

Earth Observation

A satellite image of Europe taken in March 2005, showing the continent covered in snow. The image is the background of the page, with the title 'Earth Observation' in orange at the top left.

International Charter on Space and Major Disasters

At the Earth Observation Summit in February, Minister Kandiman of Indonesia praised the International Charter for the assistance provided in response to the tragic Asian tsunami in December 2004. At the Summit, the parties of the International Charter offered it as a practical mechanism of the Global Earth Observation System of Systems (GEOSS) for responding to disasters at the local, national, regional and global level.

In 2005, the Charter was invoked 25 times for events affecting six continents, including the hurricanes Stan and Katrina in the Americas, floods in Africa, earthquakes in Iran and Kashmir, fires in Portugal and floods in Central Europe, especially in Romania and Bulgaria, at the request of national authorities as well as the European Commission's Monitoring and Information Centre and specialised United Nations organisations. On several occasions, ESA took the lead in the response, giving the opportunity to demonstrate the large-scale services being consolidated within the GMES portfolio in the field of disaster response and humanitarian assistance.

The fifth anniversary of the Charter's operation was celebrated in Bangalore, India in October, looking back over a total of 91 activations since November 2000. The year was also marked by an increase in membership of the Charter, with Japan's Aerospace Exploration Agency (JAXA) joining in February and the Disaster Management Constellation (DMC), including Algeria, Turkey and Nigeria, in November, and strengthened American support from the US Geological Survey (USGS). Following the European Union's enlargement, the civil protection agencies in all ESA and EU Member States can now request assistance under the Charter.

Global Monitoring for Environment and Security (GMES)

The ESA/EU-led GMES initiative is the most complex and ambitious Earth-observation programme to date, now being prepared for its operational start from 2008 onwards. In 2005, there were three main types of activities associated with the GMES space component:

Envisat MERIS image of Europe under snow, taken in March 2005



The Third Earth Observation Summit in Brussels (B) in February

- (a) activities to define the GMES space component programme
- (b) preparation of the GMES space component programme, leading to its endorsement and initial funding at the ESA Ministerial Council in Berlin in December, and
- (c) programmatic activities related to the governance of the overall GMES initiative.

A GMES Technical Coordination Team was set up within the Directorate of Earth Observation Programmes to monitor and coordinate all preparatory activities and support the preparation of documents for the Ministerial Council.

GMES Preparatory Activities

Based on the decision of ESA's Programme Board for Earth Observation, a total of 15 studies have been initiated to define different elements of the GMES space component. They cover the GMES architecture, the space segment and corresponding ground segment, as well as the evolution of future services.

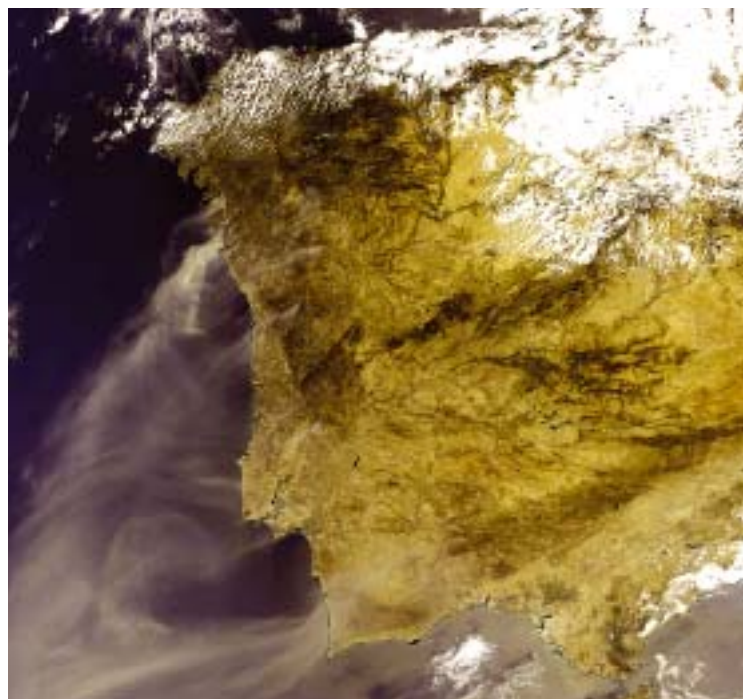
Phase-A/B1 studies have been conducted for future GMES space missions, in particular for Sentinel-1, Sentinel-2 and Sentinel-3. The studies will conclude in early (Sentinel-1) and mid-2006 (Sentinel-2 and 3). Two space segment architecture studies investigated several payload and spacecraft scenarios. A study on the socio-economic impact of GMES, led by PriceWaterhouseCoopers, has been started.

Preparation for the Ministerial Council

The content of the GMES space component programme was defined and negotiated with ESA Member States throughout the year. As GMES is a joint ESA/EC initiative, the EC as well as EU member states that are not members of ESA were consulted on a regular basis. Phase-1 of Segment 1 of the GMES space component, which was put forward for funding in Berlin in December, achieved an impressive 126% subscription from the Ministers. This strong support will allow solid implementation of the programme from the outset. It also confirmed the attractiveness of GMES, and the confidence that the Member States have in the Agency regarding the implementation of the space component.

GMES Governance

Regular meetings of the GMES Programme Office and GMES Advisory Council were held throughout the year, complemented by bilateral meetings with the European Commission and other partners such as Eumetsat or the EU Satellite Centre. The EC adopted a Communication on GMES, which confirms ESA's role as the implementing



Envisat MERIS image of forest-fire smoke plumes in Portugal, taken in August 2005

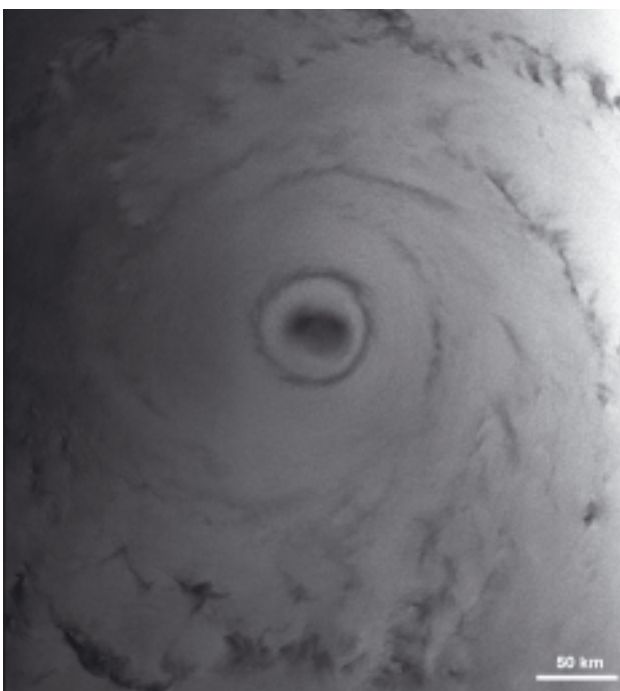
agency for the GMES space component and that the EC will provide a significant financial contribution. The third EC/ESA Space Council in Brussels in November confirmed the content of this GMES Communication.

Missions in Operation

Envisat and ERS-2

Almost four years after its launch, the Envisat mission is well established. A tangible sign of its success was the steady increase in user demand for Envisat data and services during the year, materialising as new project proposals for data use (950 scientific projects served with Envisat data by end-2005). Hence, the Payload Data Segment performances were further upgraded, allowing the generation of about 250 Gigabytes of products per day. Particular attention was paid to ease of data access, through a gradual offering of data on the Internet or via satellite.

The regular organisation of Workshops, such as those on MERIS/(A)ATSR and SAR Interferometry, continued to be an important element of the interaction between ESA and the user community, aiming at optimal mission data exploitation.



The positive image of the Envisat mission is also the result of the stable performance of both the satellite and its payload, with all instruments fully operational, with the exception of MIPAS for which a non-continuous operation scenario has been put in place.

After ten years of operations and more than 50000 orbits, ESA's second Earth-observation workhorse, ERS-2, continues to function well with all instruments still operating. A growing global network of ground stations is receiving data from the veteran spacecraft, with the low-bit-rate station network having been extended to eleven stations during the year. There is an ever-increasing demand for ERS-2 data, with an all-time record of 18 000 SAR products delivered in 2005, an increase of 33% compared with 2004. A new interferometry service has been established, leading to a revival of classical interferometry for ERS. A solid decade of ERS-2 observations has helped cement a worldwide community of more than 3000 users, and the success story looks set to continue.

The Earthnet Programme

The Earthnet Programme has been part of ESA's Earth-observation activities for more than 25 years, and assures



Two views of Hurricane Katrina acquired on 28 August 2005 with instruments onboard Envisat. The ASAR radar image of the sea surface (left) shows how Katrina's wind fields caused rippling of the ocean surface. The MERIS optical image (right) shows characteristic swirling cloud patterns around the central eye, with the eye 'walls' also visible

long-term sustainability beyond normal programmatic funding periods. In June, the Earthnet Medium-Term Plan 2006-2010 was approved, allowing the continuation of the Programme's main elements: international agreements for access to Third-Party EO missions, technology evolution and operation of a generic multi-mission ground segment, and the continuous international representation and promotion of ESA's EO activities.

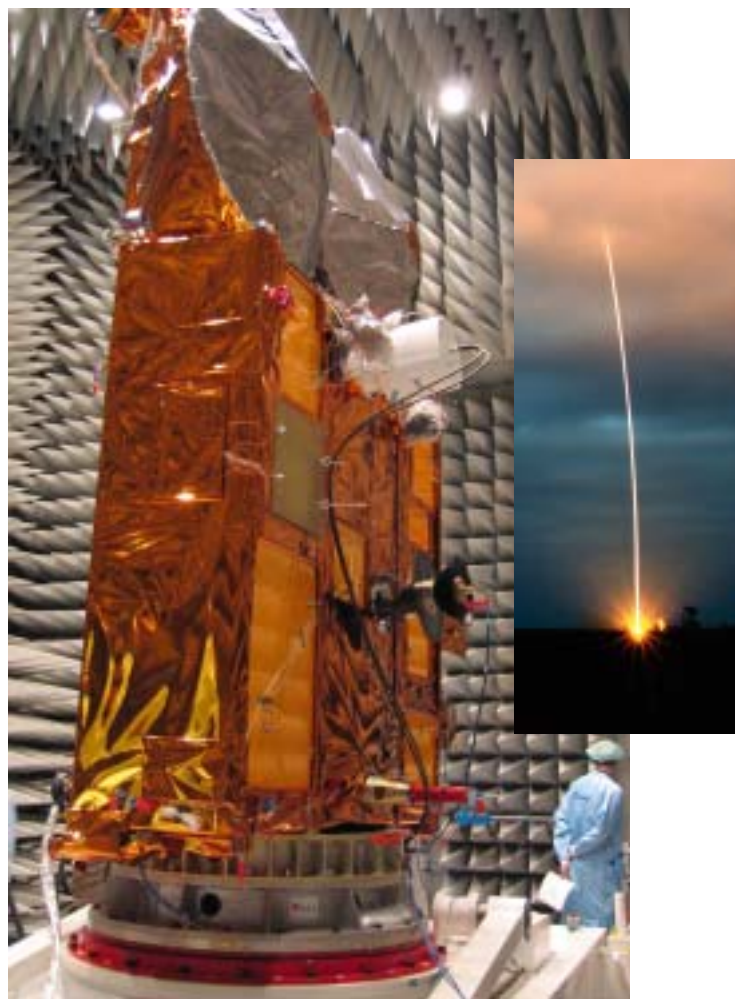
The number of Third-Party Missions grew to more than 20 in 2005. New agreements were established giving European users access to data from Landsat (USA), Scisat (Canada), KOMPSAT-1 (South Korea), IRS-P6/Resourcesat (India), ALOS (Japan) and SPOT-1 to SPOT-4 (France). Access to Third-Party Missions has also been harmonised in terms of a simplified application procedure for Category-1 scientific projects. Online accessibility, catalogues and ordering procedures have been further aligned with those for ESA missions, and the documentation on Third-Party Missions was improved.

Ground Segment Harmonisation

A major milestone was achieved in June, when the Ground Segment Coordination Body was successfully formed, including satellite operating agencies such as ASI, CNES, CSA, DLR, ESA and Eumetsat. The mandate of this group covers the efficient collaboration, cooperation and even sharing of the respective ground segments. Joint activities include the definition and establishment of interoperability standards, the setting-up of interface standards for payload ground-segment architectures, the elaboration of a common policy for long-term data preservation, and the sharing of network infrastructures, tools and other elements.

The Heterogeneous Mission Accessibility (HMA) contracts have been initiated with national agencies owning or operating Earth-observation missions, and these activities should be completed in 2006. The HMA initiative is also coordinated with the European INSPIRE initiative.

2005 saw the start of payload ground-segment architecture definition for the Sentinels, the further evolution towards a multi-mission environment, the beginning of historical archive rationalisation and management, the deployment of a high-speed network allowing high-performance online data distribution to users, the unification of the multi-



The CryoSat spacecraft undergoing electromagnetic-compatibility testing at IABG in Ottobrunn (D). Inset: The ill-fated launch from Plesetsk on 8 October

mission catalogue (containing ERS, Envisat and Third-Party Mission data) and, last but not least, the entry into full operation of the EO Web Portal, providing – on top of the ESA missions portal – a single, neutral entry point to access worldwide Earth-observation information and data.

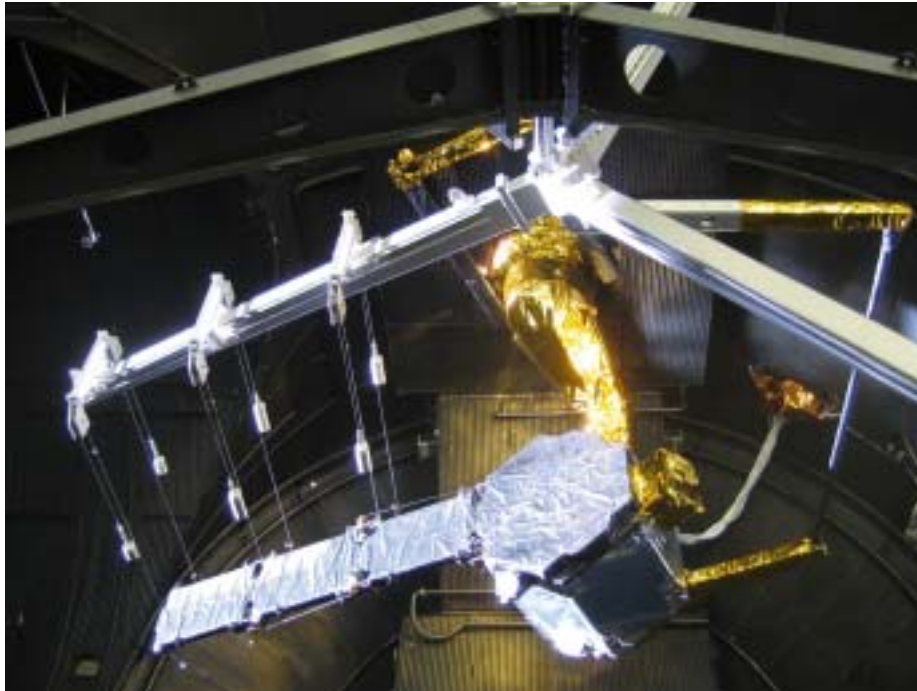
Missions under Development

Earth Explorer Missions

CryoSat

- *a mission designed to measure variations in the thickness of the polar ice sheets and the thickness of floating sea ice, which are important observations for use in Arctic and global climate studies.*

The project proceeded smoothly during the first half of the year, despite a few delays due to the replacement of some



The SMOS structural/thermal model in the Large Space Simulator (LSS) at ESTEC in Noordwijk (NL)

critical components on the proto-flight satellite. The Flight Acceptance Review was successfully completed in early September. The launch took place from Plesetsk on 8 October, but unfortunately the Rockot vehicle failed to put the satellite into orbit. Given the mission's growing importance for studying climate change, ESA is actively pursuing the building of a replacement satellite.

GOCE

- *a mission to provide unique models of the Earth's gravity field and of the geoid, on a global scale and with unprecedented accuracy and spatial resolution.*

The GOCE system-level Critical Design Review (CDR) was completed, during a year of equipment and payload testing, and in particular functional testing of the Engineering Model Test Bench of the overall satellite. Manufacture and integration of the platform flight model was also brought close to completion and its functional testing was started. On the instrument side, manufacture and integration of the satellite-to-satellite tracking instrument was initiated and advanced well. However, the gradiometer instrument activities were delayed by production problems with the flight models of the ultra-sensitive accelerometer.

The ground segment's development progressed according to plan, with the flight-operations segment successfully completing the first validation tests. The first complete

versions of the Payload Data System and the High-Level Processing Facility were accepted, and the off-line Calibration and Monitoring Facility passed its CDR.

The launch is scheduled for February 2007.

SMOS

- *a cooperative mission (ESA, CNES and CDTI) to observe two key variables of the Earth system from space, namely the soil moisture content over land surfaces and the amount of salt dissolved in the oceans.*

Two development models were completed in 2005 for the innovative payload based upon the MIRAS instrument (Microwave Interferometric Radiometer with Aperture Synthesis), namely the reduced engineering model and the structural/thermal model, which allowed the payload to successfully pass the Critical Design Review. Assembly of the Proteus spacecraft platform will begin in January 2006, after completion of the Satellite Preliminary Design Review. SMOS is due to be launched by Rockot, possibly with Proba-2 as a co-passenger, in September 2007.

ADM/Aeolus

- *a mission to provide the first-ever measurements of wind profiles from space, which are expected to enable significant advances in numerical weather prediction, especially for extreme weather events.*



The structural model of ADM/Aeolus mounted on the multi-shaker in the ESTEC Test Centre

The satellite structural-model programme was successfully completed in July, and the Critical Design Review took place in September. The flight-model structures for the platform and instrument have been delivered to Astrium Stevenage and Astrium Toulouse, respectively, and flight-model integration is underway. Most of the difficulties associated with the laser components have been overcome, and the laser qualification model is working well. An airborne version of the instrument produced the first measurement of Mie and Rayleigh backscatter during its inaugural flight on DLR's Falcon aircraft in October. The ADM/Aeolus launch is foreseen for September 2008.

SWARM

- a mission based on a constellation of three satellites in three different polar orbits at between 400 and 550 km altitude, which will provide high-precision, high-resolution measurements of the strength and direction of

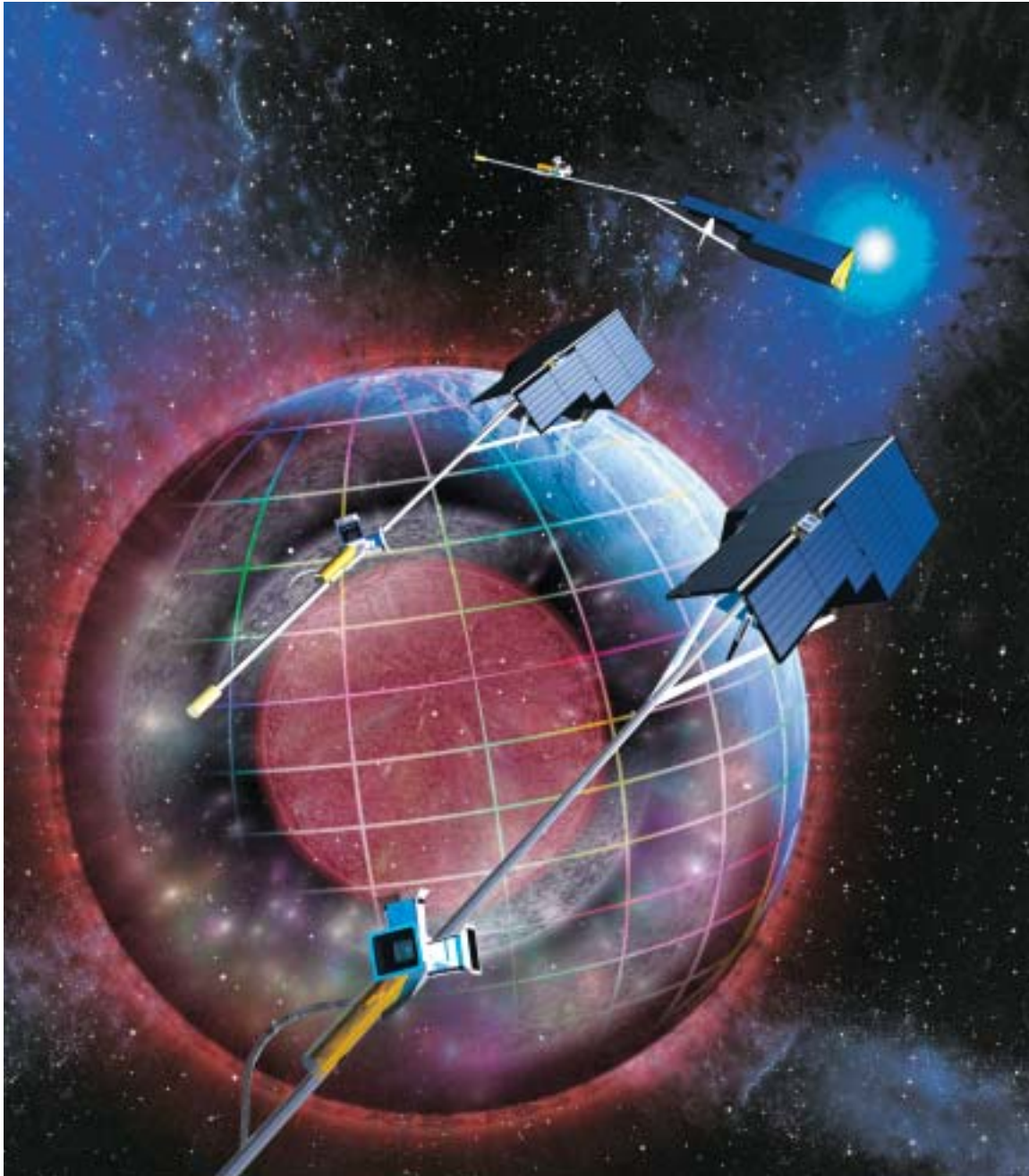
the Earth's magnetic field, allowing modelling of the various sources of the geomagnetic field and study of the interaction of the magnetic field with other physical quantities describing the Earth system.

Phase-B activities began in December with a consortium led by Astrium (Germany).

Earth Watch Missions

Meteosat Second Generation

- a series of four satellites (MSG-1 to MSG-4), to be operated until at least 2018 under the responsibility of Eumetsat, which will deliver 20 times more information – twice as fast and with higher ground resolution – than their Meteosat forerunners, resulting in a whole new range of applications.



Artist's impression of the SWARM satellite constellation (Courtesy of EADS Astrium)

MSG-1 (renamed Meteosat-8) has completed its third year in orbit, and operations are nominal. After a difficult launch campaign, MSG-2 was successfully put into a near-perfect transfer orbit on 21 December by a standard Ariane-5G launcher from Kourou. Release of the first image from MSG-2 is foreseen for January 2006 and the dissemination of imagery to the meteorological user communities for evaluation purposes is expected to start next spring, when the spacecraft will be renamed Meteosat-9.

The MSG-3 spacecraft remained in a short-term storage configuration in the Alcatel clean room until MSG-2's successful launch, and is now in long-term storage, awaiting its own launch foreseen for 2009. The MSG-4 assembly, integration and test activities are proceeding

according to plan. The Pre-Storage Review (PSR) is foreseen for the first half of 2007, after which the satellite will be put in long-term storage awaiting its launch in 2012.

MetOp

- *a series of three satellites, being developed by ESA as the space segment of the Eumetsat Polar System (EPS); Eumetsat is responsible for the ground-segment development and future system operations.*

MetOp-2, to be re-designated MetOp-A after launch, passed an important milestone in mid-2005 with the success of its Flight Readiness Review. The satellite is now in a quiescent phase, waiting for its call-up for launch, planned for end-June 2006. Meanwhile, MetOp-1 (MetOp-



Mounting of MSG-2 on its Ariane-5G vehicle in Kourou, French Guiana, for the 21 December launch (inset)

B) and the partially integrated MetOp-3 (MetOp-C) are in storage awaiting their reactivation and completion ready for their planned launches in 2010 and 2015, respectively.

Fuegosat

- a mission targeting High Temperature Event (HTE) sensing, to provide operational monitoring of forest fire and volcanic activity, both of which have major impacts on the Earth and our living environment.

After the establishment of the Fuegosat mission architecture, bridging activities were initiated in 2005 to develop a toolbox for product development and for continuous interaction with users in field campaigns. It has been shown that several phases of the fire risk evaluation can be supported by services based on data provided by operational, non-fire-dedicated missions.

Preparation of Future Missions

Earth Explorer Missions

EarthCARE was confirmed as the sixth Earth Explorer mission for launch around 2012, in cooperation with the Japanese space agency JAXA. EarthCARE will deploy two

very sensitive active sensors, namely a backscatter lidar operating in the ultraviolet with high spectral resolution and a cloud-profiling radar. A multi-spectral imager and a broadband radiometer complete the payload and will provide contextual information.

EarthCARE will collect essential data for numerical modelling and for global studies of the divergence of radiative energy, the aerosol–cloud–radiation interaction, the vertical distribution of water and ice and their transport by clouds, the vertical cloud field overlap and cloud–precipitation interactions, and other urgent scientific issues.

A new Call for Ideas for candidate missions for the third cycle of Earth Explorer Core Missions was issued in March. Twenty-four proposals had been received by mid-August, showing the strong interest and participation of the scientific community in the ESA Earth Observation Envelope Programme.

Earth Watch Eumetsat Missions

The mission and system architecture studies for the Meteosat Third Generation (MTG) were carried out



The Aladin Airborne Demonstrator mounted in the DLR aircraft for in-flight testing

together with Eumetsat. ESA and Eumetsat are jointly evaluating the results in preparation for the MTG Phase-A start in 2006. Activities were also undertaken in preparation for the future Eumetsat Polar System that should continue the service of the MetOp satellites.

Earth Watch GMES Missions: the Sentinels

A set of preparatory activities was started for the first dedicated GMES space missions, the so-called 'Sentinels', and significant progress was made during the year. These activities include socio-economic benefit studies, studies on implementation scenarios and architectures, as well as definition studies for the first three missions: Sentinel-1, a C-band SAR mission providing continuity with ERS, Envisat and Radarsat SAR data; Sentinel-2, a multi-spectral optical imaging mission providing enhanced continuity with Spot and Landsat; Sentinel-3, a mission devoted to the monitoring of the oceans and of the land/vegetation on a global scale by means of optical imaging in the visible to the thermal infrared and advanced altimetry. The preparation of the initial studies on Sentinel-4 and Sentinel-5, devoted to the monitoring of atmospheric composition from geostationary and low Earth orbits, respectively, was carried out in cooperation with Eumetsat, and will allow these studies to start in early 2006.

Instrument Pre-Development

An airborne Doppler wind lidar (Aladin Airborne Demonstrator) was manufactured in the course of 2005. This lidar is the first available airborne incoherent wind lidar, and will be used for the preparation and validation of the Aeolus mission. Its functionality was successfully tested under in-flight conditions in October.

The pre-development effort on the L-band SAR for the TerraSAR-L mission made good progress. A risk-reduction programme was initiated for the instruments for the EarthCARE Explorer Mission. The contributions to the APEX airborne hyperspectral imager are close to completion.

Services Development and Applications

The Data User Element and Data User Programme activities were once again dedicated to the management of running contracts and the starting of new projects, both in close collaboration with user institutions. Five running contracts were served within DUP, eight within DUE, and eight new DUE projects were kicked-off: GLOBCOLOUR, to develop and demonstrate an EO-based service supporting global-ocean carbon-cycle research; SEVESEO, to develop geospatial techniques for the management of industrial risks and technological accidents; and five TIGER Innovator projects, with the dual objective of giving African users and industry an opportunity to prototype and demonstrate innovative products and services for water management, and of improving the ability of African partners to use EO technology and build the basis for a long-term sustainable service. In addition, a two-day TIGER Workshop and a three-day training seminar were held at ESRIN, the latter demonstrating the use of toolboxes for data handling in application activities.

ESA's good relations with the People's Republic of China within the framework of the DRAGON Cooperation Programme were further developed, with the 2005 Symposium taking place in Santorini, Greece, at the end of June, and the Advanced Training Course on Land Remote Sensing, which took place at the Capital Normal University, Beijing, with more than 100 participants from over 50 different Chinese institutions attending.



The Data User Element (DUE) home page on the ESA portal

ESA continued to grow European industry capabilities in offering EO-based services through the EO Market Development (EOMD) Programme. Two major new initiatives were started: the first consisting of a suite of 16 small-scale, rapid activities exploring innovative prospects to develop the EO services market (examples include: UV exposure warnings via SMS messaging for public health, water quality for fish-farming in Chile, or forest-change monitoring for the electricity industry); the second consisting of seven medium-sized activities to assess the value of EO services within sustainable-development reporting of large multi-national companies - an issue at the heart of current business practices. All these activities bring new global industrial players to EO across a variety of industrial sectors. To date, the reported total spin-off commercial revenue generated directly by EOMD is 5.8 MEuro (and growing).

It was also an important year in terms of ESA's presence at international environment-related events, including: the 7th Conference of the Parties of the UN Convention to Combat Desertification (UNCCD) in Nairobi in October, the 9th Conference of the Ramsar Convention on Wetlands in Uganda in November, and the 11th Conference of the UN Framework Convention on Climate Change (UNFCCC) together with the first conference dedicated to the Kyoto

Protocol, together attended by almost 10 000 participants. On all of those and many more occasions, the usefulness of collaboration with ESA and the importance of its contributions to Earth observation were recognised and highlighted in many ways.

Maintaining such an international presence strengthens ESA's leadership in supporting International Conventions through the use of EO data, and in broadening user awareness and promotion. In this framework, the successful cooperation with UNESCO was continued and found an additional focus in the area of World Heritage Site conservation. The ESA contribution to international working groups on education, training and capacity building, such as the CEOS Working Group on Education, was also maintained. The ESA Multilingual EO Web Site for Secondary Schools was enriched with a version in Danish, paid for by the Danish Ministry of Education, whilst the versions in Portuguese and Dutch are nearing completion, together with new modules and study cases on 'Africa from Space' and 'Himalayas from Space'. Within the UNESCO Bilko project, Envisat data products now illustrate the oceanography lessons. This diverse set of initiatives underlines ESA's dedication to fostering the use of Earth observation from space in public outreach and education activities.