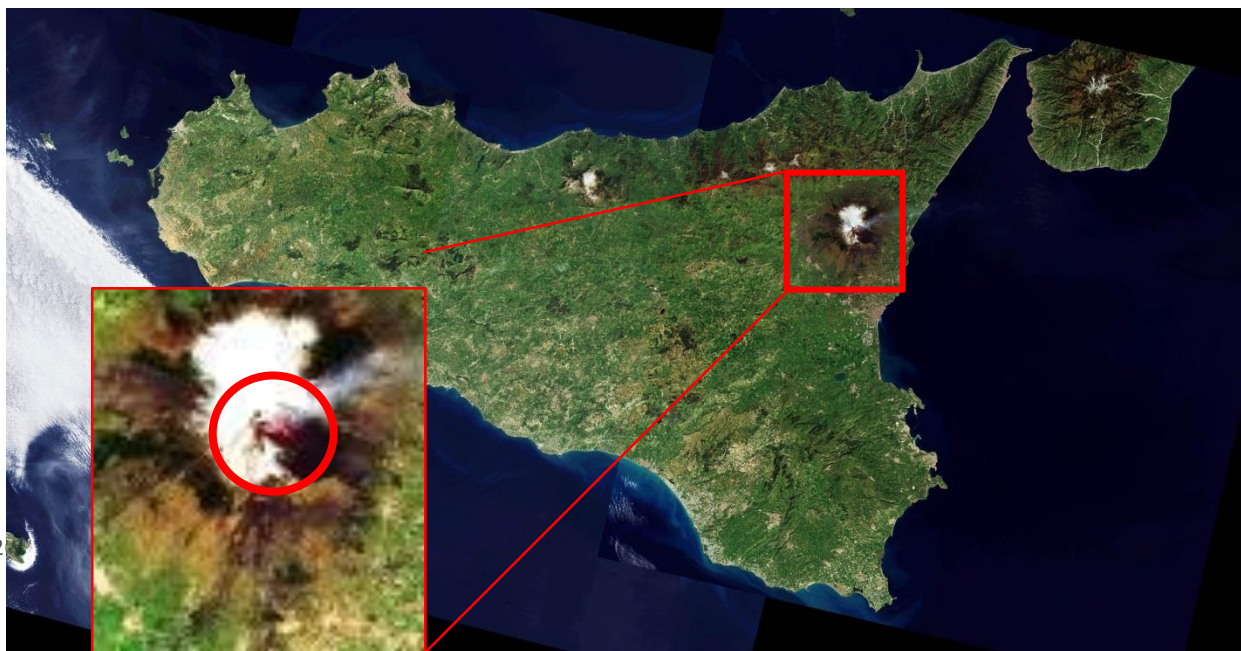


Proba-V

Etna erupting:

- mosaic  
(enhanced)

2014/2015



Landsat-8

# On-going Etna eruption

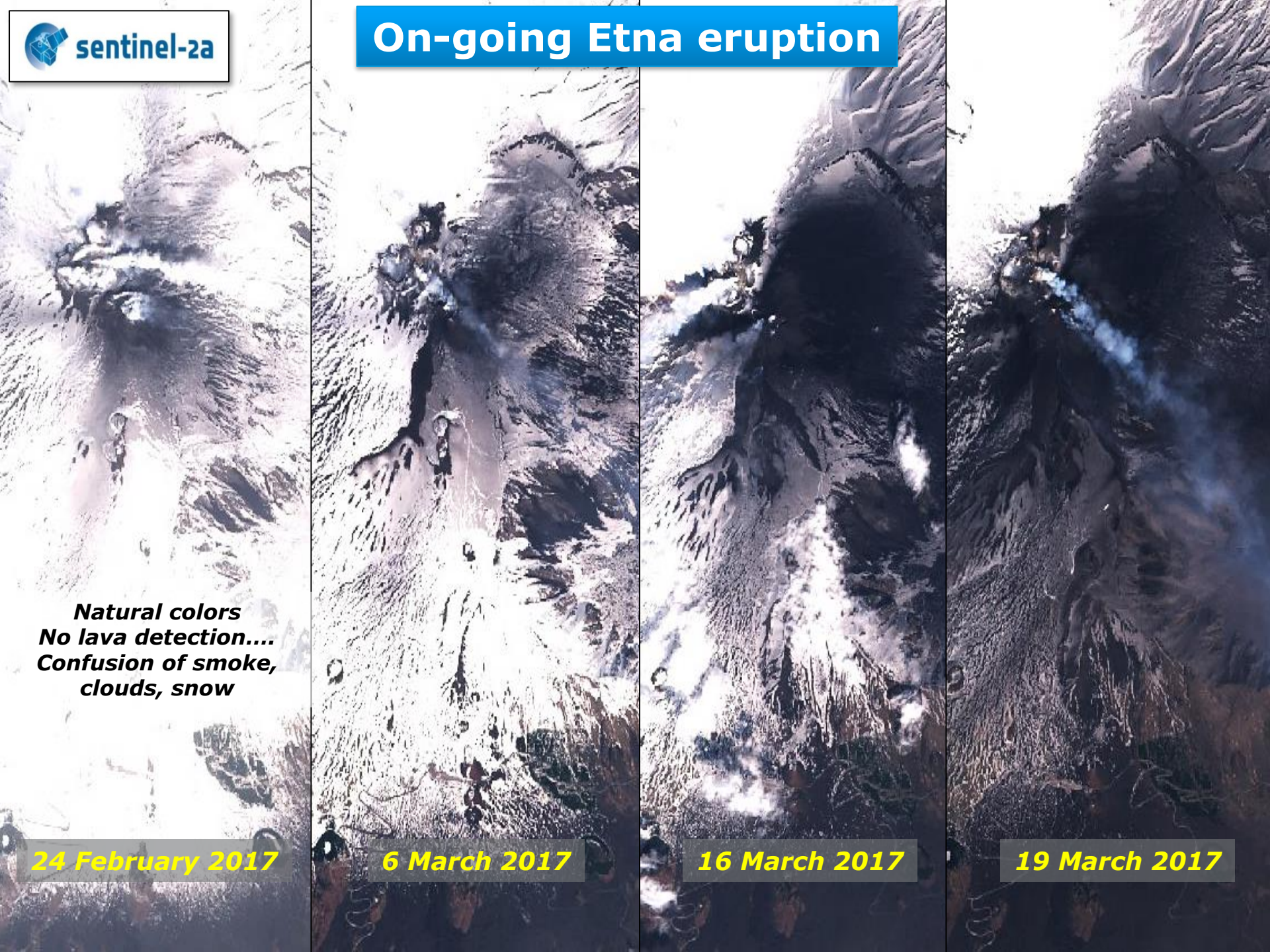
*Natural colors  
No lava detection...  
Confusion of smoke,  
clouds, snow*

**24 February 2017**

**6 March 2017**

**16 March 2017**

**19 March 2017**



# On-going Etna eruption

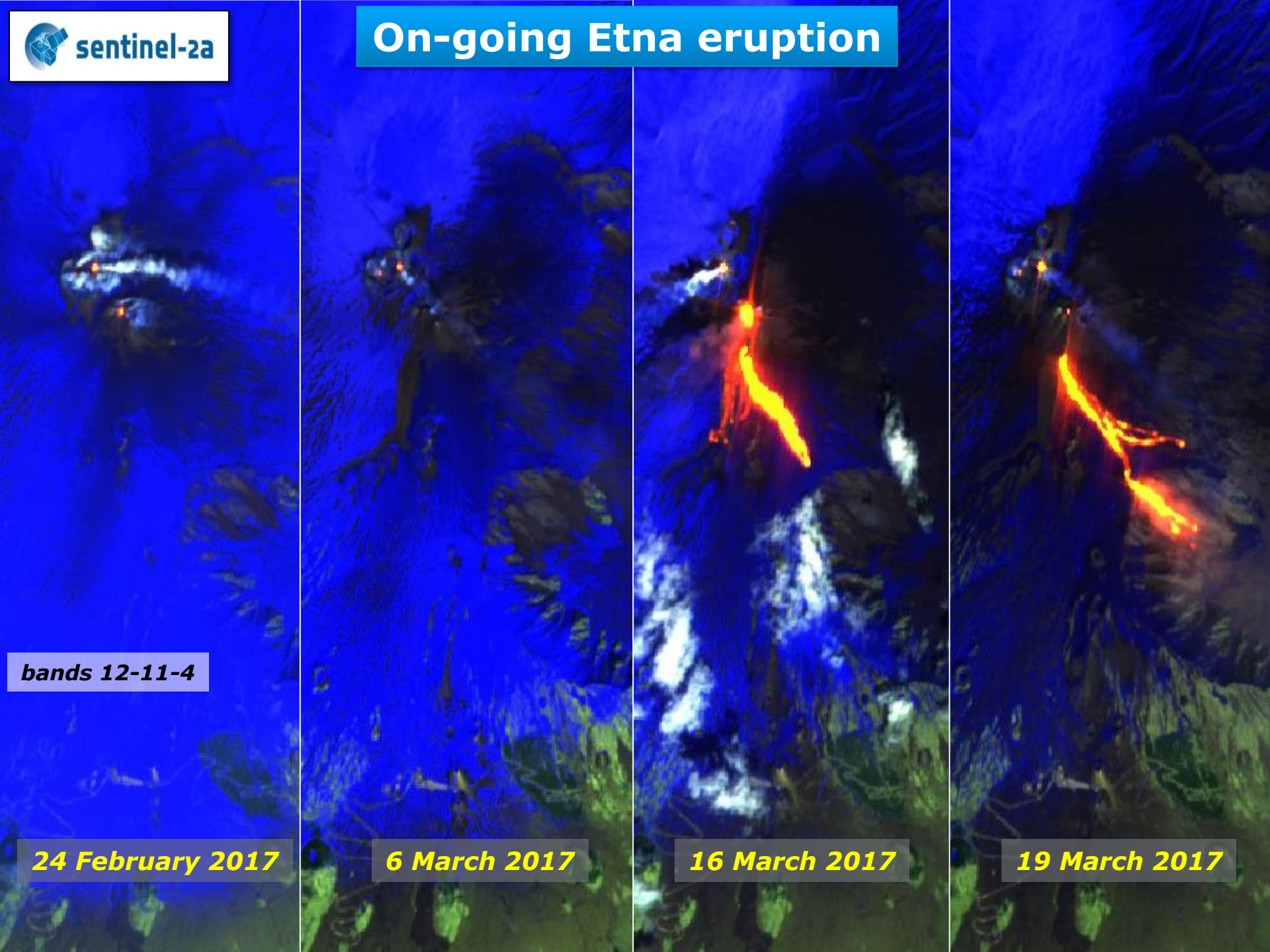
*bands 12-11-4*

**24 February 2017**

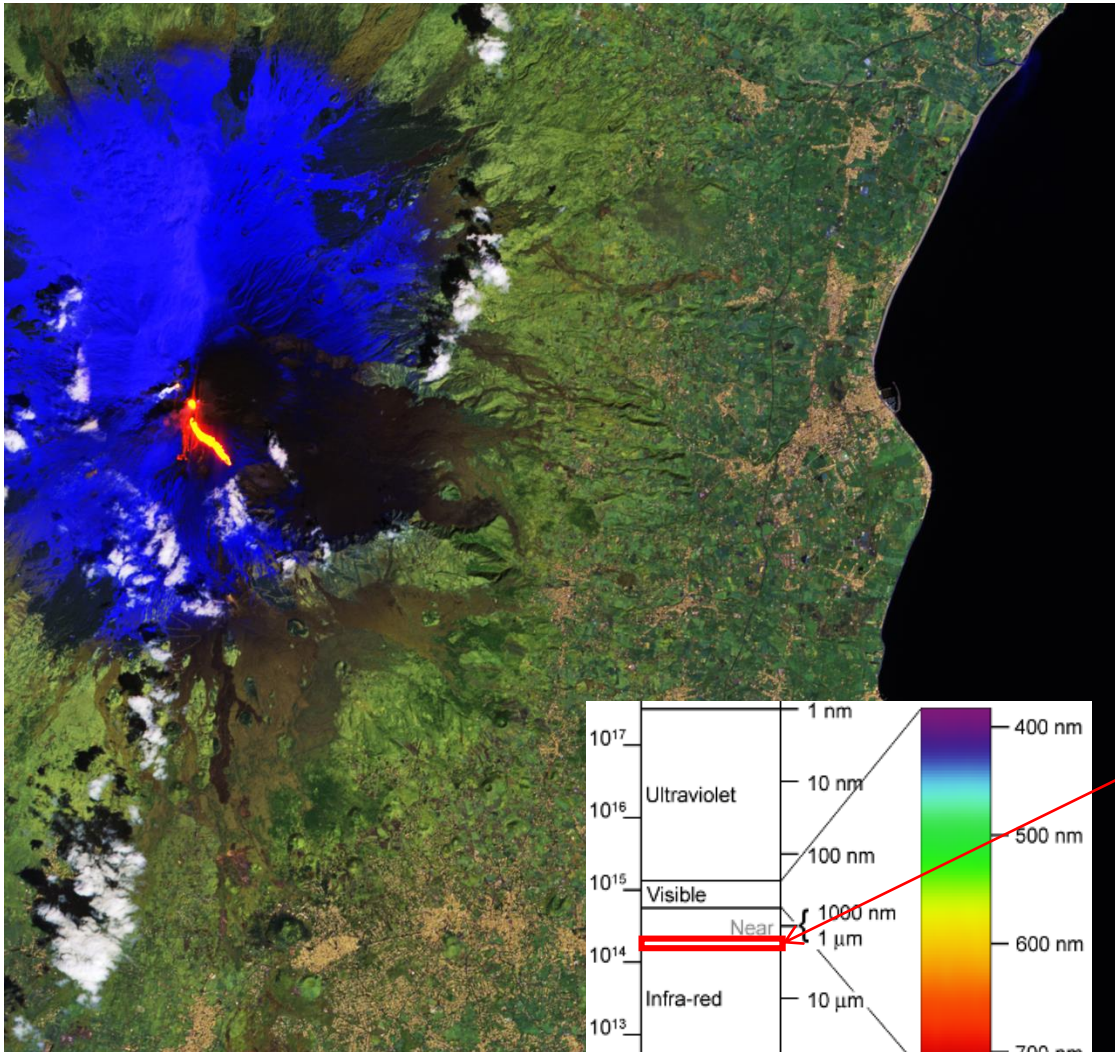
**6 March 2017**

**16 March 2017**

**19 March 2017**



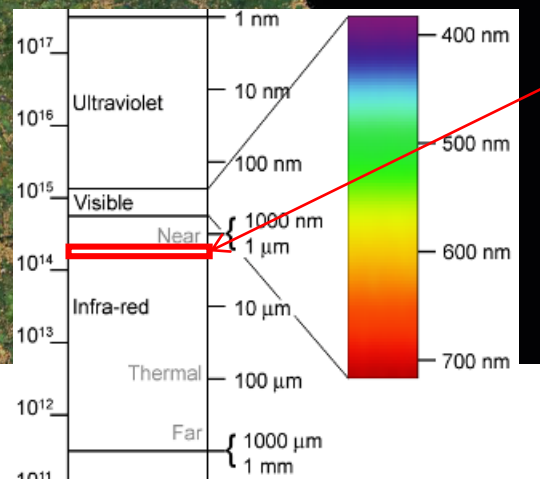
# Etna eruption 16/03/2017 (Sentinel-2A)



**Red:** hot lava flowing from Mount Etna in Sicily, Italy

**Blue:** the surrounding snow distinguished from the clouds

Artificial color composite using also the Short Wave Infrared (SWIR): B12 band (2.190 $\mu$ m)



26/04/2017 | Slide 29

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# On-going Etna eruption: a simple exercise

About 41.200 results (0,48 seconds)

**EO Browser - Sentinel Hub**

[www.sentinel-hub.com/apps/eo\\_browser](http://www.sentinel-hub.com/apps/eo_browser)

EO Browser. EO Browser combines a complete archive of Sentinel-2, Sentinel-3, ESA's archive of Landsat 5, 7 and 8, global coverage of Landsat 8, and ...

**EO Browser with Sentinel and Landsat data in one place - Sentinel Hub**

[www.sentinel-hub.com/blog/eo-browser](http://www.sentinel-hub.com/blog/eo-browser)

Over the past few weeks we have been de Hub. It combines a complete archive of Se

**EO Browser - Sentinel Hub**

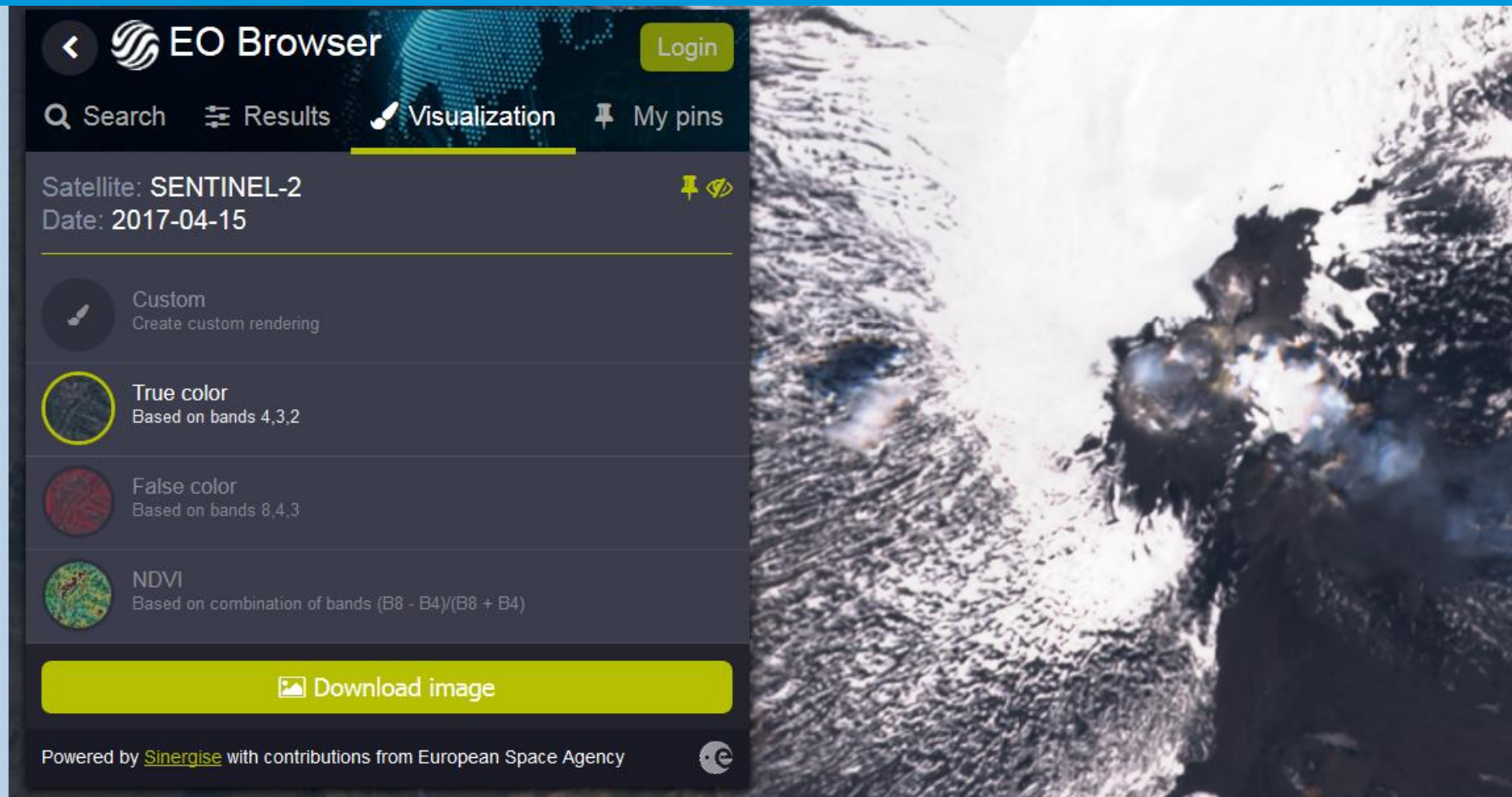
[apps.sentinel-hub.com/eo-browser/](http://apps.sentinel-hub.com/eo-browser/)

Login Sinergise EO Browser. Search; Res Landsat 5 ESA Landsat 7 ESA Landsat 8 B

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

- Select S2
- Go to your area of interest, e.g. Etna and zoom
- Select time frame, e.g. from 15 April onwards
- Search

Issue/Revision: .  
 Reference:  
 Status:  
 ESA UNCLASSIFIED - For Official Use



- Select 15 April (with lowest cloud content, e.g. 0.01)
- Compare true color, false color, NDVI
- Snow, smoke, and clouds are confused... lava is not visible...

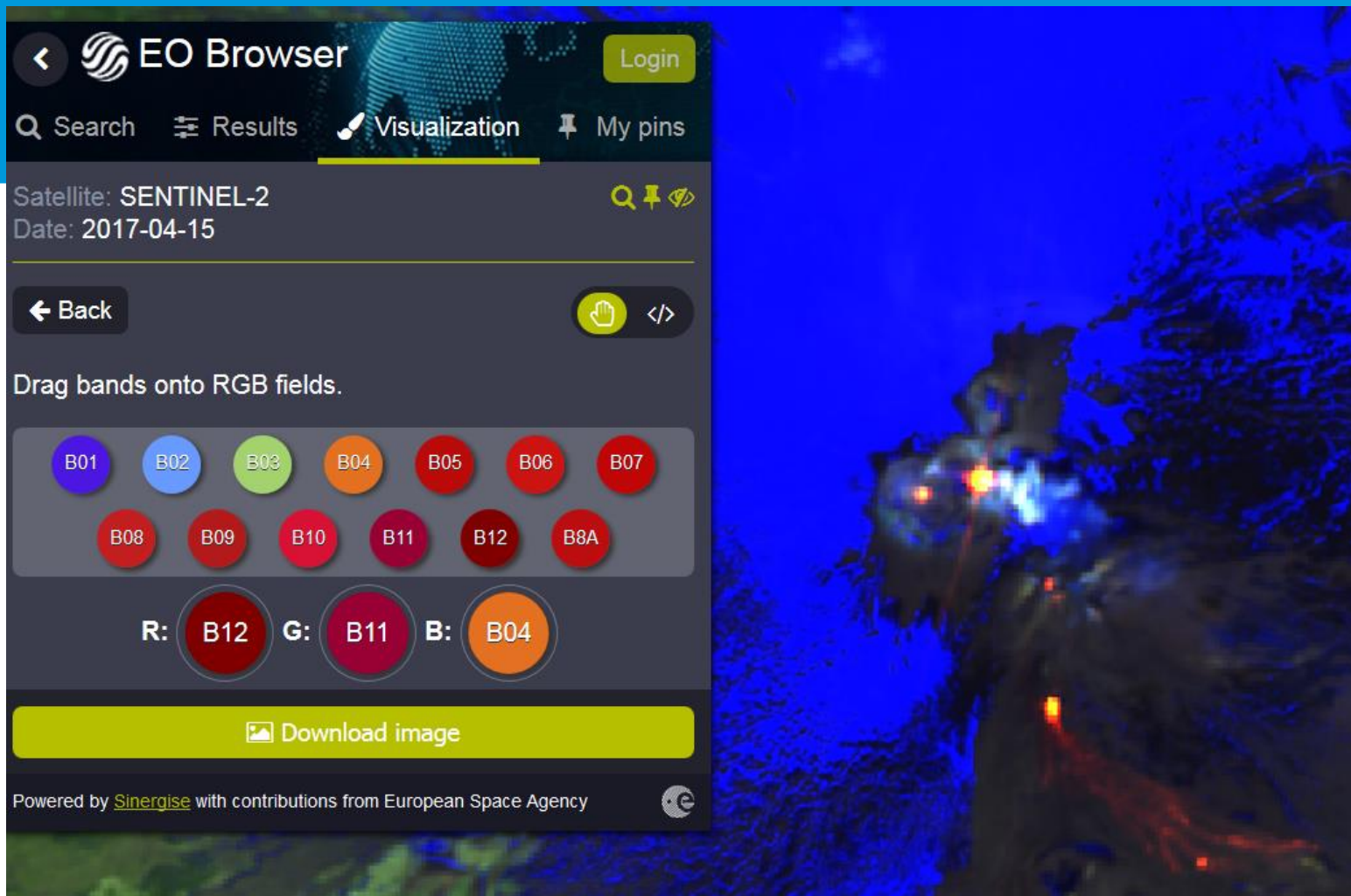
Issue/Revision: .

Reference:

Status:

ESA UNCLASSIFIED - For Official Use





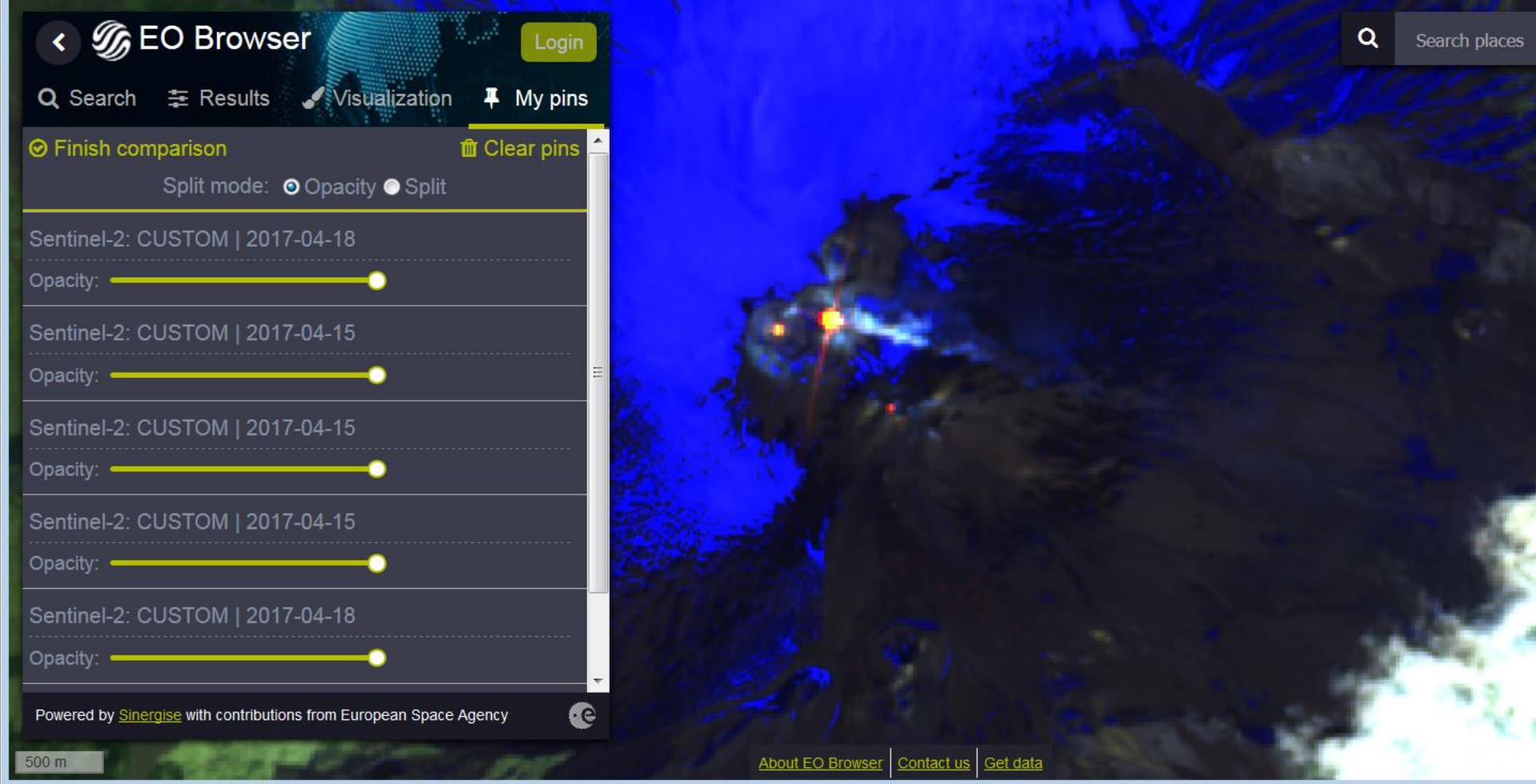
- Select now “custom” combination, associate RGB to B12, B11, B04
- Snow is different from smoke/clouds
- Lava is visible in red i.e. thanks to B12 (SWIR, 2.190  $\mu\text{m}$ ), when hotter than 500°C
- Pin this image
- Go to results and select also 18/04/2017 (lowest cloud), same combination, pin it

Issue/Revision: .

Reference:

Status:

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- Go to my pins
- compare

Issue/Revision: .

Reference:

Status:

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- Go to my pins
- compare

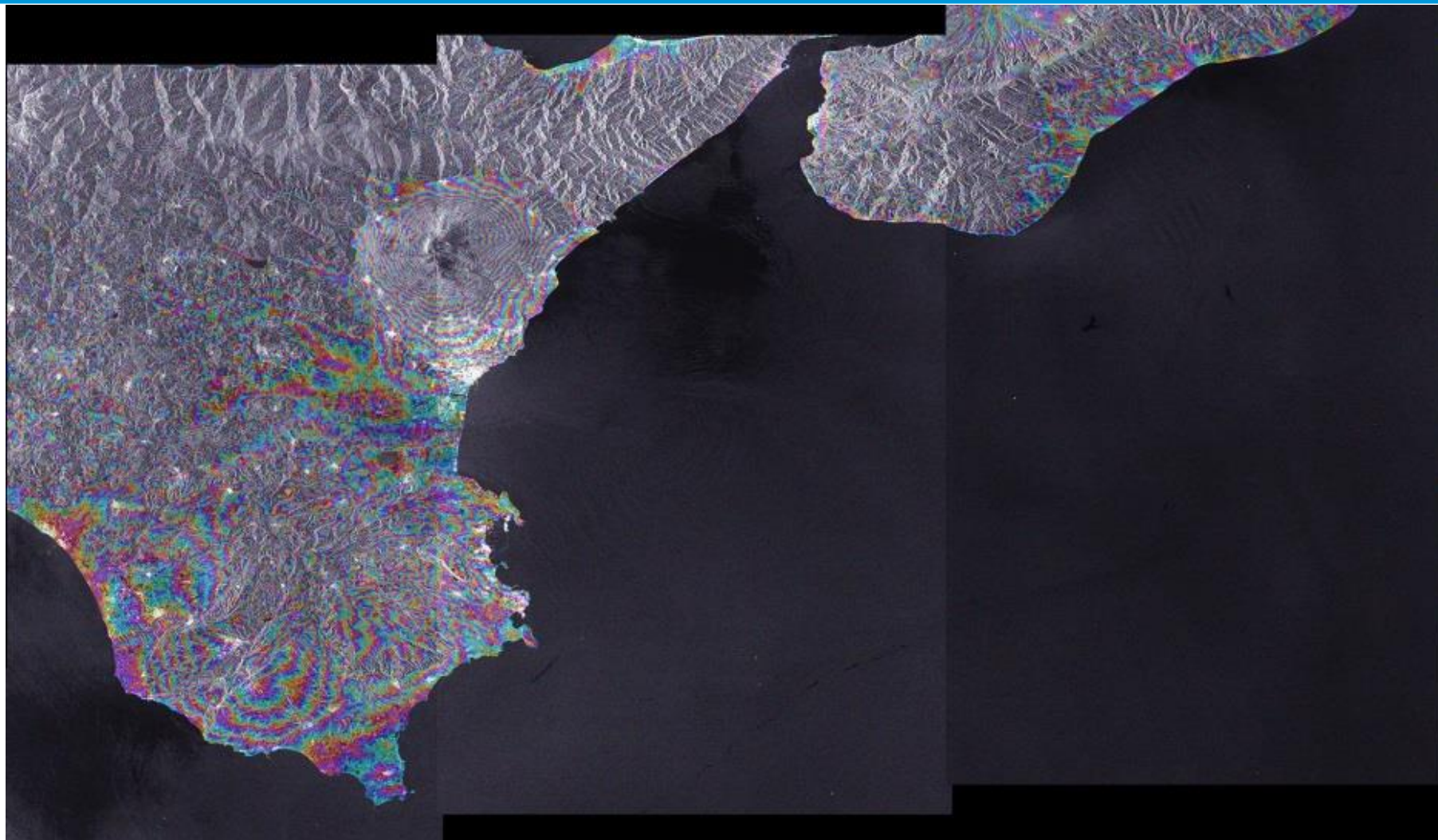
Issue/Revision: .

Reference:

Status:

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# Etna slopes 9 & 21/8/2014 (Sentinel-1A)



26/04/2017 | Slide 36

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**ETNA monitoring from space**  
**1992 - 2000**  
**Radar Interferometry**

# Santorini, Nea Kammeni, inflating (video)



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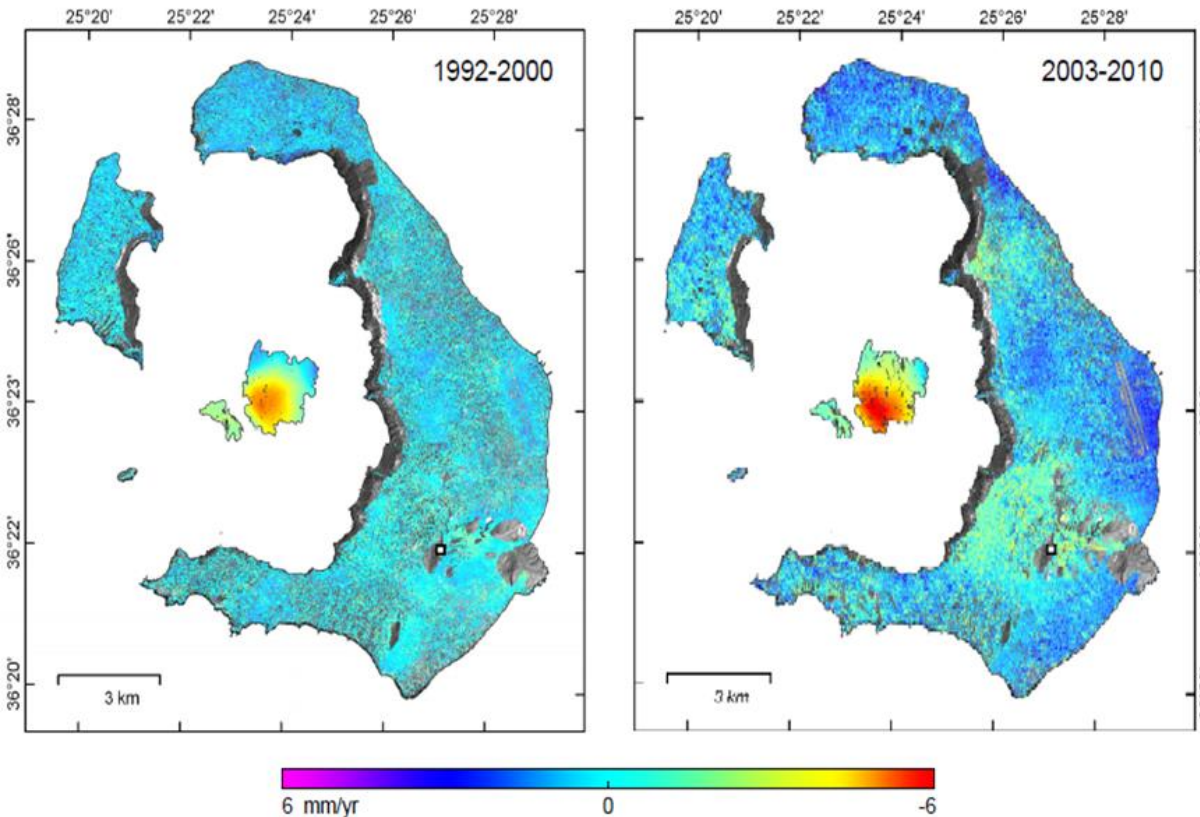
[http://www.esa.int/spaceinimages/Images/2012/09/Santorini\\_inflating](http://www.esa.int/spaceinimages/Images/2012/09/Santorini_inflating)

European Space Agency

# Santorini Island, Greece



## INSTITUTE FOR THE STUDY AND MONITORING OF THE SANTORINI VOLCANO (ISMOSAV)

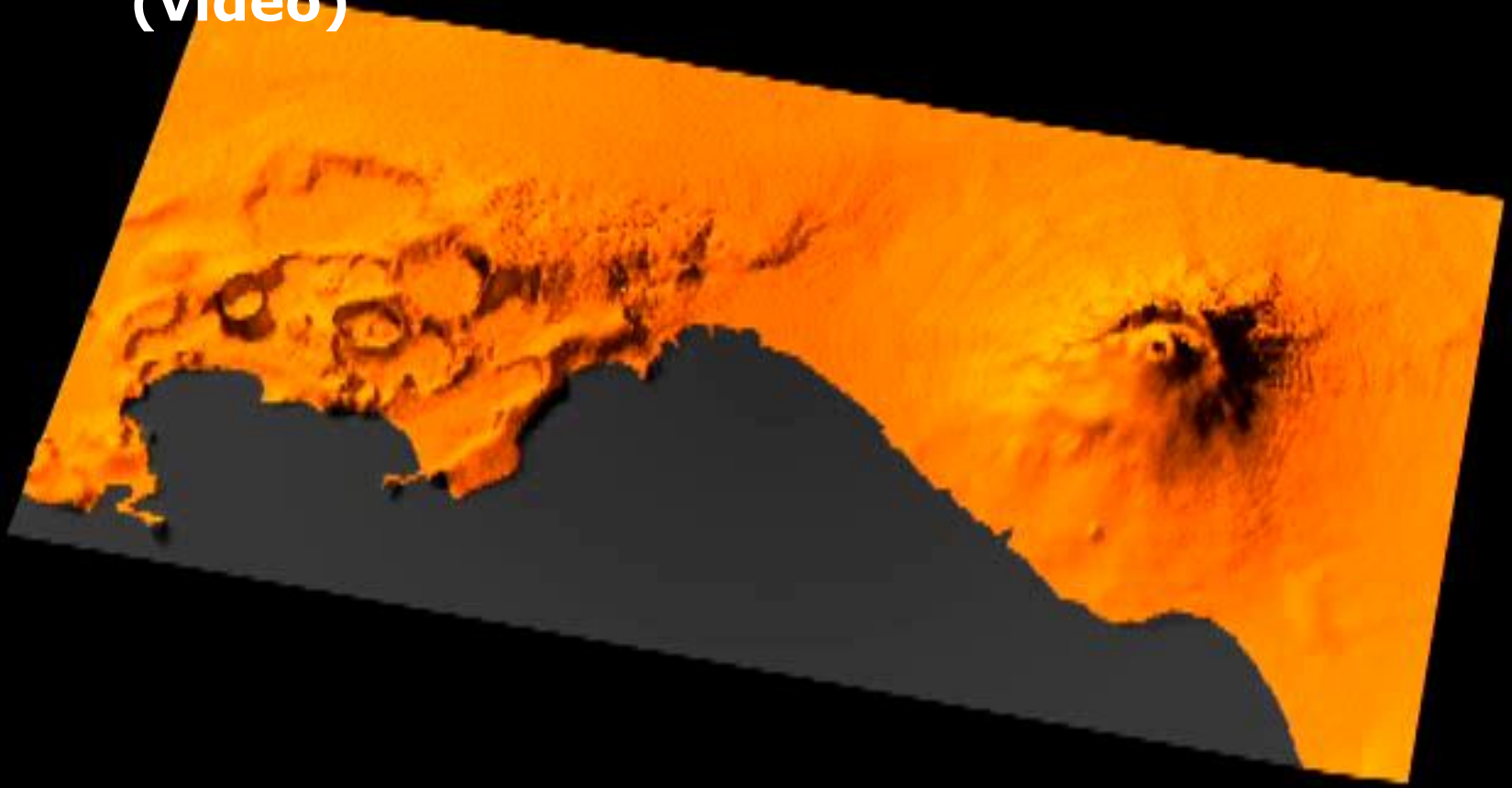


Vertical ground deformation derived from the combination of different SAR acquisition geometries, for the periods 1992-2000 and 2003-2010.

The selected reference point is shown in square (Source: Papageorgiou et al. 2011).

- *The latest explosions have occurred during the periods 1925-1928, 1939-1941, as well as in 1950.*
- *Part of the volcanic islets formed in the 1950s constitute the most recent land area in the Mediterranean!*

# Campi Flegrei: observation by InSAR (video)







A satellite view of Earth from space, showing the curvature of the planet and the atmosphere. The image is overlaid with numerous small orange dots and lines representing volcanic locations. Labels for some of these locations include 'Menengai', 'Paka', 'Oryaba Hills', and 'Karthala'. A large blue banner with white text is positioned in the lower right quadrant of the image.

## Geohazards: Volcanism

Radar satellites measure surface movement in millimetres. The Campi Flegrei in Italy is one of 20 known super-volcanoes on Earth. Data from the new Sentinel-1 satellite will help to establish area-wide continuous monitoring to reveal processes below Earth's surface.

# Land Subsidence – Venice, Italy (video)

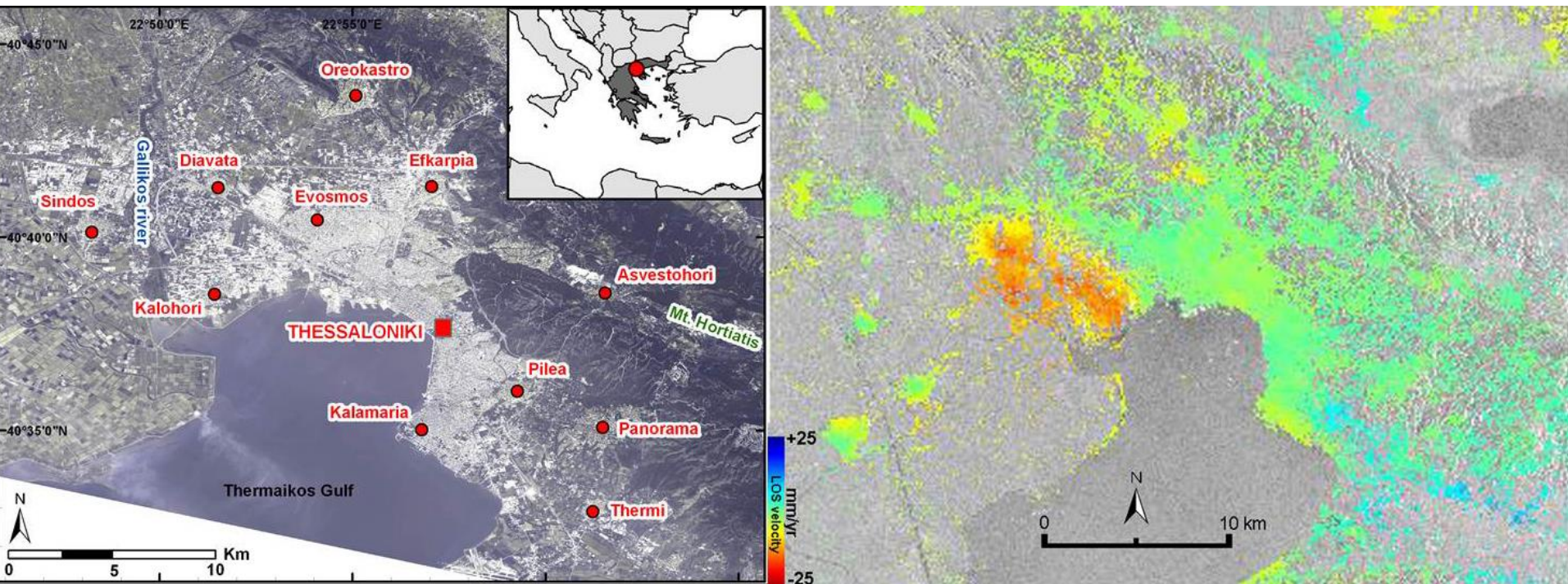


26/04/2017 | Slide 42

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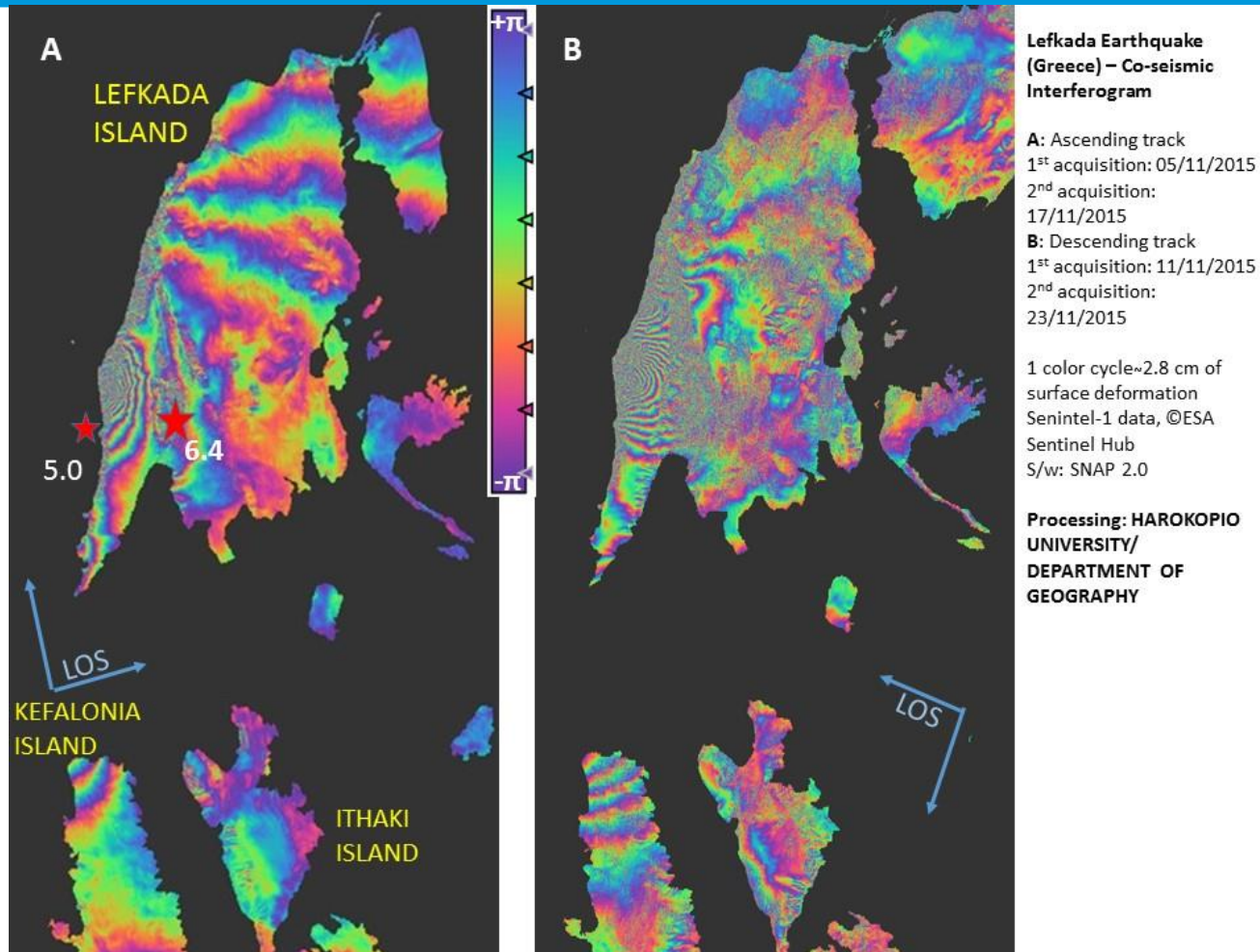
European Space Agency

# Subsidence in Northern Greece



*2004-2010 subsidence monitored by PS InSAR, using Envisat/ASAR data (Mouratidis and Costantini, 2012)*

# Earthquakes deformation, Lefkada, Greece



*Deformation owing to the Lefkada earthquakes in 2015.*

# Fires (MERIS) / (ENVISAT)



26/7/2007 Balkans and Greece



24/8/2007 Peloponnese Peninsula,  
Greece

# Hot spots across Southeastern Europe (21–26/8/2007)

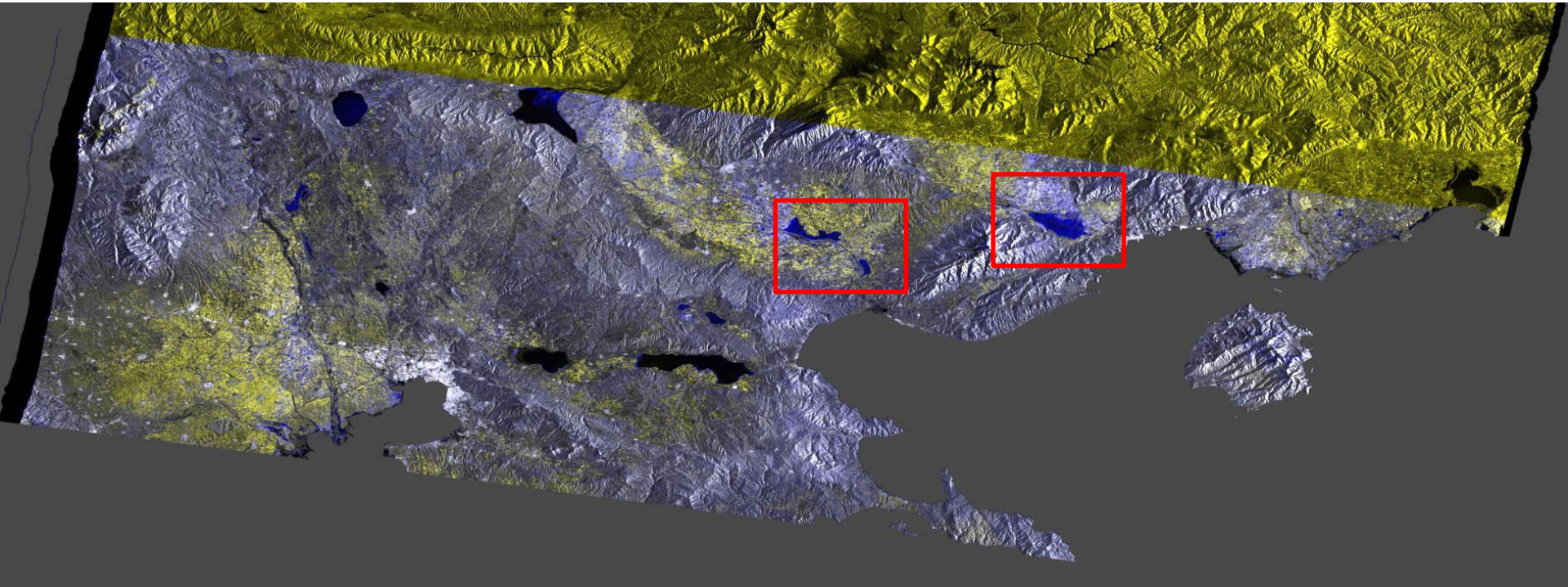


26/04/2017 | Slide 46

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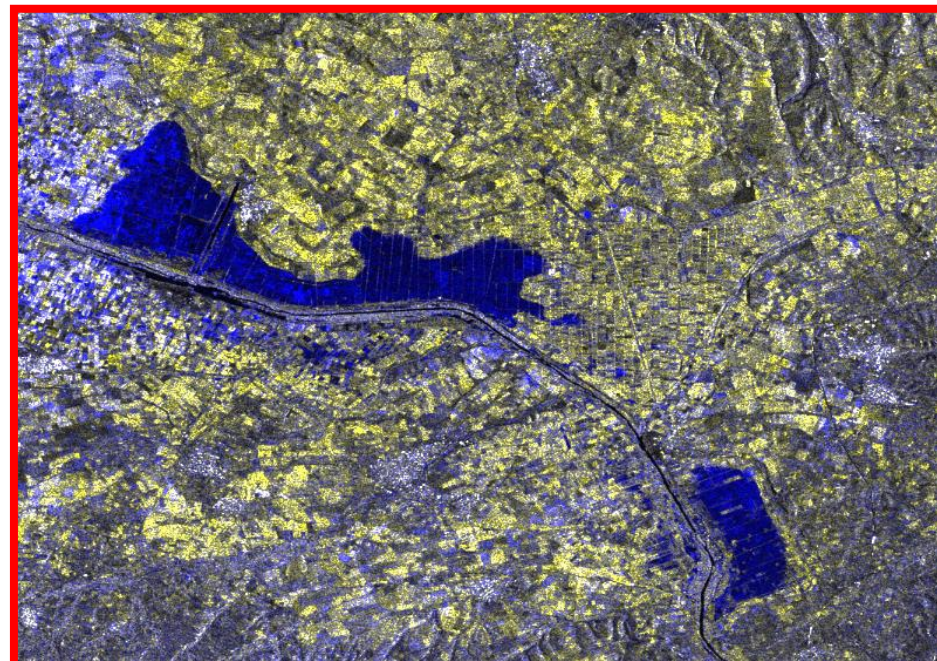
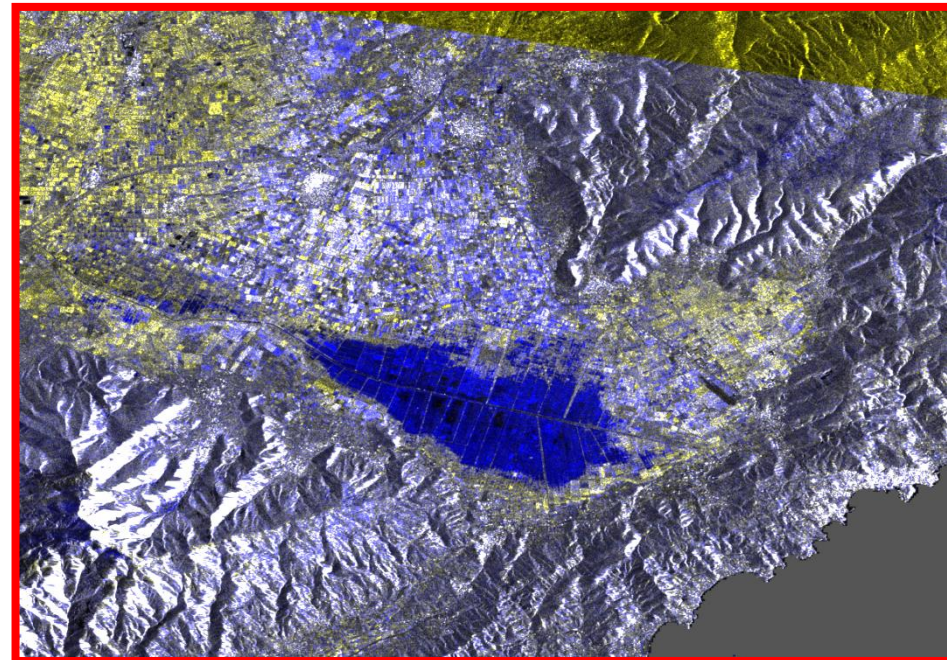
European Space Agency

# Flood mapping with Sentinel-1 data in Northern Greece



*(Pantazopoulou et al., 2016)*

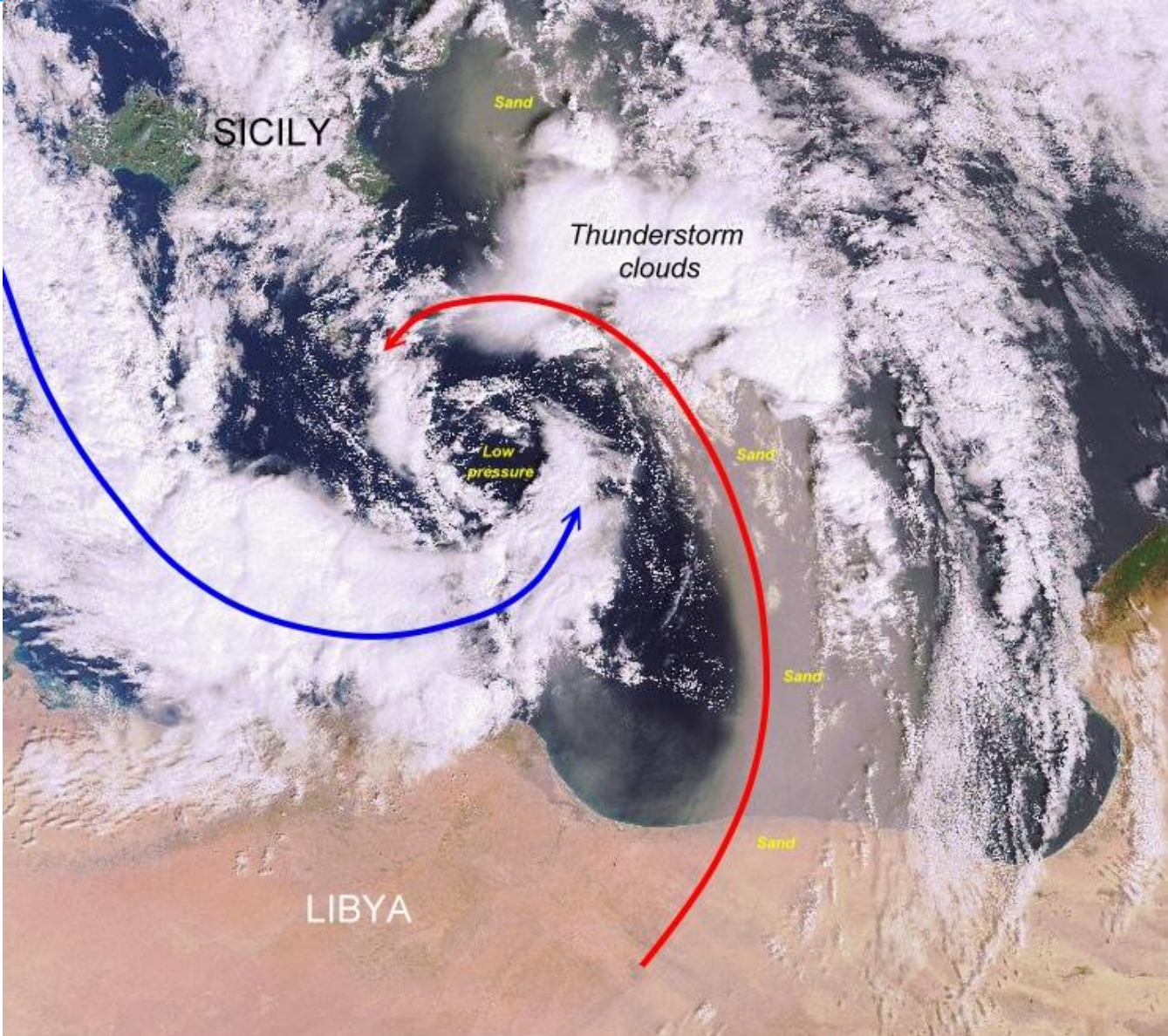
# Flood mapping with Sentinel-1 data in Northern Greece



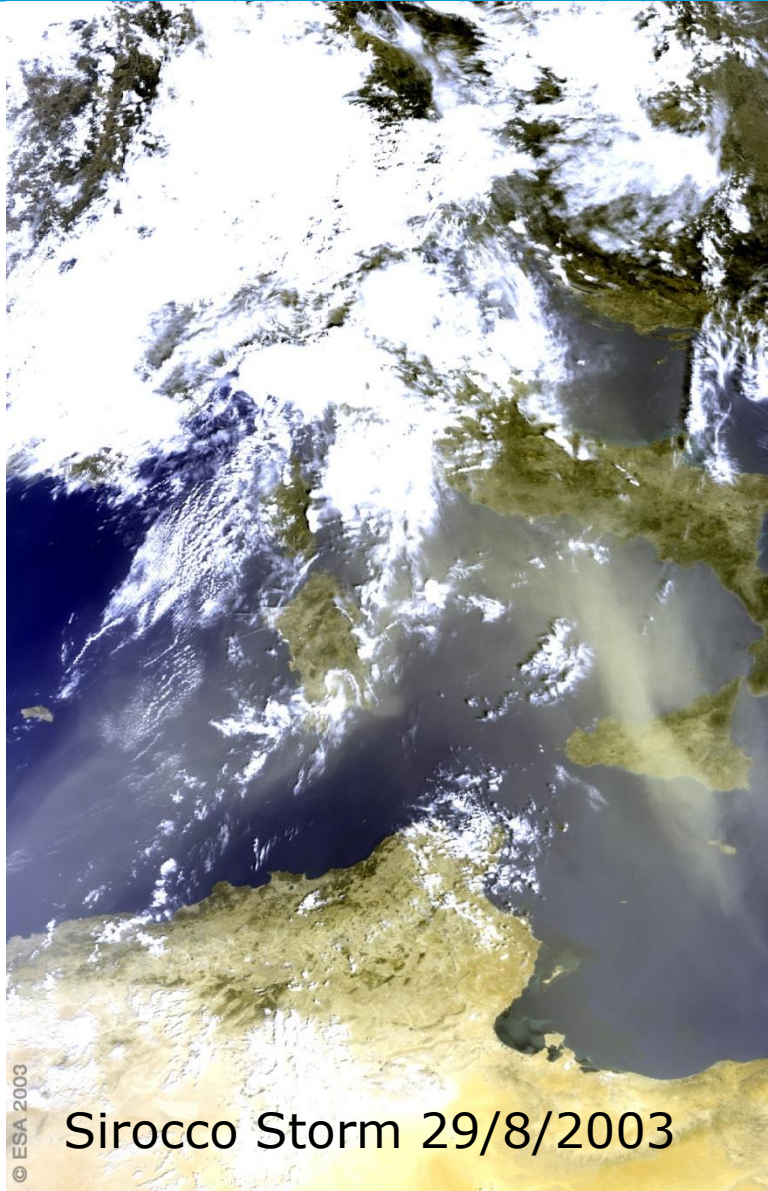
*(Pantazopoulou et al., 2016)*



# Dust Storms

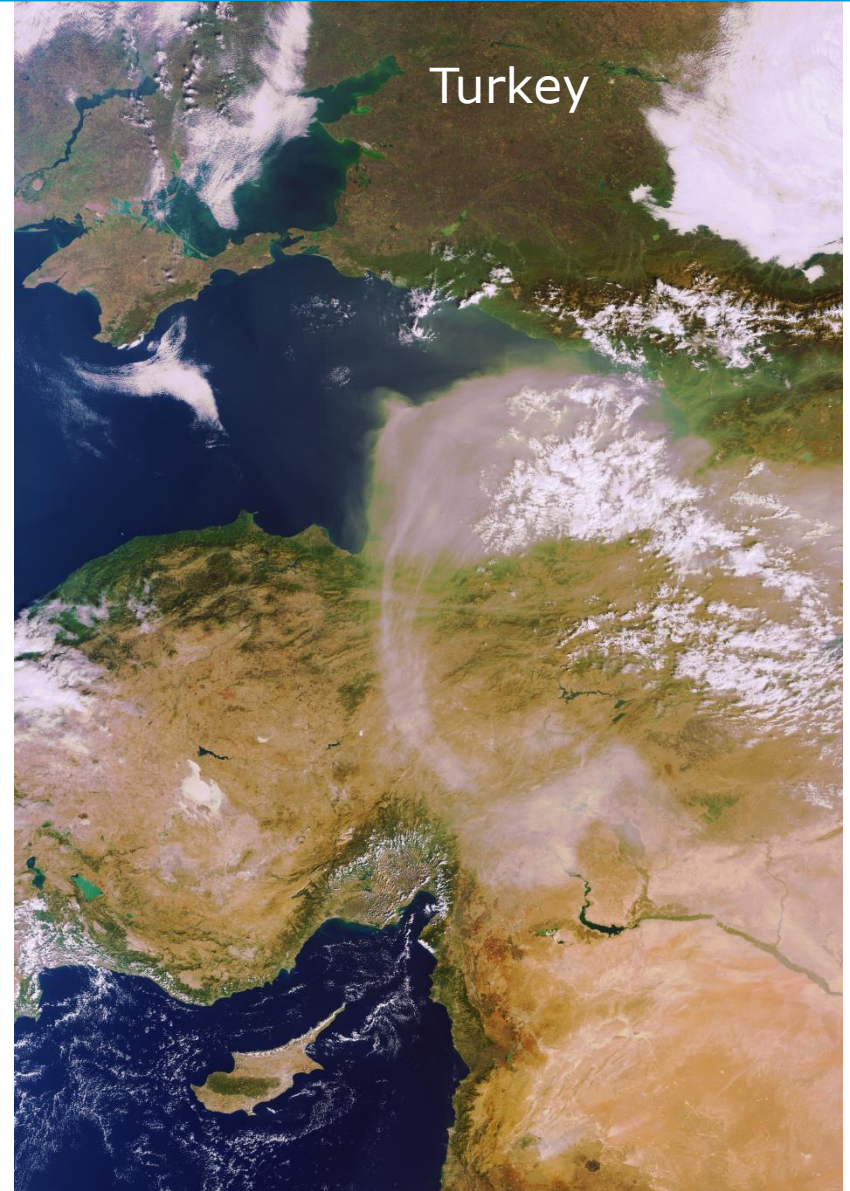


# Dust Storms



© ESA 2003

Sirocco Storm 29/8/2003



# Mediterranean Seafloor (video)



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Simulation showing the “Mediterranean emptying from its water” (courtesy DLR)

European Space Agency

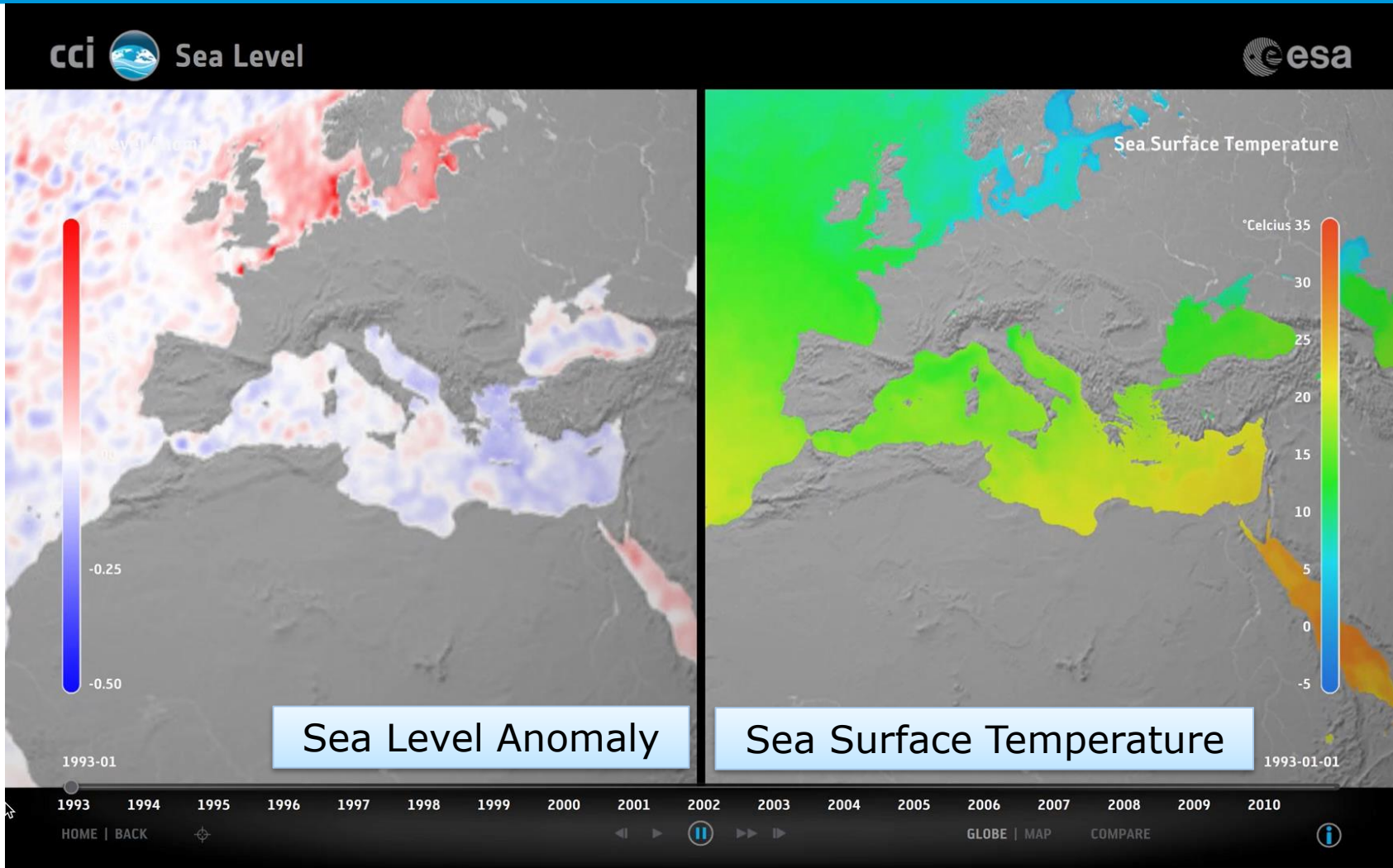


## Mapping The Seafloor

Having a detailed knowledge of the shape of the seafloor is essential for generating nautical charts for navigation. But it is also needed for exploration, fishing, coastal management and for understanding ocean currents that transport heat, nutrients and pollutants.

# Correlation: Sea Level Anomaly – Sea Surface Temperature (video)

Data: 01/1993 – 12/2010



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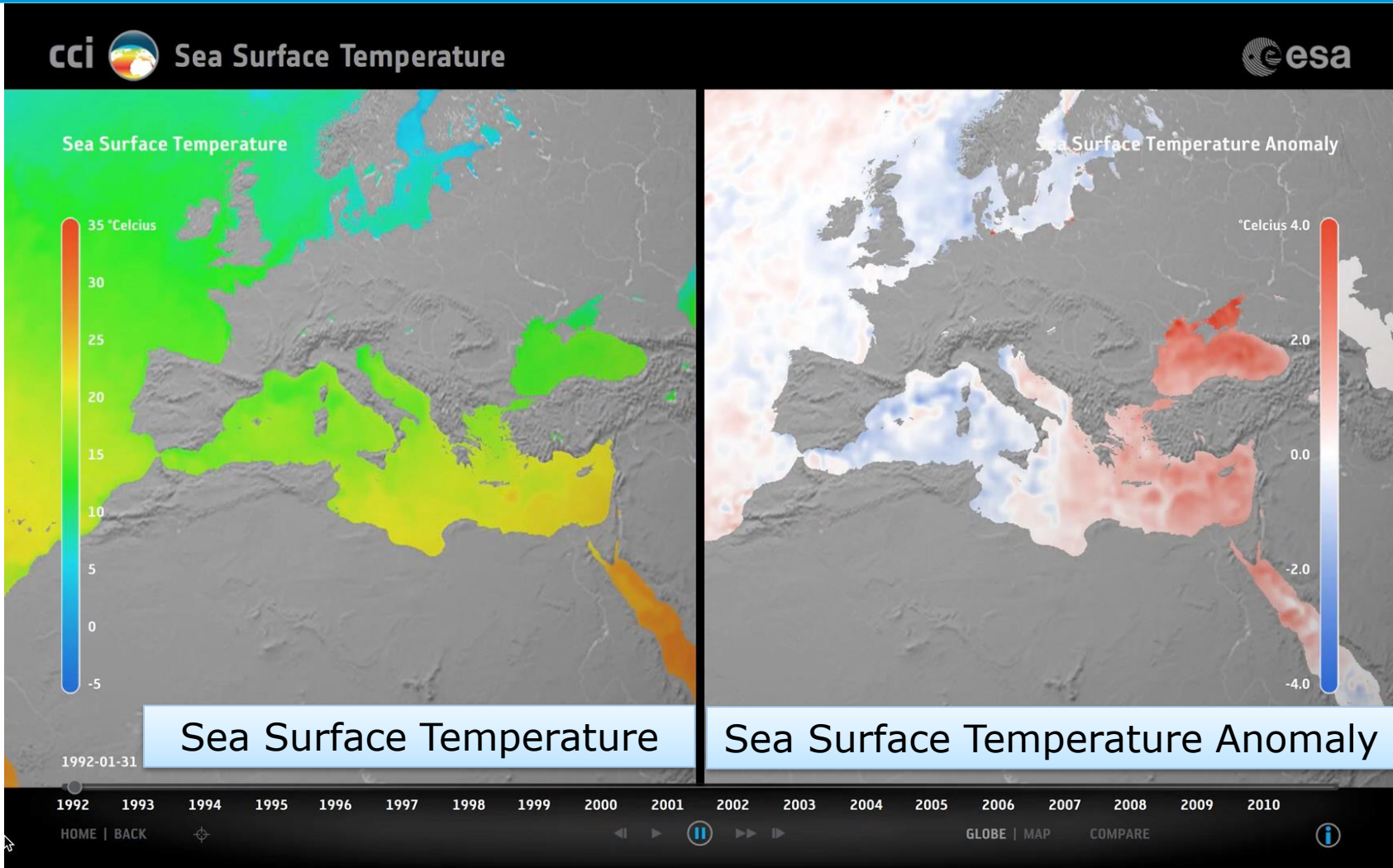
ESA UNCLASSIFIED - For Official Use

Video from CCI App visualization tool:  
<http://cci.esa.int/>

European Space Agency

# Correlation: Sea Surface Temperature – Sea Surface Temperature Anomaly (video)

Data: 01/1992 – 11/2010



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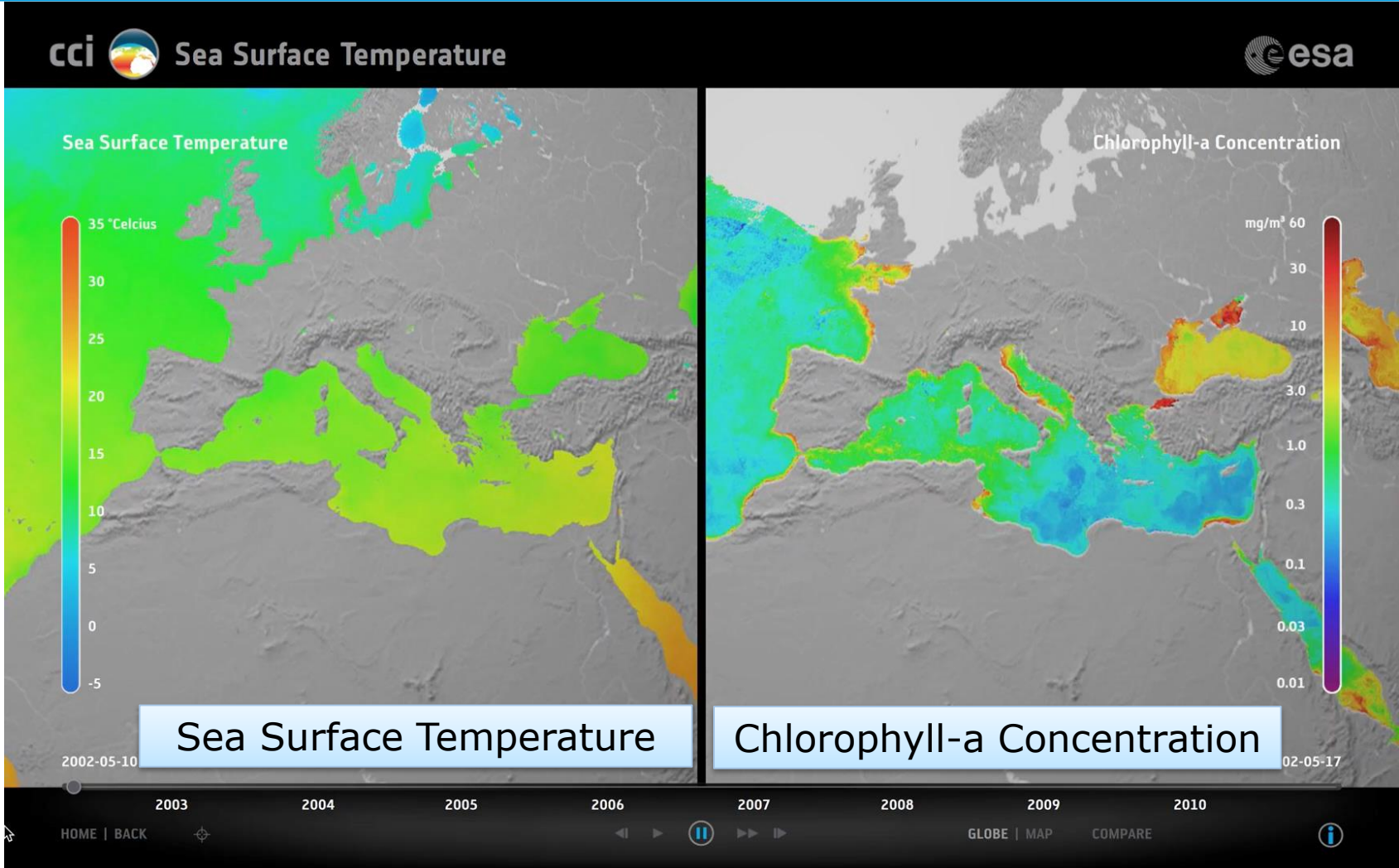
ESA UNCLASSIFIED - For Official Use

Video from CCI App visualization tool:  
<http://cci.esa.int/>

European Space Agency

# Correlation: Sea Surface Temperature – Chlorophyll-a Concentration (video)

Data: 05/2002 – 12/2010



26/04/2017 | Slide 55

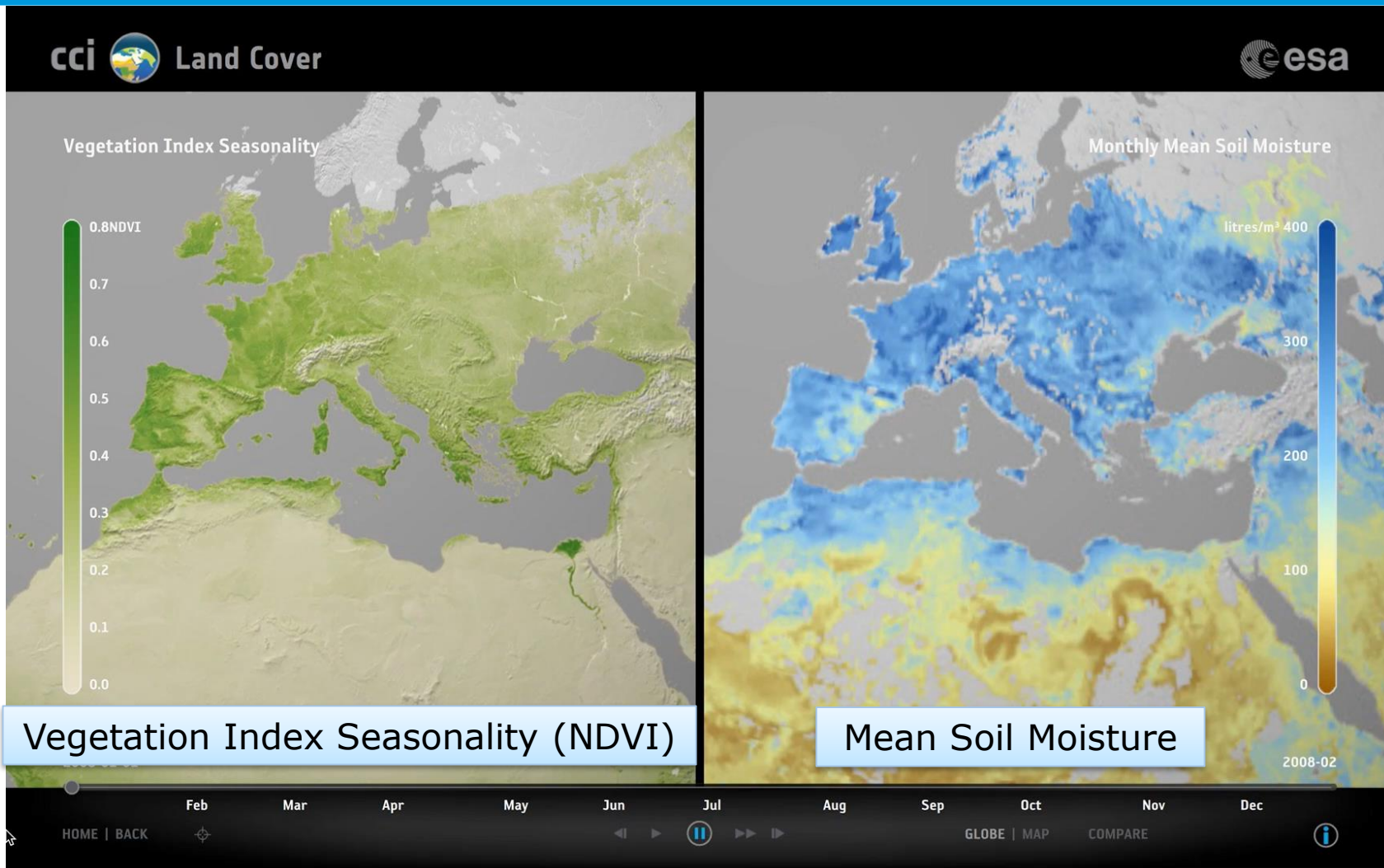
ESA UNCLASSIFIED - For Official Use

Video from CCI App visualization tool:  
<http://cci.esa.int/>

European Space Agency

# Correlation: Vegetation Index Seasonality – Mean Soil Moisture (video)

Data: 01/2008 – 12/2008



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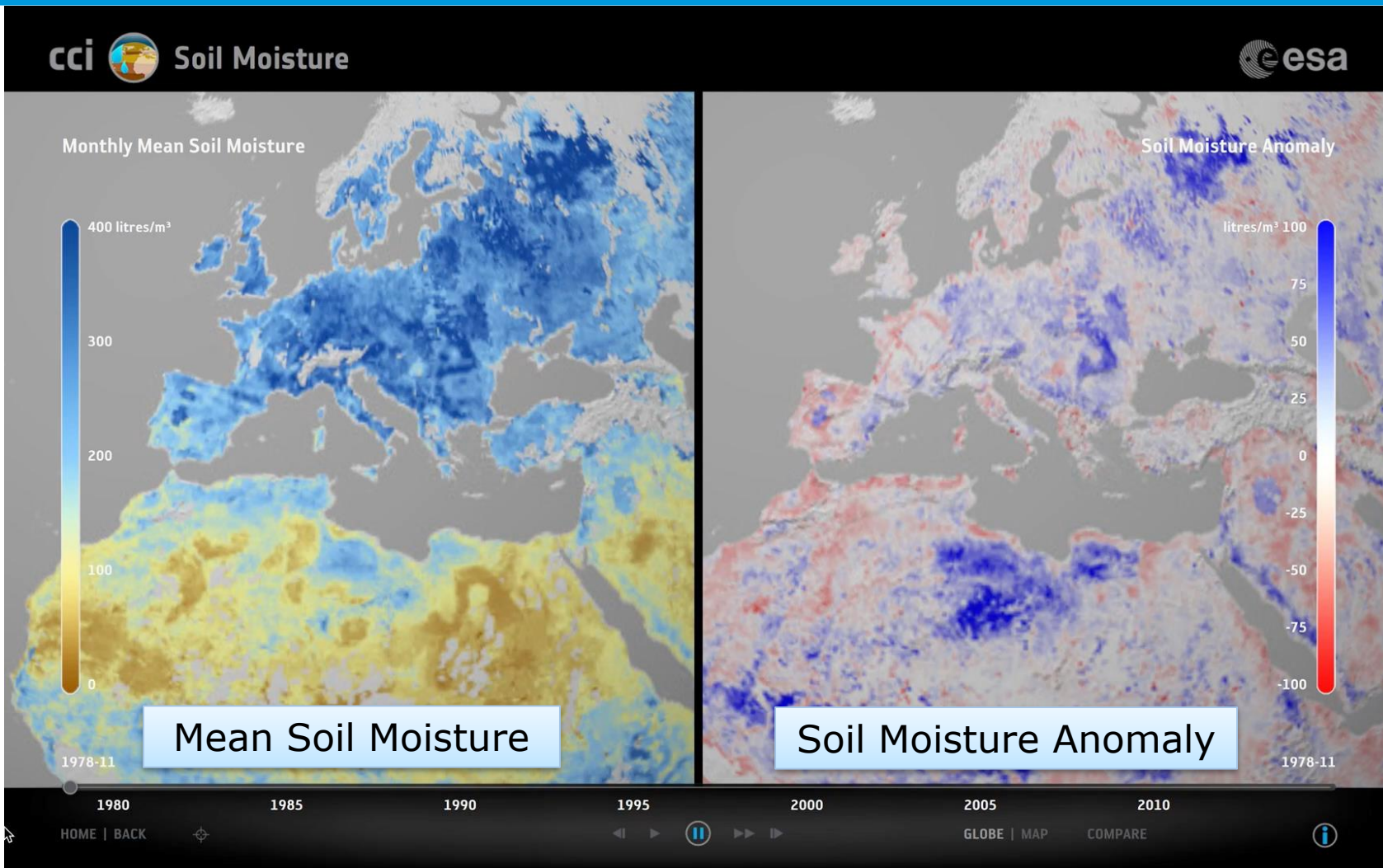
Video from CCI App visualization tool:  
<http://cci.esa.int/>

European Space Agency



# Correlation: Mean Soil Moisture – Soil Moisture Anomaly (video)

Data: 11/1978 – 12/2014



26/04/2017 | Slide 57

ESA UNCLASSIFIED - For Official Use

Video from CCI App visualization tool:  
<http://cci.esa.int/>

European Space Agency

# Correlation: Fires/Burned Areas – Aerosol Optical Depth (video)

Data: 01/2005 – 12/2011



26/04/2017 | Slide 58

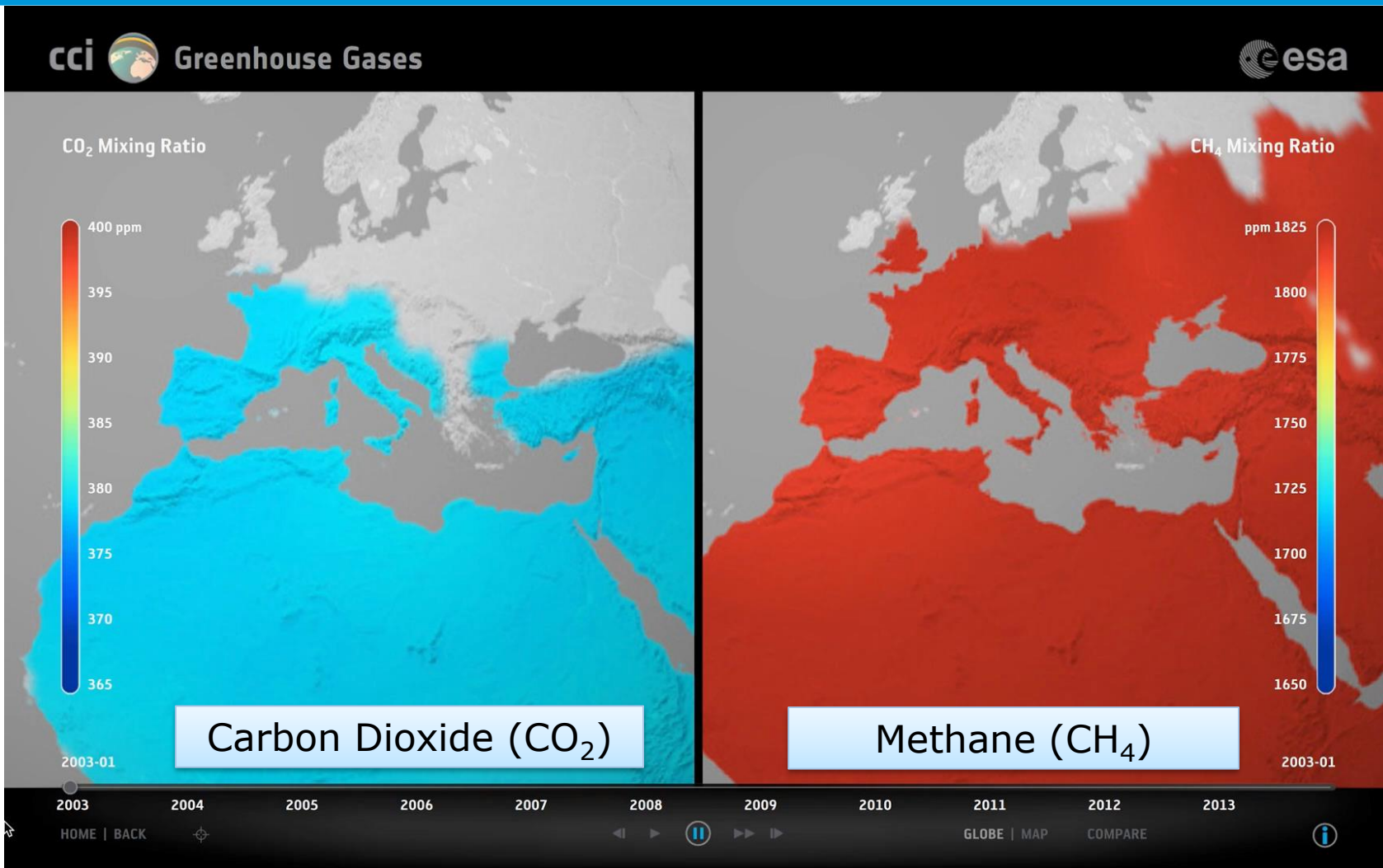
ESA UNCLASSIFIED - For Official Use

Video from CCI App visualization tool:  
<http://cci.esa.int/>

European Space Agency

# Correlation: Carbon Dioxide (CO<sub>2</sub>) – Methane (CH<sub>4</sub>)

Data: 01/2003 – 12/2013



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ESA UNCLASSIFIED - For Official Use

Video from CCI App visualization tool:  
<http://cci.esa.int/>

European Space Agency

# ESA ESERO project (European Space Education Resource Offices in ESA MS) – secondary school level



- ESERO offers an annual series of national or regional training sessions for both primary and secondary school teachers, offered in collaboration with national partners

## 6 New ESEROs in preparation:

Germany  
Hungary  
Italy  
Greece  
Spain  
Denmark

10 ESERO offices:

- **Austria:** Ars Electronica Center in Linz
- **Belgium:** Planetarium of the Royal Observatory of Belgium in Brussels
- **Czech Republic:** Prague, with Charles University of Prague and others
- **UK:** based at the National STEM Centre in York
- **Ireland:** Dublin, with the Science Foundation Ireland
- **Netherlands:** at the Nemo Science Learning Centre in Amsterdam
- **Nordic ESERO:** Denmark, Finland, Sweden and Norway (based at NAROM)
- **Poland:** in the Copernicus Science Centre in Warsaw
- **Portugal:** in the Knowledge Pavilion, Lisbon
- **Romania:** based in the Romanian Space Agency

# ESERO evolution



Nordic ESERO (NO, SE, FI)

ESERO UK

ESERO Ireland

ESERO NL

ESERO Belgium

ESERO Portugal

ESERO Denmark

ESERO Spain

ESERO France

ESERO Switzerland

ESERO Luxemburg



**Operational**

**Preparation on-going!**

Interest received

ESERO Romania

ESERO Poland

ESERO Austria,

ESERO Czech Republic

ESERO Italy

ESERO Germany

ESERO Greece

ESERO Hungary

## Tools for secondary schools

- Posters
- Atlases
- Multilingual web-based tools (Eduspace),
- Educational SW package for Image Processing and GIS (LeoWorks)

## Tools for general outreach

- i-books
- Apps for Tablets
- MOOCs

## → WHAT IS REMOTE SENSING?

"Remote sensing" is defined as the acquisition of information about an object without being in physical contact with it. A photographer taking a photo of a landscape is doing remote sensing, using his camera as a sensor.

When the target is far away from the sensor, as in the case of satellite remote sensing, we need more sophisticated instruments.

A sensor is a device that measures the amount of electromagnetic radiation, it receives and transform it in an electric signal, which is then coded and sent to ground.

By means of satellite sensors, both active and passive, we observe the Earth and measure important geophysical parameters, in order to monitor the status and the "health" of our planet.

**PASSIVE SENSORS**

They measure the radiation coming from a source external to the sensor, such as the thermal radiation emitted by the Earth or the sunlight coming from the Sun and reflected by objects on the Earth.

Examples and operations: optical instruments (imaging radiometers and visible channels), such as those on board SPOT (France), Landsat satellites and the SENTINEL-2 (ESA).

Examples and operations: microwave radiometers (remote infrared radiators), such as the AMSR on board AMSR-E and AMSR-2 (NASA/JAXA), designed primarily to measure Sea Surface Temperature, and also SMOS (ESA), SeaWiFS and Surface Temperature Radiometer.

**ACTIVE SENSORS**

These sensors use their own source of radiation in order to illuminate targets; they then measure the amount of radiation reflected back to the sensor, as well as the time it takes for it to return.

Examples and operations: Radar and SAR instruments. In particular: Synthetic Aperture Radar (SAR) on board ERS-1 and 2, ENVISAT, Sentinel-1, Sentinel-3, Copernicus Sentinel, ALOS satellites.

get more on: [www.esa.int/eduspace](http://www.esa.int/eduspace)

European Space Agency

## → SATELLITE ORBITS

Satellites in space follow trajectories called orbits. The orbits of planets, as natural satellites of the sun, were described by J. Kepler in the beginning of 17<sup>th</sup> century. Artificial satellites placed in space by humans follow the same laws of planetary motion. These laws are based on the principle of universal gravitation formulated by I. Newton in the end of the 17<sup>th</sup> century.

**NEAR POLAR SUN-SYNCHRONOUS ORBITS**

These are roughly circular orbits, almost perpendicular to the equatorial plane of the Earth and such that the satellites pass over each point along the same local mean solar time. This is the most common type of orbit for Earth observation satellites. With their sensors, they acquire different strips of the Earth at each pass and need several days, in order to cover most of the Earth's surface.

Examples of satellites: SeaWiFS (ESA), working at a velocity of 7.45 km/s, 800 km over the Earth surface.

Other satellite families in this type of orbit are, for instance: SPOT, SENTINEL, LANDSAT.

**GEOSTATIONARY ORBITS**

These are circular orbits in the plane of the Equator, about 35,800 km above the Earth's surface. Such orbits are used mostly by meteorological and telecommunication satellites. Geostationary satellites rotate around the Earth at the same angular speed as the Earth's rotation, so they are constantly "looking" at the same part of the Earth's surface, therefore appearing stationary to an observer on the Earth.

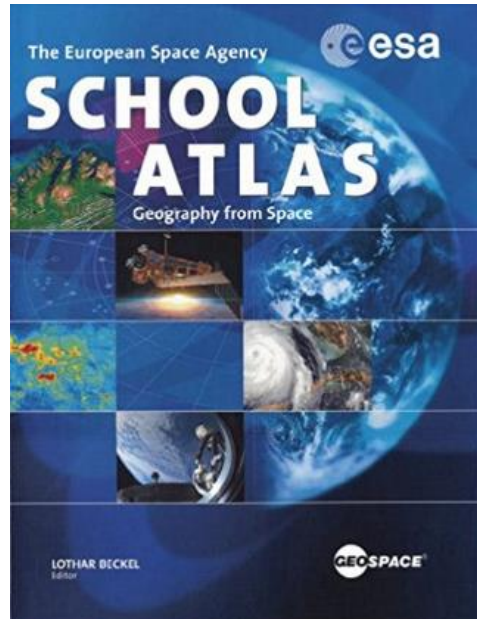
Examples of geostationary satellites are the meteorological METEOSAT family and the telecommunication EUTELSAT satellites.

get more on: [www.esa.int/eduspace](http://www.esa.int/eduspace)

European Space Agency

- Posters available in:
  - English, German, Spanish, Czech, Greek
- *What is Remote Sensing?*
- *Satellite orbits*
- *Ocean applications*
- *Land applications*
- *Ice applications*
- *Atmosphere applications*

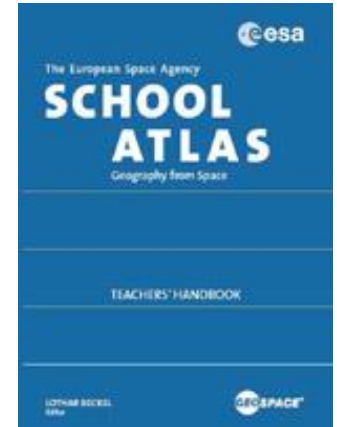
# ESA School Atlas, new ESA Water Atlas



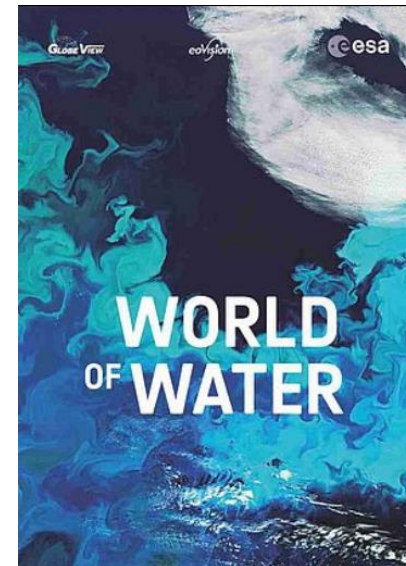
- Introduction to ESA
- Earth Observation
- Global Overview
- Continental Overview
- The Natural and Cultural Sphere

## Annex:

- Teachers' Handbook
- DVD-ROMs with the original bands of the satellite data
- Handbook content and exercises, connected to Eduspace and its SW Leoworks



- Describes the major issues related to water on Earth
- Presents water as a natural resource, focusing on global water, the oceans, seas, lakes and rivers of the Earth



Both freely available in PDF from ESA web pages  
(<https://earth.esa.int/web/guest/eo-education-and-training>)



# ESA School Atlas, new ESA Water Atlas



The screenshot shows the ESA Earth Online website. The top navigation bar includes 'Login My Earthnet', 'Register', and a search box. Below the navigation, there are dropdown menus for 'Missions', 'Earth Topics', 'Data Access', and 'PI Community'. The main content area is titled 'EO Education and Training' and features a sub-section 'EO Education for Schools' with a photo of a teacher in a classroom. Below this, there is a paragraph about ESA's educational projects and a link to the 'Eduspace' website. A smaller screenshot of the Eduspace website is shown below. The right sidebar contains a list of links under 'EO data', 'EO training activities', and 'EO software'. At the bottom, there is a section for 'EO educational resources' with links to French Guyana satellite data, the School Atlas, and the Water Atlas.

esa Earth Online

Login My Earthnet Register Google Custom Search

Need Help? Contact here European Space Agency

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

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

Follow Share

## - EO Education for Schools




### EO Education for Schools

ESA undertakes educational projects aimed at bringing Earth Observation into the school curriculum. ESA has developed the Earth Observation educational website, "Eduspace". Other activities include organising and contributing to workshops for teachers, and developing tools (such as atlases and CDs) for EO education.

#### Eduspace

ESA has produced and maintains the Earth Observation website for secondary schools, Eduspace. This website contains a wealth of knowledge about remote sensing, image processing, satellites, instruments and applications of Earth Observation. As well as being a source of information, the website is interactive and contains many exercises and case studies designed to be used with software and data that can be downloaded freely from the site. Eduspace is targeted mainly to secondary schools, but can be useful to anyone new to Earth Observation.



For more information, visit the [Eduspace](#) website.

#### Training courses for teachers

ESA provides and contributes to training courses, workshops and other events where teachers are given instruction in the use of tools that will enable them to incorporate Earth Observation into the curricula of their subject. ESA also organises outreach events where students and teachers are made aware of ESA's activities in Earth Observation.

For more information on teacher training and outreach events for exercises and presentations, see 'EGU - GIFT Workshops' portlet below.

## 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 activities

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

### - EO software

- Software Tools
- Sentinel Toolboxes
- Sentinel-1 Toolbox Tutorials
- LEOWorks
- Bilko
- ILWIS

## - EO educational resources

- French Guyana, as seen by the ERS Radar Satellite (ZIP 390 MB)
- ESA School Atlas
- ESA Water Atlas (95Mb)

## - EO educational resources

- French Guyana, as seen by the ERS Radar Satellite (ZIP 390 MB)
- ESA School Atlas
- ESA Water Atlas (95Mb)

<https://earth.esa.int/web/guest/eo-education-and-trainingweb/eo-edu/esa-school-atlas>

<https://earth.esa.int/documents/10174/226408/world-of-water>

# Eduspace: ESA web-based EO Educational tool for secondary schools



Flash Floods in Thessaloniki (Greece) →

European Space Agency

21-Apr-2017

**Flash floods in Thessaloniki**

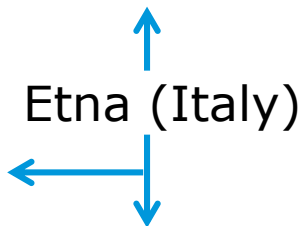
- Background
- Exercises**
- Exercise 1: Inspecting the images
- Exercise 2: Change detection – band math
- Exercise 3: Change detection – Multi-temporal analysis
- Exercise 4: GIS

European Space Agency

21-Apr-2017

**Etna**

- Change Detection and Hazard Assessment
- Monitoring of volcanic hot spots and plumes



European Space Agency

21-Apr-2017

**Etna**

- Introduction
- Change Detection and Hazard Assessment**
- Exercise 1: Exploring the volcano
- Exercise 2 : Visual interpretation using terrestrial photographs
- Exercise 3: Lava detection: crisis images and maps
- Exercise 4: Hazard assessment: GIS can help!

**Eduspace - Download**

- Etna\_Landsat\_GIS.zip

European Space Agency

21-Apr-2017

**Etna**

- Introduction
- Monitoring of volcanic hot spots and plumes**
- Exercise 1: Exploring the volcano
- Exercise 2: Hot spot and plume detection
- Exercise 3: Monitoring a plume - animation

**Eduspace - Download**

- Etna\_MODIS.zip

[http://www.esa.int/SPECIALS/Eduspace\\_EN/index.html](http://www.esa.int/SPECIALS/Eduspace_EN/index.html)

# LEOWorks 4.1

## Image Processing Software

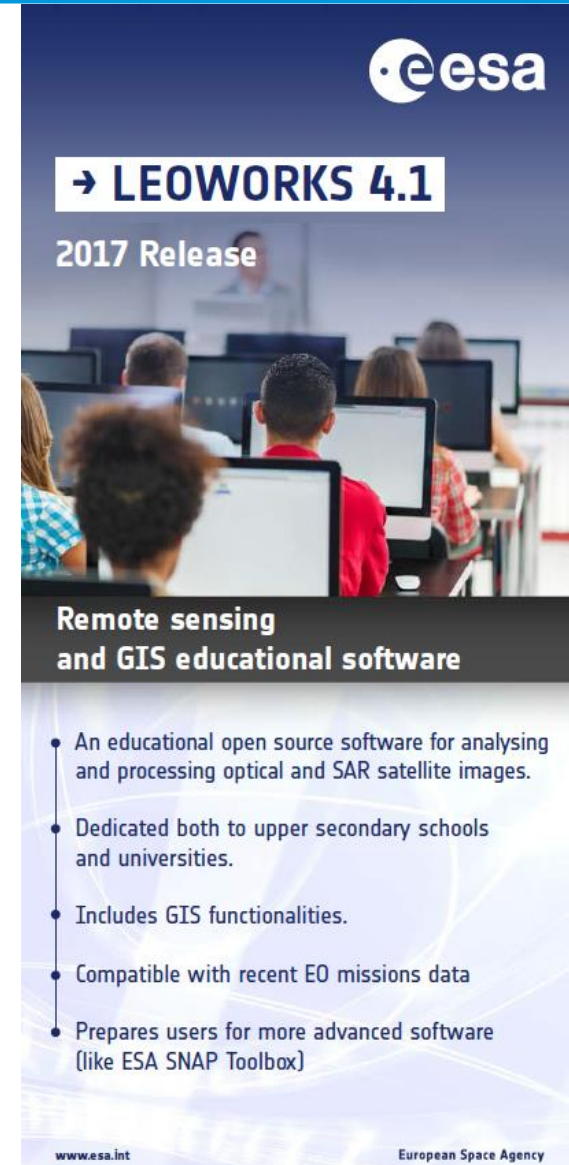
**NEW release** 

- View images, histogram, pixel values, header info
- Crop, invert, stretch, layer stack, etc
- Image arithmetic, filters
- Classification, PCA, geometric correction, pan sharpening
- Radar and optical module (multimission, including Sentinel data)
- GIS tools
- Open-source, Java-based

<http://leoworks.terrasigna.com/>

26/04/2017 | Slide 67

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The poster features the ESA logo at the top right. Below it, the text '→ LEOWORKS 4.1' is displayed in a white box, followed by '2017 Release'. The background shows a classroom with students at computers. A dark banner at the bottom of the poster reads 'Remote sensing and GIS educational software'. Below this banner, a list of bullet points describes the software's features. At the very bottom, the website 'www.esa.int' and the text 'European Space Agency' are visible.

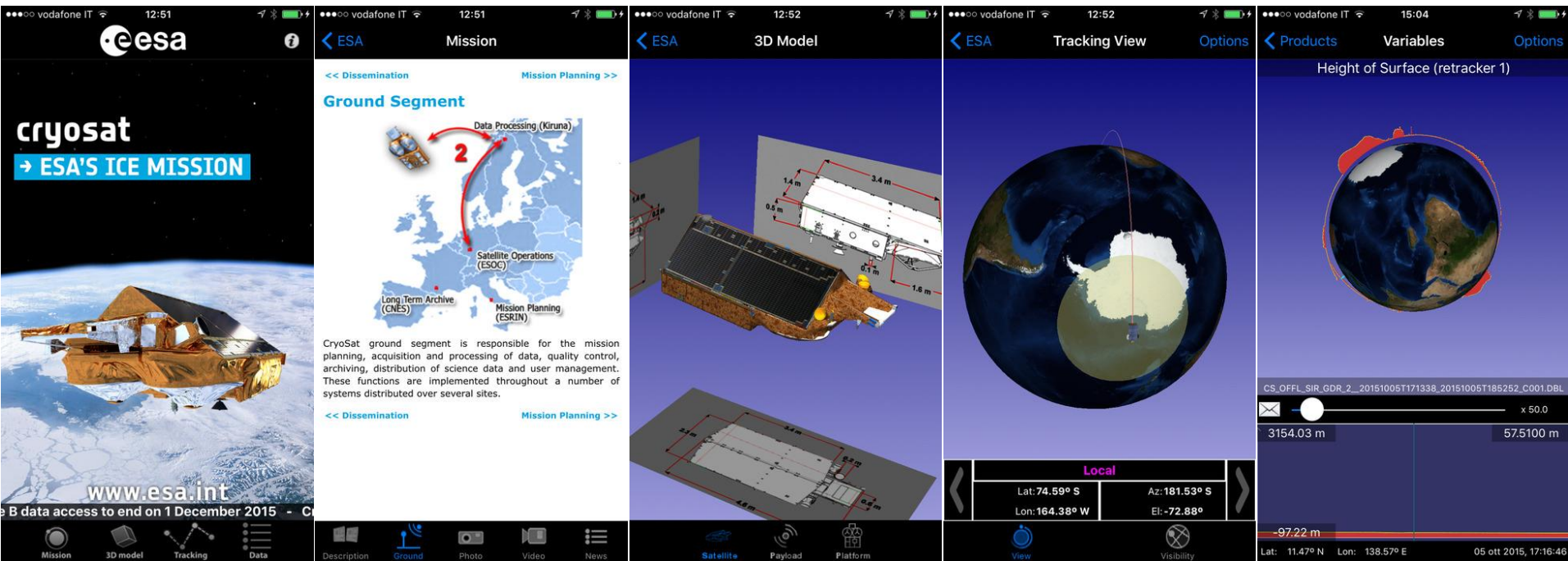
**→ LEOWORKS 4.1**  
2017 Release

**Remote sensing  
and GIS educational software**

- An educational open source software for analysing and processing optical and SAR satellite images.
- Dedicated both to upper secondary schools and universities.
- Includes GIS functionalities.
- Compatible with recent EO missions data
- Prepares users for more advanced software (like ESA SNAP Toolbox)

www.esa.int European Space Agency



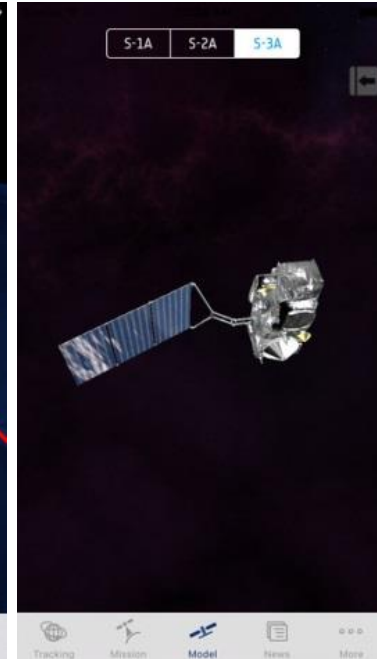
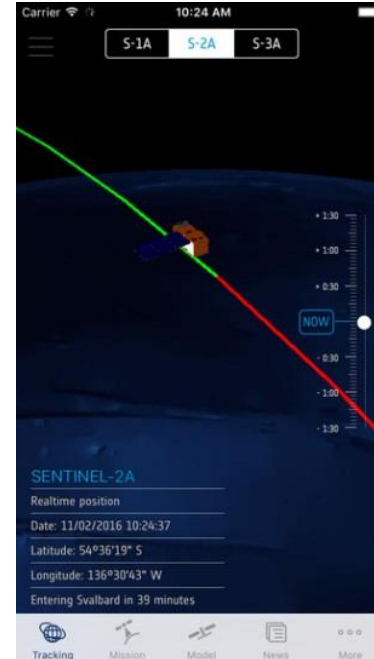


<https://itunes.apple.com/us/app/esa-cryosat/id484020380?ls=1&mt=8>

# I-books, Apps (video)



# Sentinel App



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

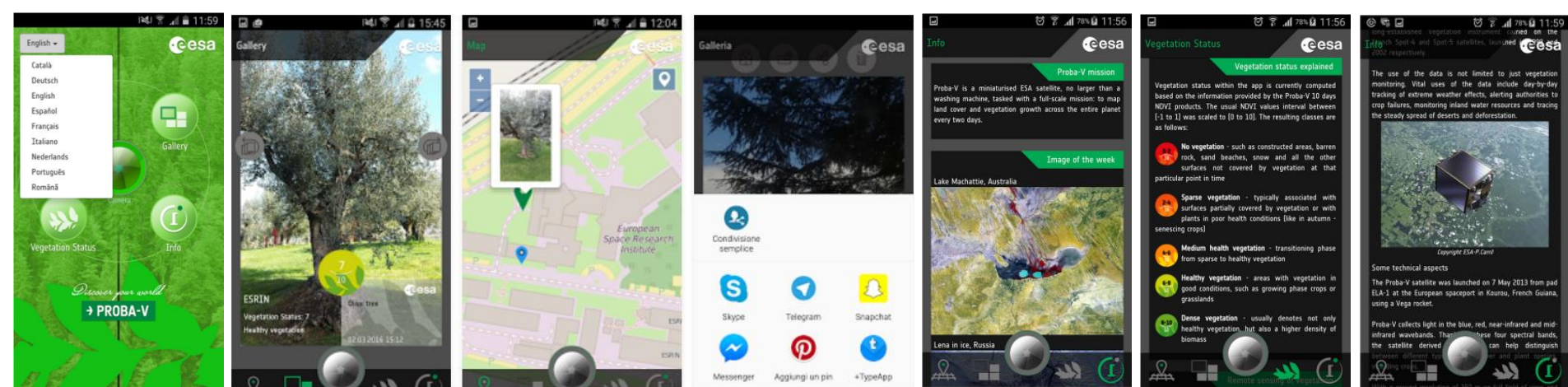
26/04/2017 | Slide 71

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European Space Agency

# Proba-V App



- Take a picture of a landscape
- Associate the vegetation status derived from Proba-V NDVI products in your area to the picture
- See graphics of the vegetation status evolution during the last 6 months (tap on picture icon or on map)
- Build your picture gallery and see all your pictures on the map
- Share the pictures on social media
- Learn about Proba-V, get news and image of the week
- Available: English, Italian, Portuguese, Dutch, Spanish, German, etc.







**NEW release soon**

- Additional vegetation indices: **L**ea**A**re**I**ndex (LAI), **D**ry **M**atter **P**roductivity (DMP) and **L**and **S**urface **T**emperature (LST)
- Visualization of NDVI, LAI, Corine Land Cover and Natura 2000 layers
- Description about each Natura 2000 area and its fauna
- Notification if the user is near a Natura 2000 area
- Social media photo sharing (Facebook, Twitter and Instagram)

## Climate from Space:

ESA's iPad App for visualization of climate data being produced through the European Space Agency's **C**limate **C**hange **I**nitiative (CCI)

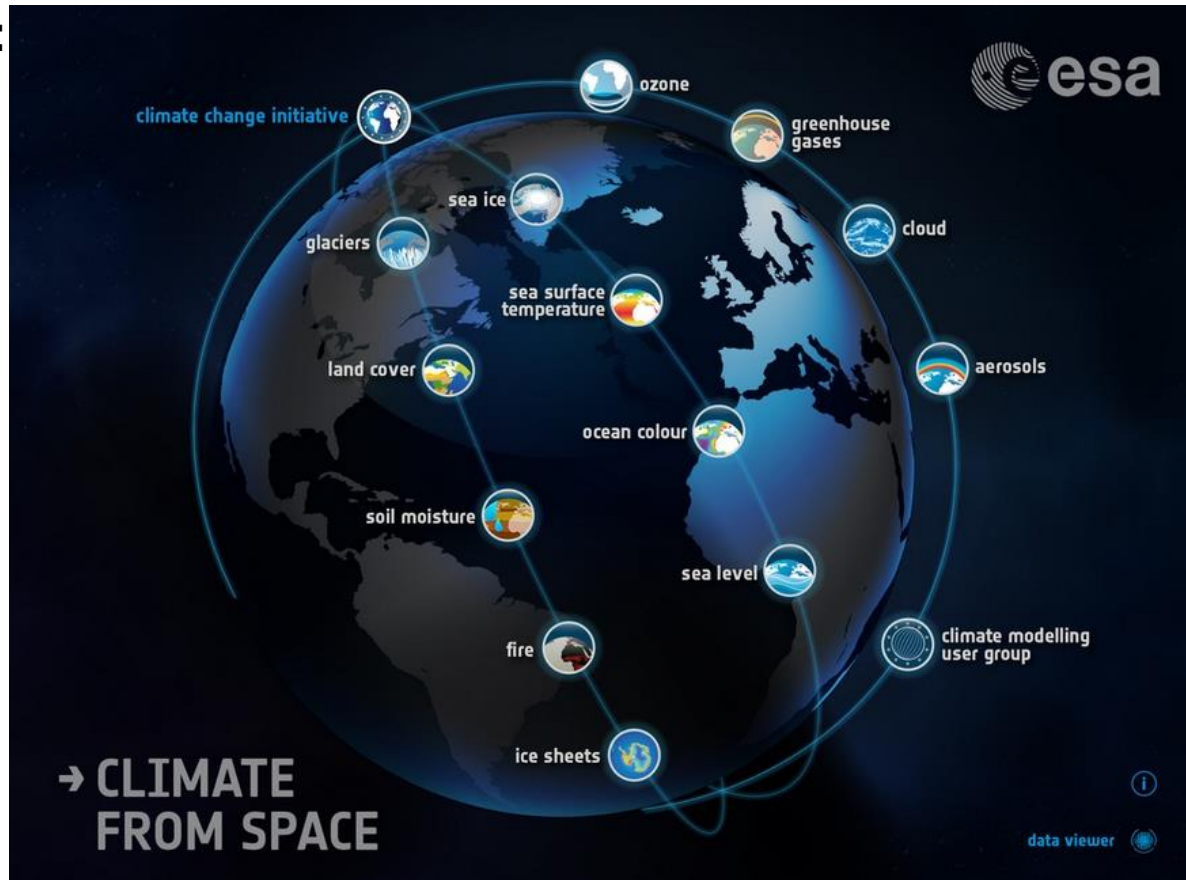
Allows to visualize temporal changes of the 13 general categories of the

## **E**ssential **C**limate **V**ariables:

- Sea surface temperature
- Sea level
- Sea ice
- Glaciers
- Ice sheets
- Ocean colour
- Land cover
- Soil moisture
- Greenhouse gases
- Fires
- Ozone
- Cloud
- Aerosols

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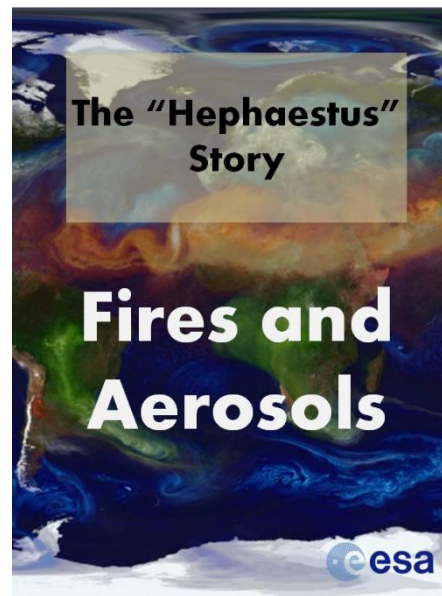
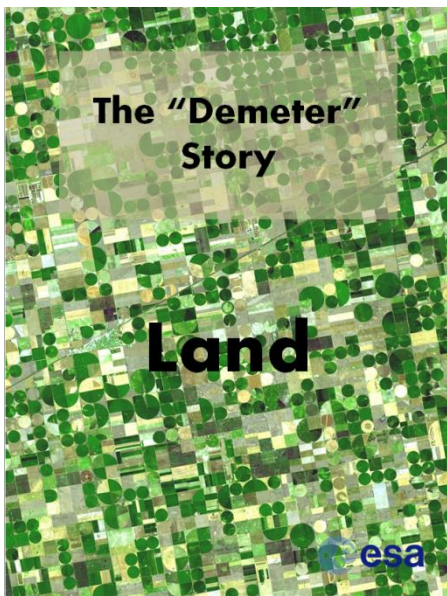
# CCI App & visualisation tool (video)



# Educational "Stories" / exercises on Climate Change



- Set of successive thematic stories and hands-on exercises based on the CCI Visualisation Tool (Climate from Space) - CCI App
- Dedicated to secondary school students
- Tutorials for teachers
- Not online, still under review



ESA recently started to create educational MOOCs for EO techniques & Applications, starting with Climate Change

## What is a **MOOC**?

- M**assive: no limitation on the number of participants. The record is 440,000!
- O**pen: free and accessible for anyone with an Internet connection
- O**nline: all activities are made online
- C**ourse: it has a specific topic, prepared by specialists, offering theoretical and practical content

# MOOC Climate from Space (Future Learn)



- <https://www.futurelearn.com/courses/climate-from-space>
- **10,000+ subscriptions**, 50% active, **completion rate** of 30% (very high!)
- MOOC 5-weeks course (June, 2015 / Dec, 2015) included videos, text, quiz, interactive exercises, satellite tracking app
- **Interactive, with O&A.** Two editions done, more will follow



## Monitoring Climate Change from Space

Explore our planet from Space and learn how we can monitor climate change through Earth observation techniques.

### ABOUT THE COURSE

We are now at a time on planet Earth where significant and rapid changes to the climate are taking place. It is becoming increasingly essential for us to study the climate and observe changes all across the planet at the highest level of detail possible. But how can we achieve such a comprehensive worldwide view?

Seeing the Earth from Space allows us to gain such a global perspective. By using Earth observation techniques it is now possible to monitor global environmental change on a scale that has never previously before been possible. Earth observation has not only revolutionised the way we perceive our home, but changed the way we understand our profound impact on the environment. This technology has brought on a transformation in the way we study our planet.

Go to course

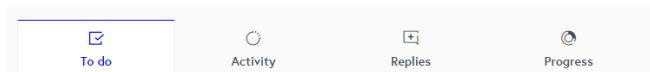
FREE online course

Duration: 5 weeks

3 hours pw

### EDUCATORS

Ravi Kapur



WEEK 5: MANAGING EO DATA: CURRENT METHODS AND FUTURE CHALLENGES 37 weeks ago



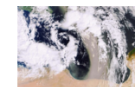
### Topic 5a - ESA Climate Change Initiative

How is ESA's Climate Change Initiative (CCI) vital in supporting the monitoring of the Essential Climate Variables (ECVs)?

5.1 TOPIC 5A - ESA CLIMATE CHANGE INITIATIVE VIDEO (08:44)

5.2 TOPIC 5A - EXPLORE THE IMAGERY, DATA & SATELLITES ARTICLE

5.3 ESA CLIMATE CHANGE INITIATIVE QUIZ



### Topic 5b - Climate Models and Data Assimilation

The role of EO in accurate climate modeling and data assimilation.

## 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.

- **3<sup>rd</sup> ESA MOOC on Climate from Space “Greenland special”**

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

- **1<sup>st</sup> ESA MOOC “EO from Space: The Optical View”**

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

## 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).

- **1<sup>st</sup> ESA MOOC “EO from Space: The Radar View”**  
Foreseen launch in October 2017

# Training courses online - centralized web page



The content of most training courses can be linked from the central web page for ESA EO Education and Training:

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

The screenshot displays the ESA Earthnet Online website. The header features the ESA logo, the text "Earthnet Online", and navigation links for "Login My Earthnet", "Register", and a search bar. Below the header is a menu with categories like "Data Access", "Missions", "Earth Topics", and "PI Community". The main content area is titled "EO Education and Training" and includes a section for "EO Education News" with a link to "Participate in the ESA LearnEO! competition". A sidebar on the right lists "EO data" and "EO training activities". The background of the page is a satellite image of Earth.

**esa Earthnet Online** Login My Earthnet Register Google™ Custom Search

Need Help? Contact here European Space Agency

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

You are here Home > EO Education and Training

Follow Share

### - EO Education News

**Participate in the ESA LearnEO! competition**  
23 September 2013

Participate in the ESA LearnEO! lesson-writing competition, bring your work to a world audience and take a chance to win up to 5,000 euros!

Find out more on the [LearnEO! competition webpage](#).

### - EO Education and Training



**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
- Access data online
- Access GMES data
- How to apply for data
- Eoii 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

**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...



# Useful Addresses



- **ESA education portal:** [www.esa.int/education](http://www.esa.int/education)
- **Eduspace:** [http://www.esa.int/SPECIALS/Eduspace\\_EN/](http://www.esa.int/SPECIALS/Eduspace_EN/)
- **ESA EO Education web page:** <https://earth.esa.int/web/guest/eo-education-and-training>
- **Climate Change Initiative:** <http://cci.esa.int/>
- **Leoworks 4.1:** <http://leoworks.terrasigna.com/>
- **i-Books, Apps:** [http://www.esa.int/spaceinvideos/Videos/2012/12/Earth\\_from\\_Space\\_the\\_Living\\_Beauty](http://www.esa.int/spaceinvideos/Videos/2012/12/Earth_from_Space_the_Living_Beauty)
- **ESERO:** [http://www.esa.int/Education/Teachers\\_Corner/European\\_Space\\_Education\\_Resource\\_Office](http://www.esa.int/Education/Teachers_Corner/European_Space_Education_Resource_Office)
- **to order EO material:** [education@esa.int](mailto:education@esa.int) or [eohelp@esa.int](mailto:eohelp@esa.int)
- **Santorini, Nea Kammeni Inflating:** [http://www.esa.int/spaceinimages/Images/2012/09/Santorini\\_inflating](http://www.esa.int/spaceinimages/Images/2012/09/Santorini_inflating)
- **Water Currents:** <http://globcurrent.oceandatalab.com/>
- **Institute for the study and monitoring of the Santorini Volcano (ISMOSAV):**  
<http://www.santorini.net/ismosav/>

# Thank you



**Francesco Sarti**, *Scientific Coordinator of Education and Training Activities*  
**Georgia Karadimou**, *ESA trainee*  
**ESA/ESRIN, Frascati, Italy**

**Antonios Mouratidis**, *ESA Consultant*  
**Aristotle University of Thessaloniki, Greece**

Email: **francesco.sarti@esa.int**