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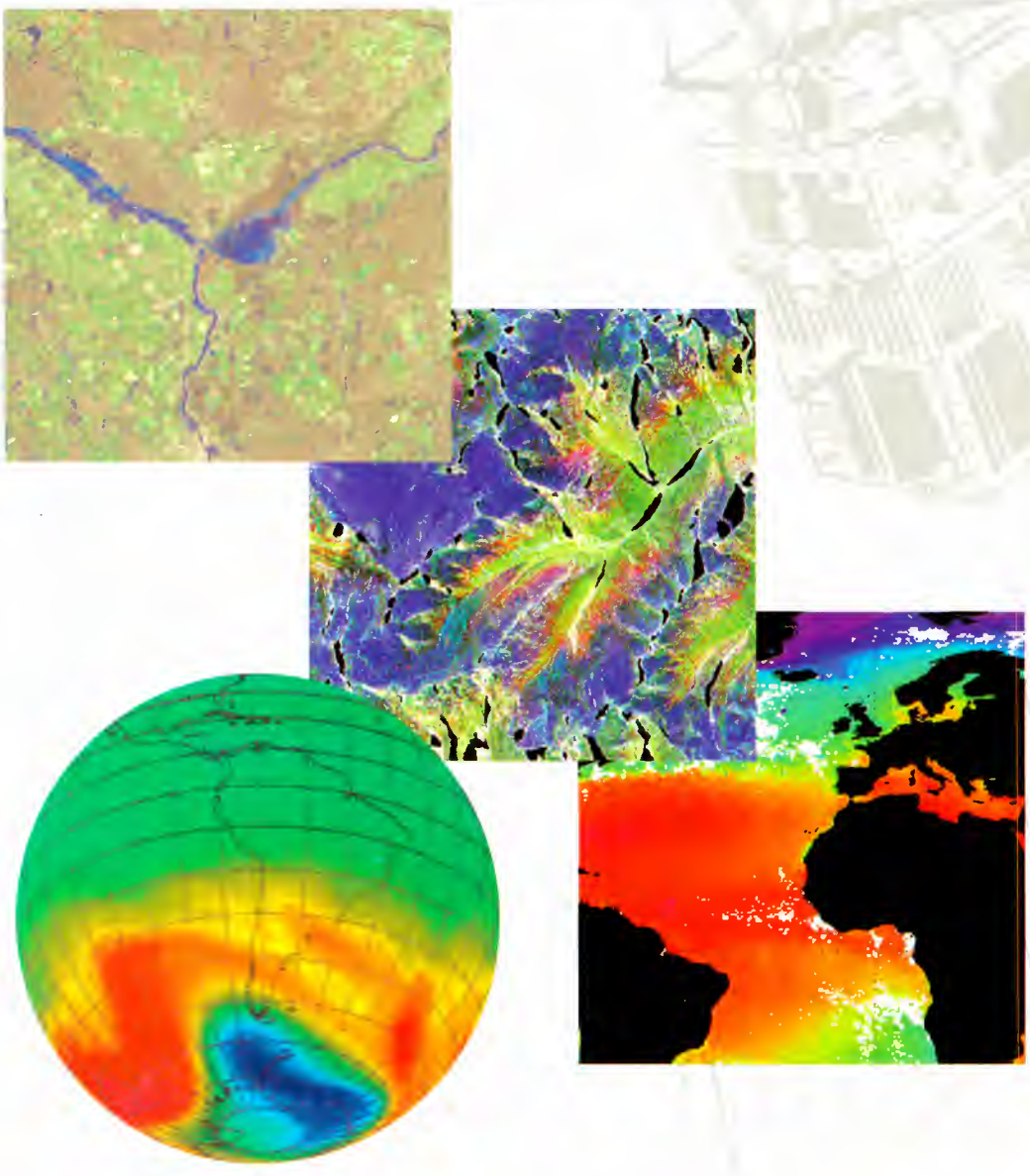
TAKING NATURE'S PULSE: EUROPE'S ERS SATELLITES



European Space Agency
Agence spatiale européenne

ERS: SERVING 3 MAJOR PURPOSES 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 cooperation 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 securing more Information Technology related employment
- Disseminating industrial skills within Europe
- Developing a European information service business to capture the world market

HIGHLIGHTS

SCIENTIFIC HIGHLIGHTS

ACCURATE GLOBAL MEASUREMENTS ARE ENABLING SIGNIFICANT IMPROVEMENTS IN MODELLING

MEASUREMENTS

OCEAN	ICE	LAND
•TOPOGRAPHY	•GLACIER 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		

ENABLES:

OCEAN CIRCULATION MODELLING

SNOW AND GLACIERS FOR WATER SUPPLY

HYDROLOGICAL MODELLING

OCEAN / ATMOSPHERE INTERACTION

GEODESY UNDER SEA ICE

CROP MODELLING

QUALITY OF LIFE BENEFITS

MEASUREMENT
UNDERSTANDING
MODELLING
PREDICTION

FORECASTING AND HAZARD MANAGEMENT

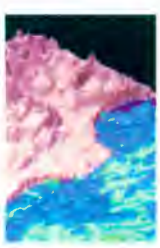
- MARINE WEATHER PREDICTION
- SHIP ROUTING
- FLOODS
- EARTHQUAKES
- VOLCANOES
- FOREST FIRES
- TROPICAL STORMS
- SUBSIDENCE

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

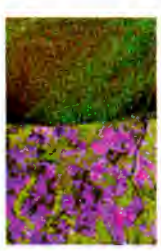
- PROVIDING AN INDEPENDENT EUROPEAN MONITORING CAPABILITY TO ALLOW EFFECTIVE PARTICIPATION IN INTERNATIONAL DECISION MAKING



COMMERCIAL BENEFITS

BENEFITS FROM BETTER OBSERVATIONS - EXAMPLE:

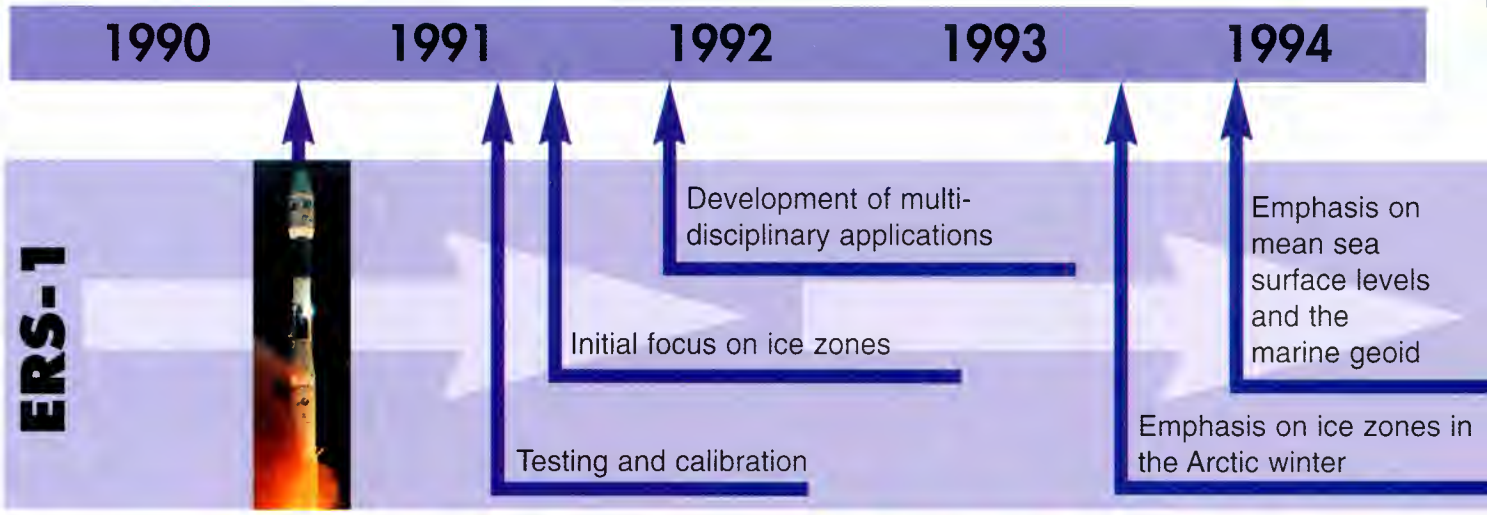
The ability of ERS SAR to identify oil seepages has led to important successes in sales to the mineral exploration markets. Using ERS data it is often possible to differentiate between natural and manmade oil slicks on the surface of the ocean. By using this information, oil exploration companies can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



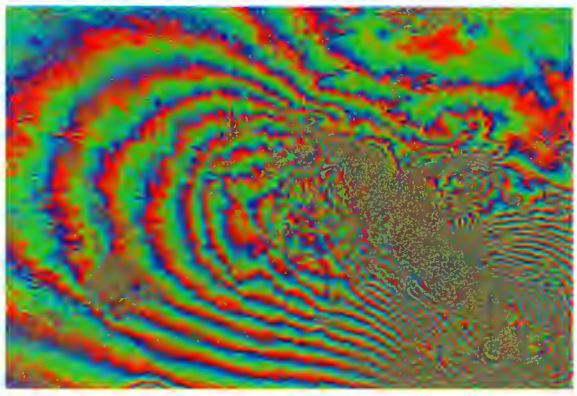
BENEFITS FROM BETTER FORECASTS - EXAMPLE:

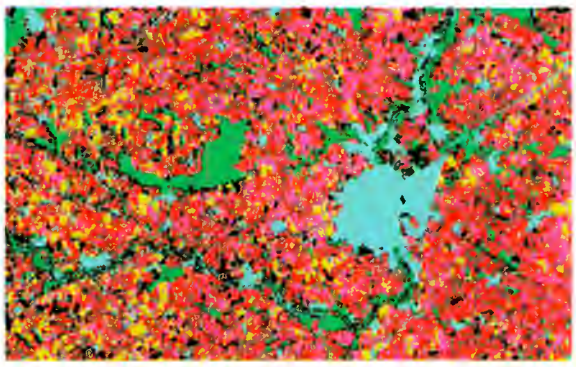
A 5% reduction in fuel consumption by the world's merchant fleets would pay for the manufacturing costs of ERS-1 in two years - ERS measurements of wind speed and wave height enable ships to steer clear of headwinds and heavy seas, helping to reduce costs.

TIMELINE 1: The early years of ERS-1

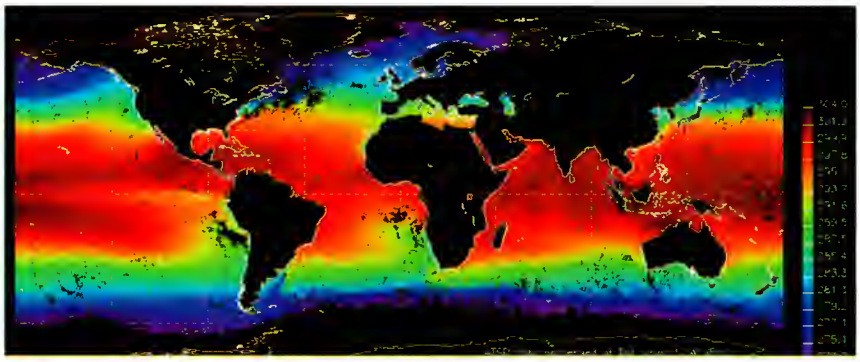


JUNE 1992, LANDERS EARTHQUAKE - EARLY WORK ON SAR INTERFEROMETRY

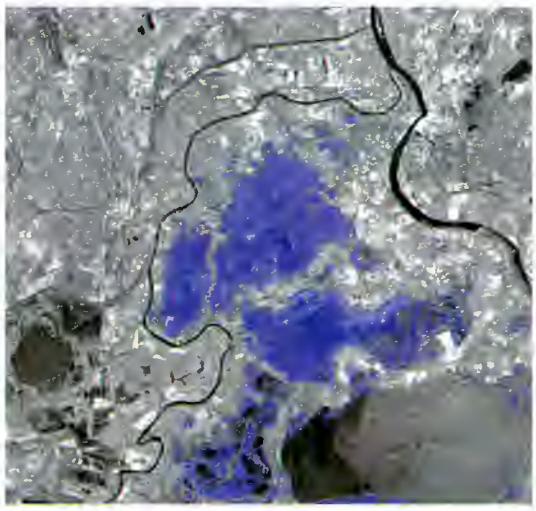




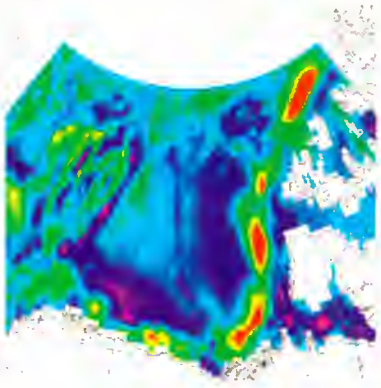
1994 - ERS SAR DATA USED IN OPERATIONAL CROP MONITORING



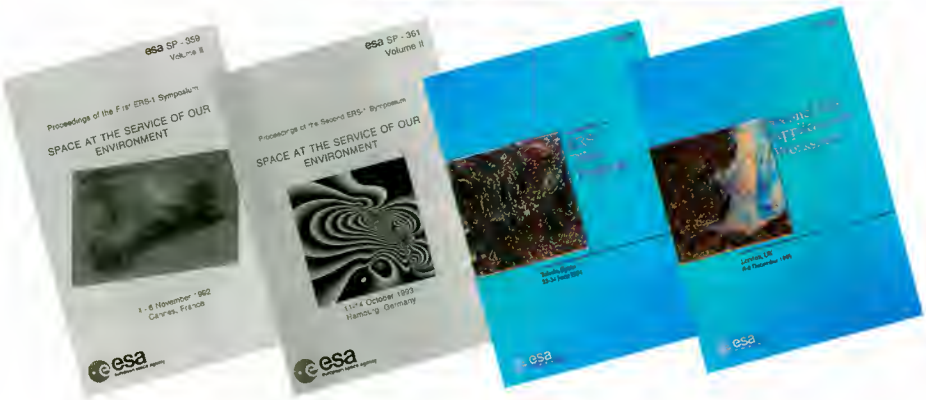
1992 EL NIÑO - MONITORED WITH ERS-1 RA AND ATSR



NOVEMBER 1993: FLOODING IN THE CAMARGUE REGION, FRANCE. ERS SAR FLOOD MAPS.



1993 GRAVITY MAPPING THROUGH SEA ICE - APPLIED TO THE ARCTIC - EXTINCT SPREADING RIDGE FOUND



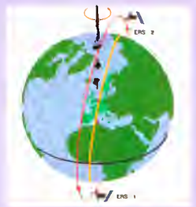
KEY MEETINGS AND DOCUMENTS WHICH ADVANCE THE USE OF ERS

TIMELINE 2: ERS-2 enters the picture

1995 | 1996 | 1997 | 1998 | 1999

ERS-1 ERS-2

Tandem Mission



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

ERS-2

ERS-2 operates as the main satellite

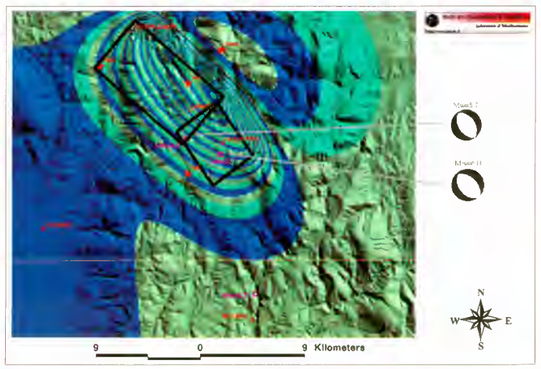
ERS-1

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

Campaigns such as additional Tandem operations performed

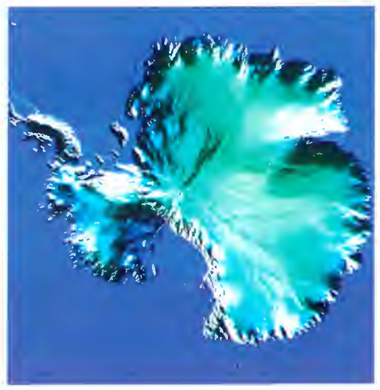
JANUARY 1996 SCATTEROMETER USE FULLY OPERATIONAL AT ECMWF

JANUARY 1995 NETHERLANDS FLOODING - SAR FLOOD MAPS



SEPTEMBER 1997: THE ITALIAN ISTITUTO NAZIONALE DI GEOFISICA USED ERS SAR INTERFEROMETRY TO RESOLVE SURFACE DISPLACEMENTS AFTER THE TWO UMBRIA-MARCHE EARTHQUAKES IN CENTRAL ITALY

1997 GRAVITY MAPPING THROUGH SEA ICE - ANTARCTIC TECTONIC HISTORY UNCOVERED. MONITORING OF ICE SHEET ELEVATION CONTINUES

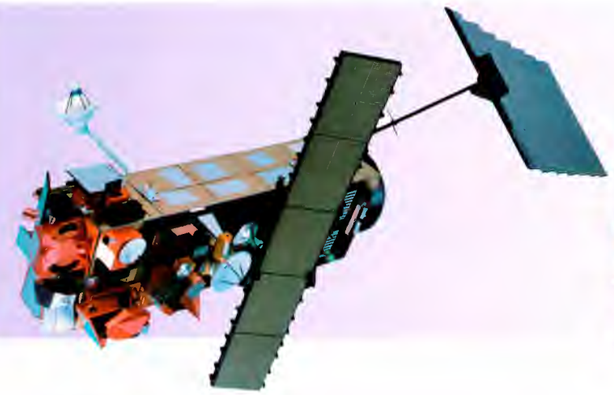


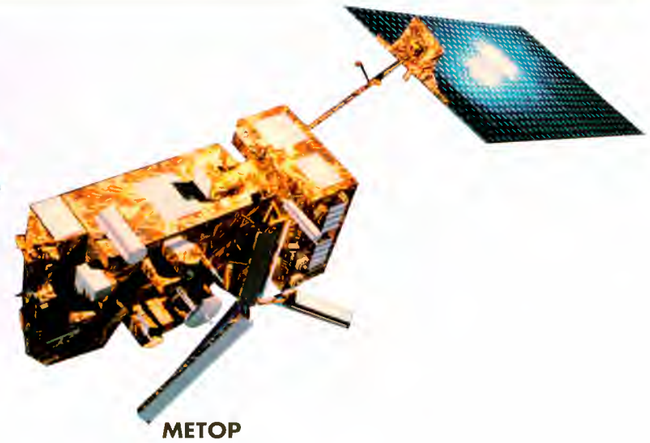
1998 examples:

SAR acquisition for natural disaster monitoring will continue over flooded areas (El Niño effects) along South America's western coast and in Argentina (Parana, Uruguay and Paraguay rivers), and over Central Umbria and the Volcano Etna (Sicily) due to recent earthquakes and expected eruptions.

TIMELINE 3: The way forward

2000 | 2001 | 2002 | 2003 | ----





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

METOP

- Fully operational weather satellite which will fit into the existing global meteorological observing system
- Additional commercial opportunities and advanced instruments
- Cost effective approach incorporating existing technology and supporting a combination of proven and new instruments

The Living Planet

The future will see more but smaller spacecraft. Using the heritage of ERS-1, ERS-2 and Envisat, Earth Observation space missions will be much more directly targeted to either the research problems that remain or to directly service user needs through customised applications.

The Living Planet programme will focus on using Earth Observation for
- developing our knowledge of the Earth
- preserving the Earth and its Environment
- managing life on Earth in a more efficient way.

Two classes of missions are proposed:

Earth Explorer: research/demonstration missions to advance the understanding of the different Earth system processes and introduce new observational techniques. The missions currently under study are:
- Atmospheric Dynamics
- Land Surfaces
- Gravity
- Atmospheric Radiation

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
- monitoring desertification
- precision agriculture
- environmental convention support

European Space Agency
Agence spatiale européenne

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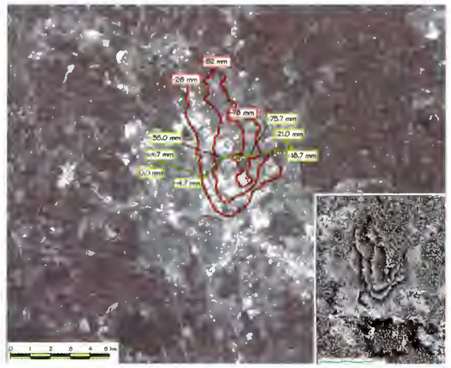
SHOWCASES 1

WATCHING THE LAND MOVE

SAR Interferometry has delivered spectacular results in monitoring earthquakes, volcanoes, land subsidence, glacier dynamics, the production of digital elevation models of the Earth's surface and the classification of different land types.

This image shows contours of subsidence (red) in 26 mm increments derived from the differential interferogram (inset) using ERS SAR images separated in time by 2 years and 4 months. Total subsidence measured over this time period amounts to 78 mm. The displacements were confirmed using GPS measurements, which are shown in yellow.

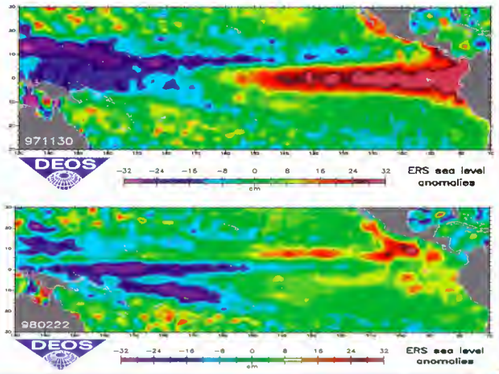


Data source: NPA Satellite Mapping and WS Atkins

WEATHER FORECASTS AND RISING SEAS

The 1997/98 El Niño has had a high profile over the last year because of the severe weather conditions it has caused. The lifecycle of El Niño is monitored by ERS. Variations in sea surface height are measured to within 6 cm and temperatures to within 0.3 °C .

The images of the Pacific shown here are variations from normal sea surface heights observed in November 1997 and February 1998. Between these dates, the reduction in sea surface height in the Eastern Pacific shows the weakening of the El Niño event.

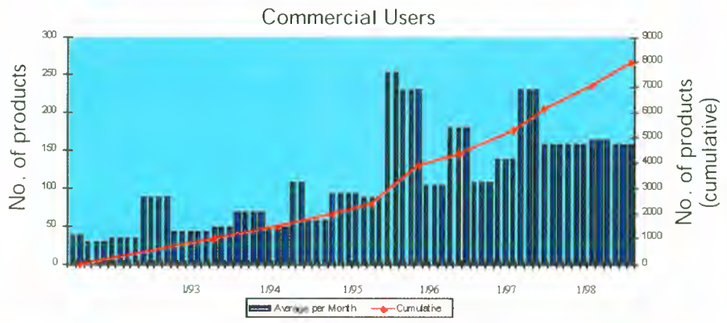


Data source: Remko Scharroo, Delft University of Technology

Market Growth

ERS data are contributing to the development of a commercial market. Sales are showing a steady rise, as shown in this chart.

Key market sectors include oil exploration, the marine and agriculture sectors.



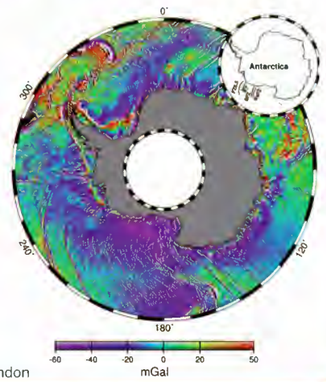
Data source: ESA

SHOWCASES 2

HOW CONTINENTS DEVELOPED

The Radar Altimeters on the ERS satellites are mapping the polar ocean basins. Variations in the sea surface height can be determined even through sea ice, leading to a gravity map of the sea floor.

By mapping the fracture zones adjacent to Antarctica it was possible to trace the early tectonic evolution of Antarctica and the Campbell Plateau. A divergence of the fracture zones close to the continent provides the first firm proof for the existence of the Bellingshausen plate, formerly only a theoretical concept. This result has had a major impact on our understanding of the tectonic evolution of Antarctica and is also of commercial interest to oil companies.



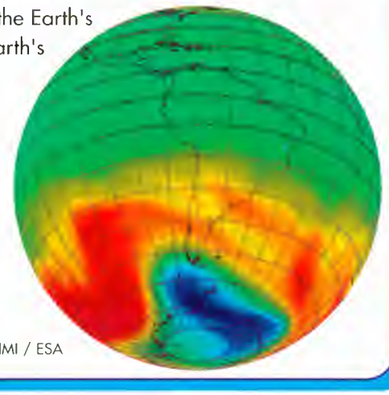
S. Laxon, University College London

OZONE: THE HOLE STORY

ERS-2 carries an instrument specially designed to measure the ozone levels in the Earth's atmosphere. Every day, this provides a comprehensive global picture of the Earth's ozone levels, including information on holes.

The accompanying picture shows the ozone hole over Antarctica on 27 November 1996. This was produced by an advection model using ERS-2 data.

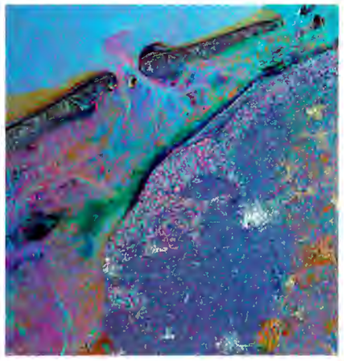
In addition to ozone, ERS-2 also measures other important trace gasses in the atmosphere and helps in the estimation of potentially hazardous UV radiation levels.



Data source: KNMI / ESA

NEW BUSINESS DEVELOPMENT

ARGOSS, in the Netherlands, is just one example of an SME established to develop commercial business using ERS data. It has developed a commercial ERS SAR based mapping service, an example of which is shown here. In 1997 a total revenue exceeding 800,000 ECU has been generated with this service. Currently these new services are provided on a relatively modest scale in Europe, the Middle East and Africa. However, in cooperation with industrial partners new initiatives have been taken to develop complete end-to-end services and to expand the services towards Asia.The current demand for this information is estimated to generate global annual revenues of several billion ECUs.



Data source: ARGOSS