EOQ N° 71 - June 2003

earth OBSERVATION QUARTERLY

esa

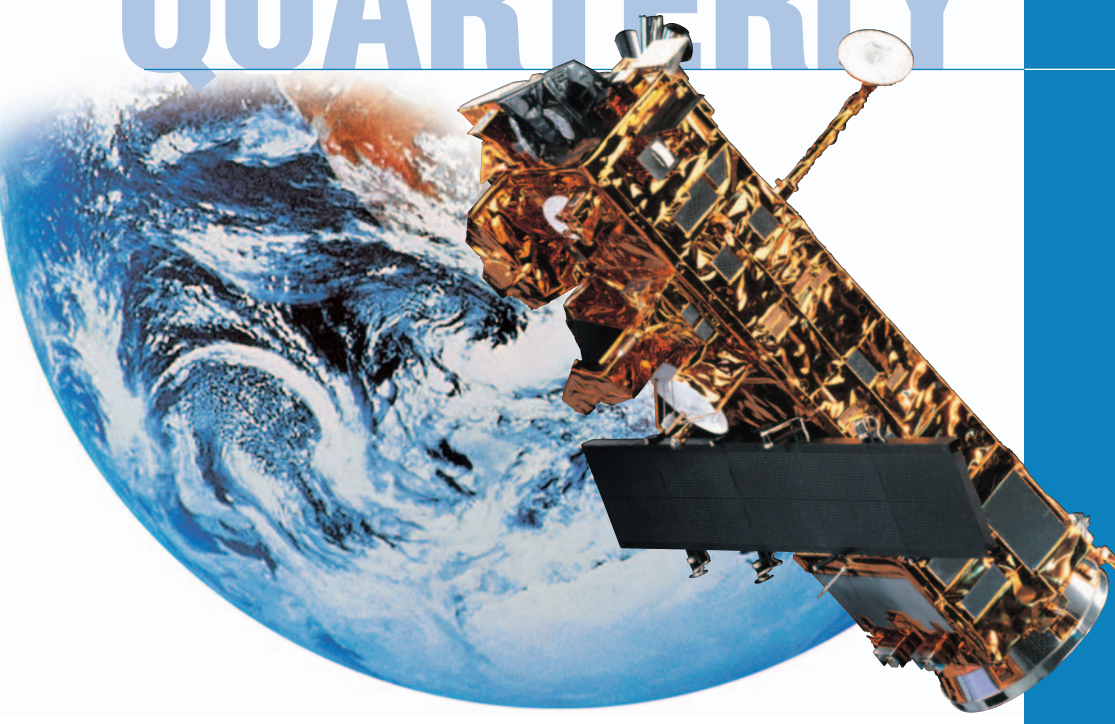
meteorology

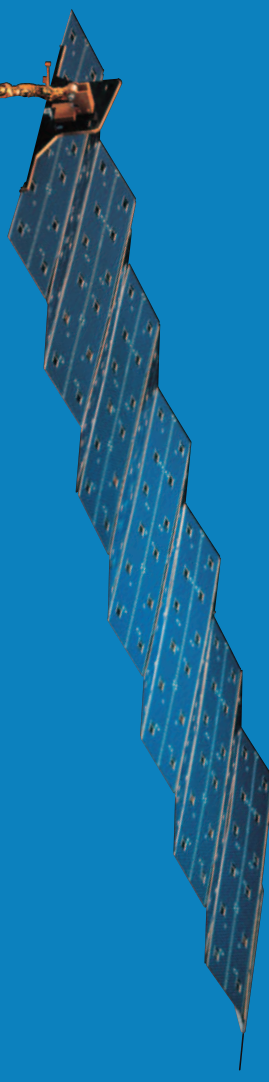
earthnet

remote sensing

solid earth

future programmes





Oxygen

A new strategy for Earth Observation

Europe has achieved leadership in many areas of Earth Observation (EO), notably in SAR imagery and the numerous applications of interferometry. The Envisat payload is now giving Europe a competitive advantage in ocean monitoring and atmospheric chemistry, which are likely to become keys to a number of political and industrial issues of the 21st century. This leadership in science, technologies and data processing is further matched by a coveted operational modelling expertise. ECMWF, the European Centre for Medium-Range Weather Forecasts, currently runs the best model available for mid-term forecasting and climate prediction and is well advanced in incorporating new satellite data into its official forecasts.

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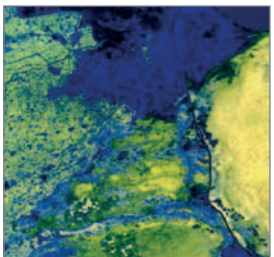
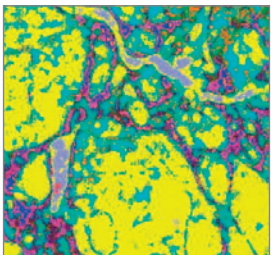




Oxygen

A new strategy for Earth Observation

Oxygen is based on the strong belief that the collective responsibilities of mankind regarding the evolution of the planet are going to be better defined and shared by guaranteeing to all actors, the European Union, National Administrations, International Organisations, developing countries and Non-Governmental Organisations an open and equitable access to space information where, when and however needed.

...continued from front page

Still, having access to data from Earth Observing satellites remains often expensive and always cumbersome. The use of these data requires large organisations and highly trained people and is therefore restricted to governmental institutions and large companies. This is severely limiting the development of science, applications and services that Earth Observation programmes should deliver. Delivery of the data may also be quite slow and this does not facilitate applications requiring near real-time access.

Oxygen (O2) stands for "Open and Operational". These two words embody at the same time the main characteristics of future Earth Watch systems and the process to achieve it. Oxygen has one objective: allowing for the sustainability of the next generation of operational Earth Observation satellites by increasing the use of EO data. It is a strategy, not another shopping list of satellites. It concentrates on defining a set of requirements from a set of users, as well as one or several mechanisms for achieving sustainability in providing Earth Observation data. In order to do so, one should increase the exposure of future users, scientists, value-adding companies, service providers, public authorities, European Commission, to the potential benefits of EO for their activities and responsibilities.

Oxygen is based on the strong belief that the collective responsibilities of mankind regarding the evolution of the planet are going to be better defined and shared by guaranteeing to all actors, the European Union, National Administrations, International Organisations, developing countries and Non-Governmental Organisations an open and equitable access to space information where, when and however needed.

Oxygen is based on the evidence that the price of data must be determined by the benefits they provide rather than by the cost of producing them.

Oxygen will be a major contribution to the implementation of GMES since it will provide access to the space component of this Environment and Security Intelligence System which we are currently building with the European Commission.

Oxygen will rationalise the acquisition, processing and distribution of data from Earth Observation satellites, in order to ensure their most effective exploitation. I would like to commit ourselves to making available, within two years, equitably to all interested entities, the whole data set generated by European satellites, and to building, in cooperation with industry, a first core of services addressing public and private needs. Success in this enterprise will mean that, by 2010, we shall be in a position to implement a new constellation of coordinated EO satellites, which we will refer to as the Oxygen Generation.

José Achache
ESA Director of Earth Observation Programmes

Global Monitoring for Environment and Security (GMES) *Industry gathers for ESA/EC global monitoring initiative*

GMES is a decision-support system for use by the public and public policymakers, with the capability of acquiring, processing, interpreting and distributing useful information related to the environment, risk management and natural resources. At a global level, GMES will provide new verification tools to contribute to the precise monitoring of compliance with international agreements, such as the Kyoto protocol on climate change, as well as security and international aid agreements. At the EU regional level, GMES will provide objective data to support a broad range of public policies, including regional development, transportation, agriculture and the common foreign and security policy. GMES also will help local authorities pinpoint environmental problems and minimize the risks and consequences of environmental changes on local populations.

Representatives from 10 industry consortia met earlier this year to plan the next phase of the ESA's contribution to the Global Monitoring for Environment and Security (GMES) programme.

The consortia were selected following an evaluation of proposals received last year for the GMES Services Elements (GSE), the initial stage of ESA's five-year, 83 million commitment to the GMES programme.

GMES is an initiative co-sponsored by ESA and the European Commission to develop a global monitoring capability for Europe's policymakers and other end users. Total GMES funding is expected to reach 400 million to develop and implement the programme by 2008.

The GSE consortia include more than 125 companies, university and other research firms, consultancies and end-user organisations that include international, national and other government agencies. Each consortium is headed by a prime contractor and consists of up to 20 organisations with an ESA-mandated mix of operational service providers, strategy consultants, system developers, R&D partners and end users.

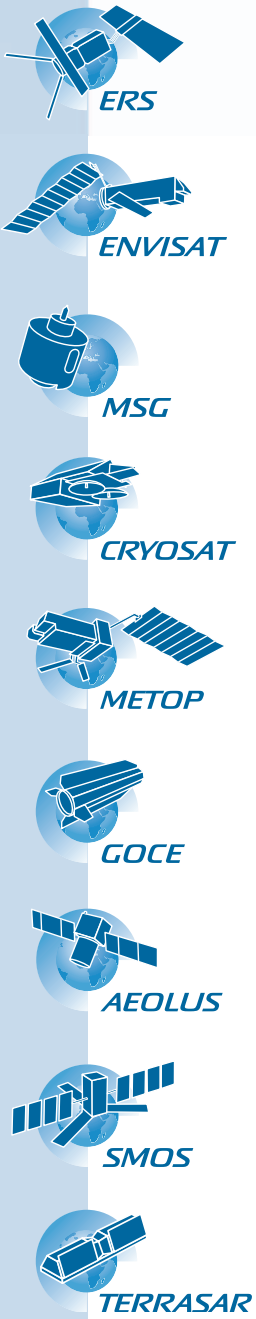
The groups will focus on developing capabilities and identifying the needs of end users under two-phase, 20-month contracts totalling 15 million. Funding will be split evenly among the 10 consortia.

The exact composition of the consortia will be announced as the contracts are finalised and signed over the next few months. A week-long meeting in mid-March at ESA's ESRIN facility outside of Rome brought the groups together for the first time to outline end-user requirements and define which existing and future Earth observation services to include in the GMES Service Elements.

ESA has tasked the 10 GSE consortia over the next 20 months to convert the high-level GMES strategy into a concrete portfolio of reliable environmental information services, and there will be plenty more to come in the future. Each of the 10 groups will start delivering services immediately, and will back this up with a blueprint for delivering long-term monitoring for themes including forests, water resources, disaster risk assessment and relief, agriculture, polar regions and urban areas.

On 15 July 2002, ESA and the European Commission launched a consultation forum on satellite-based Global Monitoring for Environment and Security (GMES). By combining spaceborne, land-based and airborne technologies, GMES seeks to make better use of Europe's existing and planned capabilities and infrastructures and to develop mechanisms for improved collection and distribution of information. It therefore responds to growing concerns among policy makers about timely, free and independent access to information on the environment and security at the global, regional and local levels. GMES will support European Union policies in areas such as sustainable development, global climate change and the European Common Foreign and Security Policy (CFSP).

PROJECT news



ERS

Launched: April 1995

ERS-2 again proved to be a very robust satellite throughout 2002, providing high-quality data to the scientific and commercial user communities, supporting the Envisat calibration and validation campaign, and helping civil protection agencies by providing data on natural disaster zones. The current exceptionally good payload and platform performance bodes well for several more years of satellite operation. The satellite is now operating in a new no-gyro mode and tests have confirmed good performance in this new mode.

The ERS archive now contains more than 11 years of continuous data (nearly 1 million high-rate scenes) and 7 years of global atmospheric measurements provided by ERS-2. The commercial demand for the high-rate imagery products increased by some 70% in 2002, to more than 16 000 scenes per year.

ENVISAT

Launched: March 2002

Launched on 1 March by an Ariane-5, Envisat reached its final orbital position on 3 April 2002, and since then has been orbiting in its assigned 35-day repeat cycle, 30 minutes ahead of ERS-2. Both satellites are controlled to fly over the same ground track with ±1 km accuracy.

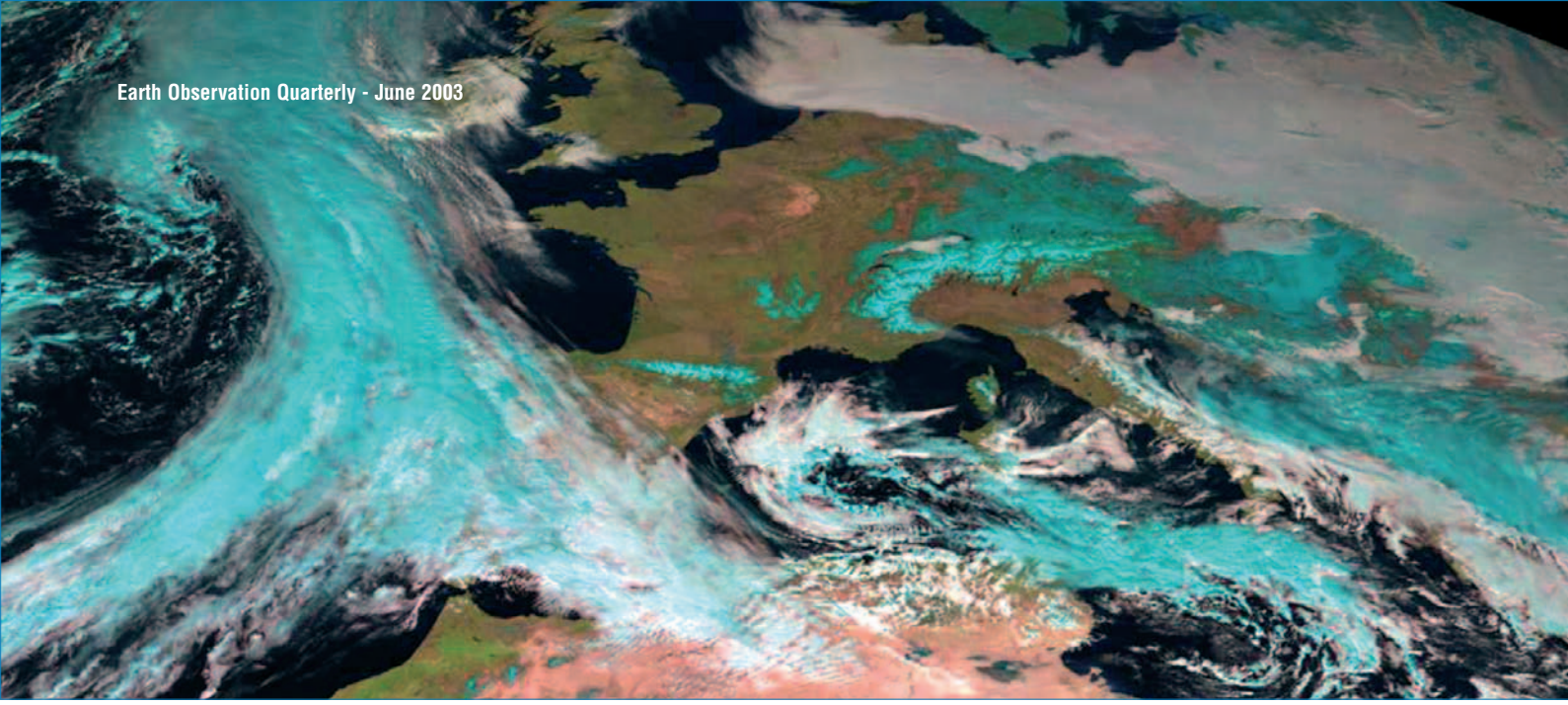
During the first weeks of the mission, all of the satellite's instruments were progressively switched on. The Commissioning Phase continued with the verification of all instrument modes. The Calibration Review in early September confirmed that all instruments were operating nominally, with very stable performance.

The Envisat mission has been operating without the Artemis data-relay satellite until March 2003, resulting in a very high workload for the Kiruna (S) ground station, which was having to handle the recovery of the full global mission (involving 14 orbits per day). The ad-hoc installation of a reception/transmission capability in Svalbard (N) provided an improvement in ground-segment performance from early November. Despite some early problems with Payload Data Segment (PDS) performance, the calibration/validation teams had received sufficient data to allow a successful Calibration Review in September and for the Validation Workshop in December. These events highlighted the Earth Science community's enthusiasm for the quality of the data being provided by all of Envisat's instruments.

METEOSAT SECOND GENERATION (MSG)

Launched: August 2002

After an extensive System Validation Test, a Readiness to Ship Review in March released MSG-1 for transport to Kourou for launch on an Ariane-5 vehicle fitted with



three special shock-attenuation devices. After its successful launch on 28 August and excellent injection into Geostationary Transfer Orbit (GTO), the satellite was thoroughly checked out and moved, by means of three burns of its liquid apogee motor, to its final orbital position. ESOC then handed over control of the satellite to Eumetsat for the commissioning phase, which will last until March 2003.

The first images from the Spinning Enhanced Visible Infrared Radiometer (SEVIRI) and the Geostationary Earth Radiation Budget (GERB) instrument have proved to be of excellent quality. The launch of MSG-1 took place during the Johannesburg World Summit on Sustainable Development, which provided an excellent opportunity to demonstrate the benefits of Earth-observing systems for sustainable development, particularly for the African continent given the satellite's equatorial location.

Following MSG-1's launch, mentioned above, the second Meteosat Second Generation flight unit, MSG-2, was taken out of storage in September and its spacecraft environmental acceptance tests were successfully completed in December. The MSG-3 subsystems and the MSG-1 engineering model remain in storage. In parallel with these activities, the final negotiations with industry for the procurement of a fourth flight unit (MSG-4) were initiated.

MetOp

Launch: Fourth quarter 2005 (MetOp-1)

The integration activites on the first flight model continue, with the start of the MetOp-1 satellite integration and test activities having been achieved. Work at Payload and Service Module level is continuing at full speed for MetOp-2 and -3.

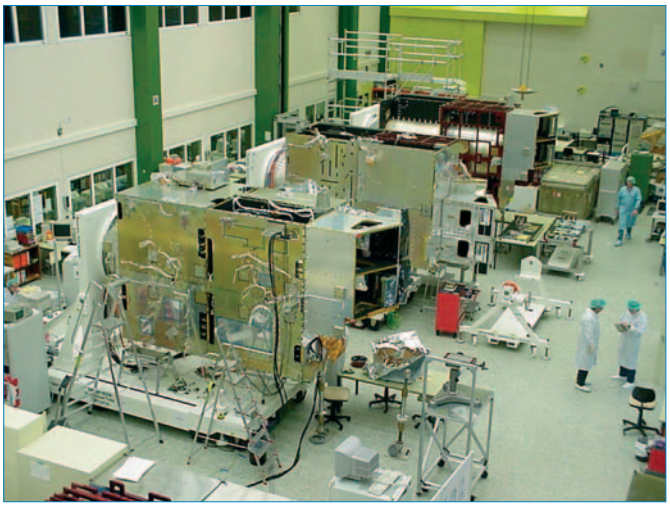
The Satellite Qualification Review was being held in this period and was aimed at evaluating the results of the important module level testing to examine the preparation of the satellite level integration and to check the qualification status of all elements of the design. The results were very successful, with only some issues of "normal work" remaining to be solved.

In parallel, EUMETSAT have performed their own Critical Design Review on the overall Polar System. ESA, and the MetOp team, actively supported the review.

The first flight model of IASI is now well into its acceptance cycle, with the delivery to MetOp foreseen in the summer. A number of problems have been identified in this process, e.g. with the (redundant half) of the corner cube mechanism, and the acoustic sensitivity of the laser sub-system. The way forward on these issues is being investigated.

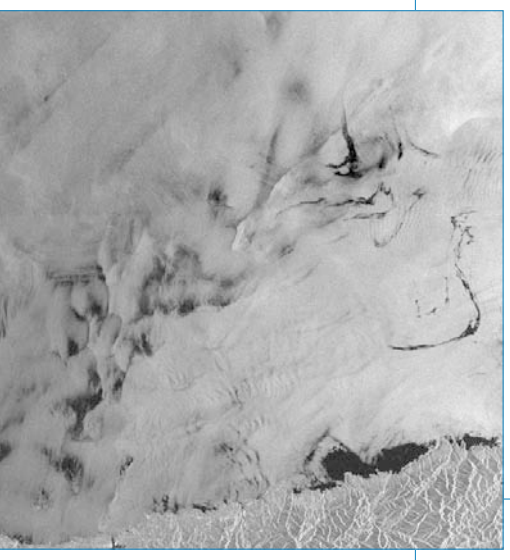
The second flight model of GOME-2 has just been delivered to MetOp. One performance issue has now been identified which points towards a degradation of the gratings used in the instruments. The cause of this is not yet clear, but the solution to the problem may required a subsequent retrofit.

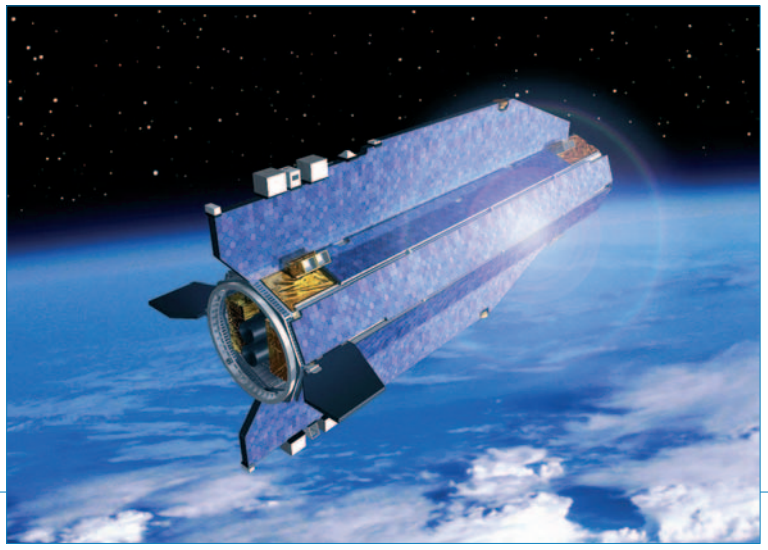
The GRAS instrument continues to make progress, albeit rather slowly. The antenna metallization issue has been resolved, by the selection of gold to replace the silver previously used.



Left: All three METOP PLM flight models simultaneously in the Astrium's Friedrichshafen clean room facilities.

Above: Image by MSG-1 on 12 February 2003 (Courtesy of Eumetsat)

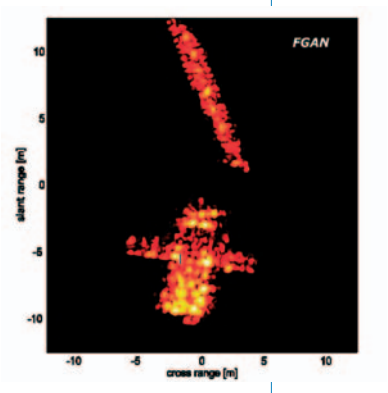




Above: ERS SAR acquisition of 22 December 2002 (orbit 40114). The rightmost dark area is with high probability an oil slick. The image is over Galicia and Asturias regions

Right: Artist's impression of Goce

Radar image of Envisat taken by FGAN TIRA ground based radar in Wachtberg Germany (Courtesy of FGAN)



Failure of the AMSU and HIRS instruments during the MetOp environmental testing has required their return to the U.S., where the problems are being investigated and repaired.

EUMETSAT and NOAA have recently agreed a "Joint Transition Agreement" which deals with the respective roles of the NPOESS system and EPS/METOP in the 2010 time frame. The agreement preserves a strong role for Europe in respect of the infrared atmospheric sounding mission in the morning orbit. Steming from this agreement is a possibility to have a rapid relaunch capability for MetOp, in case of a launch or early orbit failure. This concept is being evaluated.

InfoTerra/TerraSAR and Fuegosat

The consolidation phases for the InfoTerra/TerraSAR and the Fuegosat Earth Watch elements, approved at the Ministerial Council in Edinburgh in November 2001, were started.

The InfoTerra/TerraSAR mission is designed to provide geo-information services for institutional and commercial users exploiting data mainly from L- and X-band synthetic-aperture radars operating from two satellites - TerraSAR-L and TerraSAR-X - flying in tandem. The consolidation phase is addressing all aspects of the mission architecture. It encompasses, in particular, a Phase "B" of the TerraSAR Space and Ground Segment, which is now being initiated.

Fuegosat is a demonstrator mission for a future Fuego constellation, aimed at providing early forest-fire warning and monitoring in the Mediterranean region and at similar latitudes across the rest of the world. The initial consolidation-phase actions are to refine the mission and system concepts and learn from the precursor German BIRD mission.

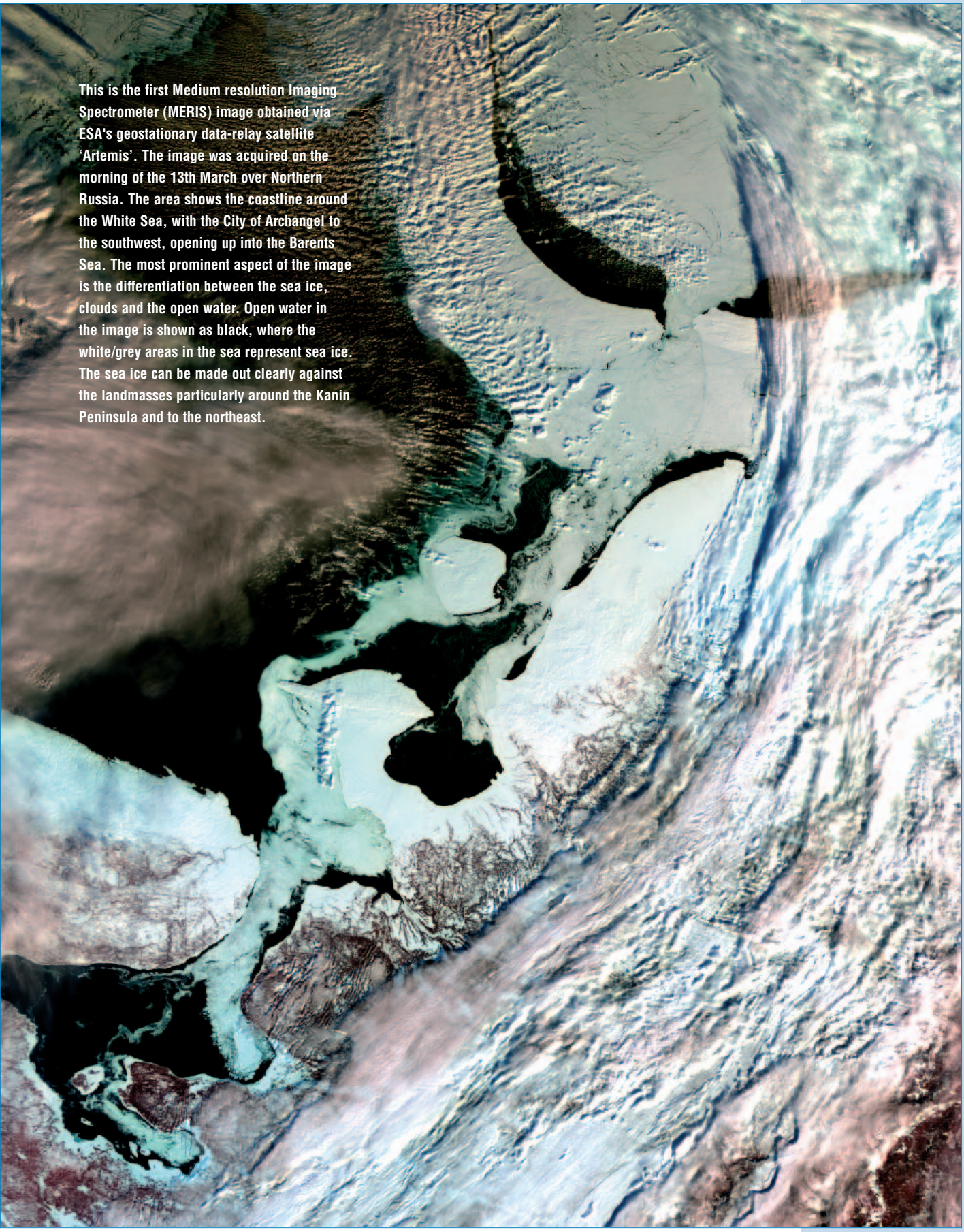
EARTH EXPLORERS

The Earth Explorer Missions are research/demonstration missions intended to advance our understanding of the Earth's environment and to demonstrate new observing techniques. They are part of the Agency's Earth Observation Envelope Programme (EOEP), and can either be large missions labelled Core missions, or smaller missions, the Opportunity missions.

CryoSat

Launch: Second half of 2004

CryoSat is an Opportunity mission designed to measure thickness variations in the polar ice sheets and the thickness of floating sea ice. Its data are to be used to study the mass balances of the Antarctic



This is the first Medium resolution Imaging Spectrometer (MERIS) image obtained via ESA's geostationary data-relay satellite 'Artemis'. The image was acquired on the morning of the 13th March over Northern Russia. The area shows the coastline around the White Sea, with the City of Archangel to the southwest, opening up into the Barents Sea. The most prominent aspect of the image is the differentiation between the sea ice, clouds and the open water. Open water in the image is shown as black, where the white/grey areas in the sea represent sea ice. The sea ice can be made out clearly against the landmasses particularly around the Kanin Peninsula and to the northeast.

Mock-Up of ADM-Aoelus

and Greenland ice sheets, to investigate the influence of the cryosphere on global sea-level rise, and to provide important observations of sea-ice thickness for use in Arctic and global climate studies.

The project is now in the middle of the main development phase (Phase-C/D) and some items of flight-model equipment have already been delivered to Astrium GmbH (D), the satellite prime contractor. Development of the ground segment is progressing according to plan.

GOCE

Launch: February 2006

The Gravity Field and Steady-State Ocean Circulation (GOCE) mission is the first Earth Explorer Core mission. Its two main instruments - the Electrostatic Gravity Gradiometer (EGG) and the Satellite-to-Satellite Tracking Instrument (SSTI) - will deliver data that will enable scientists to derive unique models of the Earth's gravity field on a global scale and with unprecedented accuracy and spatial resolution.

GOCE passed several important milestones in 2002, the most important one being the successful conclusion of the Space Segment Preliminary Design Review in April.

The year also saw the continued build-up of the industrial consortium through a competitive selection process for all equipment contracts, with authorisation to industry to proceed with space-segment development (Phase-C/D) having been given in May. The Ground Segment Requirements Review was successfully concluded in November.

ADM-Aeolus

Launch: October 2007

The Atmospheric Dynamics Mission (ADM) is an Earth Explorer Core mission that will provide global wind profiles throughout the atmosphere up to 16 km altitude. The measurements will be made by a Doppler wind lidar operating in the ultraviolet.

It will be the first time ever that wind profiles have been measured from space and this experimental mission is expected to show the great usefulness of complete wind data sets for Numerical Weather Forecasting. The resulting time series of measured wind fields will also be useful for studies of climate and the transport of chemical species and energy.

The industrial contract was kicked-off with Astrium Ltd. (UK) as prime contractor on 1 July 2002. Astrium SAS in Toulouse (F) is the subcontractor selected to develop the instrument, and Astrium GmbH in Friedrichshafen (D) is subcontracted for the platform's electrical subsystems. The satellite's design, which has been consolidated around a 1.5 m-diameter telescope, is already sufficiently advanced to allow the Invitations to Tender (ITTs) for the majority of the onboard subsystems and equipment to be issued in early 2003.

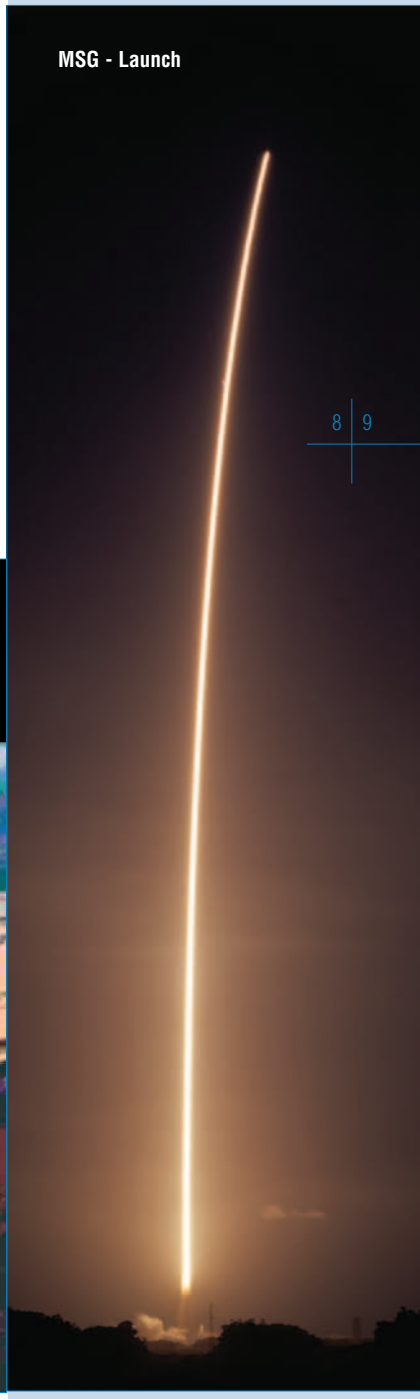
SMOS

Launch: Early 2007

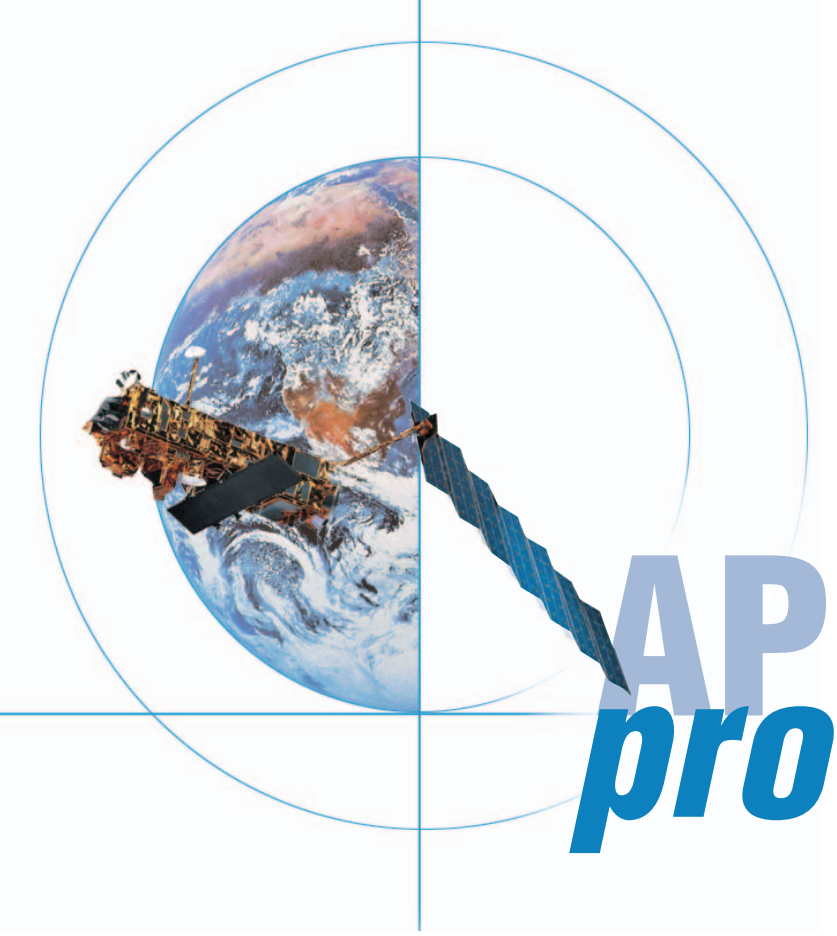
The Soil Moisture and Ocean Salinity (SMOS) is an Opportunity mission that will observe two key variables of the Earth's system, namely soil moisture over land and salinity over the oceans, to advance the development of climatology, meteorology and hydrological models. It will also provide new insight into snow and ice structure, thereby helping to advance our understanding of the cryosphere.

SMOS re-uses the generic Proteus platform developed by CNES, accommodating an innovative instrument designed as a two-dimensional interferometer acquiring brightness temperatures at L-band (1.4 GHz). The promising results of Demonstrator Pilot Projects, funded by the ESA Technology Research Programme and led by EADS-CASA (Spain), to consolidate this novel instrument technology enabled the SMOS project to enter its main design and development phase (Phase-B) in November.

Artist's impression of SMOS (Photo: CNES/MIRA Production)

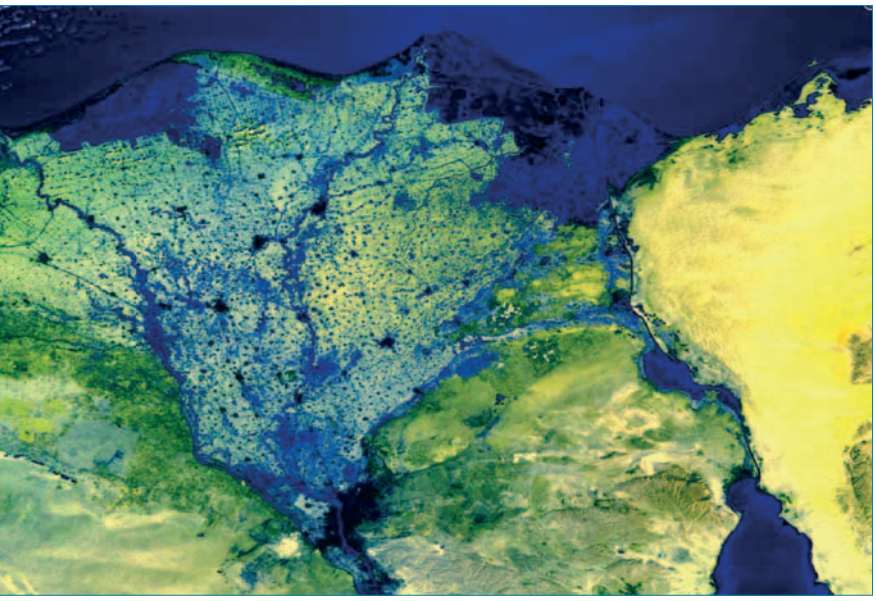


MSG - Launch



APPLICATION product

Nile Delta *MERIS, 1 March 2003*



The contrast between the lush vegetation of the Nile delta and river course and the dry sand of the Sahara can be seen spectacularly in this enhanced true colour Medium Resolution Imaging Spectrometer (MERIS) image (facing page). The grey area to the bottom of the "triangle" of the delta is Egypt's Capital, Cairo.

On the border between Israel and Jordan is the Dead Sea (top right), at 412m below the level of the Mediterranean, the lowest point on earth. The Dead Sea also has salinity 10 times that of the Mediterranean, and due to the high evaporation rate in the area, salt accumulates, and can be extracted, as can be seen in the southern part of this large inland lake. The lighter blue/green areas are increased evaporite deposits, in this case salt. The structure of the saltpans can also be seen crossed vertically by a canal.

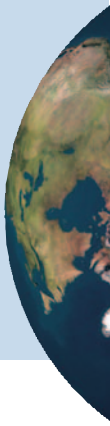
In the image detail, (left) just the Nile delta itself is shown, but this time in MERIS bands to enhance the spectral difference over land and to show up the sedimentation from the delta into the Mediterranean.

Looking closely we can see the different channels of the Nile cutting their way towards the sea. The black areas represent cities on the shores of the channels; El Mansure, Tanta and El Mahalla el Kubra are the three cities in the centre of the delta, with Cairo again clearly visible at the base. The blue plume offshore is caused by sediment from the river being pumped into the sea.

ONS

Technical Information:

Instrument:	Medium Resolution Imaging Spectrometer (MERIS)
Date of Acquisition:	1 March 2003
Orbit number:	05228
Instrument features:	Full Resolution image (300 - metre resolution)
Coordinates:	
NW Lat/Long:	N 34.50/ E 28.00
NE Lat/Long:	N 34.50/ E 39.00
SW Lat/Long:	N 24.00/ E 26.00
SE Lat/Long:	N 24.00/ E 37.00



CRYOSAT polar ice fields:

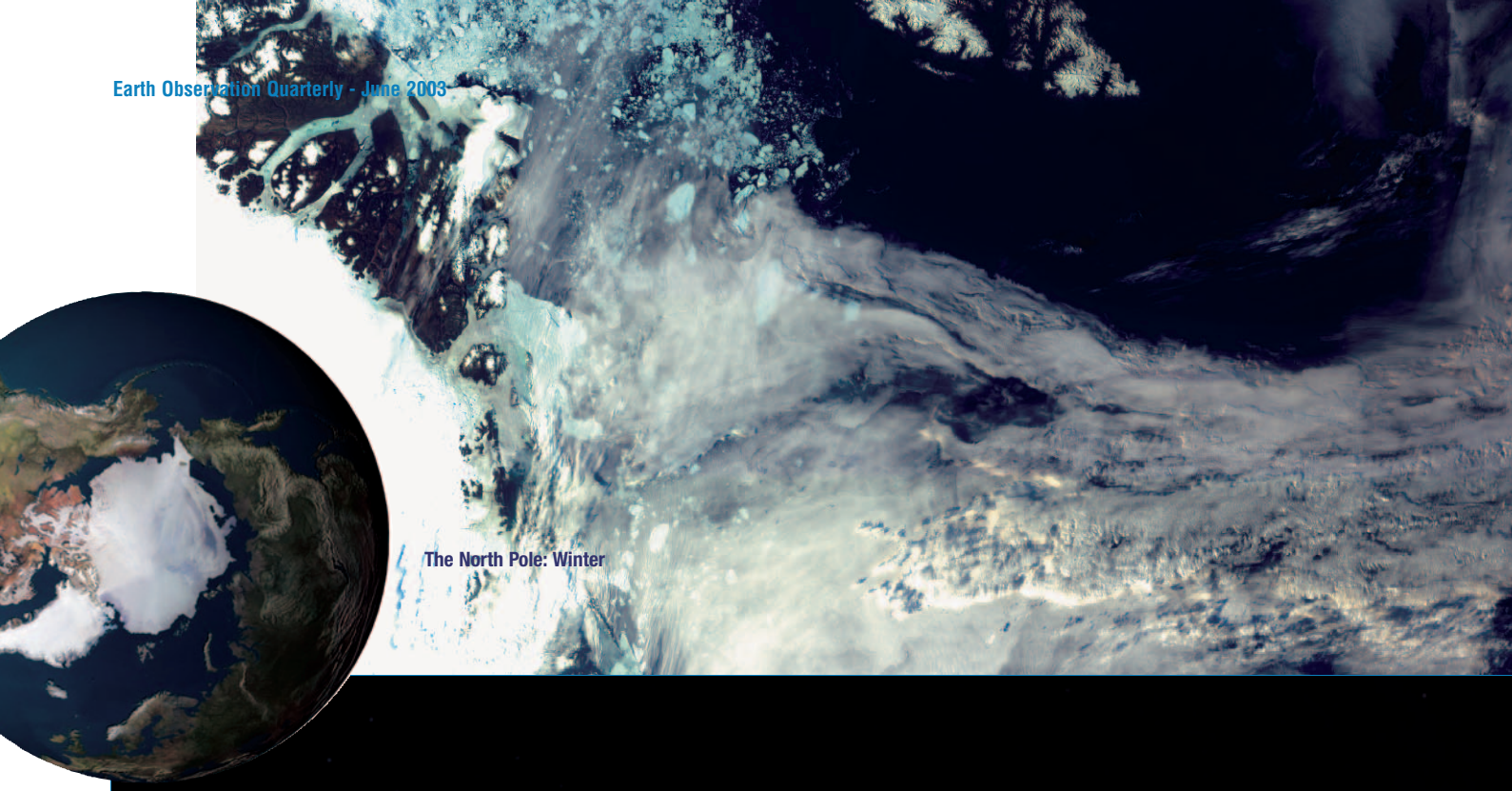
are they melting?

The 1990's was the warmest decade in the past 1000 years (according to researchers at the University of East Anglia), and this trend has continued into the current decade with 2000, 2001 and 2002 all being counted amongst the top 10 warmest years since records began. Scientists at the Hadley Centre predicted that 2003 would match the current warm record holder, 1998, and it already looks as though they were right. It is widely believed that this steady increase in global temperatures will have an impact on the polar ice fields and it is precisely to measure and monitor any such changes that the CryoSat Project was conceived in 1999.

The CryoSat project, as the first of the new Earth Explorer Opportunity missions is on a fast track development. The project is quickly approaching fruition but a significant stock-taking is being performed as this article is written. This is the “Critical Design Review” where ESA and its industrial partners carefully check the results of testing and analyses of all of the elements of the CryoSat satellite now being integrated. All the indications are that, apart from the usual crop of teething troubles which such reviews bring to light, the innovative development approach being pioneered with CryoSat is working.

In this approach much of the equipment is rebuilt from existing designs and the usual engineering test model of the satellite is replaced by software simulations of the equipment and a capable software/ hardware interface to connect them to either a test version, or a software emulation, of CryoSat's on-board computer. This "virtual satellite" is relatively easy to clone, in various configurations, and permits rapid and parallel testing activities. It is this development which is the focus of the present stage of review; later in the year the development of the scientific payload will also be put under the magnifying glass and finally the integration of all the parts and the test results will come under scrutiny.

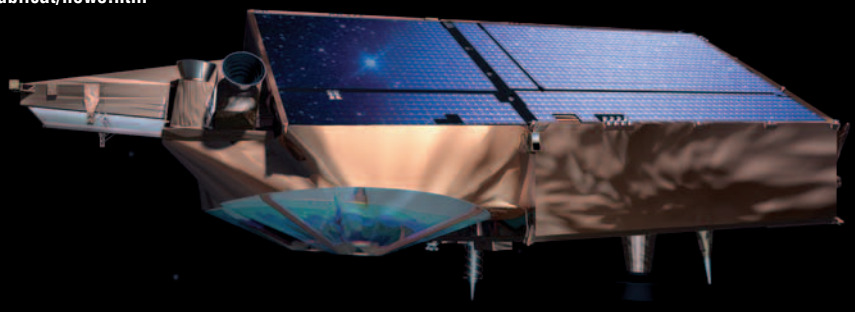
In parallel the ground segment activities are maturing fast, both in setting up the Flight Operations Control Centre and its ground station at Kiruna as well as the all-new system which will perform the demanding scientific data processing needed to convert the raw radar measurements into data products useful to polar scientists. As well as these systems a scientific team has been set up to calibrate and validate CryoSat's data products. This is important so that the scientific data can be eventually released with a definitive statement about their quality and the limits of their accuracy. The first experimental measurements in the Arctic have already been performed in order to prove the feasibility of making the required measurements in the field. A more general Announcement of Opportunity (AO) will be released before the end of the year inviting proposals from the scientific community to use and exploit the CryoSat data for polar research. This AO is a major step and effectively unveils the project to the scientific community, identifying it as a major new tool in the collection of measurement data in polar regions and inviting participation.



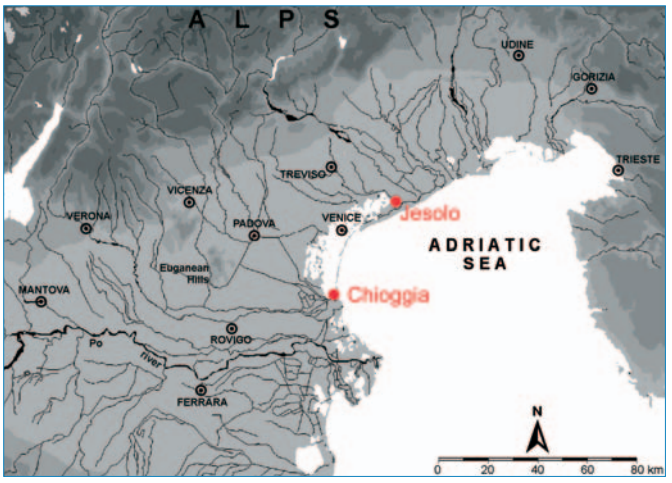
The North Pole: Winter

The project is now at a mature stage and about to become promoted in the scientific community. As part of this process ESA has released a definitive brochure describing the overall objectives of the mission and the contribution CryoSat will make towards achieving them, including a description of how its payload works. This brochure is available from ESA Publications' Bookshop, as BR-199 CryoSat – ESA's Ice Mission. It can also be downloaded from the web at

http://esapub.esrin.esa.it/publicat/news.htm

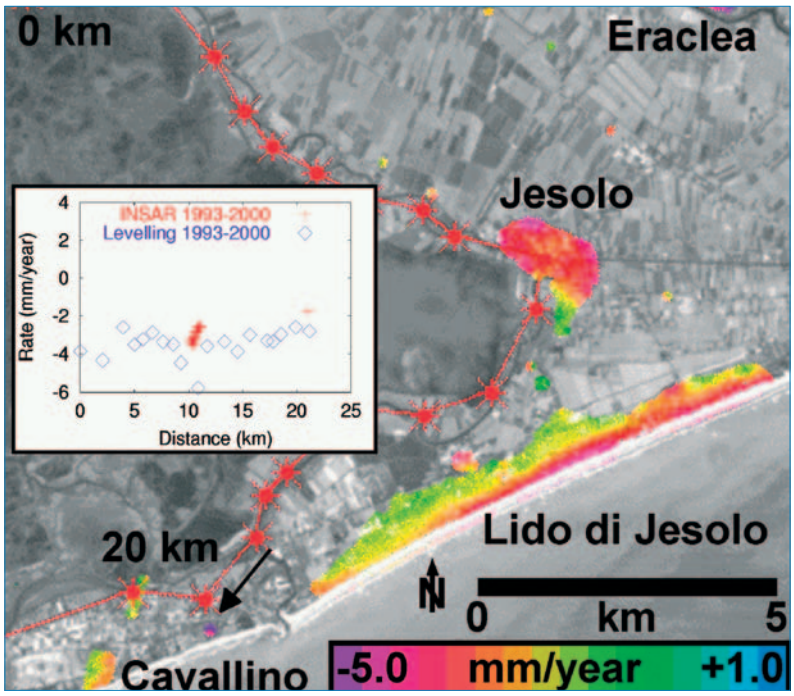


Land Subsidence Monitoring Service *in the Lagoon of Venice*



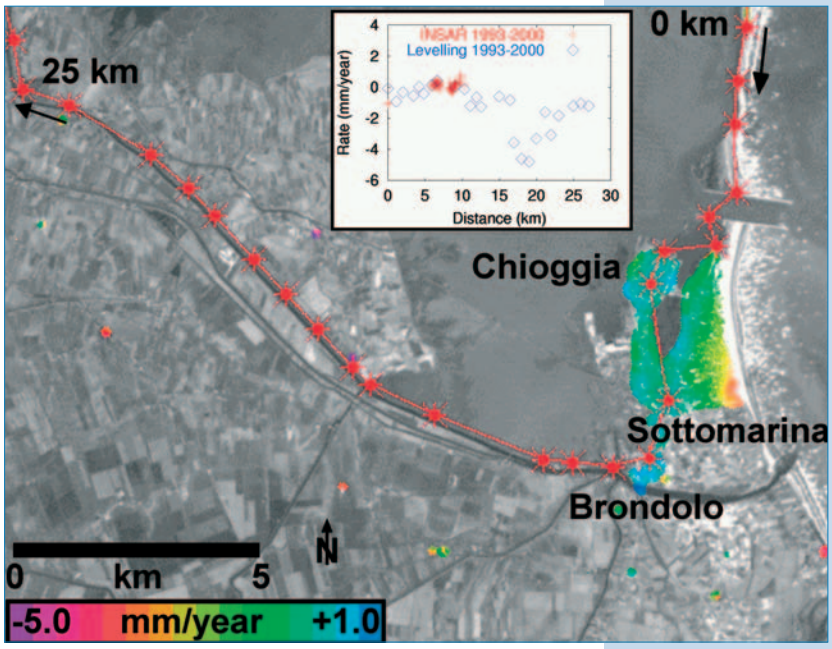
Land subsidence due to natural and anthropogenic causes has represented one of the most serious environmental problems for the Lagoon of Venice. Land subsidence has increased the vulnerability and the geological hazard (i.e. river flooding, riverbank stability, intrusion of seawater in the aquifer system, deteriorating of the littoral sectors with a general coastline regression and an increment of the sea bottom slope close to the shoreline) of these areas, a large portion of which lies below the mean sea level. After the regulation of groundwater exploitation from the Venetian aquifer-aquitard system, a remarkable slowing down of the induced subsidence in Marghera (industrial zone), in the historical center of Venice and along the littorals was ascertained in the 1970's. Recent studies have shown that land subsidence is still in progress in the southern and northern coastal areas and in the nearby mainland. In these areas groundwater is extracted from artesian wells, thicker and more compressible Holocene sediments are present, and organic soil oxidation takes place in reclaimed zones.

Until 1999, levelling of the Venice region was carried out only along the coast and the lagoon edges and the monitoring network was composed by benchmarks along single levelling lines; a fine grid network was established only in the city of Venice. In recent years, the levelling network has been updated to cover with a grid of about 1000 benchmarks all the southern part of the Lagoon, and plans exist to cover also the northern sector. The same network used for the levelling surveys is also considered for differential GPS measurements. In addition to these ground-based methods, differential SAR interferometry using long series of SAR data and the interferometric point target analysis have emerged as very promising tools for the monitoring of land subsidence at high spatial resolution and with a more complete spatial coverage.



The objective of the Data User Programme (DUP) Small Services Project VENEZIA - started in November 2001 and to be completed in November 2003 - is to implement a land subsidence monitoring service in the Lagoon of Venice for regional administrative and water authorities. An important element of the project is the integration of SAR-based monitoring techniques (conventional differential SAR interferometry and the interferometric point target analysis) with levelling and GPS surveys into an overall database and information system capable to provide the best knowledge of the subsidence process to the regional, administrative and water authorities that manage the Po Plain area around the Lagoon of Venice. Results of the project prove that this integration in the knowledge of the subsidence process can be efficiently obtained for both a back-analysis during the last decade and future monitoring of evolutionary trends. The acquisition of these physical-environmental characteristics is at present necessary for urgent restoring works and conserving plans of the lagoon's ecosystem. In future, knowledge of land subsidence may assist potential exploitations of the underground resources, i.e. water in coastal and catchment areas and gas off the littoral.

As it can be observed in the figures for two specific areas around the Lagoon of Venice, SAR interferometry exhibits complementary characteristics to the levelling surveys, because it has the capability to map urban areas at high spatial resolution. In particular, SAR interferometry is very useful to perform detailed investigations in coastal areas: in Chioggia and Jesolo a significant seaward gradient in land subsidence, practically impossible to be detected by other traditional monitoring techniques like geometric leveling and differential GPS, is visible. A critical situation is also observed in Eraclea, where the sinking velocity reaches 4 mm/year. The high precision levelling surveys, on the other hand, are used outside of the cities, as to the east of Chioggia, and to set up a reference point for the SAR subsidence values. The high accuracy of the two surveying techniques is confirmed by their cross-validation along the levelling lines.



POLinSAR 2003 *Workshop on Application of SAR Polarimetry and Polarimetric Interferometry*

With ten radar satellites expected to be in orbit by the end of the decade, radar imagery and POLinSAR techniques could find practical uses in a wide range of applications. These include detecting buried landmines, providing early warning of threats to agricultural areas, certifying forests for logging, monitoring compliance with international treaties on global warming and helping national governments to protect the biodiversity and ecological balance of their forests, wetlands and other natural assets.

An advanced technique for analysing radar images – SAR polarimetry and polarimetric interferometry – shows tremendous promise for scientists studying forests, agriculture, ice and other terrain types. More than 120 scientists and researchers from 20 countries gathered at ESA's ESRIN facility in Frascati, Italy, during January 2003 for a three-day workshop to share the latest results on scientific experiments and potential applications of SAR polarimetry and polarimetric interferometry. The workshop was also an opportunity to present the final findings of ESA-funded studies into the applications of SAR Polarimetry and Polarimetric Interferometry for two consortia involving Qinetiq, AELc, University of Rennes, SarVision and Vexcel UK and the Technical University of Denmark, CESBIO, DLR and the University of Sheffield.

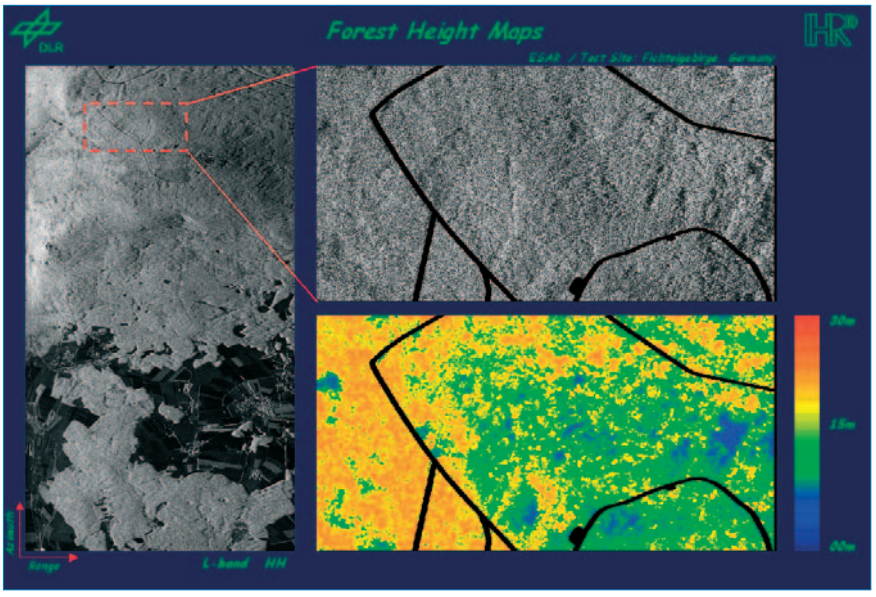
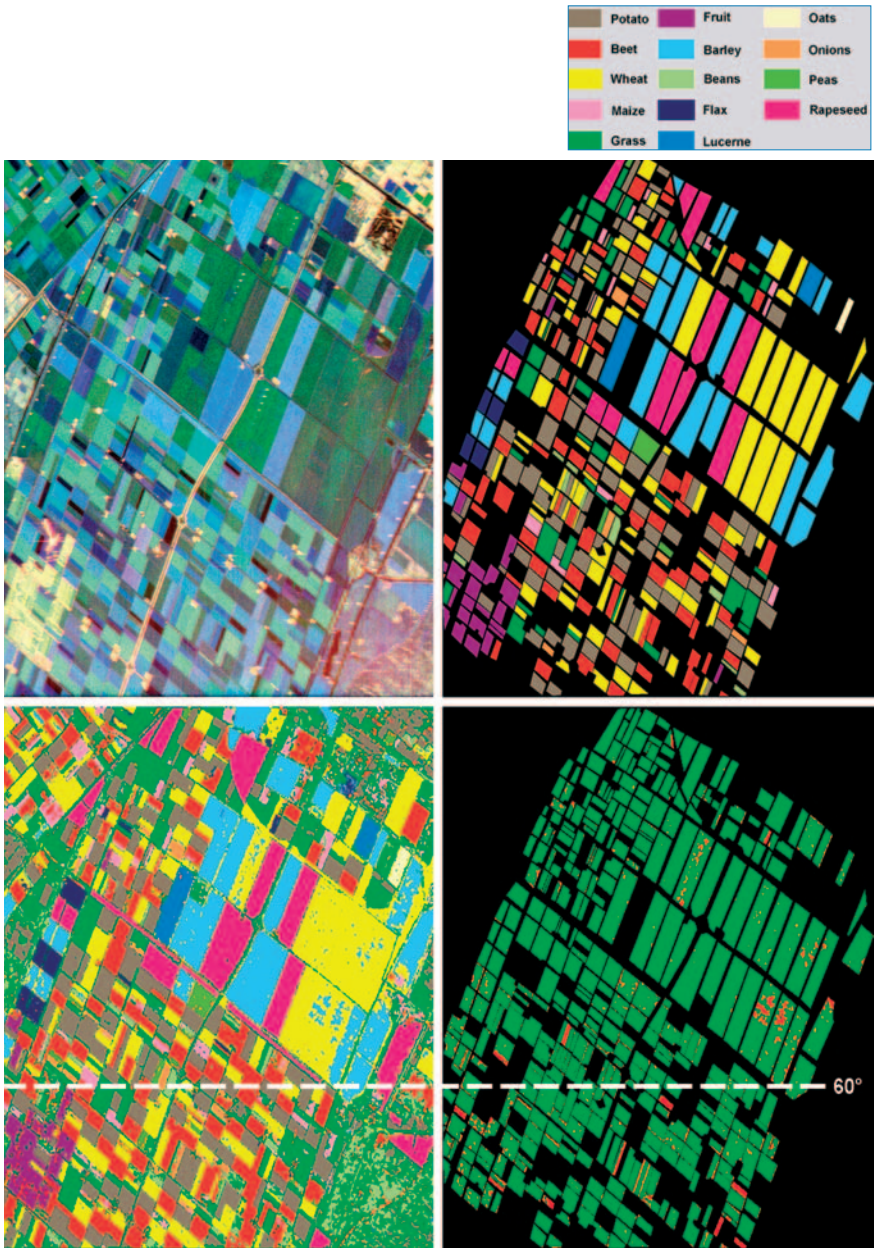


Figure 1 - Forest height derived from L-band POLinSAR data and presented in three dimensions. Courtesy of DLR.

Seeing the forest, measuring the trees

The capability of radar to penetrate ground cover and 'see' the underlying terrain, coupled with POLinSAR techniques to detect forest canopies, makes characterising tree structure and height using SAR imagery a possibility. Knowledge of the types and heights of trees in a forest enables an estimation of the biomass, which in turn provides information about an area's capacity to act as a carbon sink. Measuring these factors accurately is critical for environmental scientists to whom national governments are turning for help in meeting their international obligations under the Kyoto Protocol.

In response to this challenge, a number of tests are underway to assess how polarimetric interferometry could be used to produce accurate biomass estimates. Tree height measurements undertaken by Shane Cloude, with the UK-based AEL Consultants, produced promising validation results, within about a ten percent margin of error. "It's tough to do, and we are further along with single-species forests," Cloude said. "Forest biomass estimates are very important for measuring compliance with Kyoto targets, but we are far away from the political dimensions of using POLinSAR techniques for monitoring compliance."



From polarimetry to polarimetric interferometry

The workshop addressed the latest developments, as the research emphasis shifts from classical Synthetic Aperture Radar (SAR) studies to polarimetric SAR analysis of the Earth's surface by the combination of variously polarised views.

The POLinSAR approach combines techniques for analysing the orientation, or polarisation, of radar signals (polarimetry) with those for the analysis of phase differences between signals and to measure differential range (interferometry) using two or more images captured by synthetic aperture radar instruments (SARs). Taken together, polarimetry and interferometry offer the potential to summarise Earth surface characteristics in three dimensions with colour.

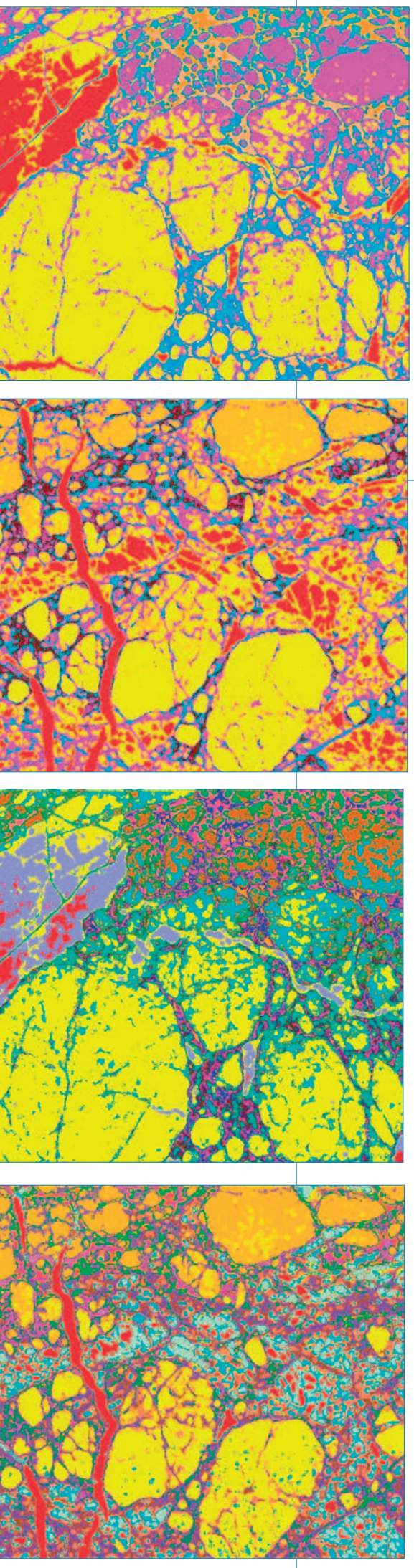
POLinSAR analysis techniques emerged in the mid-1990s and are developing quickly. "POLinSAR has matured from a 'first-results' to a 'science' status," said Konstantinos Papathanassiou, a researcher with the Institute for Radio Frequency Technology and Radar Systems at the German Aerospace Centre (DLR). "You can do things that were not possible before and are needed now."

New model for classifying agriculture

At a roundtable discussion following the presentation of results from forest studies at the workshop, several participants urged that research be expanded to include more types of forests. Dirk Hoekman, with the Department of Environmental Sciences at Wageningen University in the Netherlands, pointed out that the recent Indonesian forest fires released a gigaton of carbon into the atmosphere, or one-third of the total annual increase of global carbon gases. More POLinSAR research should be directed at tropical and peat moss forests, he said.

Hoekman's own paper on a new model for accurately classifying agricultural types in SAR imagery addresses a problem that has plagued researchers and hampered the development of reliable applications. Tests of crop classifications from imagery taken over the Dutch Flevoland agricultural test site indicate that new ways to classify the radar data can achieve levels of accuracy up to 90.4% for C-band and 88.7 % for L-band, according to Hoekman.

Figure 2 - (Top left) AirSAR Total Power image (C-band blue; L-band green; P-band red) of Flevoland, 3 July 1991. (Top right) Crop type map (ground truth). (Bottom left) Classification using C- and L-band full polarimetry model. (Bottom right) Error map: errors in red. The classification accuracy is 96.3% for the area above the 60° incidence angle line (and 95.1% for the whole image). Courtesy of D. Hoekman.



Sessions reveal potential applications

Workshop presentations, including a lively poster session gave a glimpse at the diversity of research now underway in the SAR science community.

Alex Rodrigues of Qinetiq presented details of a sea-ice classification technique employing Entropy, Alpha and Anisotropy decomposition parameters do discriminate characteristic scattering mechanisms. Initial results using L- and C-band JPL AIRSAR fully polarimetric data show that there is good discrimination between the major ice classes.

Figure 3 - L-Band unsupervised classifications of sea ice. Courtesy of A. Rodrigues.

Plans for new space SARs

With their all-weather and nighttime capabilities, coupled with these promising new analytical methods for interpreting data, space-based radars are providing new insights into the Earth's land, waters and atmosphere. Participants at the POLinSAR workshop heard details of upcoming satellite missions that will incorporate new advances in SAR technology, faster revisit times and offer a better service to scientists and users.

Canada's RADARSAT-2 satellite, planned for 2004, will feature a 3-metre resolution mode and left- or right-looking capability and will offer improvements particularly for the purposes of crop classification and monitoring and sea ice applications. The TerraSAR-X satellite will be the first German SAR for scientific and commercial applications. Planned for a 2005 launch, the X-band SAR features a 1-metre "spotlight" mode. The applications for X-band data mostly concern sea ice, snow cover and urban planning, with other uses in agriculture, map-making and risk assessment studies for floods, fires and storms. Also scheduled in 2005, beginning a program developed by the Italian Space Agency with the cooperation of France's space agency, CNES, the first of four further X-band SARs will be launched to initiate the Cosmo-SkyMed constellation. Eventually, coordinated radar and optical satellites will provide high-resolution imagery with revisit times of just a few hours.

The ESA POLinSAR workshop clearly demonstrated the strides taken by the radar research community in the past few years in radar polarimetry techniques and applications, and that more work is needed to move to applications and later services to users. The results presented confirmed that the combination of polarimetry with interferometry represents a significant breakthrough in quantitative parameter estimation for combined surface and volume scatterering mechanisms.

Following the recommendations of the workshop, ESA will support R&D efforts in the field of POLinSAR by initiating a new mission application study for future SAR missions, supporting the development of POLSAR tools and coordinating dedicated airborne campaigns.

For more information, visit the workshop web site at: ***http://earth.esa.int/polinsar/***

Applications Product

Phytoplankton

AATSR, 01 June 2002

This Advance Along Track Scanning Radiometer (AATSR) image shows a clear day over most of the United Kingdom, the Brittany region of France, and Spain. Off the coast of Brittany, a large green phytoplankton patch is visible. It appears green because these small organisms contain chlorophyll, just like plants and trees, their terrestrial counterparts. Chlorophyll is the substance by which phytoplankton retrieve their energy from the sun. This energy in then used to absorb carbon dioxide from the atmosphere, one of the gases responsible for the greenhouse effect, and stimulate their growth. Phytoplankton have also contributed for billions of years to progressively releasing the oxygen we breatheThe most important feature of the AATSR instrument is its capability to measure the world's ocean temperatures, a key parameter to monitor and understand planetary climate changes. AATSR, with its visible and infrared channels, is a key instrument onboard Envisat that helps climate researchers better understand the role of oceans in our biosphere. As this image demonstrates, the instrument also has the capability to detect phytoplankton, tiny algae living in the first tens of meter below the water's surface.

Technical Information:

Instrument:	**Advance Along Track Scanning Radiometer (AATSR)**
Date of Acquisition:	**1 June 2002**
Orbit number:	**01322**
Instrument features:	**Full resolution image (1000-meter resolution)**

Coordinates:

NW Lat/Long:	**N 61.00/ W 06.50**
NE Lat/Long:	**N 61.00/ E 01.50**
SW Lat/Long:	**N 42.00/ W 06.50**
SE Lat/Long:	**N 42.00/ E 01.50**

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Publications

BR-199 CryoSat - ESA's Ice Mission
(April 2003 - 20 pages)

SP-520: Proceedings of the Envisat Calibration Review Workshop
(November 2002 – CD-ROM, 25 EURO)

SP-526: Proceedings of CEOS Working Group on Calibration/Validation – SAR Workshop
(March 2003 – CD-ROM, 20 EURO)

SP-527: Proceedings of the First Workshop on Remote Sensing of Solar-Induced Vegetation Fluorescence (Flex)
(November 2002 – CD-ROM, 25 EURO)

SP-529: Proceedings of POLinSAR – Applications of SAR Polarimetry and Polarimetric Interferometry
(April 2003 – CD-ROM, 50 EURO)

SP-1252: COST ACTION 255 – Radiowave Propagation Modelling for Satcom Services at Ku-Band and above
(March 2002 – 587 pages, 50 EURO)

SP-1258: Envisat Application Images
(February 2002 – CD-ROM, 10 EURO)

SP-1263: METEOSAT SECOND GENERATION – MSG-1 A New Generation of Weather Satellite
(June 2002 – CD-ROM, 10 EURO)

Workshops & Conferences

MERIS Users Workshop
11 – 14 November 2003, Frascati, Italy
e-mail: envmail@esa.int
http://envisat.esa.int/meris_workshop/

Fringe 2003 – *Advances in SAR interferometry from ERS and ENVISAT missions*
2 – 5 December 2003, Frascati, Italy
e-mail: envmail@esa.int
http://earth.esa.int/fringe03/

Useful Websites & Links

ESA homepage
The latest news updated daily at
http://www.esa.int/

Observing the Earth
http://www.esa.int/export/esaSA/earth.html

Earth Observation Earthnet Online
Earthnet News, Missions, Programmes, Satellites, Instruments, Images, Product Descriptions, Catalogues, Ordering, Applications, Disaster Management, Library, Software, Events at:
http://earth.esa.int/

NEW

Interactive websites to track ESA satellites in orbit
http://orbits.esa.int/

The Earth Observation Orbits website displays in real-time the orbits and locations of ESA's Earth Observation satellites: Envisat, ERS-1, ERS-2, and Proba. You may view their positions, as they would appear if you looked overhead into the sky (Earth View) or from a viewpoint out in space looking earthward (Sky View). A set of controls allows you to step backwards and forwards through time, observing the earth's rotation and the satellite positions in the sky or as they track the earth. The Satellite Info provides details on each satellite including 3D models.