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Observing the Earth

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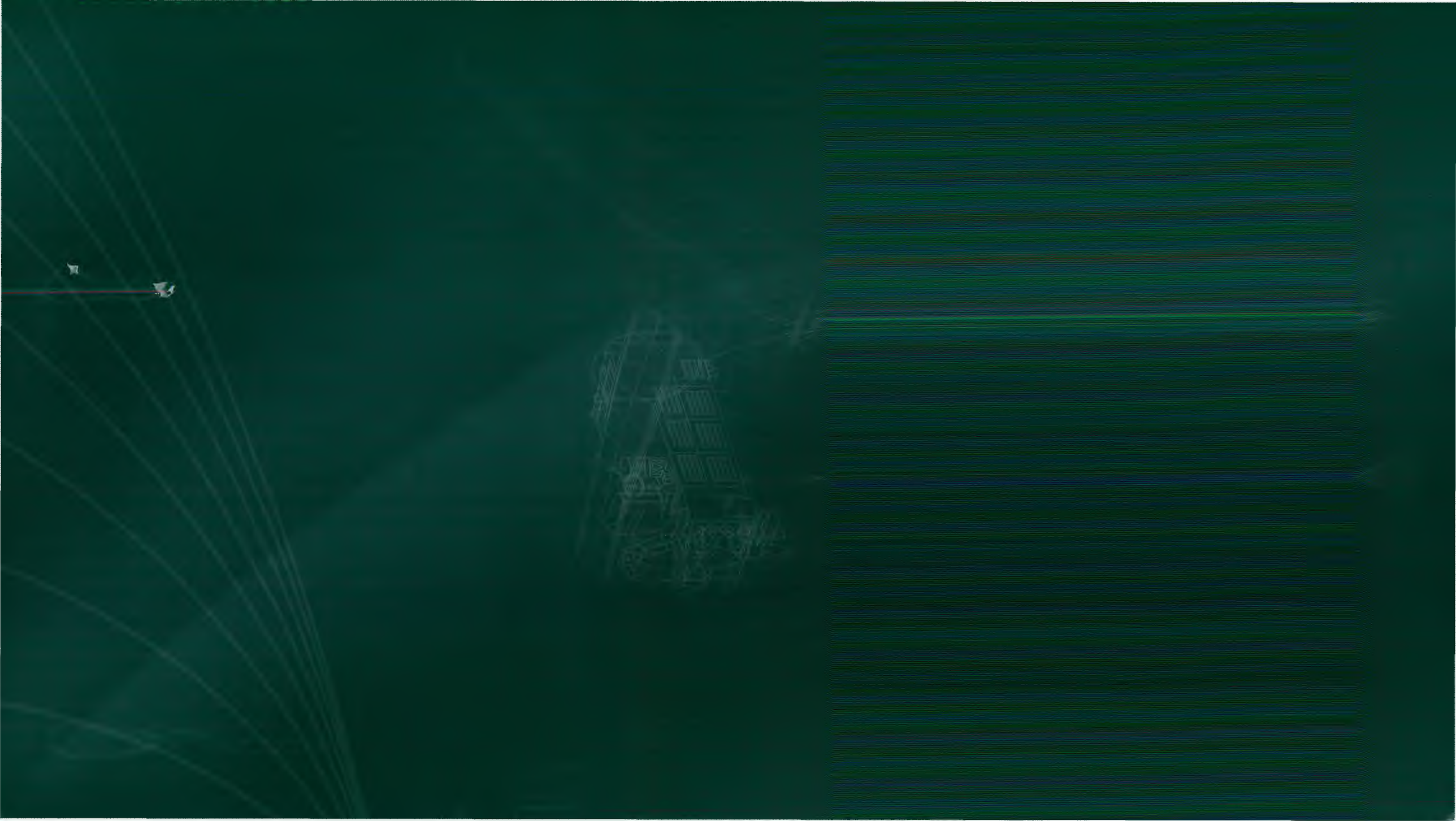

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Observing the Earth

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ESA has been dedicated to observing the Earth from space since the launch of its first meteorological mission Meteosat in 1977. Further ESA remote-sensing satellites - ERS-1, ERS-2 and Envisat - have since provided a vast amount of data and important scientific results.

Approved in 1999, ESA's ***Living Planet Strategy*** *embodies the fundamental goals of Earth Observation in developing our knowledge of the Earth, preserving the Earth and its environment and managing life on Earth in a more efficient way...*

concept: Apolloni Virtual Studio 2006

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ESA's Living Planet aims to meet the different needs and constraints of two groups: the scientific community and the providers of operational satellite-based services.
Accordingly it includes the continuing series of ***meteorological missions*** undertaken with the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) as well as new missions, such as the ***Sentinel Missions***, supporting the Global Monitoring for Environment and Security (GMES) - an initiative led by the European Union.

On the research side, the ***Earth Explorer*** series of satellites is designed to provide the European scientific community with the tools they need to understand and monitor Earth-system processes.

Training

the Trainers

Today's pupils and students are tomorrow's potential Earth Observation users who will ultimately determine the long-term benefits of scientific understanding and monitoring information delivered by Earth Observation. ESA actively promotes education and training activities in the field of Earth Observation by following the principal of "training the trainers" to improve educationalists' awareness of Earth Observation and to enable them to provide classroom learning opportunities for students at all levels.

ESA organises professional training courses, summer schools and educational presentations, often in conjunction with events run by partner institutions such as national space agencies or the United Nations.

For fast easy access to Earth Observation information and teaching resources, ESA's ***Eduspace*** website is devoted to increasing awareness of how investment in space brings benefits for citizens. This multilingual website is routinely employed by thousands of secondary schools across Europe and the world and includes a guide to the principles of Earth Observation and major application showcases. In addition, free software performing data processing on sample images is available for download offering teachers and secondary school students a means of bringing Earth Observation and its many applications into the classroom.

Fostering

International Cooperation

By its very nature, planetary monitoring is a field that requires consideration on a global scale. International co-operation is a significant means of leveraging the effectiveness of ESA Earth Observation activities.

ESA was a founder member of the ***Committee on Earth Observing Satellites (CEOS)***, an international co-ordinating mechanism aiming to optimise the benefits of global Earth Observation missions through co-operation between members in terms of mission planning and developing compatible data products, services and policies. First created in 1984, CEOS today comprises of 25 Members - mostly space agencies and 21 Associates (associated national and international organisations).

In 1999, ESA and the French Space Agency CNES initiated the ***International Charter "Space and Major Disasters"***, aimed at making space technology available to rescue authorities in the event of a natural or man-made disaster. The Charter has been since joined by the Canadian Space Agency (CSA), the Indian Space Research Organisation (ISRO), the United States National Oceanic and Atmospheric Administration (NOAA), the United States Geological Survey (USGS), the Argentinean Space Agency (CONAE) and the Japan Aerospace Exploration Agency (JAXA). The Chinese National Space Agency has also expressed an interest in participating.

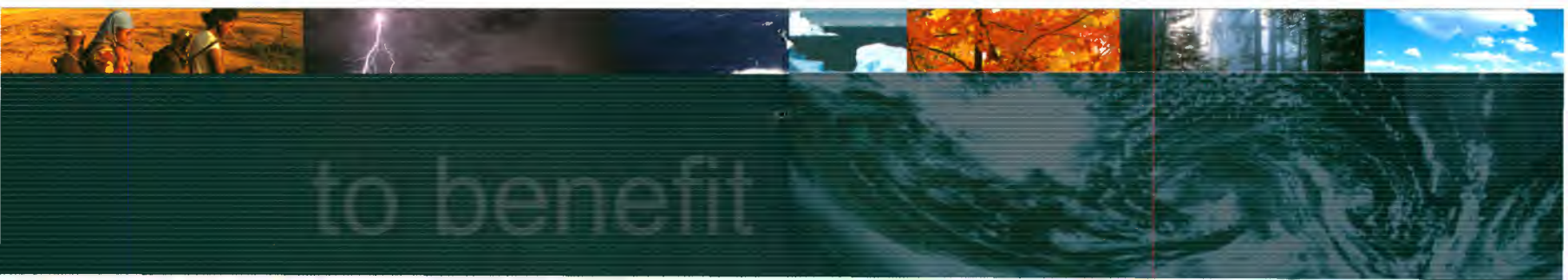
ESA also carries out its own international co-operation initiatives through the international ***TIGER*** initiative aimed at providing Earth Observation data to assist in managing water resources, primarily in Africa, and the ***Dragon*** Programme, an initiative aimed at encouraging joint European and Chinese research across a range of thematic areas, concentrating on the vast 9.6 million square kilometres of Chinese territory.

Strengthening

the Earth Observation Roadmap

Providing a series of complementary activities in full support of the development roadmap for Earth Observation, ESA's Living Planet offers the means to:

- Advance the scientific agenda in Earth Science
- Guarantee easy access to Earth Observation data through an open and operational approach
- Develop new monitoring tools and respond to the challenges of global change and of anthropogenic effects on our environment
- Strengthen the competitiveness of the European Earth Observation industry
- Guarantee European Independence in Geo-spatial Information
- Support European leadership in Earth Observation and foster international cooperation between Europe and other space stakeholders



Turning Science into Services

Earth Observation provides a whole new dimension of information and for this reason is already employed by thousands of users worldwide. ESA works to further increase Earth Observation take-up by encouraging development of new applications and services centred on user needs.

New applications usually emerge from the scientific research community - known as ***Principal Investigators*** - who receives ESA Earth Observation data free or at cost price.
Support tools and activities such as the Earth Observation Principal Investigator portal acts as the platform for Announcement of Opportunity for researchers to make use of Earth Observation data within their particular fields. It allows them to submit new proposals for the scientific exploitation of ESA data and to provide project results.

Turning data into services requires that long-term relationships are developed between research institutes, service organisations and user communities.
ESA's ***Data User Element (DUE)*** programme addresses institutional users tasked with collecting specific geographic or environmental data and aims to raise their awareness of the applicability of Earth Observation to their day-to-day operations and to develop demonstration products tailored to increase their effectiveness.
ESA's ***Earth Observation Market Development*** programme complements the DUE by providing the framework within which to organise end-to-end service chains capable of leveraging Earth Observation data into commercial tools supplied by self-supporting businesses.

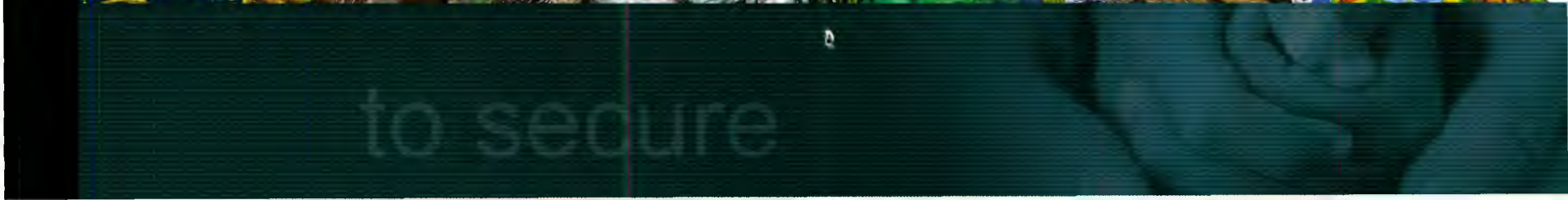
Guaranteeing European Independence in Geo-spatial Information

The next flagship initiative for space in Europe after Galileo, GMES ***(Global Monitoring for Environment and Security)*** responds to Europe's needs for geo-spatial information services, by bringing together the capacity of Europe to collect and manage data and information on the environment and civil security, for the benefit of European citizens.

Europe is leading many of the world's most urgent environmental and security issues. Without GMES, Europe cannot easily organise an evidence-based response during international negotiations. It guarantees Europe's strategic independence and international effectiveness, giving Europe an opportunity to lead the way in negotiating environmental agreements and influencing international policy and practice.

As the main partner to the European Commission in GMES, ESA is the implementing agency for the GMES Space Component, which will fulfil the space-based observation requirements in response to European policy priorities. It includes the development of a series of satellites - the ***Sentinel Missions*** - to support the data needs of GMES services from 2011 onwards. It will further provide integrated access to Earth observation missions of ESA member states and other partners to satisfy the data needs of GMES services from 2008 onwards.

In a wider context, the Group on Earth Observation (GEO) is an international partnership leading a worldwide effort to build a Global Earth Observation System of Systems (GEOSS) over the next 10 years.
GEOSS will work with and build upon existing national, regional and international systems to provide comprehensive, coordinated Earth observations from thousands of instruments worldwide; the data they collect will be transformed into vital information for society. In this context ***GMES represents the European contribution to GEOSS.***



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Space to BENEFIT Our Economy

"The advantages of Earth Observation are that it has global coverage, is scalable from big to small areas with time periodicity, and above all it is cost effective."

José Romero
Agency for the Environment, Forests and Landscape, Switzerland

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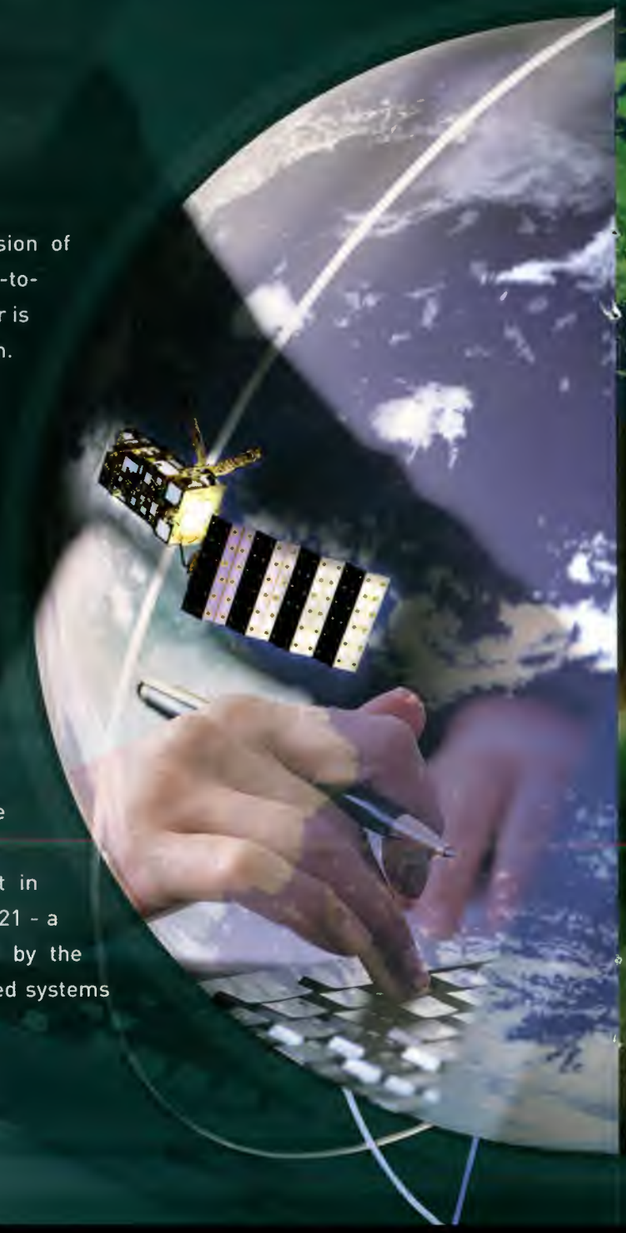
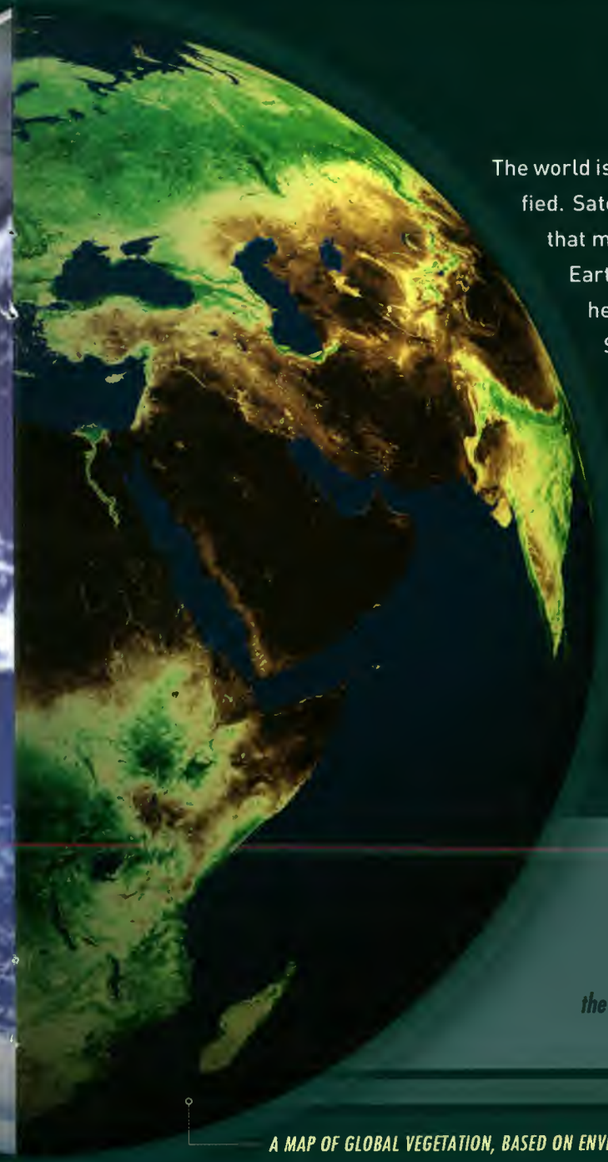
SERVING DAILY LIFE

Space-derived information provides a whole new dimension of knowledge and services which can benefit our lives on a day-to-day basis. Accurate forecasting of the ever-changing weather is vital for effective agriculture, industry and transportation. Weather forecasts also save lives through severe weather warnings of events such as storms, snowfall or flooding. Satellites have radically improved the accuracy of weather forecasts and have become a crucial part of our daily life.

SUPPORTING SUSTAINABLE DEVELOPMENT

Economic and social development need to take place on a sustainable basis. Meeting this challenge requires accurate and timely information on the state of the environment.
In 2002 the World Summit on Sustainable Development in Johannesburg, South Africa, renewed the goals of Agenda 21 - a global action plan for sustainable development adopted by the United Nations - and emphasised the vital role space-based systems can play in carrying them out.

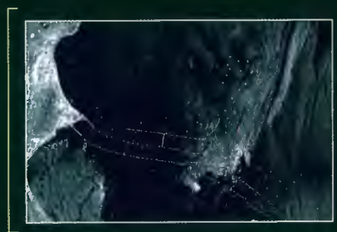




A MAP OF GLOBAL VEGETATION, BASED ON ENVISAT DATA

Surveying Natural Resources

The world is rich in resources but to be exploited they must first be identified. Satellites help reveal resources on and under the land and sea that may otherwise go untapped.
Earth Observation from space detects tiny subsidence events to help find water sources in the shape of subterranean aquifers. Satellites can also map surface faults or slight ground motion connected with hydrocarbon reservoirs and mineral deposits that are otherwise difficult to see.



Oil installations in the Caspian sea revealed by Envisat

Heights of inland water can now be measured directly from space using radar altimeters, currently carried on several satellites and originally designed to measure ocean height. This is a very exciting development which has the potential to transform the management of drought crises and water-related conflicts around the world.

Philippa Berry - De Montfort University, United Kingdom

Monitoring Human Impact

The 21st Century has seen an increase in industrial areas as people continue moving away from the countryside to towns and cities. With an increase in urban living, satellites have become useful tools for city planners by helping to identify 'hotspots' in danger of over-crowding, detecting areas prone to natural hazards, checking the continued sustainability of natural resources and monitoring air quality and pollution sources.

Tunis expansion shown by Landsat (1984 and 2004)

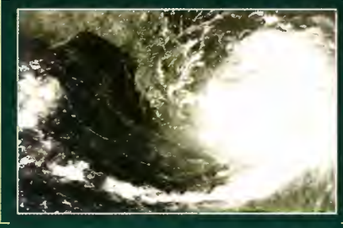
"It is very useful because there have been no new maps made of this area (Monrovia) since the 1970s, despite the fact that African cities change so fast - new suburbs can spring up rapidly as populations move. Satellite pictures represent the best way of seeing how the city has evolved."

Rémi Carrier - *Médecins Sans Frontières, Belgium*

Improving Weather Forecast

Weather prediction is the most mature application of Earth Observation. Meteosat and the Meteosat Second Generation (MSG) series, built by ESA and operated by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), have been providing images for weather forecasts for almost 30 years.

From 2006 a new MetOp series of polar satellites addressing meteorological and climate issues will complement the geostationary Meteosats. Activities initiated for a Meteosat Third Generation (MTG) and post-MetOp series, planned for 2015 and 2019 respectively, demonstrate Europe's commitment to the continuity of the meteorological missions.



Hurricane Katrina seen by Envisat

"It is critical for weather forecasters to obtain reliable characterization of the eye wall dimension and the radii of gale- tropical storm-and hurricane-force winds in order to provide skillful forecasts and warning. Satellite-based observations will facilitate better understanding of hurricane evolution and intensification."

Hans Graber - *University of Miami, USA*

METOP AND NOAA COMPLEMENTARY ORBITS

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Optimising Land Use Efficiency

Increasing the overall productivity of our land requires using it in a more sustainable manner. To do this, it is necessary to make an inventory of how land is used; satellites are an objective and cost-effective means of carrying this out.

Since they began monitoring land cover, satellites have acquired a 40-year data archive, which is essential for tracking land use changes and highlighting shifts such as growing urban encroachment onto farmland.

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Proba CHRIS image shows cotton fields in New South Wales

"Our environmental policies and legislation are based first and foremost on our knowledge of the state of the environment, what are the risks to it, what are the environmental trends. What we know is that we do not know enough at the moment, and satellites and space can bring something additional to our existing monitoring."

Timo Makela - *European Commission Directorate-General for Environment*

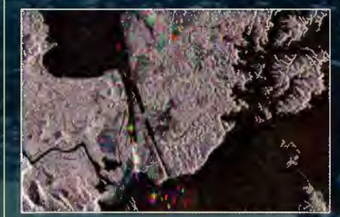
PLANET EARTH SEEN BY METEOSAT 8 SATELLITE

EUMETSAT 2003

Assisting Transport Routing

Air, land and sea transportation form the circulatory system of the global economy, enabling the flow of goods, people and services across borders. Satellites help increase transport efficiency. For instance, they can guide merchant ships through ice fields and supplement ground-based meteorological and sea state forecasts.

By characterising landscapes in a range of different ways and in unprecedented detail, satellites can also assist with planning new roads and rail links.



Vessels moving through the Panama Canal shown by Envisat

"As an Oryx Quest race meteorologist I help provide weather forecasts to the crews and work on route planning. Safety is a very high priority, and with this new satellite data analysis we can tell crews where they should steer to stay clear of ice fields."

Chris Bedford - *Sailing Weather Services, USA*

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Changes in land cover patterns, effects of environmental pollution and loss of biodiversity often do not respect national or other artificial boundaries. An updated view of such problems - or their effects - from interpreted space imagery should offer a large boost to UNEP's effort to monitor the health of the planet and our changing environment.

Ron Witt
United Nations Environment Programme (UNEP)

Space to SECURE Our Environment

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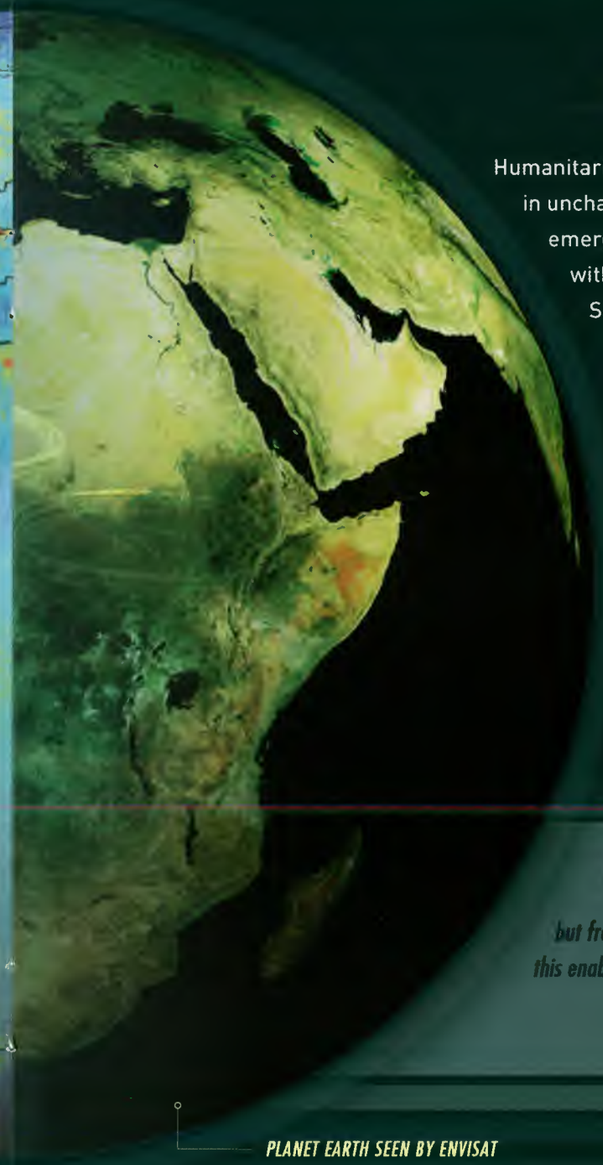
GATHERING ENVIRONMENTAL INFORMATION

European policies supporting sustainable development and protection can only be made effective with the ability to obtain reliable and timely information about the state of our world.
Satellites supply a consistent set of continuously updated global data which can offer support to policies related to environmental security by providing accurate information for informed decision making on various environmental issues.

STRENGTHENING PUBLIC SAFETY

Satellite-based rapid mapping services can support civil defense and humanitarian aid activities during crises as well as supporting risk assessment and prevention efforts in the long term. Within this context ESA co-founded in 1999 the International Charter on Space and Major Disasters – an agreement of space agencies to make near-real time satellite data available to worldwide civil protection agencies.



PLANET EARTH SEEN BY ENVISAT

Aiding Humanitarian Efforts

Humanitarian aid and development workers are often summoned to work in uncharted territory and find themselves planning either short-term emergency interventions or long-term development programmes within what might as well be geographical blank spots.
Satellite images can serve as a source of reliable data needed for operational planning, such as the speedy distribution of emergency food and medicine, or deciding emergency evacuation routes for personnel.

Satellite-based map of the Almar/Qaysar Districts in Afghanistan

We were unable to obtain an official count of the numbers, but from the satellite images we could see the layout of the camp and its buildings, this enabled us to make a good guess as to the number of people in need of our help.

Koen Van de Cauter - *Médecins Sans Frontières, Belgium*

Better Information for Tracking Epidemics

Microscopes are not the only tools available to study diseases. Satellites are being used to study, monitor and prevent the spread of epidemic outbreaks. The incidence of diseases such as malaria, meningitis and Ebola are influenced by local climate variation.
Satellite data which focuses on a region's landscape – rainfall, vegetation, water bodies, dust mapping and temperature – are helping predict when and where people are at greatest risk.

Sahara dust storm shown by Envisat

"Making use of satellite data enables us to follow week by week the development of the dust storms and the appearance of conditions favourable for an epidemic to start."

Isabelle Jeanne - Niger-based Centre de Recherche Médicale et Sanitaire

Global Monitoring for Environment and Security (GMES)

Responding to Europe's need for geo-spatial information services, the EU-led GMES initiative will bring together Europe's capacity to collect and manage environmental and civil security data and information for European citizens. ESA is the implementing agency for the GMES Space Component, which will fulfil the space-based observation requirements in response to European policy priorities. It includes the development of a series of satellites - the Sentinel missions – to support the data needs of GMES services from 2011 onwards as well as the provision of EO data from European and international missions to GMES services from 2008 onwards.

Oil spill from the Prestige tanker shown by Envisat

"Nowadays, space technologies allow the development of applications to meet the challenging needs of policy makers. With the Global Monitoring for Environment and Security initiative, Europe is committed to develop reliable and sustainable operational services to support the monitoring and development of its policies."

Valère Moutarlier - Head of the GMES Bureau, DG Enterprise & Industry, European Commission

NITROGEN DIOXIDE (NO_2) POLLUTION TRACKED BY ENVISAT

Supporting International Treaties

Environmental degradation respects no boundaries. Thus, response must be collective in nature – the underlying reason for international environmental agreements such as the Kyoto Protocol.
Satellites are useful tools to monitor and enforce such treaties. The information they provide is sound, systematic and rigorous enough to be relied upon – following integration with other data sources – to establish a consensus on the state of the environment as a basis for further action.

Web-like patterns of Brazilian deforestation revealed by Envisat

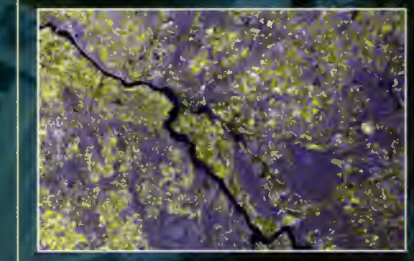
"The real ESA goldmine - where Kyoto-Inventory fits right into our current efforts - is the baseline 1990 data it provides, which is needed to measure subsequent changes in carbon stock."

Jaap Paasman - *Ministry of Agriculture, The Netherlands*

FIRE HOT SPOTS RECORDED GLOBALLY BY ENVISAT

Assisting Civil Protection

The effects of disasters, such as landslides, floods, volcanic eruptions, oil spills and earthquakes can be observed from space. Wide-view satellite imagery is employed directly as information sources as well as management tools for planning and co-ordinating emergency responses. In the framework of the International Charter on Space and Major Disasters, space-acquired data products and associated resources are made directly available to the civil protection agencies concerned.



The Elbe flood shown by ERS-2

"Our key issue is time - but very quickly the satellite maps give us an impression of the flood extent, and the areas that are affected. The maps can support high-level decision making and the best use possible of human and material resources."

Colonel François Maurer - *Directorate of Civil Defence and Security (DDSC), France*

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Satellites contribute to research into global climate change by observing globally, with continuity…
Only satellites can provide the coverage, continuity, and consistency that climate change research requires.

David Llewellyn-Jones
University of Leicester, United Kingdom

Space to UNDERSTAND Our Planet

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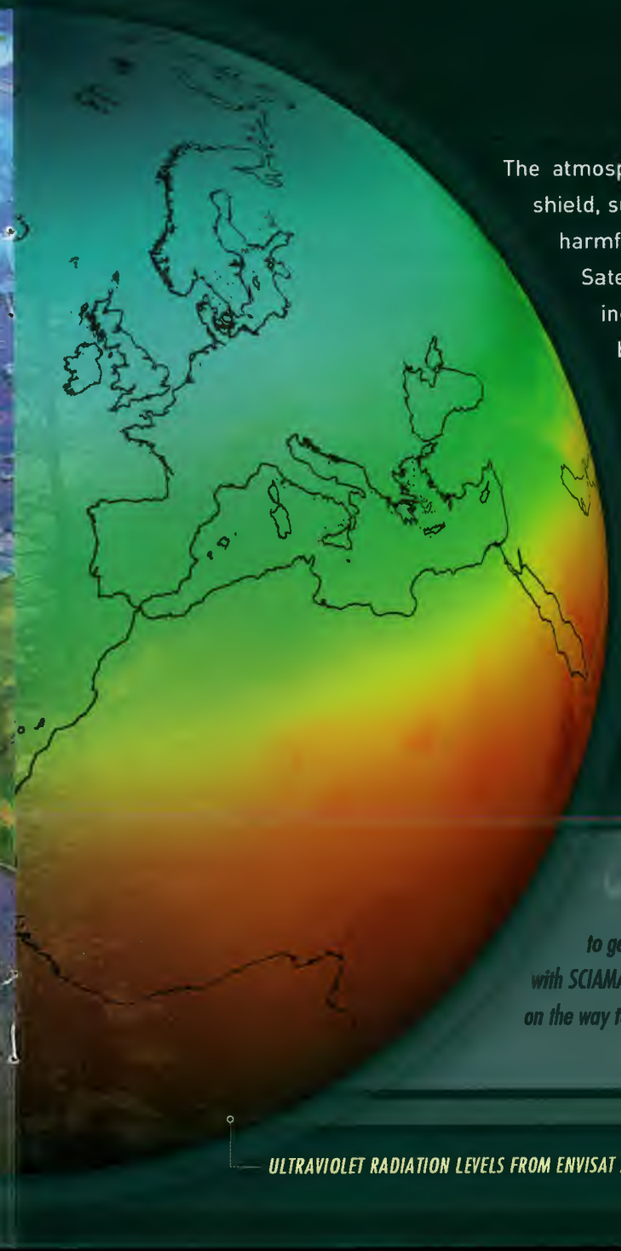
SEEING THE WHOLE PICTURE

Early pictures of the Earth seen from space became icons of the Space Age and encouraged an increased awareness of the precious nature of our common home.

Today, images of our planet from orbit are acquired continuously and have become powerful scientific tools to enable better understanding and improved management of the Earth and its environment.

EXPLORING EARTH DYNAMICS

For an improved understanding of the environment it is vital to see the Earth as the complex, dynamic system it is. Satellites provide clearer views of the various components of the Earth system – its land, ice, atmosphere, biosphere and oceans – and how these processes interact and influence each other.

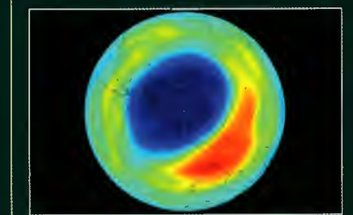


Mapping the Invisible

The atmosphere functions as a life support system and a protective shield, supplying us with the air we breathe and protecting us against harmful radiation.

Satellite sensors can map the atmosphere's composition, detecting holes in the ozone layer, plumes of aerosols and pollutants, burning forests and exhaust trails left by aircraft.

Witnessing the way our atmosphere reacts to human inputs, satellites help predict the consequences of our actions and provide reliable indicators to support the debate on global warming.



Ozone hole charted by Envisat

"Back when we were starting out, many people thought it would be impossible to get any useful results out of the troposphere. First with GOME and now much better with SCIAMACHY we are demonstrating it can be done. The success so far is an important step on the way to establishing an operational global observing system for the Earth's atmosphere."

John Burrows - *University of Bremen, Germany*

ULTRAVIOLET RADIATION LEVELS FROM ENVISAT ATMOSPHERIC DATA

Counting on Carbon

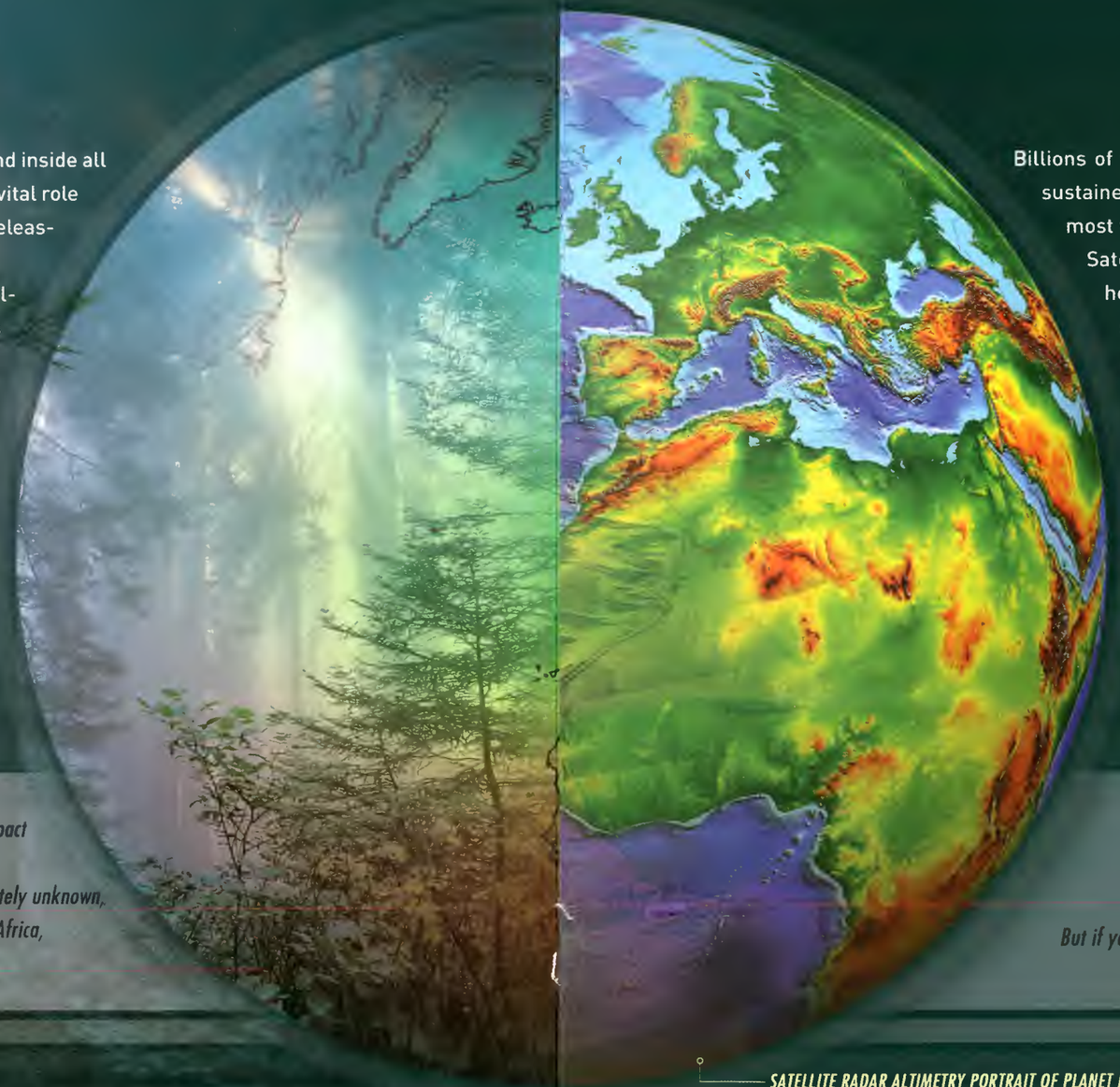
Carbon is the basis of the complex chemistry of life and is found inside all living things, the ground, sea and atmosphere. Forests play a vital role in the carbon cycle by storing it through photosynthesis and releasing it through respiration.

Satellites can make a major contribution to improving knowledge of the global distribution of the atmospheric sources and sinks of greenhouse gases by providing data on the parameters involved in the carbon cycle, such as forest inventories.

Satellite portrait of global plant growth

Direct satellite measurements of carbon dioxide will have as dramatic an impact as the Hubble Space Telescope within the Earth science field.
It should give us a completely new picture of something more or less completely unknown, showing us the carbon flux across tropical areas such as South America and Africa, where we basically have no data available right now.

Philippe Ciais - *Laboratory for Climate Sciences and the Environment, France*



SATELLITE RADAR ALTIMETRY PORTRAIT OF PLANET EARTH

Knowing our Home Ground

Billions of years of geological movement, atmospheric weathering and sustained biological activity have left the Earth's land surface with the most varied terrain in the solar system.

Satellite observations provide us with a unique insight into our home ground by enabling the objective global classification of surface land cover, mapping the distribution of forests, deserts, water bodies, agricultural land and human settlements.

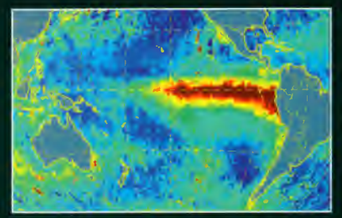
Egypt's Pyramids of Giza seen by ESA's micro-satellite Proba

Fragmentation of land is a time bomb.
Each year only a small fraction of the landscape will change its function.
This is not enough for you to really feel the change as dramatic.
But if you use satellite data over a span of ten years you can really see a difference.

Chris Steenmans - *European Environment Agency*

Fathoming our Oceans

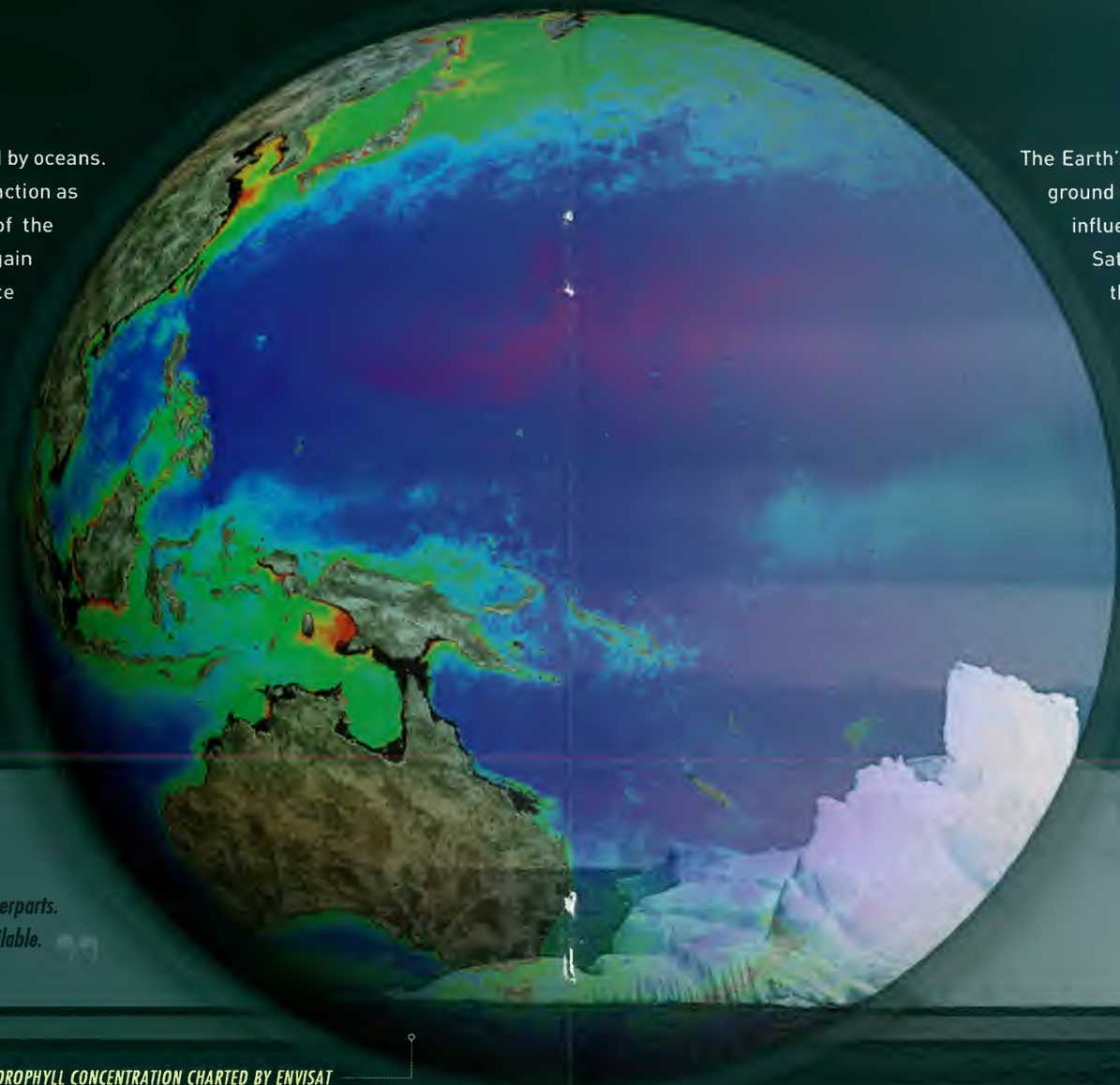
Earth is a water planet with seven tenths of its surface covered by oceans. Vital to the Earth's system, oceans regulate global climate, function as reservoirs of heat and carbon and provide us with most of the oxygen we breathe. The advent of satellites has allowed us to gain an accurate global view of the seas by charting sea-surface height and temperature, tracking current circulation and observing carbon-fixing phytoplankton populations.



El Niño revealed by ERS-2

"Only radar satellites can provide the truly global data sampling needed for statistical analysis of the oceans, because they can see through clouds and darkness, unlike their optical counterparts. In stormy weather, radar images are thus the only relevant information available."

Susanne Lehner - *University of Miami, USA*



GLOBAL CHLOROPHYLL CONCENTRATION CHARTED BY ENVISAT

Charting the Cryosphere

The Earth's cryosphere – sea ice, freshwater ice, snow, glaciers, frozen ground and permafrost – contains the majority of global freshwater, influences climate and is sensitive to temperature change.

Satellites provide an effective means of continuously monitoring the entire cryosphere and accurately measuring both ice extent and thickness, which is vital in helping determine the rate of change of the polar marine ice and continental ice sheets in response to climate change.

C-16 iceberg collision with the Drygalski Ice Tongue, captured by Envisat

"Radar interferometry has become one of the major tools for observing glaciers and advancing the knowledge of glacier response to climate change."

Helmut Rott - *Innsbruck University, Austria*

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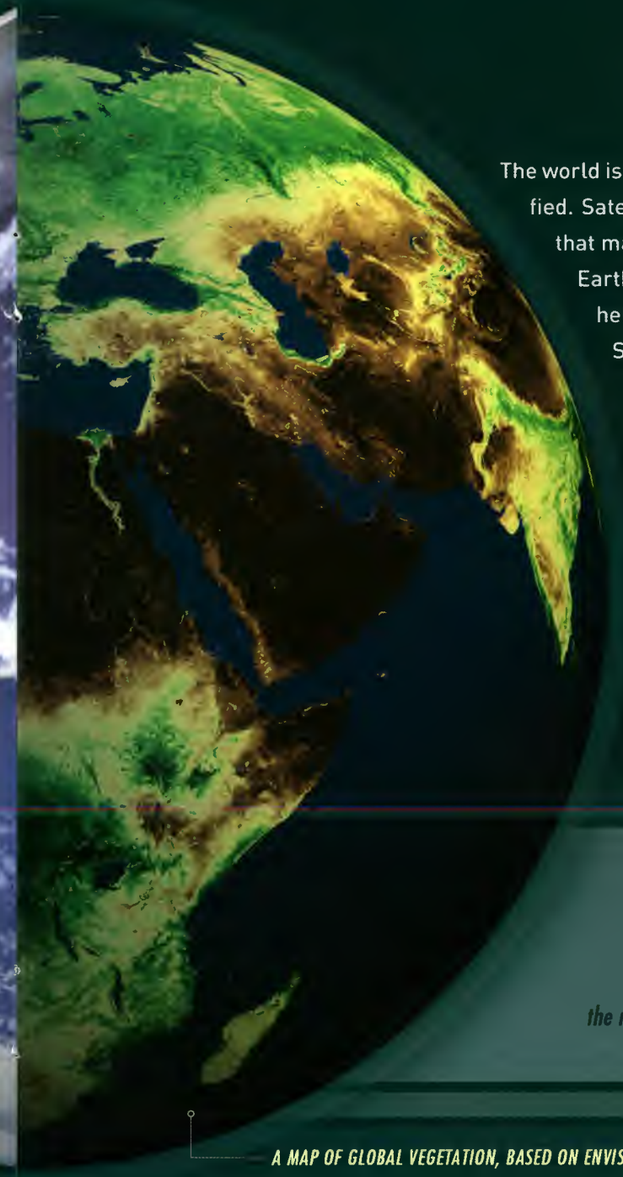

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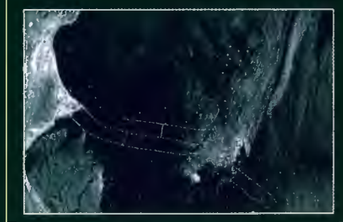
The world is rich in resources but to be exploited they must first be identified. Satellites help reveal resources on and under the land and sea that may otherwise go untapped.
Earth Observation from space detects tiny subsidence events to help find water sources in the shape of subterranean aquifers. Satellites can also map surface faults or slight ground motion connected with hydrocarbon reservoirs and mineral deposits that are otherwise difficult to see.



Oil installations in the Caspian sea revealed by Envisat

"Heights of inland water can now be measured directly from space using radar altimeters, currently carried on several satellites and originally designed to measure ocean height. This is a very exciting development which has the potential to transform the management of drought crises and water-related conflicts around the world."

Philippa Berry - De Montfort University, United Kingdom

A MAP OF GLOBAL VEGETATION, BASED ON ENVISAT DATA

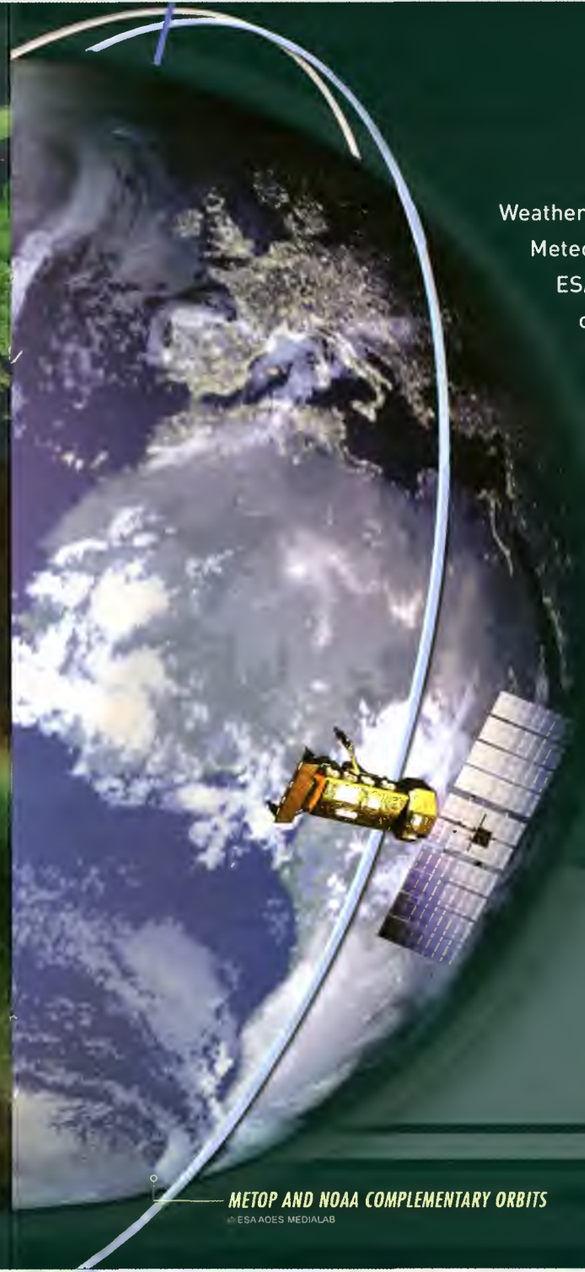
Monitoring Human Impact

The 21st Century has seen an increase in industrial areas as people continue moving away from the countryside to towns and cities. With an increase in urban living, satellites have become useful tools for city planners by helping to identify 'hotspots' in danger of over-crowding, detecting areas prone to natural hazards, checking the continued sustainability of natural resources and monitoring air quality and pollution sources.

Tunis expansion shown by Landsat (1984 and 2004)

"It is very useful because there have been no new maps made of this area (Monrovia) since the 1970s, despite the fact that African cities change so fast - new suburbs can spring up rapidly as populations move. Satellite pictures represent the best way of seeing how the city has evolved."

Rémi Carrier - *Médecins Sans Frontières, Belgium*



METOP AND NOAA COMPLEMENTARY ORBITS

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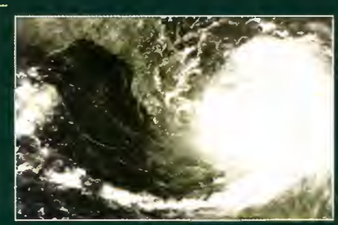
Improving Weather Forecast

Weather prediction is the most mature application of Earth Observation. Meteosat and the Meteosat Second Generation (MSG) series, built by ESA and operated by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), have been providing images for weather forecasts for almost 30 years.

From 2006 a new MetOp series of polar satellites addressing meteorological and climate issues will complement the geostationary Meteosats. Activities initiated for a Meteosat Third Generation (MTG) and post-MetOp series, planned for 2015 and 2019 respectively, demonstrate Europe's commitment to the continuity of the meteorological missions.



Hurricane Katrina seen by Envisat

"It is critical for weather forecasters to obtain reliable characterization of the eye wall dimension and the radii of gale- tropical storm-and hurricane-force winds in order to provide skilful forecasts and warning. Satellite-based observations will facilitate better understanding of hurricane evolution and intensification."

Hans Graber - *University of Miami, USA*

Optimising Land Use Efficiency

Increasing the overall productivity of our land requires using it in a more sustainable manner. To do this, it is necessary to make an inventory of how land is used; satellites are an objective and cost-effective means of carrying this out.

Since they began monitoring land cover, satellites have acquired a 40-year data archive, which is essential for tracking land use changes and highlighting shifts such as growing urban encroachment onto farmland.

© SSTL through ESA 2006

Proba CHRIS image shows cotton fields in New South Wales

Our environmental policies and legislation are based first and foremost on our knowledge of the state of the environment, what are the risks to it, what are the environmental trends. What we know is that we do not know enough at the moment, and satellites and space can bring something additional to our existing monitoring.

Timo Makela - *European Commission Directorate-General for Environment*

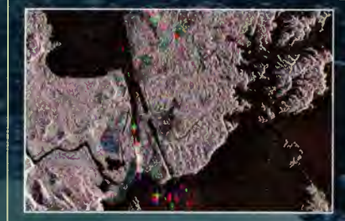
PLANET EARTH SEEN BY METEOSAT-8 SATELLITE

© EUMETSAT 2003

Assisting Transport Routing

Air, land and sea transportation form the circulatory system of the global economy, enabling the flow of goods, people and services across borders. Satellites help increase transport efficiency. For instance, they can guide merchant ships through ice fields and supplement ground-based meteorological and sea state forecasts.

By characterising landscapes in a range of different ways and in unprecedented detail, satellites can also assist with planning new roads and rail links.



Vessels moving through the Panama Canal shown by Envisat

As an Oryx Quest race meteorologist I help provide weather forecasts to the crews and work on route planning. Safety is a very high priority, and with this new satellite data analysis we can tell crews where they should steer to stay clear of ice fields.

Chris Bedford - *Sailing Weather Services, USA*

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Europe's ENVIRONMENTAL Missions

© ESA 2006

- ERS-1, ERS-2 and Envisat satellites have been providing us with a wealth of invaluable data about the Earth, its climate and changing environment.
- They are powerful scientific tools which play a vital part in the improved understanding and management of the Earth and its environment, helping us to understand our planet at both global and regional levels.

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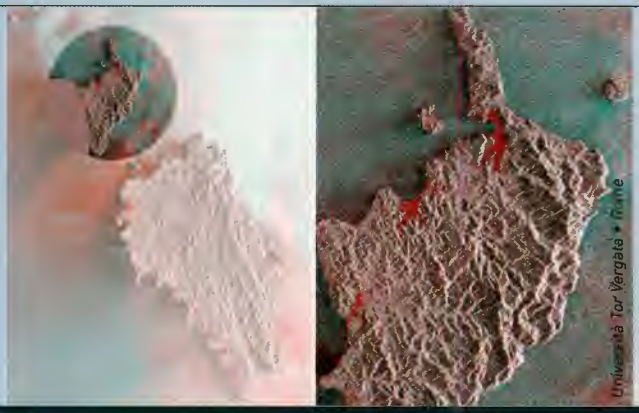
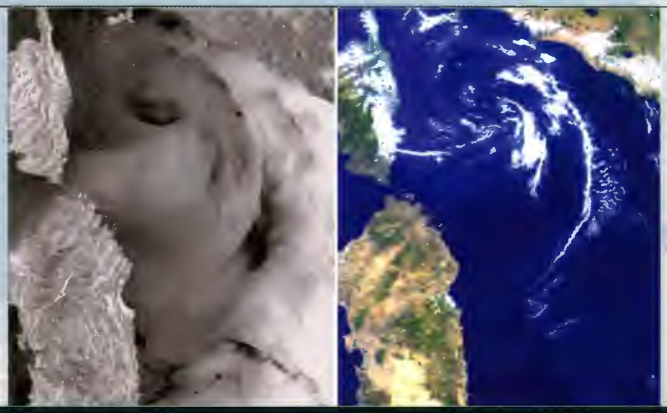


Asian tsunami 2004 - combining pre-tsunami ERS-1 images with post-tsunami ERS-2 images shows changes occurring to coastal areas



Corsica and Sardinia, seen simultaneously by Envisat radar and optical instruments

ERS-1 & ERS-2

European Remote Sensing satellite, ERS-1, launched in 1991, was ESA's first Earth Observation satellite.

It carried a comprehensive payload including an imaging Synthetic Aperture Radar (SAR), a radar altimeter and other powerful instruments to measure ocean surface temperature and winds at sea. It was joined in orbit in 1995 by ERS-2 carrying on-board an additional sensor for atmospheric ozone research.

ENVISAT

Launched in 2002, Envisat, short for environmental satellite, ensures the continuity of the data measurements of ESA's ERS satellites. It has a unique combination of 10 different instruments which collect data about the Earth's atmosphere, land, sea and ice - providing scientists with the most detailed picture yet of the state of the planet. Envisat was initially intended to stay in orbit for five years, however, given the overall excellent standing of the satellite, the Envisat mission has been extended until 2010.

"*Simultaneous operation of ERS-2 and Envisat provides excellent and important opportunities to cross-calibrate and cross-validate the data from the two sensors.*"

David Llewellyn-Jones - *University of Leicester, United Kingdom*

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EARTH EXPLORER Missions

- Following the successful implementation of the ERS satellites and Envisat, which address Earth science issues of a global nature, Earth Explorers are smaller research missions dedicated to specific aspects of our Earth environment.
- Earth Explorer Missions focus on the atmosphere, biosphere, hydrosphere, cryosphere and the Earth's interior with the overall emphasis on learning more about the interactions between these components and the impact that human activity is having on natural Earth processes.

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Designed for research purposes, Earth Explorer Missions fall into two categories:
*'**Core**' missions addressing specific areas of great scientific interest, and faster,*
*lower cost '**Opportunity**' missions to address areas of immediate environmental concern.*
Of the six Earth Explorers selected for implementation, three are Core missions
and three are Opportunity missions.
Currently there are six additional Earth Explorer missions selected for further study.

APPROVED EARTH EXPLORER MISSIONS:

GOCE — CORE MISSION

How does the gravity field affect ocean currents and sea level?

SCHEDULED FOR 2007

SMOS — OPPORTUNITY MISSION

Is climate change accelerating the water cycle?

SCHEDULED FOR 2007

ADM-AEOLUS — CORE MISSION

How does measuring the wind improve weather forecasting?

SCHEDULED FOR 2008

CRYOSAT-2 — OPPORTUNITY MISSION

Are the ice caps shrinking?

SCHEDULED FOR 2009

SWARM — OPPORTUNITY MISSION

How fast is the Earth's magnetic shield weakening against solar radiation?

SCHEDULED FOR 2010

EARTHCARE — CORE MISSION

To what extent do clouds and aerosols influence global warming?

SCHEDULED FOR 2012

"ESA's Earth Explorer Opportunity programme seemed like a great chance for us to build on what we had learned from the earlier ESA missions to design a mission that was really focused on altimetry over ice."

Seymour Laxon - *University College London, United Kingdom*

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the SENTINEL Missions

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- GMES (Global Monitoring for Environment and Security) will bring together Europe's capacity to collect and manage environmental and civil security information for European citizens.
- The Sentinel Missions, developed by ESA, as part of its role as the implementing agency of the GMES Space Component, are the first space missions explicitly conceived to meet the GMES service requirements.

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The GMES Space Component programme will fulfil the space-based observation requirements in response to European policy priorities - ESA is the implementing Agency of the GMES Space Component.

The GMES Space Component includes the development of a series of satellites - the Sentinel Missions - to support the data needs of GMES Services from 2011 onwards.

The GMES Space Component will also integrate national and other international missions.

FORESEEN SENTINEL MISSIONS:

SENTINEL 1

A C-band SAR mission to provide continuity with ERS and Envisat and to complement the Radarsat missions.

SENTINEL 2

A multispectral imaging mission for global land observation at high resolution.

SENTINEL 3

A mission devoted to the monitoring of ocean and global land/vegetation cover at medium resolution. It will also assure the provision of altimeter data from high inclination orbits.

SENTINEL 4/5

Geostationary Earth Orbit (Sentinel-4) and Low Earth Orbit missions (Sentinel-5) with atmospheric composition monitoring capabilities.

*"Environmental monitoring is more important than ever before.
GMES has the potential to bring together existing and new technology -
helping us to better understand and protect our planet."*

Lord Sainsbury - *Science and Innovation Minister, United Kingdom*

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Europe's METEOROLOGICAL Missions

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- Europe's meteorological satellites, built by ESA and operated by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), have been providing images for weather forecasts for almost 30 years with the Meteosat and the Meteosat Second Generation (MSG) series.
- From 2006 a new series of polar satellites addressing meteorological and climate issues will complement the geostationary Meteosats.
- Activities initiated for a Meteosat Third Generation (MTG) and post-MetOp series, planned for 2015 and 2019 respectively, demonstrate Europe's commitment to the continuity of the meteorological missions.

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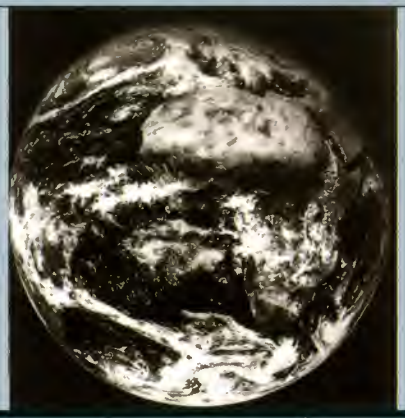
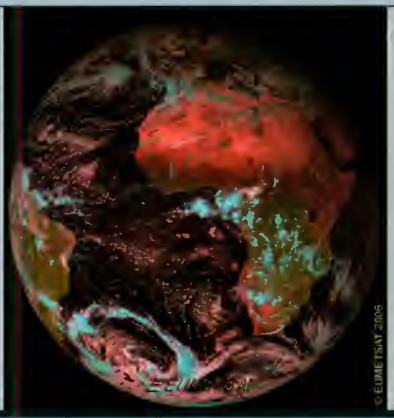


First image from Meteosat-1, December 1977



First colour image from MSG-2, January 2006

MSG

Meteosat Second Generation (MSG) follows up the success of the first generation Meteosat weather satellite series with a larger design boasting higher performance. Launched in 2002, MSG-1 was joined in orbit by MSG-2 in 2005.

Another two MSG satellites will assure MSG's operational service for a nominal period of 18 years.

METOP

Launched in 2006, MetOp is Europe's first polar-orbiting satellite dedicated to operational meteorology and climate monitoring. It carries a set of 'heritage' instruments provided by the United States and a set of new generation European instruments that offer improved remote sensing capabilities to both meteorologists and climatologists.

MetOp is a series of three satellites to be launched sequentially over 14 years, forming the space segment of EUMETSAT's Polar System (EPS).

"We anticipate that within six months, the EPS mission will be formally declared operational and users in Europe and beyond can start benefiting from MetOp's unique capabilities."

Lars P. Prahm - *EUMETSAT's Director-General*

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THIRD PARTY Missions

- ESA uses its multi-mission ground systems to acquire, process and archive data from other satellites - known as Third Party Missions. The data from these missions are distributed under specific agreements with the owners or operators of the mission, following the ESA Data policy.
- Third party missions both complement the observations of ESA missions and allow the exploitation of synergy between all EO data sources. The benefits are an increased sustainability of their services and a wider range of observation parameters.

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ESA's Project for On-Board Autonomy (Proba) spacecraft is one of the most advanced small satellites ever flown in space. Just 60x60x80 cm and weighing only 94 kg, its payload includes a compact hyperspectral imager and high-resolution camera.

Launched in 2001 as a technology demonstration mission, it is now operated under the Earth Observation Third Party Mission scheme.

CURRENT THIRD PARTY MISSIONS SUPPORTED BY ESA INCLUDE:

ALOS

Advanced Land Observing Satellite
Japan Aerospace Exploration Agency (JAXA), *Japan*

IRS-P6

Indian Remote-Sensing Satellite
Indian Space Research Organisation (ISRO), *India*

KOMPSAT-1

Korea Multi-Purpose Satellite-1
Korea Aerospace Research Institute (KARI), *Korea*

SCISAT-1/ACE

Science Satellite - Atmospheric Chemistry Experiment
Canadian Space Agency (CSA), *Canada*

LANDSAT TM/ETM

Landsat Thematic Mapper - Enhanced Thematic Mapper
U.S. Geological Survey (USGS) & National Aeronautics and Space Administration (NASA), *USA*

NOAA-AVHRR

Advanced Very High Resolution Radiometer sensor aboard the Polar Orbiting Environmental Satellites (POES) of the National Oceanic and Atmospheric Administration's (NOAA), *USA*

TERRA / AQUA MODIS

Moderate Resolution Imaging Spectroradiometer aboard the Terra and Aqua satellites of the National Aeronautics and Space Administration (NASA), *USA*

SPOT 4

Satellite Pour l'Observation de la Terre
Centre National d'Etudes Spatiales - Spotimage, *France*

"Global space agencies are operating or planning around 170 satellites with an Earth Observation mission over the next 15 years. These satellites will carry over 340 different instruments."

Committee on Earth Observation Satellites (CEOS)