



Earth Observation Principles and Applications

ESA Earth Observation Programme and related educational programme

*Francesco Sarti, ESA, Scientific Coordinator of the
Education and Training Activities in Earth Observation*

Trans-Atlantic Training – Pécs 2017

Programme of the first three days



Multi-sensor Approaches in Studying Land Use/Land Cover Change 16-20 June 2017

Day 1: Friday, June 16		
9:30 – 10:00	<u>Registration</u>	
10:00 – 12:00	Opening & session 1	
	<u>Welcoming remarks, training objectives, logistic</u>	<u>Premysl Stych, Charles University, Czechia</u> <u>Levente Ronczyk, University of Pécs, Hungary</u>
	<u>Welcome Adresse of Host</u>	<u>András Trócsányi, vice-dean University of Pécs, Hungary</u>
	<u>Introduction to the ESA EO missions and data and data access</u>	<u>Francesco Sarti, ESA – ESRIN, Italy</u>
12:00 – 13:00	Lunch	
13:00 – 14:45	Session 2	
	<u>Introduction to SAR Remote Sensing processing– Sentinel-1 mission</u>	<u>Prof. Isaak Parcharidis, University of Athens-c/o ESA/ESRIN,</u> <u>Francesco Sarti, ESA – ESRIN, Italy</u> <u>Chris Stewart, ESA – ESRIN, Italy,</u>
14:45 – 15:00	Break	
15:00 – 17:00	Session 3	
	<u>Terrestrial applications of SAR data. Examples and computer exercises with SNAP</u>	<u>Prof. Isaak Parcharidis, University of Athens-c/o ESA/ESRIN,</u> <u>Chris Stewart, ESA – ESRIN, Italy,</u>

Programme of the first three days



Day 2: Saturday, June 17

9:00 – 12:00	Session 4
	ESA EO data Access; Applications of SAR data in the <u>Land Use/Land Cover Changes</u> <i>Prof. <u>Isaak Parcharidis</u>, University of Athens-c/o ESA/ESRIN, Chris Stewart, ESA – <u>Esrin</u>, Italy</i>
12:00 – 13:00	Lunch
13:00 – 17:00	Session 5
	<u>Examples and computer exercises with SNAP</u> <i>Prof. <u>Isaak Parcharidis</u>, University of Athens-c/o ESA/ESRIN, Chris Stewart, ESA – <u>Esrin</u>, Italy</i>

Day 3: Sunday, June 18

9:00 – 12:00	Session 6
	<u>Land Cover Mapping</u> – The <u>use of multi-temporal and multi-sensor (SAR & Optical) data</u> <i>Dr. <u>Francesco Holecz</u>, <u>Purasca</u>, <u>sarmap SA</u>, Switzerland</i>
12:00 – 13:30	Session 7
	<u>Introduction and demonstration of the customized Sentinel-1 processing chain on HSC (supercomputer University of Pecs)</u> <i>Dr. <u>Bogdan Zavalnij</u>, University of Pecs</i>
14:00 – 17:00	<u>Lunch and wine testing (Viticulture Research Institute University of Pécs)</u>

Introductory Exercise to SAR (Chris Stewart)

Introduction to SNAP:

Basic processing of Sentinel-2 data over Pécs

Metadata view

Generic functions (subset, resample, band maths, etc.)

Optical functions (spectral analysis, spectral profiler, NDVI etc.)

Basic processing of Sentinel-1 data over Pécs: Metadata view; SAR functions overview (description of GRD and SLC processing chains)

Exercise about flood monitoring (Issaak Parcharidis)

Title: *Flood hazard monitoring in a transboundary reservoir-regulated River basin*

Area and motivation: *SAR images from ESA's Sentinel-1 satellite will exploit for monitoring the related water volume changes in the Kerkini Lake-reservoir during the period 2014 – 2015, and at the same time used for flood hazard mapping in the downstream of Strymon River (Serres basin, Northern Greece) which occurred in 2015*

Products to generate: *Water/non-water images, multitemporal SAR amplitude images.*

Data and tools used: *SNAP, Sentinel 1, subset image, calibration of SAR data, Speckle reduction, Binarization, Band-maths, Coregistration-stack geometric correction*

Exercise about Interferometry (Issaak Parcharidis)

Title: *Ground deformation monitoring in a basin, of intensive agricultural activity, in the era of climate change*

Area and motivation: *The aim is to investigate seasonal surface deformation signals associated with groundwater withdrawal, demonstrating the suitability of DInSAR for examining dewatering induced subsidence.*

Products to generate: *deformation maps*

Data and tools used: *SNAP, Sentiinel 1 SLC images, interferometric processing*

ABOUT THE EUROPEAN SPACE AGENCY (ESA)



PURPOSE OF ESA

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

Article 2 of ESA Convention



22 MEMBER STATES AND GROWING



ESA has 22 Member States: 20 states of the EU (Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, The Netherlands, Poland, Portugal, Romania, Spain, Sweden, UK) **plus Norway and Switzerland.**

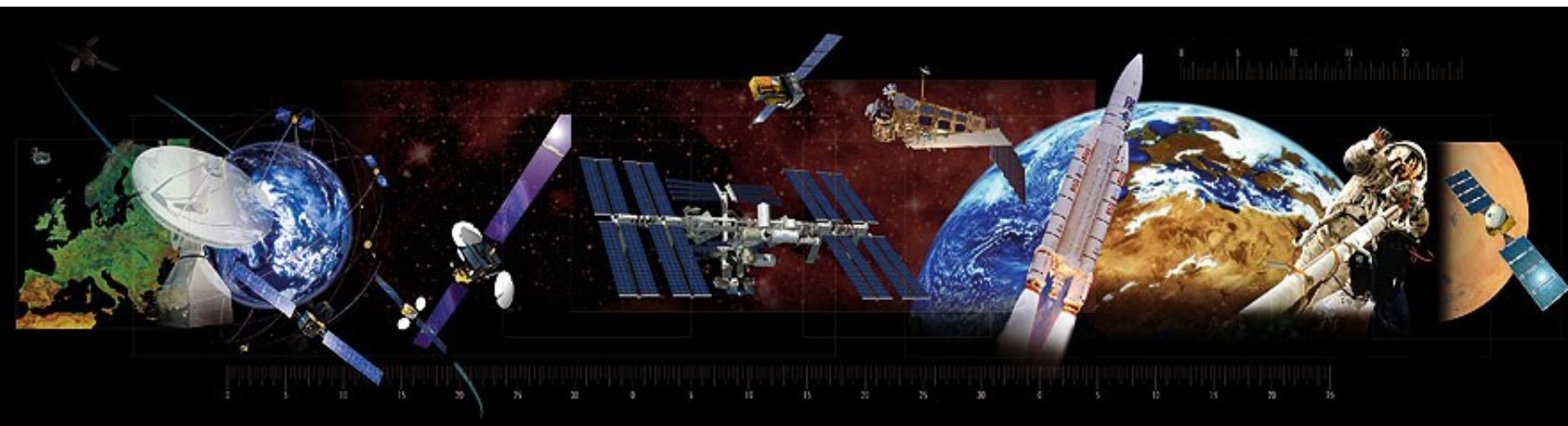
Other EU states have Cooperation Agreements with ESA, such as Bulgaria, Cyprus, Lithuania and Malta. Latvia, Slovenia and Slovakia are participating in the Plan for European Cooperating States (PECS).

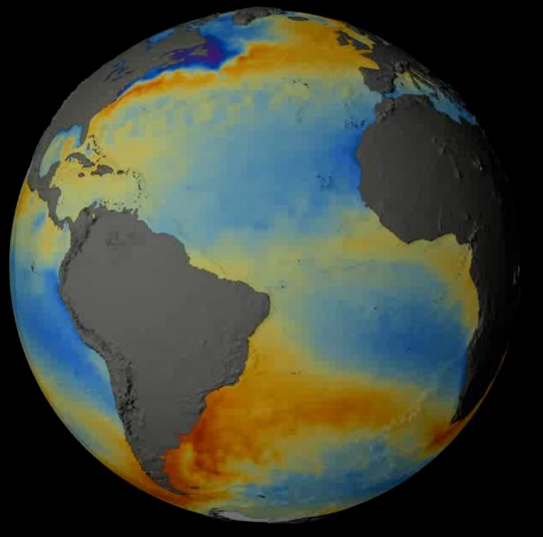
Canada takes part in some programmes under a Cooperation Agreement.



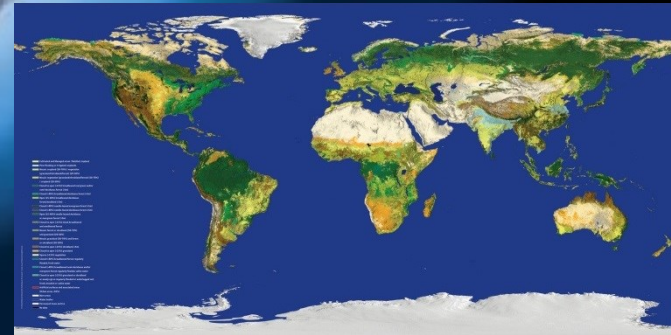
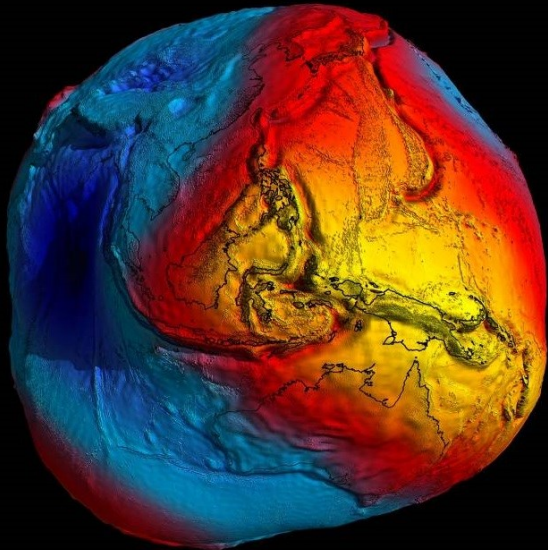
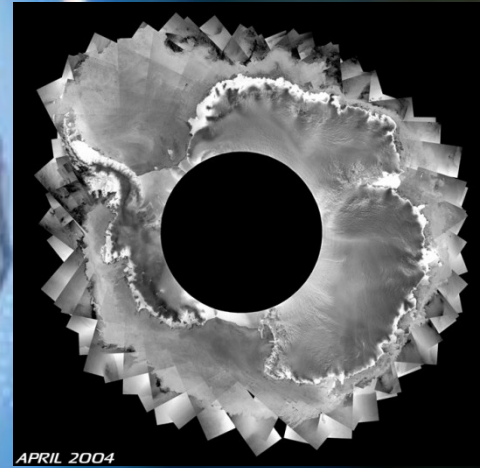
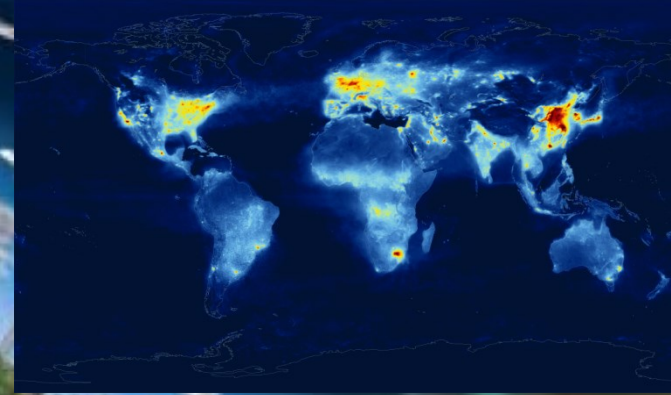
ESA is one of the few space agencies in the world to combine responsibility in nearly all areas of space activity.

- 1. Space science**
 - 2. Human spaceflight**
 - 3. Exploration**
 - 4. Earth observation**
 - 5. Launchers**
- **Navigation**
 - **Telecommunications**
 - **Technology**
 - **Operations**

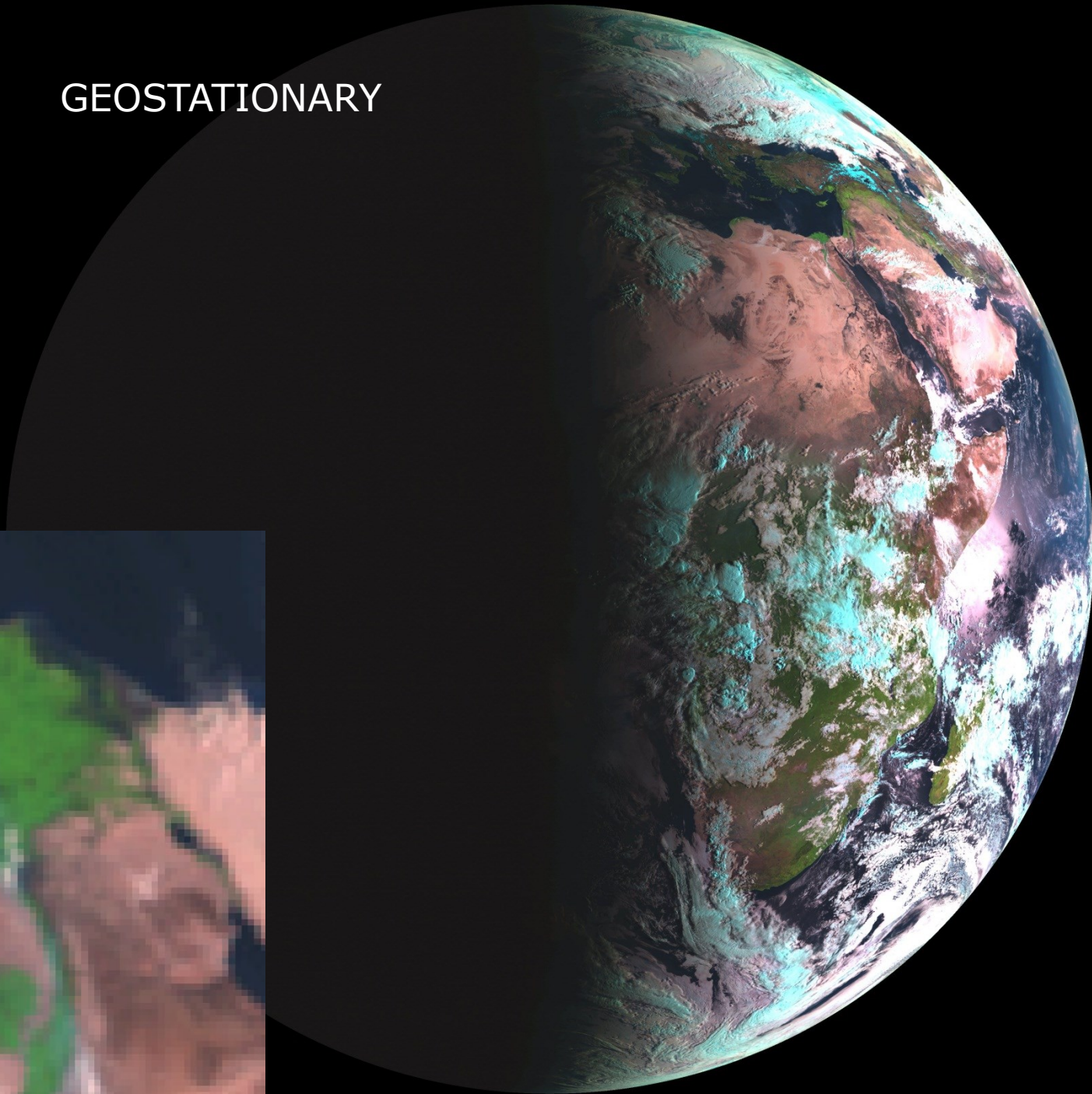


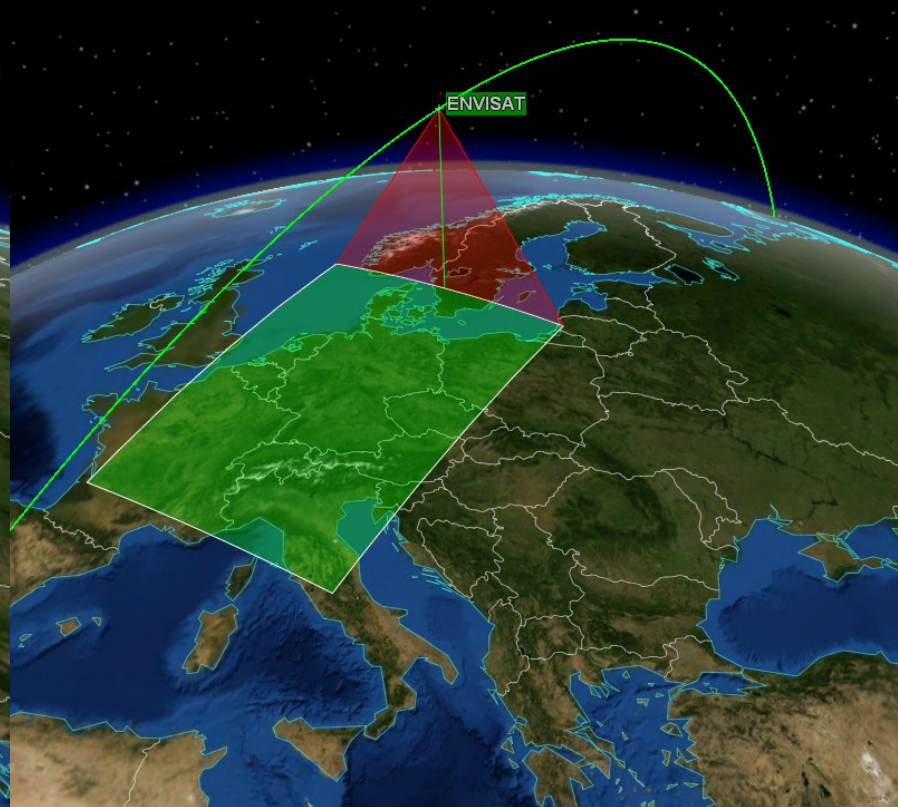


Earth Observation



GEOSTATIONARY





2008-Aug-09 09:47:01 UTC

Lat : 0.0000

Lon : 0.0000

MLST : 09:47:01

SZA : 37.59 deg

Range : 13923 km

Altitude : 13923 km

Intersection Mode ON

Auto Steering ON

9-Aug-2008 09:47:10

w32 Aug-2008

w33 Aug-2008

w34 Aug-2008

w35 Sep-2008

w36 Sep-2008

SPOT-4

RapidEye-1

ENVISAT

RapidEye-5

SPOT-5

RapidEye-4

esa

Constellation of polar satellites

SAVOIR - Swath Acquisition Viewer - © European Space Agency - Taitus Software

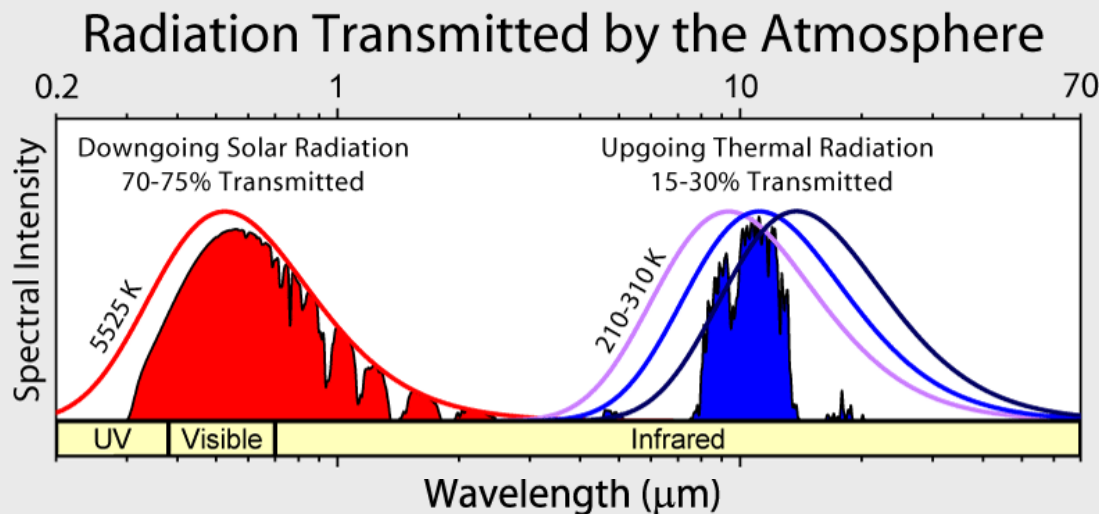
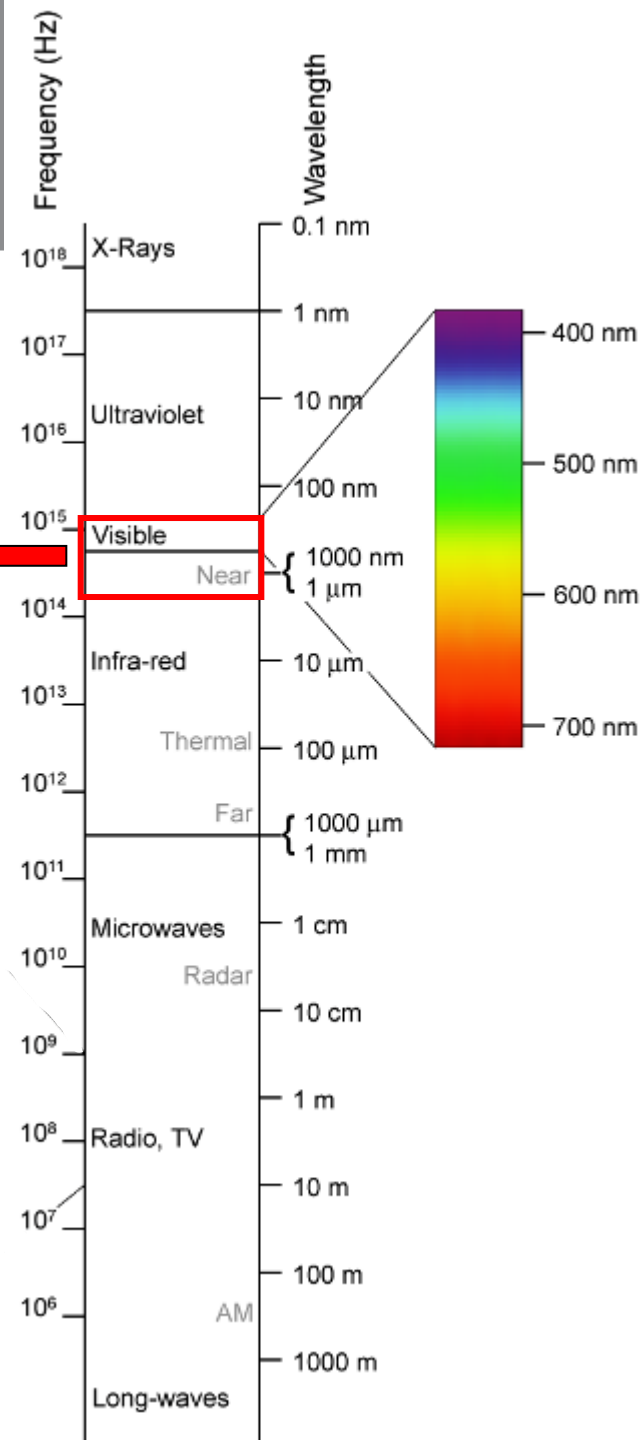
ESA P

ESA U

European Space Agency

The electromagnetic spectrum

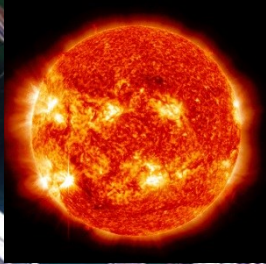
Visible (VIS) + Near Infrared (NIR) = Optical ←



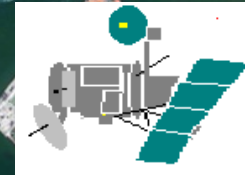


Passive Sensors

sa

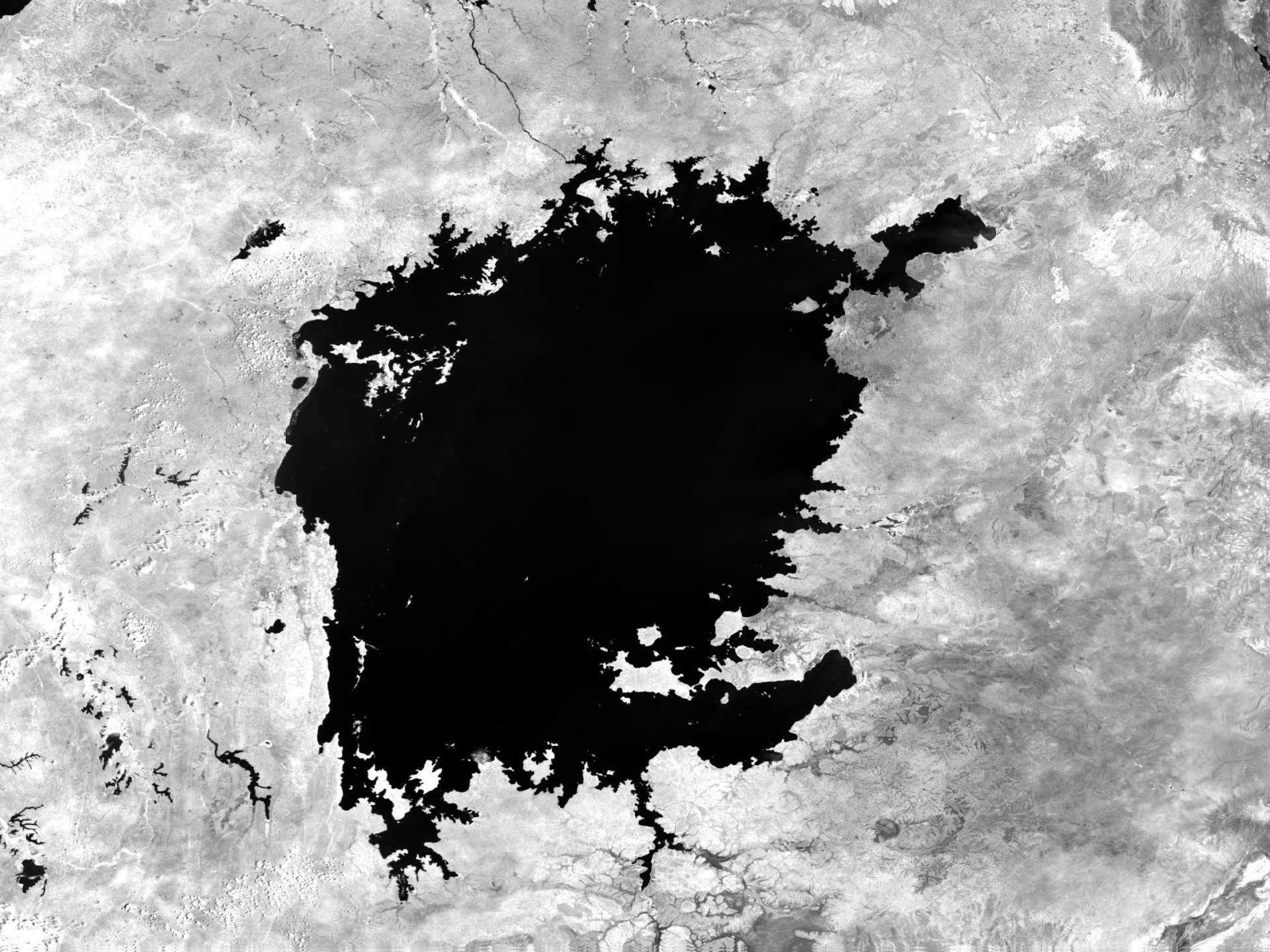


Primary source
of energy: *Sun*

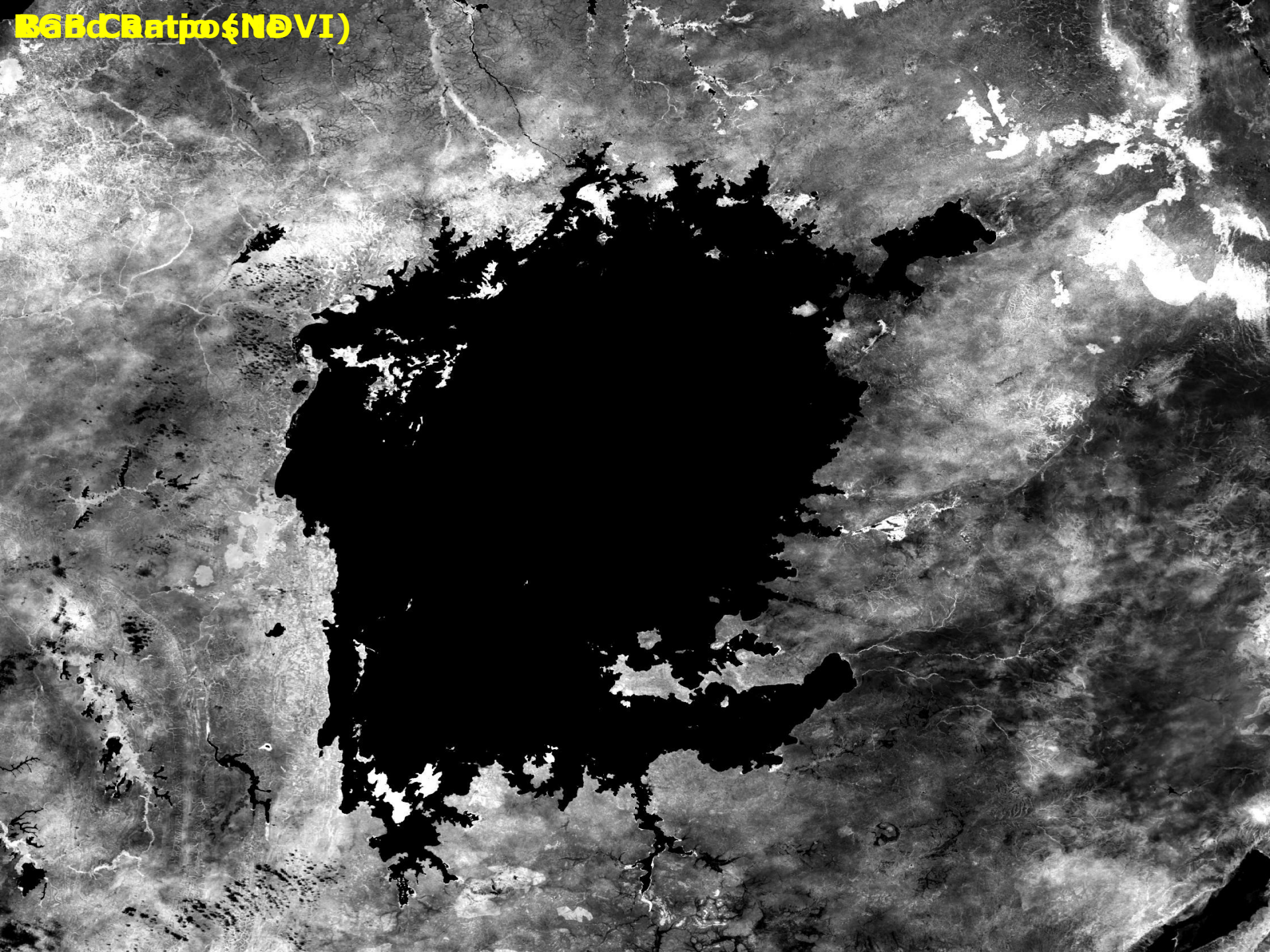




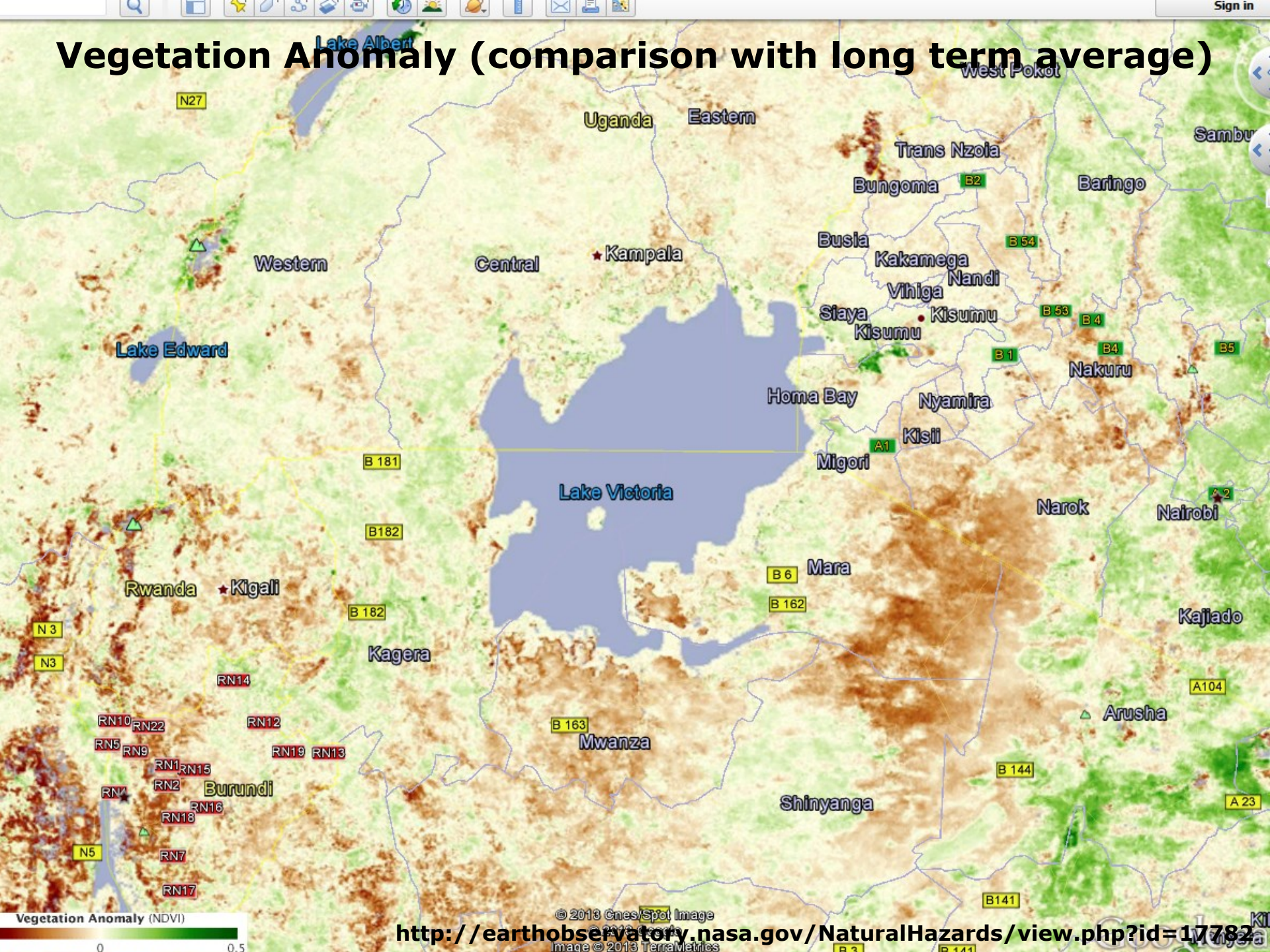
Rondônia, Brazil: 1975–2011



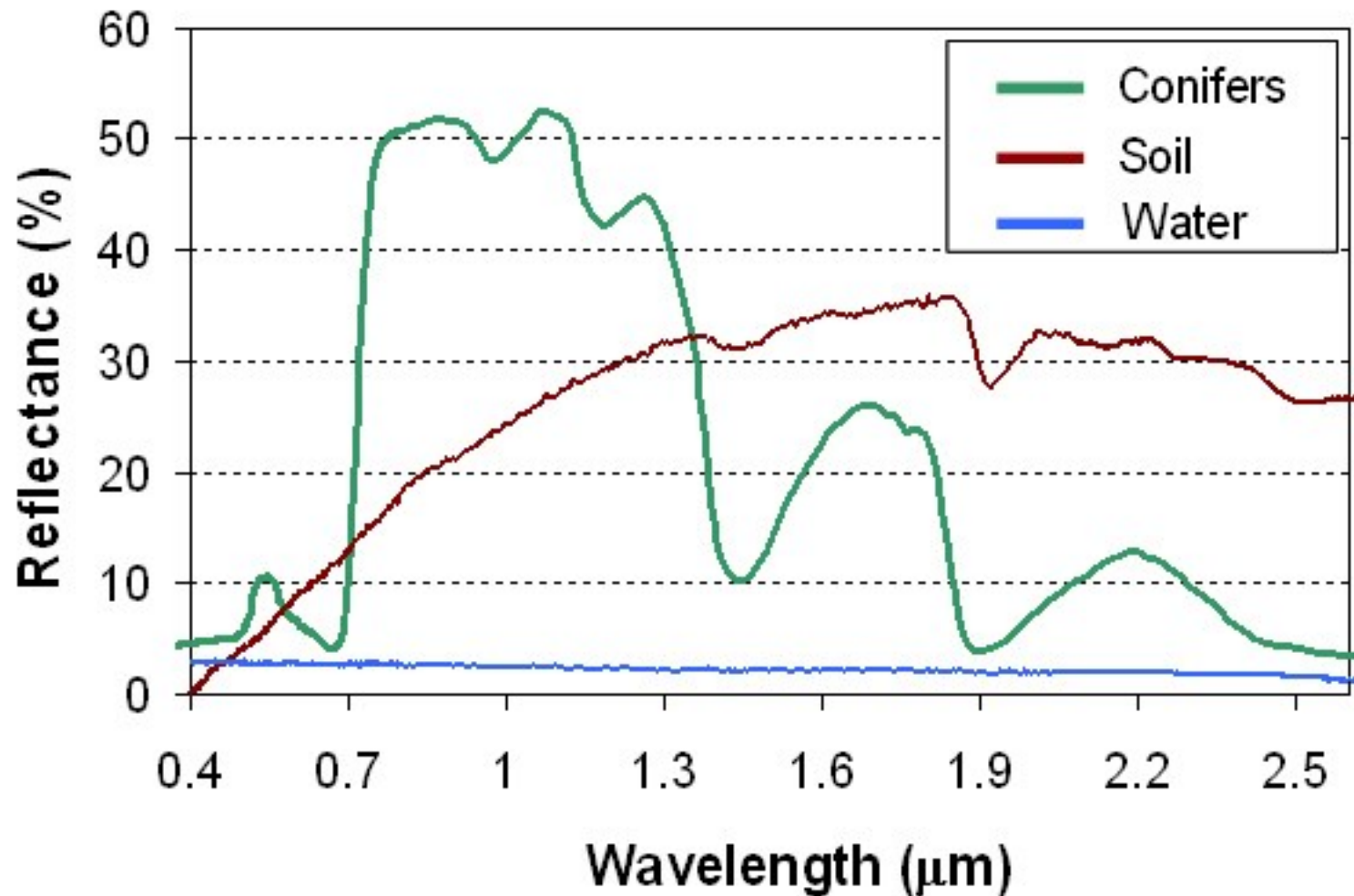
B&BdCBatp(\$NDVI)

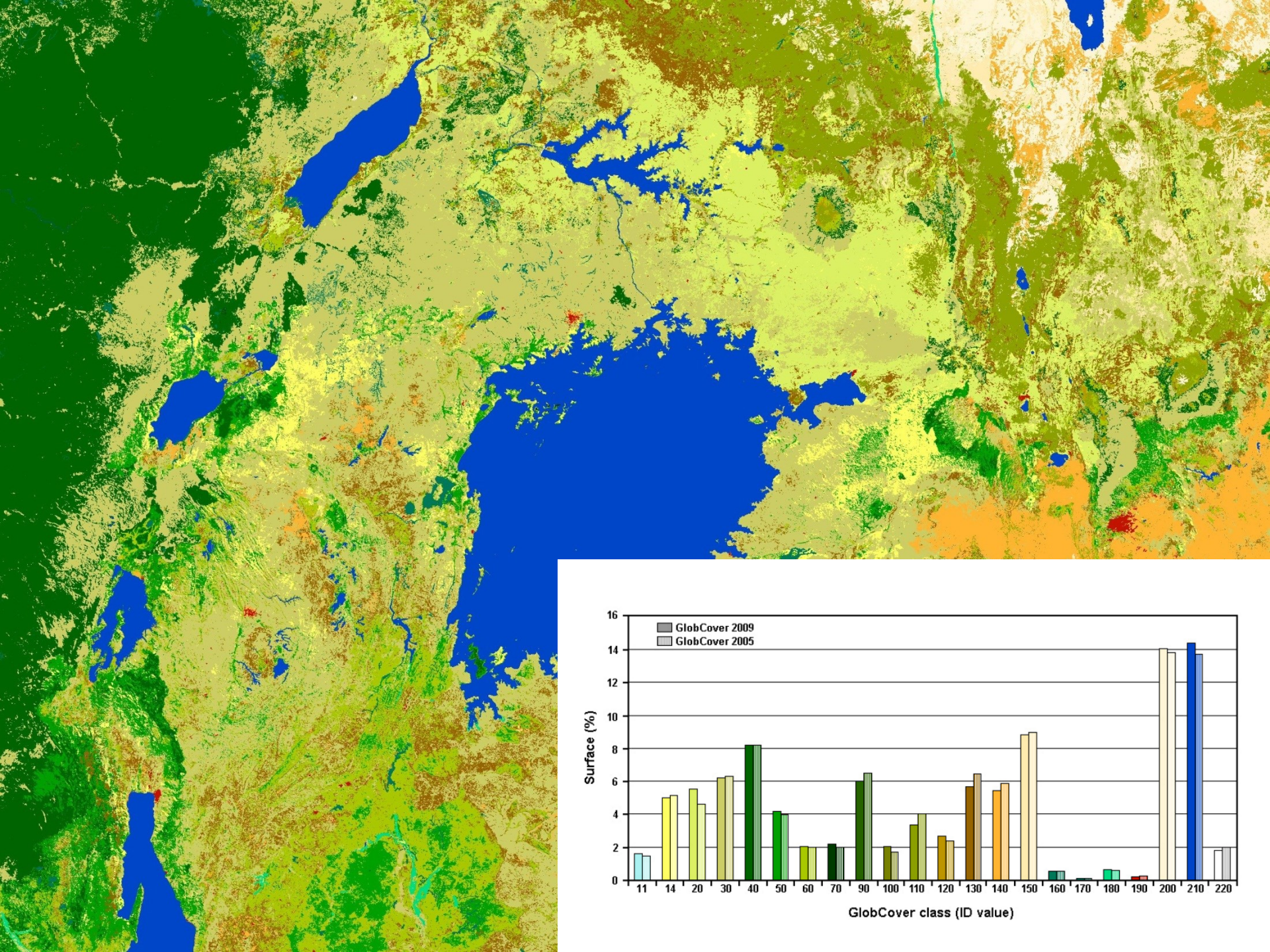


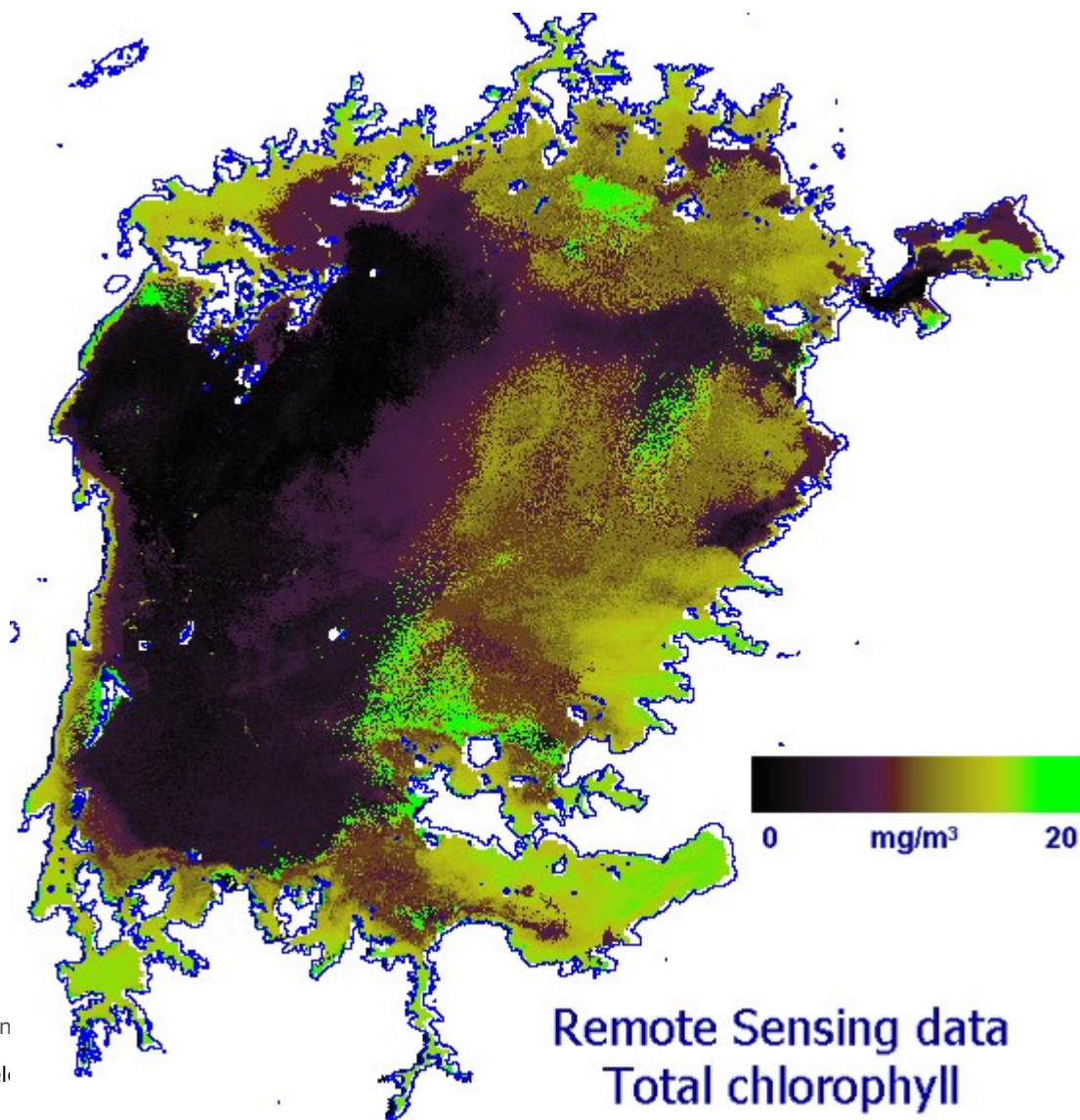
Vegetation Anomaly (comparison with long term average)

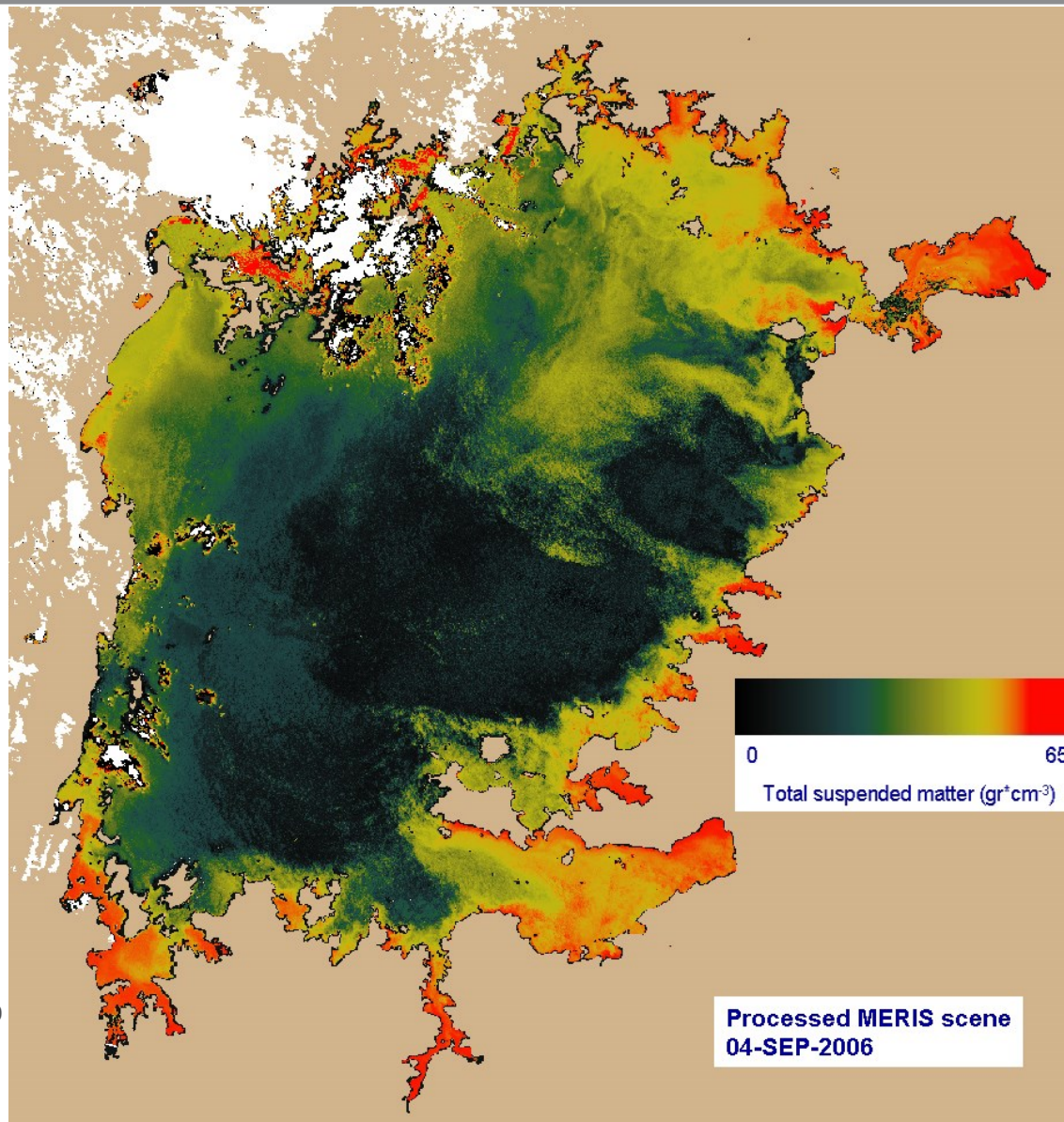


Spectral signatures



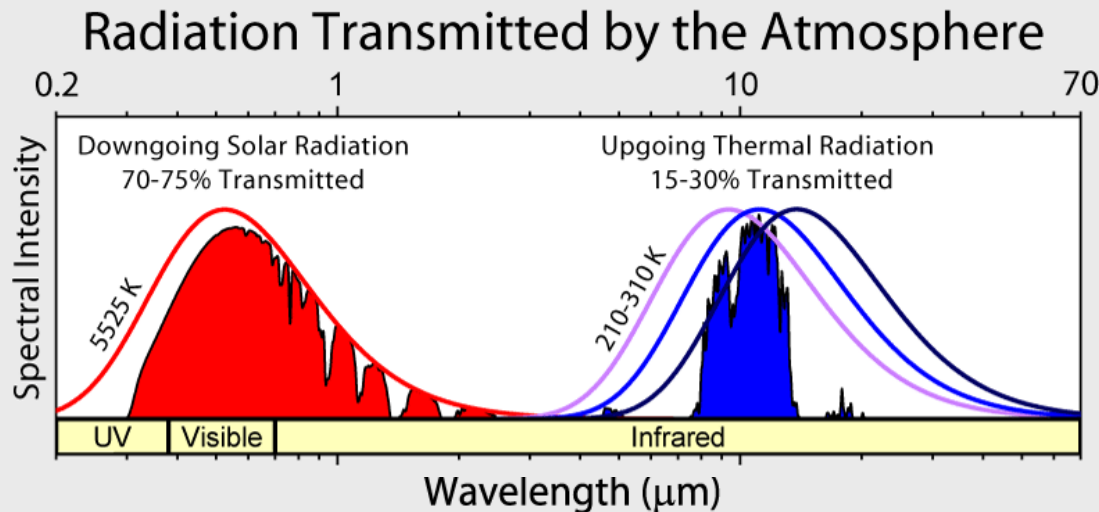
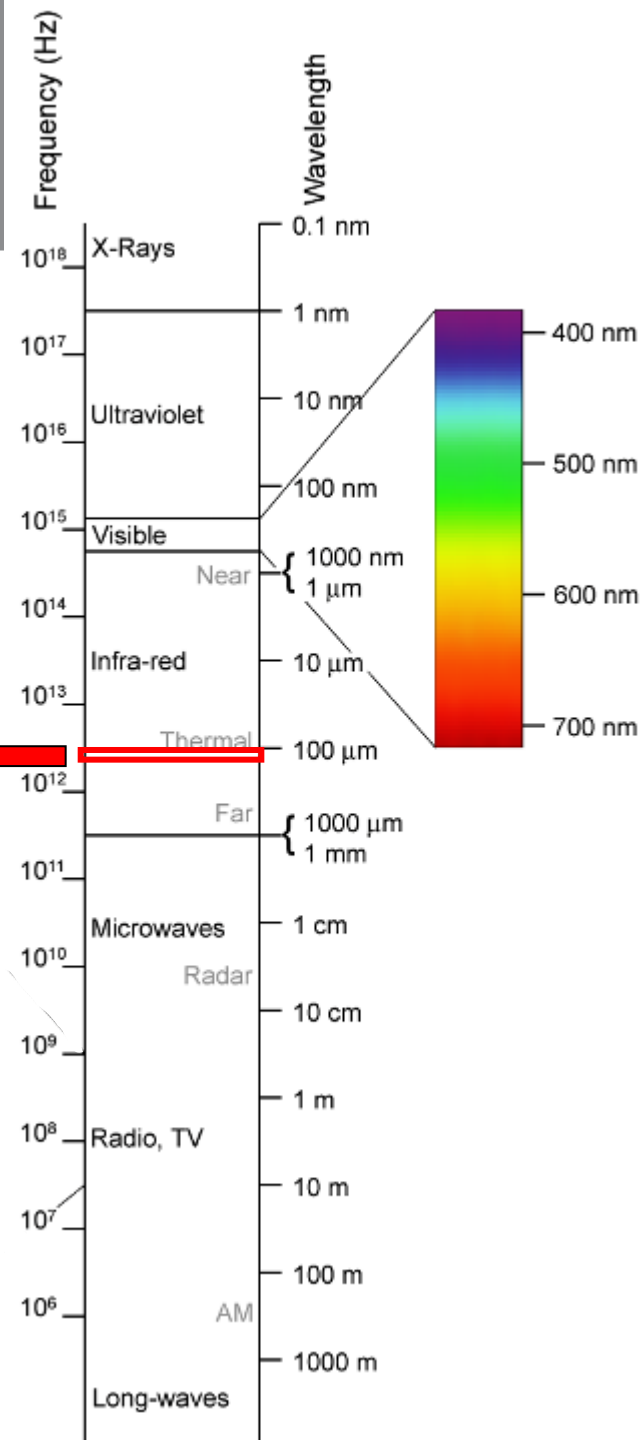




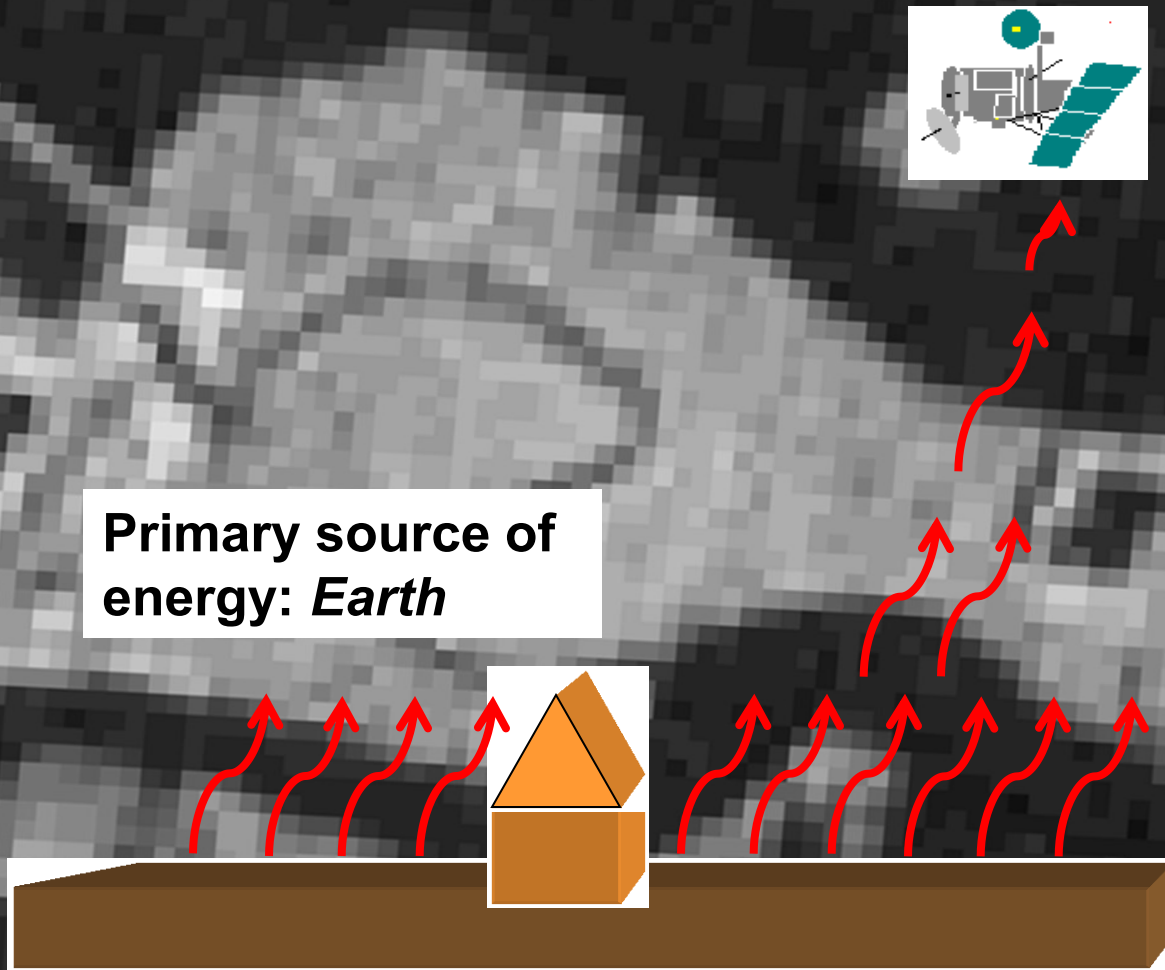


The electromagnetic spectrum

Thermal Infrared (TIR)



Passive Sensors



Derived from 3
AATSR scenes:

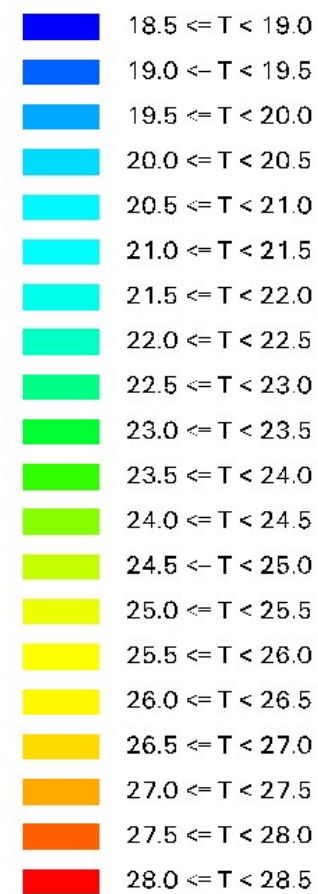
16-AUG-2006

19-AUG-2006

24-AUG-2006

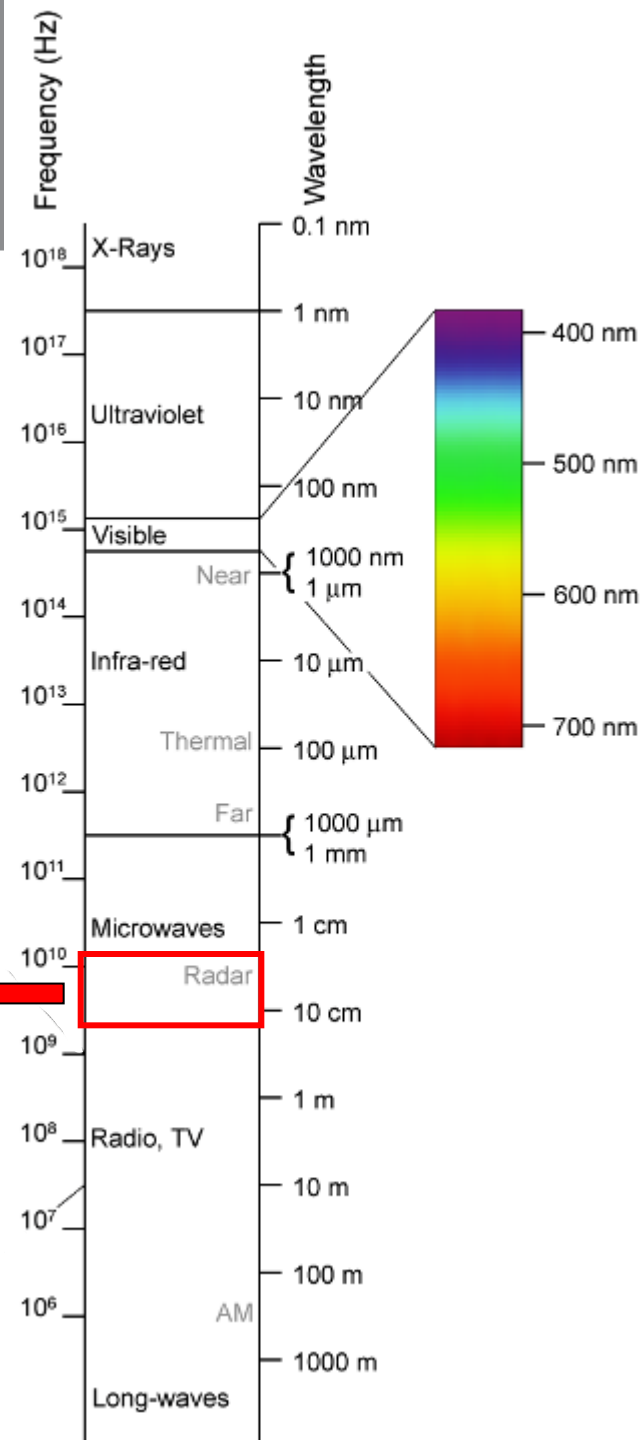
Legend

Temperature ($^{\circ}\text{C}$)



The electromagnetic spectrum

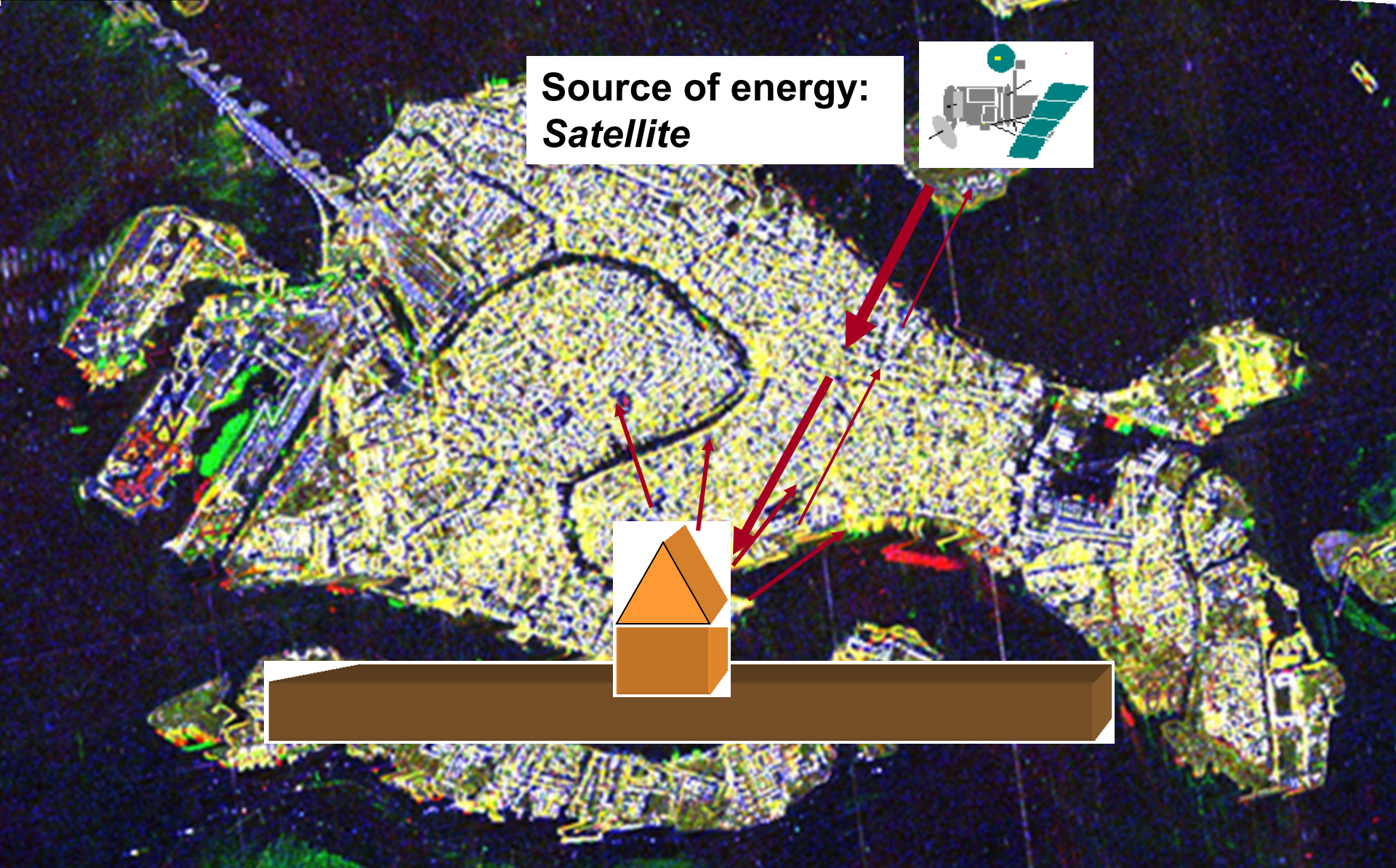
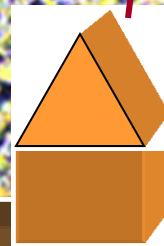
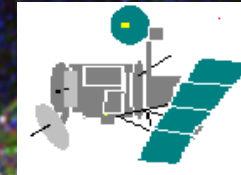
Synthetic Aperture Radar (SAR)





Active Sensors

Source of energy:
Satellite





ESA-DEVELOPED EARTH OBSERVATION MISSIONS



The Heritage: ERS and Envisat data



- ERS and Envisat missions 1991-2012
- More than 2 Petabytes of data
- Two decades of global change records
- Need for preservation, availability and exploitation



Michelson Interferometric Passive
Atmospheric Sounder
MIPAS

MERIS
Medium Resolution
Imaging Spectrometer

GOMOS
Global Ozone Monitoring
by Occultation of Stars

RA-2 Antenna
Radar Altimeter 2

LRR

AATSR Advanced Along Track Scanning Radiometer

SCIAMACHY
Scanning Imaging Absorption Spectrometer
for Atmospheric Cartography

MWR Microwave Radiometer

Ka-band
Antenna

DORIS
Doppler Orbitography and Radio-positioning
Integrated by Satellite

X-band
Antenna

ASAR Advanced Synthetic Aperture Radar
Antenna

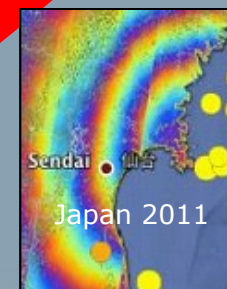
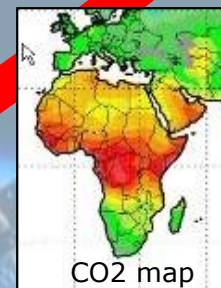
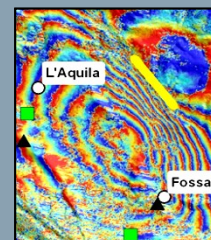
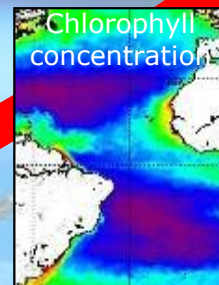
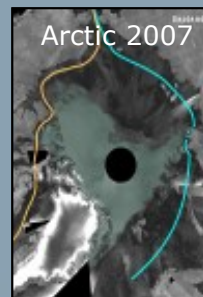
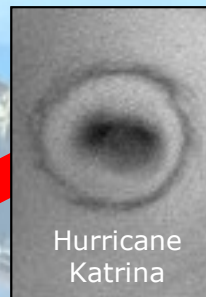
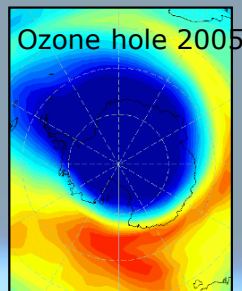
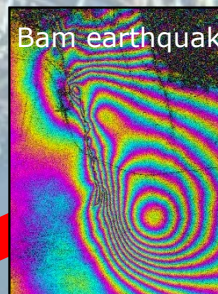
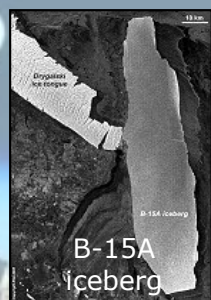
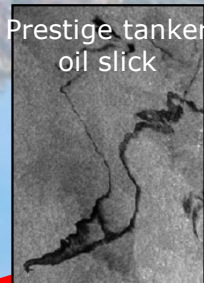
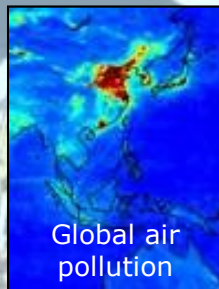


- **Dimensions (in orbit)**
26m x 10m x 5m
- **Mass**
8140 Kg
- **Orbit**
800 km as ERS, sun synchronous
10:00, i.e. 30 minutes before ERS-2

ENVISAT mission: 10 years



First images



**Serving
4000 scientific projects and
many operational users.
Many applications for disaster
monitoring**

Envisat
Symposium
Salzburg (A)

Envisat
Symposium
Montreux (CH)

Living Planet
Symposium
Bergen (N)

Sep 04

Apr 07

Jun 10

Mar 12

and many workshops dedicated to specific Envisat user communities

ENVISAT

An example of multisensor application: Risk Management

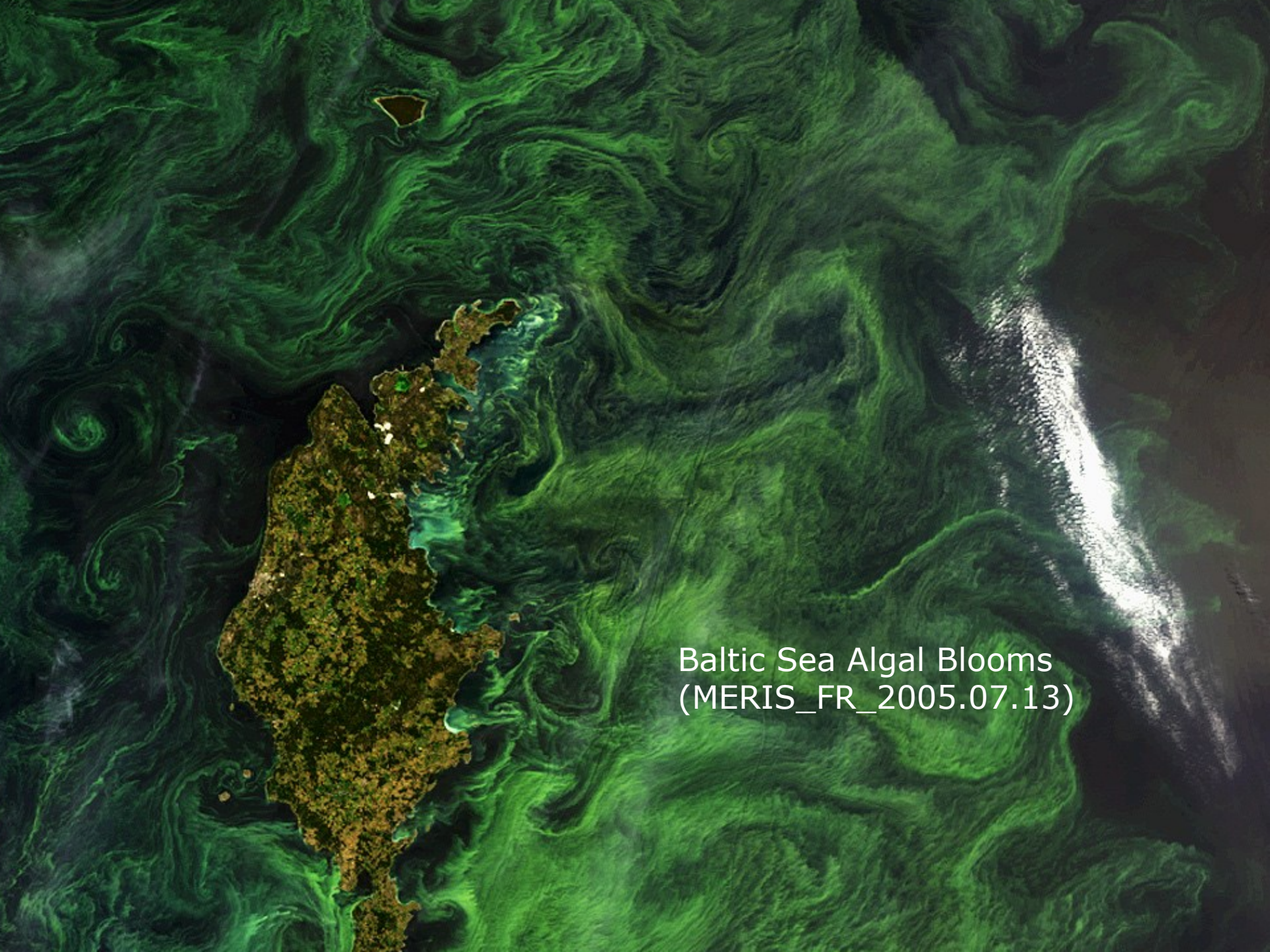


1) Use of optical data for Risk Management





Moscow Fires (Meris FR 2011)

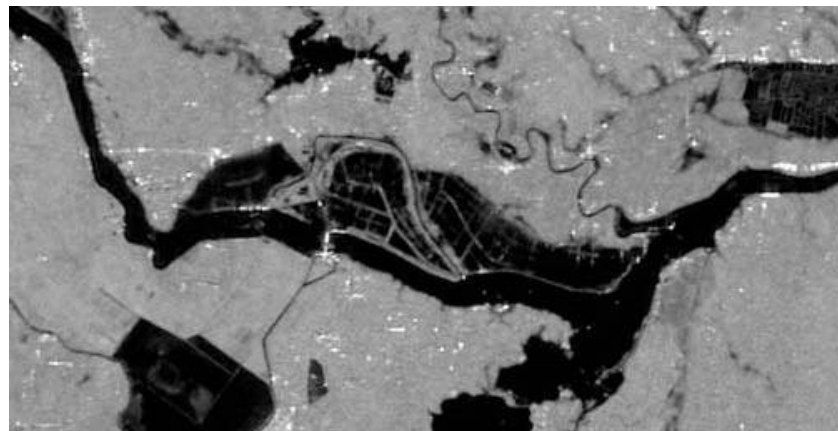


Baltic Sea Algal Blooms
(MERIS_FR_2005.07.13)

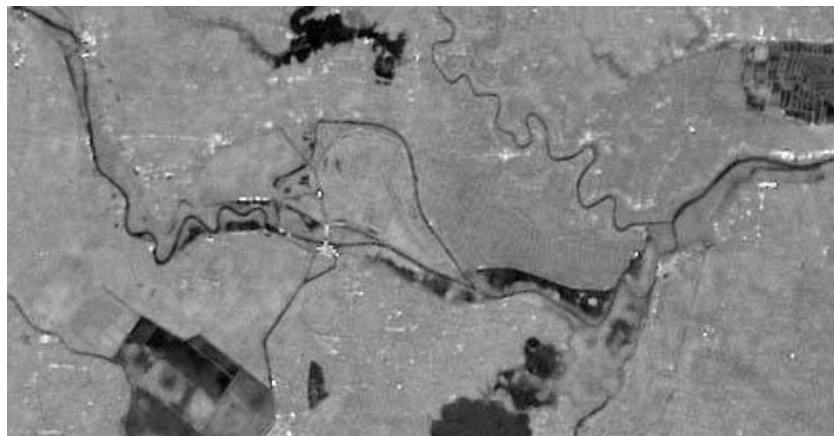
2) Use of radar backscatter for Risk Management



Flood mapping using satellite radar



ASAR WSM 150m spatial resolution acquired 15th July 2007, descending pass, polarisation HH.

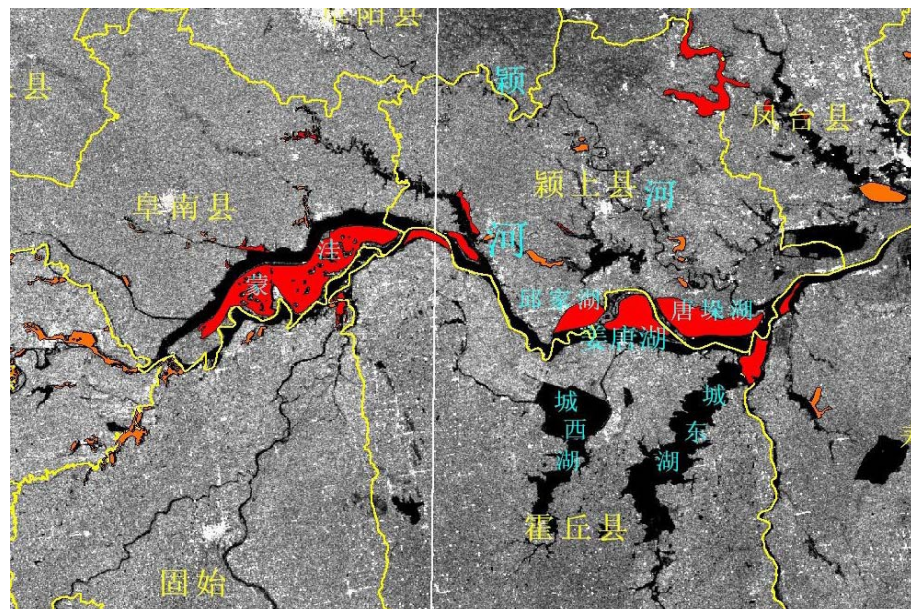


ASAR WSM 150m spatial resolution acquired 12th August 2006, descending pass, polarisation HH.

Inundated areas are clearly visible in this Envisat ASAR image acquired during floods in China in July 2007.

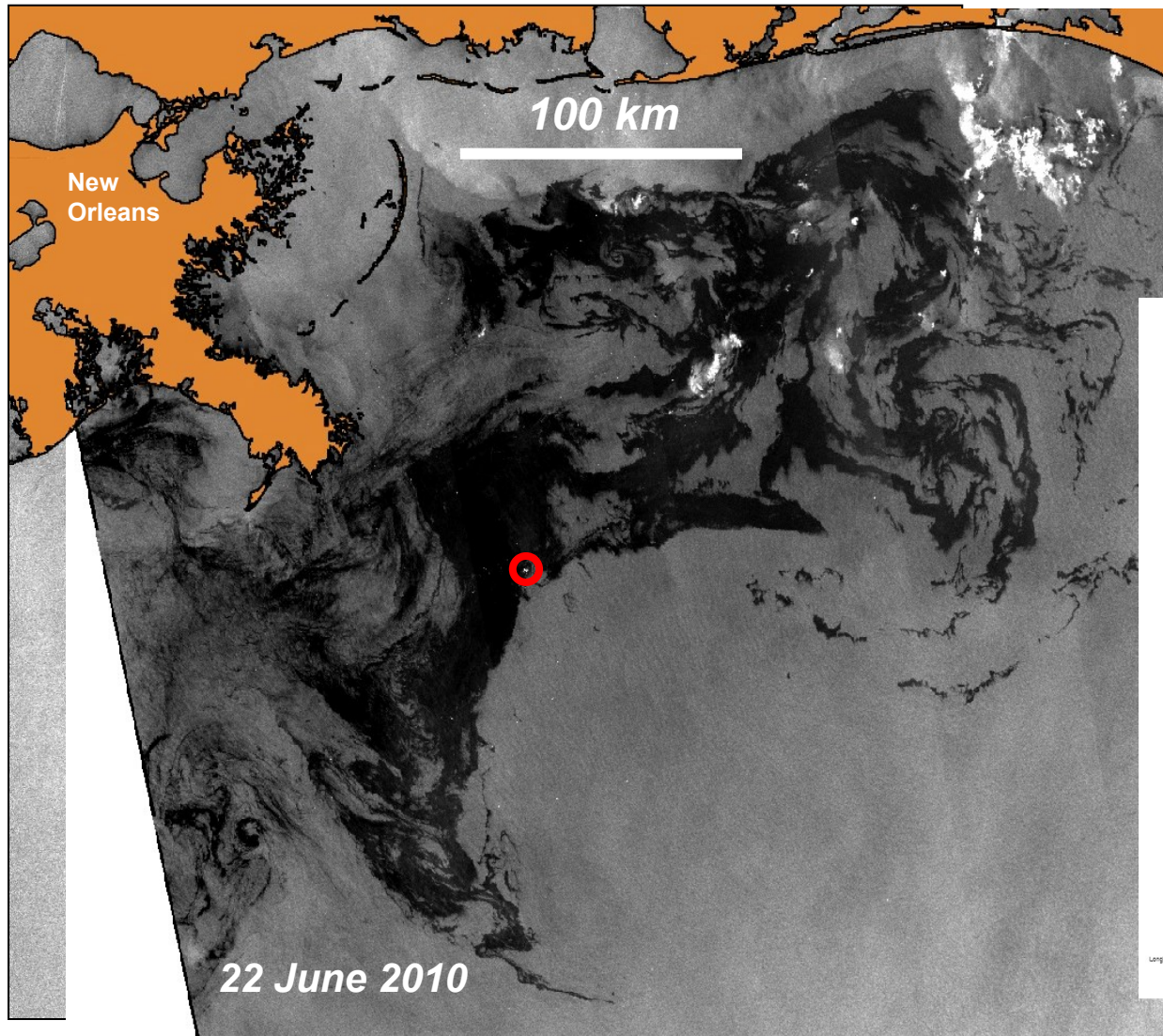
FLOODING IN CHINA (JULY 2007)

The two images were acquired during the same season but different years, one during the flooding, the other the year before. By comparing the two images, both **with the same geometry (Wide Swath Mode, descending pass) and same polarisation (HH)** it is possible to assess the extent of the flooding.

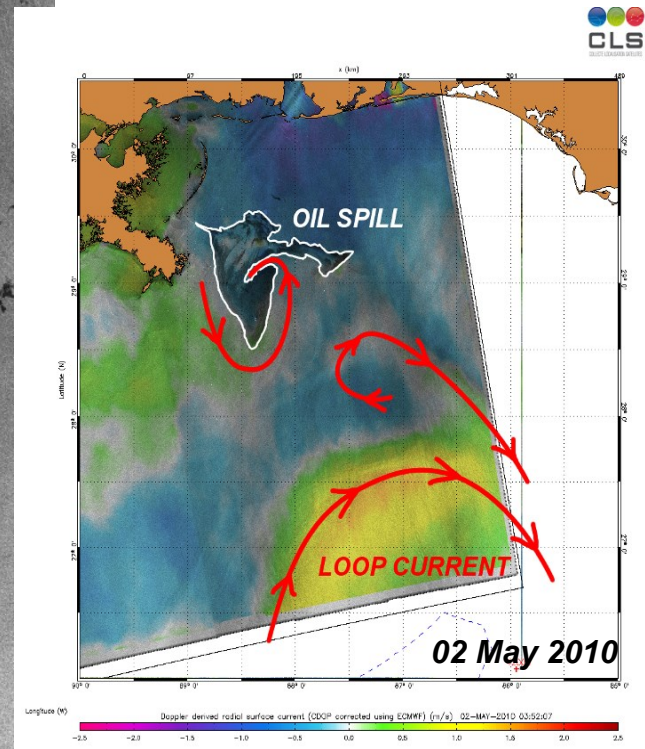


Courtesy of IWHR, Beijing

Oil spill monitoring using radar satellite



The Louisiana Oil Spill disaster from space (Envisat ASAR)





Costa "Concordia" Ship

This is a grayscale ASAR (Advanced Synthetic Aperture Radar) satellite image showing the Costa Concordia cruise ship. The ship is oriented vertically, with its bow at the top and stern at the bottom. The hull is dark, and the white superstructure is visible. A red arrow points from the text label to the ship's bow. The background is a textured, grainy gray, representing the sea surface.

Costa Concordia (ASAR IMP 10.Feb.2012)



*ice tongue
piece*

Drygalski
ice
tongue

B-15A
iceberg

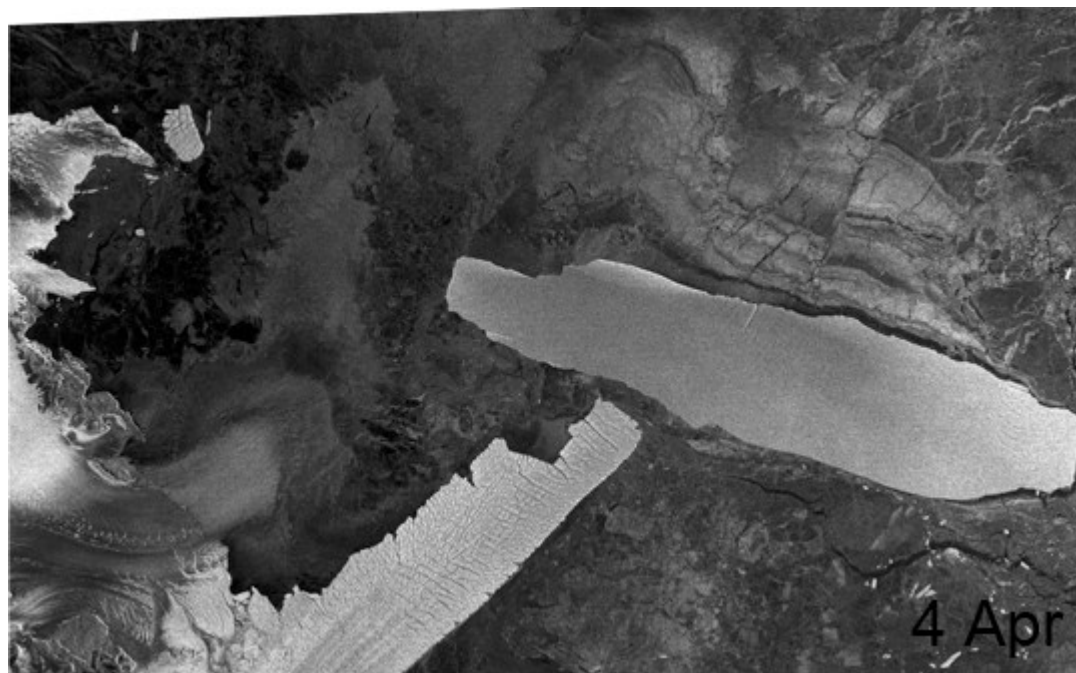
Ross Sea

Iceberg B-15A
(ASAR_WSM_15Apr05)

a

ncy

Iceberg B-15A Antarctic (ASAR_WSM from 4th to 20th Apr 05)



Use of radar phase (InSAR, PS) for Risk Management

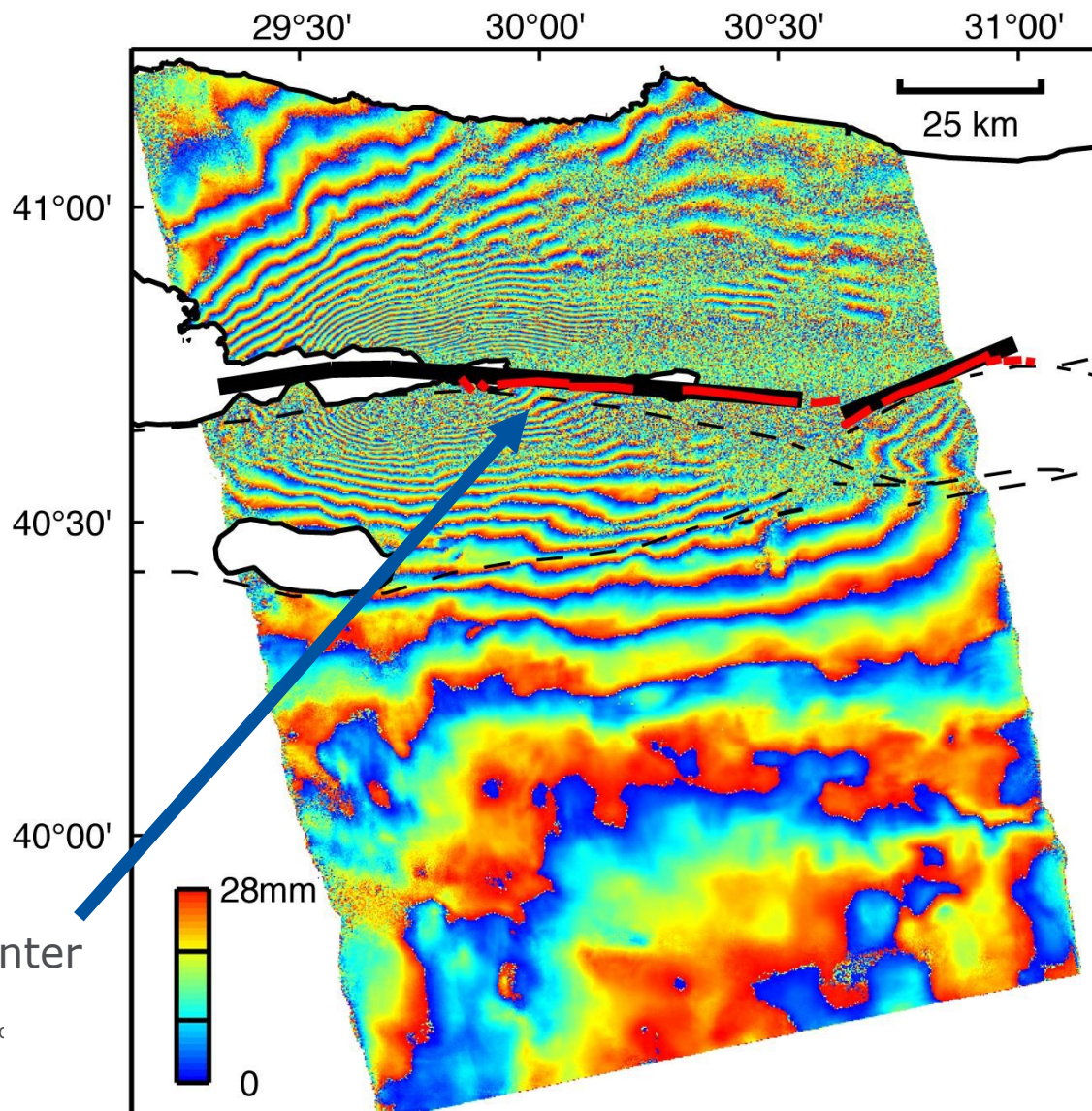


Earthquake in Izmit, Turkey (1999)

Post-seismic deformation measured by Interferometric SAR

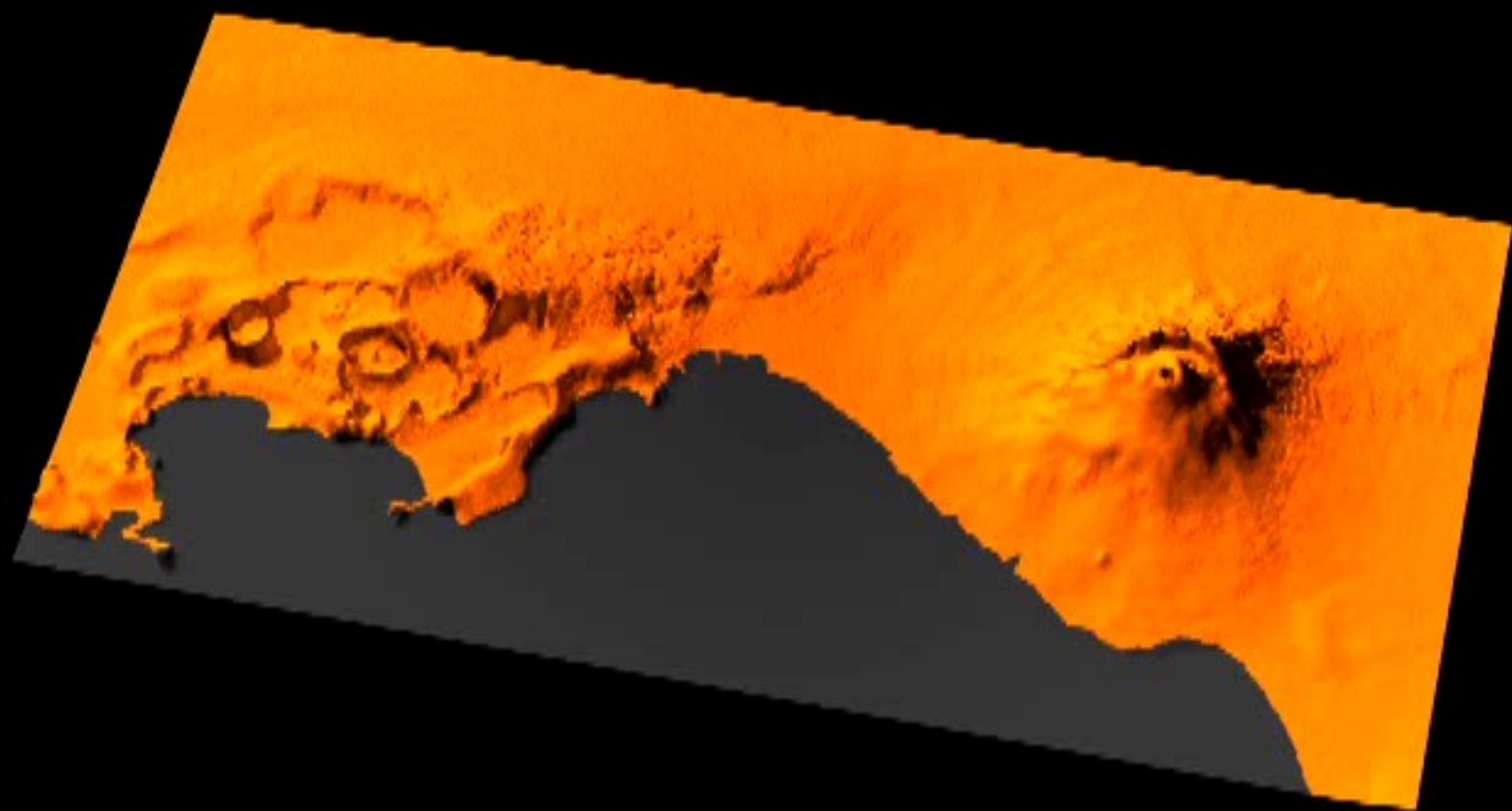
- Synthetic Aperture Radar (ERS-1, ERS-2)
- Generation of Interferogram (phase difference between two SAR images)
- One colour pattern (fringe) corresponds to 28 mm deformation along the line of sight
- This works through clouds or darkness (Radar Data)

Epicenter



Campi Flegrei: observation by InSAR



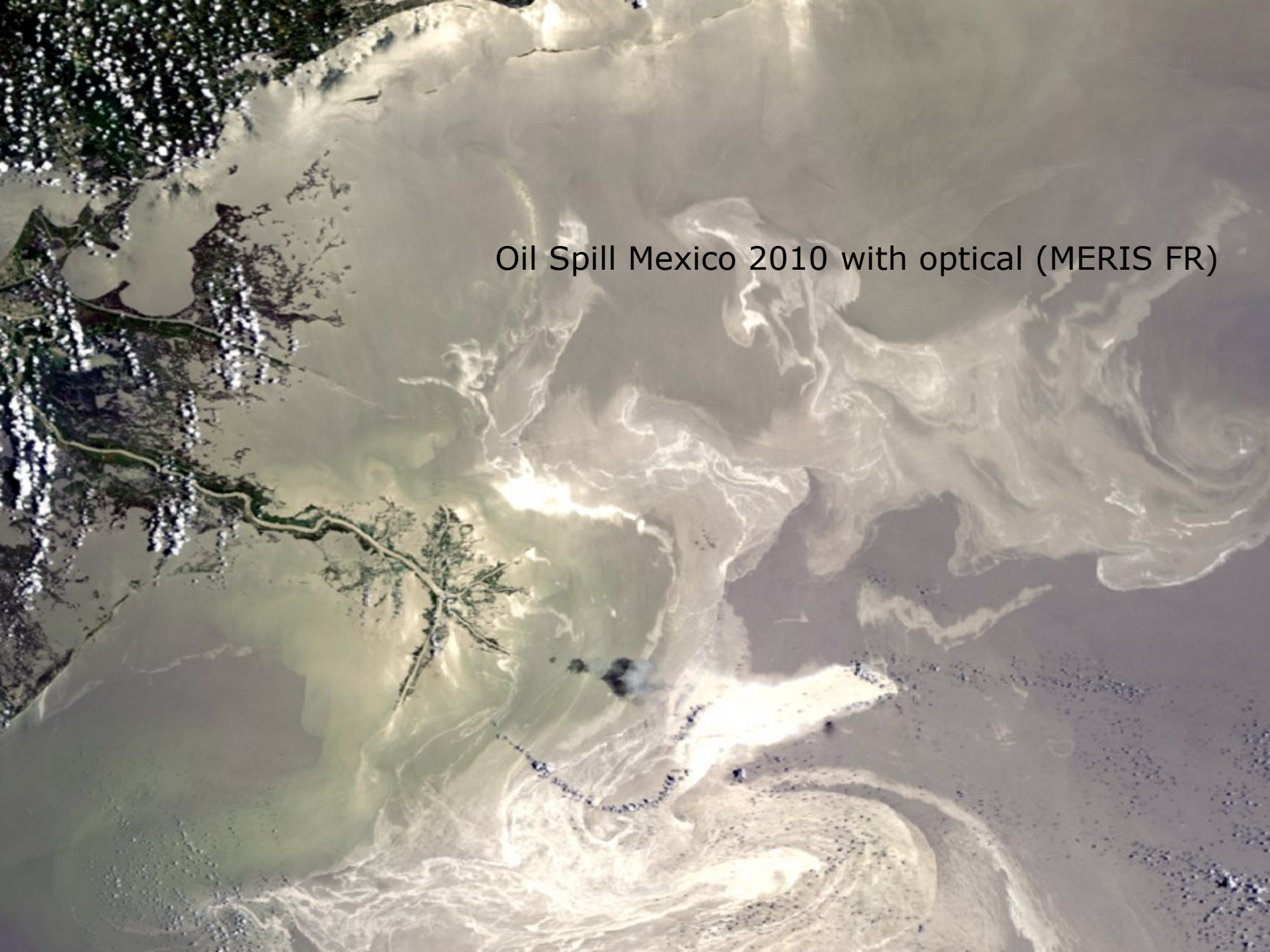


3) Use of radar backscatter, combined with optical data, for Risk Management

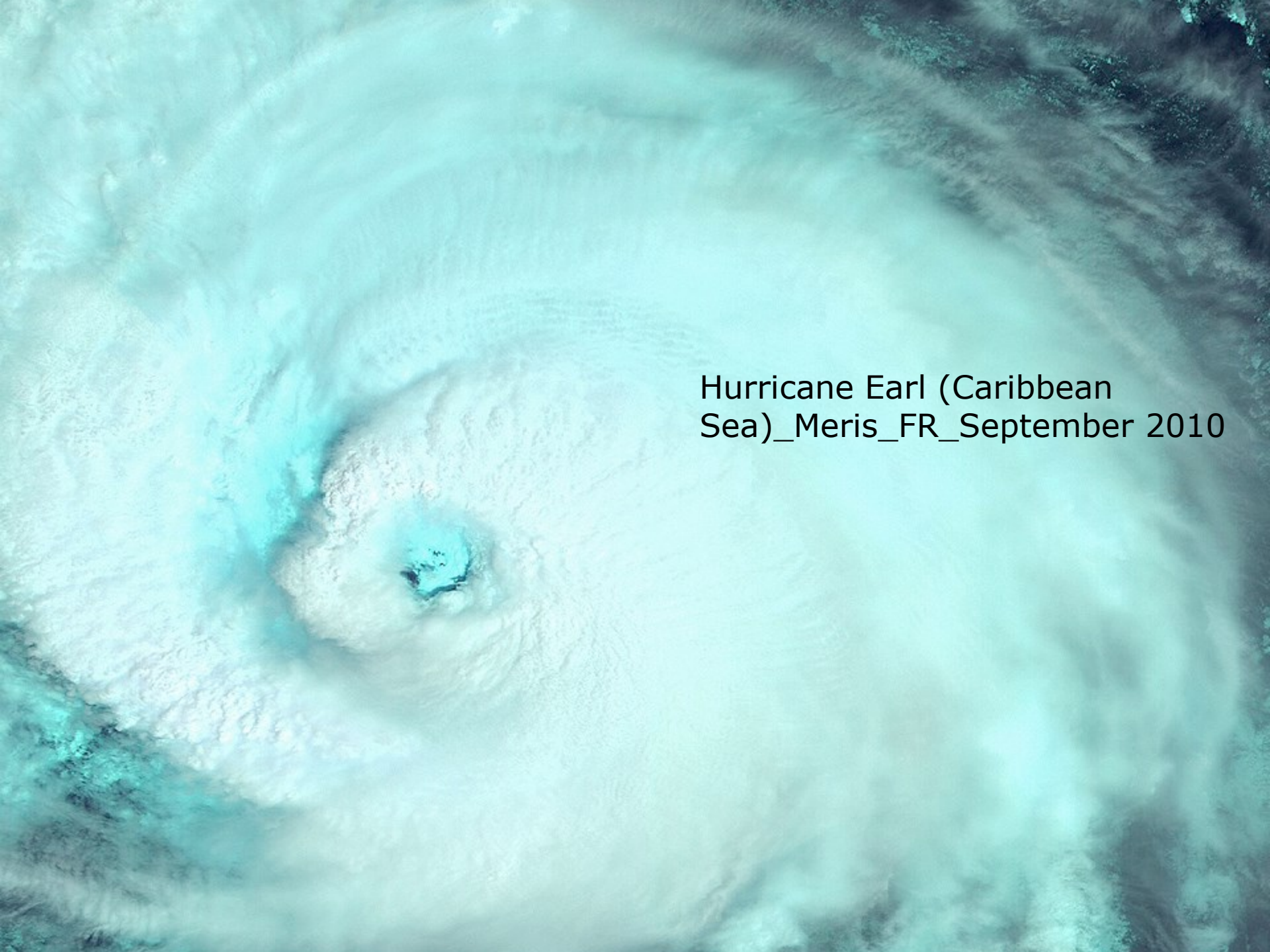




Oil Spill Mexico 2010 with radar (ASAR_WSM)



Oil Spill Mexico 2010 with optical (MERIS FR)



Hurricane Earl (Caribbean
Sea)_Meris_FR_September 2010

A grayscale satellite image of Hurricane Earl, showing a well-defined eye and spiral cloud bands. An arrow points from the text 'Hurricane Earl' to the center of the storm.

Hurricane Earl

Hurricane Earl (Caribbean
Sea)_ASAR_WSM_September 2010

Hurricane Gustav: wind and currents



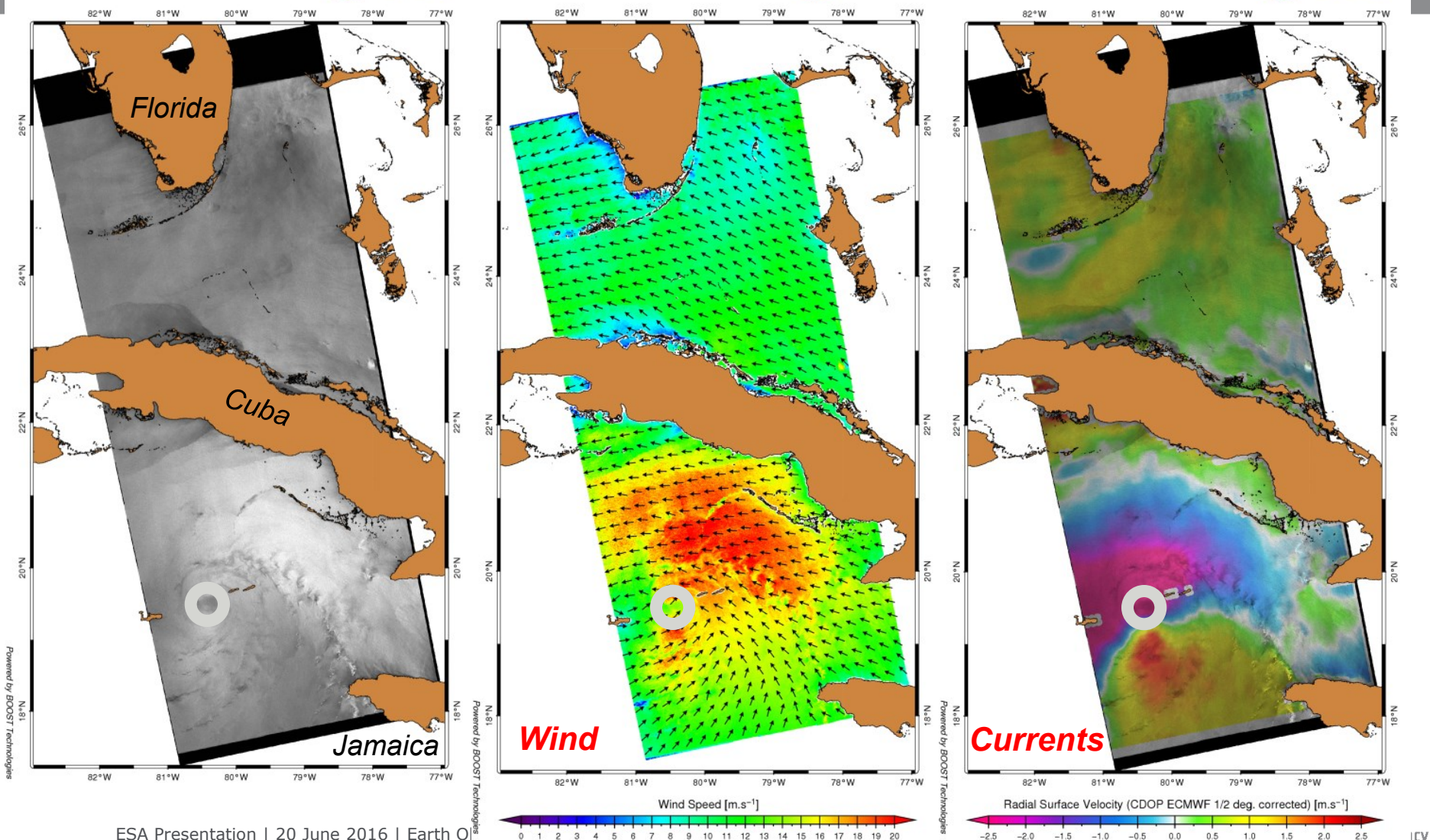
30-August-2008 03:21:37 (UTC)
ENVISAT WSM Product



30-August-2008 03:21:37 (UTC)
ENVISAT WSM Product



30-August-2008 03:21:37 (UTC)
ENVISAT WSM Product

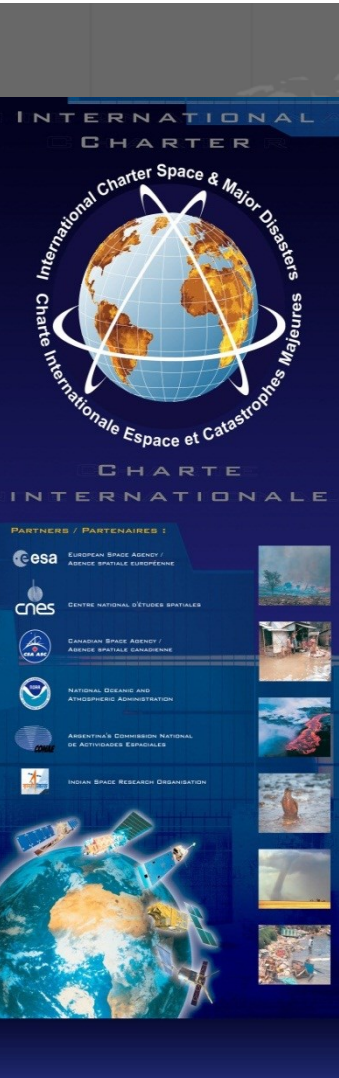


ESA Presentation | 20 June 2016 | Earth O

ESA UNCLASSIFIED – Releasable to

<http://soprano.boost-technologies.com>

International Charter Space & Major Disasters

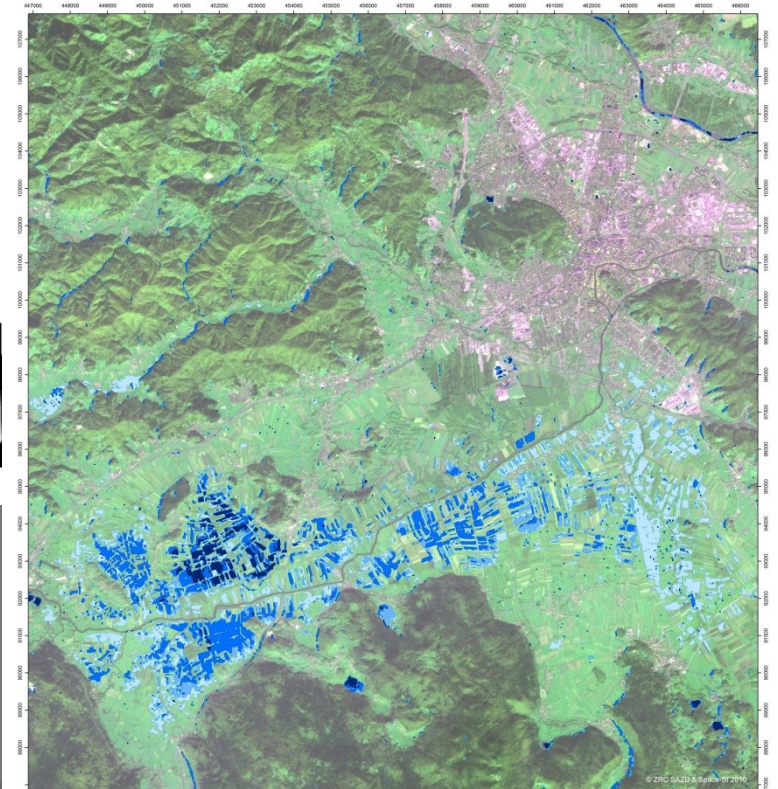


More than 500 activations
in 110+ countries
since 2000 !

www.disasterscharter.org

Event / Dogodek: Floods in Slovenia 2010 / Poplave v Sloveniji 2010
Mapped area / Kartirano območje: Ljubljana

Situation map / Situacijska slika
State / Stanje: 19.9. - 2.10.2010



Overview map / Pregledna karta

Legend / Legenda

- water extent - 19.9.2010 - ENVISAT ASAR
- water extent - 23.9.2010 - RADARSAT-2
- water extent - 26.9.2010 - RADARSAT-2
- water extent - 28.9.2010 - RADARSAT-2
- water extent - 2.10.2010 - RADARSAT-2

Processing and analysis

ENVISAT ASAR data was processed and georeferenced, filtered and classified. RADARSAT-2 images were processed and georeferenced, filtered and classified. SPOT 5 georeferenced.

Obdelava in analiza

Georeferenciranje in obdelava podatkov ENVISAT ASAR, georeferenciranje in obdelava podatkov RADARSAT-2, SPOT 5 georeferenciranje.

Interpretation

Heavy rains on September 17th to 19th 2010 triggered severe flooding in many parts of Slovenia. One of the most serious areas was southern part of capital Ljubljana, where two major rivers (Savinjska and Ljubljanska) flooded nearby. Situation in the Ljubljana ASAR satellite image of September 19.9. is shown in the map. The flooded areas and its dynamics (water retention) are presented in blue color range. The total amount of flooded areas outside of Ljubljana can be clearly seen. Detection of flooding in urban parts was not possible due to scattering mechanism of radar signal (geometry and composition of objects rise the signal). Similarly, all the areas where radar scattered on vegetation or tall crops exposure above the water are water-underestimated. SPOT 5 image acquired on October 27, 2008 serves as background.

Interpretacija

Močno deževje med 17. in 19. septembrom 2010 je povzročilo hude poplave po Sloveniji. Ena od bolj prizadetih območij je bil jugovzhodni del prestolnice Ljubljane, kjer sta poplavljena Savinja in Ljubljanska. Stanje na tem območju je prikazano na satelitski sliki RADARSAT-2 z dne 23.9.2010. V sliki so prikazane poplavljene površine Ljubljane. Zlasti v urbanih delih in tistih območjih zaradi narave radarjskega signala, ki se odraža na vegetaciji ali visoki travi, ki se odraža nad vodno gladino, kar pomeni, da so ti deli precejeni. Za ozadje službo uporablja SPOT 5, slika 27. oktobra 2008.

Cartographic info / Kartografski opis

Original satellite image - Sentinel-2A, Sentinel-2B, Sentinel-2C, Sentinel-2D, Sentinel-2E, Sentinel-2F, Sentinel-2G, Sentinel-2H, Sentinel-2I, Sentinel-2J, Sentinel-2K, Sentinel-2L, Sentinel-2M, Sentinel-2N, Sentinel-2O, Sentinel-2P, Sentinel-2Q, Sentinel-2R, Sentinel-2S, Sentinel-2T, Sentinel-2U, Sentinel-2V, Sentinel-2W, Sentinel-2X, Sentinel-2Y, Sentinel-2Z, Sentinel-2AA, Sentinel-2AB, Sentinel-2AC, Sentinel-2AD, Sentinel-2AE, Sentinel-2AF, Sentinel-2AG, Sentinel-2AH, Sentinel-2AI, Sentinel-2AJ, Sentinel-2AK, Sentinel-2AL, Sentinel-2AM, Sentinel-2AN, Sentinel-2AO, Sentinel-2AP, Sentinel-2AQ, Sentinel-2AR, Sentinel-2AS, Sentinel-2AT, Sentinel-2AU, Sentinel-2AV, Sentinel-2AW, Sentinel-2AX, Sentinel-2AY, Sentinel-2AZ, Sentinel-2BA, Sentinel-2BB, Sentinel-2BC, Sentinel-2BD, Sentinel-2BE, Sentinel-2BF, Sentinel-2BG, Sentinel-2BH, Sentinel-2BI, Sentinel-2BJ, Sentinel-2BK, Sentinel-2BL, Sentinel-2BM, Sentinel-2BN, Sentinel-2BO, Sentinel-2BP, Sentinel-2BQ, Sentinel-2BR, Sentinel-2BS, 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The example of the 2010 Slovenia Floods
(from Envisat ASAR, Radarsat-2)

Universal Access since Sept. 2012

Disasters types supported



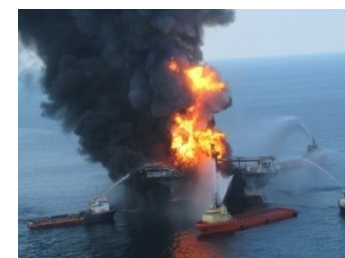
The International Charter makes priority tasking of different EO missions in a rapid fashion; it is designed to address sudden requests concerning major disasters caused by:

Natural events

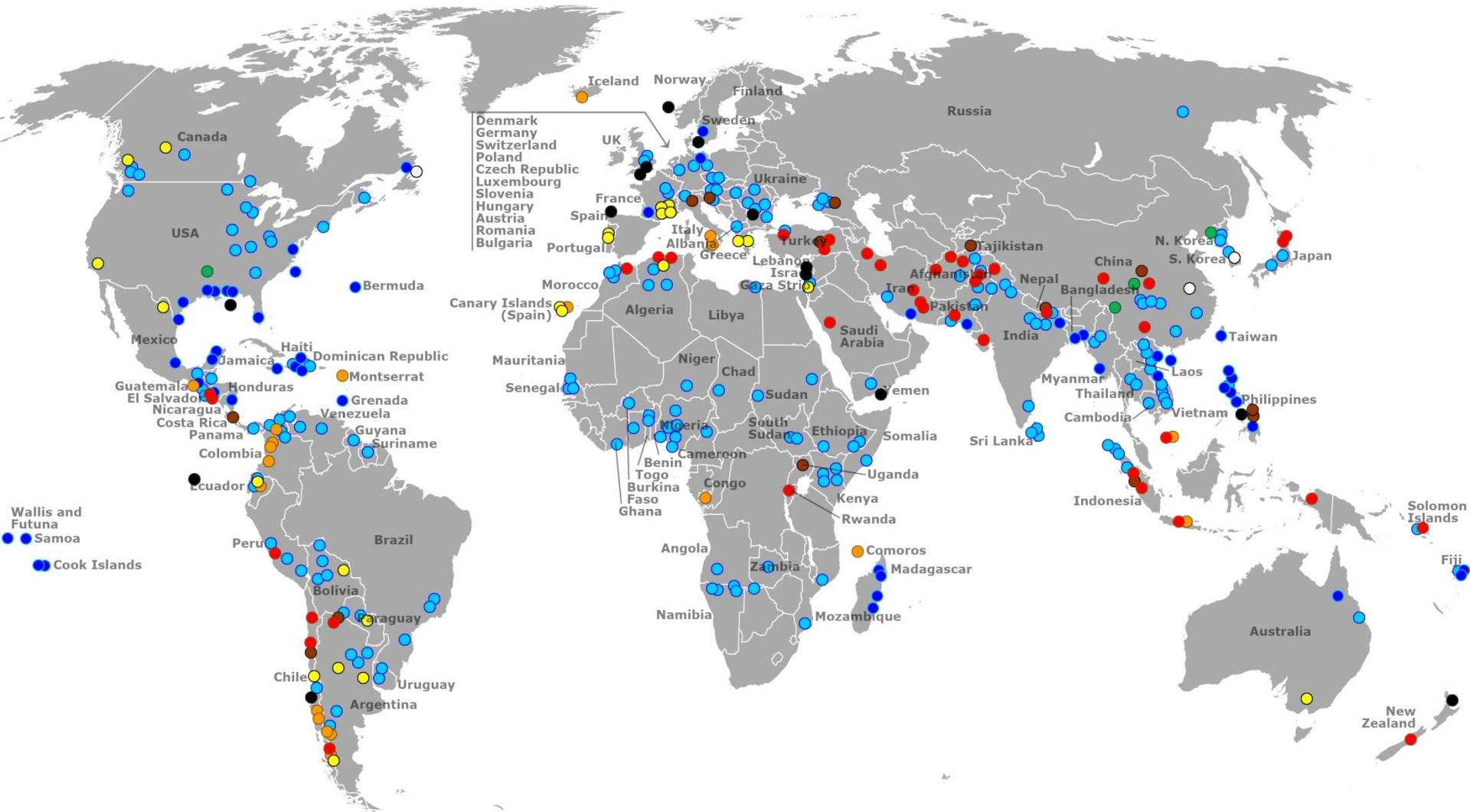
- Earthquakes
- Fires
- Floods
- Ice jams
- Landslides
- Tsunamis
- Ocean storms
- Volcanic eruptions

Man-made events

- Oil spills
- Industrial accidents



Activation Distribution



As of October 15, 2012

Activations in Hungary

Type of Event:	Flooding
Location of Event:	Hungary
Date of Charter Activation:	14/04/2006
Charter Requestor:	European Commission Civil Protection Monitoring and Information Centre
Project Management:	DLR

Description of the event

Heavy rainfall and snowmelt in Hungary at the end of March and in April 2006 caused the highest peak of overflow in the last century of the river Tisza, a major tributary of the Danube. The cities of Prague, Budapest, and Belgrade were threatened; by mid-April, thousands had been evacuated.



Hungary, Tisza Flood: Szeged

Source: RADARSAT-1, Landsat 7 ETM+
Acquired: 15/04/2006, 20/08/2000 The map shows the city of Szeged in Hungary during the flooding event of the Danube/Tisza rivers in April 2006. The flooded area has been extracted from radar satellite data (RADARSAT) acquired on 17 April 2006. The background satellite image is based on Landsat 7 ETM+ data acquired on 20 August 2000 displayed as real colour composite. The flooded area has been mapped with highest possible accuracy.

Copyright: Canadian Space Agency 2006, USGS 2000 Image processing, map created 18/04/2006 by DLR in the framework of GMES RISKEOS.

[Higher resolution version](#)

Hungary, Tisza Flood: Szolnok

Source: RADARSAT-1, Landsat 7 ETM+
Acquired: 15/04/2006, 20/08/2000 The map shows the city of Szolnok in Hungary during the flooding event of the Danube/Tisza rivers in April 2006. The flooded area has been extracted from radar satellite data (RADARSAT) acquired on 17 April 2006. The background satellite image is based on Landsat 7 ETM+ data acquired on 20 August 2000 displayed as real colour composite. The flooded area has been mapped with highest possible accuracy.

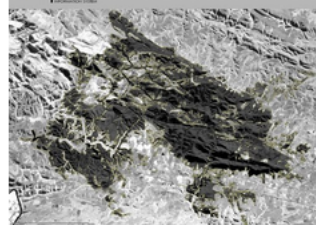


@DisastersChart

#SPOT7 acquired this view of the burn scar from the #fire at Thornhill in #SouthAfrica on 13 June: bit.ly/2tdjFiZ #KnysnaFire



Thornhill Fire



Quadrat cell: 815
 Thornhill burn scar
 Sensor: Spot 7
 Scanning date: 2017-06-13
 Estimate Area Burnt: 15980 ha



9h



Disasters Charter

@DisastersChart



#RADARSAT2 was used to map the #floods in #Uruguay on 8 June: bit.ly/2r94JkF

<https://www.disasterscharter.org/web/guest/-/flooding-in-hunga-2>

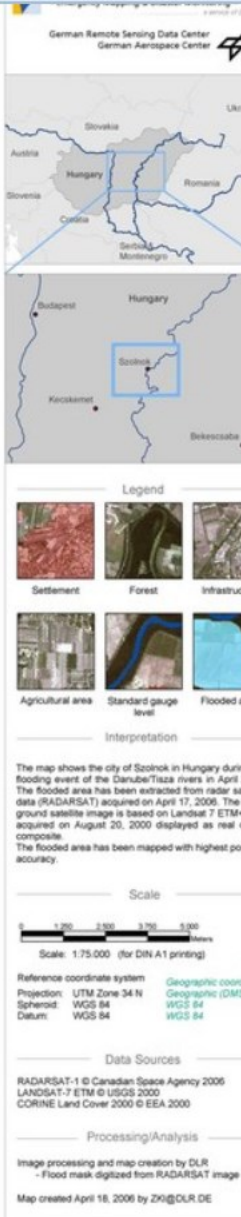
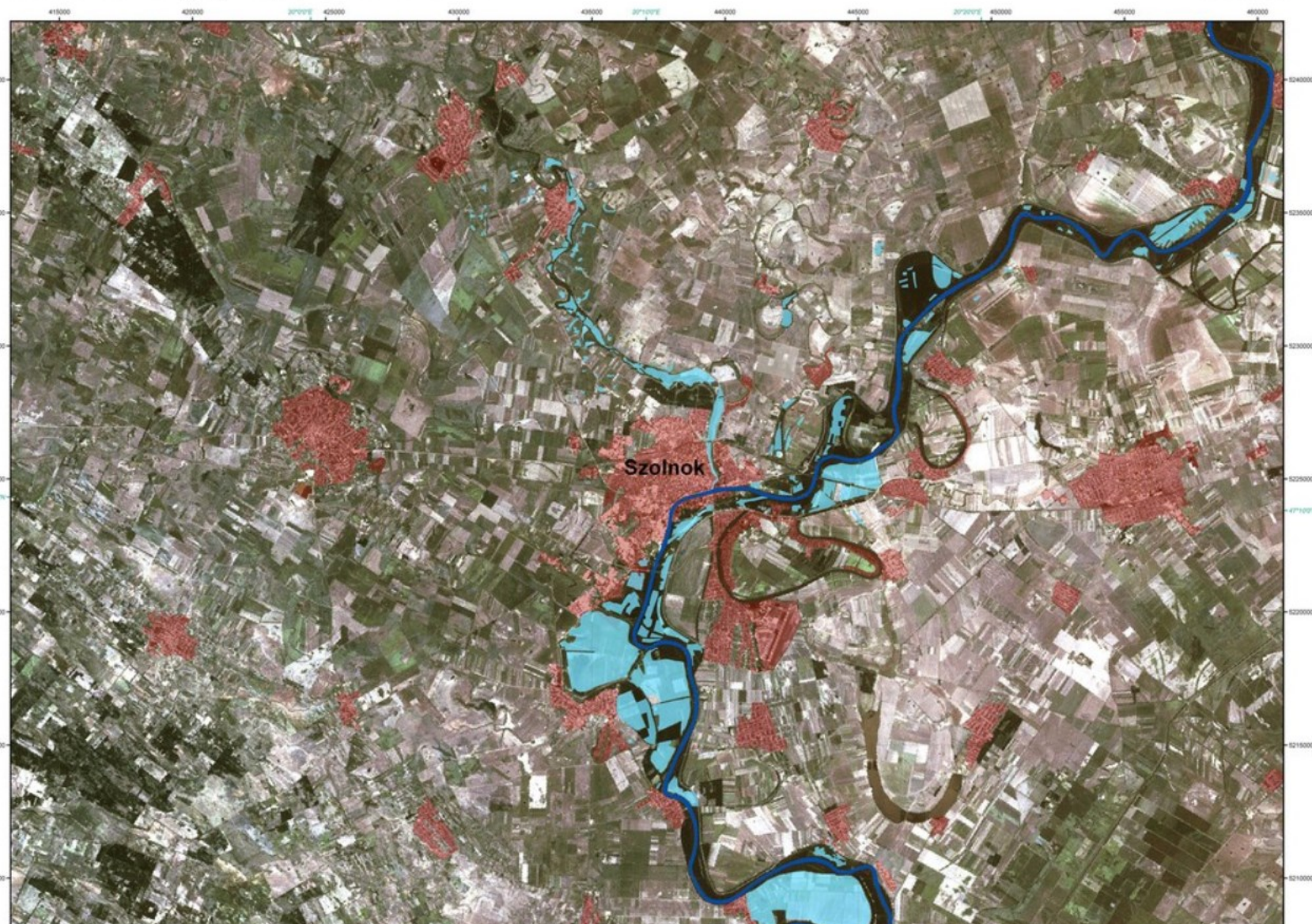
Activations in Hungary



Floods in Hungary - April 2006 - Szolnok

Radarsat-based

1 : 75.000



Charter website



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Activating the Charter

There are several [mechanisms to activate the Charter](#). It is based on a pre-defined list of appointed users, known as 'Authorized Users' (AUs). Until now AUs are typically disaster management authorities, from countries of Charter member agencies, able to request Charter support for emergencies in their own country, or in a country with which they cooperate for disaster relief.

Since its inception, the Charter has demonstrated a strong commitment to expanding its number of users. Initiatives include collaboration with UNITAR/UNOSAT and UN OOSA, active in many countries and who can submit requests to support in-country UN relief agencies, and Sentinel Asia, a regional network for Earth observation-based Emergency Response in 32 countries.

Universal Access

Building on a decade of success in making satellite data available for disaster response, the International Charter is now opening its doors even wider. The Charter Members have adopted the principle of Universal Access to further strengthen the Charter's contribution to disaster management worldwide. Any national disaster management authority will be able to submit requests to the Charter for emergency response. Proper procedures will have to be followed, but the affected country will not have to be a Charter member.

Universal Access benefits national disaster management authorities in countries beyond those of the Charter members, previously unable to make direct requests to the Charter.

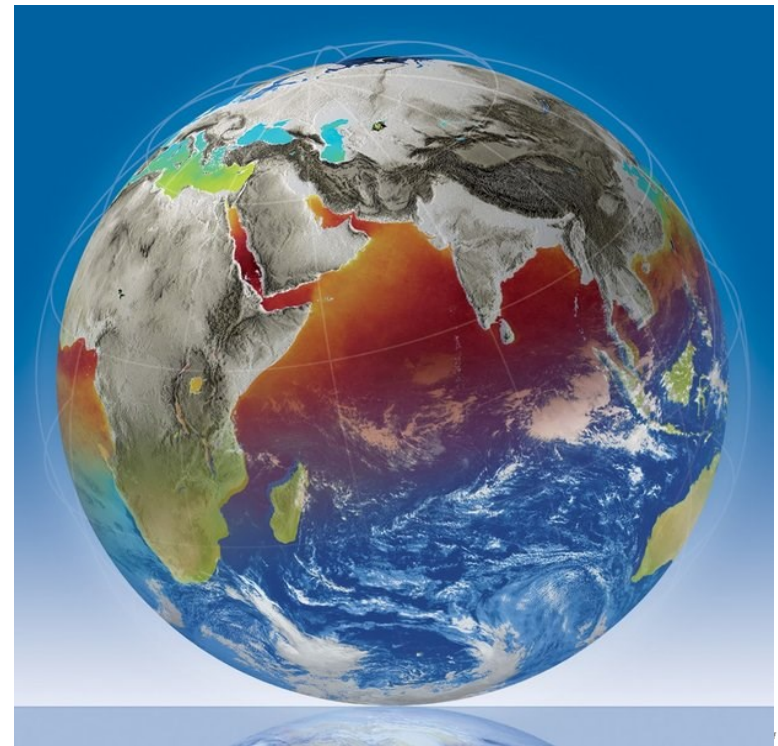
A registration process is in place for national authorities interested in participating in the Charter as an "Authorized User". This process will validate the ability of national authorities to access and use Charter assets for disaster response, in accordance with Charter operational procedures. Steps and applicable conditions are explained in the Charter's [Universal Access Information Brochure](#) available together with its [Registration form](#).

What is Copernicus?



Integrated Earth observation system of systems. European response to global needs, such as

- managing the environment,
- mitigating the effects of climate change and
- ensuring civil security

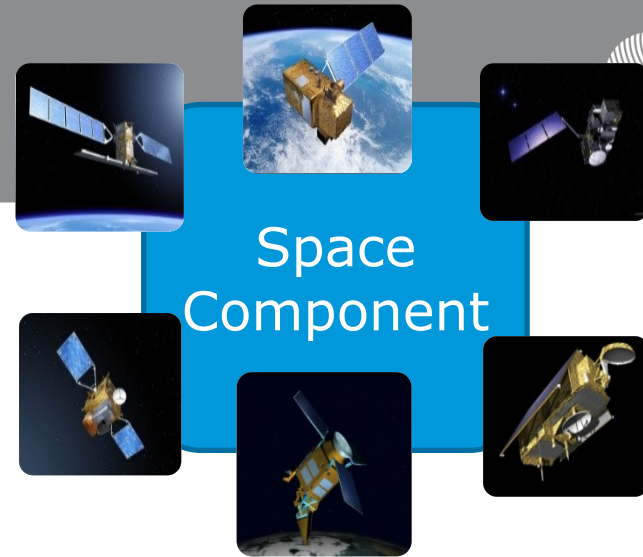


Copernicus Components

Overall
Programme
Coordination:



Space
Component



Services
Component



Copernicus: A New Generation of Data Sources



Sent-1A/B



Sentinel-2A/B



Sentinel-3A/B



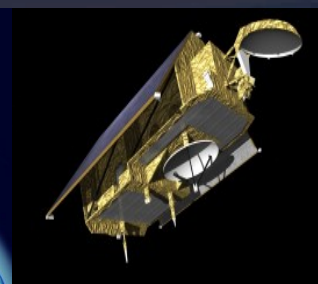
Sentinel-4A/B



Sentinel-5/5P



Sentinel-6A/B



- **Copernicus is a European space flagship programme led by the European Union**
- **ESA coordinates the space component**
- **Copernicus provides the necessary data for operational monitoring of the environment and for security**
- **Free and open data policy**

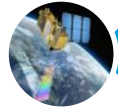


Copernicus Space Component: the dedicated Sentinels ...



S1A/B: Radar Mission
2016

3 Apr 2014/25 Apr

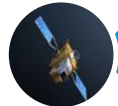


S2A/B: High Resolution Optical Mission
2017

23 June 2015/7 March



S3A/B: Medium Resolution Imaging and Altimetry Mission
2016/2017



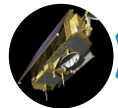
S4A/B: Geostationary Atmospheric Chemistry Mission
2021/2027



S5P: Low Earth Orbit Atmospheric Chemistry Mission
2017



S5A/B/C: Low Earth Orbit Atmospheric Chemistry Mission
2021/2027



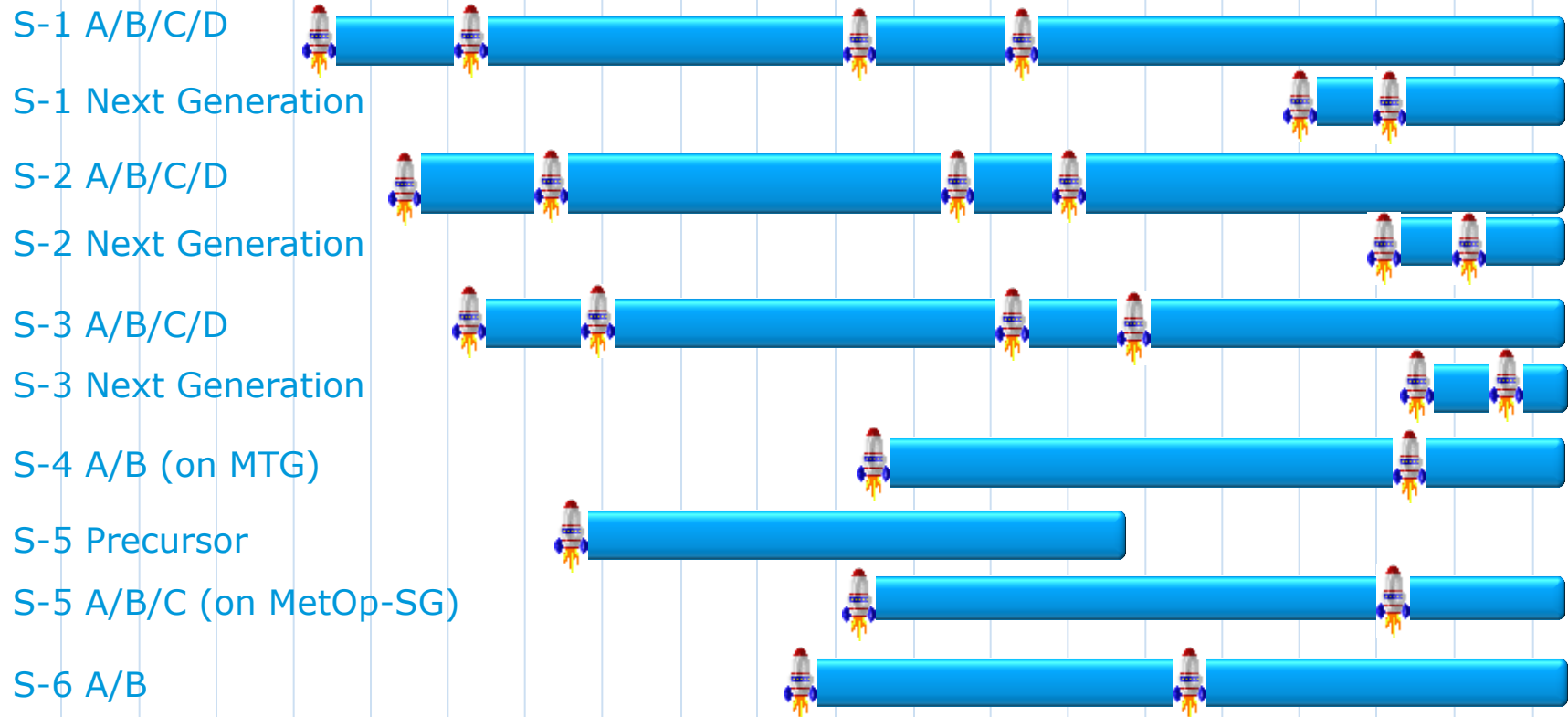
S6A/B: Altimetry Mission
2020/2025

... with a long-term operational perspective (with Next Gen)



2011 2014 2020 2030

Access to Contributing Missions



Status of ESA Sentinels missions



1. Sentinel-1 (1A launched on 3/04/2014; 1B on 25/04/2016)
2. Sentinel-2 (2A launched on 23/06/2015; 2B on 7/03/2017)
3. Sentinel-3 (3A launched on 16/02/2016; 3B to be launched within 2017)
4. Sentinel-4 (launch planned for 2019)
5. Sentinel-5 (launch planned for 2021)
6. Sentinel-5P (launch planned for August 2017)
7. Sentinel-6 (launch planned for 2020)

Sentinel Expansion

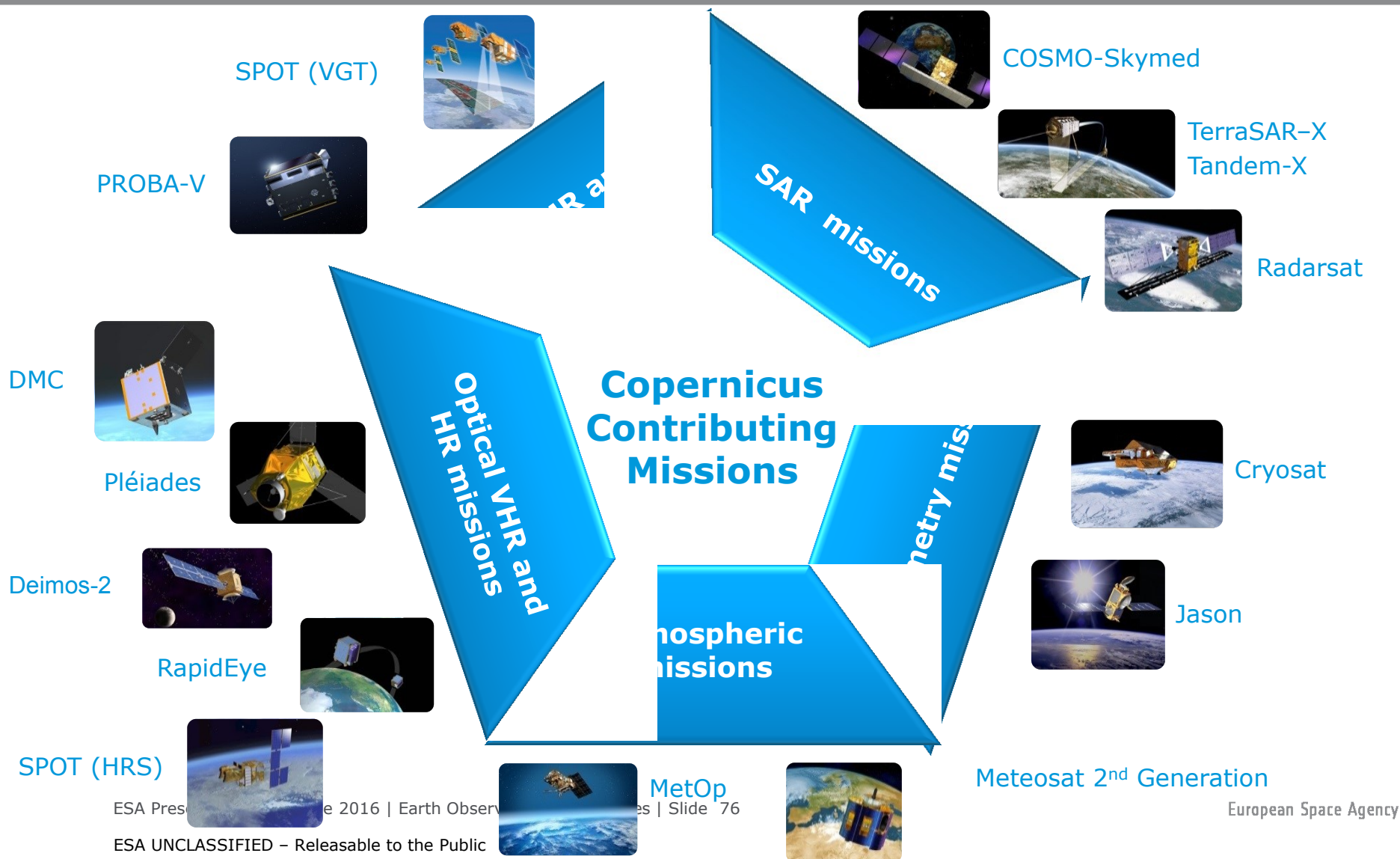


Candidates
to be verified through
requirements process !

It is assumed that the following Sentinels are confirmed as a result of the user consultation process and following a gap analysis :

- Sentinel-7: an anthropogenic CO₂ monitoring mission
- Sentinel-8: a Thermal Infrared Imager (companion to Sentinel-2 C/D)
- Sentinel-9: components:
 - S-9 ICE: Enhanced Ice and Snow Continuity mission
 - S-9 HEO: Polar Weather Payload on a Highly Elliptical Orbit
- Sentinel-10: a Hyper-spectral mission

Copernicus Contributing Missions

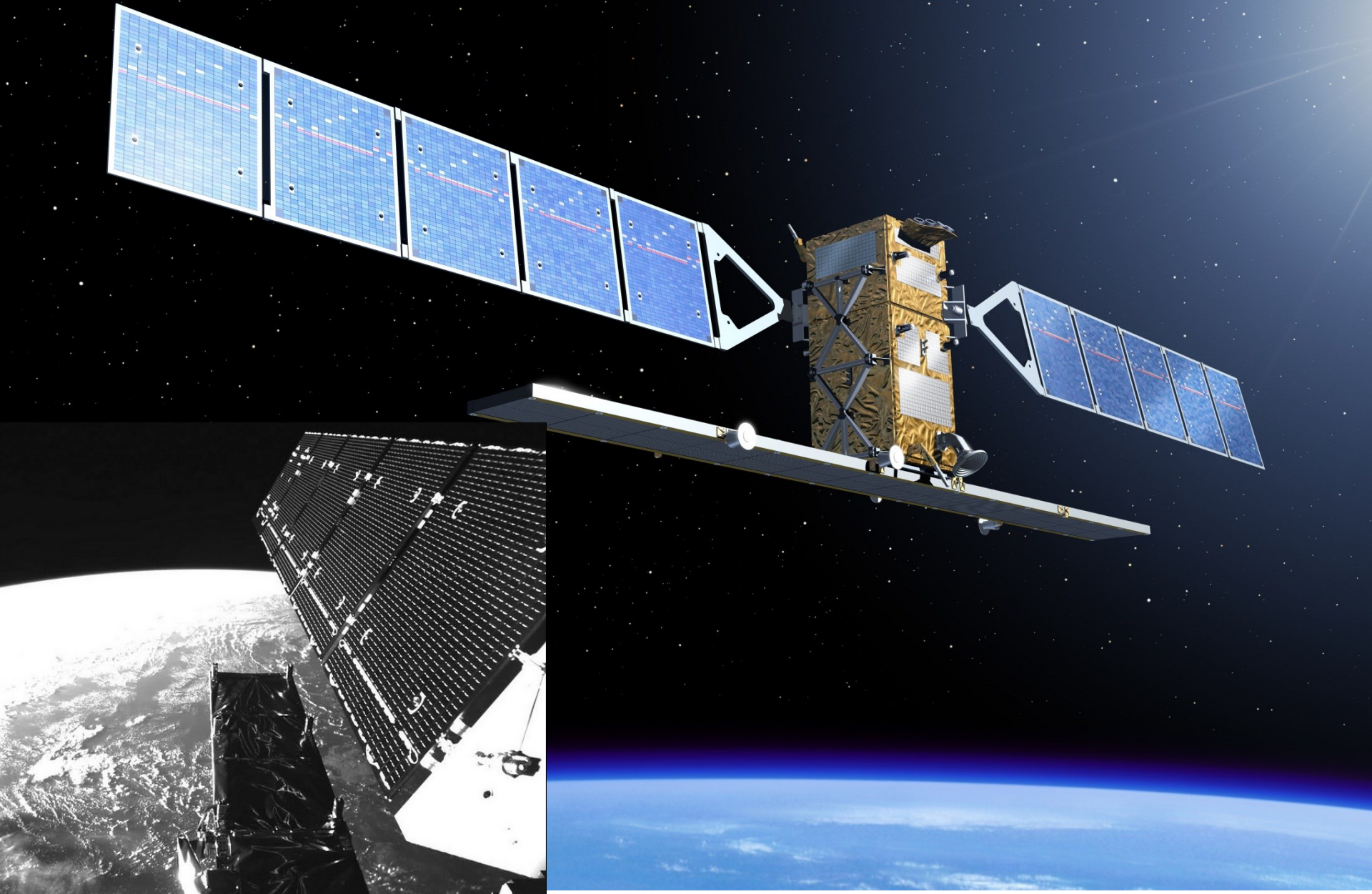


Sentinel Data Policy = **FULL, FREE, OPEN** access

- **ESA Sentinel Data Policy** (Sep 2013) and **EU Delegated Act** on Copernicus Data and Information Policy (Dec 2013)
- Main principles of Sentinel data policy:
 - **Open** access to Sentinel data by anybody and for any use
 - **Free** of charge data licenses
 - **Restrictions possible** due to technical limitations or for security reasons



Sentinel-1 (A: launched April 2014, B: launched April 2016) is the first of a series of operational radar satellites that will provide data continuity until 2030



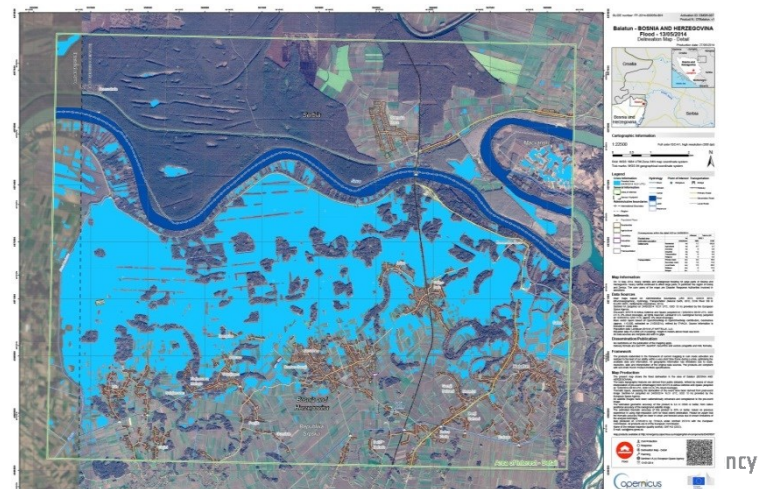
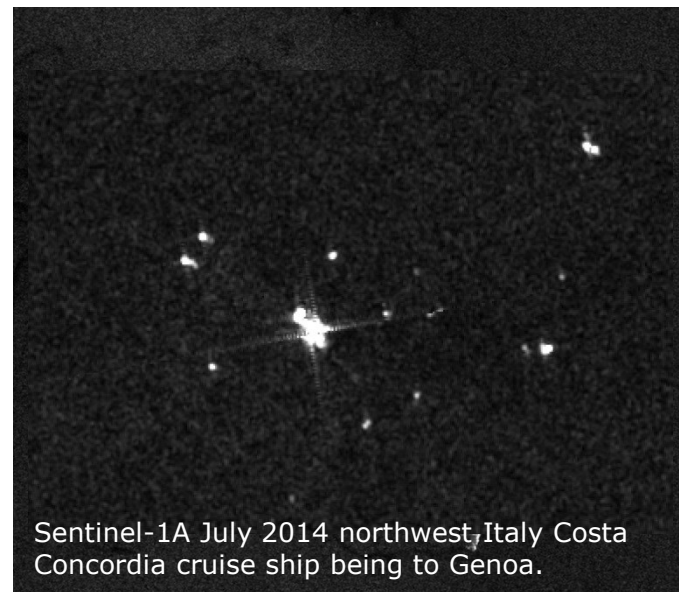
Sentinel-1 mission objectives



✓ Data continuity of ERS and ENVISAT missions

✓ Copernicus imaging radar mission for ocean, land, emergency applications:

- monitoring sea ice zones and the arctic environment
- surveillance of marine environment (oil spill monitoring)
- maritime security (e.g. ship detection)
- wind, wave, current monitoring
- monitoring of land surface motion (subsidence, tectonics, volcanoes)
- support to emergency / risk management and humanitarian aid in crisis situations
- mapping of land surfaces: forest, water and soil, agriculture, etc.



Sentinel-1

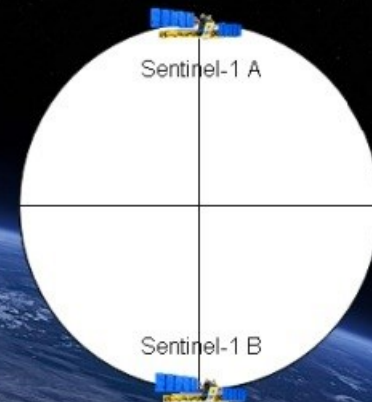
Mission Overview



- Two satellites
- C-band Radar instrument
- Sun-synchronous orbit at 693 km altitude
- Inclination: 98.18°
- 7 years lifetime
- Consumables for 12 years
- Mean LST: 18:00h at ascending node
- 12-day repeat cycle at Equator (with 1 satellite) 

Laser data transmission via the geostationary data relay system EDRS was demonstrated for S-1

Now 6-day repeat cycle at Equator (with 2 satellites). Sentinel 1-B data distributed since 26 Sept 2016

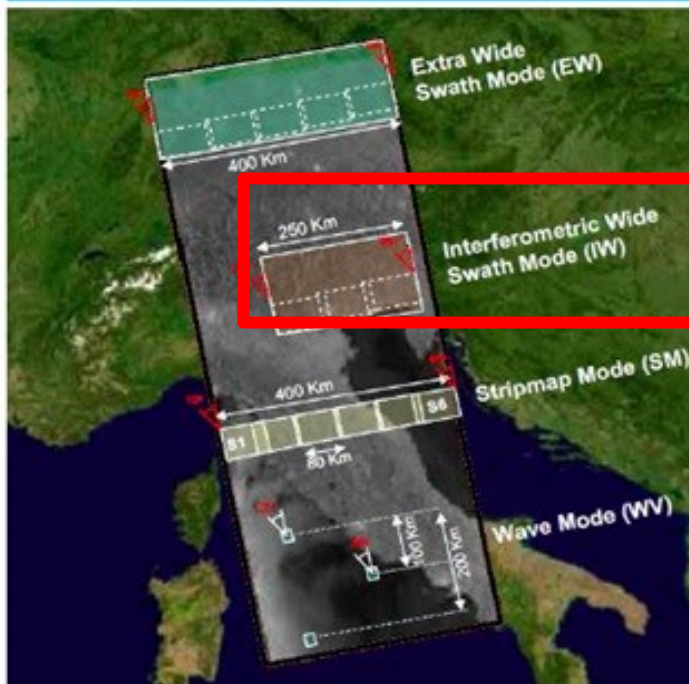


Sentinel-1

SAR Operational Modes



Operational Modes



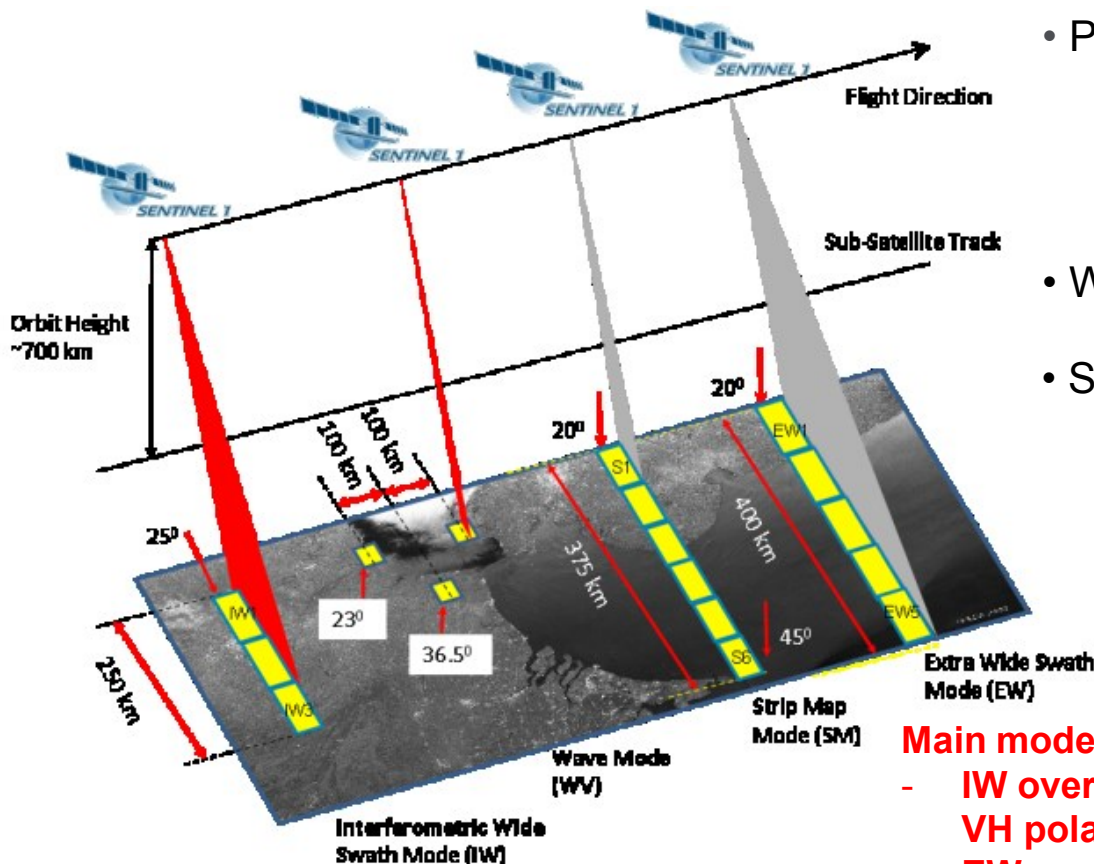
Resolution	Swath Width	Polarisation
20 x 40 m ²	> 400 km	HH+HV or VV+VH
5 x 20 m ²	> 250 km	HH+HV or VV+VH
5 x 5 m ²	> 80 km	HH+HV or VV+VH
5 x 5 m ²	20 x 20 km ² at 100 km spacing	HH or VV

➤ **Daily coverage of high priority areas, e.g. Europe, Canada, shipping routes**

Main modes of operations:

- IW over land and coastal waters (normally VV or VV-VH polarization)
- EW over extended sea (VV or VV-VH) and sea-ice (HH or HH-HV) areas
- WV over open oceans

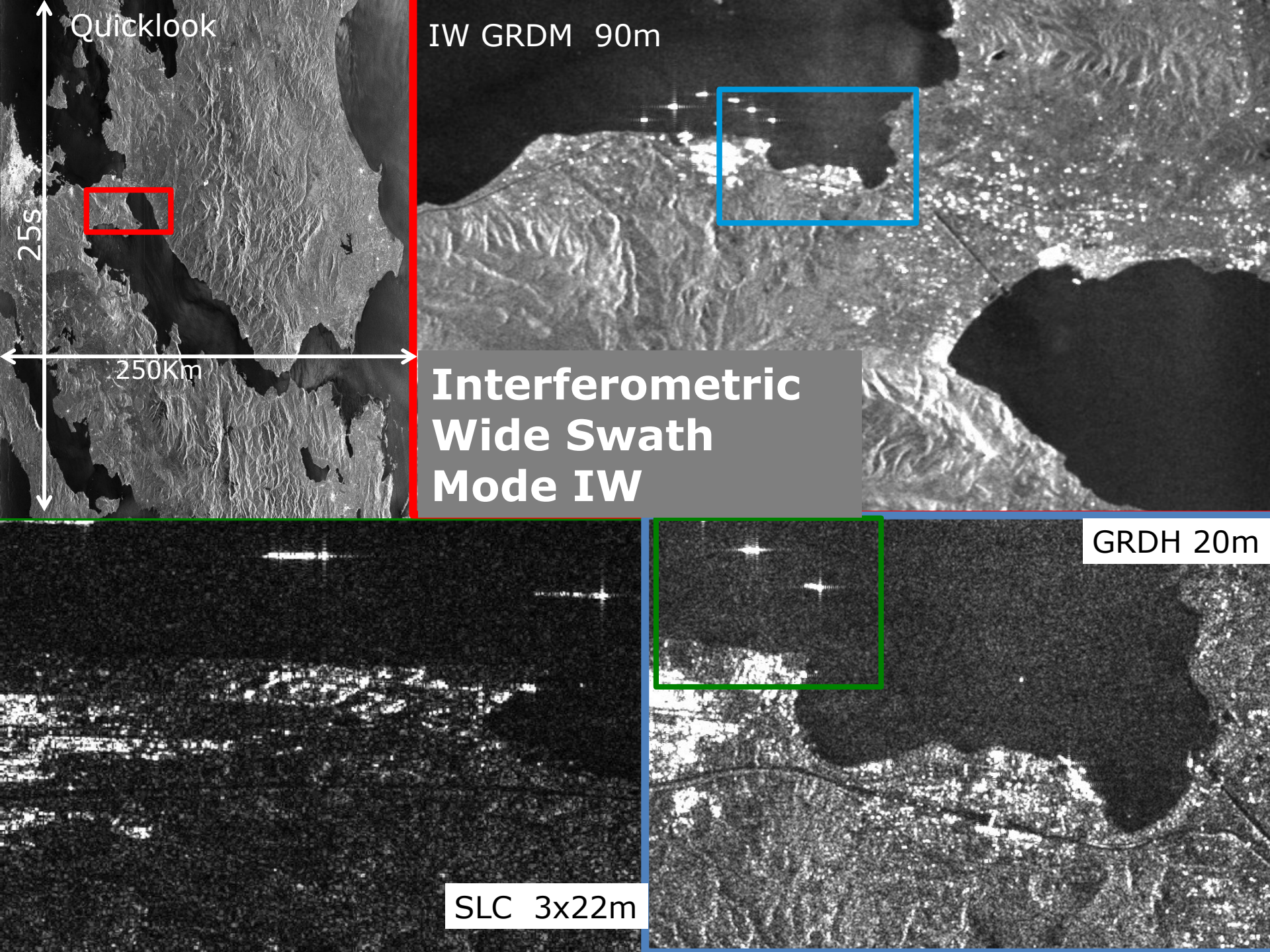
4 mutually exclusive SAR modes with different resolution and coverage

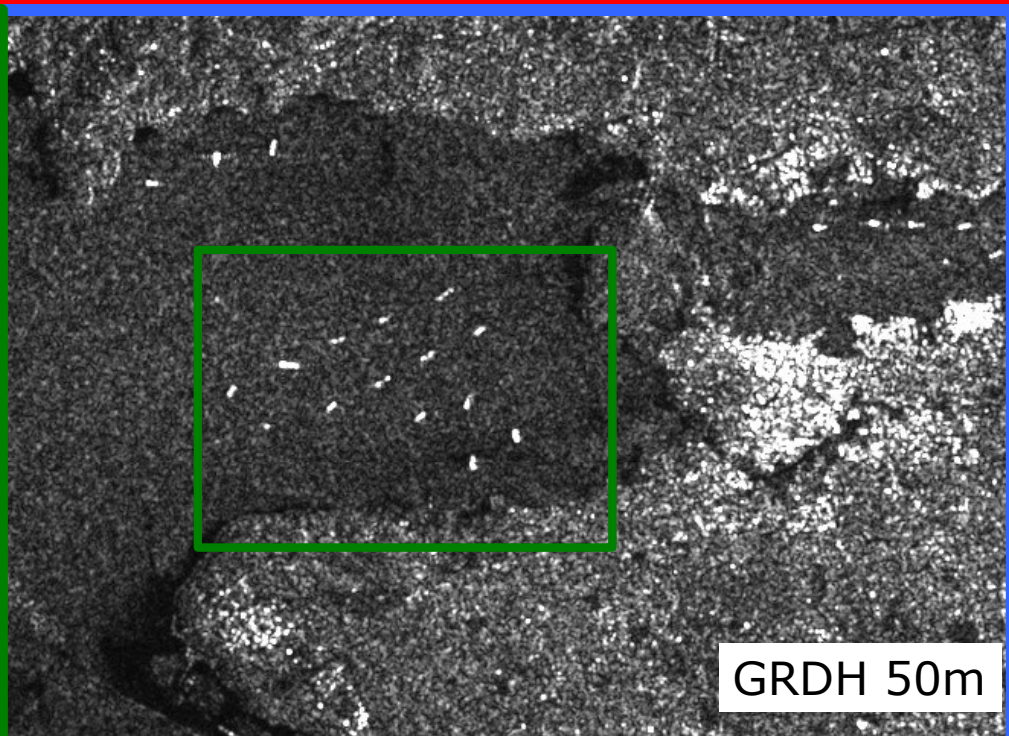
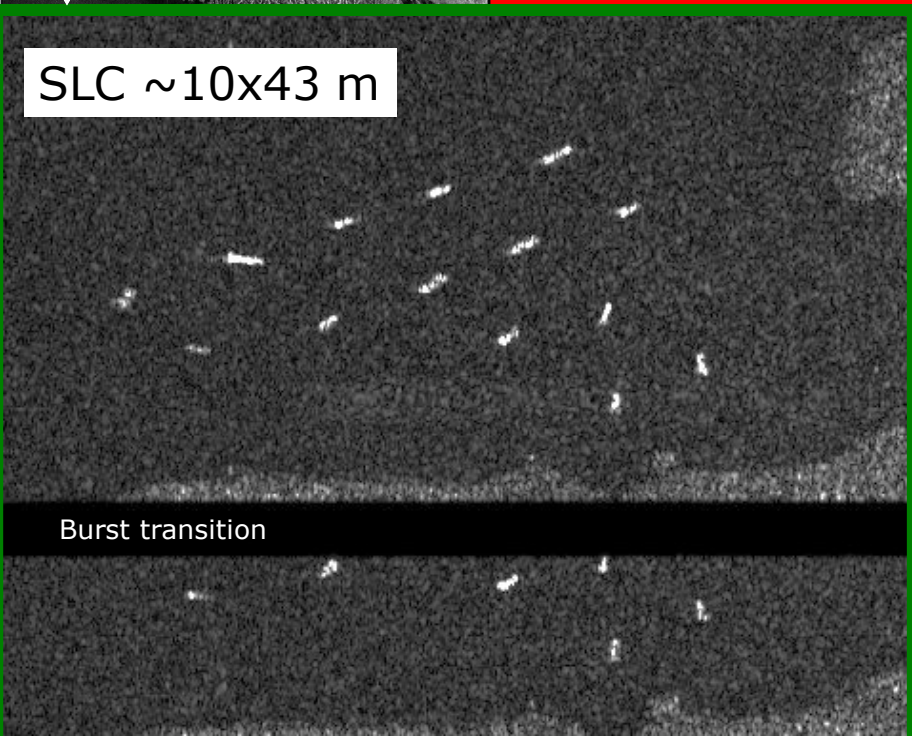
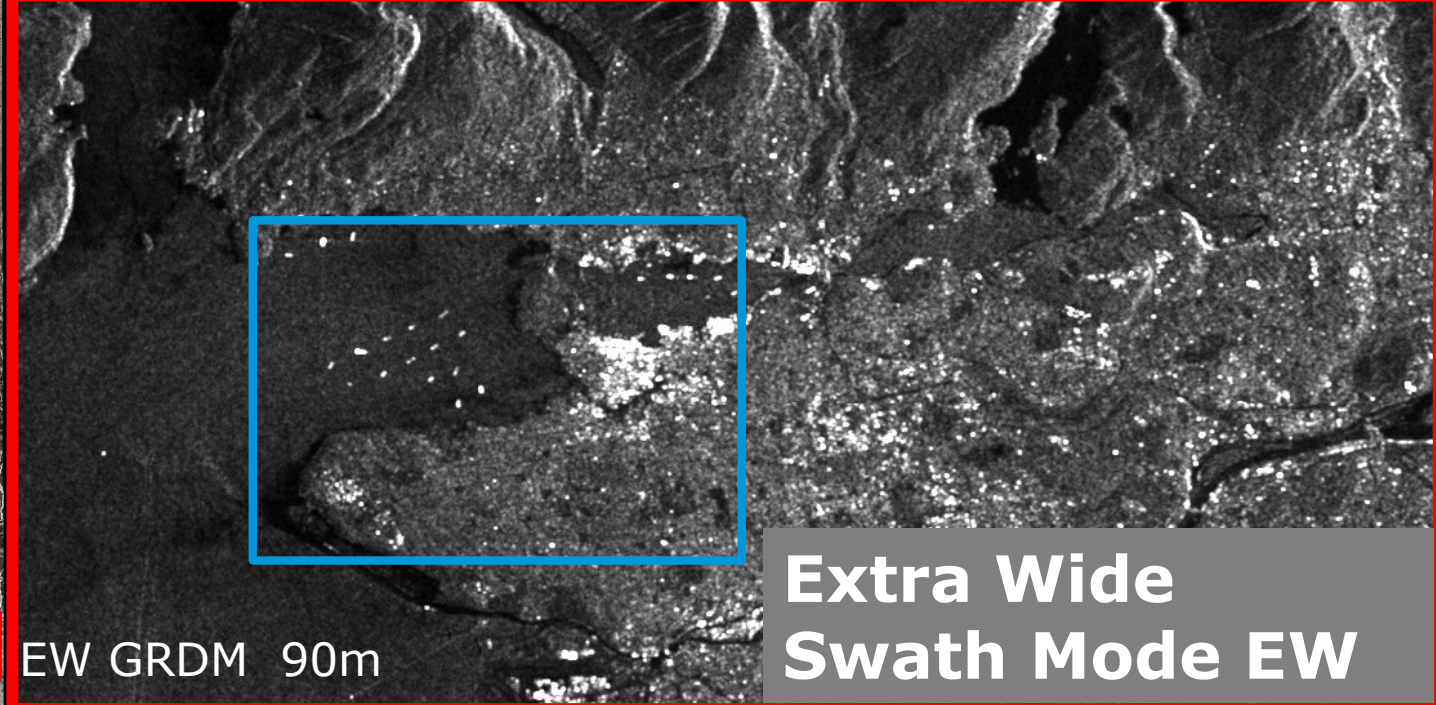
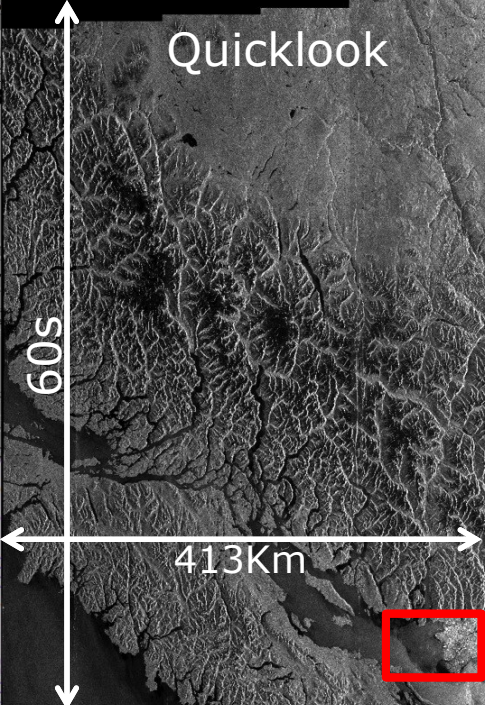


- Polarisation schemes for IW, EW & SM:
 - ✓ single polarisation: HH or VV
 - ✓ dual polarisation: HH+HV or VV+VH
- Wave mode: HH or VV
- SAR duty cycle per orbit:
 - ✓ up to 25 min in any of the imaging modes
 - ✓ up to 74 min in Wave mode

Main modes of operations:

- IW over land and coastal waters (normally VV or VV-VH polarization)
- EW over extended sea (VV or VV-VH) and sea-ice (HH or HH-HV) areas
- WV over open oceans





Sentinel-1 (SAR) versus Envisat ASAR



Sentinel-1

- **10 m** ground range resolution (stripmap mode)
- **250 km** swath width (Interferometric wide swath mode – 20m ground range resolution)
- **6 days** repeat cycle (with 2 satellites)
- **2 x 260 Mb/s** downlink data rate
- **7 years** design lifetime (consumables for 12 years)

Envisat ASAR

- **20 m** ground range resolution
- **100 km** swath width (Imaging mode)
- **35 days** repeat cycle
- Up to **100 Mb/s** space to ground data rate
- **5 years** design lifetime

Flooding event captured by Sentinel-1 (Namibia)



European Space Agency

ESA UNCLASSIFIED – Releasable to the Public

Sentinel-1 Flood Monitoring of Caprivi Flood Plain, Namibia



24°30'0"E

25°0'0"E



Legend

- Country border
- Derived HAND Index > 10 m
- Flooded areas

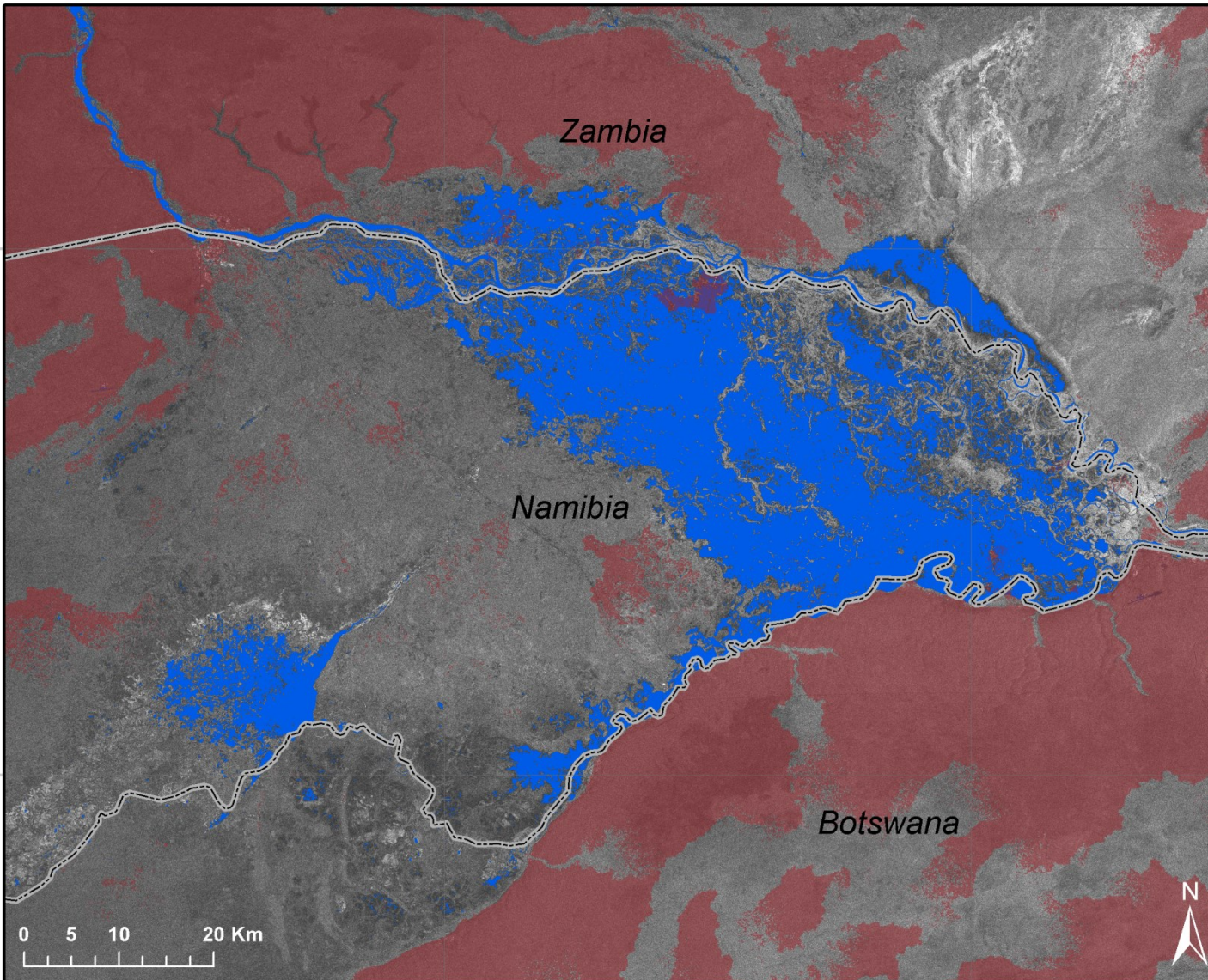
Description:

This map shows the flooding situation in the Caprivi flood plain of Zambezi River on 13th of April, 2014. The flood was delineated with the Water Observation and Information System (WOIS) based on SENTINEL-1A satellite data.

Source data:

SENTINEL-1A IW mode, 20 m resolution, acquired on 13th of April, 2014 at 03:50 GMT. SENTINEL-1 image was provided by the European Space Agency.

Cartographic Reference
Projection: EPSG:4326
Datum: WGS 84



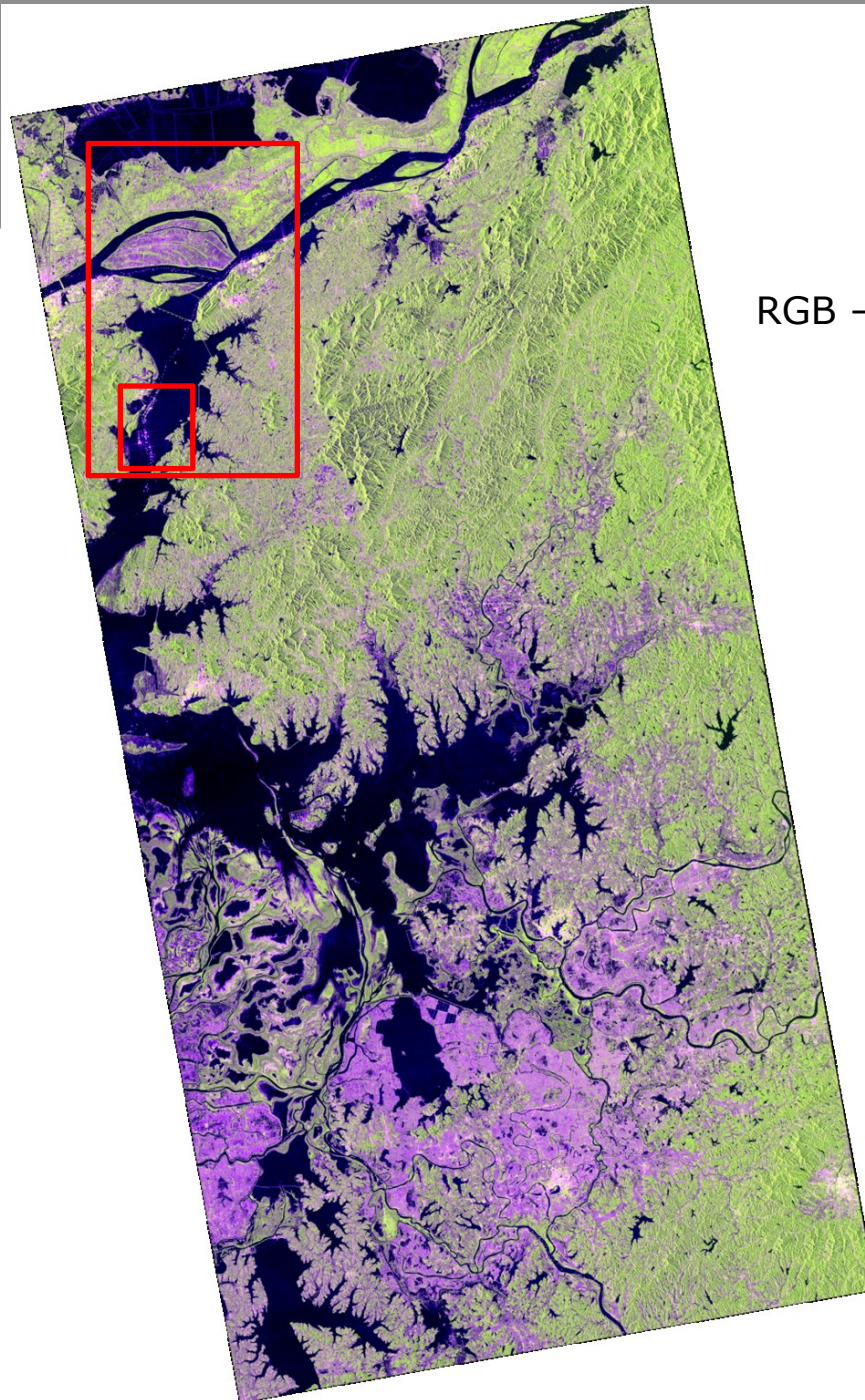
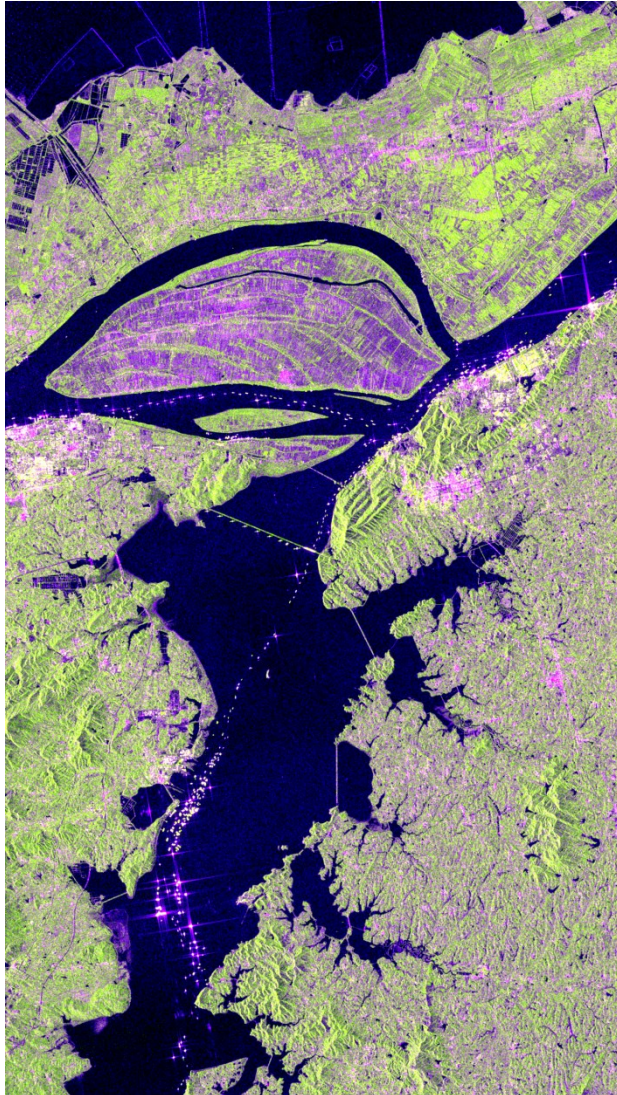
24°30'0"E

25°0'0"E

S1A Polarimetric Composition Poyang Lake



RGB – VV VH VV/VH

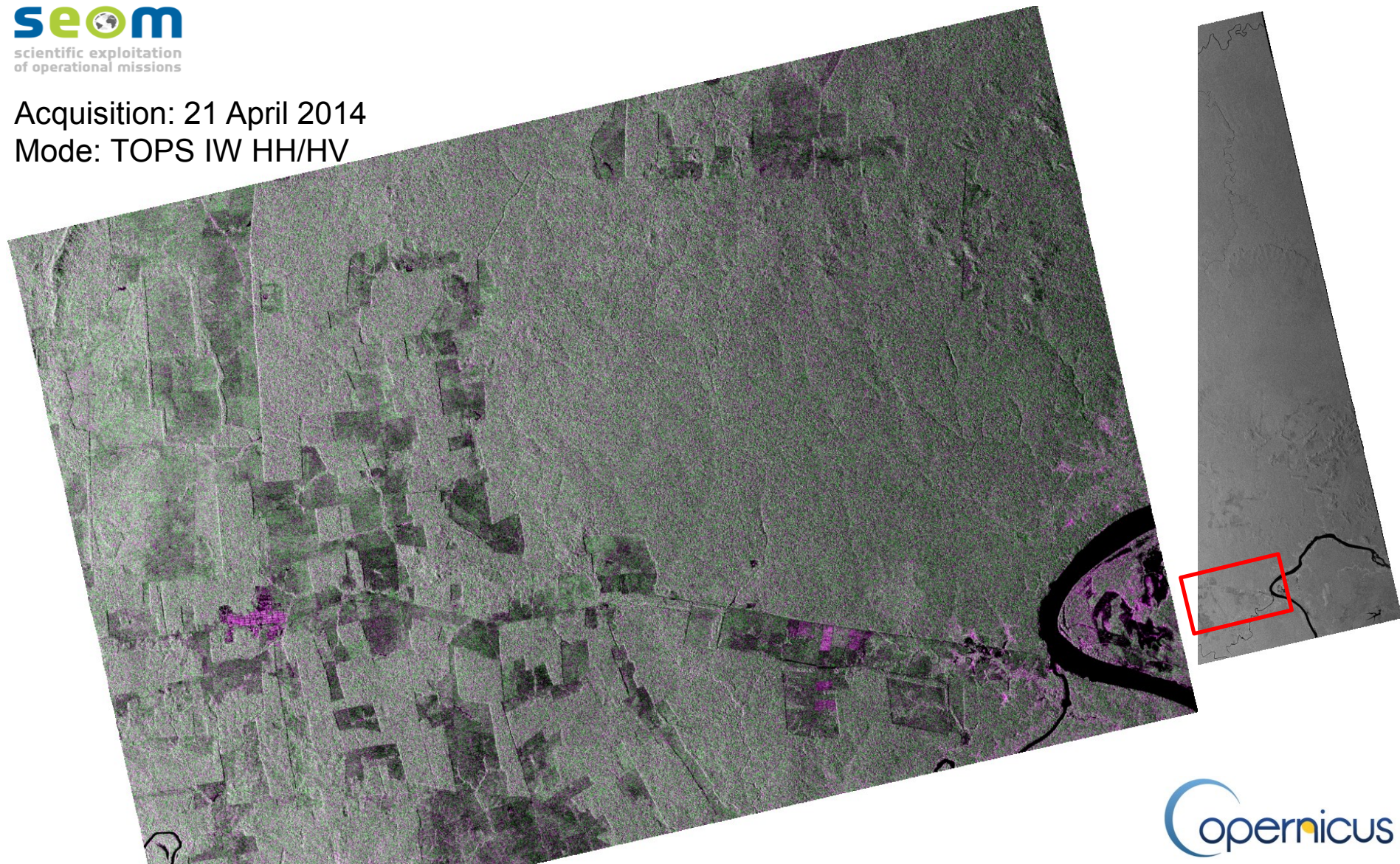


Sentinel-1

Deforestation over Brazil



Acquisition: 21 April 2014
Mode: TOPS IW HH/HV



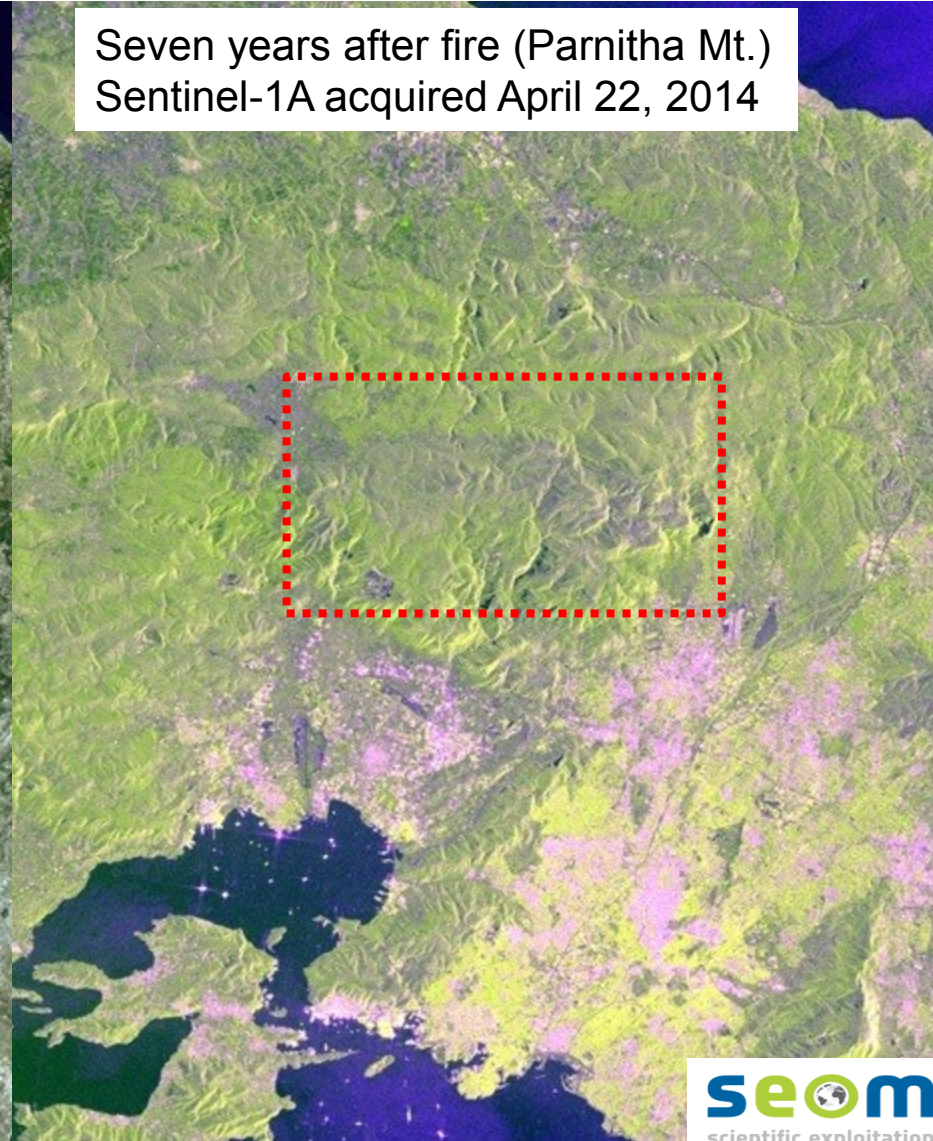
Sentinel-1

Vegetation Regeneration – Burn Scar (Greece)



A month after fire (Parnitha Mt.)
ASTER acquired July 20, 2007

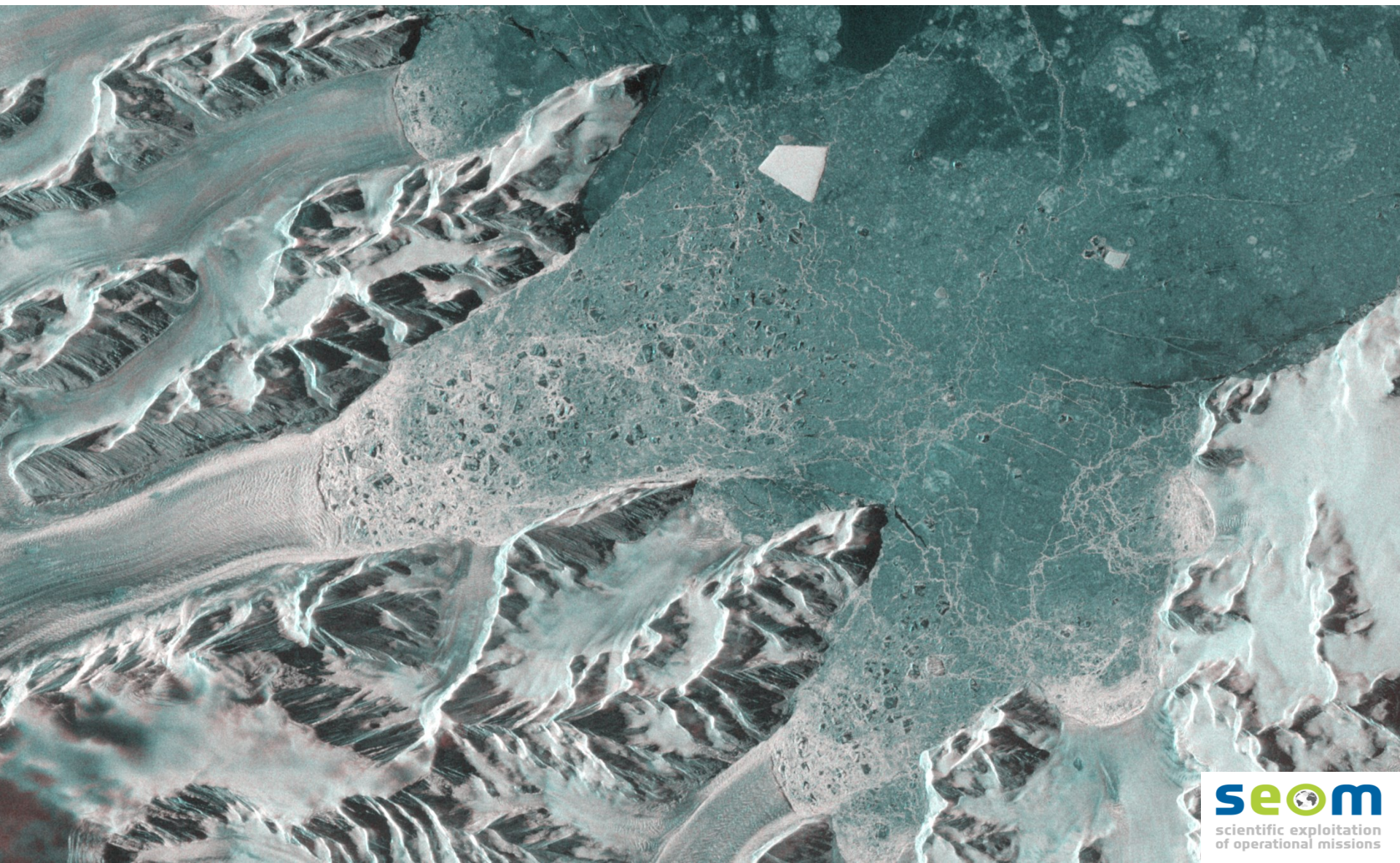
Seven years after fire (Parnitha Mt.)
Sentinel-1A acquired April 22, 2014



Icebergs Antarctica Peninsula

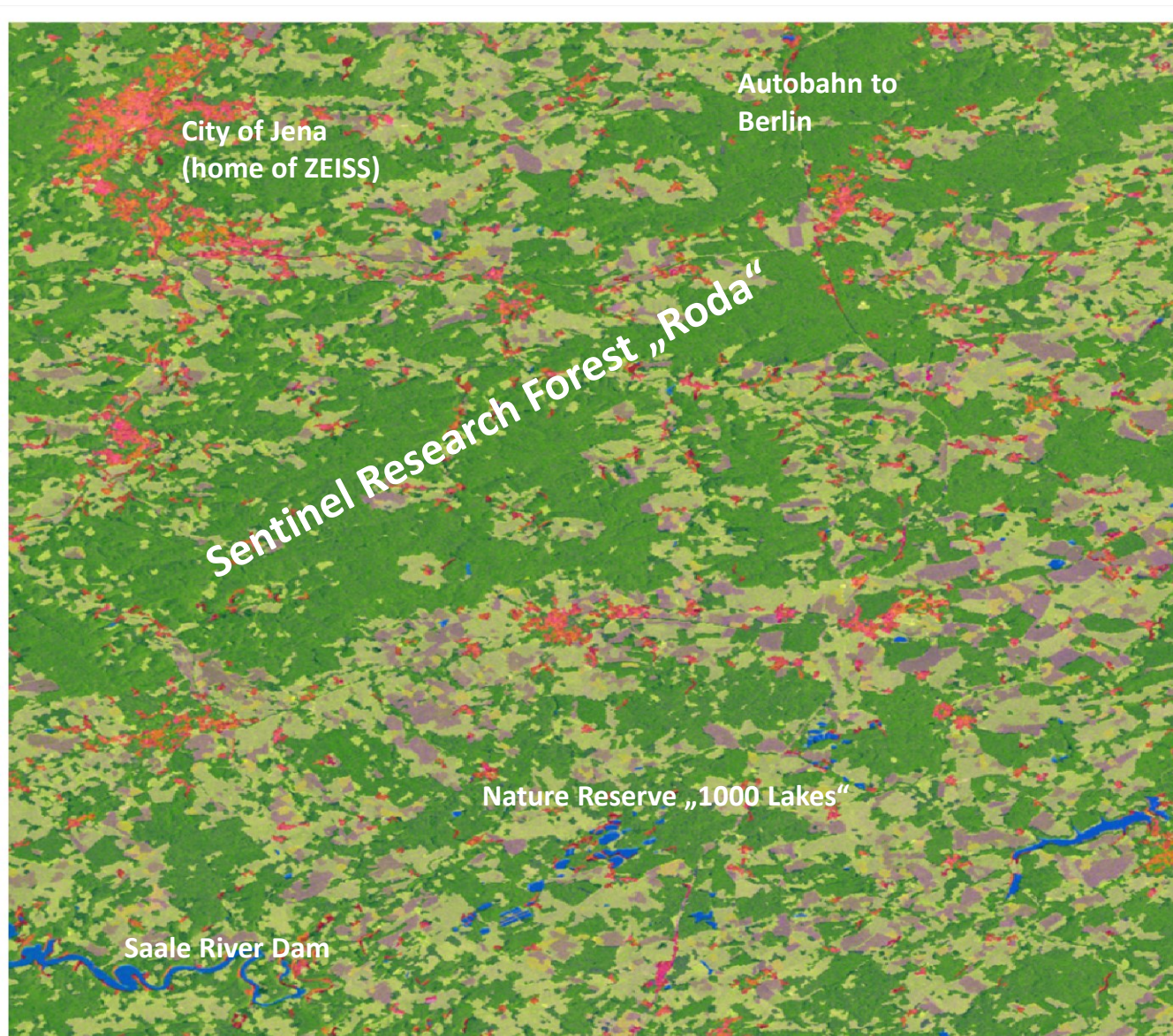
Sentinel-1A (RGB HV-HH-HH)

Post processing with Sentinel 1 Toolbox



Sentinel-1

Land Classification Dual Pol HH-HV (Germany)



Class. Method:
Random Forest

Classes:

Forest

Water

Urban

Winter crops

Bare fields

Location: Thuringia,
Central Germany

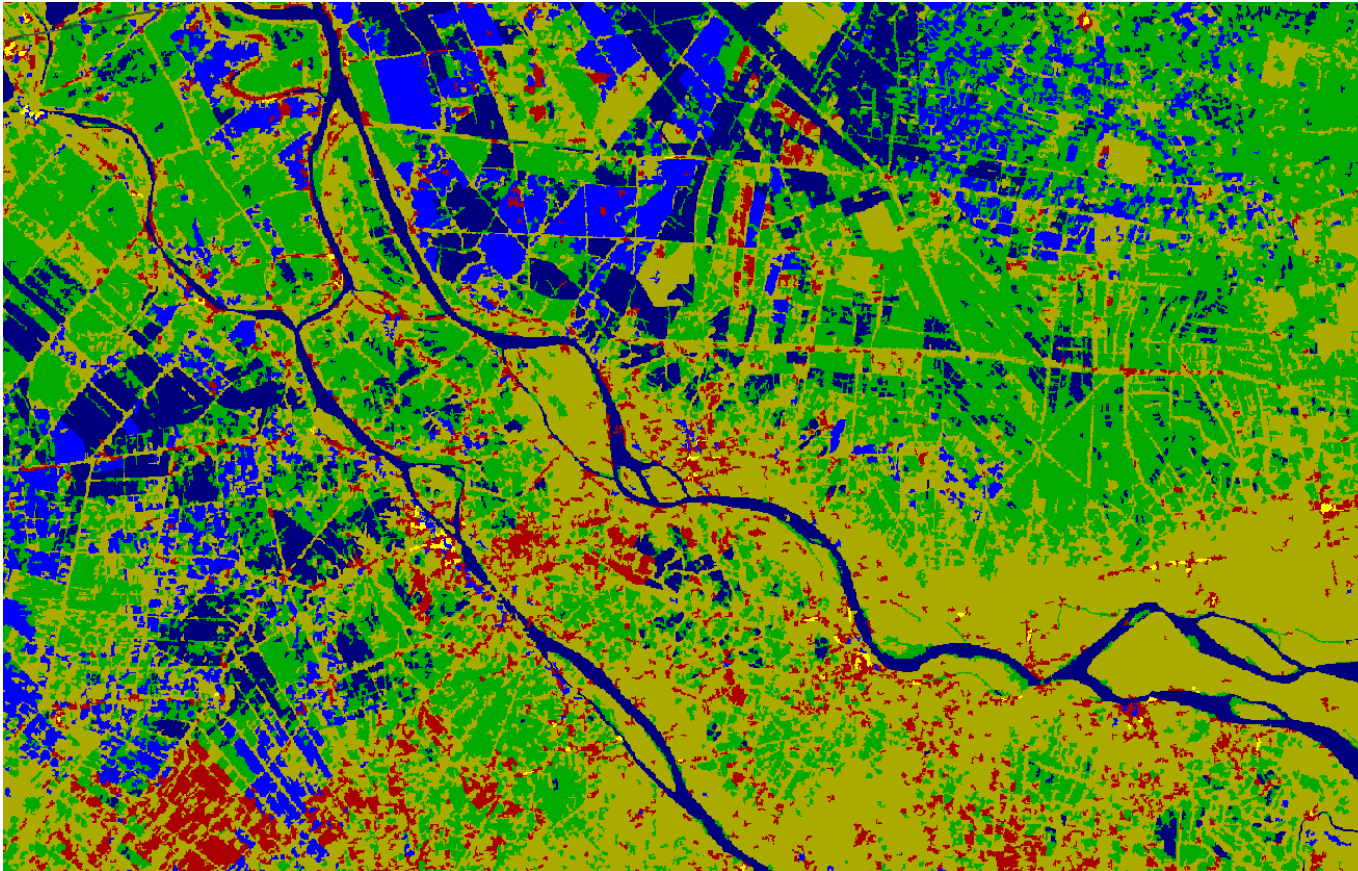
Acquisition Date:
26-April-2014

Credit Univ. of Jena
European Space Agency
Chris Schnmullius

RICE MONITORING



S-1A geocoded – 8 & 20 Aug, 80m (detail) – Vietnam

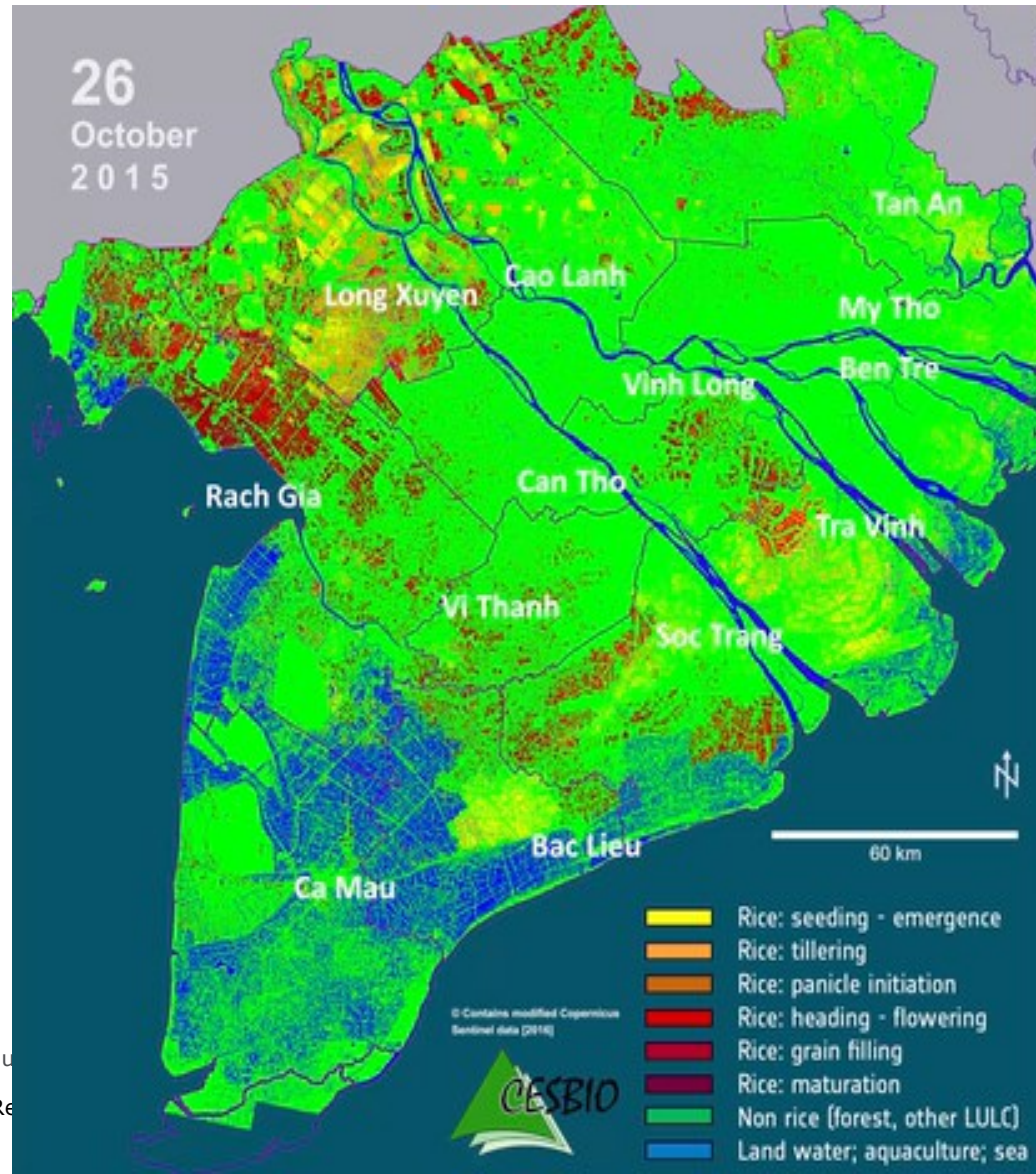


rice stage 1
rice stage 2
rice stage 3
non-rice

Courtesy SARMAP

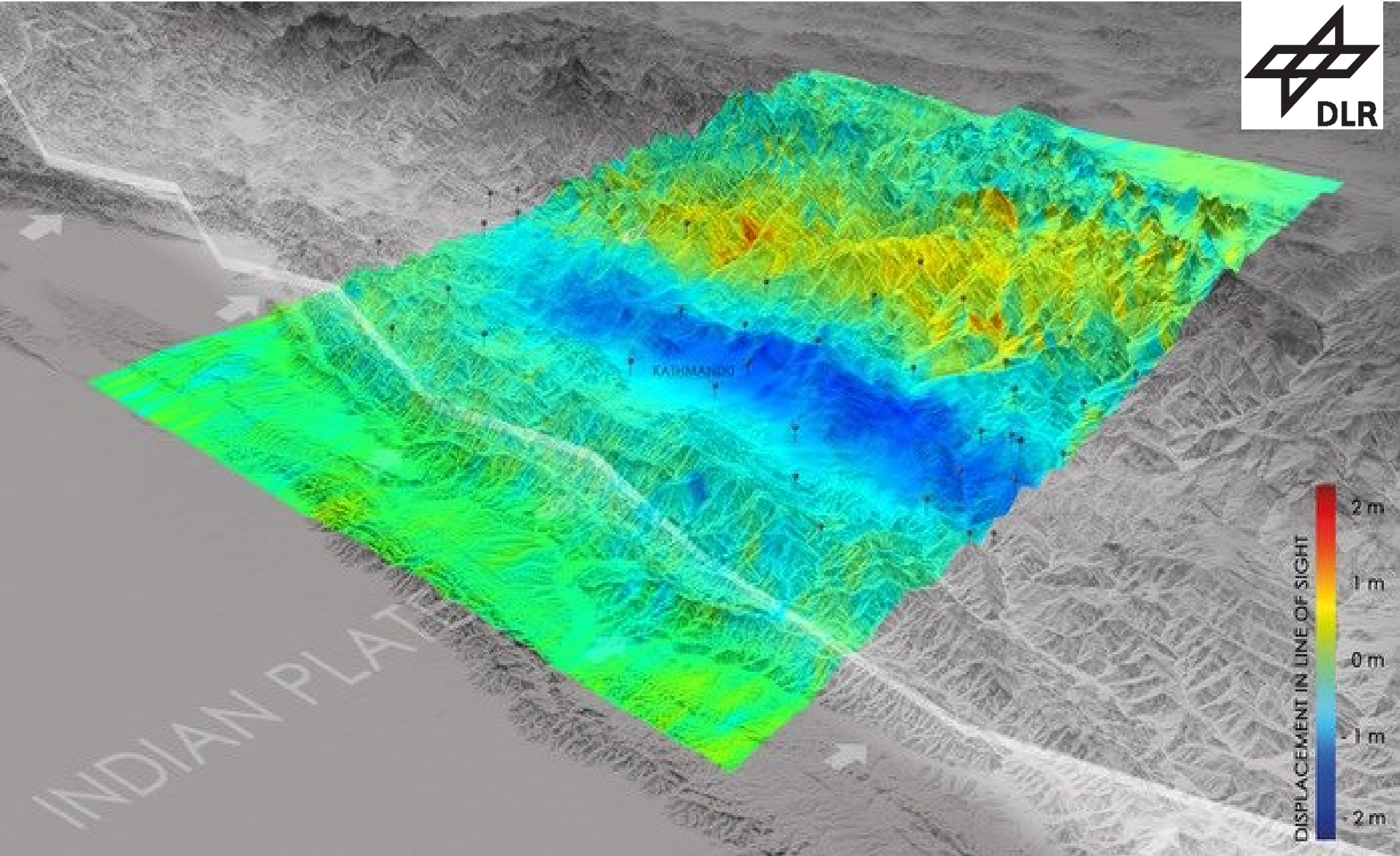
© sarmap

Sentinel-1: Mekong Delta Rice Crops



contains modified
Copernicus
Sentinel data
(2015–16)
/CESBIO/ESA
DUE GEO-Rice
Innovator project

Sentinel-1A: Nepal Earthquake



Sentinel-1 Napa Valley Earthquake *INSARAP (NORUT-PPO.labs-Univ. Leeds-COMET)*



Sentinel-1 maps earthquake

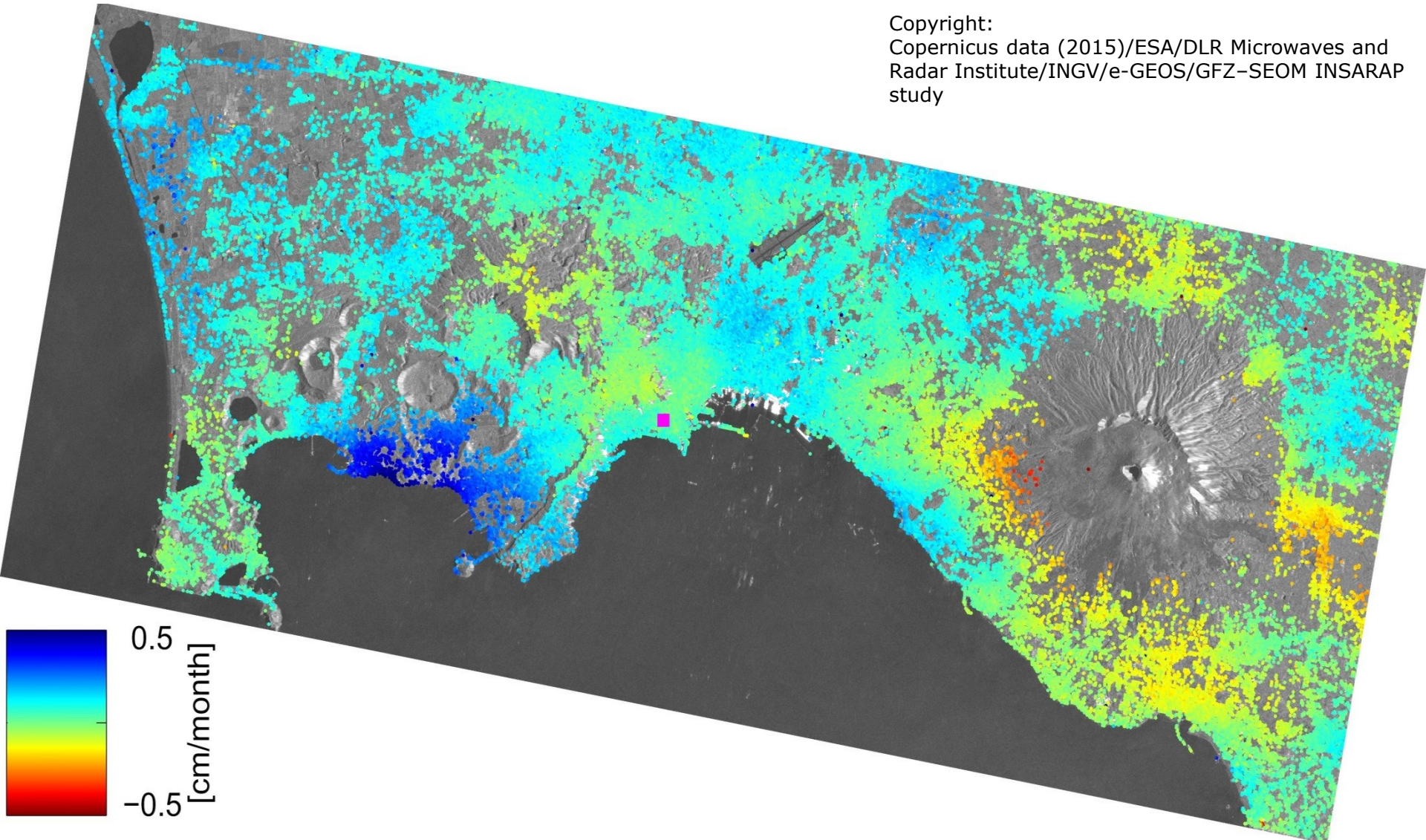
The biggest earthquake in 25 years struck California's Napa Valley in the early hours of 24 August 2014. By processing two Sentinel-1A images, acquired on 7 August and 31 August 2014 an interferogram was generated. Deformation on the ground causes phase changes in radar signals that appear as the rainbow-coloured patterns around the Napa Valley. Each colour cycle corresponds to a deformation of 28 mm deformation. The maximum deformation is more than 10 cm, and an area of about 30x30 km was affected significantly.

Copyright: Copernicus data (2014)/ESA/PPO.labs/Norut/COMET-SEOM Insarap study

Campi Flegrei seen by Sentinel-1A



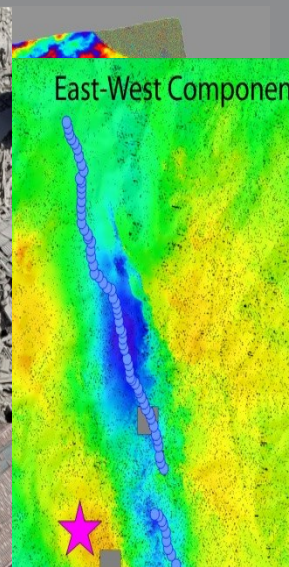
Copyright:
Copernicus data (2015)/ESA/DLR Microwaves and
Radar Institute/INGV/e-GEOS/GFZ-SEOM INSARAP
study



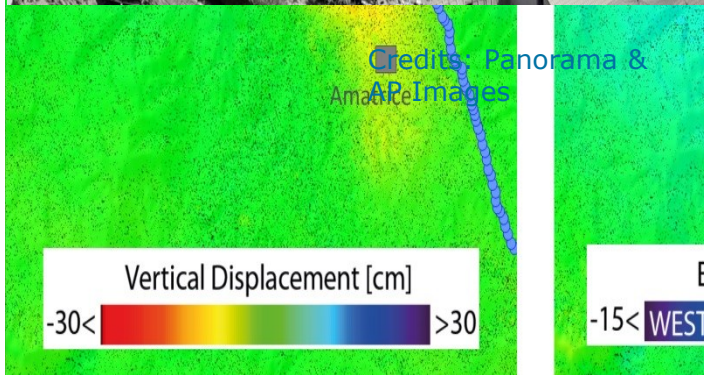
Sentinel-1A: Example of Land Monitoring



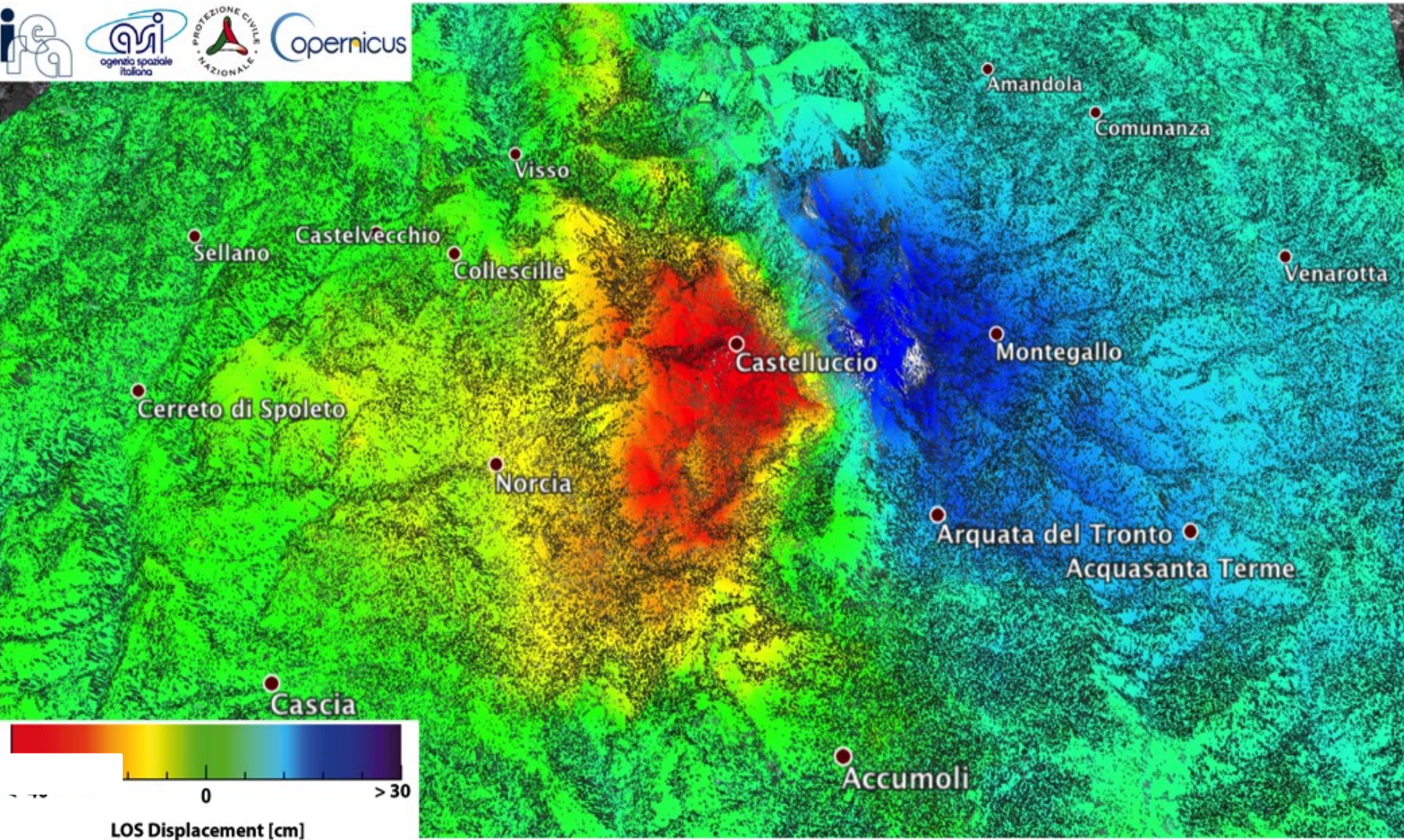
Devastating earthquake
in central Italy on
24th August 2016
(Magnitude: 6.2)



Interferogram
obtained combining
Sentinel-1A images
before and after the
earthquake and
showing ground
deformation

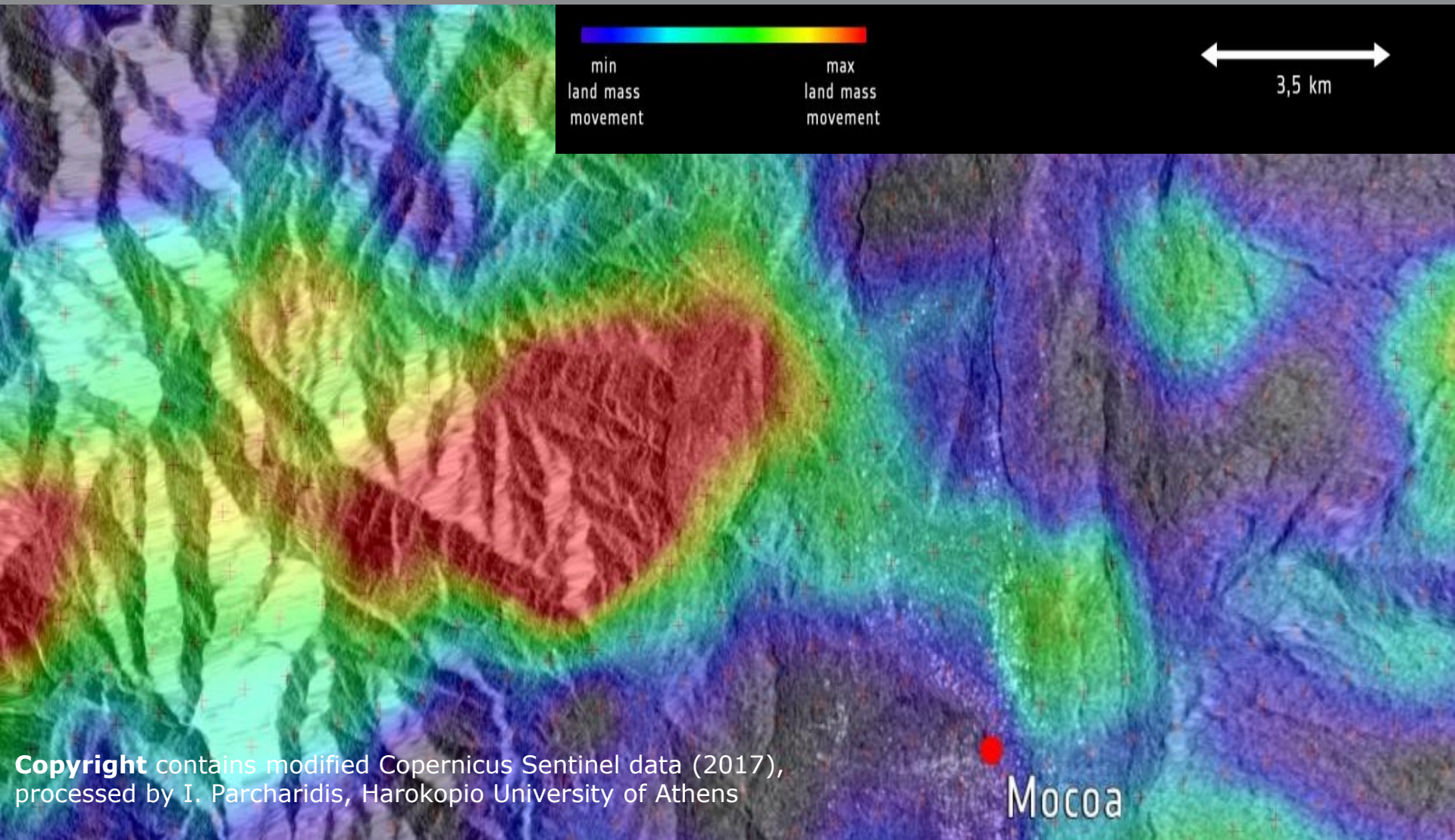


Sentinel 1: Earthquake Italy 30 Oct 2016



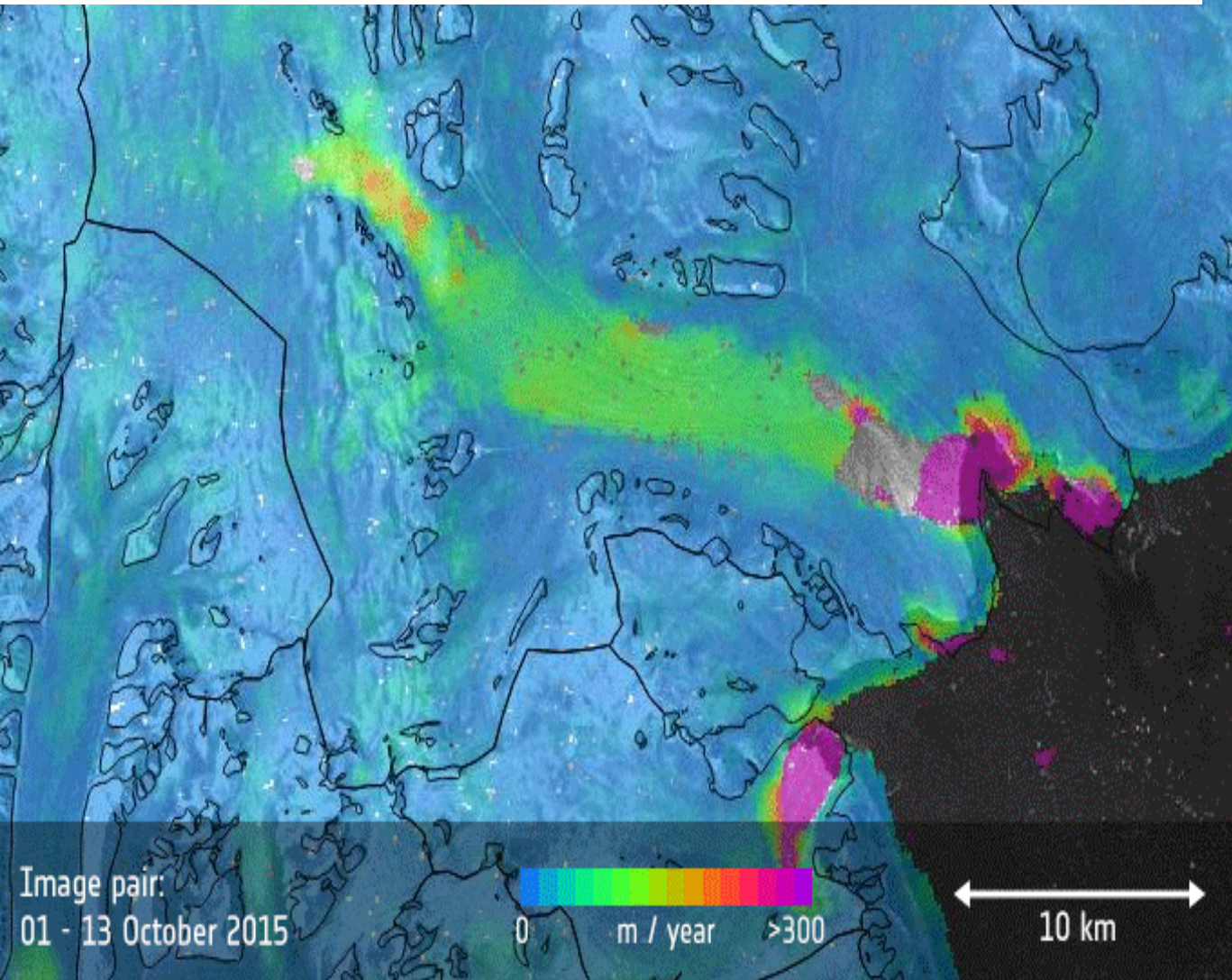
Sentinel 1: Mocoa (Colombia) Landslide

1 April 2017



Copyright contains modified Copernicus Sentinel data (2017),
processed by I. Parcharidis, Harokopio University of Athens

Sentinel 1: Negribreen Glacier



Copyright contains modified Copernicus Sentinel data (2016/17), processed by T. Strozzi

36 Years of Radar Vision



Upper glacier
receded by about
5.5 km over the past
36 years,
contributing to sea-
level rise

→ **36 YEARS OF GLACIER RETREAT**
southeast Greenland

5 km

Sentinel-2 (A and B launched)



- Wide swath high resolution super-spectral imaging mission
- Land and Security Services
- Data continuity Landsat and SPOT-type missions

Mission profile

- 
- ↑ Multispectral instrument with **13** spectral bands (VIS, NIR & SWIR)
 - ↑ Sun synchronous orbit at **786 km** mean altitude
 - ↑ **290 km** swath width
 - ↑ **5 days** repeat cycle at Equator (cloud free) with 2 satellites
 - ↑ **7 years** design life time, consumables for 12 years
 - ↑ **10, 20 and 60 m** spatial resolution (depending on the band) (1)

Mission objectives:

- Generic land cover maps
- Risk mapping and disaster relief

Sentinel-2

The European "Super Landsat"



Coverage (d)	26	16	5 (2 satellites)
Swath (km)	60	185	290
Spectral bands	4+1	8+1	13
Resolution (m)	2.5	30,(15)	10,20,(60)

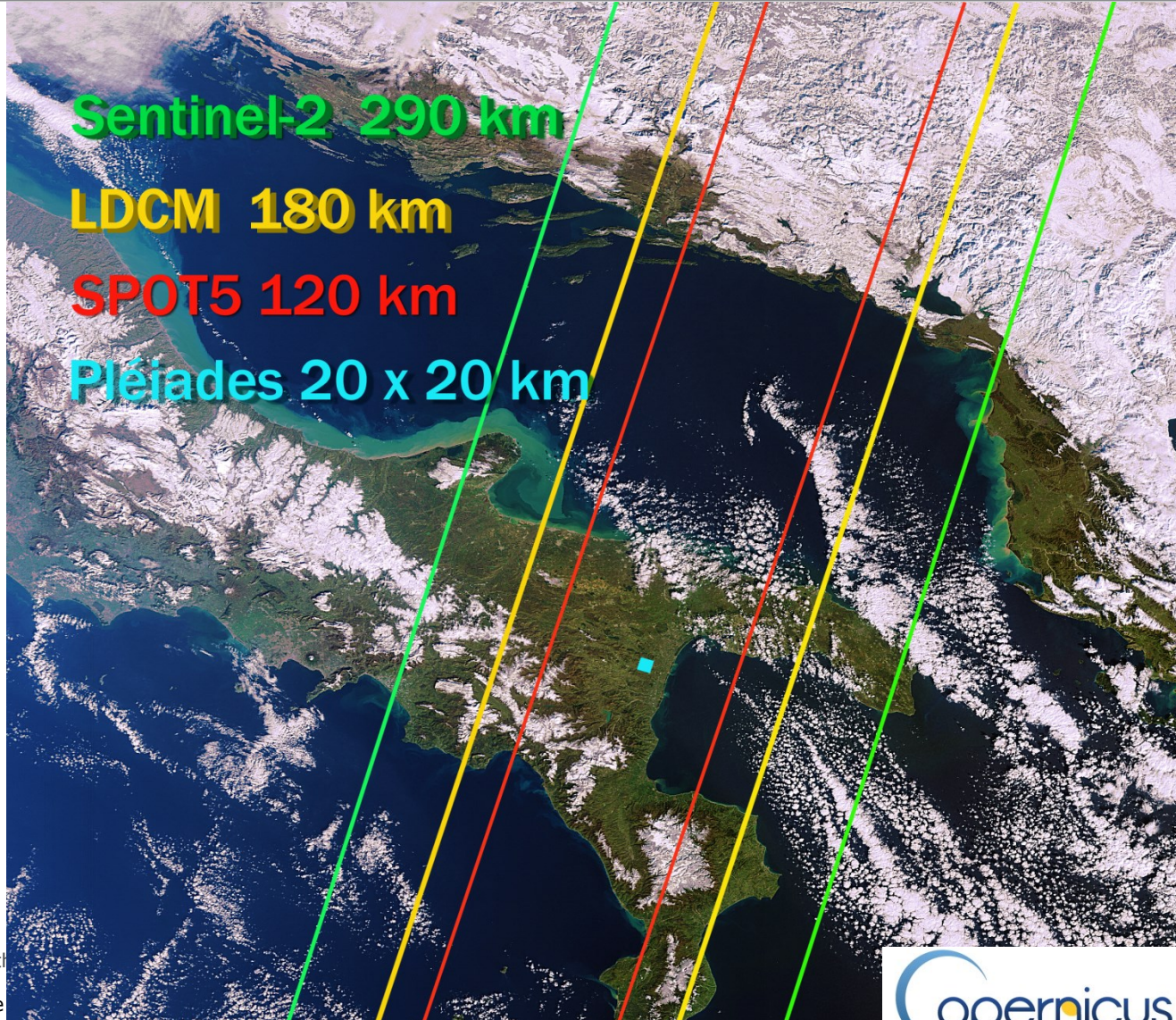
Sentinel-2

Swath width



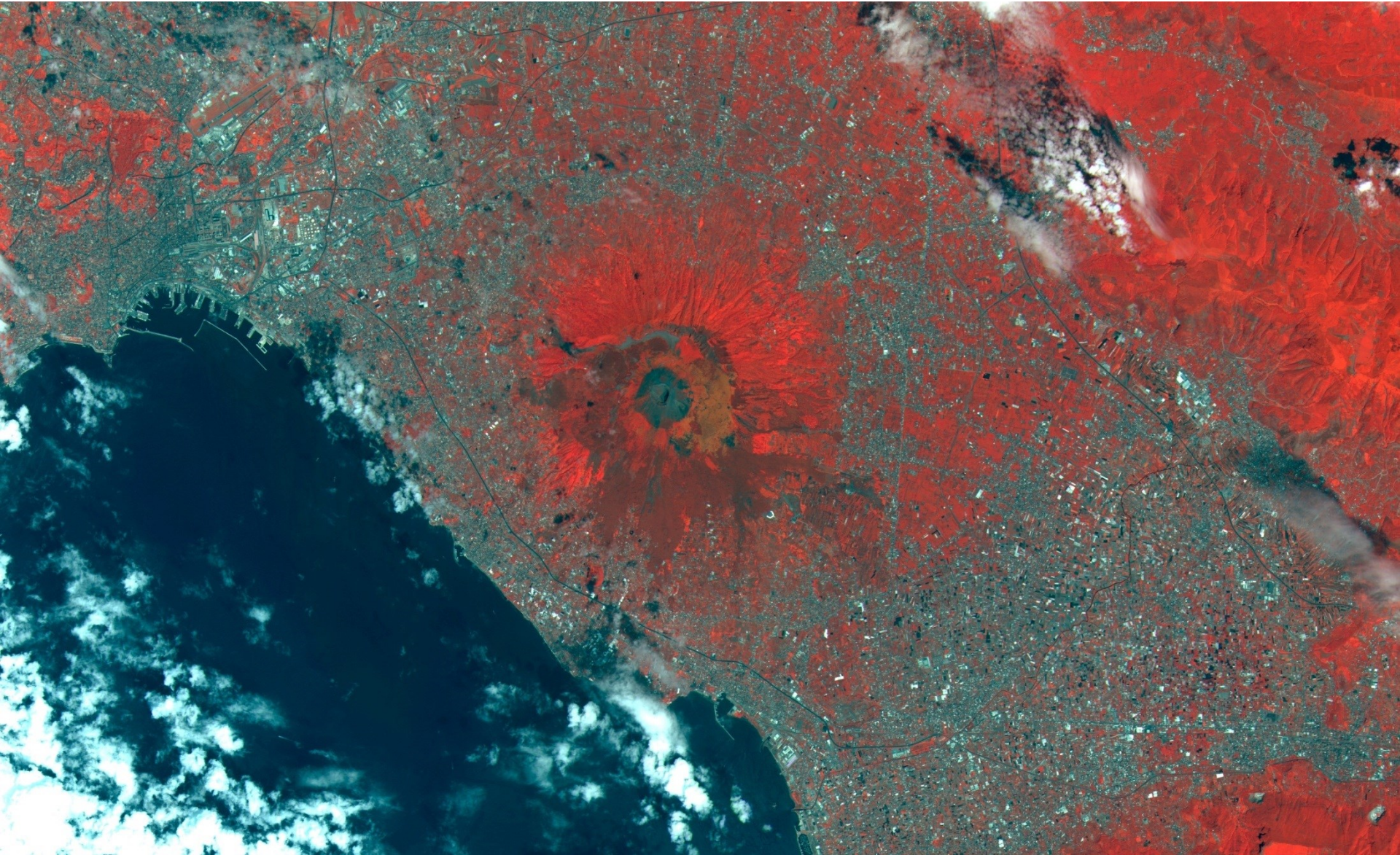
Sentinel-2 (A+B):
Full Earth Coverage
(at Equator) in 5 days

Sentinels are
complementary to
High-Res commercial
and national missions

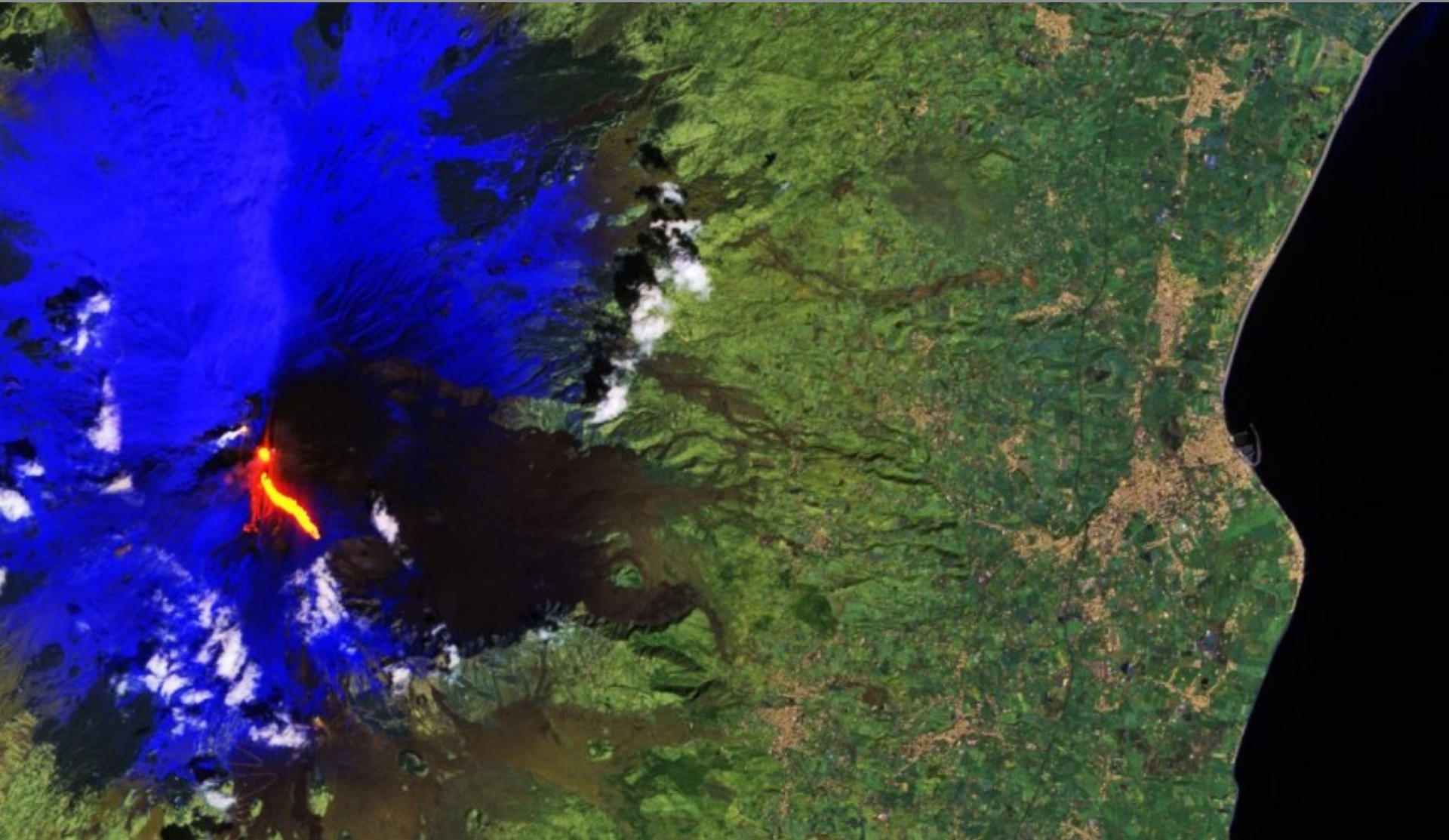


Sentinel-2A: Vesuvius

False colour
composite (8-3-
2): Near infrared
- Green -Blue



Sentinel-2A: Mount Etna Eruption, Italy, April 2017



Sentinel-2A: Mapping Water Bodies



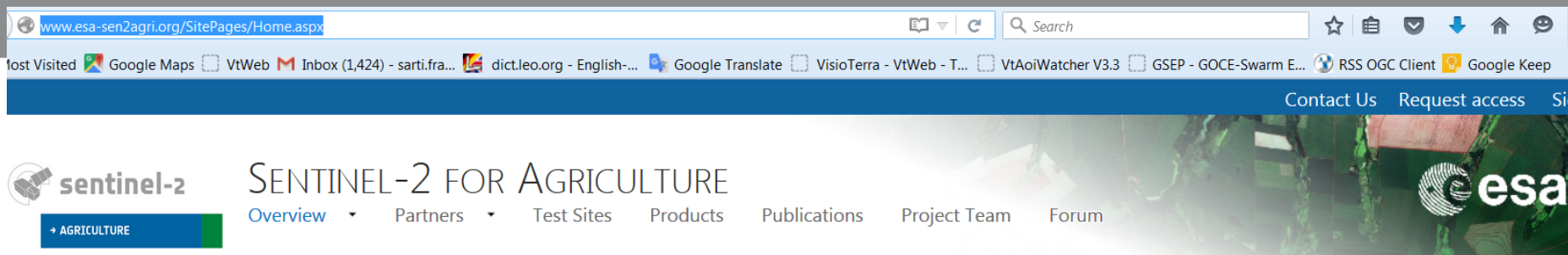
This animation shows a Sentinel-2 image over southern Spain from 12 July 2015, and how information on inland water bodies can be isolated to help better detect changes. By providing measurements of water quality and detecting changes, Sentinel-2 can support the sustainable management of water resources

Sentinel-2: Agriculture



contains modified Copernicus Sentinel data [201





PREPARING SENTINEL-2 EXPLOITATION FOR AGRICULTURE MONITORING

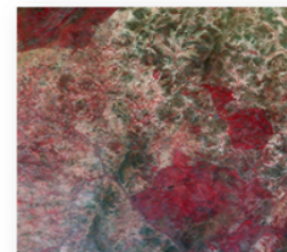
Agriculture is a key remote sensing application with high requirements. Short-term observation requirements in a global perspective for agriculture monitoring were tentatively defined by the GEO Agricultural Monitoring Community of Practice. The critical importance of the decameter resolution capabilities was highlighted to cover the whole diversity of the agricultural landscapes.

In this respect, the up-coming Sentinel-2 mission is a unique opportunity. Its 10-20m spatial resolution, its 5-day revisit frequency, its global coverage and its compatibility to the Landsat missions offer new opportunities for regional to global agriculture monitoring.

In this context, the Sentinel-2 for Agriculture (Sen2-Agri) project has recently been launched by ESA, as a major contribution to the R&D component of the GEOGLAM initiative and to the JECAM network activities. The project will demonstrate the benefit of the Sentinel-2 mission for the agriculture domain across a range of crops and agricultural practices. The intention is to provide the international user community with validated algorithms to derive



Earth Observation products relevant for crop



SPOT5 TAKE5 to acquire a new Sentinel-2 like dataset

UPCOMING EVENTS

Sen2-Agri project at IGARSS 2015

7/26/2015, Milano, Italy

Sen2-Agri project [presented](#) at IGARSS 2015, in Milano.

Sentinel-2 for Science Workshop

5/20/2014, Frascati, Italy

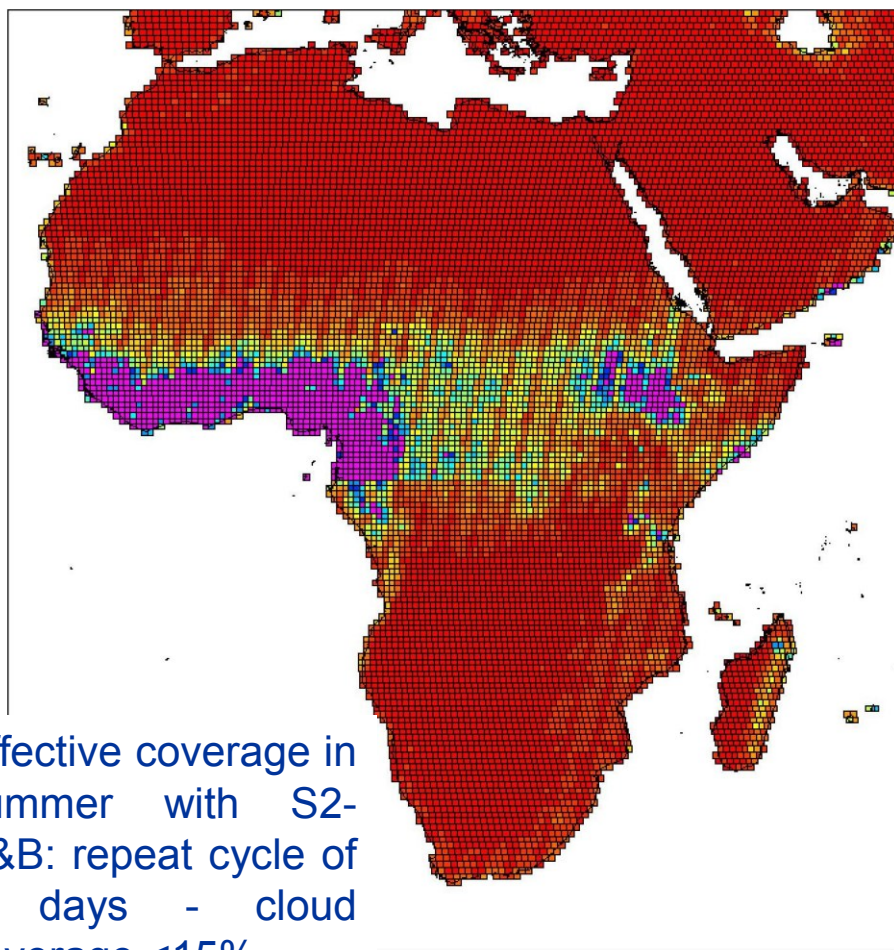
[Sentinel-2 for Science Workshop](#) hosted by ESA-ESRIN between May 20th and 22nd, 2014.

Sentinel-2 Revisit Time Capability

5 days revisit for crop dynamics

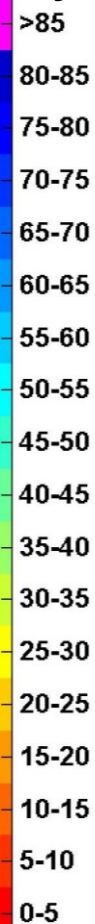


[Sentinel-2 for agriculture](http://www.esa-sen2agri.org/SitePages/Home.aspx) <http://www.esa-sen2agri.org/SitePages/Home.aspx>



Effective coverage in summer with S2-A&B: repeat cycle of 5 days - cloud coverage <15%

days



South Africa JECAM site: 5 days revisit, February-June 2013 - RapidEye

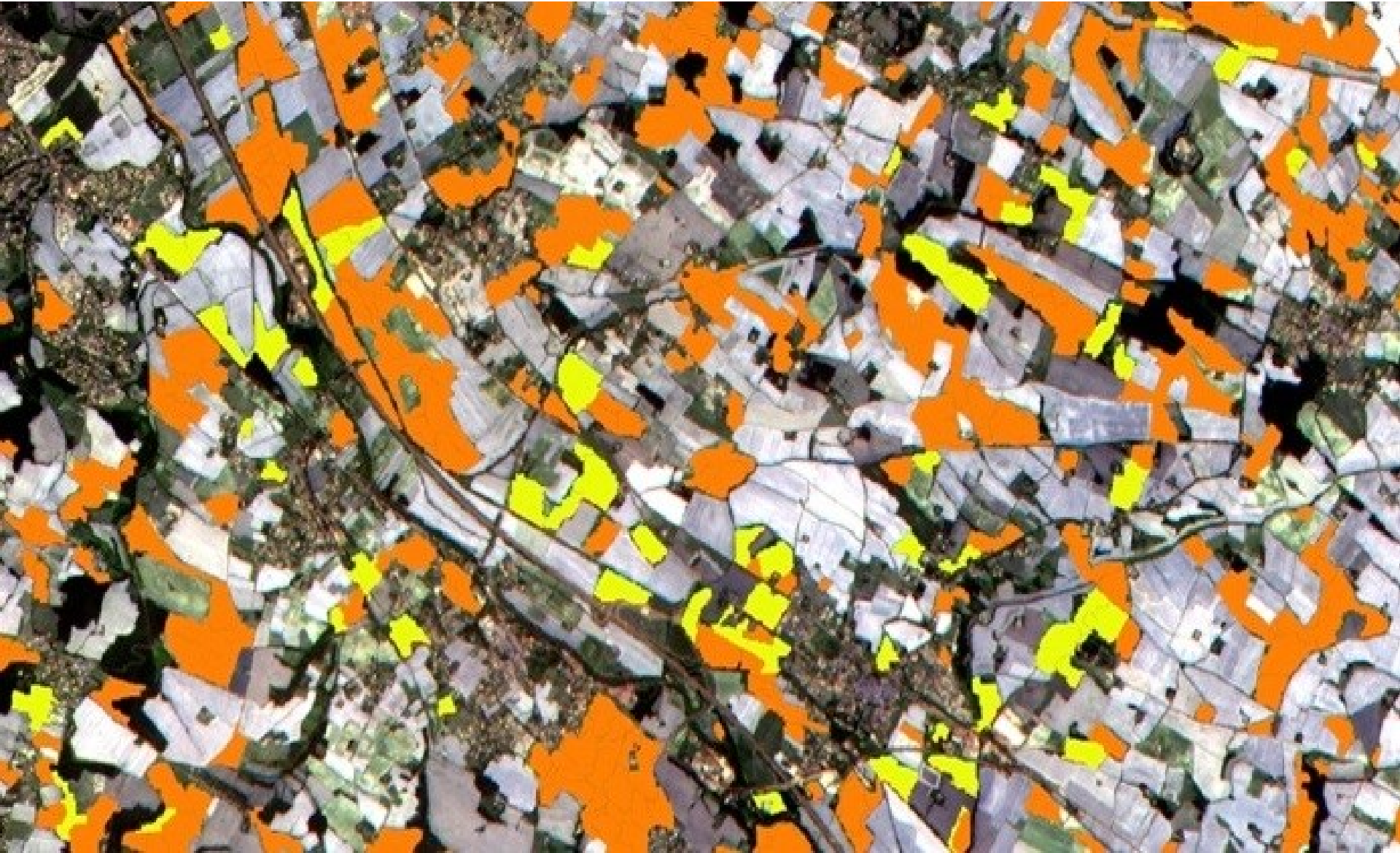


Monthly cloud free composites possible for most areas

Sentinel-2A: Agricultural Monitoring

See also: S-2 for vegetation
<http://www.esa-sen2agri.org/SitePages/Home.aspx>

Sentinel-2 is the first optical mission to include 3 bands in the 'red edge', providing information on the state of vegetation. In this image (6 July 2015 near Toulouse) the multispectral instrument was able to discriminate between two types of crops: sunflower (in orange) and maize (in yellow).



Sentinels in Co-Operation

Using both S1 and S2 data (and Landsat-8). Innovative crop type map at national scale: pilot project for potential future Copernicus service agricultural components



→ CZECH AGRICULTURE FROM SPACE

contains modified Copernicus Sentinel data [2016]



CZECH CROP TYPE MAP 2015

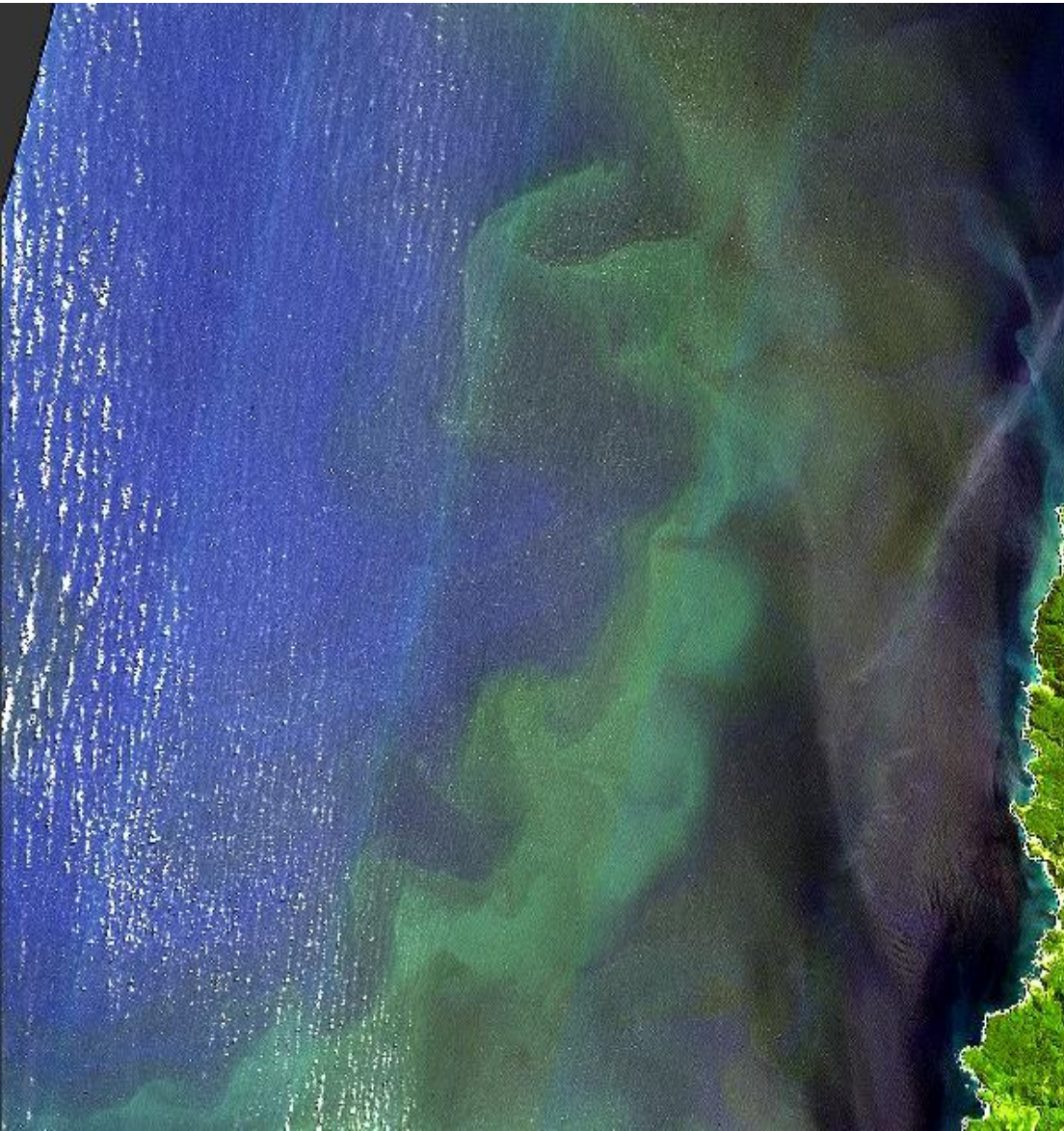
- winter rapeseed
- winter cereals
- spring cereals
- sugarbeet
- maize
- potatoes
- fodder crops
- other annual crops

Data sources:
Sentinel-1, Sentinel-2,
Landsat-8, Czech LPIS



Funded by the 4th Earth Observation Envelope Programme (EOEP4) of ESA

Sentinel-2A: Algal Bloom



Algal bloom along the coast of Valdivia, Chile

Extreme economic impact: more than 24 Million of salmon died, more than 800 Millions of USD loss

Sentinel-2A,
5 March 2016

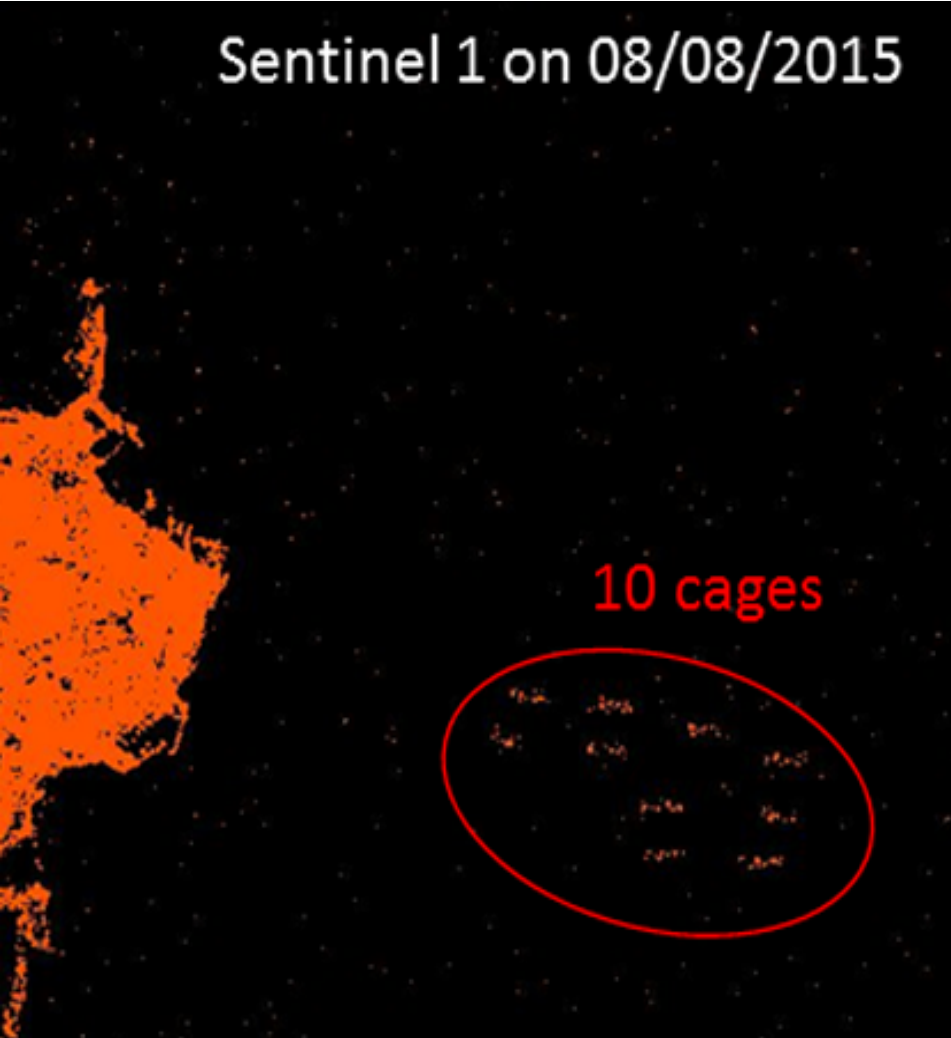


contains Copernicus Sentinel data [2015]

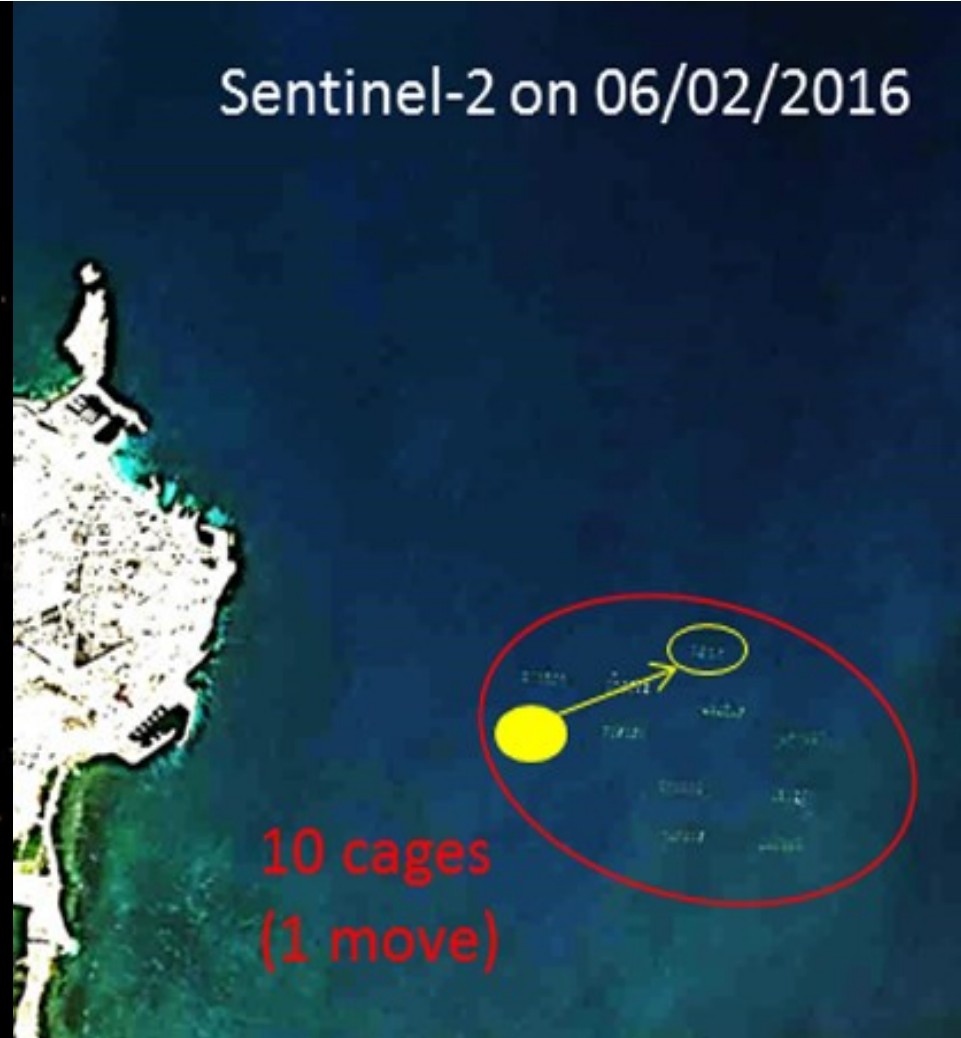
Sentinels in Co-Operation



Sentinel 1 on 08/08/2015



Sentinel-2 on 06/02/2016



Sentinel-1A und -2A: Traffic Jam on the Danube



SENTINEL-1A
acquired 02.08.2015
07:30 local time (EEST)

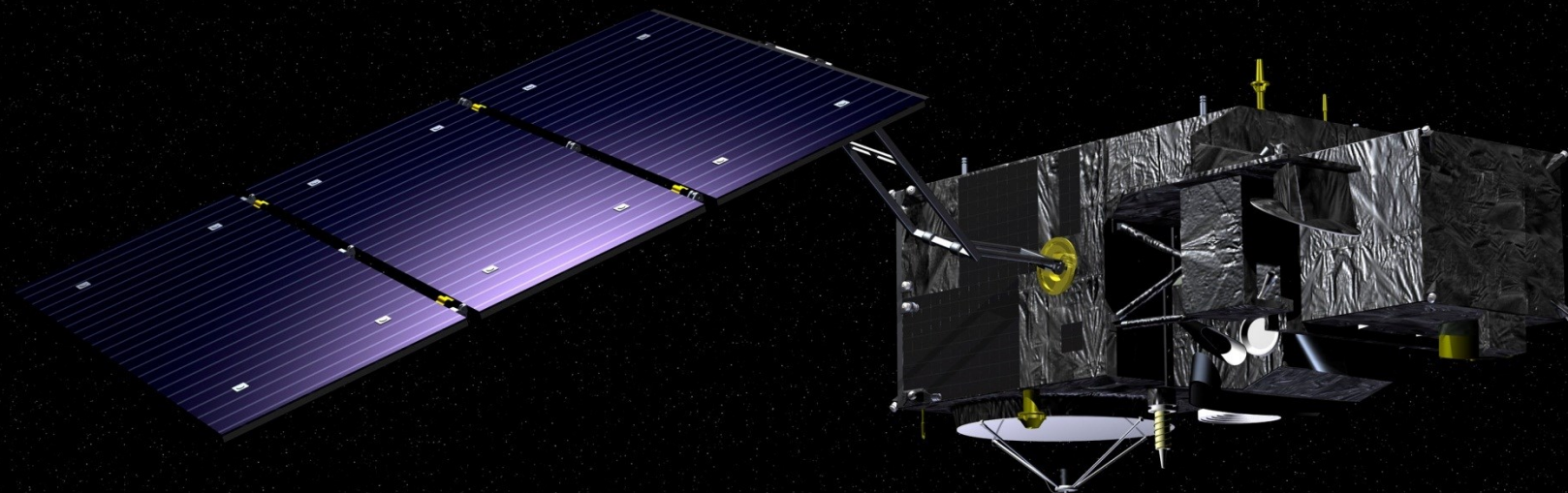


Sentinel-3 (3-A launched)



March 2016

- Medium resolution imaging and altimetry mission
- Land and ocean applications



Sentinel-3 Payload

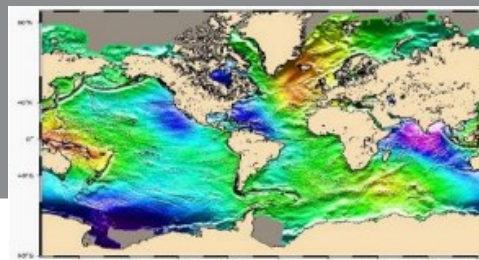


Optical Mission Payload

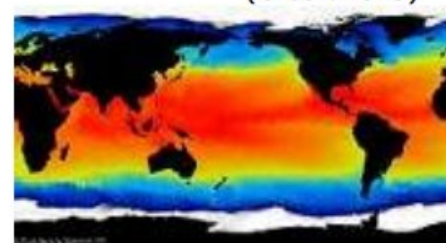
- Ocean and Land Colour Instrument (OLCI)
- Sea and Land Surface Temperature Radiometer (SLSTR)

Topography Mission Payload

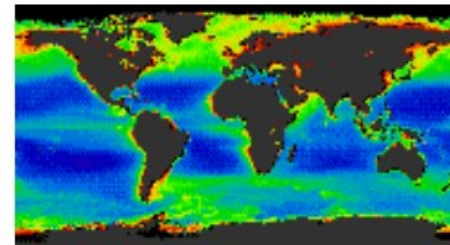
- Ku-/C-band Synthetic Aperture Radar Altimeter (SRAL)
- MicroWave Radiometer (Bi-frequency)
- Precise Orbit Determination (POD) including:
 - GNSS Receiver
 - DORIS
 - Laser Retro-Reflector



Sea Surface Height products
(Credit: CLS)



Sea Surface Temperature products
(Credit: Met Office)



Ocean colour products
(Credit: MyOcean)



Land cover
products
(Credit: ESA)

Sentinel-3 Revisit Time & Coverage: Optical Mission



	Number of Satellites	Revisit at Equator	Revisit for latitude >30°	Spec.
Ocean Colour (Sun-glint free, day only)	2 Satellites	< 1.9 days	< 1.4 days	< 2 days
Land Colour (day only)	2 Satellites	< 1.1 day	< 0.9 day	< 2 days
SLSTR dual view (day and night)	2 Satellites	< 0.9 day	< 0.8 day	< 4 days

➤ **Short Revisit times for optical payload**

OLCI: Ocean and Land Colour Instrument comparison to MERIS



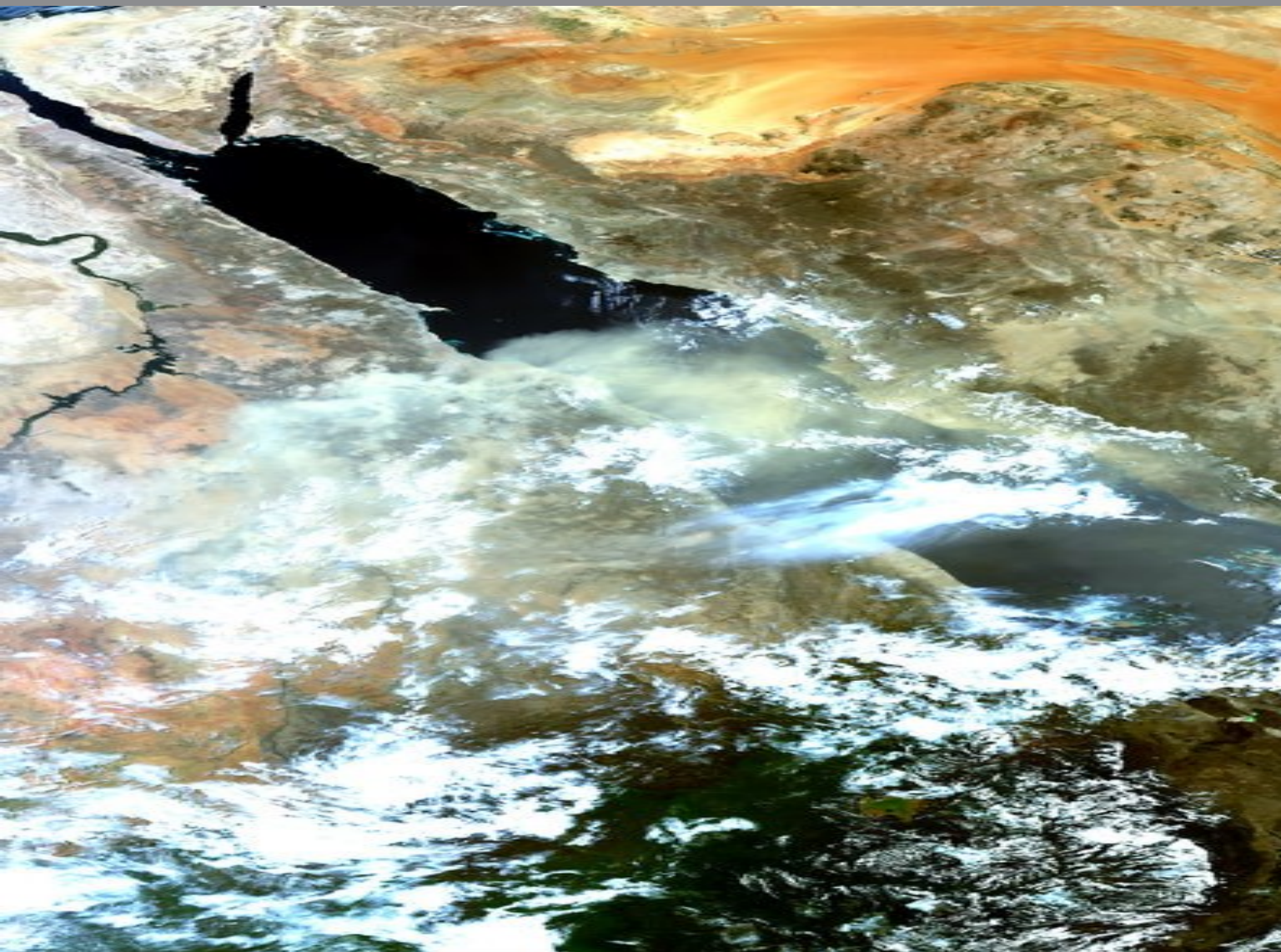
Pushbroom Imaging Spectrometer (VIS-NIR) – similar to MERIS

Key Improvements:

- More spectral bands (from 15 to 21) 400-1020 nm
- Broader swath: 1270 km
- Reduced sun glint by camera tilt in west direction (12.20°)
- Absolute (relative) accuracy of 2% (relative 0.5%)
- Polarisation sensitivity < 1%
- Full res. 300m acquired systematically for land & ocean
- Reduced res. 1200m binned on ground
- Improved characterization, e.g. straylight, camera boundary characterization
- **Timeliness: 3 hours NRT Level 2 product**
- **100% overlap with SLSTR**

MERIS Bands	λ center	Width
Yellow substance/detrital pigments	412.5	10
Chl. Abs. Max	442.5	10
Chl & other pigments	490	10
Susp. Sediments, red tide	510	10
Chl. Abs. Min	560	10
Suspended sediment	620	10
Chl. Abs, Chl. fluorescence	665	10
Chl. fluorescence peak	681.25	7.5
Chl. fluorescence ref., Atm. Corr.	708.75	10
Vegetation, clouds	753.75	7.5
O ₂ R-branch abs.	761.25	2.5
O ₂ P-branch abs.	778.75	15
Atm corr	865	20
Vegetation, H ₂ O vap. Ref.	885	10
New OLCI bands	λ center	Width
Aerosol, in-water property	400	15
Fluorescence retrieval	673.75	7.5
Atmospheric parameter	764.375	3.75
Cloud top pressure	767.5	2.5
Atmos./aerosol correction	940	20
Atmos./aerosol correction	1020	40

Sentinel-3A : Dust storm over the Red Sea



**acquired
27/07/2016
12:00 pm**

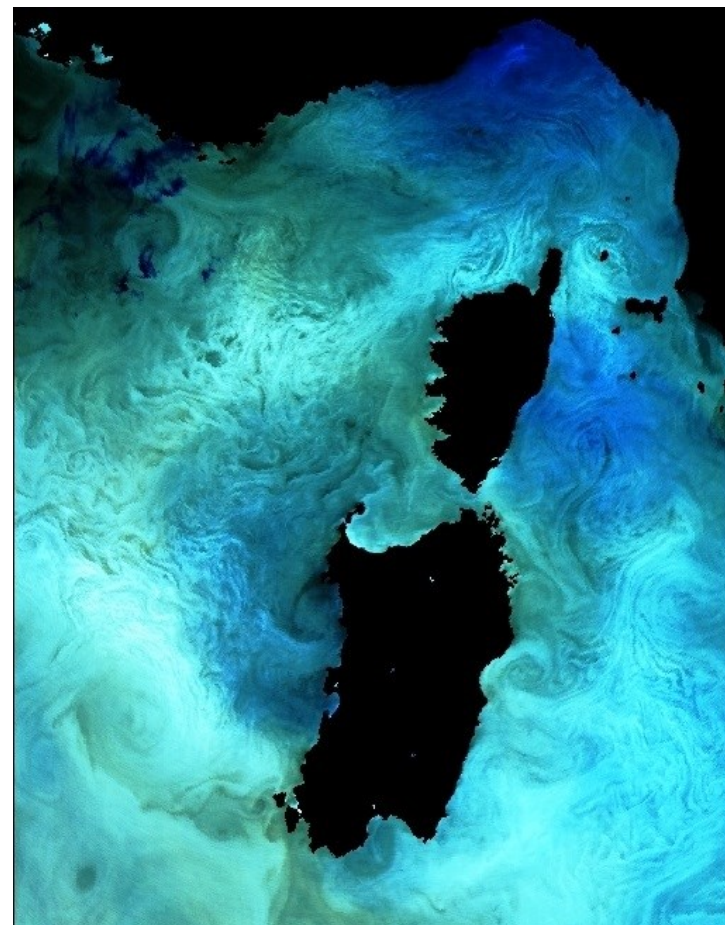
Sentinel-3A

**Copyright:
Contains modified
Copernicus Sentinel
data (2016),
processed by ESA**

European Space Agency

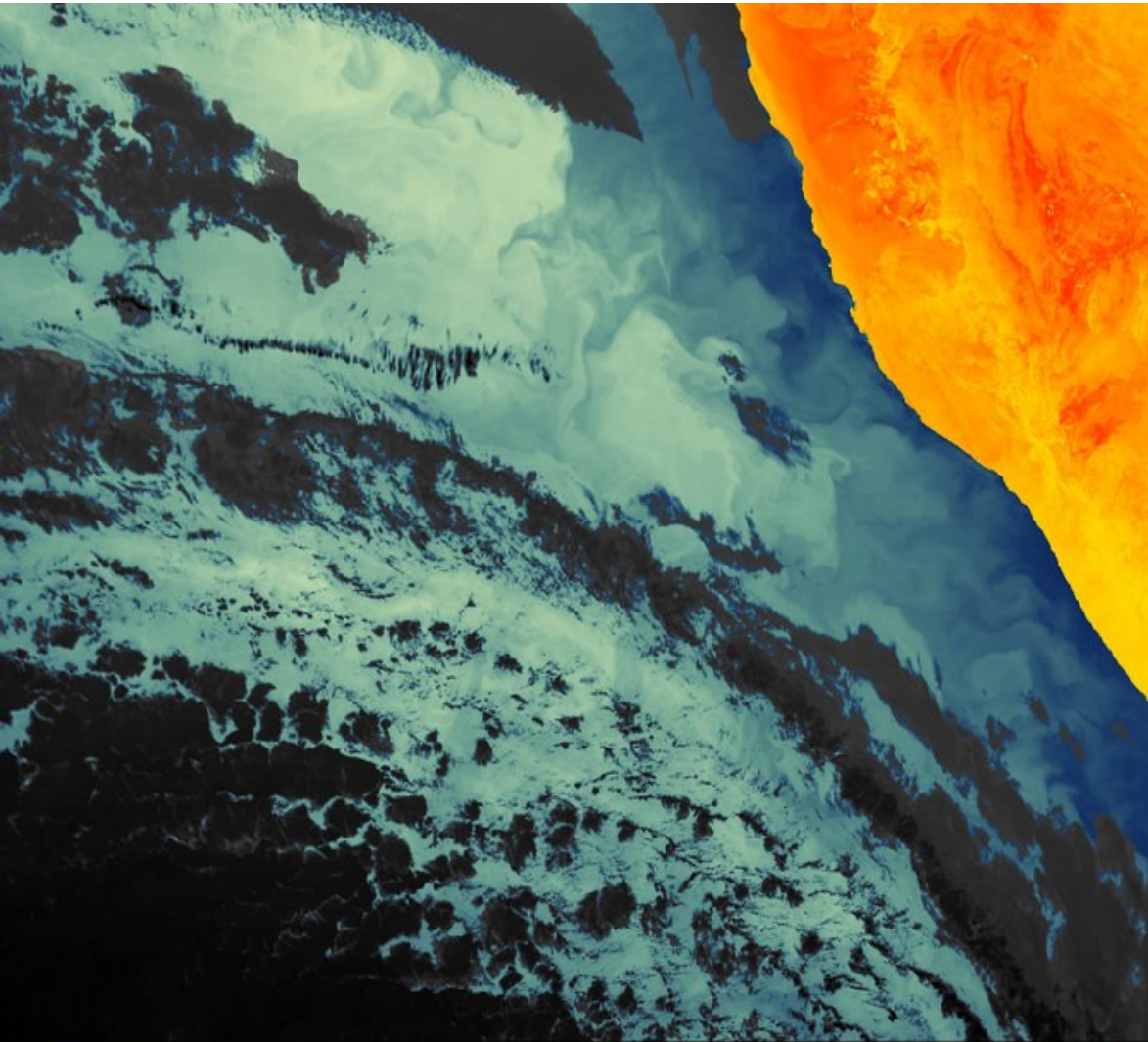
Key Improvements:

- number of spectral bands from 7 to 9 (new 1.3 and 2.2 μ m) for better Ci Cloud detection
- increased resolution for VIS and SWIR channels (0.5 km @ nadir, TIR 1 km @nadir)
- maintain along track scanning with increased swath of oblique view to 750 km
- increased nadir swath coverage to 1400 km
- 100% overlap with OLCI
- improved coverage Ocean < 4 days (practically ~ 2 days)
- dedicated Active Fire channels
- Timeliness: 3 hours NRT Level 2 product



Thermal Structure in the Med,
ENVISAT AATSR

Sentinel-3A: Thermal Signatures



Namibian Coastline,
29 March 2016



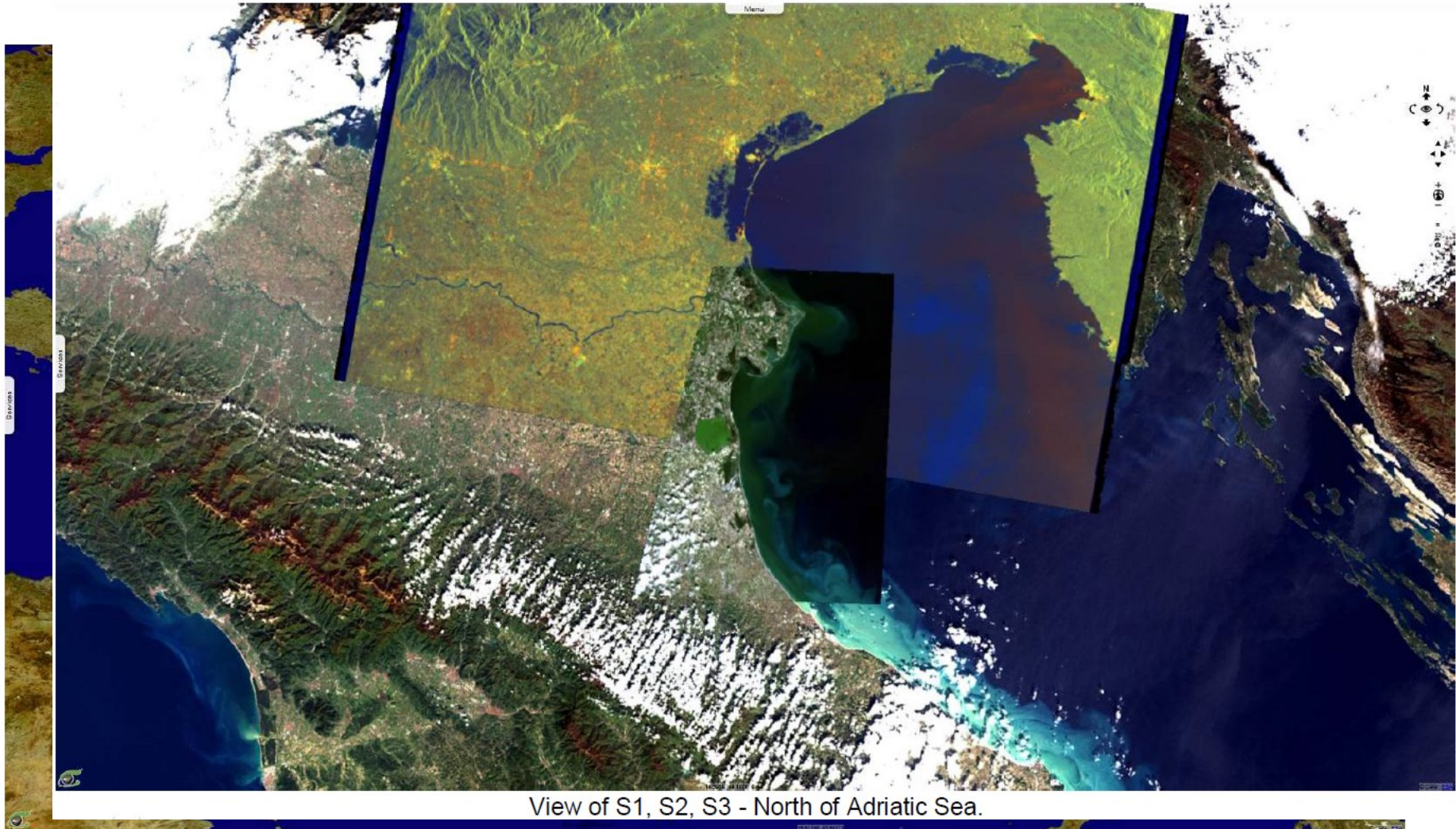
Contains modified
Copernicus Sentinel data
[2016]

European Space Agency



S1,S2,S3 co-location over Italy

- Sentinel-C-SAR IW DV acquired on **19 October** 2016 05:18:09 GMT
- Sentinel-2 MSI (1 tile) acquired on **24 August** 2016 10:00:32 GMT

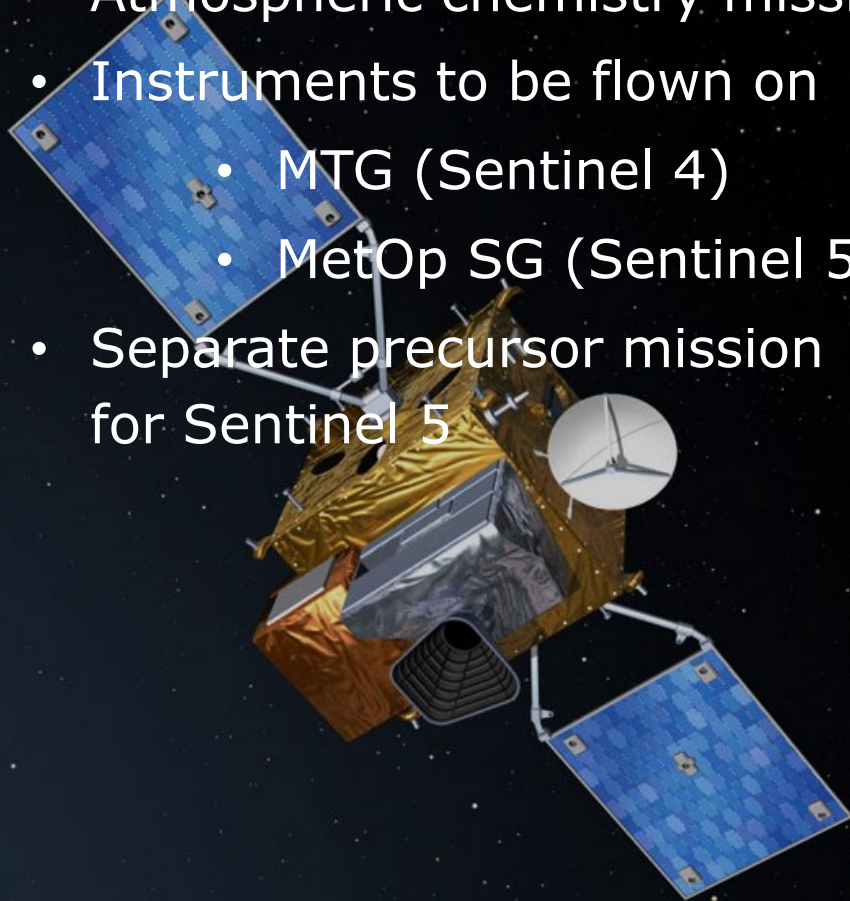


View of S1, S2, S3 - North of Adriatic Sea.

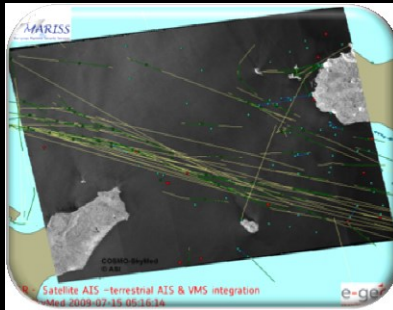
Full image of S1, S2, S3 - Envisat MERIS RR (2003) basemap.

Sentinel-4/5/5p

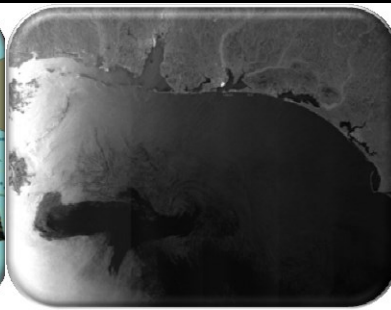
- Atmospheric chemistry missions
- Instruments to be flown on
 - MTG (Sentinel 4)
 - MetOp SG (Sentinel 5)
- Separate precursor mission for Sentinel 5



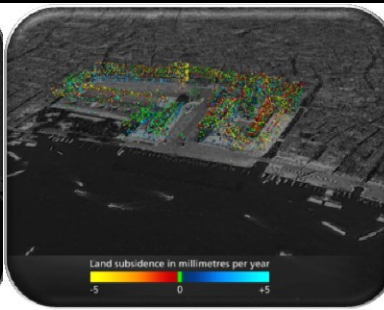
Some Sentinel Application Areas



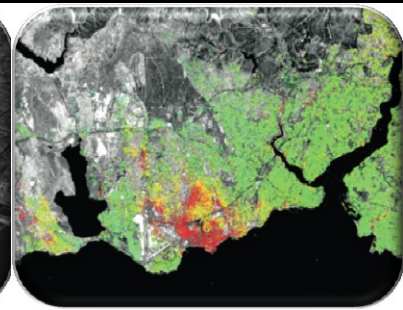
Maritime surveillance



Oil spills



Land subsidence



Tectonics



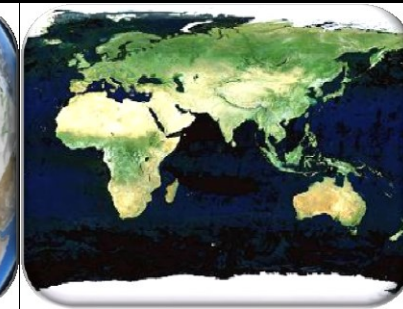
Volcanoes



Floods



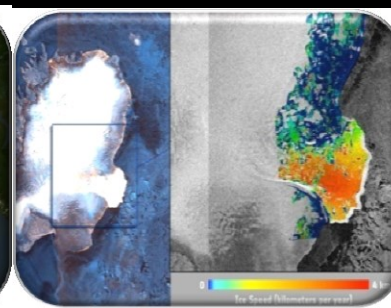
Deforestation



Vegetation



Sea ice extent



Ice speed

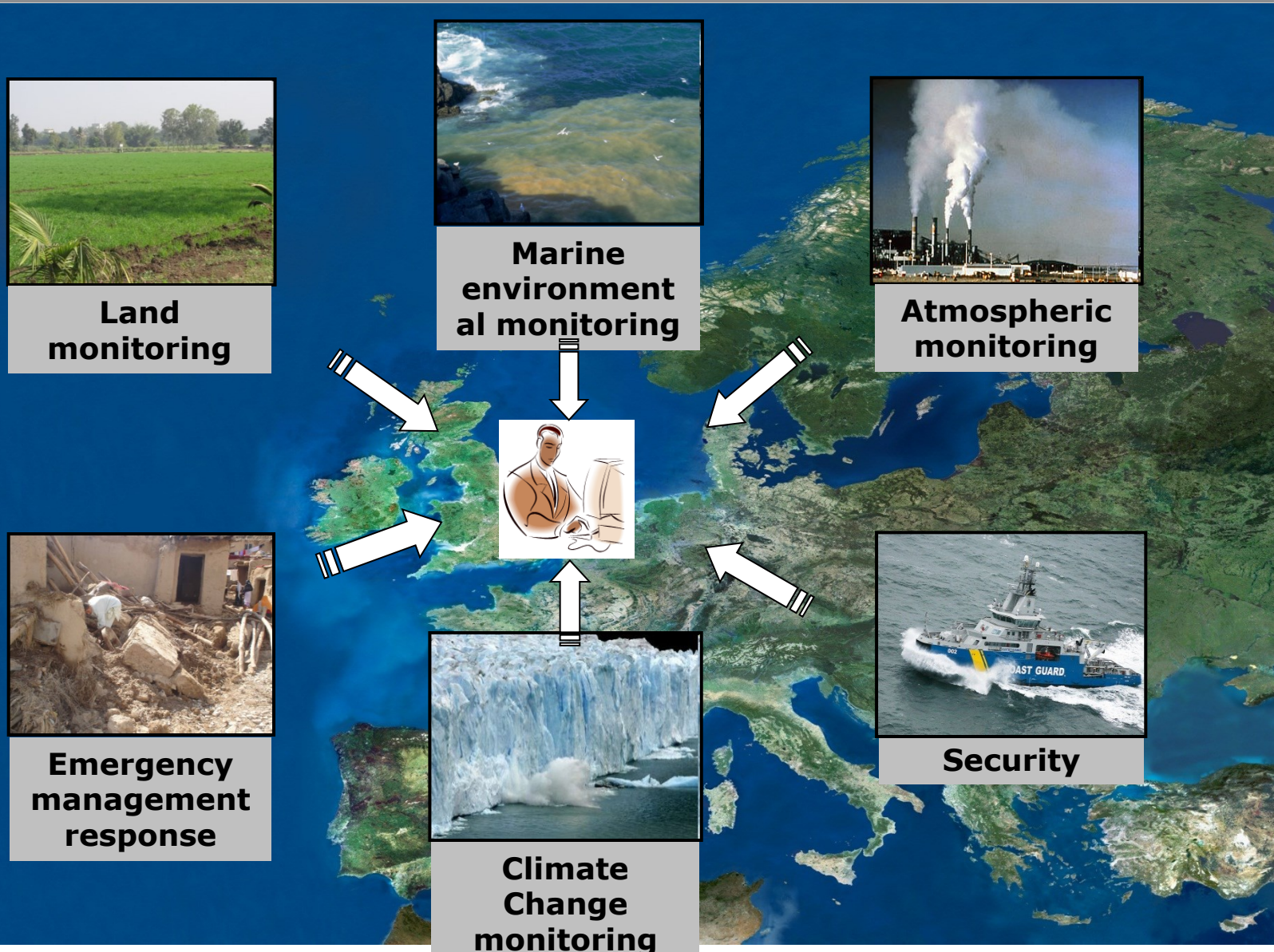


Atmosphere

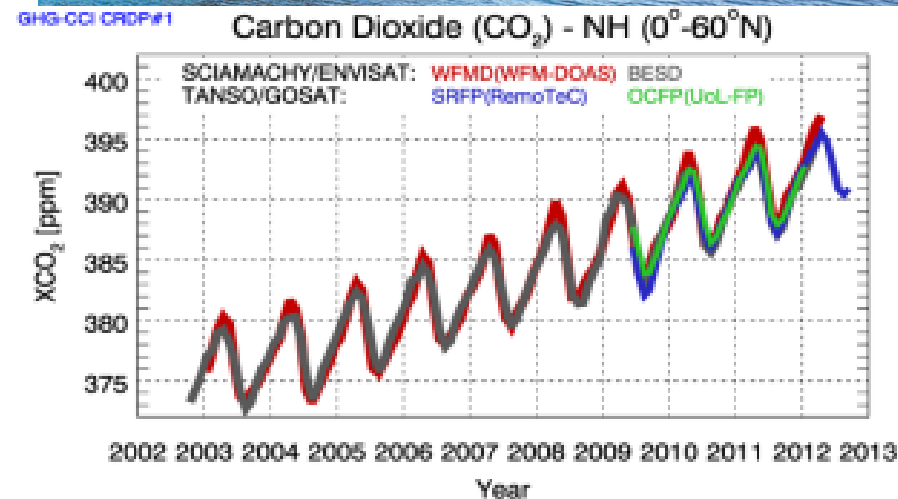
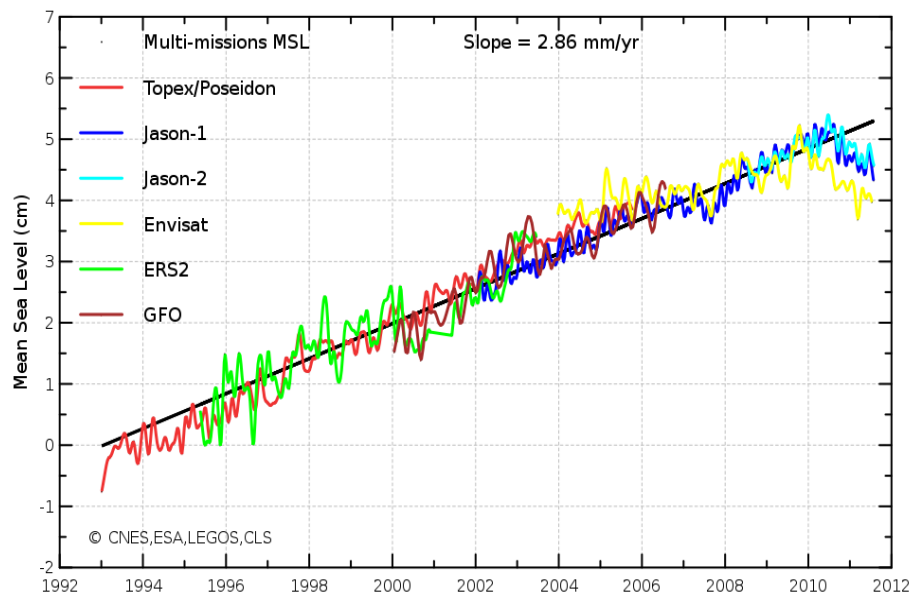


Ocean colour

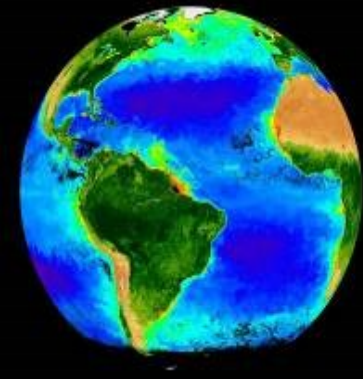
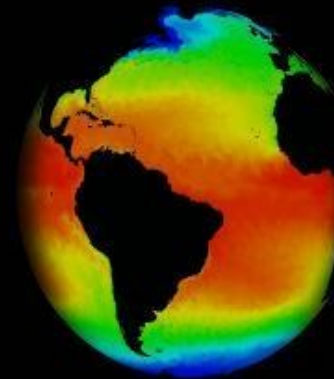
Copernicus Services domains

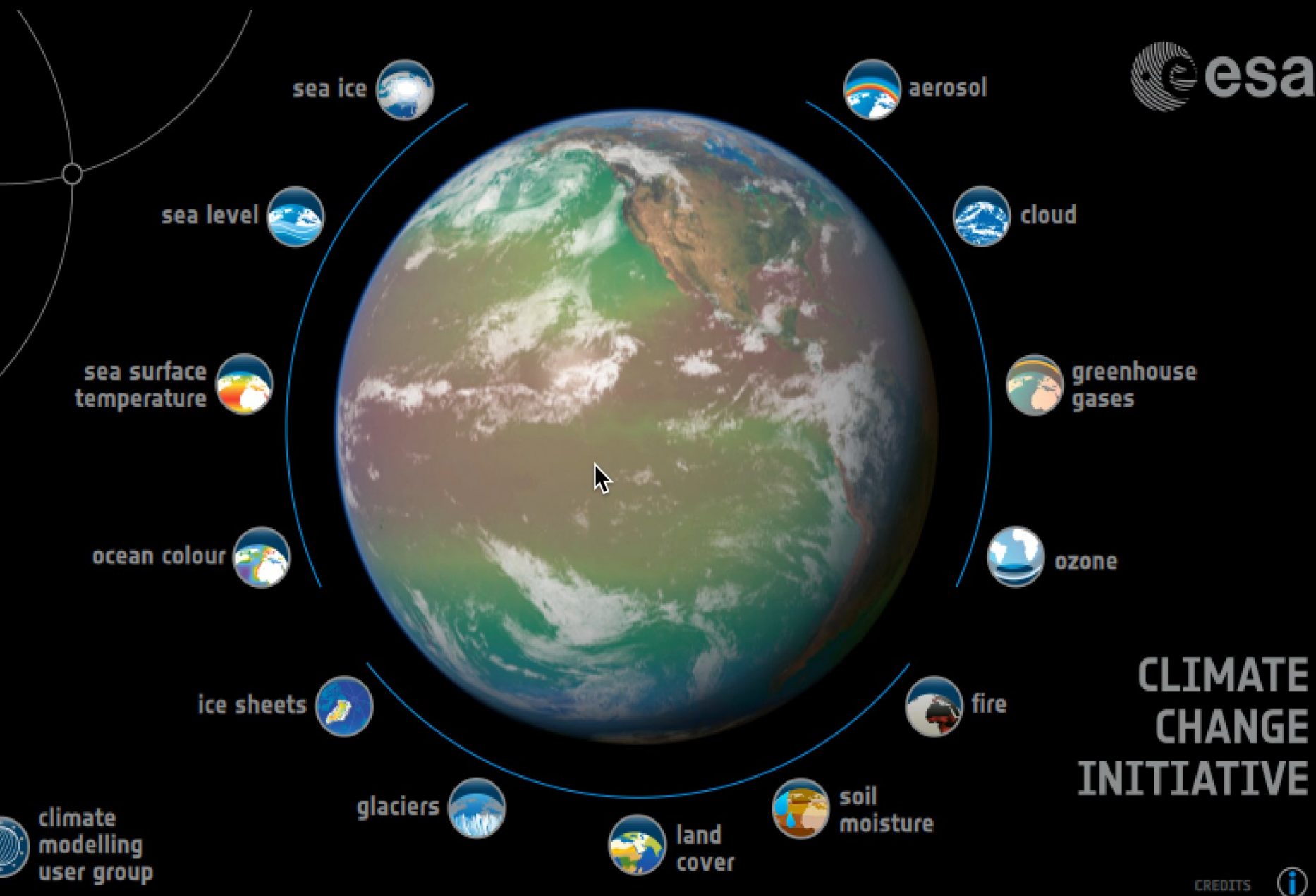


The ESA Climate Change Initiative (CCI)



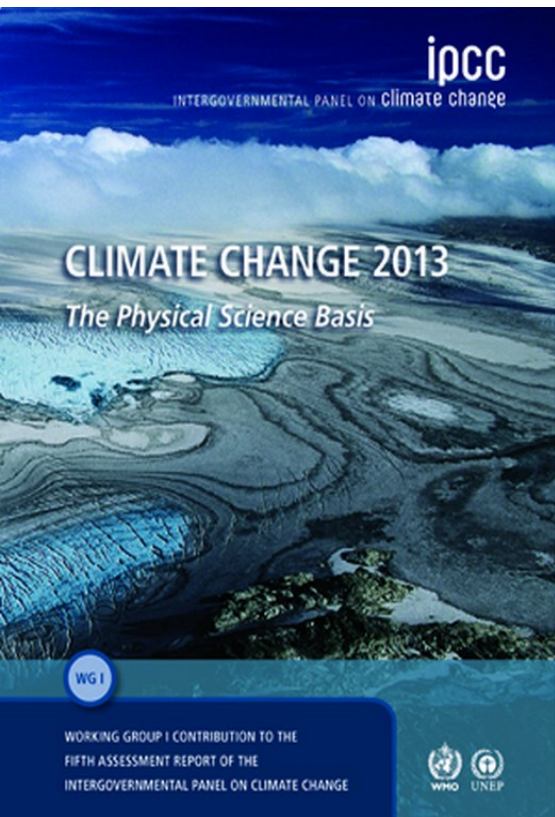
- Cloud Properties
- Carbon Dioxide, Methane & other GHGs
- Ozone
- Aerosol properties
- Sea Surface Temperature
- Sea Level; Sea Ice
- Ocean Colour
- Glaciers and ice caps
- Land cover
- Fire disturbance
- Soil moisture



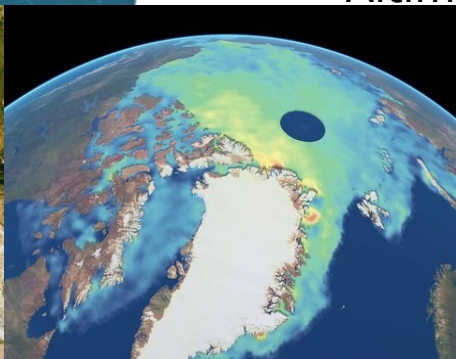
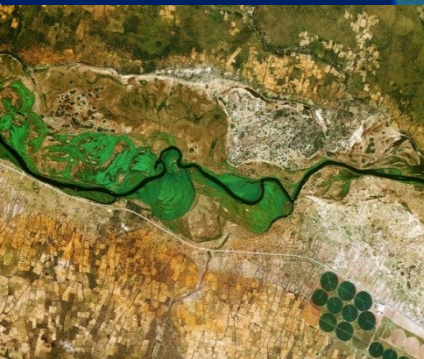


CLIMATE CHANGE INITIATIVE

EOEP Impact on IPCC



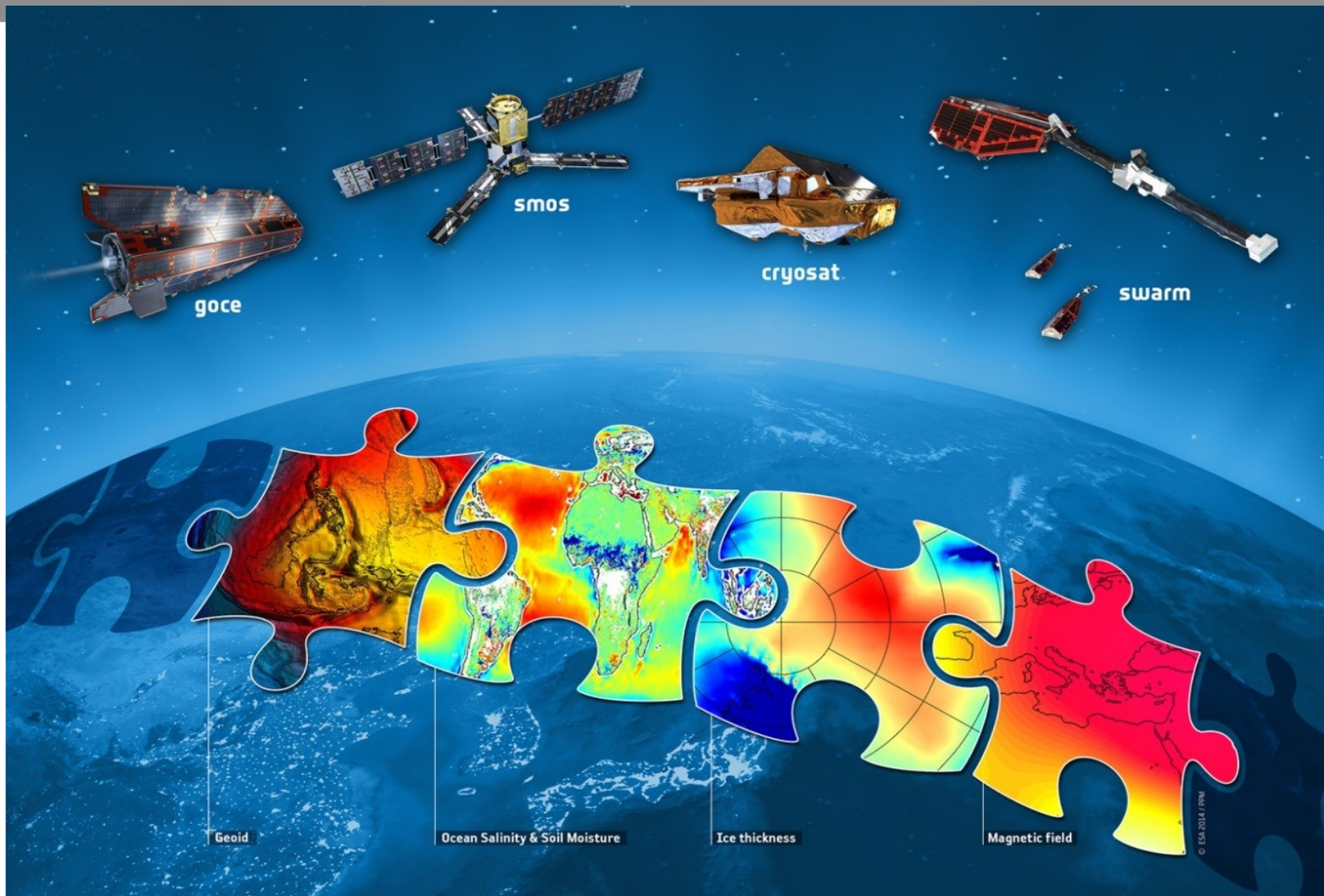
- “Satellites have improved the capabilities of observations for climate science, in terms of volume and quality”
- Chapter 2: Observations: Atmosphere and Surface
 - ATSR series
- Chapter 4: Observations: Cryosphere
 - Altimetry/SAR (ERS-1/2; Envisat); Cryosat-2; IMBIE
- Chapter 13: Sea Level Change
 - Altimetry (ERS-1/2; Envisat)



Science – the Earth Explorers



Earth Explorers launched so far



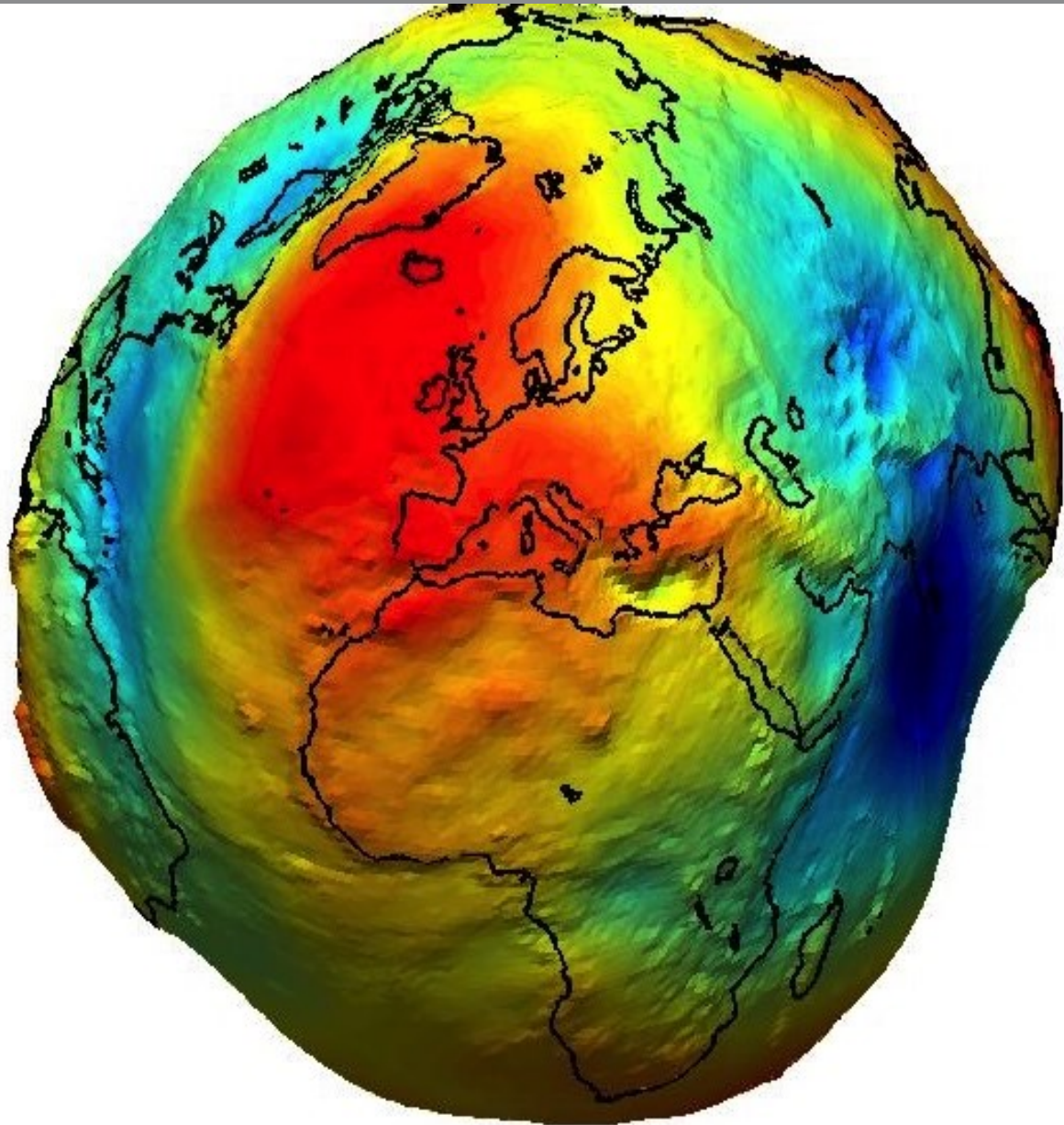
Space Agency

Status of ESA Earth Explorers:



1. GOCE – mission accomplished
2. SMOS – still operating
3. CryoSAT - still operating
4. SWARM - still operating
5. ADM-Aeolus (launch planned for the end 2017)
6. EarthCARE (launch planned for 2018)
7. BIOMASS (launch planned for 2021)

GOCE: Mission accomplished

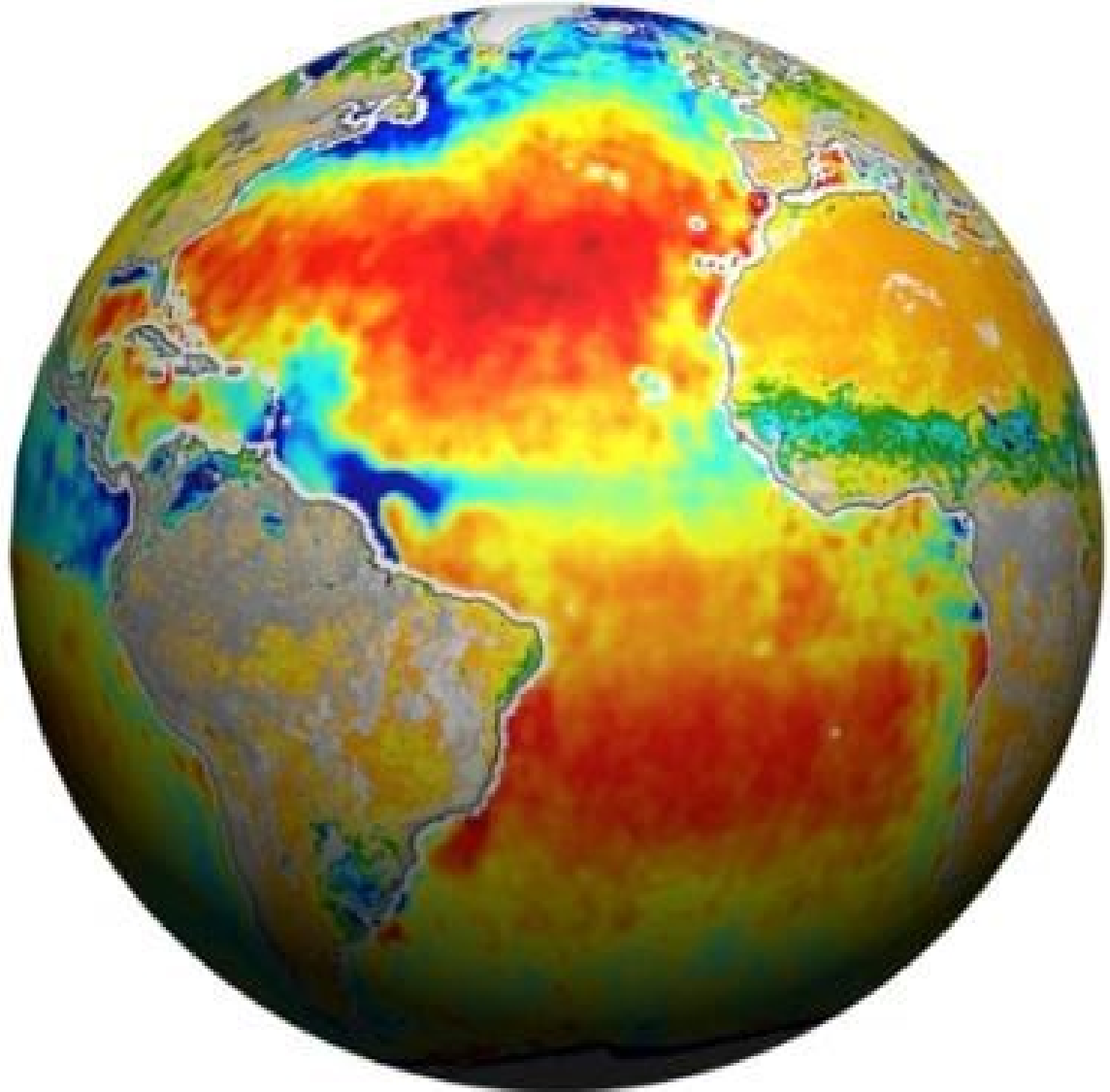


Most precise geoid to date

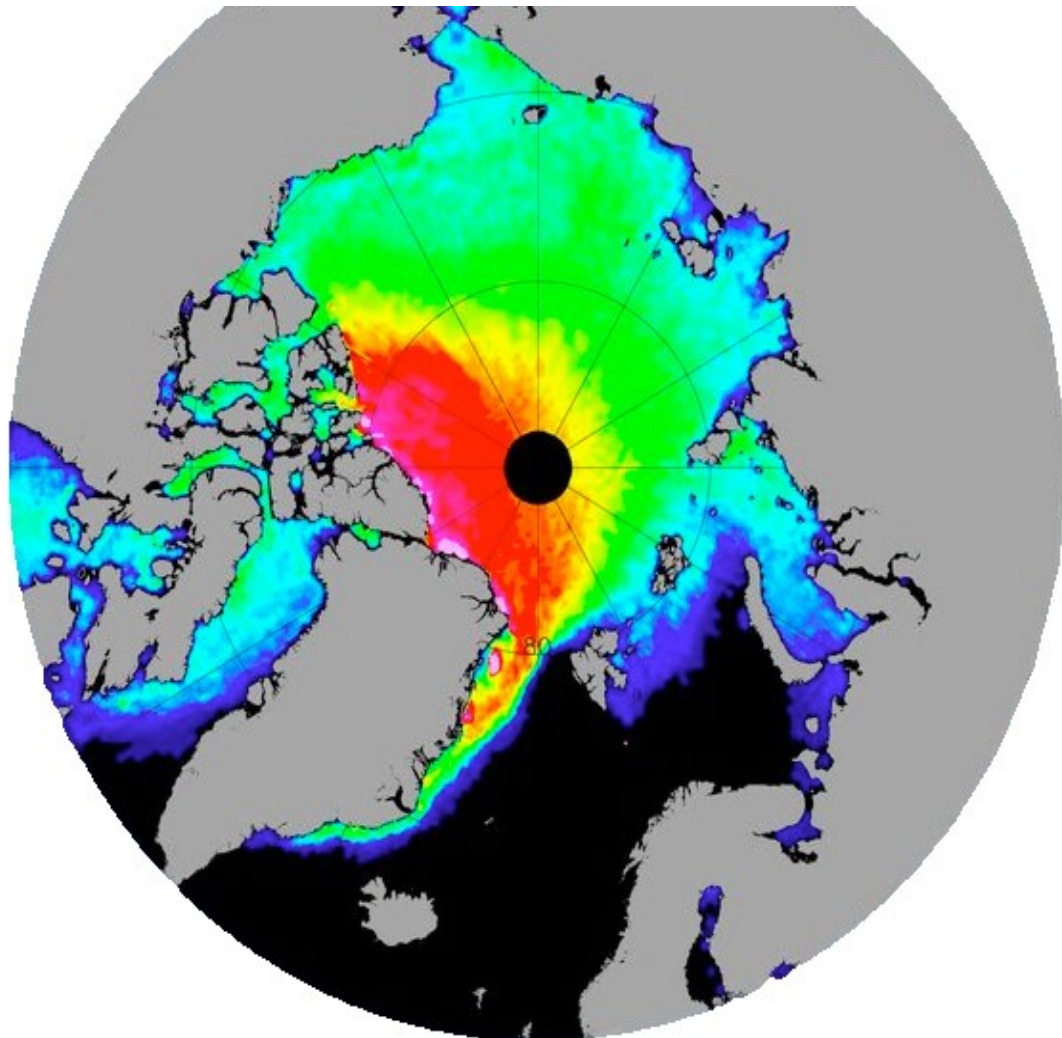
SMOS: Mission accomplished and ongoing



Monitoring soil moisture and
ocean salinity. Globally.



Cryosat: Mission accomplished and ongoing esa



Surveyed sea ice thick

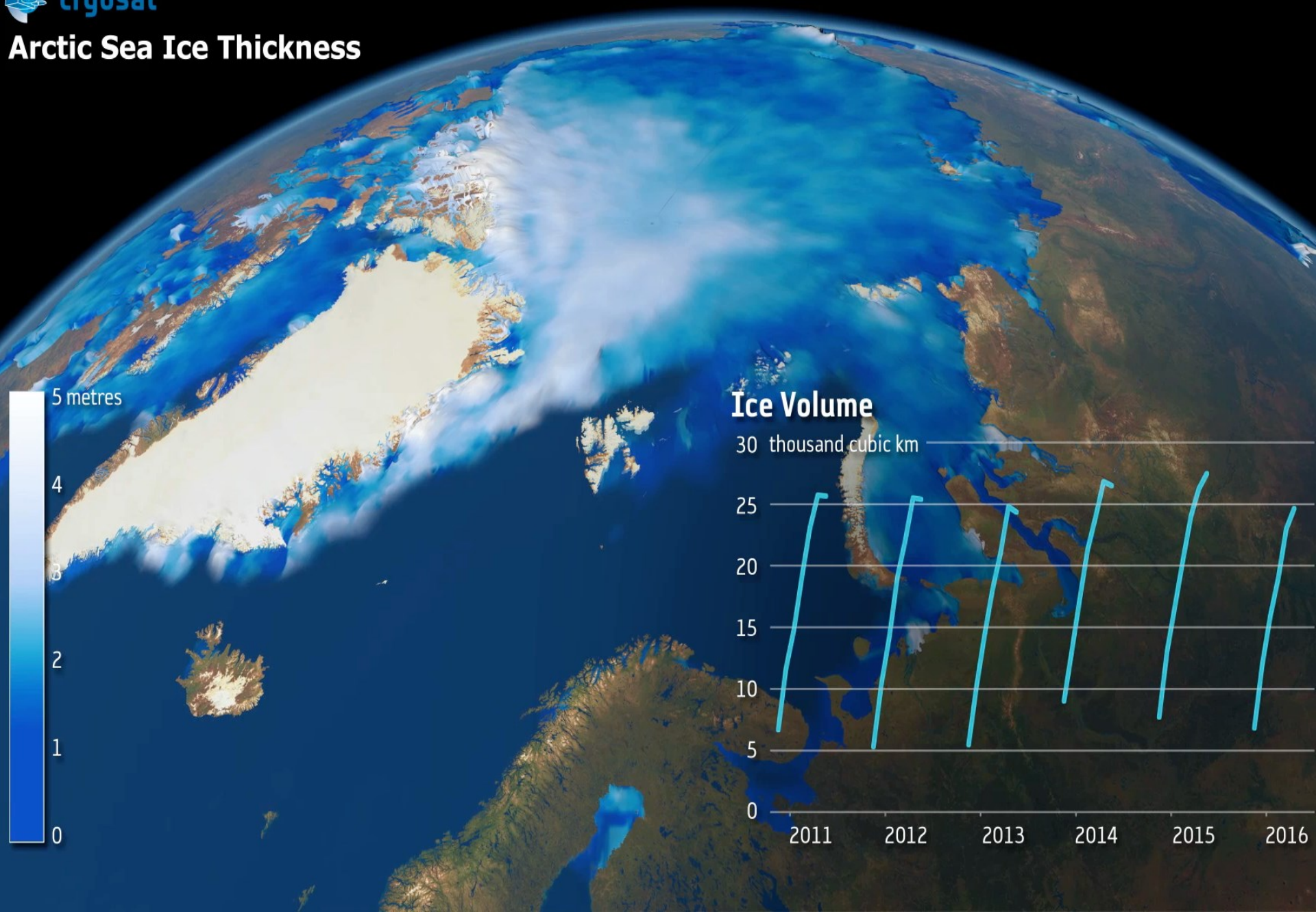
Average spring sea ice thickness 2010-2015

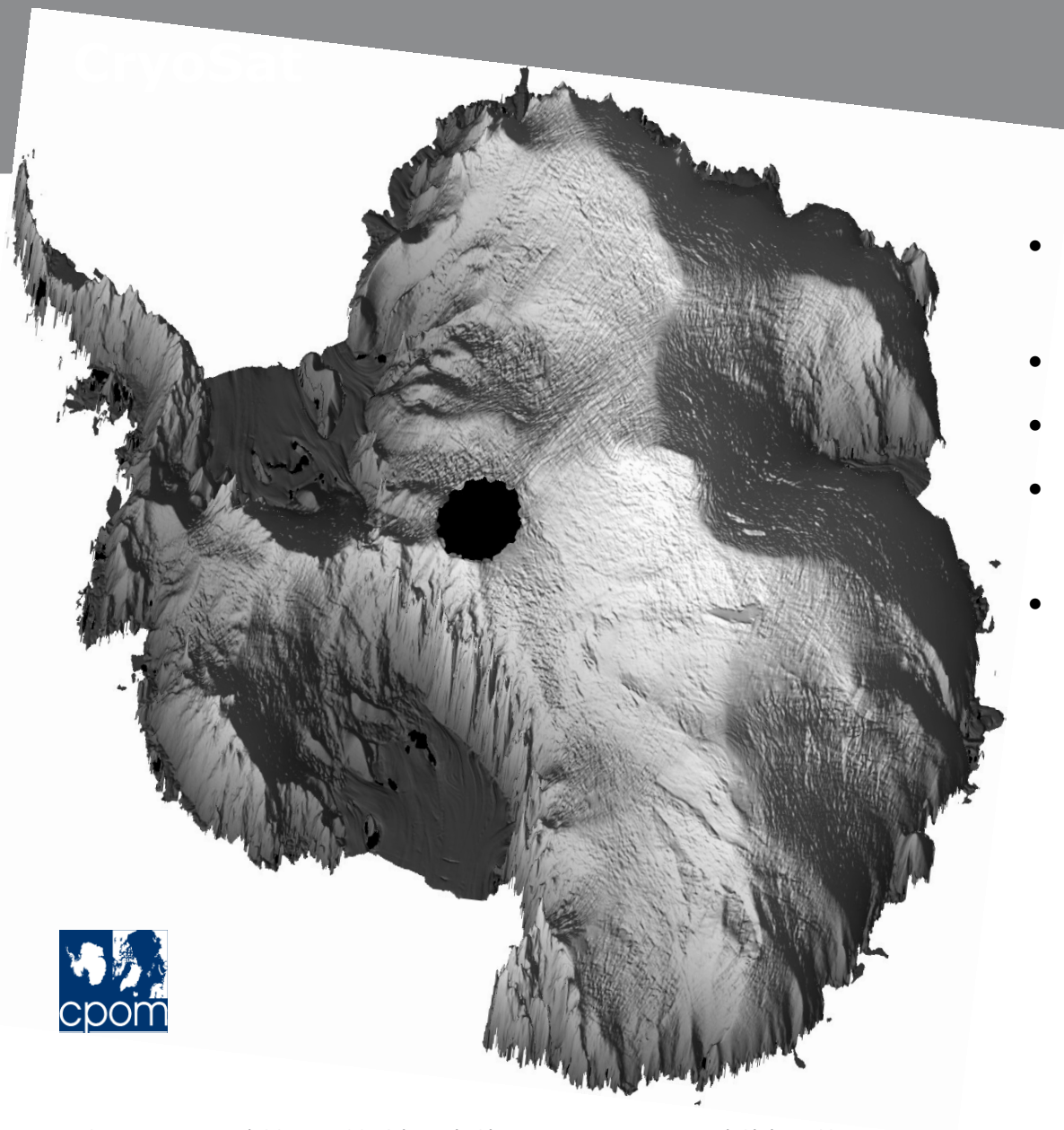


0

3.5m

Arctic Sea Ice Thickness

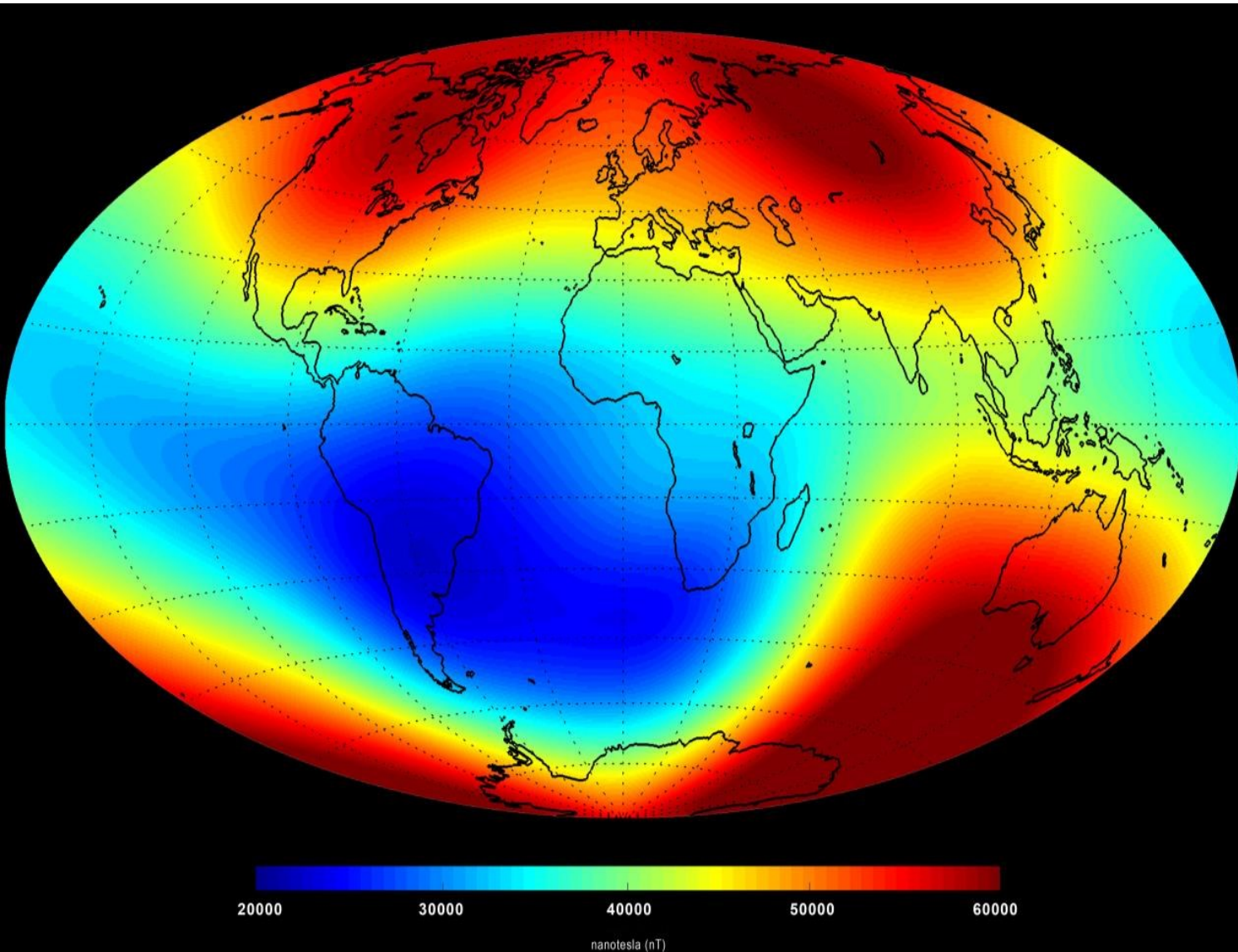




- CryoSat Antarctica **digital elevation model**
- 2 km grid resolution
- Covers 99% of the continent
- Fully validated and accurate to within 25 m on average
- Distributed to all conference attendees

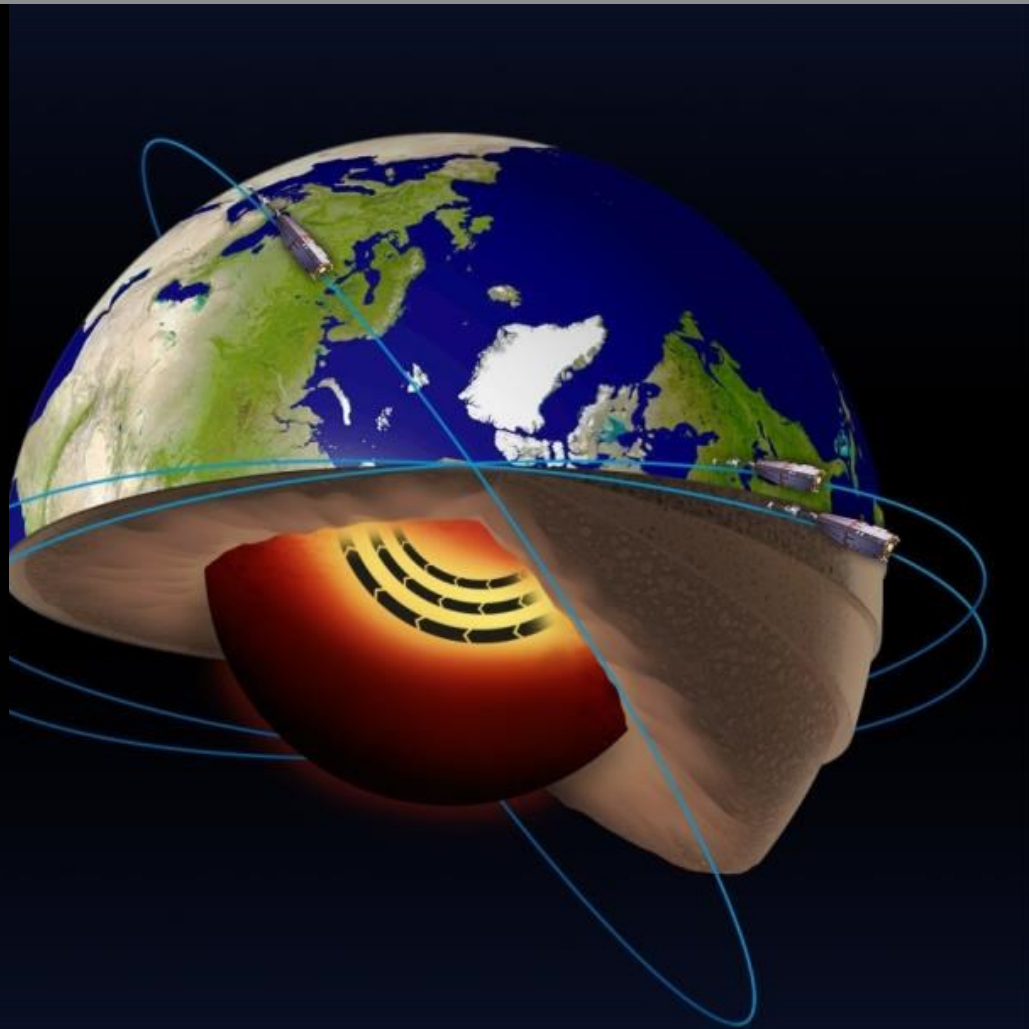


Swarm: Mission accomplished and ongoing



Tracking
Earth's
dynamic
magnetic
field. European Space Agency

Swarm: Jet Stream in Earth's Core

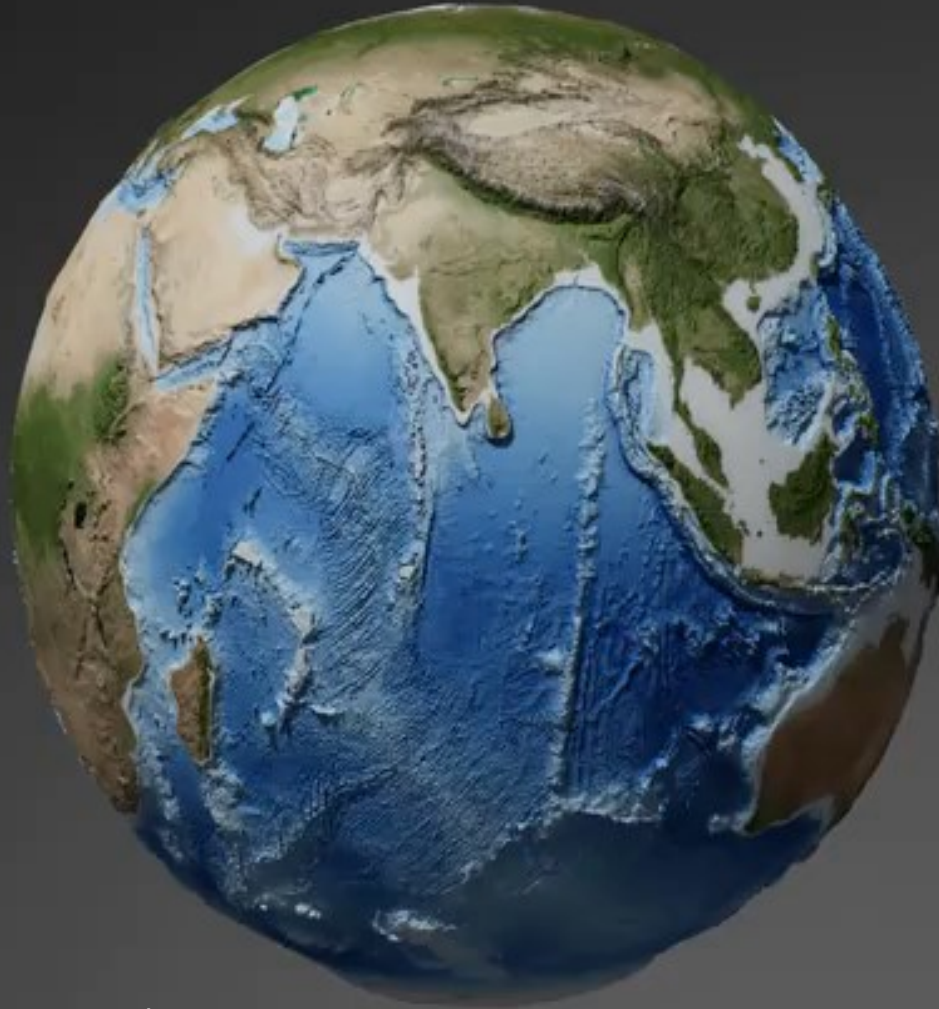


Copyright: ESA

ESA Presentation | 20 June 2016 | Earth Observation P

ESA UNCLASSIFIED – Releasable to the Public

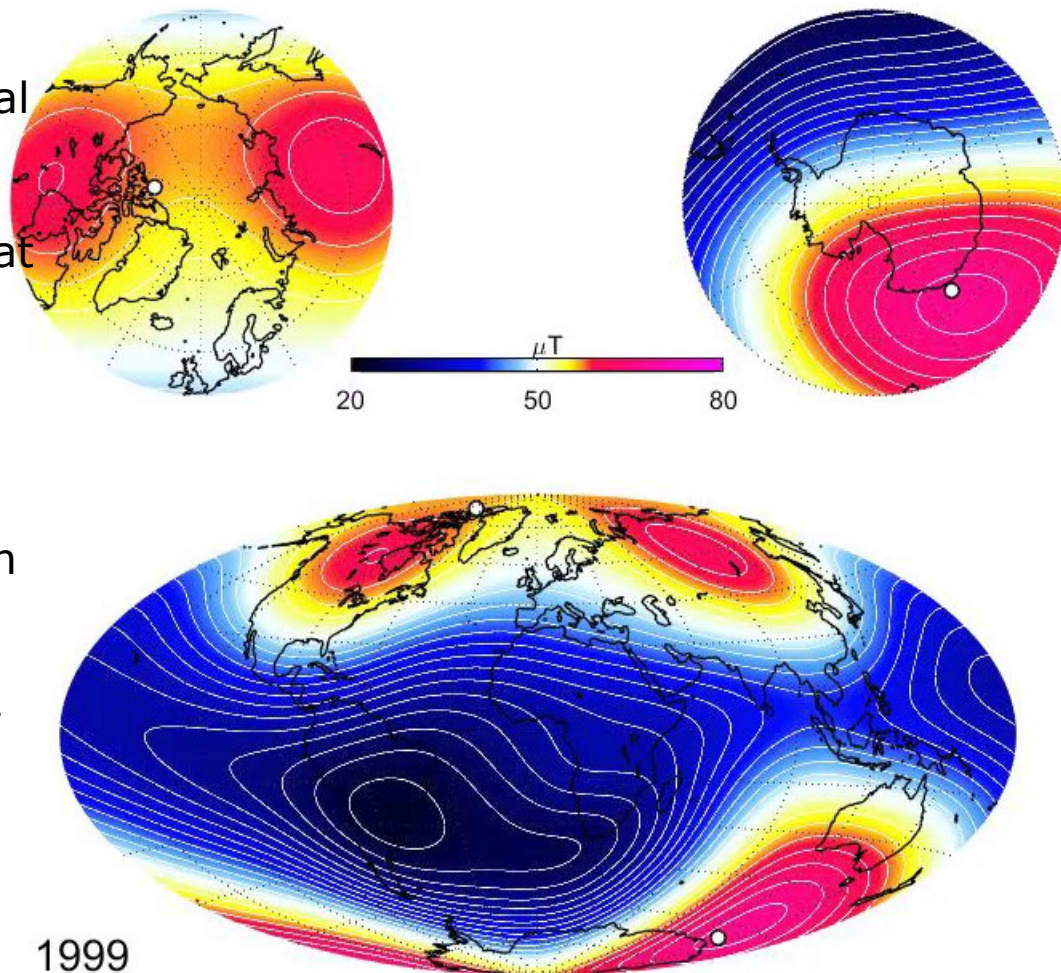
Swarm/CHAMP: Lithospheric Magnetic Field



Copyright ESA/DTU Space/DLR

Swarm: Geomagnetic Field Changes

- Field strength and location of poles are evolving on a decadal time scale
- Field strength concentrations at high latitude
- North America -3.5% in 17y;
North Asia +2% in 17y
- South Atlantic Anomaly -2% in 17y and migrating westward
- Swarm also tracks rapid inter-annual accelerations



Upcoming Earth Explorers



Aeolus

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



EarthCARE

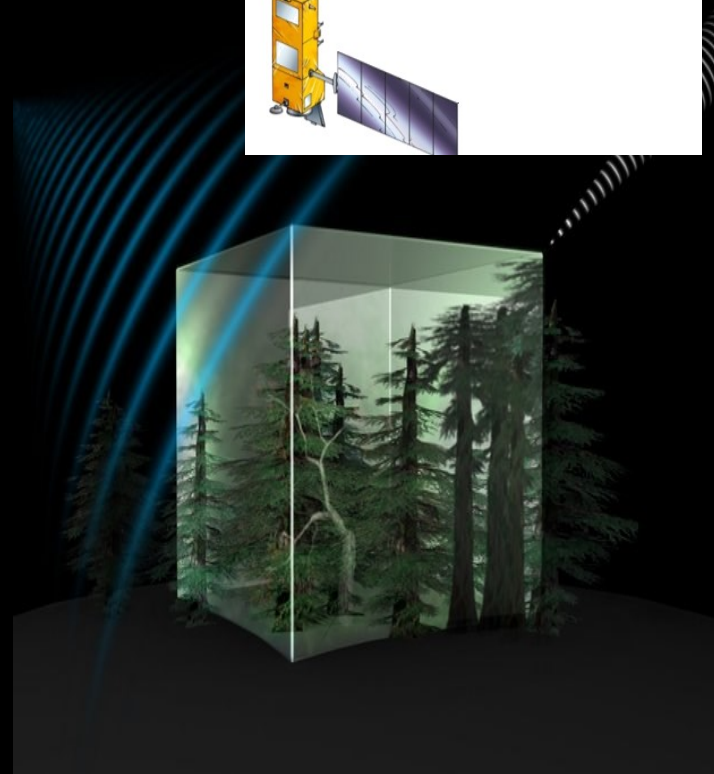
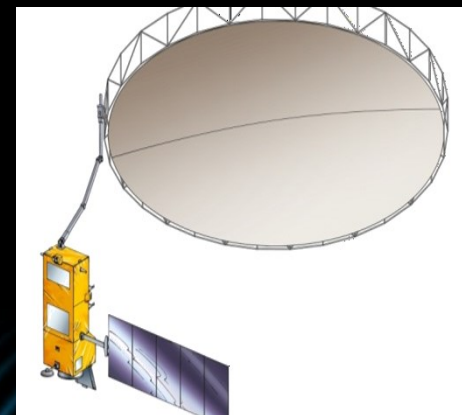
- Global observations of clouds, aerosols and radiation
- Launch planned for 2019
- Cooperation with JAXA



Further Earth Explorer Missions



- 7th Earth Explorer: Biomass
 - Biomass estimates based on global interferometric and polarimetric P-Band Radar observations
- 8th Earth Explorer: FLEX
 - global maps of vegetation fluorescence, which can be converted into an indicator of photosynthetic activity



ESA LPS 2016



PRAGUE 09-13 MAY 2016

Main Objective: Presentation of Exploitation Results based on ESA
Earth Observation Measurements



living planet symposium | PRAGUE 09-13 May 2016



<http://lps16.esa.int>

European Space Agency



A satellite image showing a large river delta system, likely the Amazon, with a prominent dark, winding river channel cutting through a vast green landscape. The terrain is a mix of lush green vegetation and lighter, brownish-yellow areas, possibly indicating different types of land cover or elevation. A blue banner with white text is overlaid on the left side of the image.

EO Tools for Education

Creation of Tools for Earth Observation Education, Training and Outreach



Tools for secondary schools

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

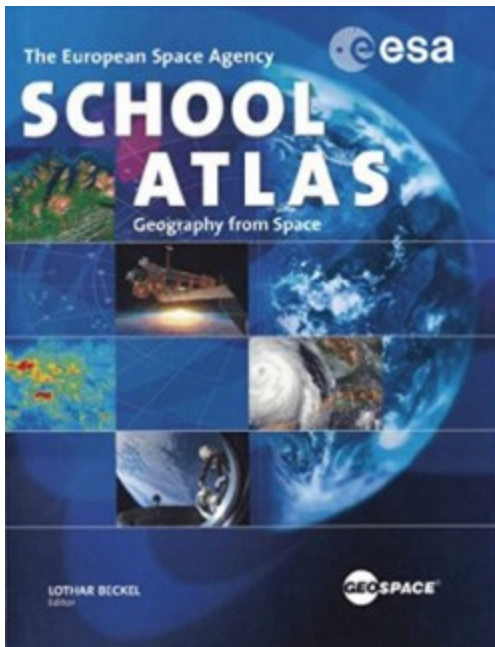
Tools for general outreach

1. i-books
2. Apps for Tablets

Tools for University level

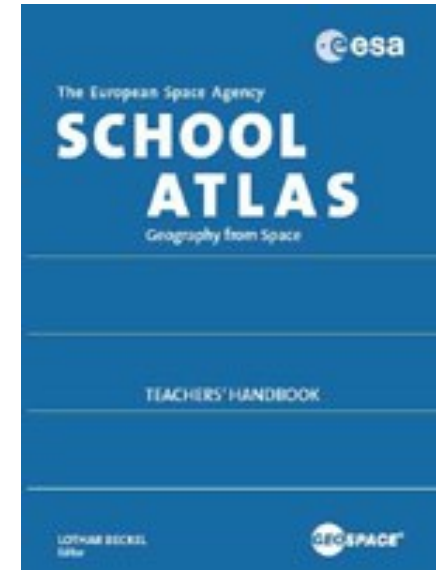
1. MOOCs
2. SAR videos
3. SNAP Tutorials
4. Thematic Exploitation Platforms (TEP's)

ESA School Atlas, new ESA Water Atlas

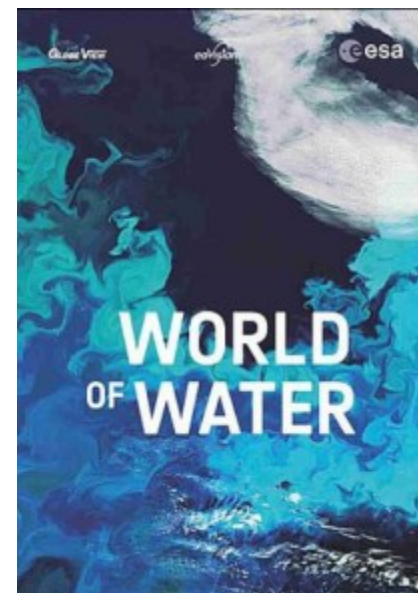


Introduction to ESA; Earth Observation; Global Overview; Continental Overview; the Natural Sphere; The Cultural Sphere.

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. It also 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>)

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



European Space Agency

ESA Education **Home** Earth from Space Environmental Issues Envisat for Schools

03-May-2010

Earth from Space:
Image of the week

About Eduspace

What is Eduspace? ▶

What tools does it offer? ▶

Languages... ▶

Remote Sensing Principles

What is remote sensing? ▶

Remote sensing in depth ▶

History of Earth observation ▶

Mapping and satellite data ▶

Satellite orbits ▶

Resource satellites ▶

Weather satellites ▶

Resources... ▶

Multimedia

Image Gallery ▶

Video Gallery ▶

MIRAVI: Earth live ▶

Services

Eduspace
Earth from Space



European Space Agency

ESA Education **Home** Weather and Climate Global Change Natural Disasters

About Eduspace

What is Eduspace? ▶

What tools does it offer? ▶

Choose your language... ▶

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History of Earth observation ▶

Mapping and satellite data ▶

Satellite orbits ▶

Earth observation satellites ▶

Resources... ▶

Multimedia

Image Gallery ▶

Video Gallery ▶

Services

Contact us ▶

Search in Eduspace ▶

Search

GO

Flash floods in Thessaloniki

Floods are considered one of the most catastrophic natural disasters. They affect more people than any other natural disaster, posing serious risks for people's lives, properties and infrastructure. Due to the increasing frequency of severe flood events, as well as evidence of global climate change and rise in sea levels, floods are now considered a serious threat.

[Full story ▶](#)

The Gulf Stream

The Gulf Stream is a warm, fast flowing current that forms the western boundary of the North Atlantic Gyre. During its course, its temperature gradually drops as it releases heat into the atmosphere.

[Full story ▶](#)

Climate change and glaciers

Detecting and quantifying glacier retreat and advancement, glacier area changes, and glacier lake changes is one of the most important contributions satellite technology can make to further our understanding of climate change. For a large number of glaciers, especially those found in remote places, satellite remote sensing is the only method scientists have to study them.

06-Nov-2013

Earth from Space:
Image of the week



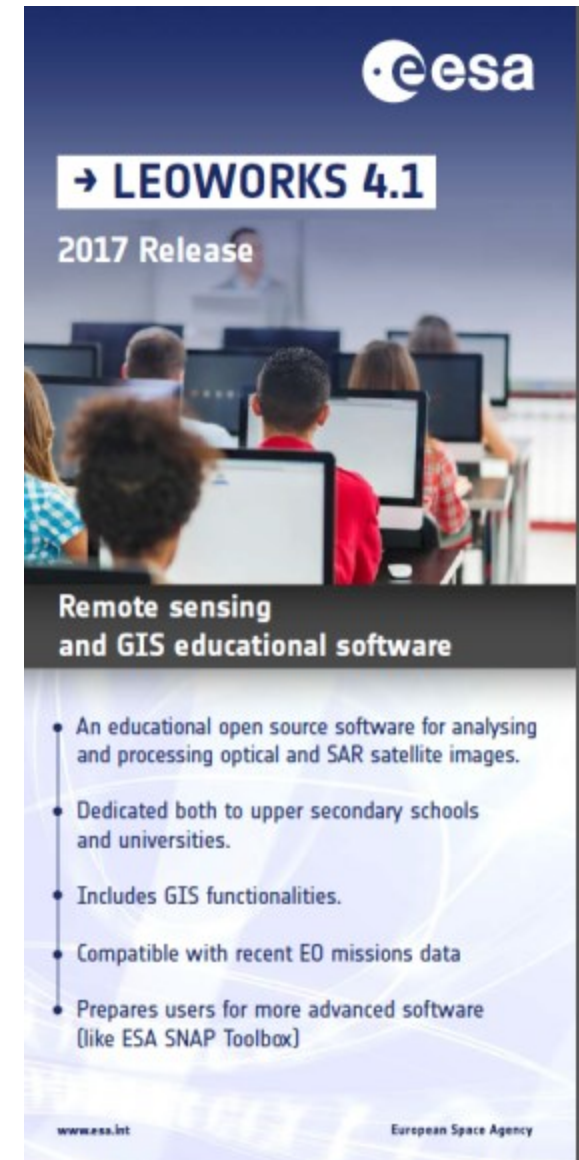
[Image archive](#)

LEOWorks 4.1

Image Processing Software



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



Sentinel Application Platform (SNAP): SW toolboxes with tutorials and forum



1. Set of tutorials for SNAP
(Sentinel toolboxes)

<http://step.esa.int/main/doc/tutorials/>

1. User forum dedicated to
Sentinel toolboxes (SNAP)

<http://forum.step.esa.int/>

Tutorials

TUTORIAL CATEGORIES

SNAP (General toolbox usage)

SENTINEL-1 TOOLBOX (SAR applications)

SENTINEL-2 TOOLBOX (High resolution optical applications)

SENTINEL-3 TOOLBOX (Medium resolution optical applications)

ESA TRAINING COURSES (ESA Training Courses)

EXTERNAL RESOURCES (Other tutorials)

ALL (All tutorials)

SEARCH (11 tutorials found)

Search for tutorials...

SELECTED: SNAP (1 to 6 / 11)

Sort By (Tutorial Id) ▲



Overview

December 29, 2015

SNAP reunites all Sentinel Toolboxes in order to offer the most complex platform for this mission.



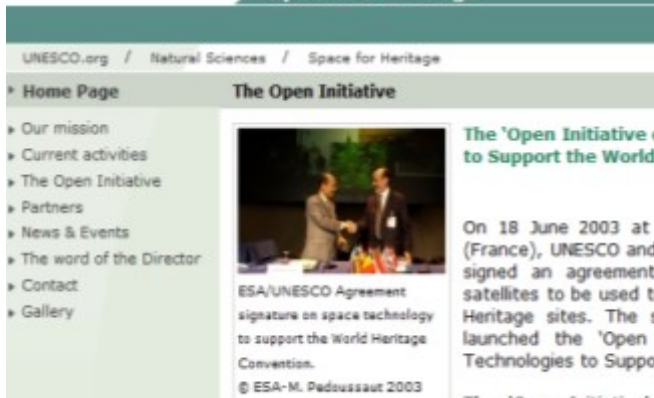
Colour Manipulation Tool

December 29, 2015

Introduction to the usage of the colour manipulation tool.



Capacity Building in the frame of International Cooperation with UNESCO



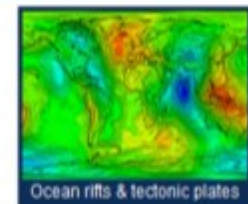
From the Kilimanjaro in Tanzania to the Gre China, there are 890 different sites on UNESCO Heritage list (April 2009). These include 689 cultural, 176 natural and 25 mixed properties in 148 States Parties. UNESCO considers 31 of them currently under threat. The idea of the Open Initiative is that data from space will be used to monitor these sites, alerting authorities to land use changes that could place the sites in danger.

The 'Open Initiative' has nowadays (May 2010) [53 partners](#) that includes space agencies, universities, research institutes and from the private sector.



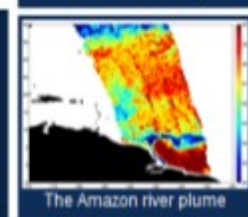
A holistic framework for EO education

- Lessons on different EO applications.
- Over 200 data sets with description.
- New powerful version of the Bilko software
- Resource library with extra information and tools.
- Support for lesson writers and lesson users



Lesson Writing Competition

Do you care about EO education?
Do you want to share your expertise?
Do you have examples



I-books, Apps



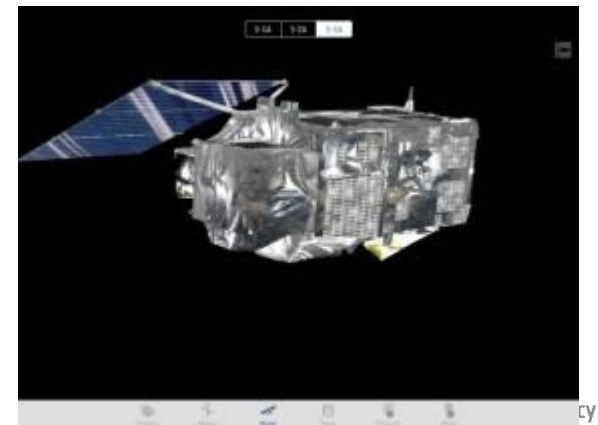
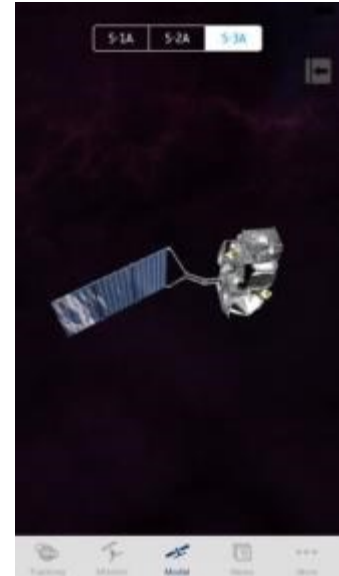
ESA Presentation | 20 June 2016 | Earth Observation Programm

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Sentinel App



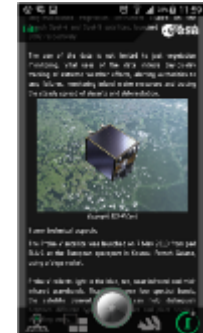
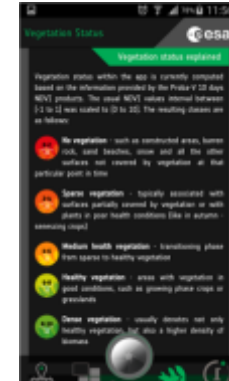
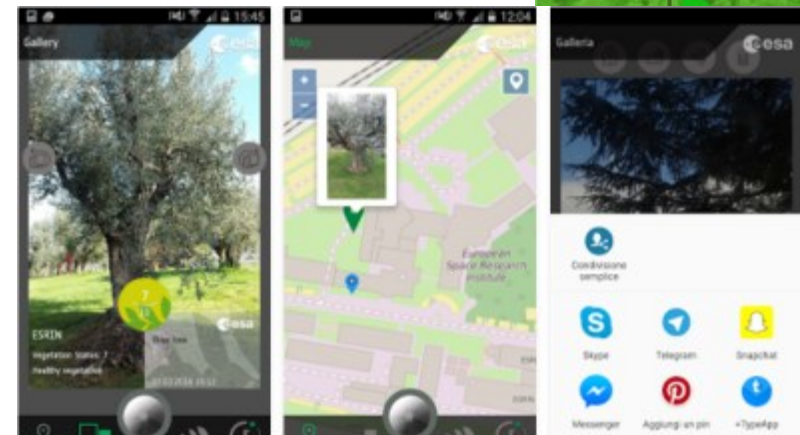
- See where the Sentinel satellites are in real-time
- See the last and next time they have been and will be over your location; Move them to the time of the last data transmission and smoothly move them back to their current location over the 3D globe
- Explore the Sentinel satellite 3D models
- Get 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



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
- UI available in several languages: English, Italian, Portuguese, Dutch, Spanish, German, etc.



Climate from Space, ESA's iPad App for visualization of climate data being produced through the European Space Agency's Climate Change Initiative (CCI)



Allows to visualize temporal changes of:

- sea surface temperature,
- the ice sheets,
- sea level,
- sea ice,
- carbon dioxide,
- soil moisture and many more.



Video courses (University level) about EO



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

What is a MOOC?

- 1. Massive:** no limitation on the number of participants. The record is 440,000!
- 2. Open:** free and accessible for anyone with an Internet connection
- 3. Online:** all activities are made online
- 4. Course:** it has a specific topic, prepared by specialists, offering theoretical and practical content

1st MOOC about “Climate from Space”



- <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 Q&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 per

EDUCATORS



Ravit 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.

Other ESA MOOCs



Monitoring Climate from Space



Explore our planet from space and learn how Earth observation is used to monitor climate change, with this free online course.

Earth Observation from Space: the Optical View



Discover how optical Earth observation data is gathered and used in this free online course from the European Space Agency (ESA).

- **3rd ESA MOOC on Climate from Space “Greenland special”**

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

- **1st ESA MOOC on “EO from Space: The Optical View”**

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

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

SAR video lectures and SNAP tutorials (French)



1. SAR basic theory and practical exercises with SNAP (French version)
2. Subtitles (Spanish, English) done for free by students, in preparation

EO course (French)
European Space Agency, ESA


▶ ODTWÓRZ WSZYSTKIE

26 filmów • 3 373 wyświetlenia • Ostatnia aktualizacja: 19 wrz 2016

- 1 Introduction 1: Henri Laur 1
European Space Agency, ESA
2:15
- 2 Introduction 2: Henri Laur 2
European Space Agency, ESA
4:13
- 3 Introduction 3: Pierre Potin
European Space Agency, ESA
39:33
- 4 Introduction 4: Alessandra Tassa
European Space Agency, ESA
17:27
- 5 Introduction 5: Jean-Paul Rudant
European Space Agency, ESA
3:52








European Space Agency

**esa** Earthnet Online

Need Help? Contact here European Space Agency

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


You are here [Home](#) » [EO Education and Training](#)

- 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



Overview of Earth Observation Training at ESA
ESA undertakes a wide range of activities in the field of Earth Observation education, training and capacity building. The scope of these activities ranges from high level training in state-of-the-art processing for the next generation of Principal Investigators to more general outreach activities and Earth Observation education for schools.
The aim of this website is to provide a single portal that supplies information about these activities, and enables access to resources produced in their framework.

- EO data

- EO data distributed by ESA
- Access data online
- Access GME \$ data
- How to apply for data
- Eoli Catalogue
- ESA Multimedia Gallery

- EO training activities

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


- EO software

- NEST Training
- LEOVorks Download (19.5mb)
- Bilko
- ILVVIS

- Key Resources

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


- LearnEO!



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

[Read more](#)


- Education for Schools




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

[Read more](#)

- EO Summer Schools



- TIGER Training



Central page for EO education and training

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

Central page for EO education and training



https://earth.esa.int/web/guest/training-packages/-/article/sar-land-applications-tutorial

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Need Help? Contact here European Space Agency

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

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Training Package Details

SAR Land Applications Tutorial

The aim of this tutorial is to introduce beginners to land applications of satellite remote sensing using synthetic aperture radar (SAR). It is intended to give students a basic understanding of SAR technology, the main steps involved in the processing of SAR data, and the type of information that may be obtained from SAR images. The tutorial has three main components:

- [Background and Theory](#) – an overview of the principles behind SAR remote sensing, data processing techniques, examples of land applications, and current and future sources of SAR data
- [The Bilko Exercise](#) - a computer practical using the Bilko software with ENVISAT ASAR data, allowing students to apply the theoretical knowledge to the processing and interpretation of actual SAR data
- [Answers and Examples A](#)
- [Answers and Examples B](#)

Model answers to questions from both parts of the tutorial.

EO Education and Training

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- EO Education for Schools
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Earth Online Resources

EO Data Access

- EO data distributed by ESA
- Access data online
- Access Copernicus data
- How to apply for data

Resources

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- EO Software Toolboxes

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Space Agency

https://earth.esa.int/web/guest/training-packages/-/article/sar-land-applications-tutorial

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Explore more... ▾

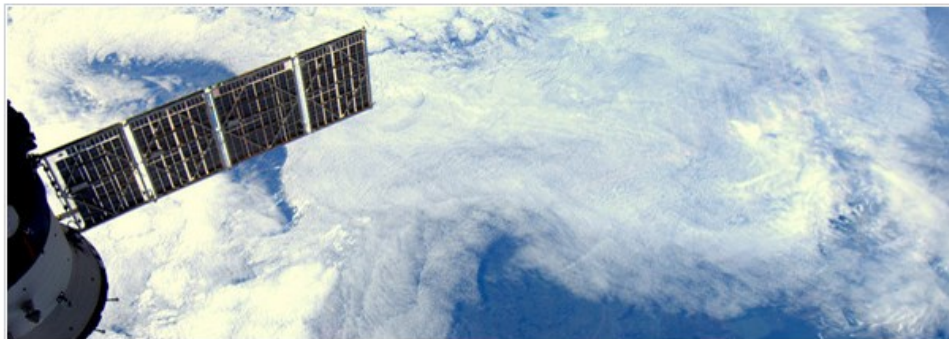
You are here [Home](#) > [EO Education and Training](#) > [Other EO Training](#)

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Other EO Training



In addition to the programmes listed in the Overview page, ESA organises other EO training events on an ad hoc basis, and produces EO training material at various levels.

Below is a list of each training package listed in chronological order (to access the material for each package, click on the links provided in the list):

Training Packages

7th ESA Training Course on Radar Remote Sensing (30 May - 4 Jun 2016)

Training course on the theory and applications of spaceborne Synthetic Aperture Radar (SAR). The course is held in Sofia, Bulgaria.

[Read more](#)

EO Education and Training

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[EO Education for Schools](#)

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EO Data

[EO data distributed by ESA](#)

[Online Archives](#)

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[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](#)

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

European Space Agency

Central page for EO education and training



Earth Online

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Need Help? [Contact here](#)

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Data Access

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Earth Topics

PI Community

Explore more...

You are here [Home](#) , [EO Education and Training](#) , [EO Education for Schools](#)

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EO Education for Schools

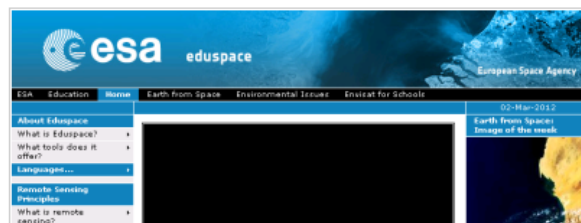


EO Education for Schools

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.



EO Education and Training

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EO software

European Space Agency

Central page for EO education and training



The screenshot shows the ESA Earth Online website. The header includes the ESA logo, 'Earth Online', and navigation links like 'Data Access', 'Missions', 'Earth Topics', and 'PI Community'. The main content area is titled 'EO Education and Training' and contains several paragraphs of text about the ESA School Atlas, its educational value, and where to find more resources. A sidebar on the right lists 'EO data' and 'EO training activities'.

esa Earth Online

Need Help? [Contact here](#) [European Space Agency](#)

[Data Access](#) [Missions](#) [Earth Topics](#) [PI Community](#) [Explore more...](#)

You are here [Home](#) > [EO Education and Training](#) > [EO Education for Schools](#)

ESA School Atlas

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

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

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

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

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

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

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

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

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

The Atlas contains the following content:

EO Education and Training

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

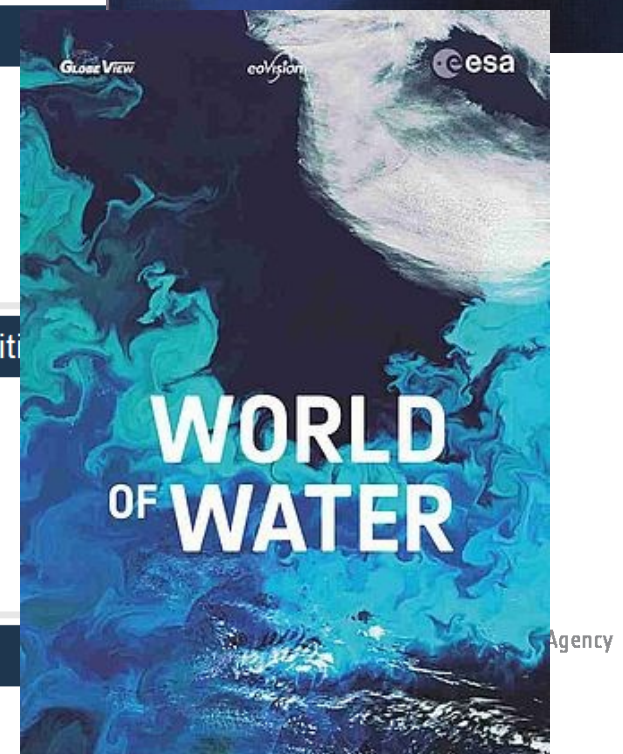
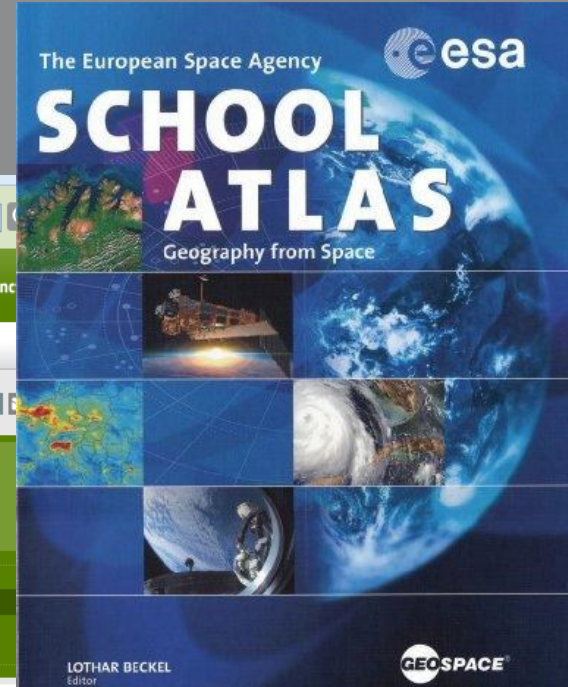
EO data

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EO software

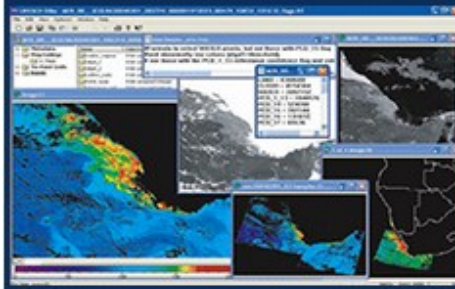


LearnEO!

Learn Earth Observation with ESA

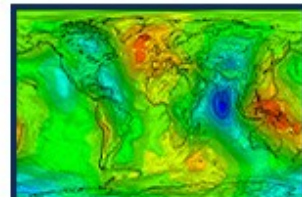
[Home](#) [Lesson competition](#) [About](#) [Data sets](#) [Lessons](#) [Software](#) [Resource library](#) [Information for authors](#) [Register](#)

Hands-on activities with Bilko



A holistic framework for EO education

- Lessons on different EO applications.
- Over 200 data sets with description.
- New powerful version of the Bilko software
- Resource library with extra information and tools.
- Support for lesson writers and lesson users



Ocean rifts & tectonic plates

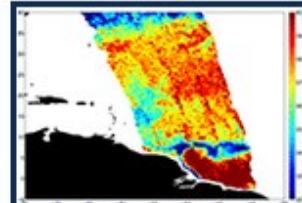
Lesson Writing Competition



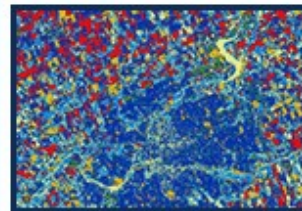
Do you care about EO education?
Do you want to share your expertise?
Do you have examples of how EO data can make a difference?

Prizes: €5000, €3000, €2000

Open to anyone over 18 anywhere in the world
See our [competition pages](#) to learn more



The Amazon river plume



Land cover mapping

Platforms and missions



National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

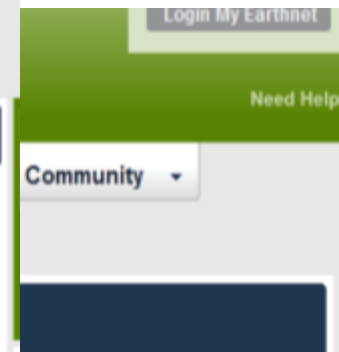
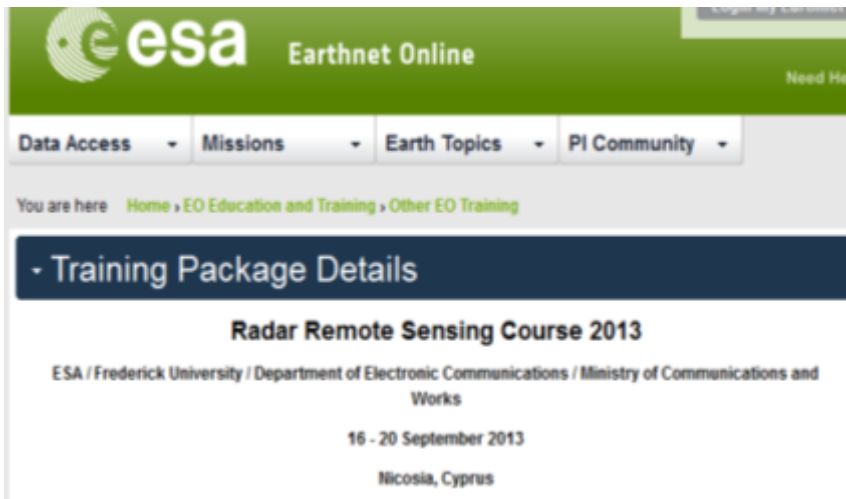


Training courses at University level in Europe: ECS (Capacity Building in Earth Observation)



Series of Radar Training Courses in ECS countries since 2008 (University level): first for Radar Remote Sensing, now extended to the Sentinels

Czech Republic (2008), Romania (2009), Poland (2010), Hungary (2011), Estonia (2012), Cyprus (2013), Malta (2014), Slovenia (2015), Bulgaria (May 2016) and Latvia (Sept 2016), **Lithuania (July 2017)**



ESA/CSO Radar Remote Sensing Course
27-31 October 2008

Training courses at University level in Europe: Innovative Training for Next generation EO Scientists, in MS



seom scientific exploitation of operational missions

ESA

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Ocean
France, Sep 2015

Ifremer

ESA

4th ESA ADVANCED TRAINING ON OCEAN REMOTE SENSING

7-11 September 2015 | IFREMER | Brest, France

BACKGROUND

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ESA

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Land
Spain, Sep 2014

8-12 September 2014, University of Valencia, Valencia, Spain

ESA

5th ESA ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

8-12 September 2014 | University of Valencia | Valencia, Spain

Highlights

Valencia, Spain, seen from over 300 km above Earth by an orbiter on the International Space Station on 9 October 2013

Released: 10/12/2013

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ESA

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Atmosphere
Germany, Oct 2014

JÜLICH

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POLARIMETRY COURSE 2015

SEOM

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Polarimetry
Italy, Jan 2015

Highlights

International L. processing for

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



→ **EARTH OBSERVATION
SUMMER SCHOOL**

Earth System Monitoring & Modelling



1-12 August 2016 | ESA-ESRIN | Frascati (Rome), Italy

**1-12 August 2016 Summer School
ESRIN**

**70 early career scientists
have taken part.**

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



Topics :

**Global Observing Systems, Earth
System Modelling, Data
Assimilation, Global Change**

ESA UNCLASSIFIED – Releasable to the Public



Training courses at University level in Europe: EARSeL



Long-term cooperation in organising joint Workshops for teachers / young researchers with EARSeL (European Association of Remote Sensing Laboratories)



European Association of Remote Sensing Laboratories

Special Interest Group

Remote Sensing in Education and Training

10 - 13 July 2017
Museum of the World Ocean, Kaliningrad, Russia
54°44'N 20°29'E

3rd Student Workshop on Ecology and Optics of Coastal Zones

A Summer School jointly organised by:

- EARSeL's Special Interest Group Education & Training
- Faculty of Physics, Lomonosov Moscow State University, Russia
- Immanuel Kant Baltic Federal University, Kaliningrad, Russia
- Institute of Physics, University of Oldenburg, Germany
- Museum of the World Ocean, Kaliningrad, Russia
- The Atlantic Branch of P.P. Shirshov Institute of Oceanology, Kaliningrad, Russia

to be held in the premises of the [Museum of the World Ocean](#) in Kaliningrad, Russia, on 10-13 July 2017.

New: Lecturer Meeting on 13 July, 14-17h
Lecturers and other interested participants will meet on 13 July afternoon for a strategy meeting. Focus will be on the creation of new educational material for different school and university levels in natural sciences, mathematics and engineering, and for authorities responsible for monitoring and surveillance of the marine environment. The outcome shall be a bundle of project ideas, to be elaborated by partner consortia, and submitted to national and European funding agencies.



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2nd Workshop 2016

1st Workshop 2014

SIG Homepage



Recent EARSeL Workshop and Trainings: Bonn (June 2016), Beijing (July 2016) and Frascati(Rome)/ESRIN on RS for Archaeology (November 2015)

Upcoming event: 3rd Student Workshop on Ecology and Optics of the Coastal Zones (10-13 July 2017, Kaliningrad, Russia)

Training courses at University level in Europe: cooperation with other space agencies (DLR, NASA)



Examples: Cooperation with NASA (Trans-Atlantic Training on LULC in Baltic Countries and Eastern Europe). Forthcoming TAT training event in Hungary, June 2017.

See TAT <http://web.natur.cuni.cz/gis/tat/>
LCLUC workshop http://www.nyme.hu/lcluc_training.html?&L=4
<https://web.natur.cuni.cz/gis/lucc/>



Cooperation with CEOS WGCapD

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Our Work

Working Groups

| WGCapD

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WGCapD

The Working Group on Capacity Building and Data Democracy

The WGCapD (formed at the 25th CEOS Plenary in 2011) undertakes a variety of activities based on the four pillars of the Data Democracy Initiative Mission and aims to unify CEOS efforts toward:

- Providing wider and easier access to Earth Observation data
- Increasing the sharing of software tools such as the use of open source software and open systems interface
- Increasing data dissemination capabilities and transferring relevant technologies to end users
- Providing intensive capacity building, education, and training (including awareness and outreach) for enabling end users to gather the information they need and for increasing communication on achieved results



The WGCapD-6 Group Photo in Oberpfaffenhofen, Germany (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>

A screenshot of the ESA Earthnet Online website. The page has a green header with the ESA logo and 'Earthnet Online' text. Navigation tabs include 'Data Access', 'Missions', 'Earth Topics', and 'PI Community'. The main content area is titled 'EO Education and Training' and features several sections: 'EO Education News' with a competition announcement, 'EO Education and Training' with a satellite image, 'EO data' with a list of links, and 'EO training activities' with a list of programs. The page is flanked by two large, abstract, textured images in shades of brown and blue.

esa Earthnet Online

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Need Help? Contact here European Space Agency

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

You are here Home » EO Education and Training

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](#).

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Overview of Earth Observation Training at ESA

ESA undertakes a wide range of activities in the field of Earth Observation education, training and capacity building. The scope of these activities ranges from high level training in state-of-the-art processing for the next generation of Principal Investigators to more general outreach activities and Earth Observation education for schools.

seom

scientific exploitation of operational missions



ESA SEOM OBJECTIVES ACTION LINES CONFERENCES NEWS TOOLBOX TRAININGS

ESA EO

COPERNICUS

SENTINEL

NEW OPPORTUNITIES

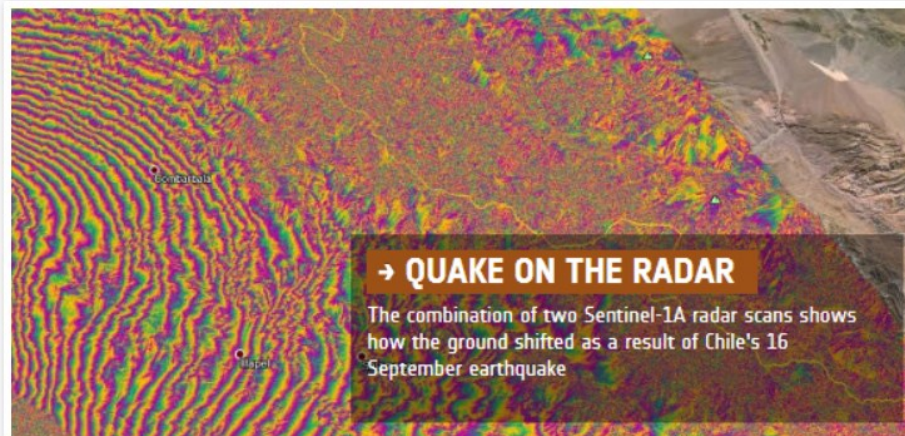
Invitations to Tender

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seom
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EO OPEN SCIENCE



Ocean Training Course 2017



Land Training Course 2017

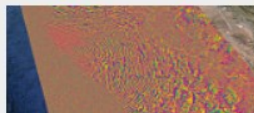


EO Science for Society



SEOM STUDIES RESULTS

Chile earthquake on the Radar



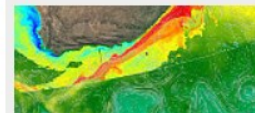
©INSARAP study PPO.labs/NORUT

S1 Toolbox Mosaic of Estonia



©Copernicus data/ESA (2015)

Ocean Virtual Laboratory



©OceanDataLab

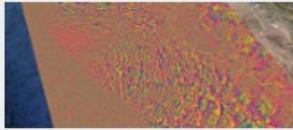
Launch of EO Open Science 2.0

SENTINEL-2 for Science

Shaping next-generation

SEOM STUDIES RESULTS

Chile earthquake on the Radar



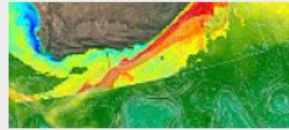
©INSARAP study PPO.labs/NORUT

S1 Toolbox Mosaic of Estonia



©Copernicus data/ESA (2015)

Ocean Virtual Laboratory



©OceanDataLab

Launch of EO Open Science 2.0



SENTINEL-2 for Science Workshop



Shaping next-generation scientists



The SEOM (Scientific Exploitation of Operational Missions) element:

The prime objective of the SEOM element of the Earth Observation Envelope Program 4 is to federate, support and expand the large international research community that the ERS, ENVISAT and the Envelope programmes have build up over the last 20 years. It aims to further strengthen the international leadership of European Earth Observation research community by enabling them to extensively exploit observations from future European operational EO missions. SEOM will enable the science community to address many new avenues of scientific research that will be opened by free and open access to data from operational EO missions.



EO Science for Society



FRINGE 2017



Polinsar 2017



Polarimetry Course 2017



ESA EO summer school



EO OPEN SCIENCE 2016

Thanks for your attention!!!



Web sites of interest for EO Education:

Copernicus: <http://copernicus.eu/>

ESA Earth Watching: <http://ew.eo.esa.int/web/guest/home>

ESA Education: <http://www.esa.int/Education>

SEOM: <http://seom.esa.int/>

ESA Earth Observation:
[http://www.esa.int/Our Activities/Observing the Earth](http://www.esa.int/Our_Activities/Observing_the_Earth)

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

Eduspace: [http://www.esa.int/SPECIALS/Eduspace EN/](http://www.esa.int/SPECIALS/Eduspace_EN/)

International Charter: www.disasterscharter.org

