

How Earth Observation (EO) from space changed our knowledge of the planet

Major Events that Shaped the Earth
2018 EGU/GIFT Workshop, Vienna, Austria, 9-11 April 2018

Francesco Sarti, Chris Stewart
ESA



1. Introduction to ESA

2. Fundamentals of Earth Observation (EO)

3. EO to obtain a synoptic view of the Earth

4. EO to monitor the dynamic Earth and its processes

5. ESA EO Educational & Training



1. Introduction to ESA

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

Article 2 of ESA Convention

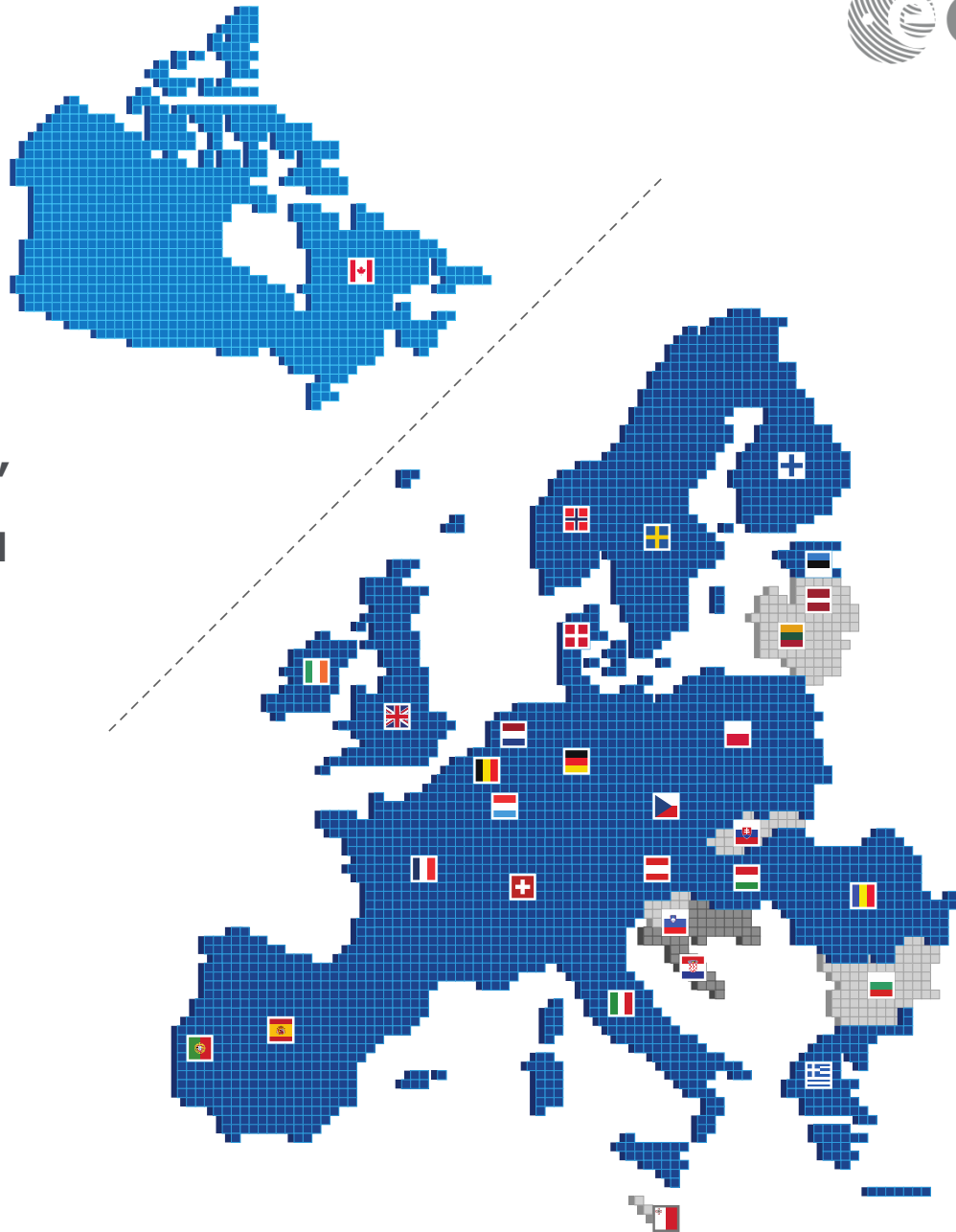


Member States

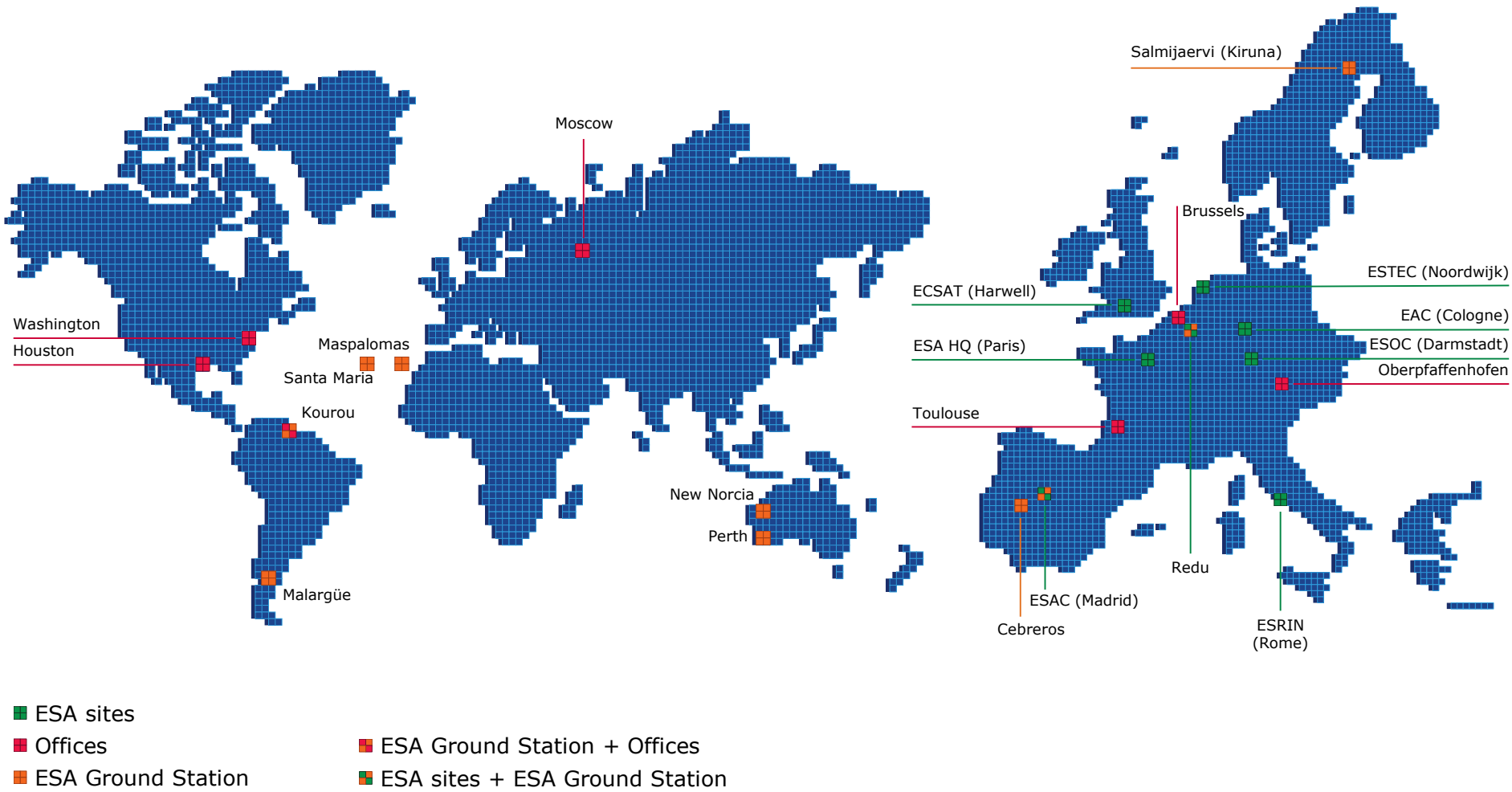
ESA has 22 Member States:
20 states of the EU (AT, BE, CZ, DE, DK, EE, ES, FI, FR, IT, GR, HU, IE, LU, NL, PT, PL, RO, SE, UK) plus Norway and Switzerland.

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

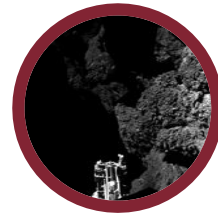
Canada takes part in some programmes under a long-standing Cooperation Agreement.



ESA's locations



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



space science



human spaceflight



exploration



earth observation



launchers



navigation



operations



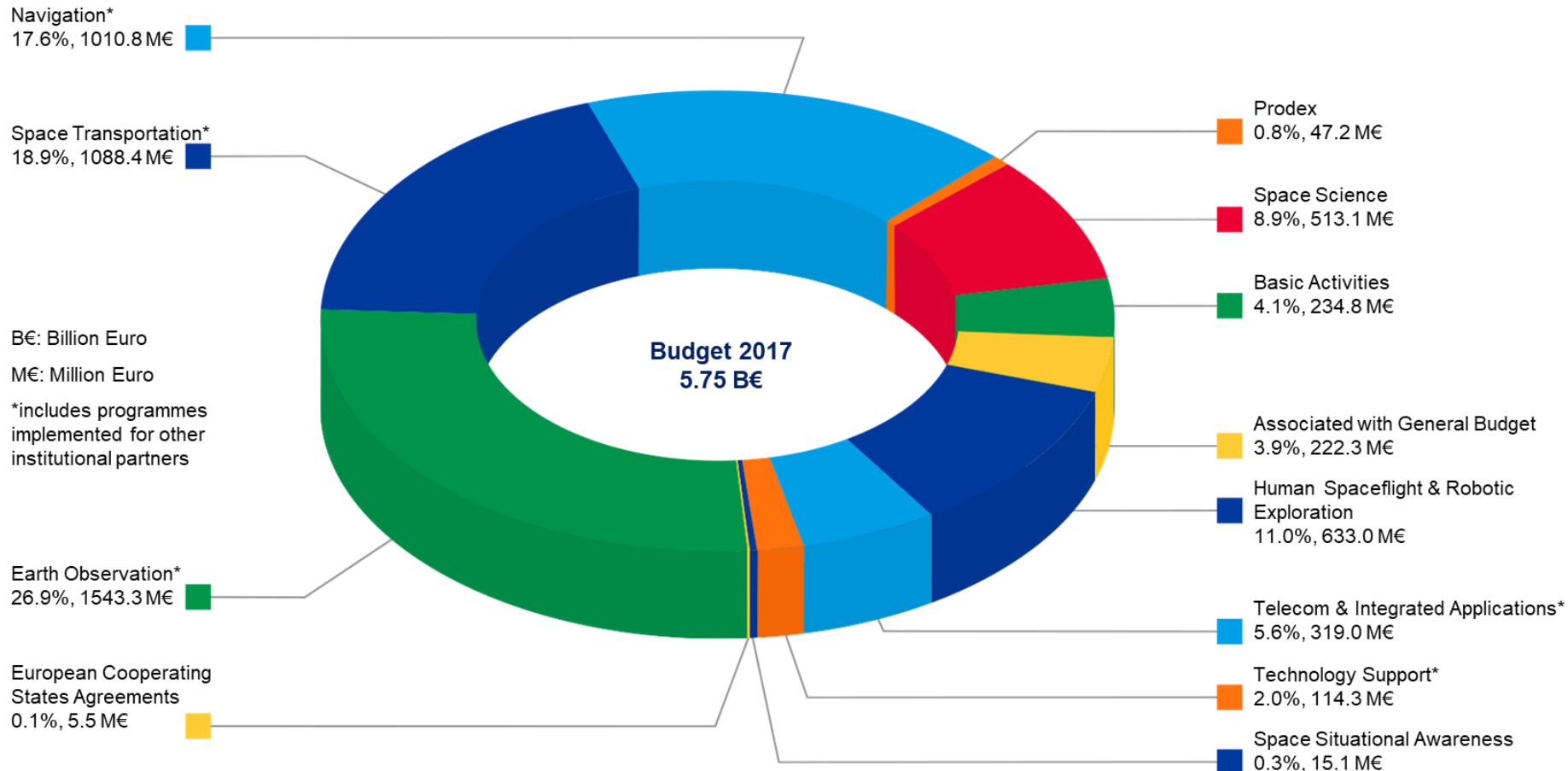
technology



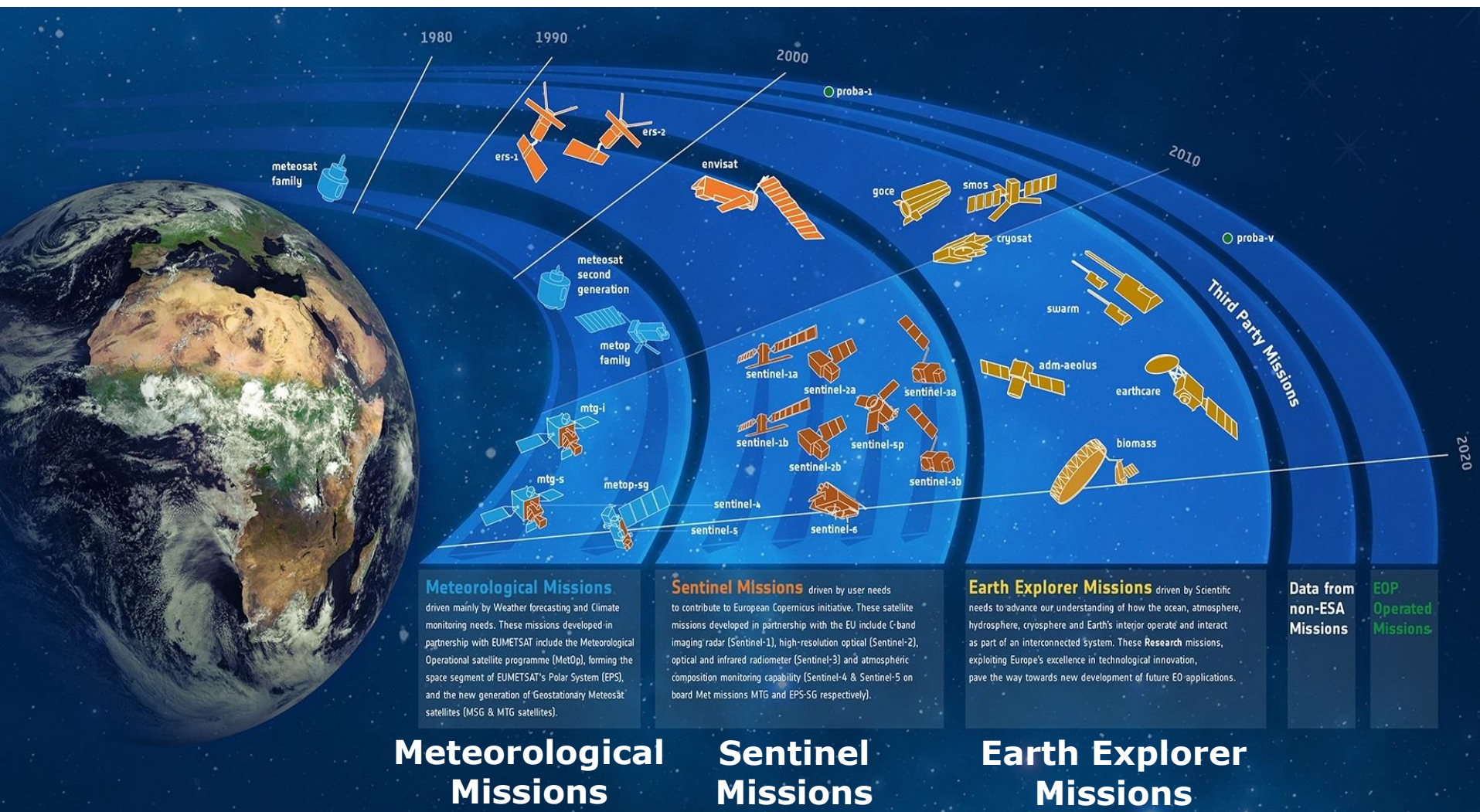
telecommunications

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

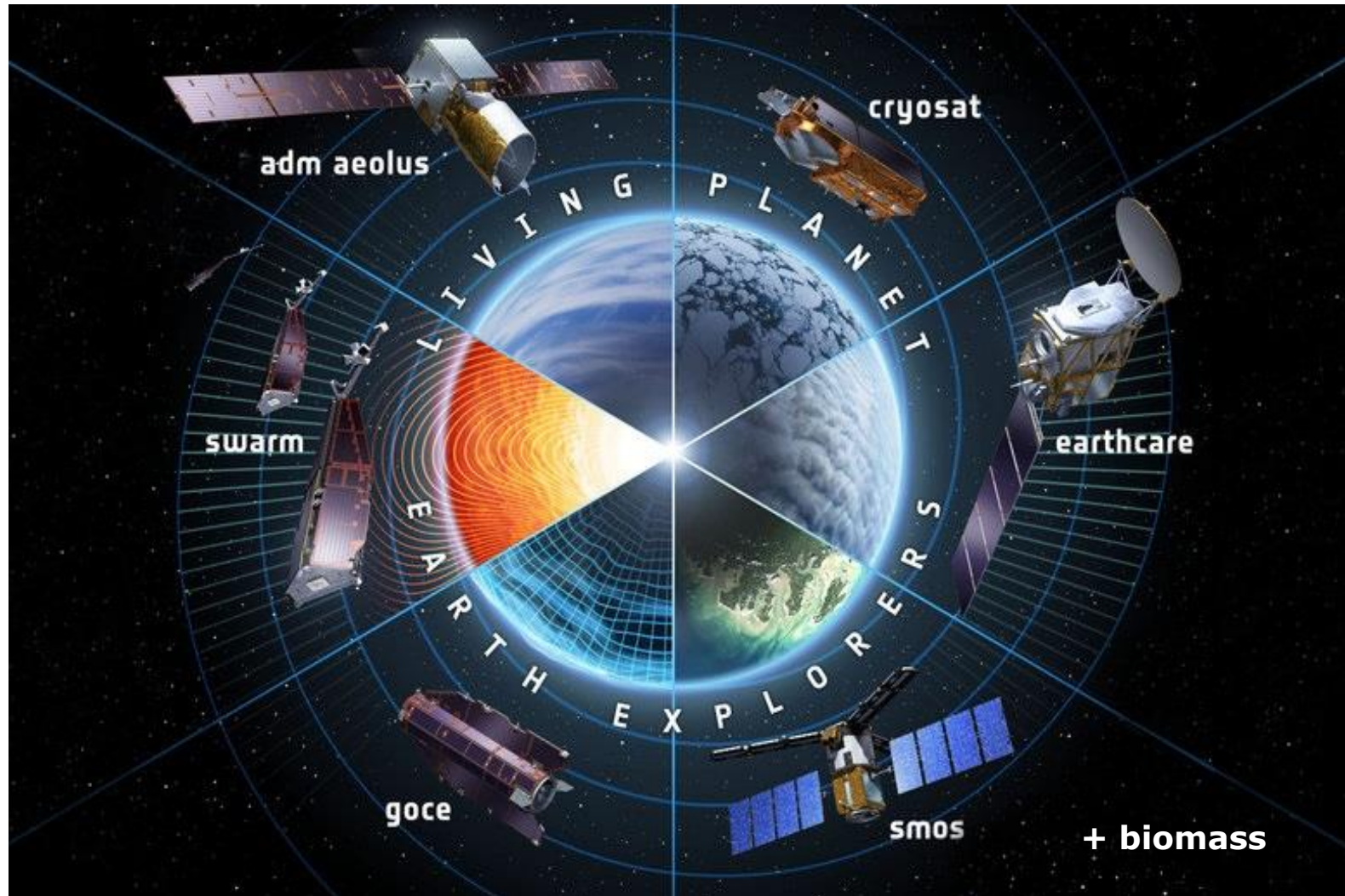
ESA budget for 2017: by domain



ESA Earth Observation Programmes

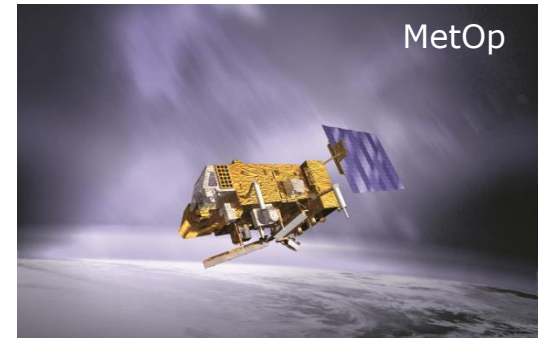
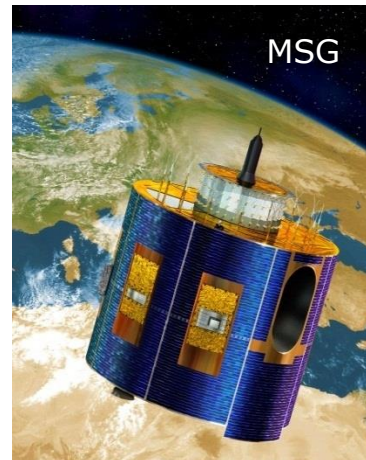


The Earth Explorers



Meteorological missions

- ESA: develops prototype satellites and, on behalf of EUMETSAT, procures recurrent satellites
- EUMETSAT: procures launchers and LEOP services, operates the satellites
- **Meteosat Second Generation** (MSG) missions in GEO and MetOp missions in LEO
- **MeteoSat Third Generation** (MTG) missions and MetOp **Second Generation** (SG) under development



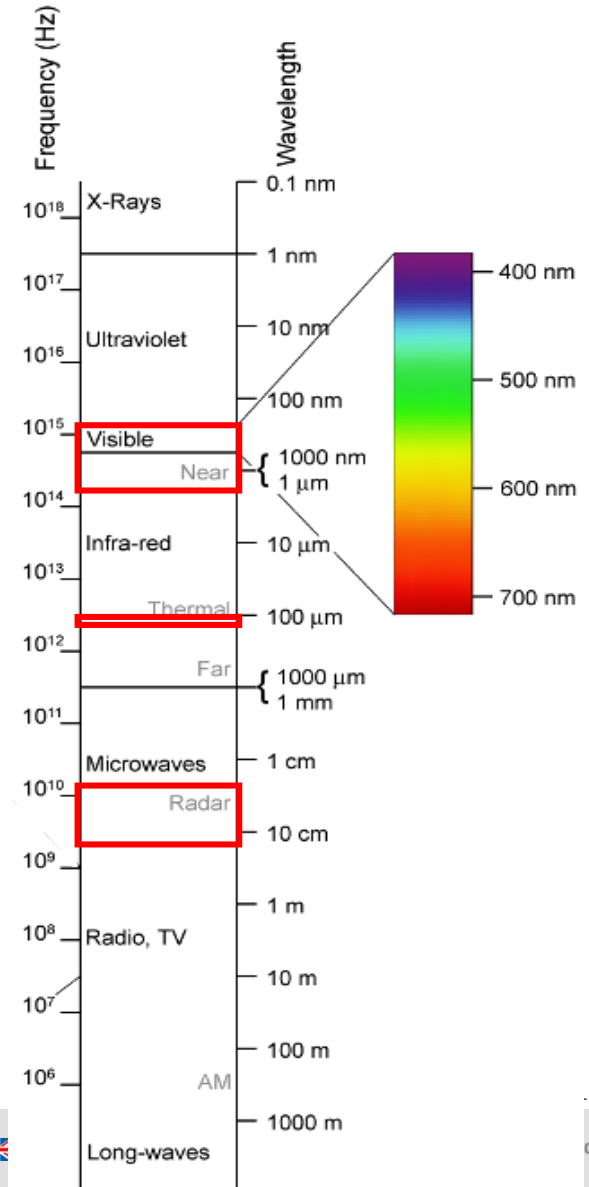
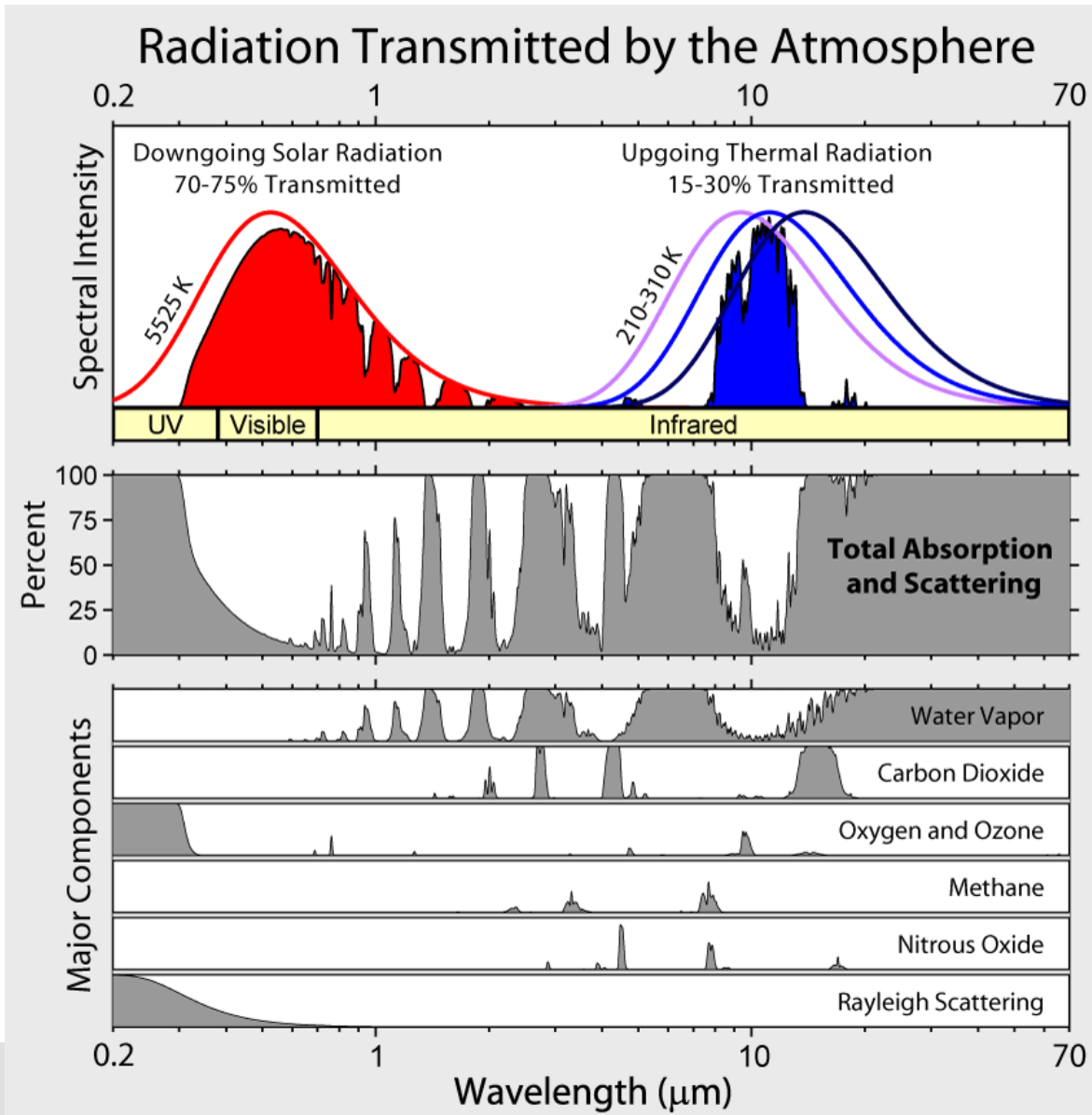


2. Fundamentals of Earth Observation (EO)



0 days 00 hours 00 minutes
Sentinel 2 constellation:
summer solstice

Electromagnetic Spectrum

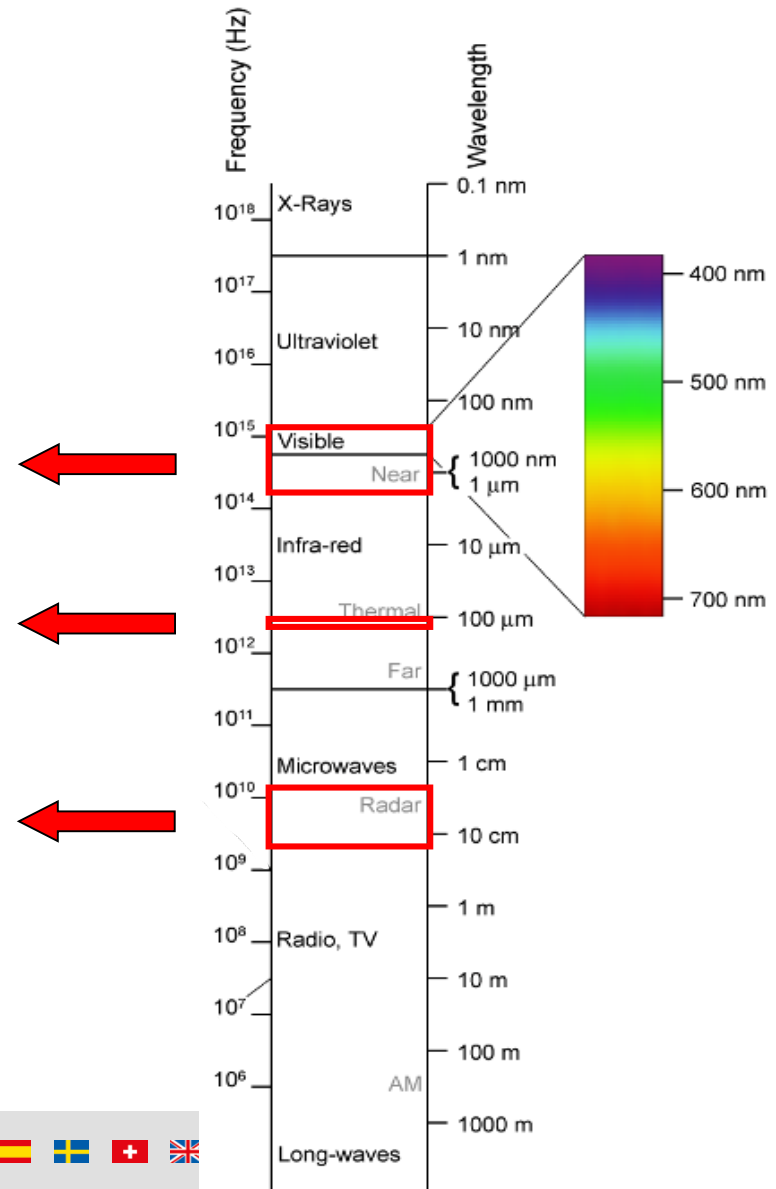


Electromagnetic Spectrum

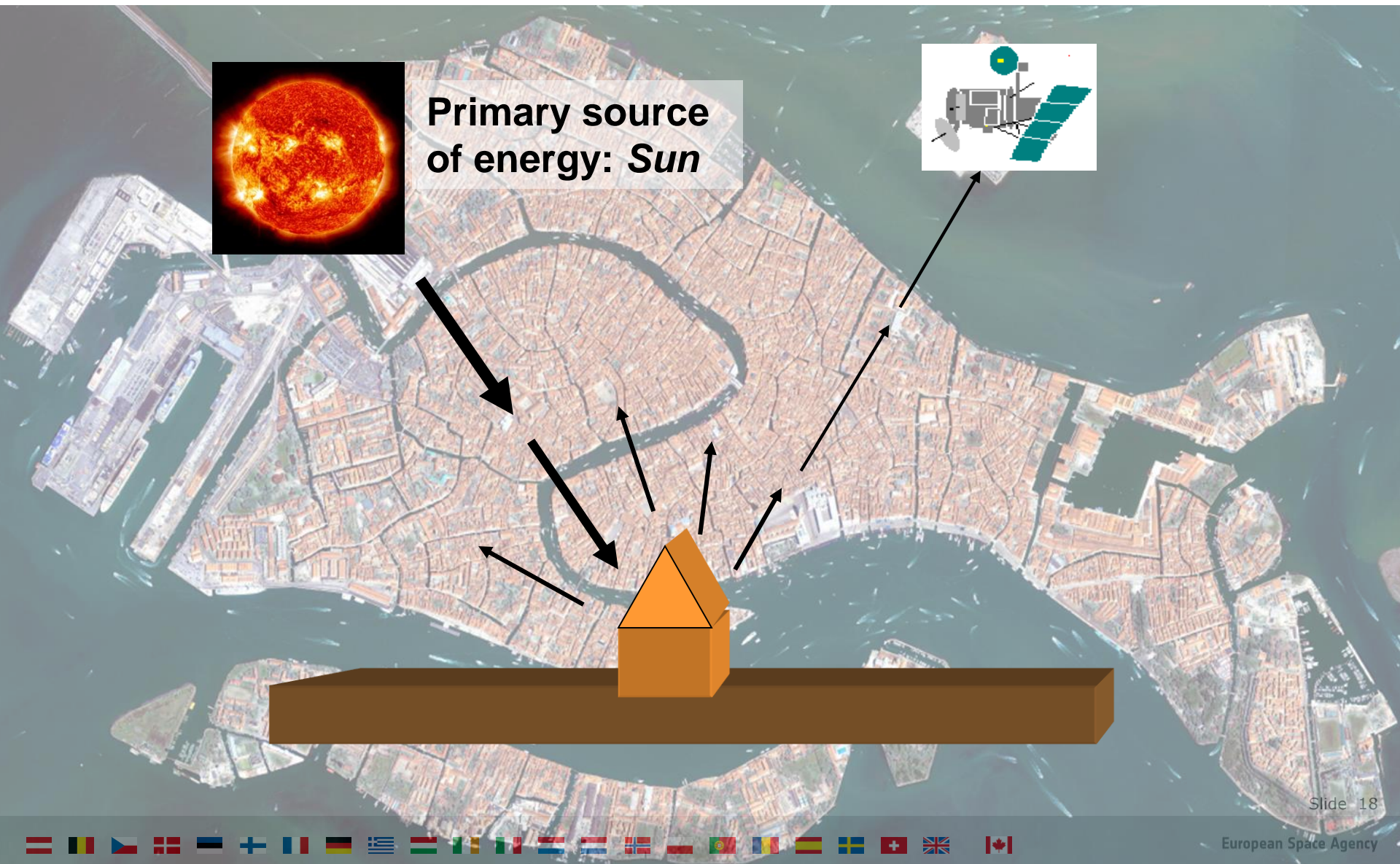
**Visible (VIS) + Near Infrared (NIR) =
Optical**

Thermal Infrared (TIR)

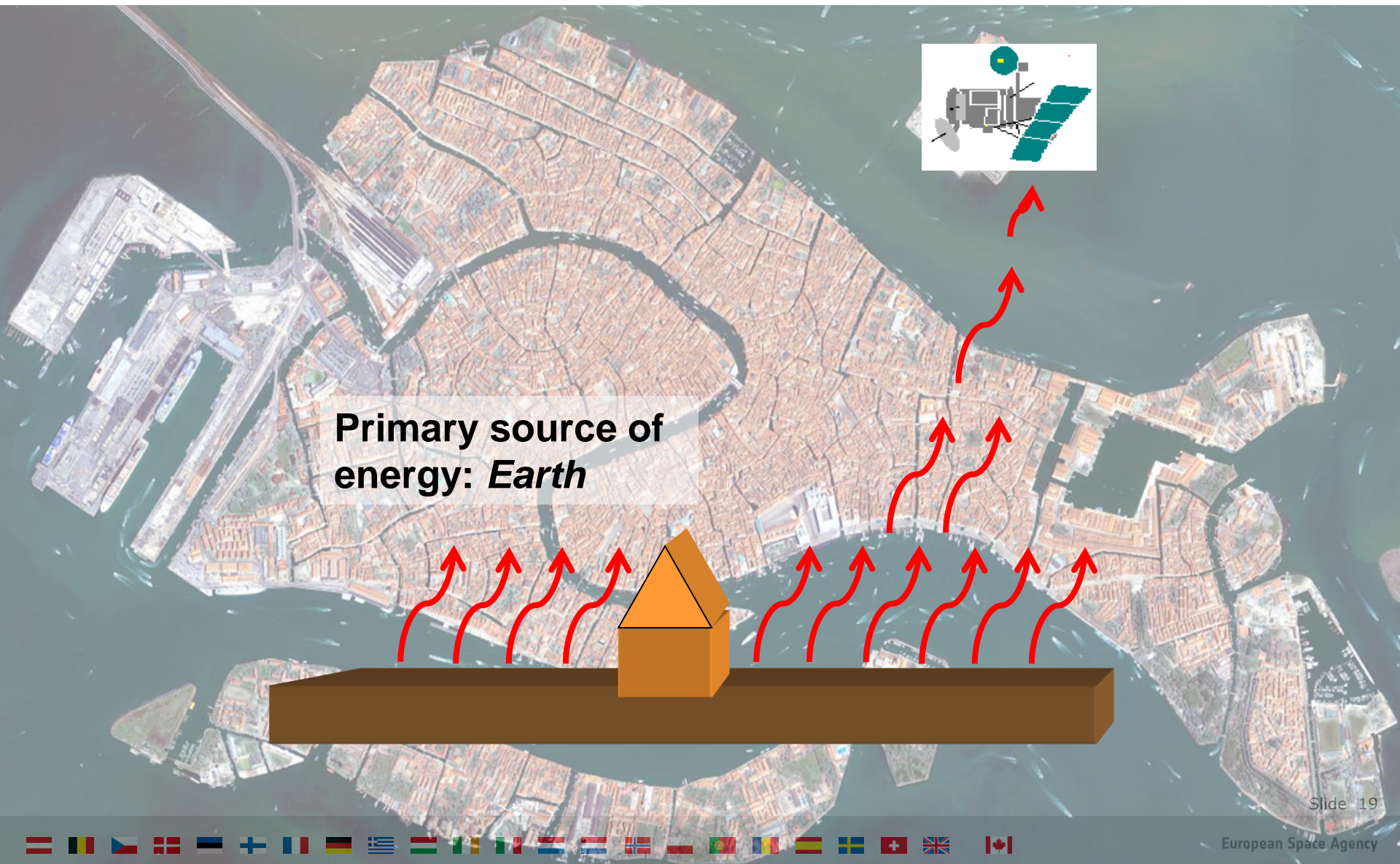
Synthetic Aperture Radar (SAR)



Passive Sensors

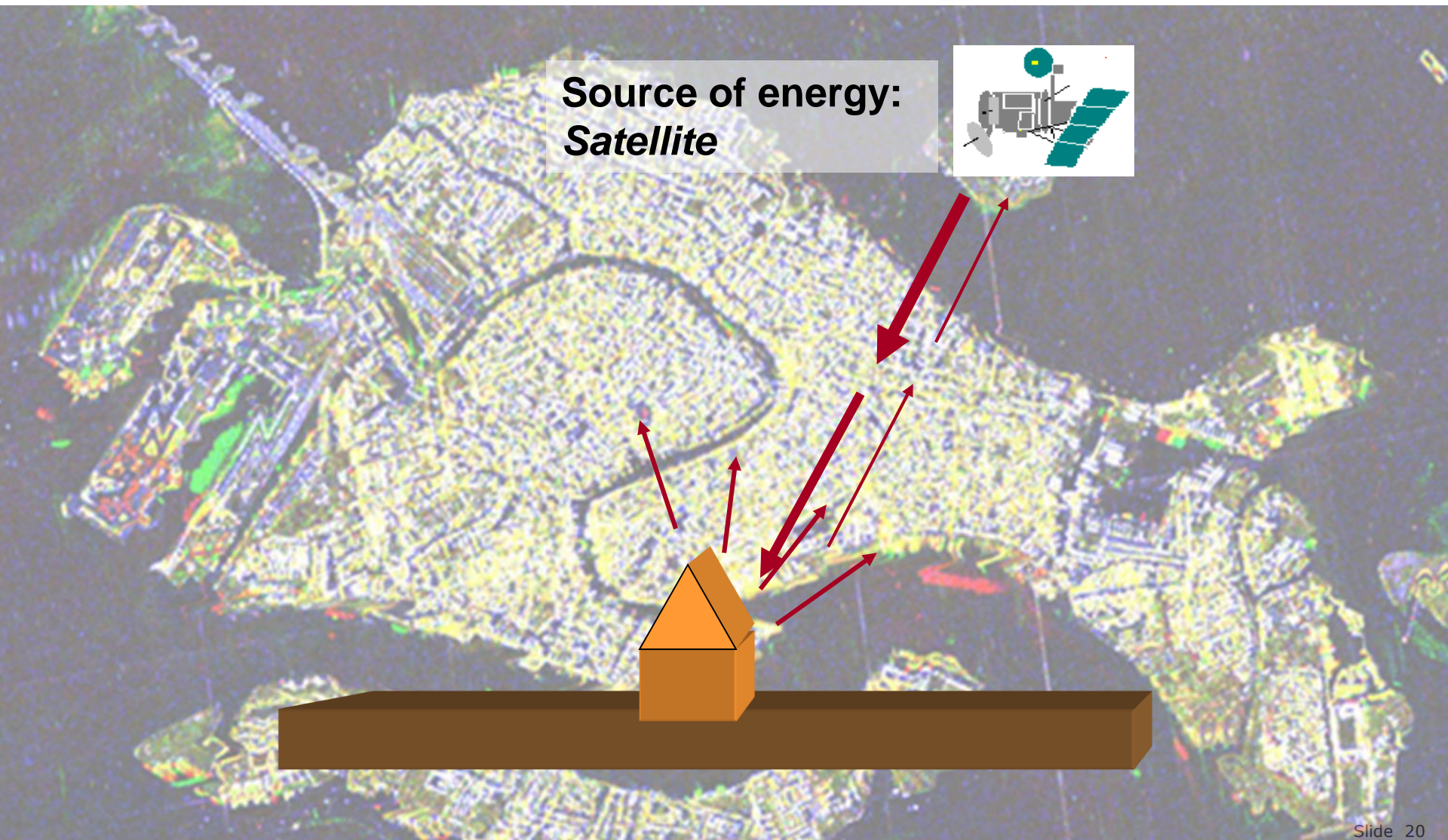


Passive Sensors



Active Sensors

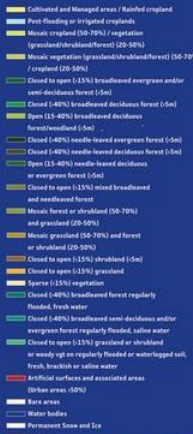
**Source of energy:
Satellite**



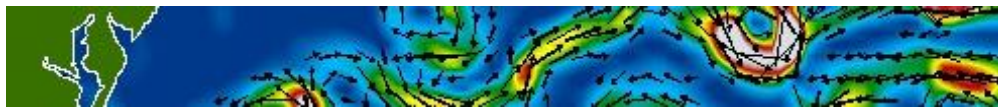
Slide 20



3. Earth Observation to obtain a synoptic view of our planet

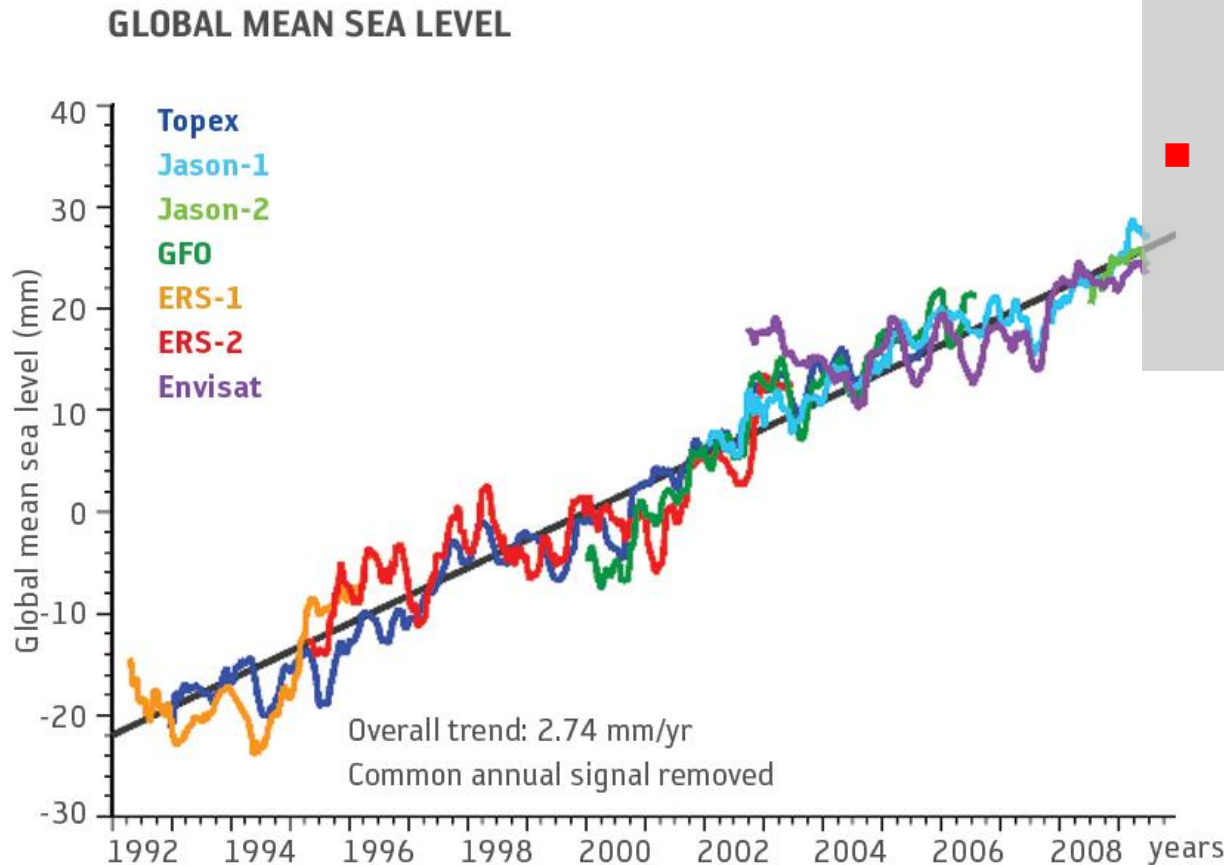


→ GLOBCOVER 2009 | MERIS 300m

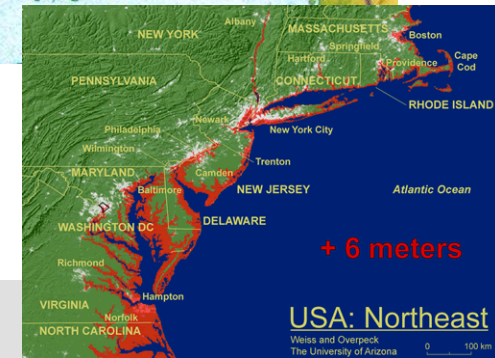


Altimetry

Global Sea Surface Height measurements initiated with the altimeters in the early 1990s



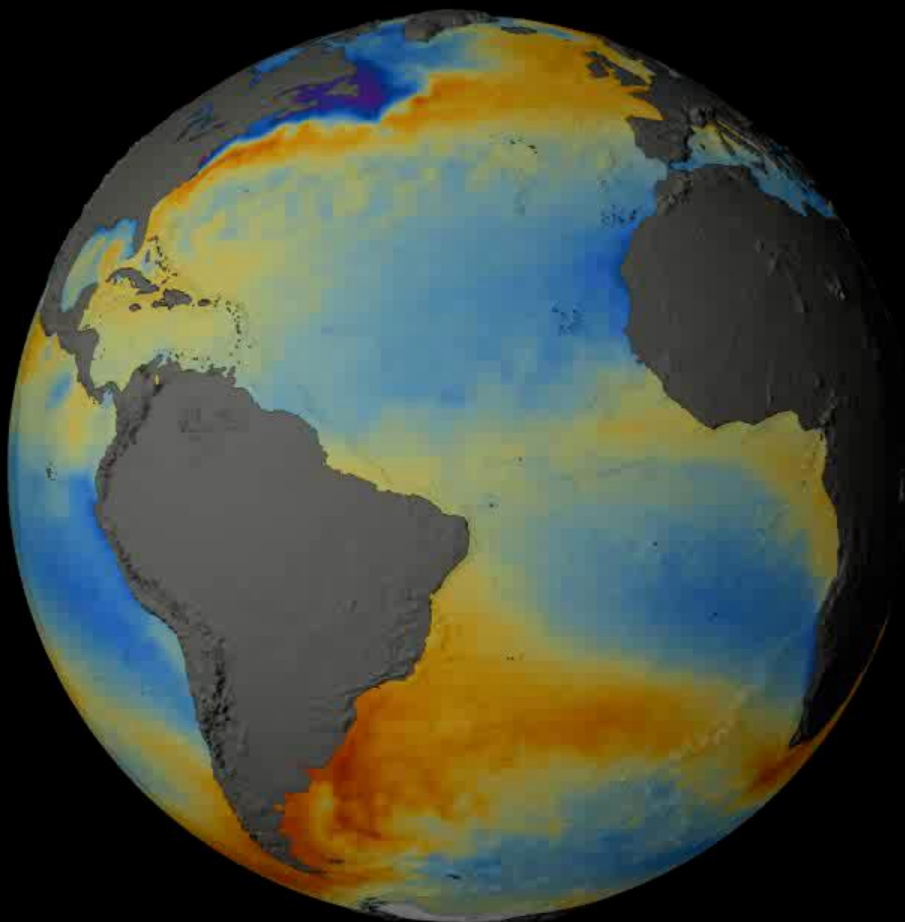
- Sea Level Rise: Thermal expansion of the oceans and melting ice
- Problems for countries with low reliefs like Bangladesh (food security, etc.)



R. Scharroo, Altimetrics, LLC

Courtesy of Remko Scharroo, Altimetrics LLC

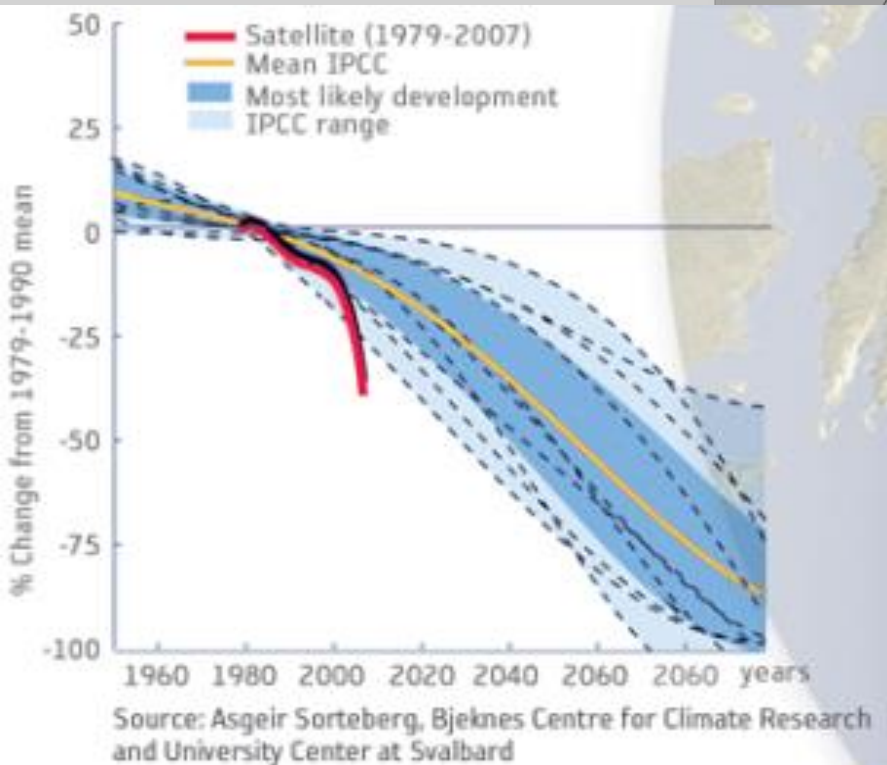
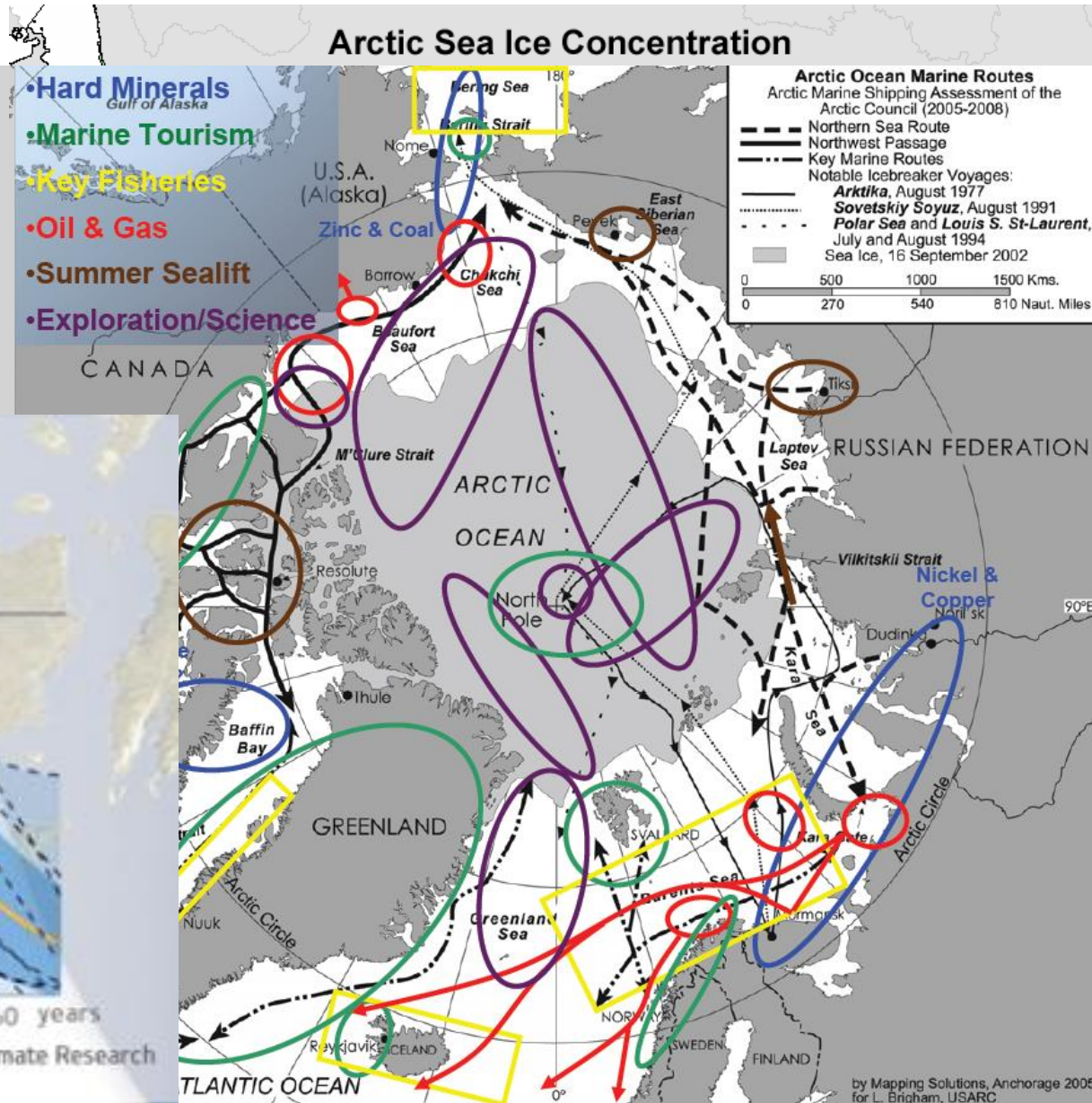




01.1995

Synoptic Views: Polar Regions

- **Arctic sea-ice extent (September) has shrunk by 12% per decade since 1978**
- The Arctic increasingly becomes an arena of high geopolitical relevance



Envisat ASAR mosaic
Mid-August 2008

North
Pole

Chukchi
Sea

Alaska

Beaufort
Sea

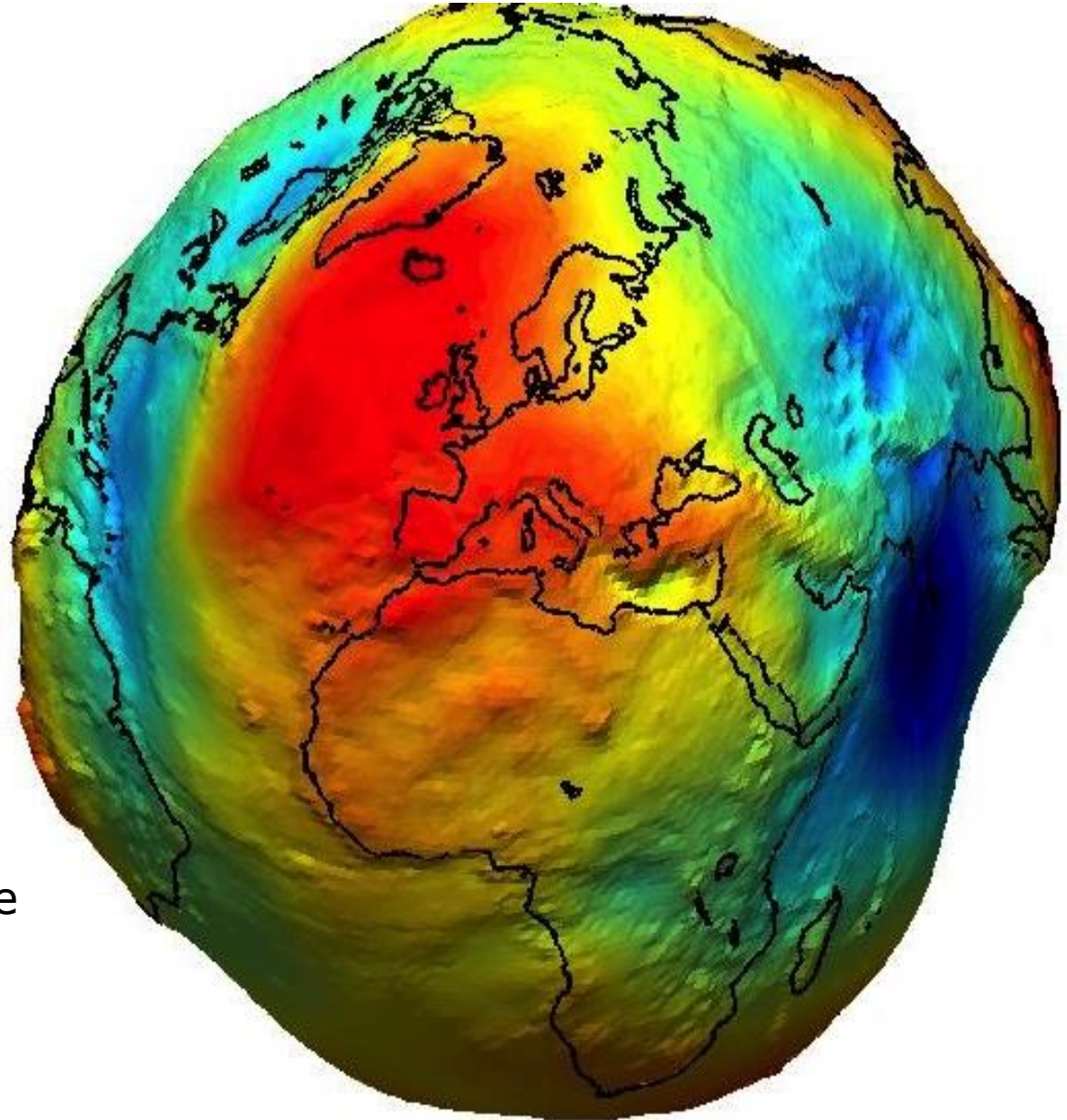
Greenland

Baffin
Bay

Canada

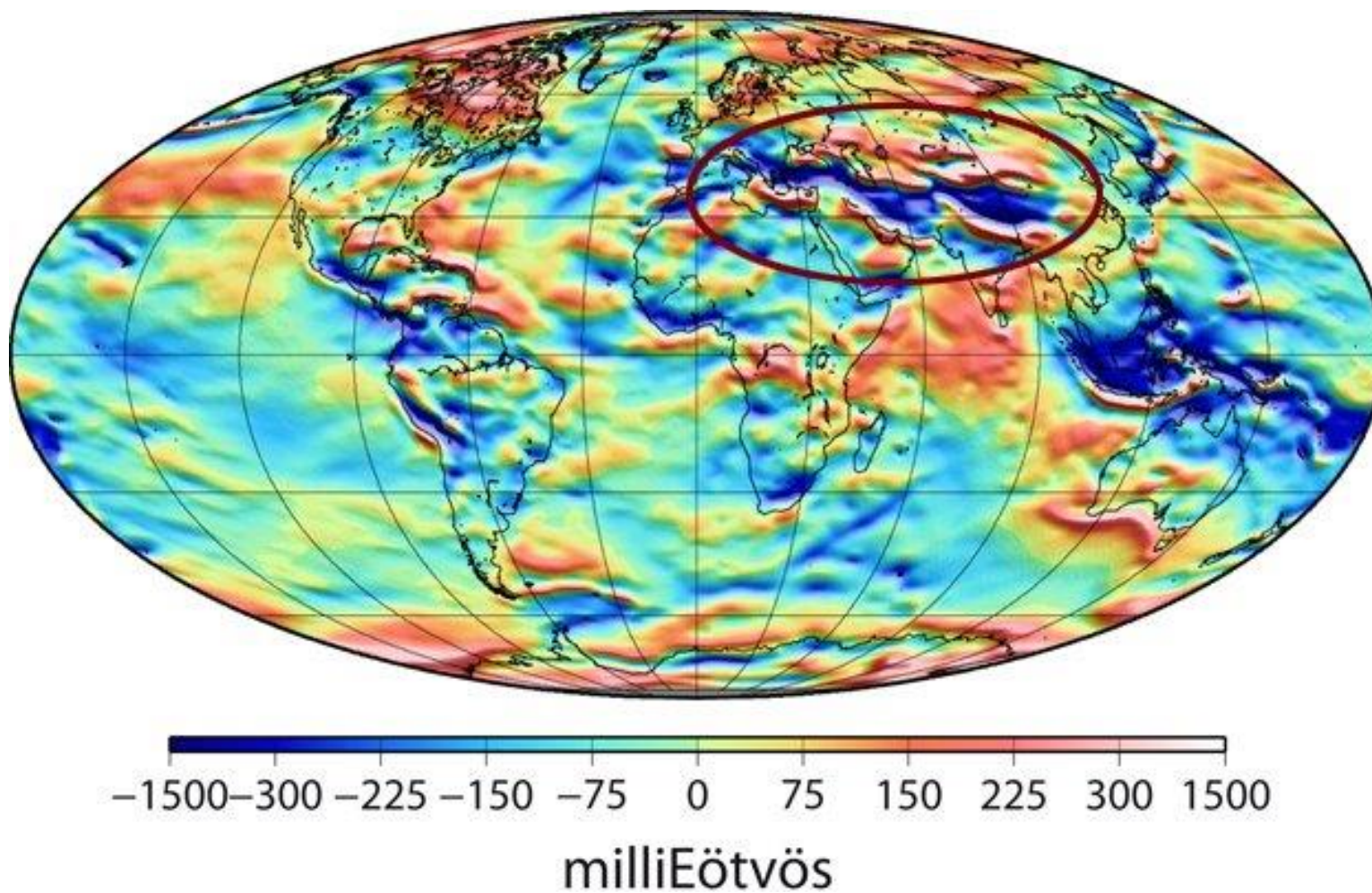


GOCE: Mission accomplished



Most precise geoid to date

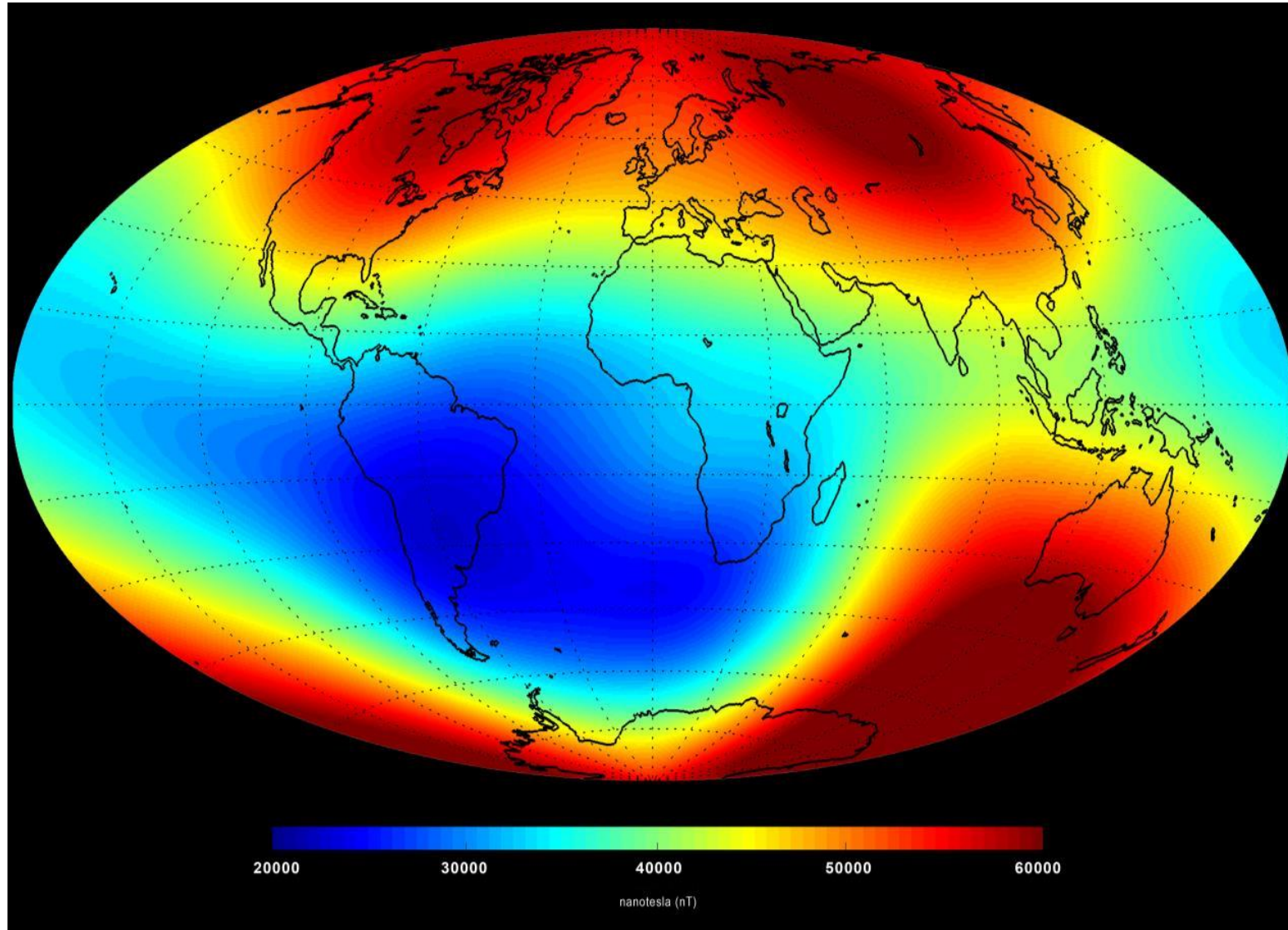
GOCE: Remnants of Tethys Ocean



Swarm: Mission accomplished and ongoing



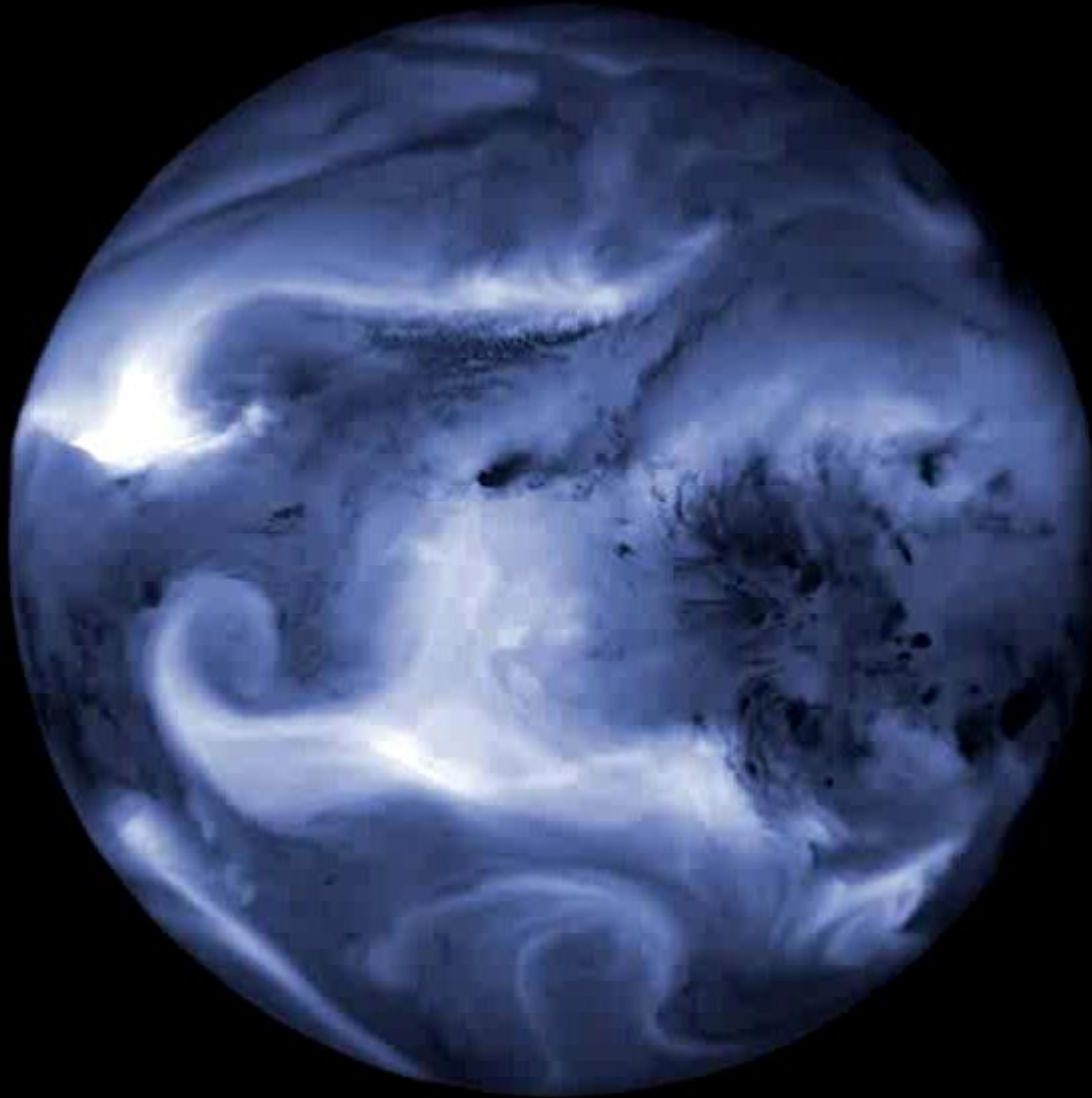
Tracking
Earth's
dynamic
magnetic
field.





4. Earth Observation to monitor the dynamic Earth and its processes

Water vapour animation courtesy DLR

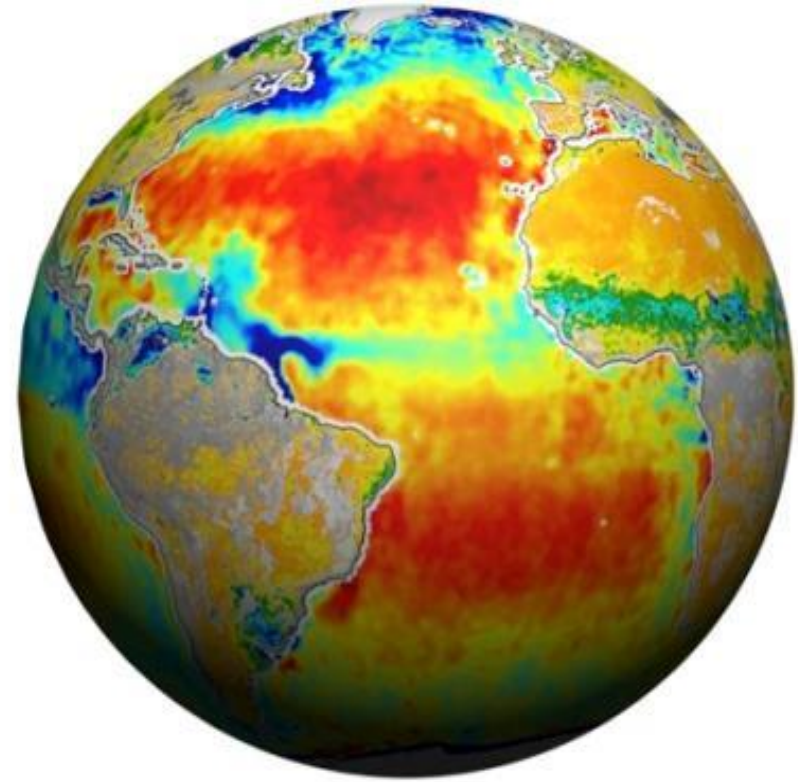
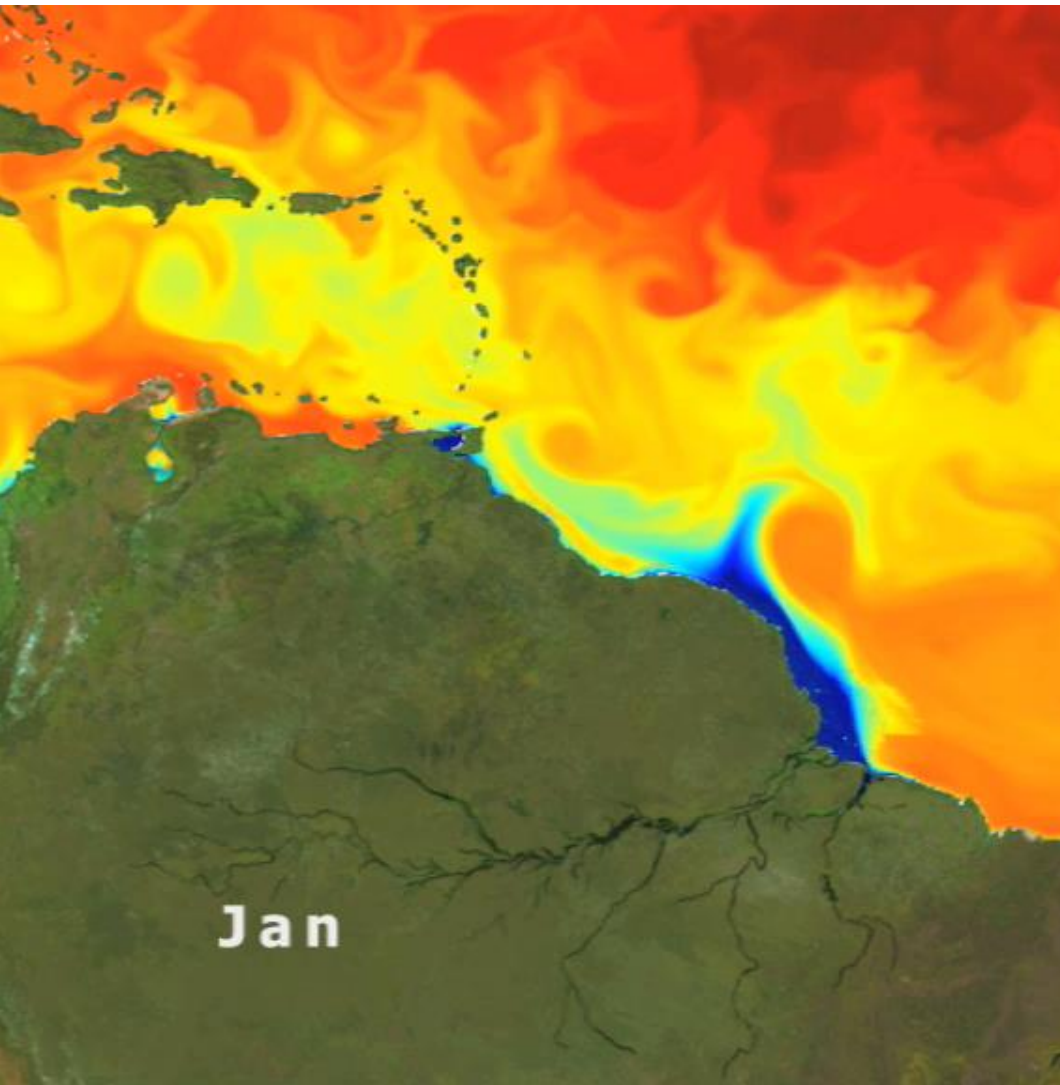


Hurricane Gustav

30 August 2008, 15:40 UTC

28 August 2008, 15:00 UTC

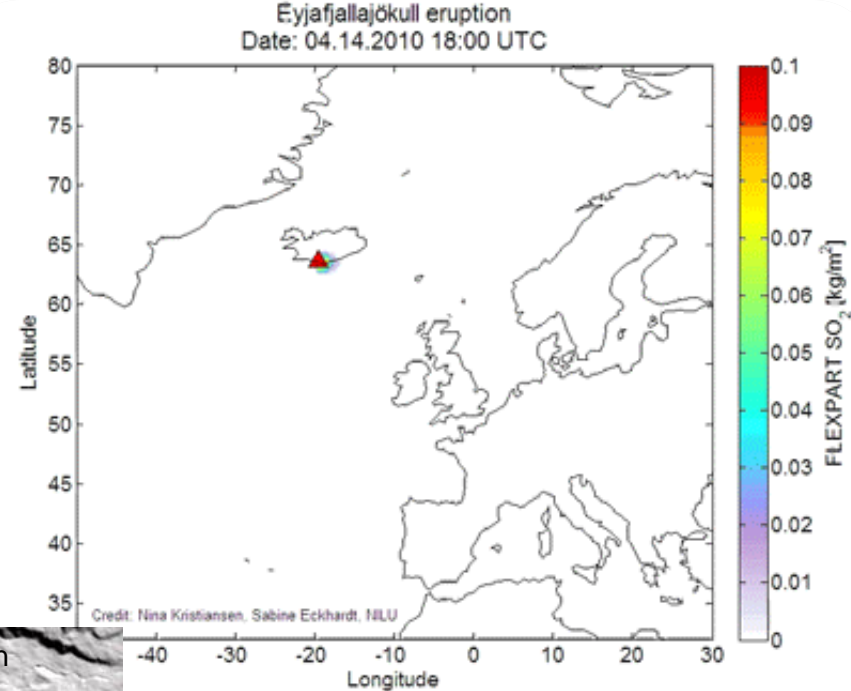
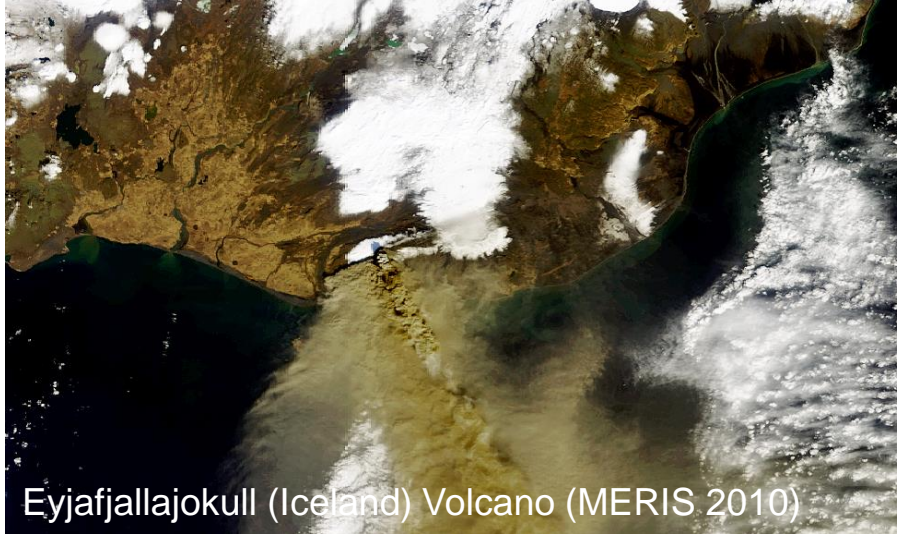
25 August 2008, 15:00 UTC



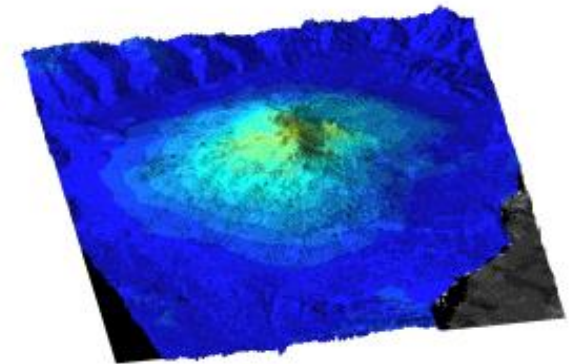
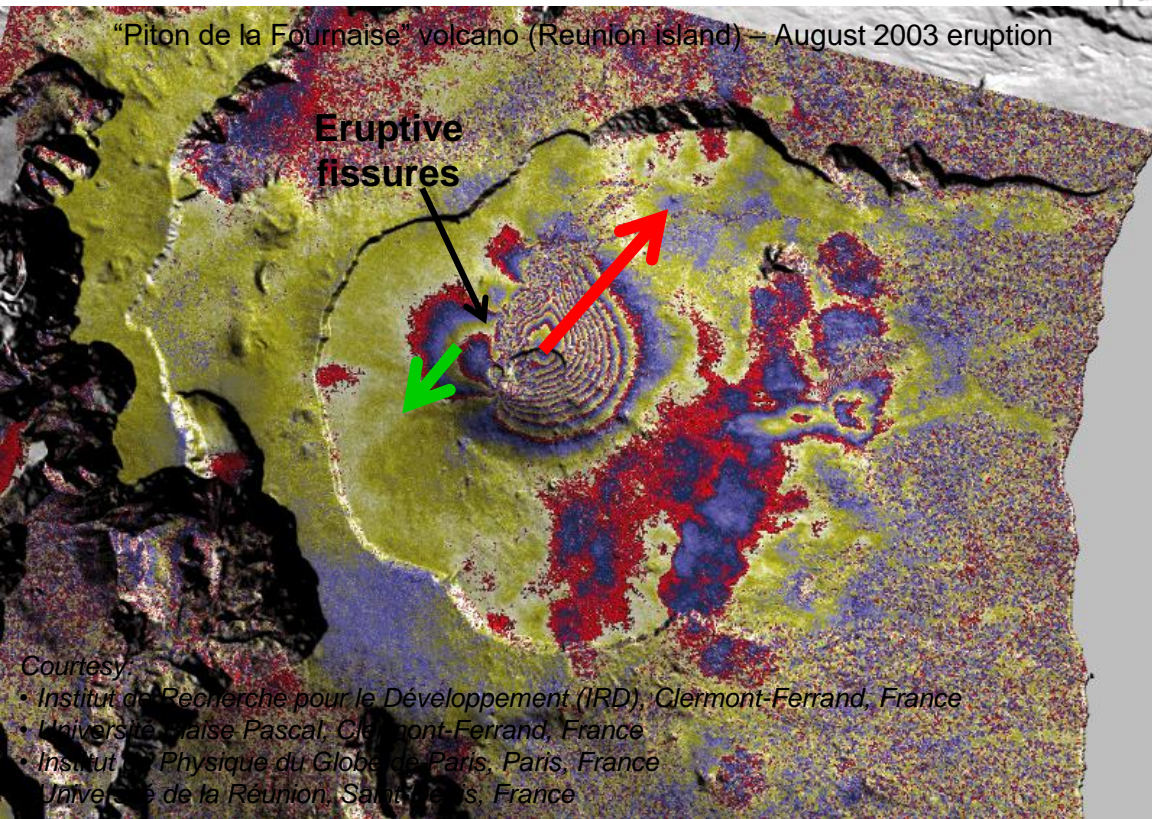








30 cm displacement **7 cm displacement**



0 range displacement 14 cm

1992 year 2001



5. ESA EO Educational & Training

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)

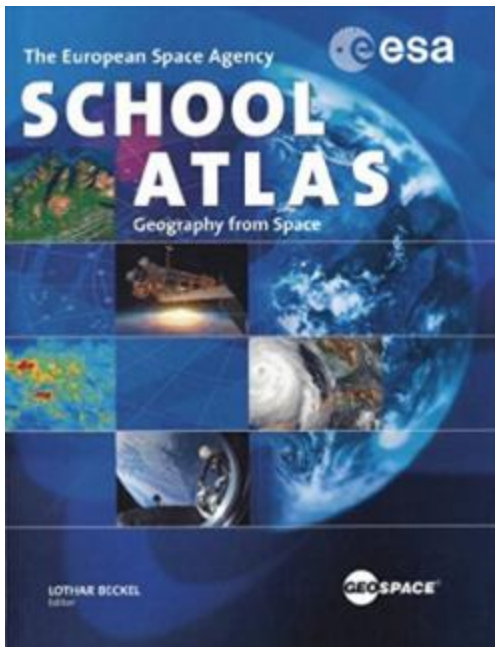
Tools for general outreach

1. i-books
2. Apps for Tablets

Tools for University level

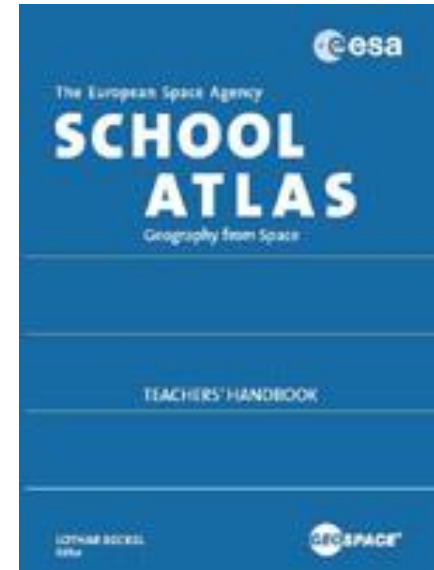
1. MOOCs
2. SAR videos
3. SNAP Tutorials
4. Thematic Exploitation Platforms (TEP's)

ESA School Atlas, new ESA Water Atlas

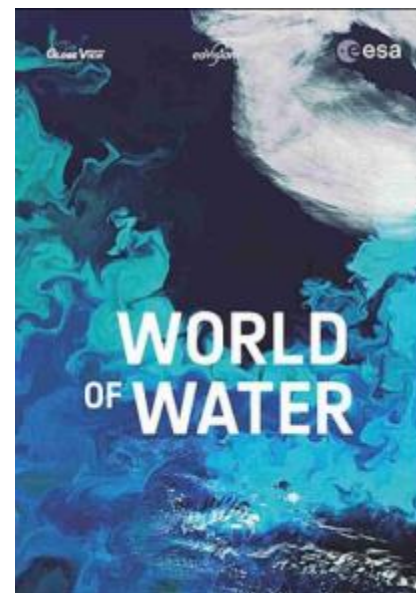


Introduction to ESA; Earth Observation; Global Overview; Continental Overview; the Natural Sphere; The Cultural Sphere.

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

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Choose your language... ▶

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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](#)

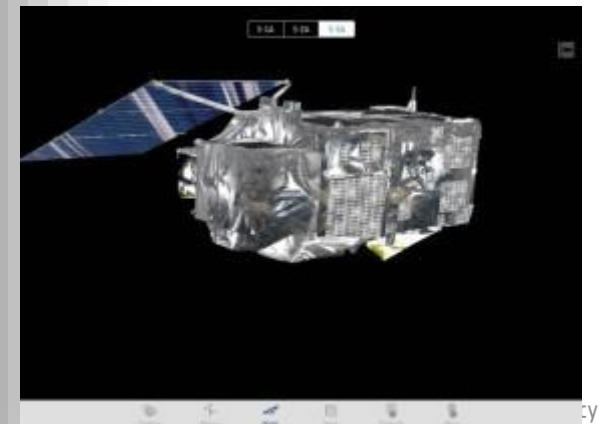
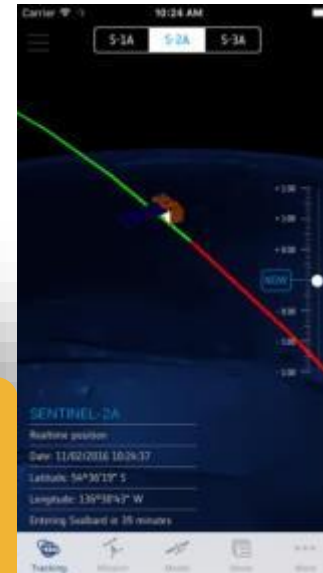
I-books, Apps



Sentinel App



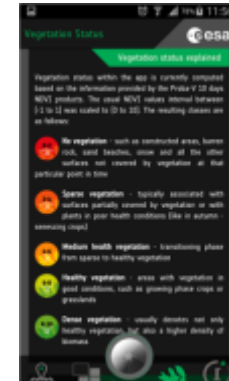
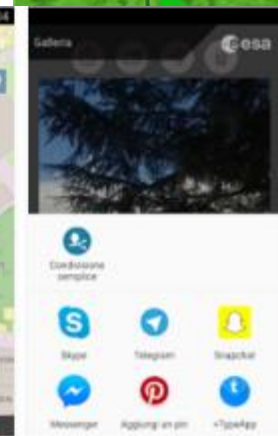
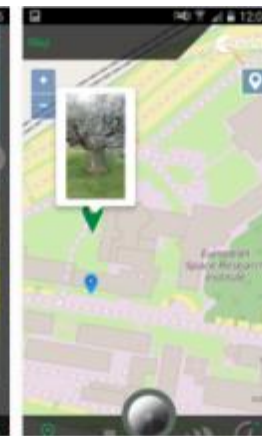
- See where the Sentinel satellites are in real-time
- See the last and next time they have been and will be over your location; Move them to the time of the last data transmission and smoothly move them back to their current location over the 3D globe
- Explore the Sentinel satellite 3D models
- Get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



de 47

an Space Agency

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 week

EDUCATORS



Rafel Kijour



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

- 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.

- 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



EO Education and Training

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

- EO data

- EO data distributed by ESA
- Access data online
- Access GME's 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
- LEOVworks Download (19.5mb)
- Bilbo
- ILVVIS

- Key Resources

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

Central page for EO education and training

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

Central page for EO education and training



**Earth Online**

Login My EarthnetRegisterGoogle™ Custom Search

Need Help? Contact hereEuropean Space Agency

Data AccessMissionsEarth TopicsPI CommunityExplore more...

You are hereHomeEO Education and TrainingEO Education for Schools

FollowShareFacebookTwitterGoogle+Email

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

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

EO data

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

EO training activities

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

EO software

Central page for EO education and training



The screenshot shows the ESA Earth Online website. The header features the ESA logo, 'Earth Online', and navigation links like 'Data Access', 'Missions', 'Earth Topics', and 'PI Community'. A search bar and social media links are also present. The main content area is titled 'EO Education and Training' and includes a section for the 'ESA School Atlas'. The text describes the atlas as an educational resource launched by ESA and Geospace, built on satellite imagery, and available as a DVD kit. It also lists links for downloading the DVDs and the Teacher's Handbook.

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.

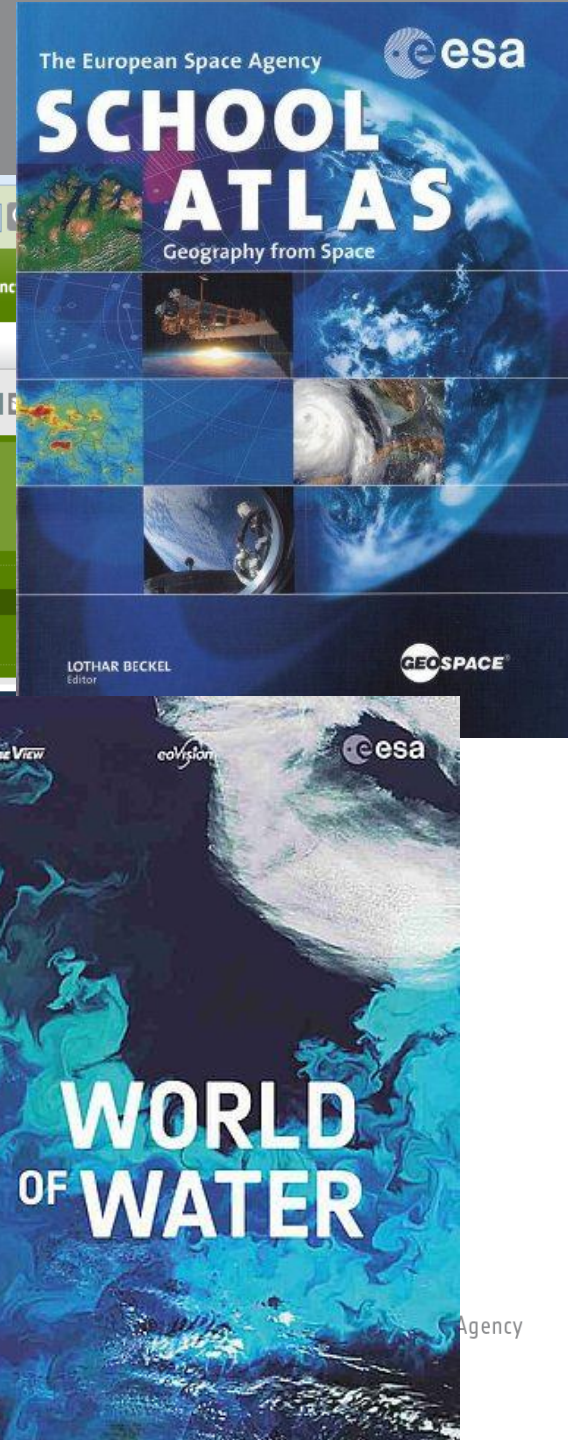
The ESA School Atlas kit is a very valuable resource also for students of Geographic Information Systems (GIS). There are many ready made digital exercises on DVDs provided with the Atlas that can be used with the free software packages LEOWorks and ArcExplorer.

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:



The image shows the cover of the 'ESA School Atlas' and 'World of Water' book. The top part features the ESA logo and the title 'SCHOOL ATLAS' in large white letters. Below the title is the subtitle 'Geography from Space'. The cover is decorated with various satellite images of Earth. The bottom part of the image shows the cover of the 'World of Water' book, which has a blue and white abstract design and the title 'WORLD OF WATER' in large white letters. The ESA logo is also visible on the bottom right of the book cover.

The European Space Agency **esa**

SCHOOL ATLAS

Geography from Space

LOTTHAR BECKEL
Editor

GEOSPAC

World of Water

Agency

1. LearnEO! is an Earth observation education project funded by the European Space Agency. 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.

2. Lessons use Bilko software.

3. The Amazon river plume
4. Monitoring oil pollution at sea
5. El Niño and the Southern Oscillation (ENSO)
6. Monitoring Atlantic storms
7. Observing Earth gravity:
8. Monitoring Arctic sea ice
9. Forest monitoring
10. Monitoring urban growth
11. Land cover mapping
12. Monitoring soil moisture

ESA Presentation | 20 June 2016

ESA UNCLASSIFIED – Releasable



LearnEO!



Learn Earth Observation with ESA

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[Software](#)
[Resource library](#)
[Information for authors](#)
[Register](#)

Hands-on activities with Bilko



Platforms and missions




ENVISAT



CRYOSAT



GOCE



SMOS

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 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



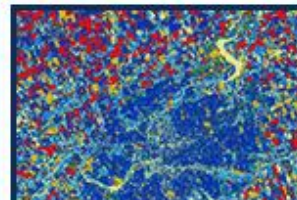
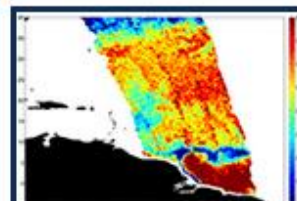
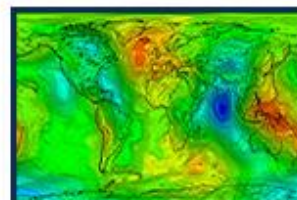
National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL











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)

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