EGU/GIFT 2010, Vienna, 3 May 2010

Introduction to the ESA Earth Observation Programme - Educational tools for schools

Francesco Sarti

ESA/ESRIN

GOCE, SMOS,
CRYOSAT

The purpose of the European Space Agency (ESA)

An inter-governmental organisation (18 member states) with a mission to provide and promote (for exclusively peaceful purposes) the exploitation of:

- Space science, research & technology
- Space applications

ESA programmes

All Member States participate in activities related to space science and in a common set of programmes (mandatory programmes).

In addition, members chose the level of participation in optional programmes:

- Human spaceflight and Exploration
- Microgravity research
- Earth observation
- Telecommunications
- Satellite navigation
- Launcher development

For over 30 years ESA's space science projects have shown the scientific benefits of multi-nation cooperation.

Space Science

Space environment of the Earth

Solar-terrestrial interaction

Interplanetary medium

Moon, planets and other objects

Stars and the universe

Fundamental Physics.

Earth Observation

The quest for information about the Earth

- Meteosat, MSG series of weather satellites, METOP
- environmental and climate research and monitoring satellites ERS-1 & 2 and Envisat;
- first three Earth Explorers.

Respectively for:

- Meteorology
- Environmental & climate monitoring
- Earth resource management & other applications
- Better understanding of the earth (gravity field, ocean circulation & salinity, soil moisture, cryosphere)

Europe's first weather satellites

Eumetsat owns and exploits these satellites

The first Meteosat was launched in 1977.
Five more followed and the seventh was launched in 1997.

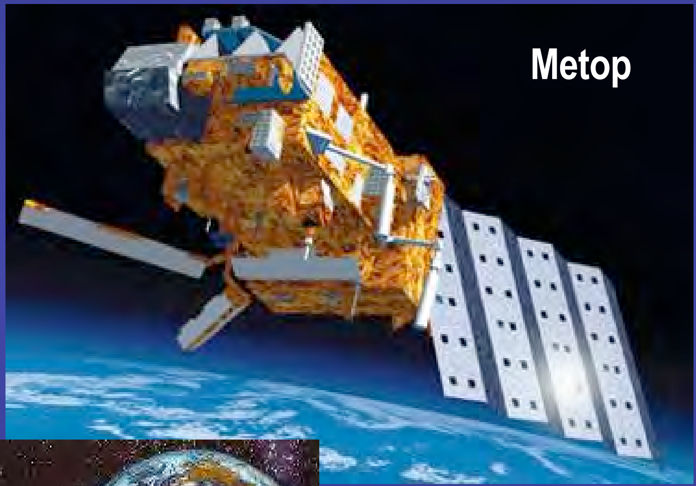
- Placed in geostationary orbit
- Take pictures of the Earth every 30 min
- Distribute meteorology data

Since 2002: MSG (Meteosat Second Generation): series of 4 geostationary (enhanced) meteorological satellites

Since 2006: METOP (series of Meteorological Operational Polar Orbiting Satellites)

Cooperation with Eumetsat

ESA is cooperating with Eumetsat, the European Organization for the Exploitation of Meteorological Satellites on the development of two series of meteorological satellites:



- MSG (Meteosat Second Generation): series of 4 geostationary meteorological satellites (enhanced performances with respect to Meteosat). First launch: 2002

- METOP (Meteorological Operational Polar Orbiting Satellites): a European series of polar orbiting spacecraft embarking a very comprehensive series of meteorological payload.

A radar view of the Earth: ERS, ENVISAT

The ERS (European Remote Sensing) satellites use radar instruments to survey the Earth's surface day & night and in all weather conditions.

- ERS-1, launched in 1991 ended its mission in March 2000.

- A second ERS satellite (ERS-2) was launched in 1995, with an additional instrument for ozone monitoring. A constant flow of data from ERS-2 provides information on status and changes of:
  - Ocean currents, sea surface and ocean winds
  - Polar ice caps & ice movement
  - Atmospheric ozone.

ENVISAT:
focusing on the environment.

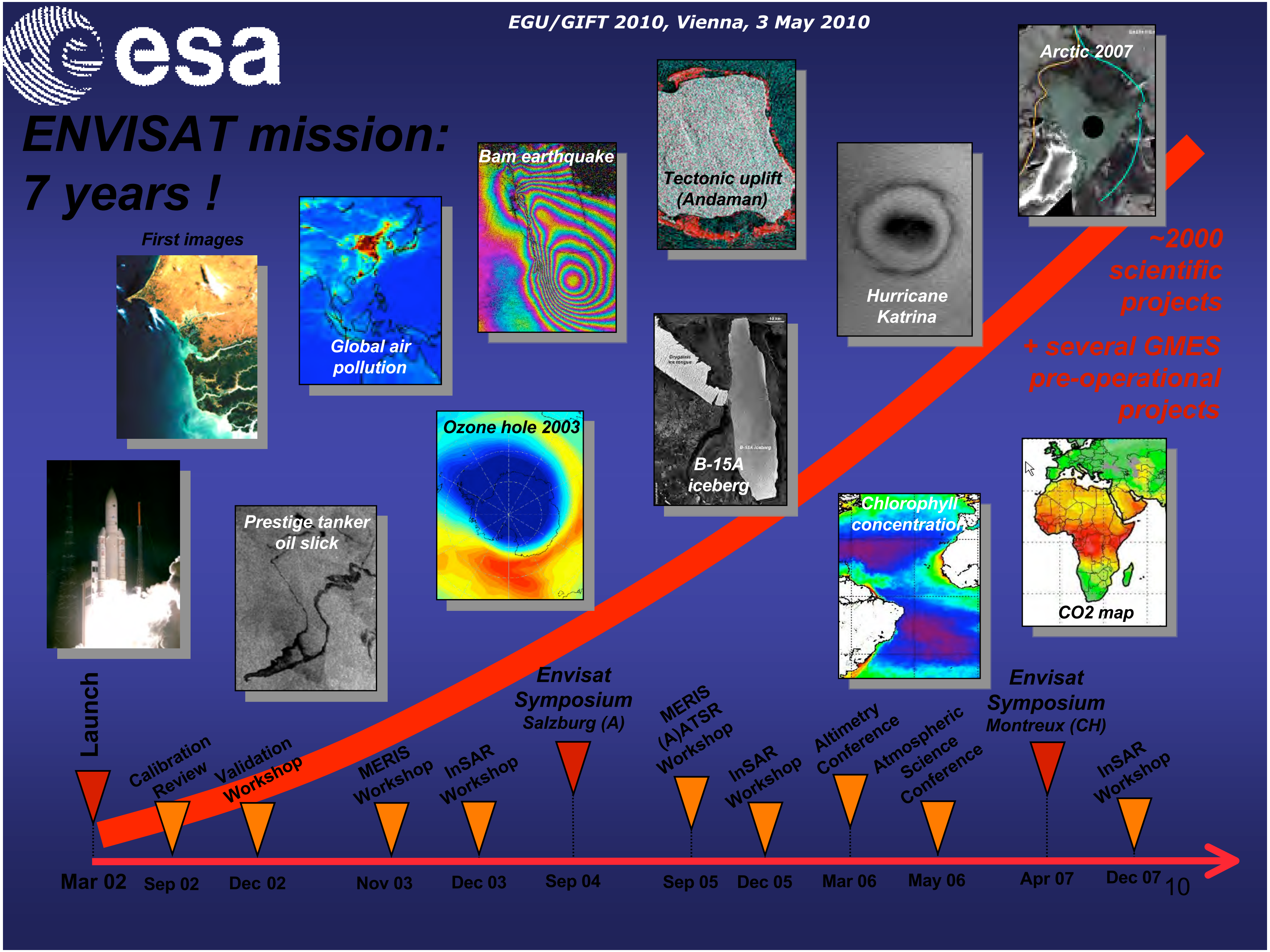
ENVISAT is the largest and most ambitious Earth observation satellite ever built.

8 ton spacecraft launched in 2002 by an Ariane-5 into polar orbit at an altitude of 800 km. Payload consisting of 10 instruments to monitor the earth system and providing:

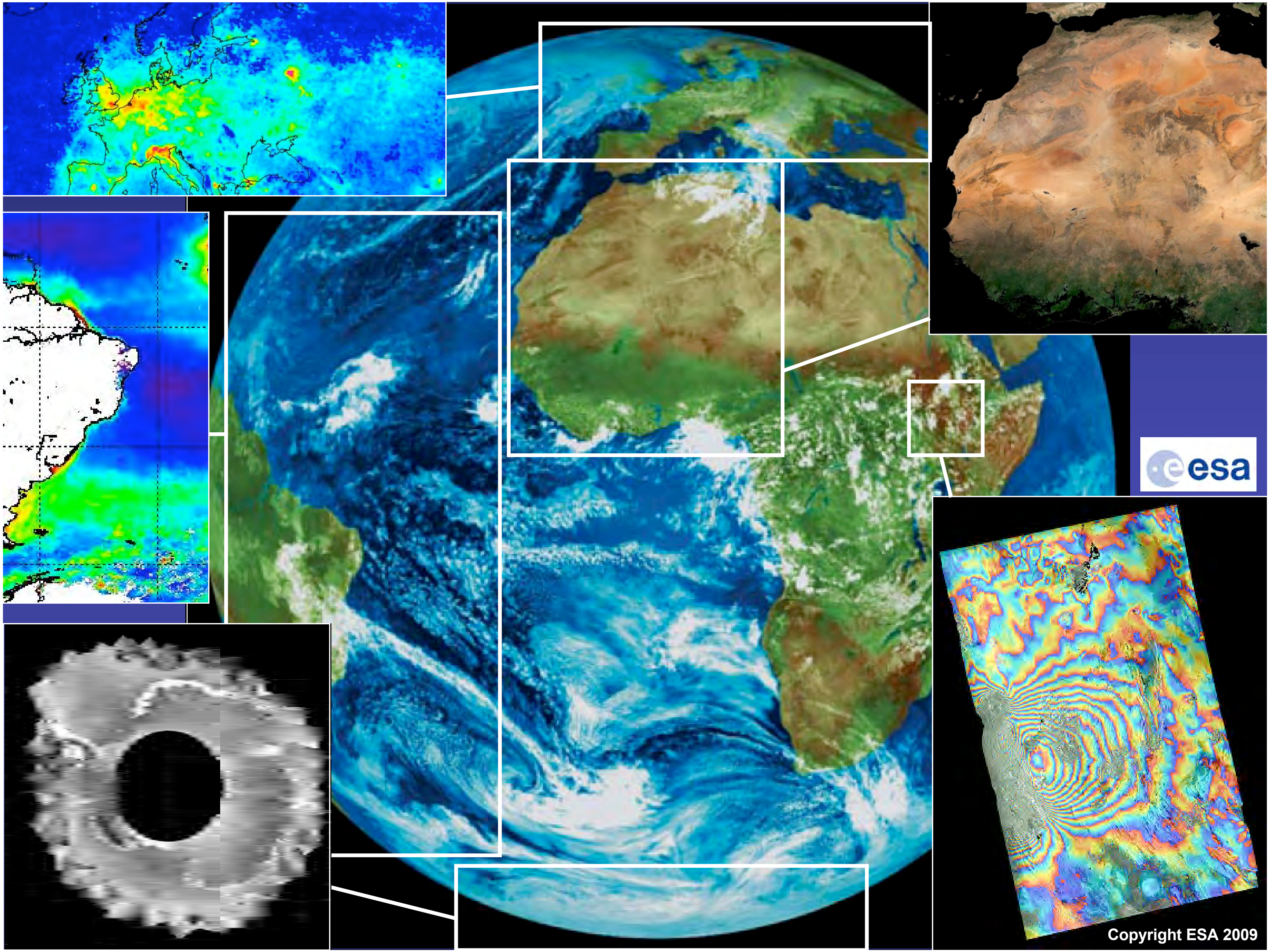
- a smooth transition from the measurements taken by ERS-1 and ERS-2 (radar in particular)
- new data on marine biology and atmospheric chemistry.

Along with ERS-2, it provides a continuous supply of services to scientists and operational users over almost 20 years in the field of:

- **Crop inventories and forest management**
- **Tropical deforestation**
- **Biodiversity**
- **Natural disasters / damage assessment (flooding, forest fires, earthquakes, volcanic eruptions, etc.)**
- **Generation of digital terrain models**
- **Ozone layer / monitoring of ozone layer depletion and green house effect.**



esa
EGU/GIFT 2010, Vienna, 3 May 2010
ENVISAT mission:
7 years !
First images
Global air pollution
Bam earthquake
Tectonic uplift (Andaman)
Hurricane Katrina
Arctic 2007
~2000 scientific projects
+ several GMES pre-operational projects
Ozone hole 2003
B-15A iceberg
Prestige tanker oil slick
Chlorophyll concentration
CO2 map
Launch
Calibration Review
Validation Workshop
MERIS Workshop
InSAR Workshop
Envisat Symposium
Salzburg (A)
MERIS (A)ATSR Workshop
InSAR Workshop
Altimetry Conference
Atmospheric Science Conference
Envisat Symposium
Montreux (CH)
InSAR Workshop
Mar 02
Sep 02
Dec 02
Nov 03
Dec 03
Sep 04
Sep 05
Dec 05
Mar 06
May 06
Apr 07
Dec 07
10

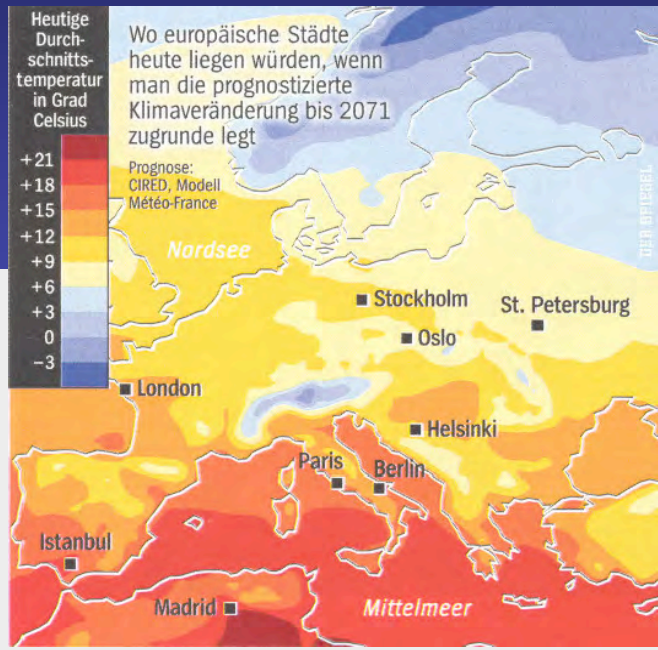

Copyright ESA 2009

The challenge of global change

The IPCC Report 2007

Model: *Global temperature increase between + 2.4 and 6.4 degrees until 2100*

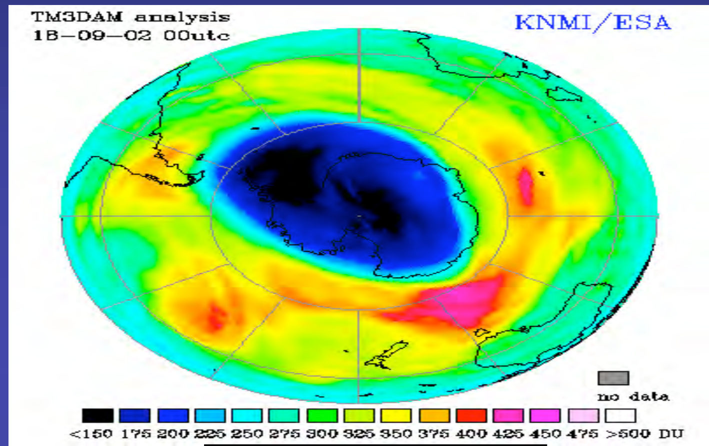
- **Arctic:** ice-free as of 2nd half of the century
- **Permafrost:** up to 90% melting until 2100, freeing high amounts of Methane gas
- **Precipitation:** decrease in arid regions and increase in wet areas
- **Storms and surges:** less in number but significantly stronger in intensity
- **Gulf Stream:** significantly weakened
- **Sea level rise:** up to 48cm until 2100 due to thermal expansion of water only



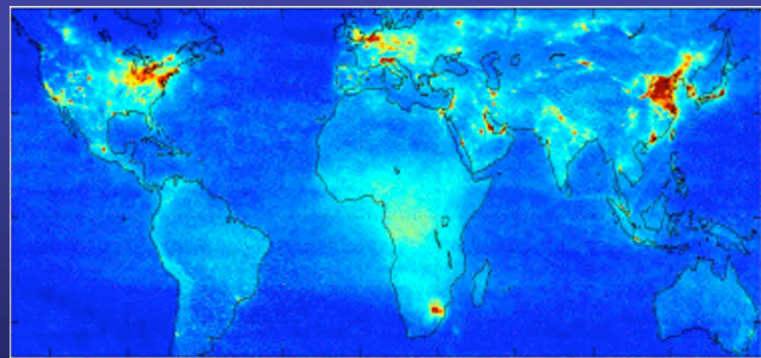
Space-based data contribute to global change monitoring

Major scientific results of ENVISAT and ERS

- **Climate change:** Global sea level rise of ~3mm/year and sea surface temperature increase of ~0.1 deg. C since 1992
- **Atmosphere:** Worldwide monitoring of air pollution, evidence of fast growing air pollution in China since 1995
- **Polar areas:** Daily monitoring of sea ice motion and observation of Antarctica ice-shelves collapse
- **Oceanography:** Quantification of global chlorophyll concentration, an index of the oceanic phytoplankton biomass
- **Tectonics:** Identification of the blind tectonic fault at the origin of the Bam earthquake in December 2003

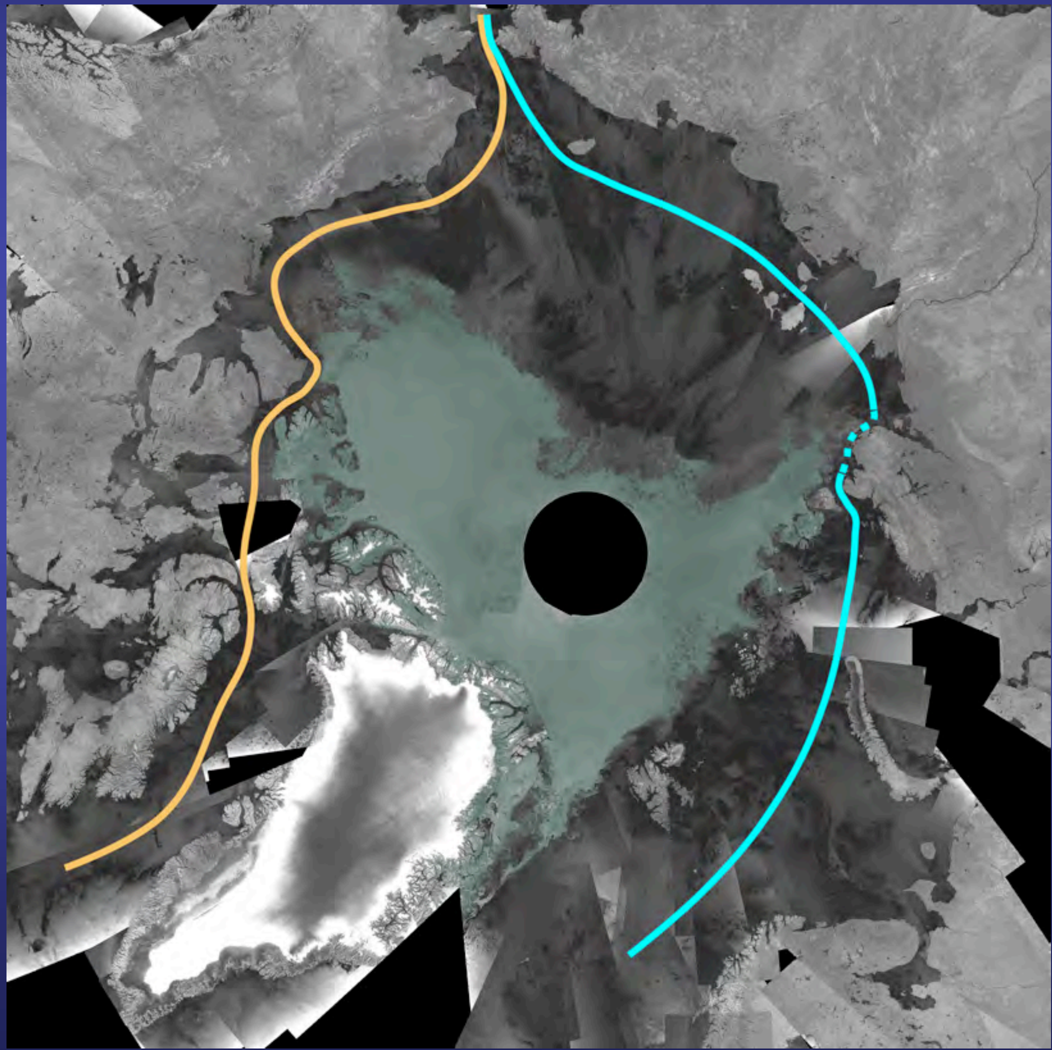


Ozone hole



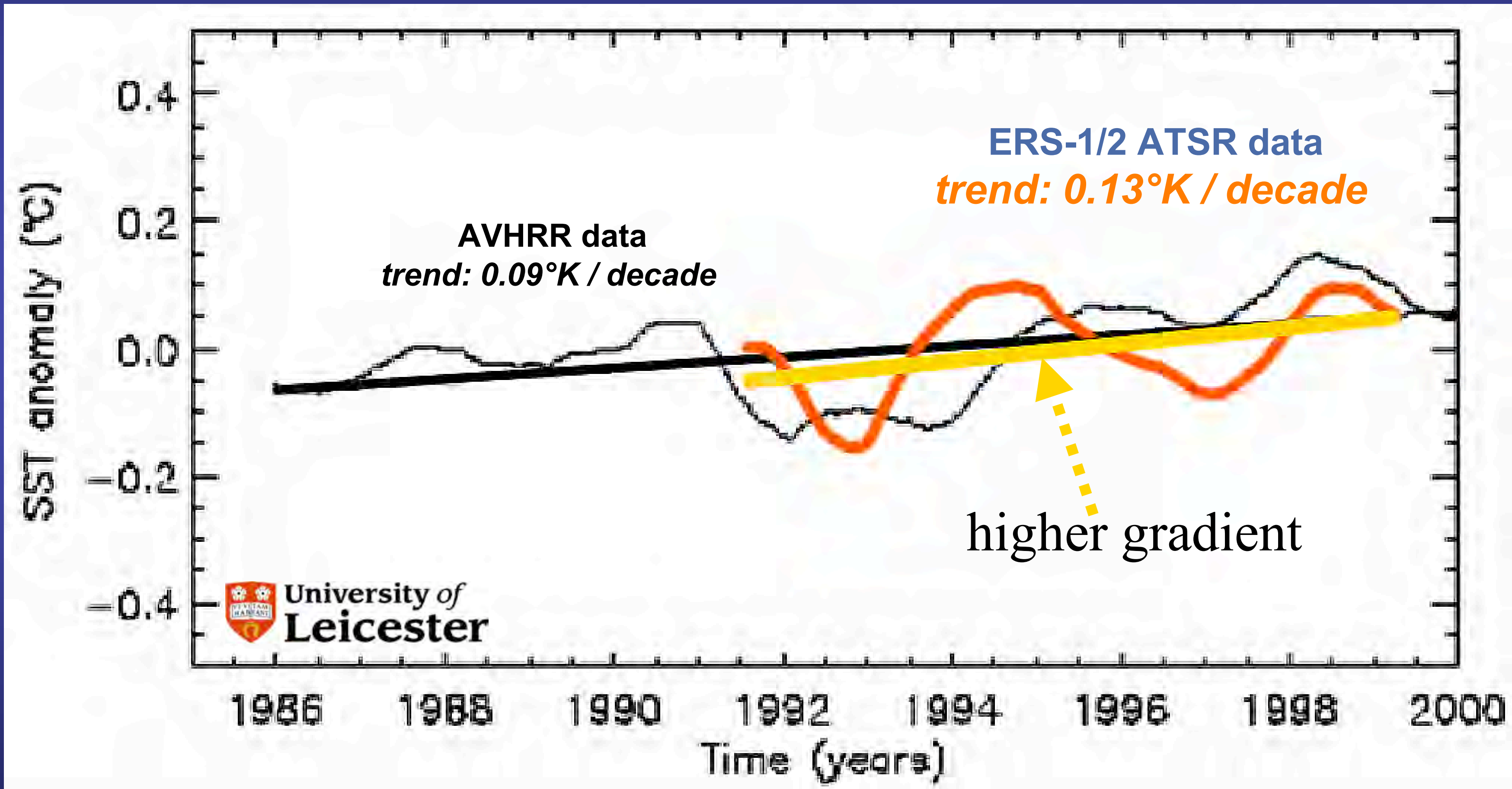
NO_2 from SCIAMACHY (Jan. 2003 - June 2004)

Lowest Arctic ice coverage (summer 2007)



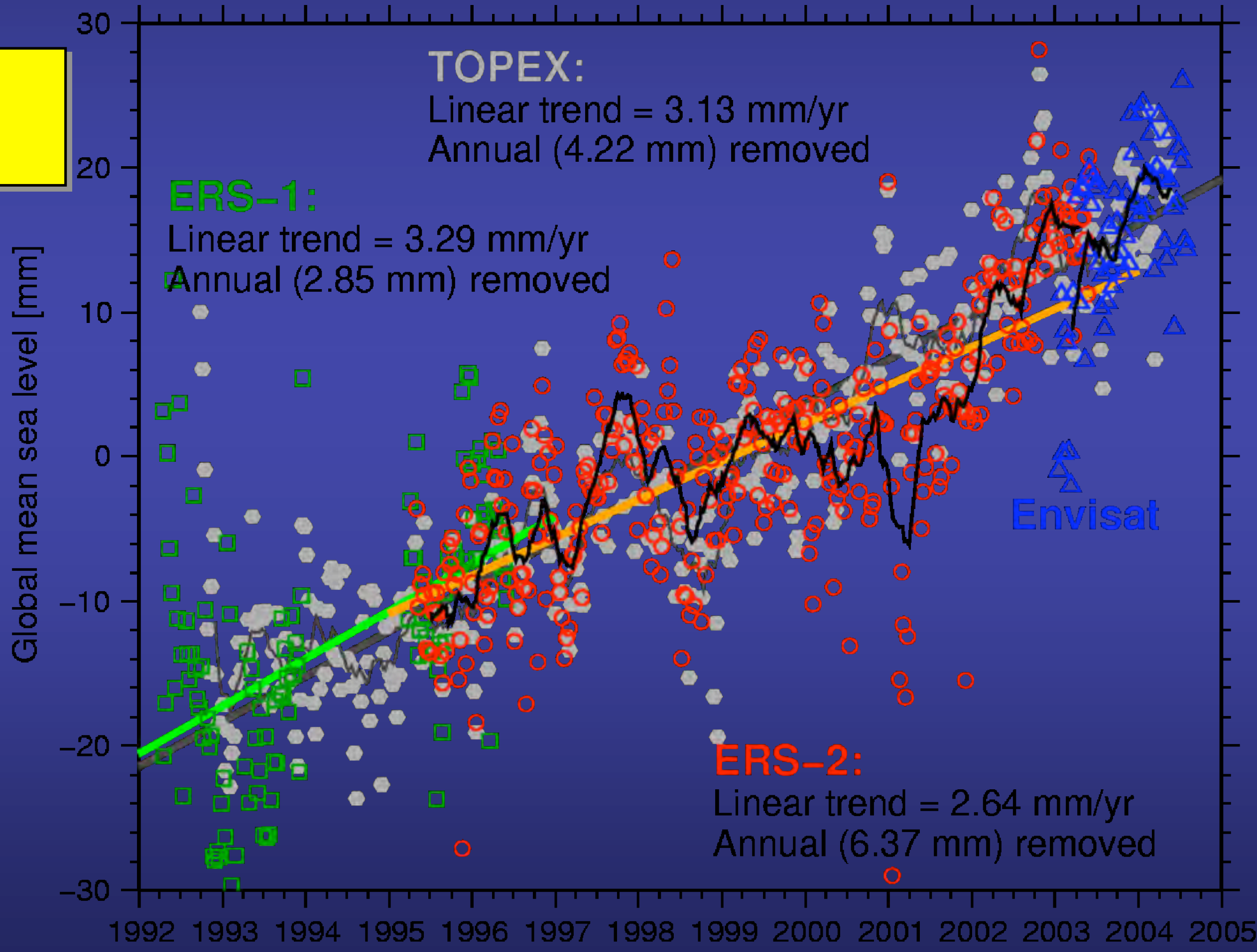
Northwest Passage open (orange line) and Northeast passage only partially blocked (blue line). The dark grey colour represents the ice-free areas, while green represents areas with sea ice.

Measurement of Residual Trends in Global Sea Surface Temperature



The ENVISAT altimeter provides continuity to the measurements initiated in the early 1990

Sea level rise
Trend: +3 mm/yr

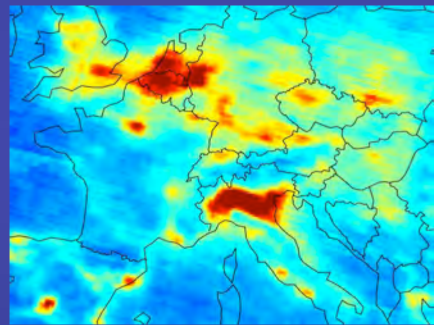


Courtesy of Remko Scharroo, NOAA,US

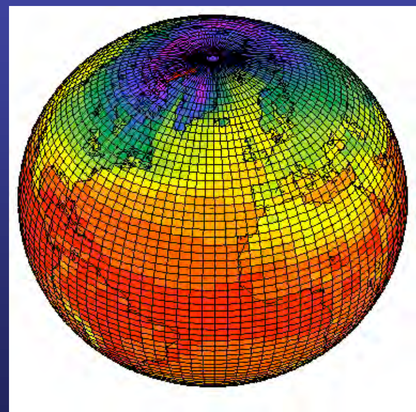
ESA Initiative on Climate Change

UNFCCC Conference 2007 **Bali Action Plan**

“parties should describe the status of their programmes for contributing observations of the essential climate variables (ECVs) to the international community”



- **Earth observation from space plays a vital role in this endeavour**
- **ESA through CEOS has committed to deliver global observations of ECV and associated products**
- **ESA has 30 years of archived data and will concentrate on those ECV which can be fed by ESA data**



The International Charter on Space and Major Disasters

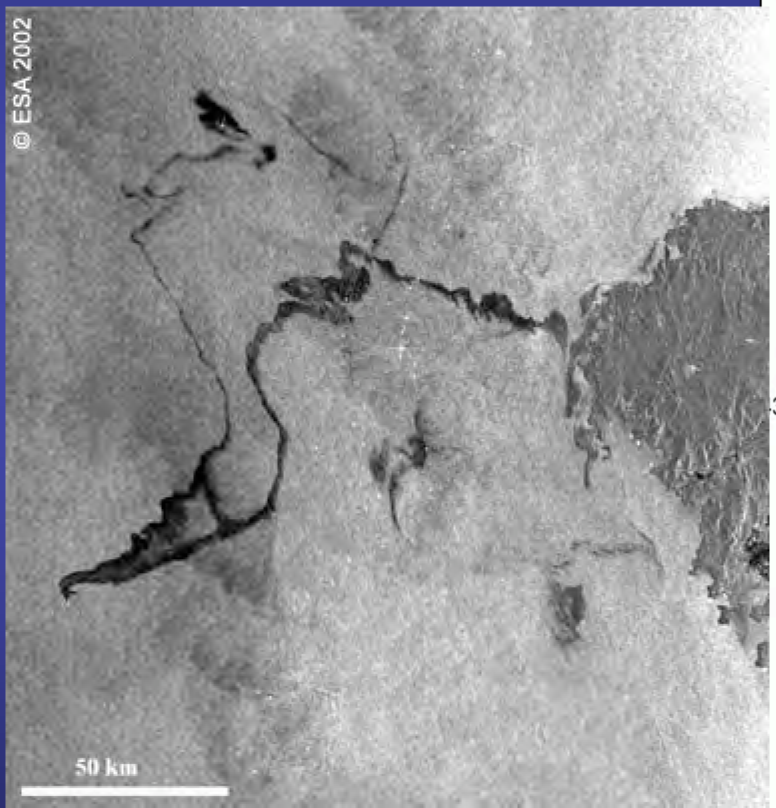
- Unified system of space data acquisition & delivery in case of natural or human-made disasters
- Data delivery to civil protection agencies, emergency & rescue services

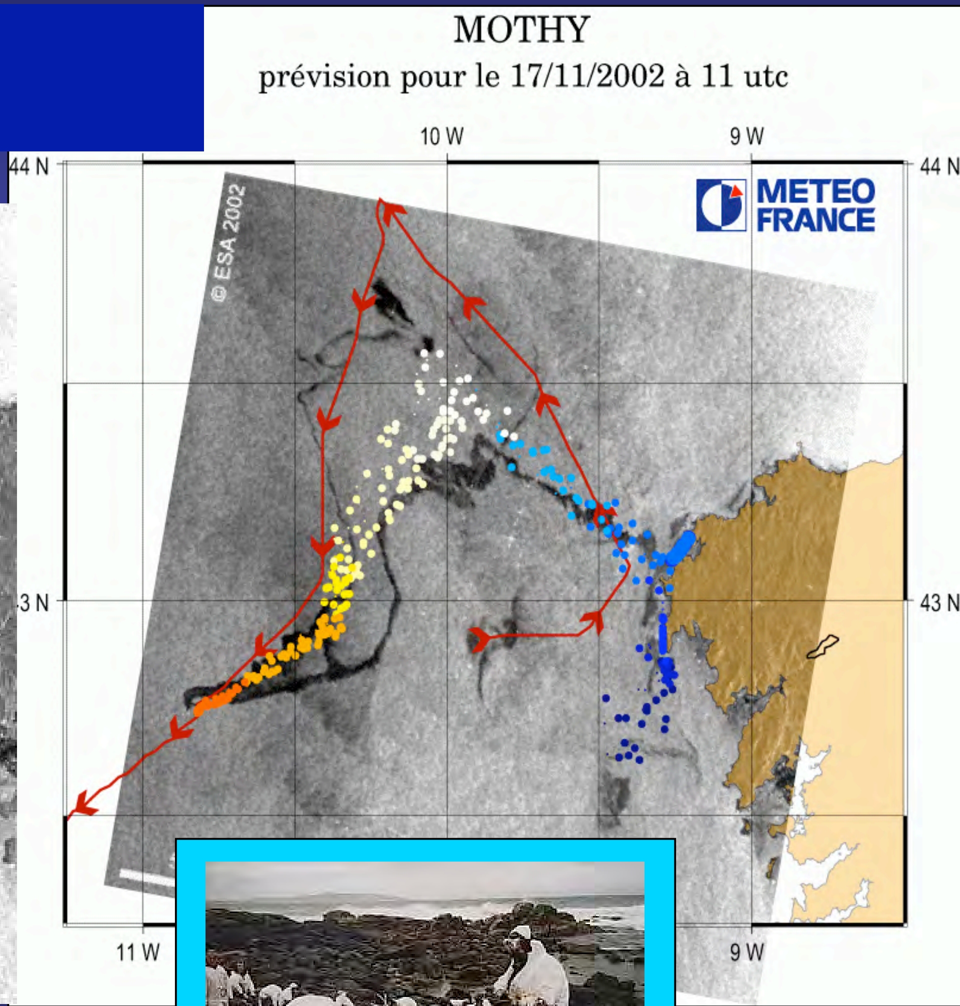
Examples of activations:

- Bam Earthquake 2003
- Darfur Crisis 2004
- Tsunami Catastrophe 2004/2005
- Hurricane Katrina 2005
- Fires in the Mediterranean region (Italy, Greece) 2007
- Cyclone Nargis 2008

Application to oil spill monitoring:

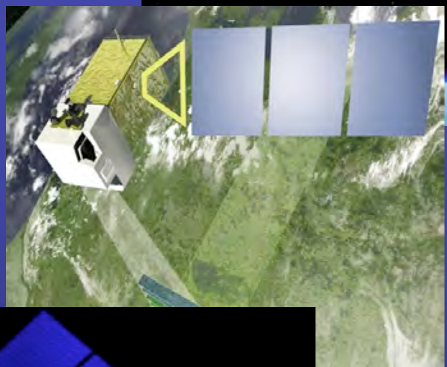
Oil slick of "Prestige" tanker accident viewed by Envisat

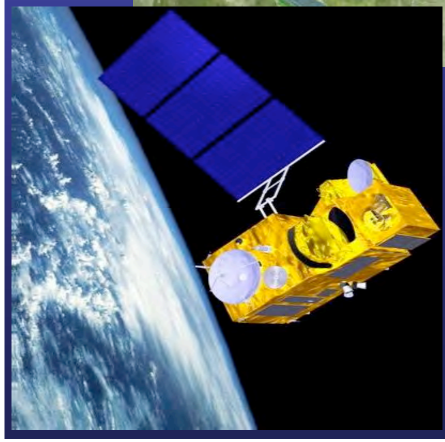




GMES Space Component:

space infrastructure in support of European policy prioritie





GMES (Global Monitoring for Environment and Security). Jointly led by ESA and the European Commission, it will be the European contribution to the Global Earth Observation System of Systems (GEOSS), for environment and security monitoring

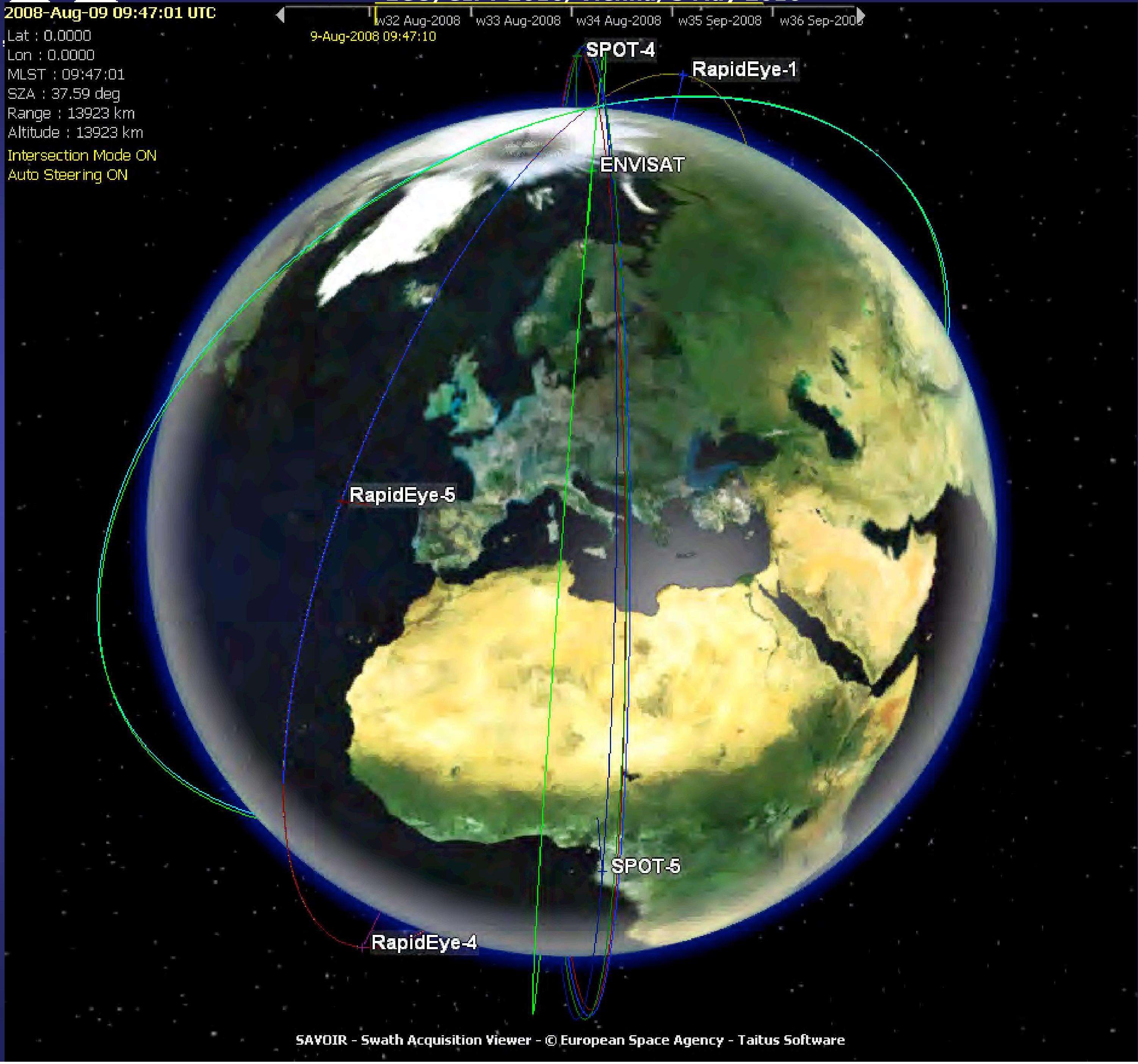
GMES space segment (after 2011):

- Sentinel-1: Imaging radar mission (all weather, day/night)
- Sentinel-2: Land monitoring mission (Superspectral imaging)
- Sentinel-3: Global ocean (and land) monitoring mission
- Sentinel-4,5: Atmospheric chemistry missions in GEO and LEO.

GMES ground segment:

- Provision of Earth observation data for GMES services
- Access to ESA, Eumetsat, national and third party missions.

EGU/GIFT 2010, Vienna, 3 May 2010



The Earth Explorer Missions

In order to better understand the Earth

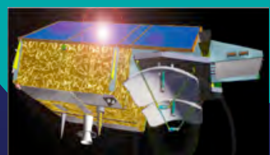
Research oriented, focused on specific topics/techniques

GOCE

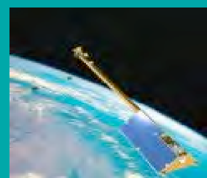
SMOS

ADM AEOLUS

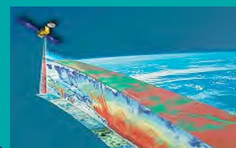
CRYOSAT 2



SWARM



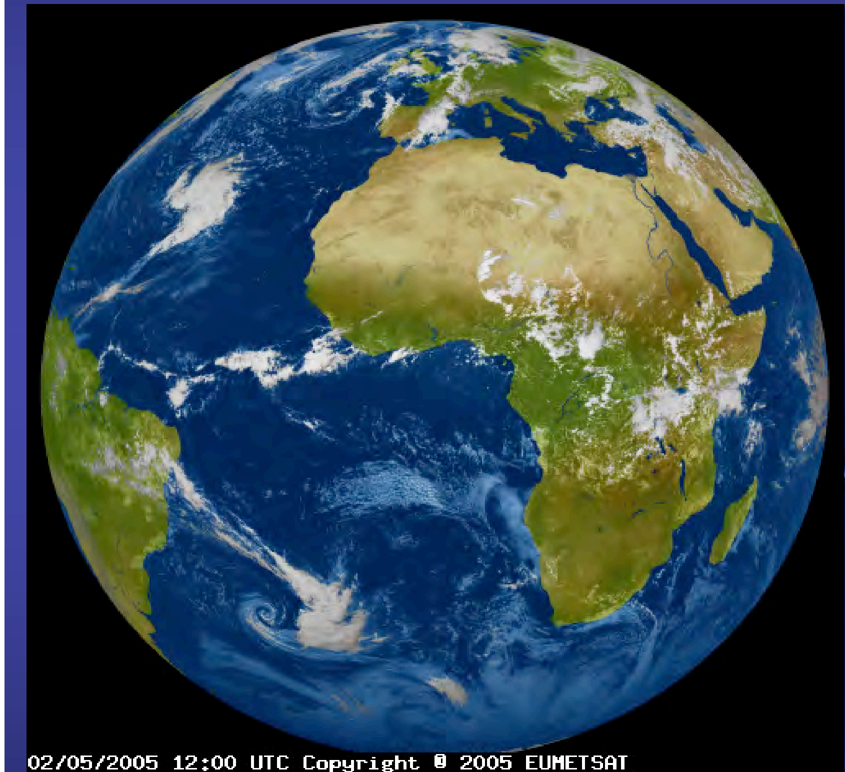
EARTH CARE

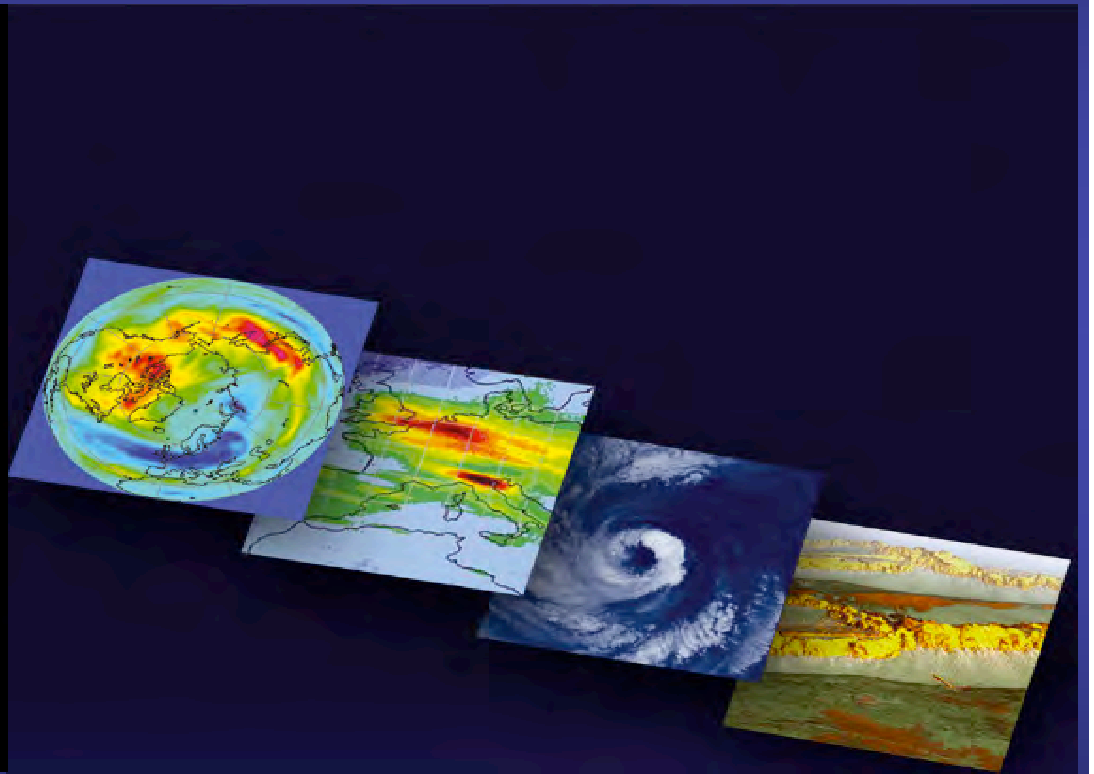


7th EE

Earth Observation: a tool for multidisciplinary Education in secondary schools

Explaining to kids why "Earth Observation"?





Answering basic questions like… WHERE we are and HOW the earth system works

Satellites

In order to better observe the earth (and not only), man always wished to fly, higher and higher ….

The moon, our natural satellite:

- distance 384.403 km
- radius1.700 km, 1/4 of the earth's one
- Double planet earth-moon

Satellites

The satellite “earth”

Historical references: heliocentric and geocentric system

- Galileo, Kepler, Kopernicus

- universal gravitational law

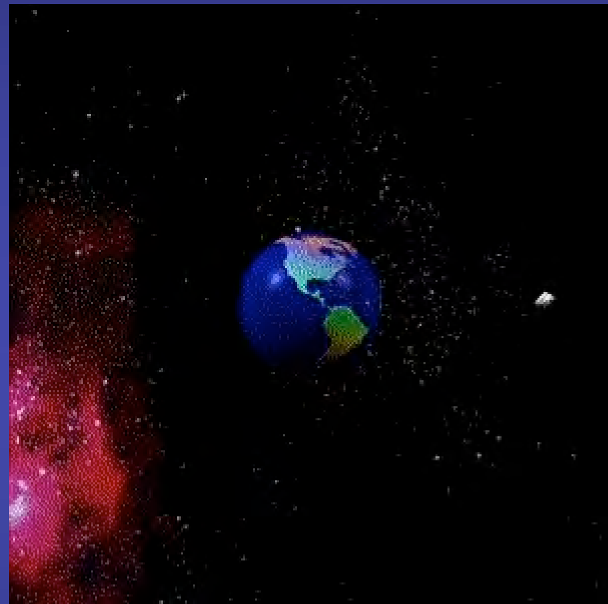
-Keplerian orbits

-Orbital elements

geostationary satellites

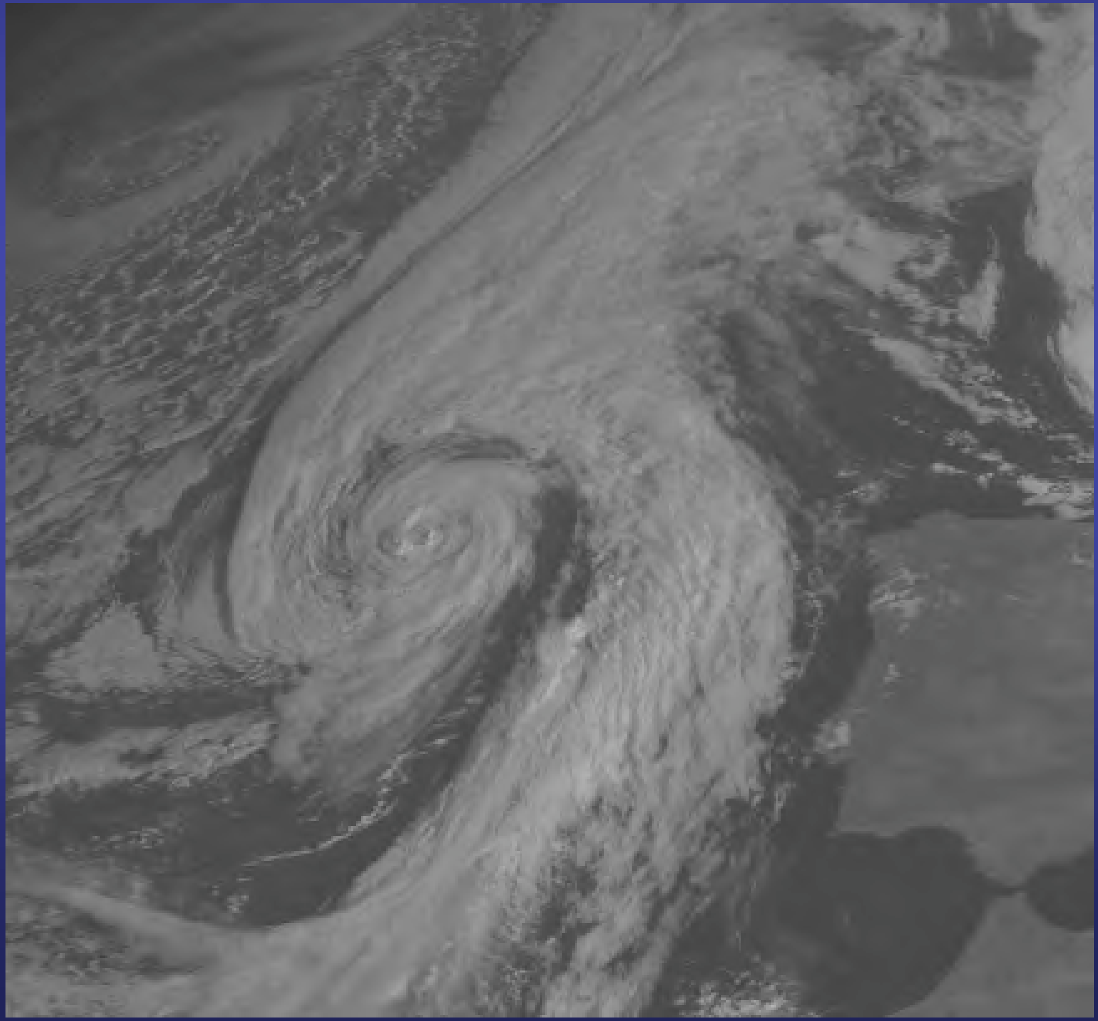
- Meteosat, MSG
- 36.000 km from earth (6 earth radii)
- GEO Orbit

Applications: METEOROLOGY CLIMATOLOGY

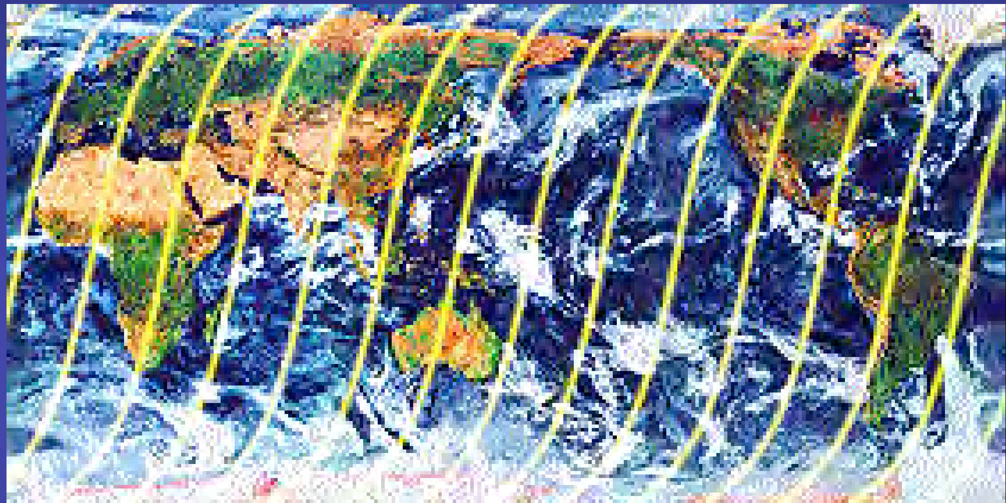


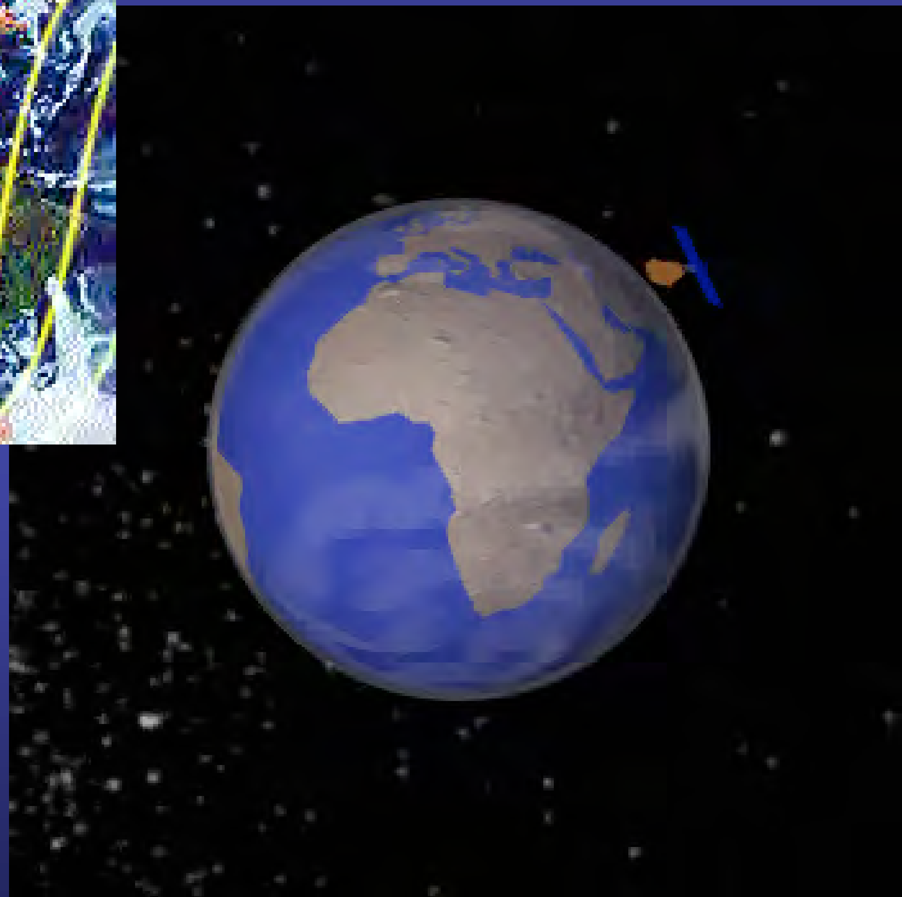
- Many images per day (MSG: one every 15 min)
- Low Space resolution, very large coverage

geostationary satellites



Polar Satellites

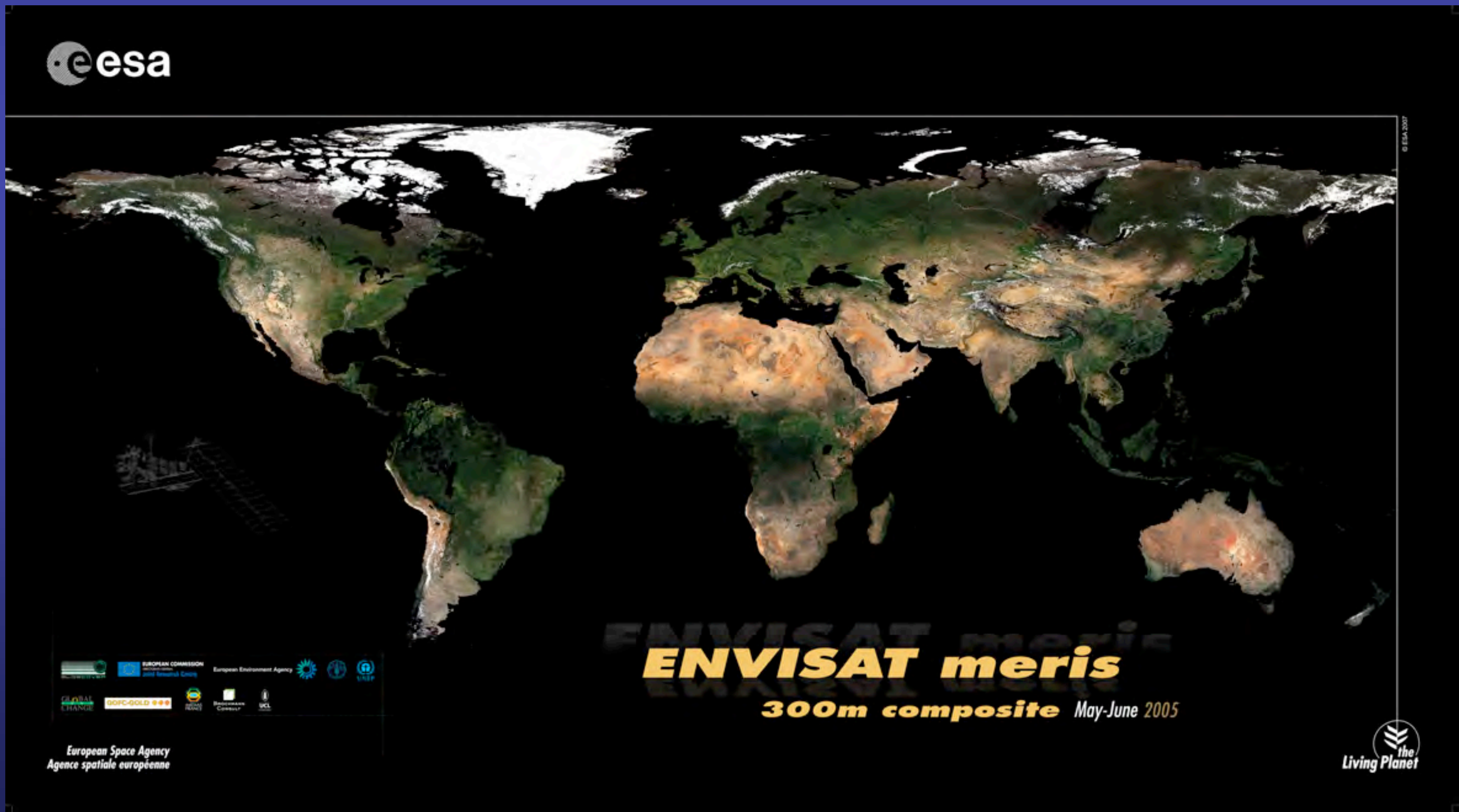




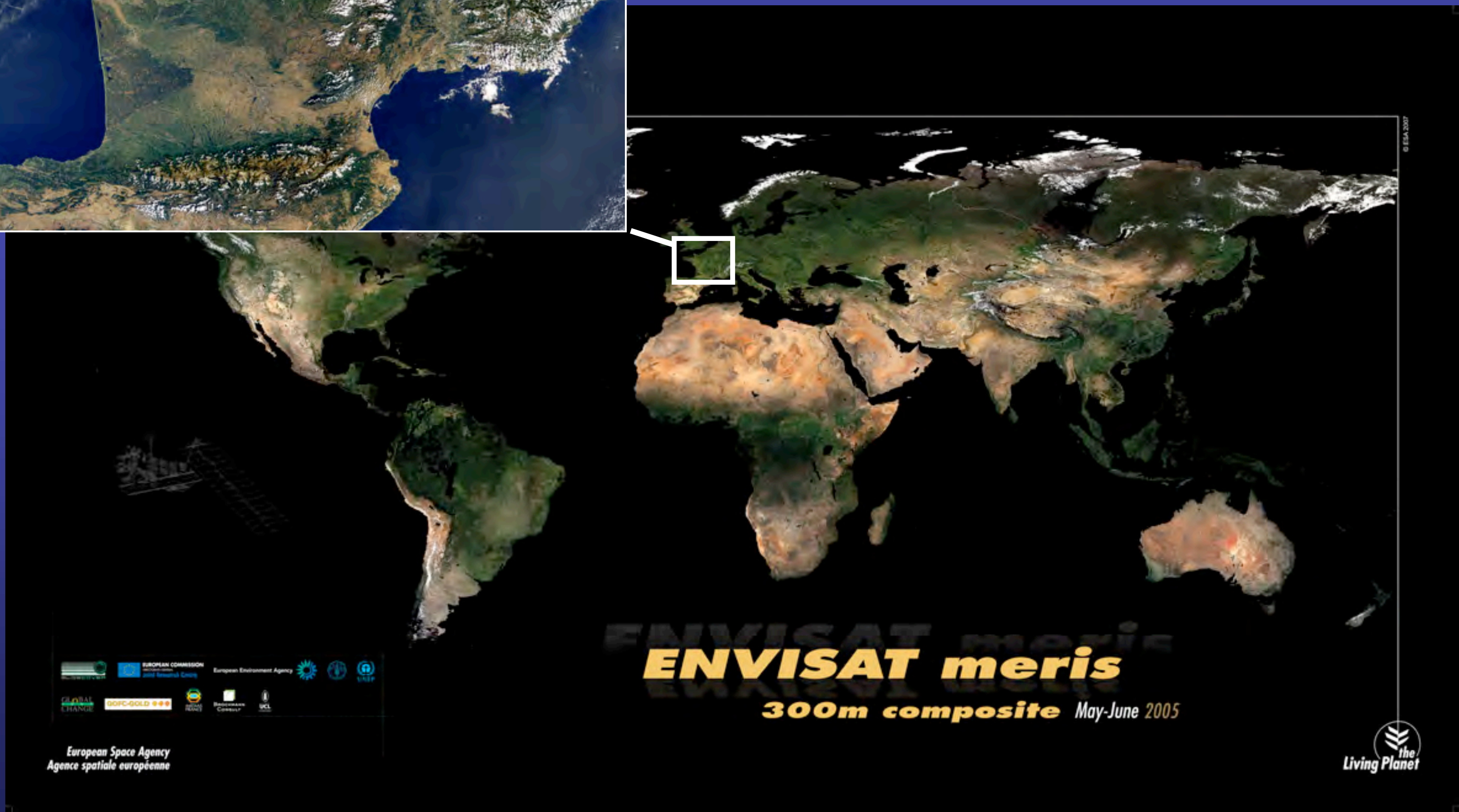
sat_polar.avi

Heliosynchronous orbits, LEO

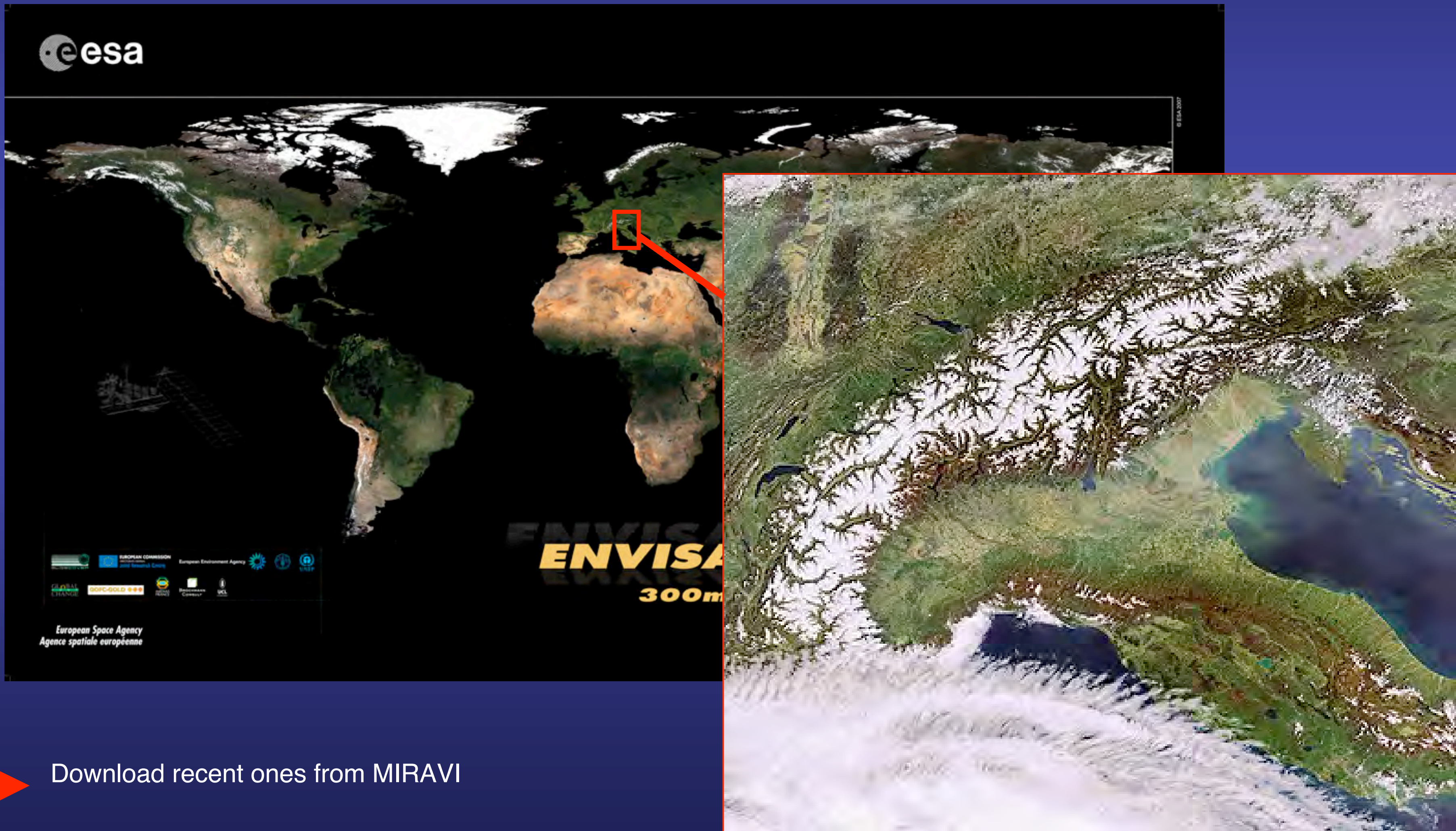
• LEO “Low earth orbits” 800 km height from the earth surface



- polar “LEO”
- high space resolution … smaller coverage but with details



- polar “LEO”
- high space resolution … smaller coverage but with details



Download recent ones from MIRAVI

ESA Earth Observation Education:
available tools for schools

Eduspace

ESA web-based EO Educational tool

The European Earth Observation Web Site for Secondary Schools: Learning (Geography, Earth Science, Physics, Languages) with Earth Observation.

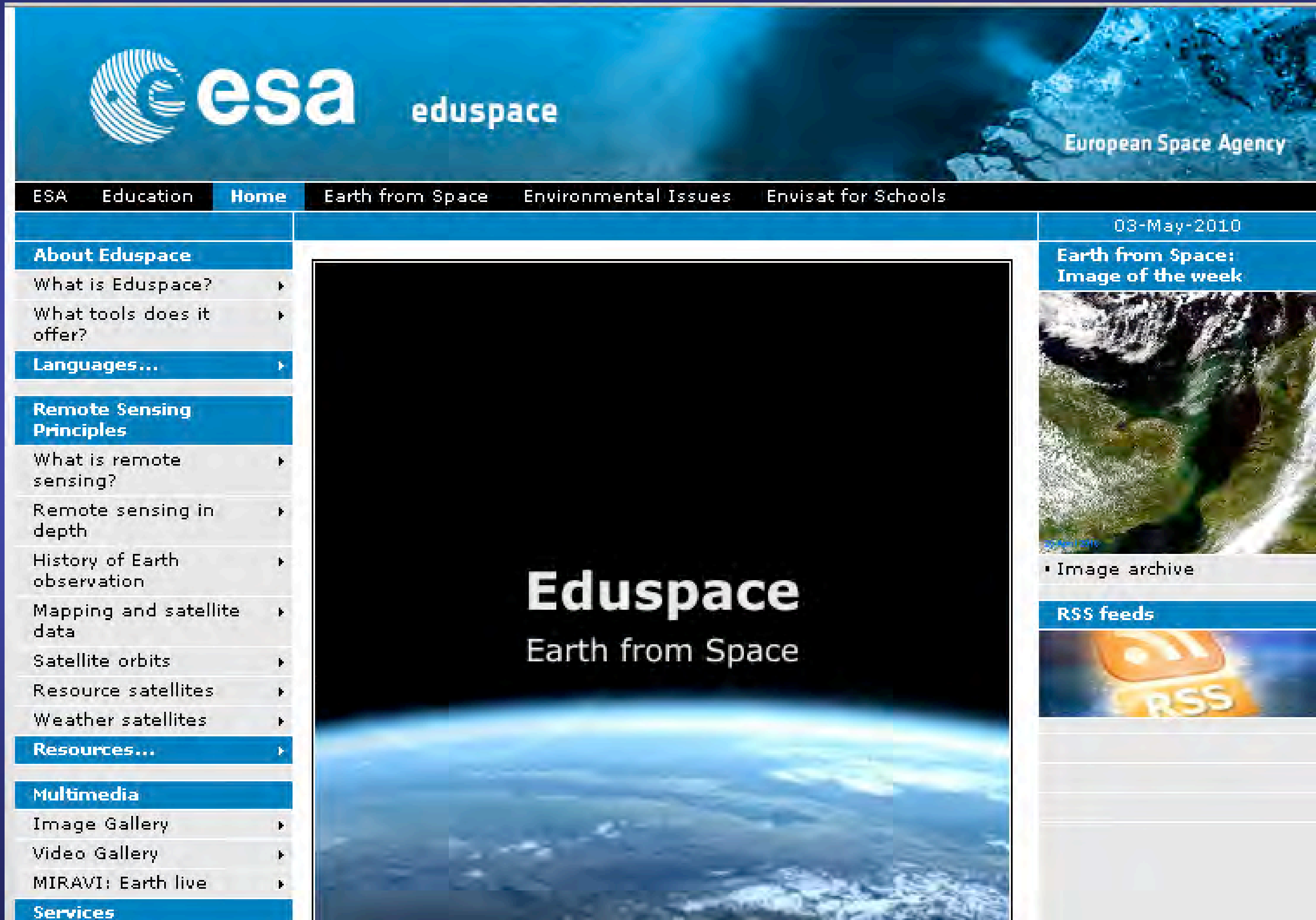
Including Disaster Monitoring, Global Change.

Multilingual: Danish, German, Dutch, English, Spanish, French, Italian, Portuguese, soon Greek.

www.eduspace.esa.int

Eduspace

ESA web-based EO Educational tool



www.eduspace.esa.int

Eduspace

Target Groups

- **Secondary school teachers who want to incorporate EO into their curricula**
- **Secondary school students to extend on what they have learned in class**
- **University students pursuing related academic studies**
- **Access to website www.eduspace.esa.int is free**

Modules

Europe/Africa/Himalaya from Space; ENVISAT for schools; Global Change; Disaster Monitoring

In preparation: Polar Module, World Heritage, Latin America from space

A large **Image Data Bank** (complete European coverage with Landsat and ERS-1&2 SAR, to be soon extended outside Europe and enlarged to more sensors)

SW and GIS

Latest upgrade: Leoworks v.3.2 (June 2008).

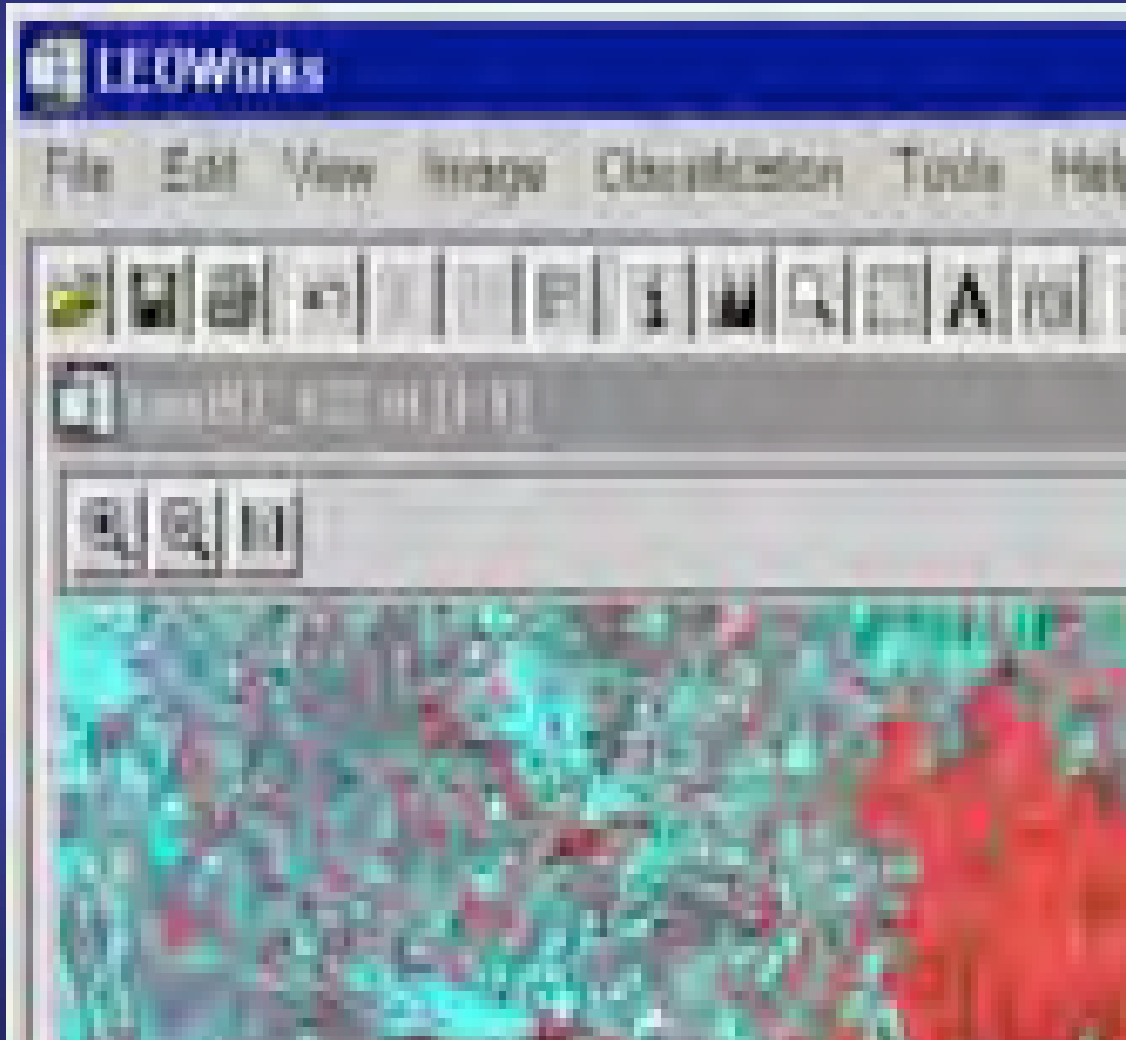
Leoworks 4.0 (end 2010) will be an <u>open-source</u>, free and platform-independent Image Processing <u>optical-radar</u> SW and <u>extended GIS</u> for High Schools. Beta versions available already (Chris.Stewart@esa.int).

LEOWorks 3.0

Image Processing Software (with GIS functionality)

- View images, histogram, pixel values, header info
- Crop, invert, stretch, layer stack, etc
- image arithmetic, filters
- Classification, PCA, geometric correction, pan sharpening
- GIS tools

eduspace



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

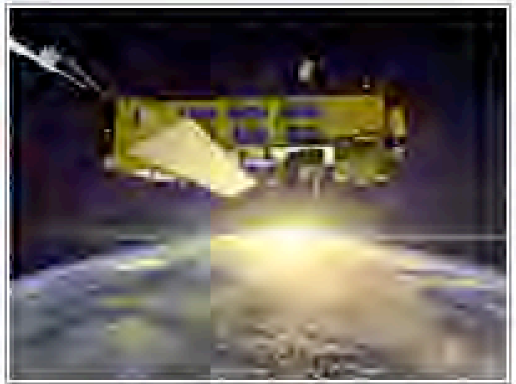
MIRAVI: Earth live

Services

Search

GO

BOOKMARK



What is remote sensing?

Remote sensing is a way of collecting and analysing data to get information about an object without the instrument used to collect the data being in direct contact with the object.

For example, if you take a photograph of your house, and on the picture you see that the house is composed of a roof, walls and windows, all of which appear as different colours, then this is remote sensing.

In remote sensing, three elements are essential. They are:

1 - a platform to hold the instrument
2 - a target object to be observed
3 - an instrument or a sensor to observe the target

For example, when you take a photograph of your house, you are the platform, the photographic emulsion of the film inside the camera is the sensor and the house is the target object.

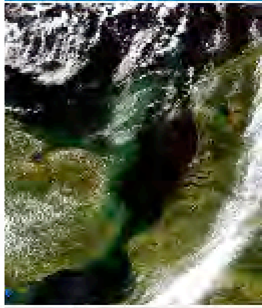
A key additional element, and the main purpose of remote sensing systems, is:

4 - the information that is obtained from the acquired data, and how it is used and stored

In the example of the photograph of your house, the information obtained is all you can identify about the house from the photograph.

03-May-2010

h from Space:
ge of the week



ge archive

feeds

MIRAVI: Earth live

Services

EGU/GIFT 2010, Vienna, 3 May 2010

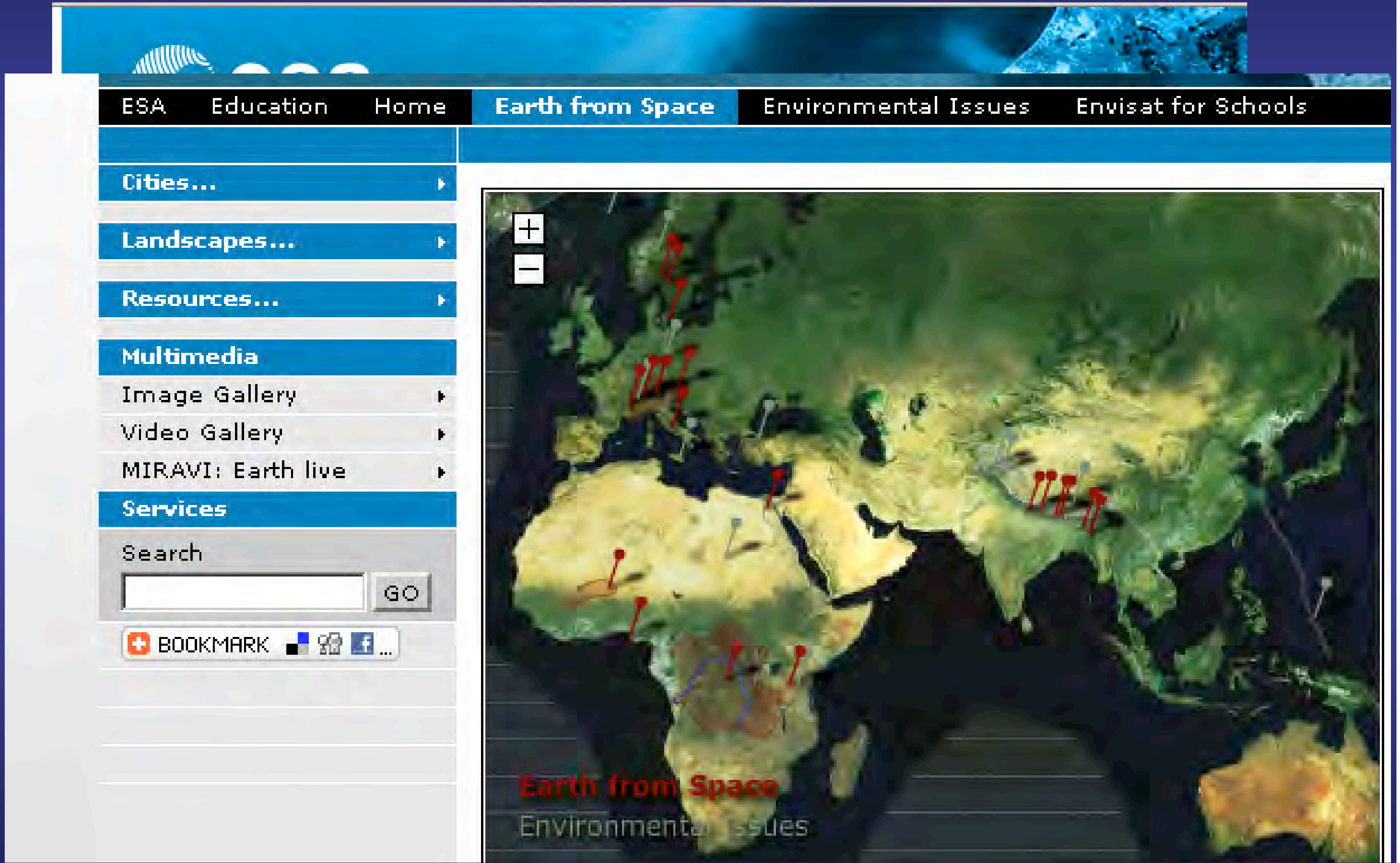
Eduspace

ESA web-based EO Educational tool

www.eduspace.esa.int

Eduspace

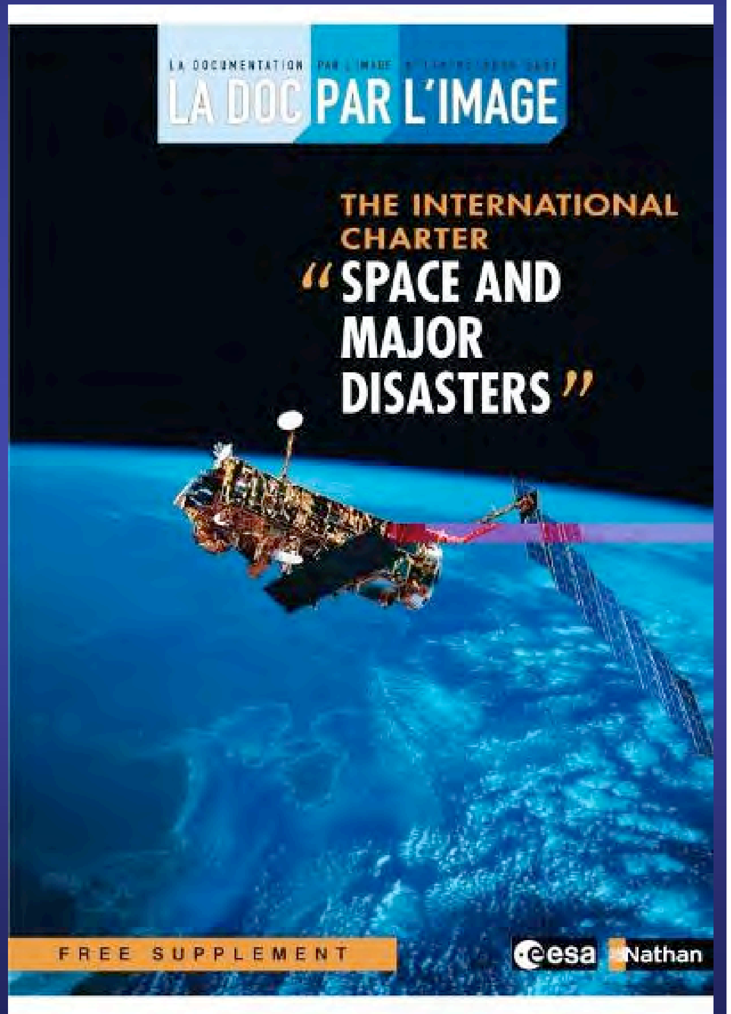
ESA web-based EO Educational tool



www.eduspace.esa.int

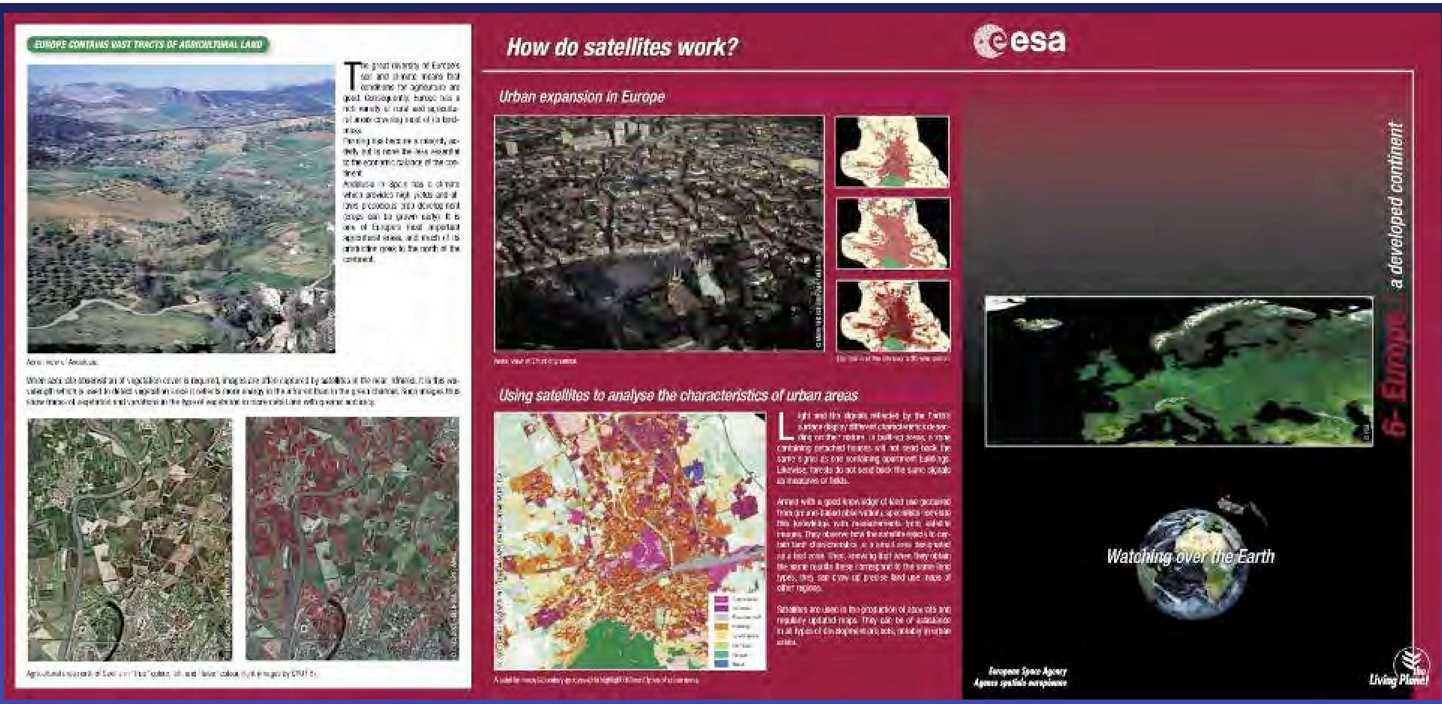
INTERNATIONAL CHARTER "SPACE AND MAJOR DISASTERS"

- target: primary/lower secondary level (8-12 years)
- objective: make the role of space facilities to manage natural and technological disasters more visible to youngsters
- product: a children supplement in 5 languages (En, Fr, It, Sp, Ger) downloadable in pdf from the Charter website *http://www.disasterscharter.org/ecoles_e.html*
- includes 3 worksheets to be used in the classroom as exercises and to stimulate



SCHOOL KIT (alias TEACHER's PACK)

- target: lower secondary level (11-14 years)
- objective: provide teachers with a working tool to introduce EO themes in schools.
- available in several languages (En, Fr, Sp, Dutch, German). Italian translation is ongoing
- product: a folder containing <u>11 worksheets on EO themes</u> related to teaching subjects <u>such as geography, life and Earth sciences, physics</u>. Each worksheet is composed of 3 colour pages recto-verso (triptych), plus an exercise sheet and a teacher information note



triptych (recto and verso)

SCHOOL KIT

TOPICS

1. Earth observation satellites
2. The Earth viewed from space
3. Humans on Earth
4. Africa and environmental diversity
5. Asia and rice-growing
6. Europe: a developed continent
7. Living species and their environments
8. Water on Earth
9. Volcanoes: Mount Etna, a case study
10. Flood monitoring

EARTH EXPLORER MISSIONS

- target: secondary level (15-18 years)
- product: CD-Rom in 2 languages (En, Fr)

CD-Rom

website

ESA School Atlas

ESA School Atlas – Funded by ESA, **produced by GEOSPACE**

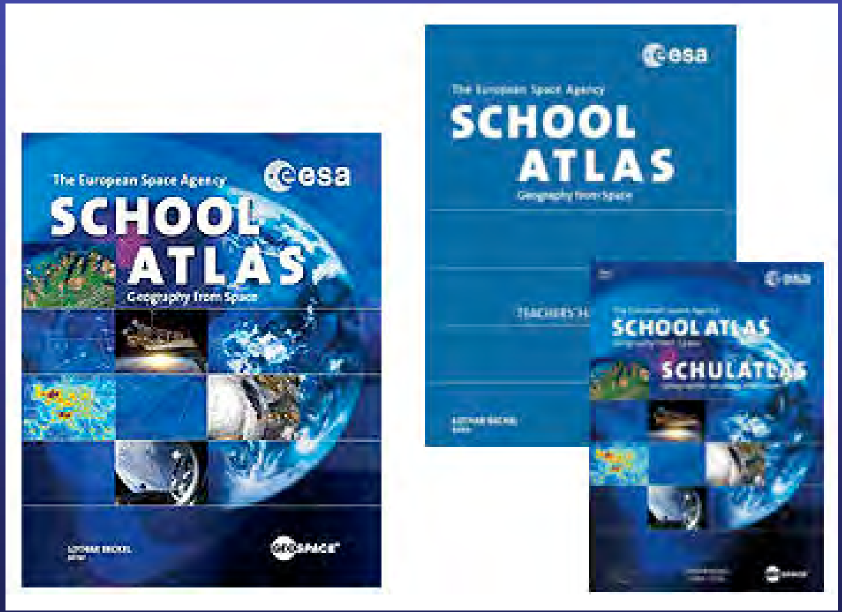
Targeting secondary schools and first university courses:

Realistic views of the Earth's surface, combined with thematic maps demonstrate the dynamic processes of our globe.

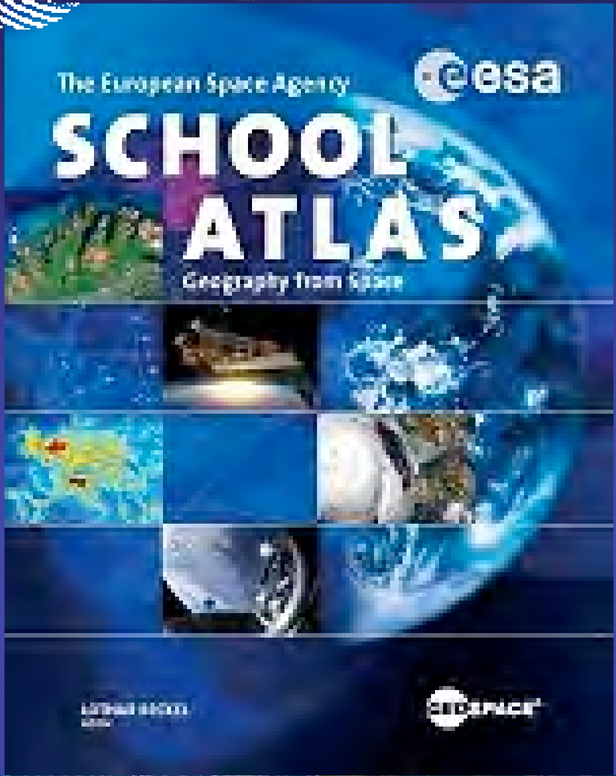
The atlas is accompanied by a Teachers' Handbook, a digital version on 2 DVD's and is also connected to Eduspace and its SW Leoworks.

The Atlas is available in both English and German from the Geospace website at a special concessionary price for schools.

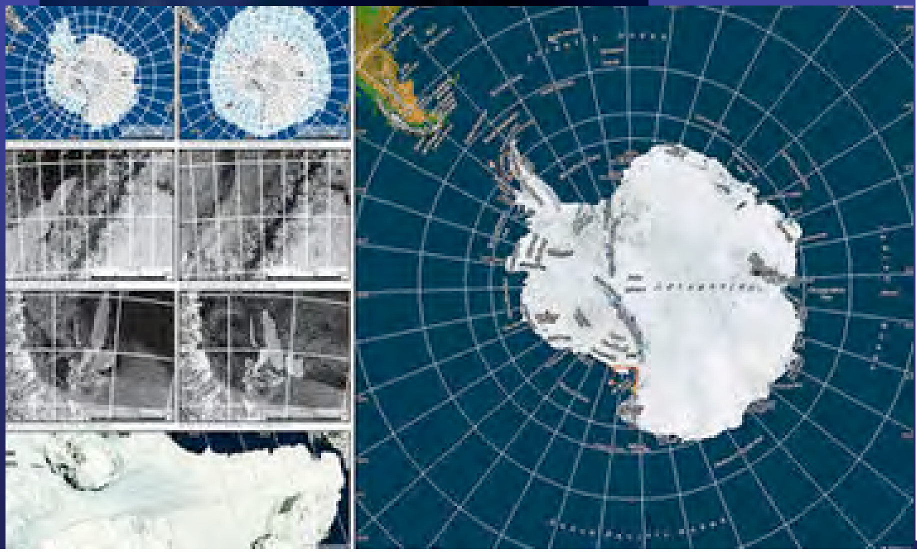
Order from: **www.geospace.co.at**

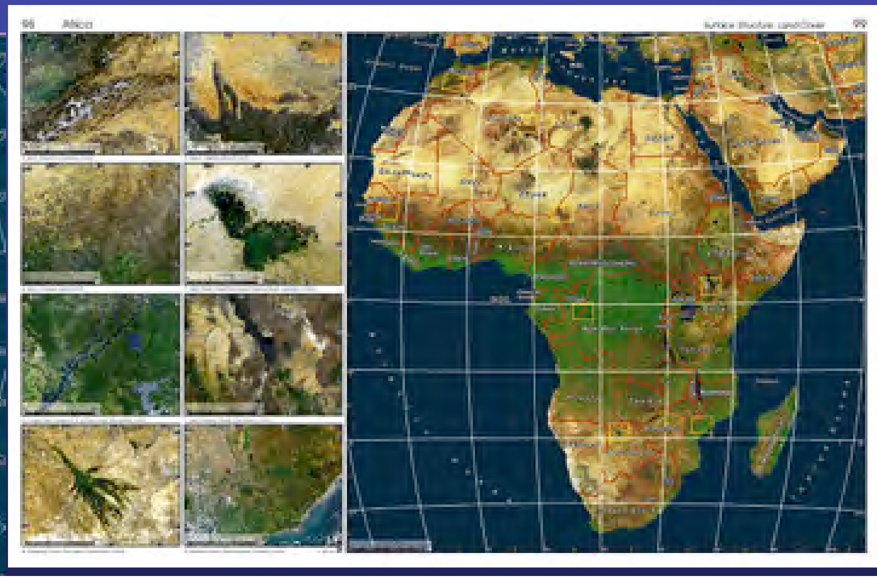


ESA School Atlas

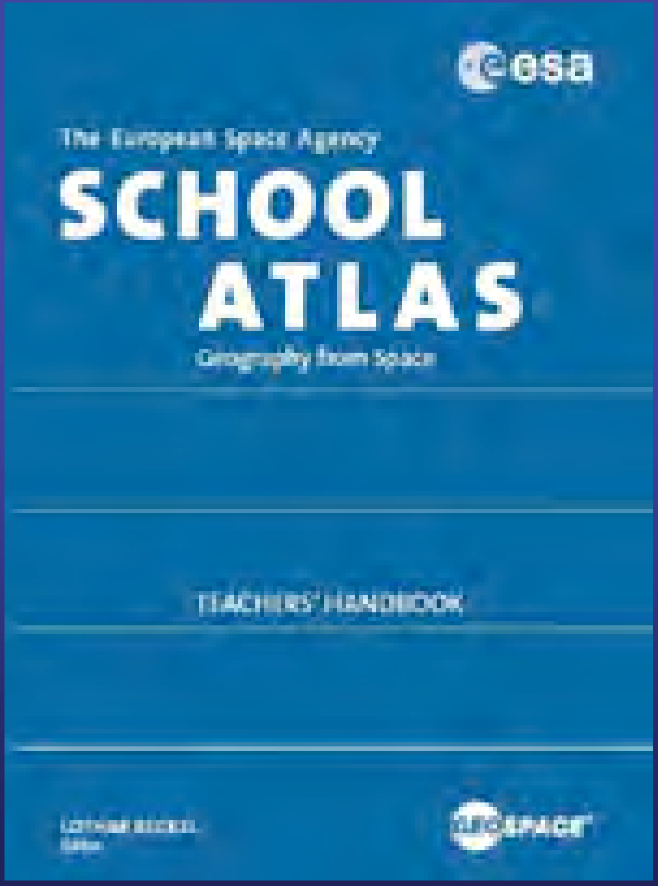


1) Introduction to ESA (10 pages)
2) Earth Observation (8 pages)
3) Global Overview (20 pages)
4) Continental Overview (82 pages)
5) The Natural Sphere (60 pages)
6) The Cultural Sphere (78 pages)
Index (18 pages)





Annex to the ESA School Atlas - Teachers' Handbook



Provides an introduction to Earth Observation and a general description of each double page of the Atlas. For every image or thematic map, technical information on the data, as well as descriptions and interpretation aids are included.

The purpose of the Teachers' Handbook is to support teachers in the use of the Atlas in the classroom. There are numerous suggestions of questions and exercises – for many of them the LEOWorks software may also be used.

EGU/GIFT 2010, Vienna, 3 May 2010

Projects with external partners :

Science Education via EO for High Schools (SEOS)

6th Framework Programme of EC

http://www.seos-project.eu/home.html

Final Remarks

• EO education and capacity building is becoming increasingly more important in view of climate change, more frequent natural disasters (storms, flash floods, etc…), natural & cultural heritage degradation and need of preservation

• ESA and many other space agencies are taking this very seriously and aim to promote EO to an increasingly large, world wide audience

• All audiences including schools are targeted as decision makers and disaster managers of tomorrow are sitting in the classrooms today! EO and Space Education should be available for youngsters in schools, well before university level…..

USEFUL ADDRESSES

- ☞ education portal: *www.esa.int/education*
- ☞ eduspace: www.eduspace.esa.int
- ↴ to order EO material: *education@esa.int* or *eohelp@esa.int*