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# Happy Birthday, ERS

# [1991 - 2001]

## ERS: a 10-year Earth Observation satellite mission for Europe


### IMPROVE SCIENTIFIC CAPABILITY AND UNDERSTANDING

- Taking regular global measurements of the oceans, ice and land to support Earth system science
- Monitoring ozone and detecting aerosols in the atmosphere for atmospheric pollution studies
- Building a consistent long term data record for climate research
- Increasing knowledge and fostering international co-operation among scientists. Europe's scientists are now key partners in many new areas

### CONTRIBUTE TO QUALITY OF LIFE THROUGH PUBLIC SERVICES

- Improving forecasts for weather, sea state, sea ice and crop monitoring services
- Helping to build the knowledge base for a sustainable society in Europe and developing nations
- Informing environmental decision making and international treaty compliance
- Enhancing hazard management for the benefit of European citizens and those in developing countries

### DEVELOP A COMPETITIVE INDUSTRY

- Developing an independent European industrial capability from prime contractor to component manufacture in spacecraft and ground systems
- Building new markets for integrated geo-information services and
  more Information Technology related employment
  ing industrial skills within Europe
  a European information service business to capture the world

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nvisat.esa.int • http://www.esa.int/sympo2000/
etin/bullets.htm • http://esapub.esrin.esa.it/eoq/eoq.htm

# HIGHLIGHTS

## SCIENTIFIC HIGHLIGHTS

**ACCURATE GLOBAL MEASUREMENTS ARE ENABLING SIGNIFICANT IMPROVEMENTS IN MODELLING**

**MEASUREMENTS:**

| OCEAN | ICE | LAND |
|---|---|---|
| TOPOGRAPHY | GLACIERS ICE | SURFACE WATER |
| TEMPERATURE | SNOW | VEGETATION |
| WAVE HEIGHT AND LENGTH | SEA ICE EXTENT AND CONCENTRATION | GEOLOGY |
| MARINE GEOID | SEA ICE DRIFT | ELEVATION CHANGES |
| INTERNAL WAVES | | |
| WIND SPEED AND DIRECTION | | |

**ENABLE:**

| | | |
|---|---|---|
| OCEAN CIRCULATION MODELLING | SNOW AND GLACIERS FOR WATER SUPPLY | HYDROLOGICAL MODELLING |
| OCEAN/ATMOSPHERE INTERACTION | GEODESY UNDER SEA ICE | CROP MODELLING |

**Furthermore, GOME on board ERS-2 allows tracing atmospheric greenhouse gases and monitoring the ozone hole**

## QUALITY OF LIFE BENEFITS

**MEASUREMENT**
**UNDERSTANDING**
**MODELLING**
**PREDICTION**

**FORECASTING AND HAZARD MANAGEMENT**

- MARINE WEATHER PREDICTION
- SHIP ROUTING
- FLOODS
- EARTHQUAKES
- VOLCANOES
- FOREST FIRES
- TROPICAL STORMS
- SUBSIDENCE

**CONTRIBUTIONS TO PUBLIC POLICYMAKING IN EUROPE:**

- ENVIRONMENTAL POLICY
- AGRICULTURAL & FISHERIES POLICY
- TRANSPORT POLICY
- SCIENCE POLICY
- REGIONAL DEVELOPMENT POLICIES
- (INCLUDING ENLARGEMENT OF THE EUROPEAN UNION)

**DEVELOPING EUROPE'S INTERNATIONAL ROLE**

- PROVIDING AN INDEPENDENT EUROPEAN MONITORING CAPABILITY TO ALLOW EFFECTIVE PARTICIPATION IN INTERNATIONAL DECISION MAKING

## COMMERCIAL BENEFITS

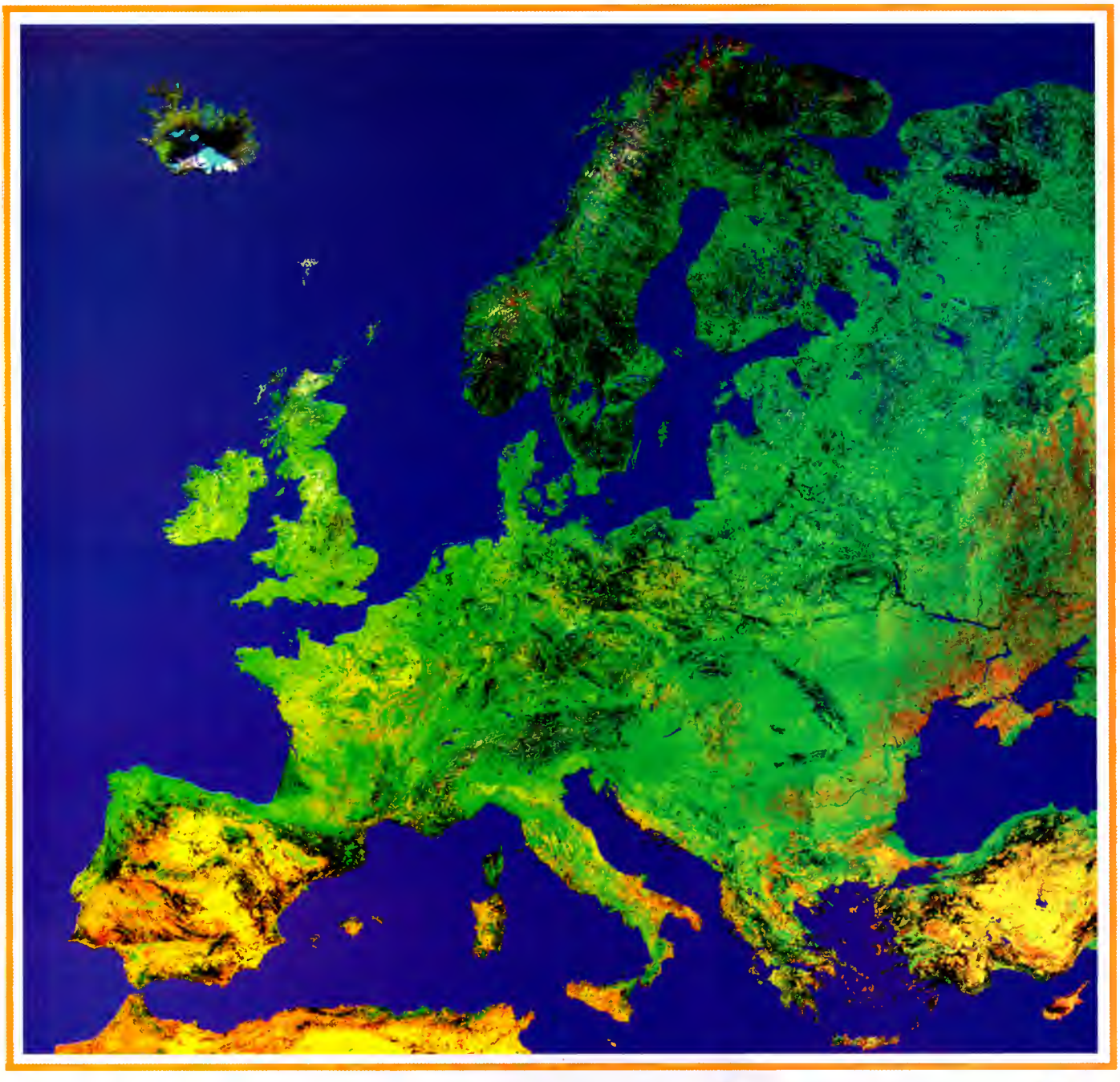
### BENEFITS FROM BETTER OBSERVATIONS - EXAMPLE:

The ability of ERS SAR to identify oil seepages has led to important successes in sales to the mineral exploration markets. Using ERS data it is often possible to differentiate between natural and manmade oil slicks on the surface of the ocean. By using this information, oil exploration companies can pinpoint drilling locations with improved accuracy.

### BENEFITS FROM BETTER FORECASTS - EXAMPLE:

A 5% reduction in fuel consumption by the world's merchant fleets would pay for the manufacturing costs of ERS-1 in two years - ERS measurements of wind speed and wave height enable ships to steer clear of headwinds and heavy seas, helping to reduce costs.

# ERS SHOWCASE: EUROPE FROM SPACE



**Happy Birthday, ERS**
**[1991 - 2001]**

Colour composite image derived from the Along Track Scanning Radiometer - ATSR instrumentation onboard ERS-1 and ERS-2, the European Remote Sensing Satellites launched by the European Space Agency – ESA - in 1991 and 1995, respectively.
ATSR was designed and built by the Rutherford Appleton Laboratory, with funds of the Natural Environment Research Council – NERC, both in the UK.
The data were acquired in August 1998. Over 2500 standard frames were electronically processed in a colour composite of the 1.6 (red), 0.87 (green) and 11 (blue) micrometers channels.
**Image processing by ESA ESRIN.**



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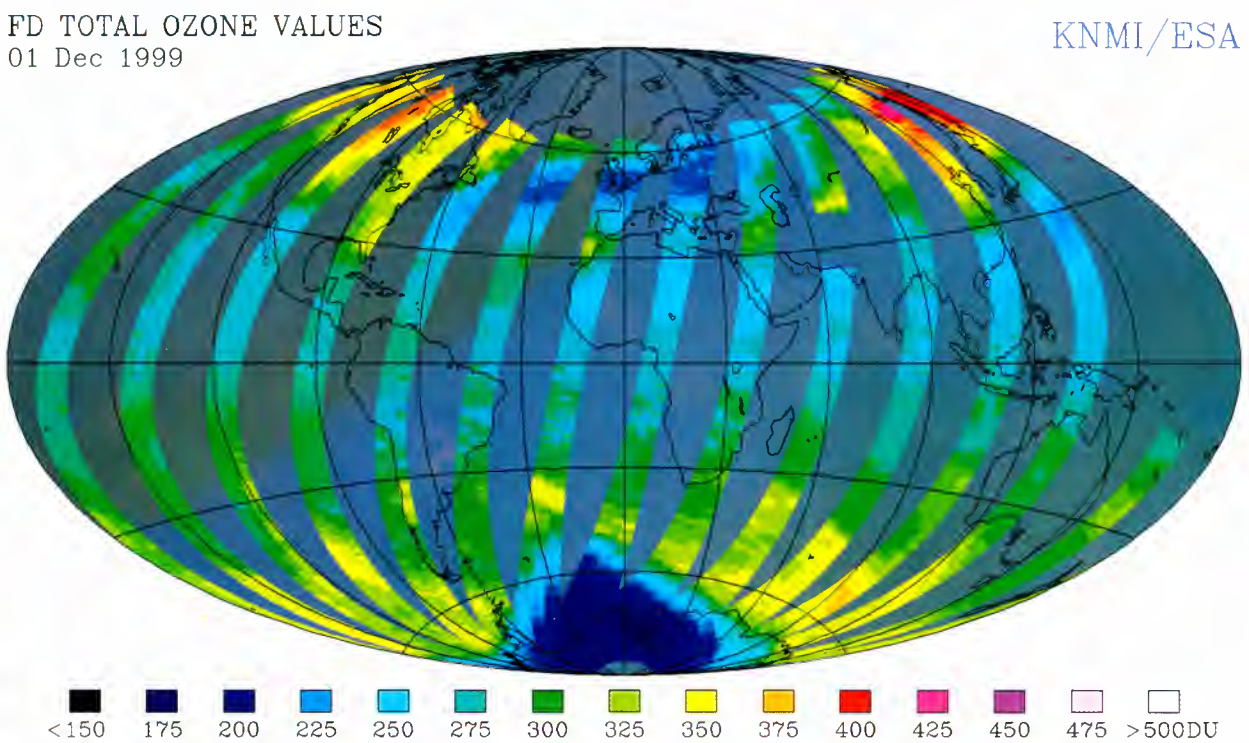
EU and ESA's Member States have signed a number of international environmental treaties, such as the Kyoto Protocol, that calls for legally binding commiments to monitor carbon sinks and sources of each signatory state, and are implementing the concept of GMES, Global Monitoring for Environmental and Security. ESA contributes to the Kyoto Protocol through several environment-oriented satellite mission programmes meant to support Global Change issues worldwide.

# ERS SHOWCASE: THE OZONE HOLE




**Happy Birthday, ERS**
**[1991 - 2001]**

Ozone values measured on 1st December 1999 by the Global Ozone Monitoring Experiment – GOME – instrumentation on board ERS-2, the European Remote Sensing Satellite launched by the European Space Agency –ESA – on April 21, 1995. The GOME swath (960 km) is imaged along a time period of 24 hours.

GOME measures the backscatter light from the atmosphere, that is why a data gap is visible over the North Pole (lack of illumination).

The very low ozone values (about 200 DU – Dobson Units) over Northern and Western Europe appearing in dark blue indicate a so-called "mini-ozone hole" of limited duration (about 2 days).

The Antarctic ozone hole, of several months duration (August to mid-December, roughly), is visible as well at the bottom of the image.



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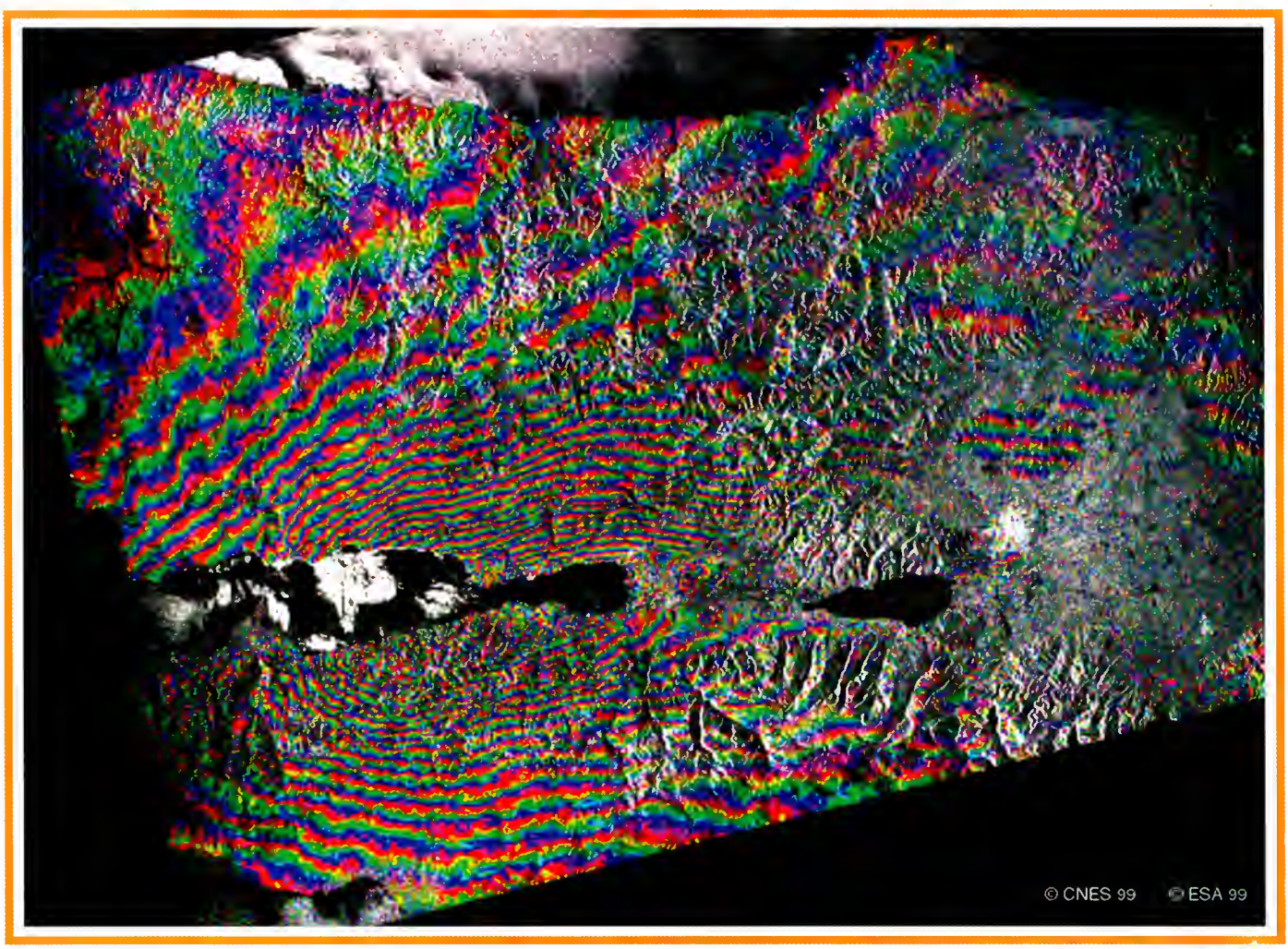
# ERS SHOWCASE: The Izmit Earthquake

Turkey, 17 August 1999




**Happy Birthday, ERS**
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North-western Turkey was hit by a strong earthquake starting with a sequence on 17 August 1999. The National Earthquake Information Centre reported on a magnitude of 7.8, almost as high as the 7.9-magnitude of the San Francisco's quake that caused 700 victims in 1906. In Turkey, four days after the event, the death toll rose up to over 10,000 victims, with reported 45,000 injured people and thousands of people still missing.
The epicentre was identified between Izmit and Bursa, at about 100 km east of Istanbul.

A pair of Synthetic Aperture Radar (SAR) data from ERS-2, acquired on 13 August 1999 (before the earthquake), and on 17 September 1999 (after the earthquake), has been used to obtain a differential interferogram showing the surface deformation in the area between the Istanbul eastern periphery and the eastern part of the Sapanka Lake. The fringes are superimposed on a SAR amplitude image.
Each colour cycle (from red to yellow) in the ERS SAR interferogram corresponds to a ground movement of 28 mm in the satellite slant range direction (i.e. the viewing direction of the SAR sensor). This allows to calculate the co-seismic deformation, counting the number of interferometric fringes (each fringe is a Red, Green, Blue cycle in the image above).
SAR interferometric techniques can be used to quantify ground deformations caused, among others, by earthquakes, subsidence, landslides.

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# ERS SHOWCASE: FIRES

**Happy Birthday, ERS**
**[1991 - 2001]**

As reported at the Kyoto Convention in 1997, industrial and agricultural emissions of carbon dioxide, methane and other greenhouse gases seriously threaten the environment.
Earth Observation data collected from the Along Track Scanning Radiometer - ATSR - instrument on board the European Remote Sensing Satellites - ERS - of the European Space Agency - ESA, contribute to monitor agricultural as well as wildfires at global scale and in near-real time.
The image shows an example of the contents of the ATSR Fire Atlas, the first multiyear Global Fire Atlas built by ESA. Hot spots, including gas flares, with a night brightness temperature higher than 312 K, are precisely mapped. The Atlas contains data acquired from November 1996 onwards from both, ERS-1 and ERS-2 missions. About 80,000 ATSR scenes are processed every year in order to update the Atlas regulary. To fulfill the requirement of long term monitoring, an advanced ATSR instrument, called AATSR, is mounted on board ENVISAT, the forthcoming Earth Observation mission of ESA due for launch in Autumn 2001.



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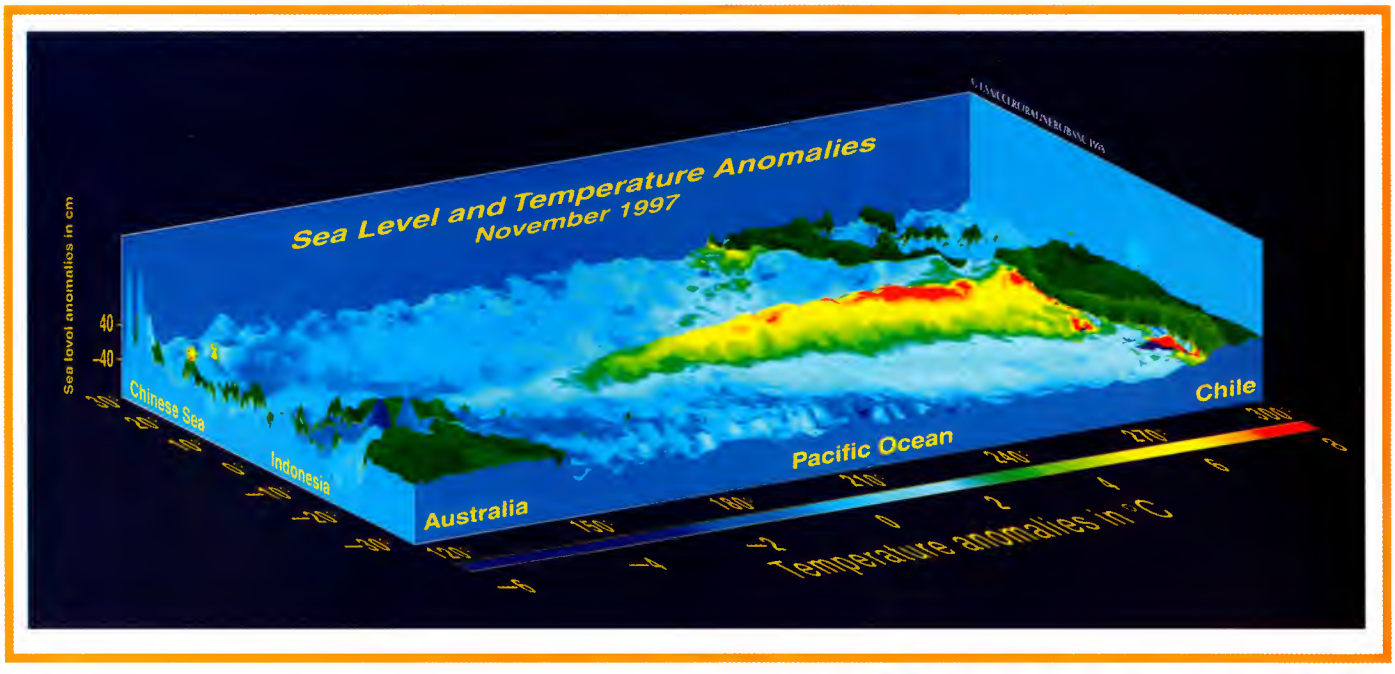
# ERS SHOWCASE: EL NIÑO




**Happy Birthday, ERS**
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El Niño is a phenomenon of the ocean-atmosphere system in the tropical Pacific affecting the weather around the globe.
It was originally recognised by fishermen off the coast of South America as the appearance of unusually warm water in the Pacific ocean, occurring near the beginning of the year.
The 1997-1998 El Niño was one of the strongest of the century, with increased rainfall causing destructive flooding in the US and Peru, and drought in the Western Pacific, associated with devastating fires.
The phenomenon is characterised by a rise in sea level (up to 40 cm) and in sea surface temperature (up to 8° C) in the eastern equatorial Pacific, and by a drop in sea level (up to –40 cm) and in sea surface temperature (up to –6° C) in the western equatorial Pacific. Observation of these manifestations is invaluable for short-term climate variation prediction.
Sea levels and sea surface temperatures are closely monitored by two instruments on ESA's European Remote Sensing satellites – ERS, namely the Radar Altimeter and the Along Track Scanning Radiometer.
Anomalies in surface temperature and height were computed to determine the extent and range of changes over the 1997-1998 time period.
This 3-D image shows the state of the Pacific ocean in November 1997, when the phenomenon reached its maximum extent. Its height represents sea level anomalies ranging from –40 cm to 40 cm. Colours indicate sea surface temperature anomalies ranging from –6° C (in blue) to 8° C (in red). Clearly visible is the correlation between temperature and sea level anomalies.
The ATSR on board ERS was designed and built by the Rutherford Appleton Laboratory, with funds of the Natural Environment Research Council, both in the UK


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# TIME LINE 1: The early years of ERS-1

1990 | 1991 | 1992 | 1993 | 1994

ERS-1

Testing and calibration

Initial focus on ice zones

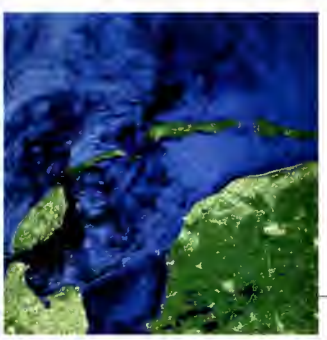
Development of multidisciplinary applications

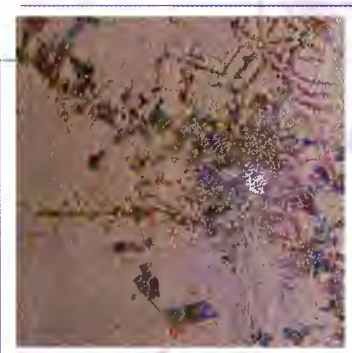
Emphasis on ice zones in the Arctic winter

Emphasis on mean sea surface levels and the marine geoid

First ERS-1 SAR image of the Frisian islands, the Netherlands. The four islands of Texel, Vlieland, Terschelling and Ameland (from West to East) are visible.

Bottom right: the agricultural regions of Friesland.
Bottom left: the Wieringermeer Polder





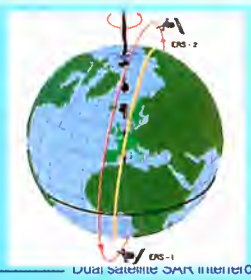
ERS-1 and ERS-2 SAR data sets were processed to generate a multitemporal image of Rio Branco town and surroundings, State of Acre, Brasil.

In various colours: all land cover changes, primarily clearcuttings and regrowth, occurred in the time frame 1992-1999. Forest untouched in 1999 is shown in grey.

# TIME LINE 2: ERS-2 enters the picture

1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001

ERS-1 ERS-2



Dual satellite SAR interferometry for:
- Generation of Digital elevation Models (DEM)
- Worldwide monitoring of earth-quakes, volcanoes & subsidence

**ERS-2**
ERS-2 operates as the main satellite

**ERS-1**
ERS-1 continues to operate successfully as a backup to ERS-2

end of the ERS-1 mission

Campaigns such as additional Tendem operations performed

# TIME LINE 3: The way forward

2001 | 2002 | 2003 | onwards

## ENVISAT

- A major technology challenge because of the complexity and diversity of the payload data
- Features include many developments of the ERS missions
- Supporting further commercial business based on radar imagery
- Continued global sea surface temperature for climate change
- Improved measurements of the variability of sea surface height
- More advanced monitoring of atmospheric chemistry including ozone
- New measurements of ocean and land surface biosphere

## THE LIVING PLANET

The ESA Living Planet Programme describes the plans for the Agency's new strategy for Earth Observation in the post-2000 time frame. It marks a new era for the European Earth Observation, based on a programme that is user-driven, spanning the whole spectrum of interests ranging from scientific research-driven Earth Explorer missions through to application-driven Earth Watch missions. The user community is therefore now able to look forward to a programme of more frequent but very specific missions directed at the fundamental problems of the Earth environment.

## EARTH EXPLORER

Earth Explorer is a research/demonstration Mission to advance the understanding of the different Earth system processes and introduce new observational techniques. It aims at a better understanding of: Earth interior, physical climate, geosphere, biosphere, atmosphere and marine environment. To the purpose, several Earth Explorer Missions will be launched. They fall under two main denominations, Core Missions (large) and Opportunity Missions (smaller), and address all Earth Systems. In particular: cryosphere, atmosphere, oceans, land surface, Earth interior and their interaction.

## EARTH WATCH

Earth Watch will seek to set up operational systems which will be self sustaining in the long term.
Topics currently receiving much attention include:

- Disaster management
- Environmental convention support
- Precision agriculture
- Monitoring desertification

## A few more ERS facts and figures

**Cat.1: scientific users*
**Cat.2 : all other users*

### ERS-1

*ESA's first sun-synchronous polar-orbiting mission*
*• excellent service for nine years*
*• extended duration (over three times its planned lifetime)*
*• **45,000** orbits recorded*
*• over **1,5** million individual Synthetic Aperture Radar (SAR) scenes acquired*
*• SAR images and data derived from other instruments onboard delivered worldwide to over **4,000** users in science and applications*
*• very interesting results in the field of SAR interferometry thanks to ERS-1 and ERS-2 tandem operations*
*• success story of ERS-1 mission ended on 10 March, 2000*

### ERS-2

*• launched in 1995*
*• still operational, far exceeding its nominal lifetime*

*SAR acquisitions (scenes)*
*Worldwide over **600,000***
*ESA Stations over **200,000***

*Low Bit Rate prodocts (worldwide)*
*acquisitions: over **1,400***
*distribution: over **33,000***

*SAR product distribution*
*Worldwide: over **28,000***
*ESA Stations: over **13,000** (April '95/Oct.2000);*
*over **100** (Cat.1*) and over **1,100** (Cat.2*): Nov. 2000/June 2001*

### ERS-1 and ERS-2

*• support to ESA Announcement of Opportunities (AOs) campaigns*
*• over 450 ERS AO-3 project achievements reported at the ESA ERS-ENVISAT Symposium "Looking down to Earth in the New Millennium", Gothenburg, Sweden – October 2000*

*• data product distribution relying on ESA s Partners EURIMAGE, RADARSAT International and SPOTIMAGE worldwide network*
*• important role of ESA s, as well as national and foreign, ground stations to ensure the data flow continuity*
*• various, successful Tandem acquisition campaigns, especially the one from 1/10/95 to 29/4/96*