Earth Observation

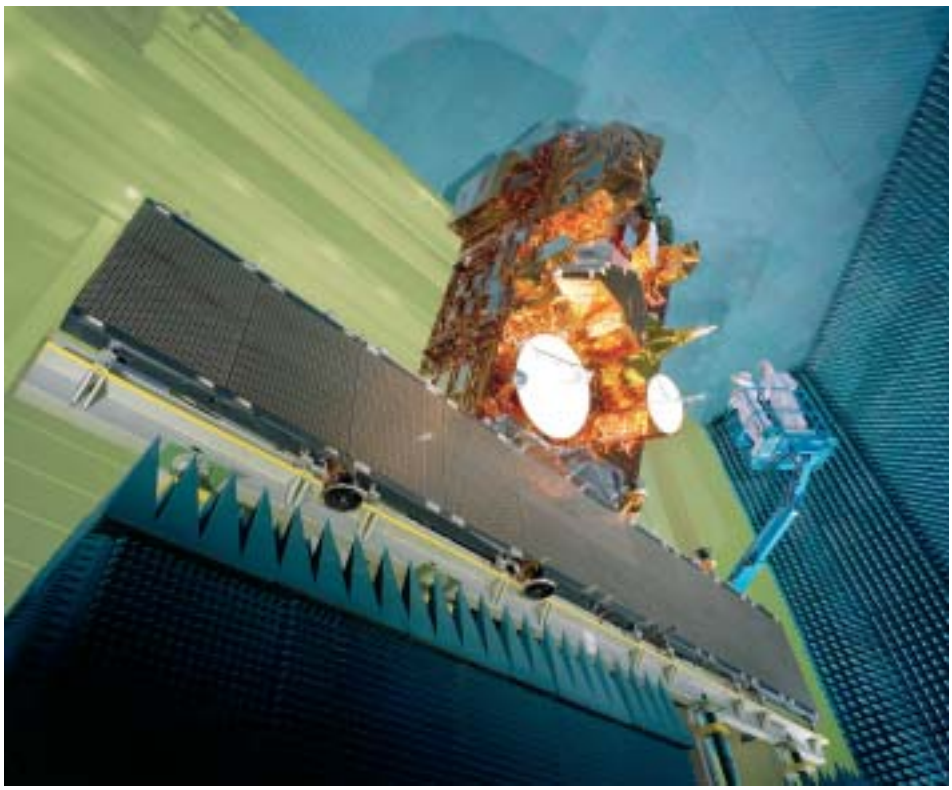
Envisat

The last major satellite environmental test, addressing radio-frequency (RF) compatibility, was conducted in early February at ESTEC in Noordwijk (NL). The ASAR antenna was deployed and all instruments and communication links were exercised as per their nominal in-orbit operations. Following successful completion of the satellite functional tests with ESOC having direct control of the spacecraft, the Flight Acceptance Review was satisfactorily concluded by early April.

The satellite was transported from Amsterdam to the Centre Spatial Guyanais (CSG) in Kourou (Fr. Guiana) by an Antonov on 15 May, and was installed the same day in the newly available S5 facilities specifically designed for large Ariane-5 payloads.

The first phase of the launch campaign was satisfactorily concluded by mid-July. Unfortunately, the failure of the upper stage on Ariane-5 flight V142 on 12 July resulted in all subsequent Ariane-5 flights being put on hold awaiting the outcome of the investigation initiated immediately after the mishap. The measures proposed to avoid a recurrence of the anomaly were endorsed in mid-December by the Failure Enquiry Board. By year's end, the upper-stage engine assigned to the Envisat launch vehicle had been selected and a challenging but realistic schedule leading to an early-March 2002 launch set.

The Ground Segment Readiness Review (GSRR) was satisfactorily concluded by end-March. The Flight Operations Segment (FOS) review was also completed satisfactorily. Given the highly complex nature of the Payload Data Segment (PDS), with its numerous external interfaces, and the need to complete the overall ground-segment, a 'delta GSRR' was scheduled for, and successfully completed in mid-September.



Flight model of Envisat being prepared for RF compatibility testing at ESTEC in Noordwijk (NL)

By the end of 2001, the FOS and the PDS were ready to support the early in-orbit operations and subsequent in-orbit commissioning phase. The launch and ground-segment commissioning had been prepared through extensive training of the operations teams. All nationally provided Processing and Archiving Centres (PACs) had been integrated into the PDS. The Expert Support Laboratories and Principal Investigators involved in the commissioning phase used the launch delay to optimise their preparations.

MSG-2 during integration at Alcatel Space Industries in Cannes (F)

Meteosat Second Generation (MSG)

The MSG-1 flight unit was taken out of storage in September in preparation for an Ariane-4 launch in July 2002. The launch-readiness reviews for the spacecraft and for the ground segment and operations were started within ESA and Eumetsat, respectively.

MSG-2, MSG-3, and the MSG-1 engineering model were put into storage until after the MSG-1 launch.

MetOp

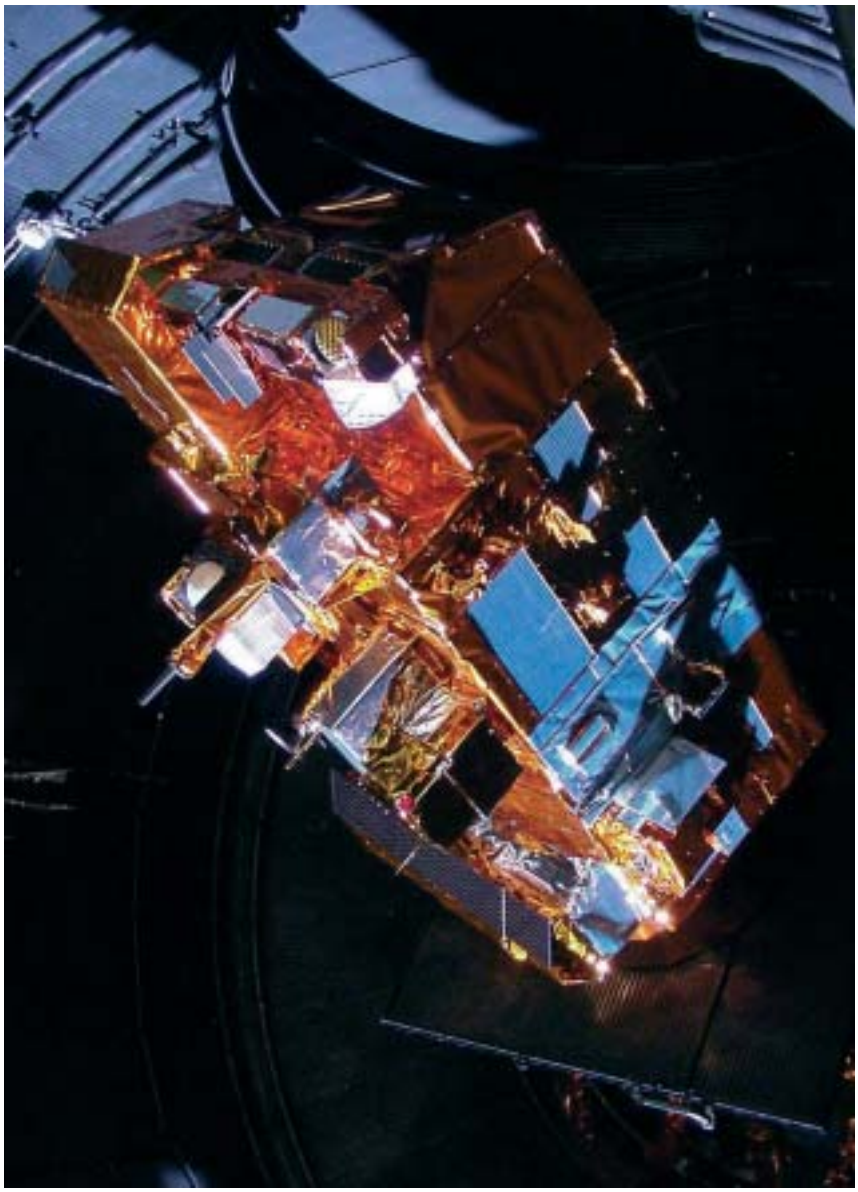
The year saw very satisfactory progress in the development of the MetOp satellite. The structural-model programme was completed, with vibration, acoustic, and mass property tests taking place at ESTEC (NL). The results confirmed the structural design and, with some small exceptions, the derived environmental levels for the instruments and equipment. Of particular note was the successful participation of the IASI structural and thermal model in a dedicated acoustic test run, and the demonstration that the US-provided AVHRR and HIRS instruments are indeed able to withstand the MetOp-induced environment.

The engineering-model Payload Module also completed its test programme with an extensive set of tests, including thermal-balance/thermal-vacuum testing in ESTEC's Large Space Simulator, electromagnetic and radio-frequency (EMC/RFC) compatibility testing on ESTEC's Compact Test Range, and deployment testing of the various antennas. The results confirmed the validity of the thermal and electrical design, and the very important EMC/RFC compatibility.

The development-model programmes were the subject of Critical Design Reviews (CDRs) at instrument and module level, with the final system CDR being held in September/October. These reviews were very successful, with only a limited number of open issues being identified, most of which were closed out by year's end.

In addition, good progress was made with the ESA-developed instruments (ASCAT, GOME and GRAS), with the first flight models nearing completion at the end of the year.

The structural mechanical subsystem of the MetOp-1 Service Module was completed by year's end, ready for the start of electronics integration in 2002. Work also started on the integration of the MetOp-1 Payload Module.



The MetOp engineering model Payload Module in ESTEC's Large Space Simulator

ERS

17 July marked the 10th Anniversary of the ERS mission, with the ERS-2 satellite in its sixth year of operation. A joint ESTEC, ESOC and ESRIN team effort in developing the means and techniques for operating the satellite in zero-gyro mode have resulted in a continuous ERS data service to users for more than twice the satellite's predicted lifetime, servicing new applications in long-term trend monitoring for the Earth's atmosphere and hydrocarbon cycle.

From an operational point of view, the ESA data acquisition, processing and distribution (ERS-1 and ERS-2) activities continued successfully, with several thousand products being shipped to users and new data acquired for the archive.

Scientific exploitation of the ERS mission was further extended through some 120 new Category-1 (research) projects, which were initiated following the implementation of the common ERS and Envisat Data Policy. This success is largely thanks to the efficient peer review carried out by a panel of more that 50 independent external experts who are actively supporting ESA to make data access faster and easier for high-quality R&D projects. Since its launch, the mission has served more than 3500 science projects, and will in future be a complementary data source to Envisat, with many Envisat Calibration/Validation Projects already using ERS data.

Third-Party Missions

The activities of acquisition, processing and distribution of data from Third-Party missions (Landsat, SPOT, SeaWIFS, TIROS, MODIS, etc.) continued successfully, with thousands of products distributed to users and new data acquired for the archive. Data were transcribed onto new media to preserve the historical archives of ERS (SAR and LBR), Landsat TM and MSS.

New missions (NASA-AQUA and NOAA-TIROS follow-on) were approved by the ESA Remote-Sensing Programme Board following the selection mechanism for Third Party EO missions (non-ESA) to be handled in the Earthnet framework. A report was also prepared on new missions of interest aimed at complementing ESA's own.

NASDA offered Europe the opportunity to create the ALOS Data European Node (ADEN). An agreement between CNES and ESA was elaborated by which CNES is responsible for the high-level European Node functional specifications, while ESA is responsible for the development, deployment and operations of the ADEN technical elements, including the embedding of ALOS in the multi-mission user services at ESRIN. The launch is scheduled for mid-2004.

The transfer to ESA of the INFEO information system developed by the European Commission/JRC was completed and the system successfully put on line.

The experience acquired over the last 10 years in the operation and exploitation of the ESA and Third-Party missions is being fed back into the definition of ground segments and mission exploitation strategies for ESA's own Earth Explorer missions. The ground segments will be based as much as possible on the re-utilisation and integration of existing facilities and services, thereby ensuring a maximum sharing of resources and an easy and simple access point for all data users. The centralised user interface for all ESA Earth Observation missions, i.e. the ERS, Envisat, Third-Party and future Earth Explorer missions, provides access and support for all of the different data sources and products.

Other Ongoing Activities

Contacts with end-user groups in government and public bodies across Europe were greatly enlarged during the year. They include civil-protection and environmental agencies, as well as research institutes, Non-Governmental Organisations (NGOs) and UN agencies. Valuable new contacts were established with the secretariats responsible for several global environmental treaties. Many of them are eager to benefit from the information that Europe's EO space systems and expertise can offer. These contacts have also led to a number of application-development projects within the Data User Programme.

Cooperation with civil-protection agencies in particular was greatly enhanced in 2001, the first year of the International Charter for Space and Natural Disasters. Through this initiative, the space agencies have committed to immediately deploy their EO satellites to collect information from natural-disaster zones and deliver it promptly to relief agencies. The founding members ESA and CNES, along with the Canadian Space Agency, were joined during the year by NOAA and ISRO in this undertaking.

ESA took on major international responsibilities for co-operation on Earth Observation when it was invited to chair of the Committee on Earth Observation Satellites (CEOS) and co-chair IGOS (Integrated Global Observing Strategy) for the year 2002, along with chair of the CEOS Working Group on Cal/Val for three years. At the CEOS Plenary meeting in Japan in November, the ESA-proposed priorities for a major review of CEOS strategy and representation at the WSSD meeting in Johannesburg 2002, were fully endorsed.

The new Market Development element of the Earth Observation Envelope Programme has drawn a very positive response from European value-adding industry during its first two years. More than 120 proposals were received and 30 contracts initiated to explore both short-term and long-term market opportunities. The priority actions for this programme are established based on industry inputs. The very challenging aim of delivering marketable EO services remains a central element of ESA's long-term strategy to implement sustainable EO systems and services. It was promising news that, in a very difficult economic climate, the ERS Data Distributing entities successfully met

their business plans for ERS SAR services in 2001. The reduced prices for users have greatly increased the volume of data flowing via the distributors.

ESA also strengthened it efforts in promoting the benefits of Earth Observation particularly to the general public, key decision makers and end users. A major public communications campaign relating to the Envisat mission included press, television, radio and web coverage, as well as public exhibitions in more than 40 centres throughout Europe.

Future Programmes

As far as future programmes are concerned, 2001 was characterised by three main activities:

- Full implementation of the new Earth Observation Envelope Programme: This programmatic framework completed its second year of operation and has proven its usefulness in allowing the Agency to respond faster and more efficiently to EO user requirements and priorities, providing a longer planning horizon and facilitating the search for international co-operation agreements.

- Launch of the new Earth Watch Programme at the ESA Ministerial Council in November: This ambitious programme is intended to deliver new EO-based information services that respond directly to Europe's environmental policies. It will be a first step towards establishing an autonomous European Global Monitoring capability for Environment and Security (GMES) by 2008. It is also a key element of the new European Space Strategy agreed by ESA and the Commission. Last but not least, it will allow completion of the two-pronged strategy of the ESA Living Planet Programme (detailed in ESA publication SP-1234) by adding the operational service-driven Earth Watch missions, covering commercial and institutional needs, to the existing science-oriented Earth Explorer missions.

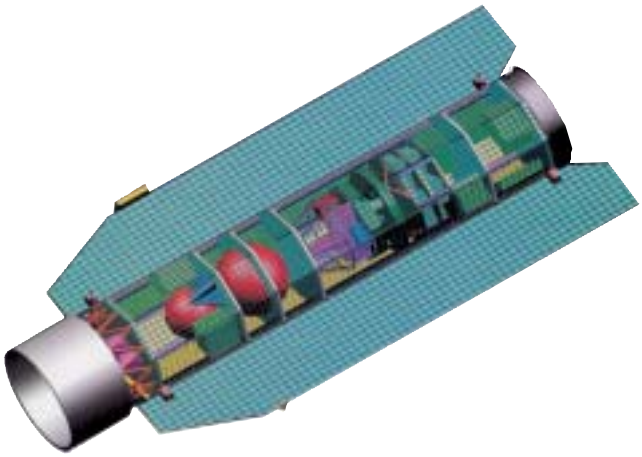
- Preparation of the second phase of the Earth Observation Envelope Programme (2003-2007): This second phase will allow the continuation of the existing Earth Explorer mission-generation mechanism. Additional activity lines will enhance the overall efficiency and visibility of the Agency's EO activities. Despite the full political support of the ESA Delegations, subscription to this second phase at the Ministerial Council fell short of expectations, and actions will be taken in 2002 that will hopefully remedy this situation and maintain the plans endorsed by the EO scientific community.

Earth Explorers

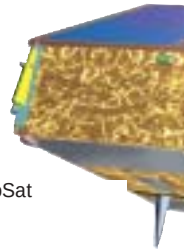
The Earth Explorer missions are research/demonstration missions intended to advance our understanding of the Earth's environment and to demonstrate new observing techniques. There are two complementary types of Earth Explorer mission:

- Core Missions - large research/demonstration missions led by ESA.
- Opportunity Missions - smaller research/demonstration missions not necessarily led by ESA.

Several missions have already been selected in both categories, based on a process of extensive interaction with the scientific community, assessment by the Earth Science Advisory Committee (ESAC), and further endorsement by the Programme Board for Earth Observation.



GOCE



CryoSat

ADM

The first four Earth Explorer mission spacecraft concepts

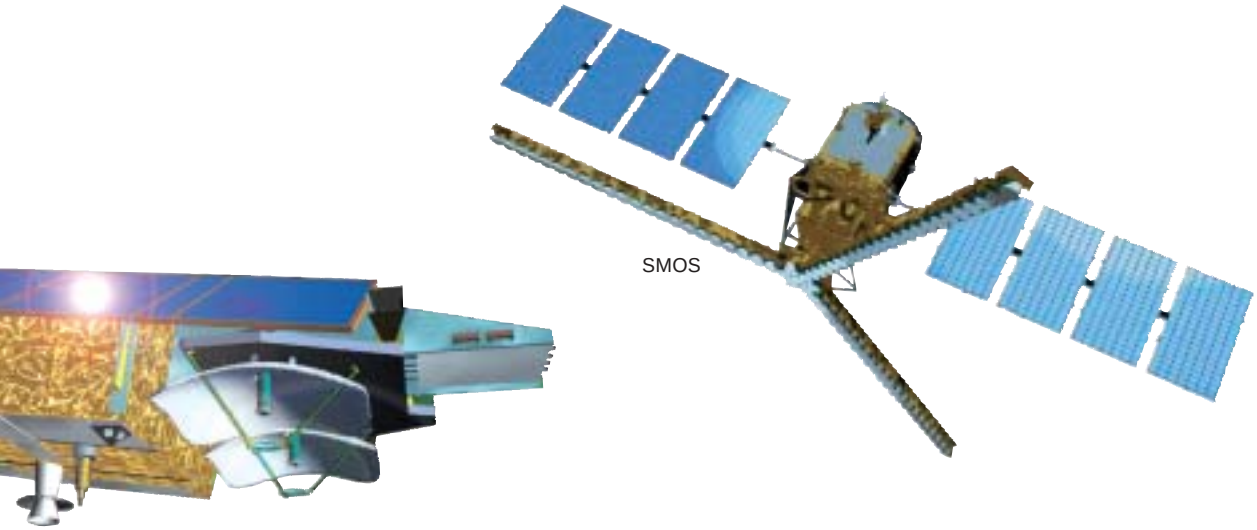
The first four Earth Explorer missions - the Core missions GOCE and ADM, and the Opportunity missions CryoSat and SMOS - are currently under implementation.

Core Missions

GOCE (Gravity Field and Steady-State Ocean Circulation) addresses the needs of the solid Earth physics, geodetic and oceanographic communities by providing unique models of the Earth's gravity field and of the derived geoid with unprecedented accuracy and resolution, using a three-axis gradiometer. This will help to advance knowledge of the Earth's interior structure and provide an essential reference for oceanographic and climate studies. Phase-B of the project was kicked-off at the end of 2000 and the main challenge in 2001 was the building-up of the industrial consortium through a competitive selection process of the subcontractors responsible for the various satellite equipment items. The contract for the GOCE space segment covering Phases-B/C/D/E1 was signed with Alenia Spazio in Turin in November. The Preliminary Design Review is planned for the first quarter of 2002, marking the completion of Phase-B. GOCE is scheduled for launch at the end of 2005.

ADM (Atmospheric Dynamics Mission) will provide, with the aid of a Doppler wind lidar, direct observations on a global scale of atmospheric wind profiles over the full depth of the atmosphere, thereby filling a crucial gap in current observing systems. These data will increase our understanding of atmospheric processes for climate studies particularly in tropical regions, as well as improving the accuracy of the numerical models used in weather forecasting. Following selection of the preferred lidar design concept, instrument pre-development started in 2001 and is expected to last 2 years. The mission is scheduled for launch in 2007.

As part of the selection process for new Core Explorer missions, in 2000 ESA received ten proposals from the scientific community, five of which were selected for pre-Phase-A study. In October 2001 the results of these studies



were presented to the scientific community and the Earth Science Advisory Committee. Three missions were retained for study at Phase-A level:

- EarthCARE (Earth Clouds, Aerosol and Radiation Explorer): Instruments, including radar, lidar, imager, radiometer and spectrometer, will peer closely at the interaction between clouds, aerosol and radiation to better understand their impact on climate. EarthCARE is a joint ESA/NASDA mission.

- SPECTRA (Surface Processes and Ecosystem Changes Through Response Analysis): A high-performance imaging spectrometer and a thermal imager will study the relationship between vegetation and climate change, across the entire world's ecosystems.

- WALES (Water vapor and Lidar Experiment in Space): A differential absorption lidar (DIAL) will map atmospheric water-vapour concentrations. It will provide improved insights into the distribution of atmospheric water vapour and information on aerosols in the troposphere and lower stratosphere relevant to climate-change, atmospheric-modelling and chemistry studies, and numerical weather forecasting.

Opportunity Missions

CryoSat is being designed to measure variations in the thickness of the polar ice sheets and floating sea ice. Its data are to be used to study the mass balances of the Antarctic 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. Following the successful completion of the Phase-B, the implementation of the full CryoSat mission was approved and the project entered Phase-C/D, with development activities being conducted in parallel for the satellite and the ground segment. The mission is scheduled for launch in 2004.

SMOS (Soil Moisture and Ocean Salinity) is intended to demonstrate the observation of two key variables of the Earth system, namely soil moisture over land and salinity over oceans, to advance the development of climatological, meteorological and hydrological models. In addition, the mission should provide new insights into snow and ice structure, thereby helping to advance our understanding of the cryosphere. The status of scientific and technical definition was thoroughly assessed at the end of Phase-A in November and Phase-B is planned to start by mid-2002. The mission is scheduled for launch in 2006.

In addition, ACE (Atmospheric Climate Experiment), which would exploit the refraction of signals from GNSS satellites to provide temperature and humidity observations in the upper atmosphere, has been maintained as a 'hot spare' and is the subject of mission and system studies.

Following the results of the NASDA selection, the SWIFT instrument is being studied for a potential flight on their GCOM-A1 mission (2007/8). SWIFT will employ a Doppler interferometer for the simultaneous observation of wind and ozone-concentration profiles in the stratosphere.

The second call for Opportunity Mission proposals was issued in June and by year's end 25 proposals had been received, covering all fields of Earth science. A few selected for feasibility study in 2002.

Further information on the Earth Explorer missions and programmes can be found on the Earth Explorer web site at http://www.esa.int/export/esaLP/.

Earth Watch Missions

Earth Watch preparatory studies continued in 2001. For the first cycle of the Earth Watch Programme, three selected elements were endorsed at the ESA Ministerial Council in November:

- GMES Services: This element is intended to ensure a sustained European supply of EO-based information products and services derived from current and future EO missions, in line with the goals of the European Commission/ESA GMES initiative. This will be achieved by supporting the operational provision of these EO-based services, focusing initially on services derived from current missions.

- InfoTerra/Terrasar (consolidation phase): This initiative is aimed at serving institutional and commercial user requirements for geo-information services, based on the exploitation of the Terrasar system, which includes satellites flying both L-band and X-band SAR instruments. The consolidation phase will complete the system studies prior to entering the implementation phase. Pre-development activities started at the end of 2001 will provide a demonstrator for the L-band SAR.

- Fuegosat (consolidation phase): This is a demonstration mission for the Fuego constellation, aimed at providing early warning and monitoring of forest fires in the Mediterranean areas and at similar latitudes in the rest of the world.

In addition to the above, operational meteorological missions, post-MSG and post-EPS/MetOp, have been discussed with Eumetsat within the well-established cooperation framework. An operational oceanography mission (Ocean Watch), including altimetry and imagery for ocean colour and sea-surface temperature, is under definition, with the Phase-A to start in 2002. Other possible future Earth Watch elements are also being analysed, such as advanced multispectral imaging and atmospheric composition monitoring.