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Committee on the Peaceful Uses of Outer Space

International cooperation in the peaceful uses of outer space: activities of Member States

Note by the Secretariat

Addendum

Contents

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II. Replies received from Member States

Austria

[Original: English]

1. In 2003, Austria continued its space-related activities within the framework of the programmes of the European Space Agency (ESA), the Austrian space applications programme and the Austrian Radionavigation Technology and Integrated Satellite Navigation Services and Products Testbed Programme. Several of the space application projects being implemented in these programmes respond to the recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III).

2. Bilateral and international cooperation in space activities continued with other national space agencies in the fields of space sciences, space applications and the development of related technologies and discussions with prospective space cooperation partners were held throughout 2003. It is expected that some of these discussions will lead to formal cooperation agreements in 2004.

3. With regard to space education, the Austrian Space Agency organized the twenty-seventh Alpbach summer school on the theme of working and living in space: from the International Space Station to the Moon and Mars; the summer school was held in Alpbach, Austria, from 15 to 24 July 2003. The annual summer school is organized in cooperation with the Federal Ministry of Transport, Innovation and Technology of Austria, ESA and the national space authorities of the member States of ESA.

4. Following the decision taken in December 2002 by the member States of ESA to establish in Austria the European Space Policy Institute, documents on the establishment of the Institute were signed in Vienna by ESA officials and representatives of the host country on 26 November 2003. The Institute is expected to start operating in 2004.

5. Within the framework of its cooperation with the United Nations Programme on Space Applications, Austria supported the United Nations/Austria/European Space Agency Symposium on Space Applications for Sustainable Development: Supporting the Plan of Implementation of the World Summit on Sustainable Development, which was held in Graz, Austria, from 8 to 11 September 2003. Austria will continue to support the activities of the Programme in 2004.

6. Detailed information on Austrian space activities is available from the web site of the Austrian Space Agency (www.asaspace.at).

France

[Original: French]

1. Earth observation

(a) Satellite pour l'observation de la Terre (SPOT-5) (Earth observation satellite)

1. The operational use of the Earth observation satellite SPOT-5 is continuing successfully. The satellite has already produced stereoscopic data on more than 30 million square kilometres (km^2). SPOT-5 has a high-resolution geometry instrument and a new stereoscopic imaging system (a high-resolution stereoscopic instrument) that enables modelling of the target terrain in three dimensions.

2. An improvement in resolution to 5 and 2.5 metres (m), together with the capacity to generate data in scenes 60 x 60 km or 60 x 120 km, has enabled Spot Image, the company responsible for operation of the SPOT satellites, to meet new requirements in the field of Earth observation. The balance between high resolution (2.5 m) and wide-area coverage is a major asset for applications such as medium-scale land mapping (1:25,000) and local urban and peri-urban planning (1:10,000) and the management of major hazards.

3. The second major advantage of SPOT-5 is the unparalleled capacity of its high-resolution stereoscopic instrument, which covers a wide swathe of territory in a single pass. The stereoscopic images are indispensable for all applications requiring a precise knowledge of relief, such as flight simulator databases or mobile telephony networks.

4. Like its predecessor on board SPOT-4, the Vegetation-2 instrument on board SPOT-5 enables environmental observation to be conducted on a continental scale.

5. The launch of the international SPOT-5 validation programme has been agreed with Spot Image and documents to that effect have been signed. The programme will enable eight selected foreign organizations to demonstrate to the international community the full benefit of the high resolution of SPOT-5, together with its large coverage. The UNOSAT project, which is being implemented by the United Nations Office for Project Services on behalf of the United Nations Institute for Training and Research and developed in partnership with the Government of France and ESA, has been selected for a mapping project on landslide risks in Nicaragua.

6. A programme of scientific evaluation of the high-resolution stereoscopic instrument, for which 28 experiments on nine test zones around the world were selected, is currently being carried out. The images from the instrument and reference data provided by the main researchers have been distributed to all the researchers, who will evaluate the quality and accuracy of the digital elevation models obtained from the high-resolution stereoscopic instrument. The results will be presented at the Congress of the International Society for Photogrammetry and Remote Sensing to be held in Istanbul, Turkey, from 12 to 23 July 2004.

(b) Pléiades minisatellites

7. The Optical and Radar Federated Earth Observation (ORFEO) system of France and Italy will consist of Pléiades high-resolution optical minisatellites and four Constellation of Small Satellites for Mediterranean Basin Observation

(COSMO Skymed) radar satellites. The Centre national d'études spatiales (CNES) recently signed a contract for the development of the French part of Pléiades with the European Aeronautic Defence and Space Company (EADS) Astrium, the prime contractor for the production of the platforms; Alcatel Space will produce the high-resolution instruments. The satellites will ensure the continuity of SPOT service in panchromatic and broad multispectral imaging. Their resolution will be 70 centimetres (cm) for a swathe of 20 km. Their tilting capacity allows them to take several images in succession along the track or outside the track. Their memory has been increased to 600 gigabits (Gb) and onward transmission to the ground has been increased to 450 megabits per second (Mbps).

(c) Optimizing Access to SPOT Infrastructure for Science

8. The Optimizing Access to SPOT Infrastructure for Science (OASIS) programme will enable the European scientific community to access SPOT data for a nominal fee, thanks to an agreement concluded between CNES and Spot Image on funding from the European Union under the Sixth Framework Programme for Research and Technological Development of the European Union. The German Aerospace Center (DLR) and the Italian Space Agency (ASI) are involved in this programme.

(d) Infrared atmospheric sounding interferometer

9. The infrared atmospheric sounding interferometer (IASI) instrument will be used in the Meteorological Operational polar (Metop) satellites of the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT). Its advanced technology will permit the measurement of temperature and humidity with a vertical resolution of 1 km and an accuracy of 1 kelvin and 10 per cent humidity. The first flight model was delivered in July 2003. The qualification review of IASI began in November 2003.

2. Scientific Earth observation missions

(a) Jason-1 and Jason-2 minisatellites

10. The Jason-1 minisatellite, a product of cooperation between France and the United States of America, is functioning nominally and is delivering its products routinely.

11. The aim of the Jason-2 mission is to ensure the continuity of the ocean altimetry measurements (climate forecasting and sea state) currently taken by Jason-1, which was launched in December 2001, and the ocean Topography Experiment/Positioning Ocean Solid Earth Ice Dynamics Orbital Navigator (TOPEX/POSEIDON), which was launched in 1992.

12. The mission is a cooperative venture involving the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA), both of the United States, EUMETSAT and CNES.

13. At the European level, the memorandum of understanding between CNES and EUMETSAT was unanimously approved by the EUMETSAT Council in November 2003.

14. The four partners have continued their negotiations on an international agreement, the negotiation of a quadripartite memorandum of understanding will continue in 2004 and the launch of Jason-2 is planned for late 2007.

(b) Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations

15. Current uncertainties about the radiative impact of clouds and aerosols limit understanding of the climate system and the forecasting of global changes. The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) mission will provide a set of unique data about vertical profiles of the atmosphere measured by the first satellite-borne backscatter lidar.

16. CALIPSO is to fly in formation with two other United States satellite missions, Aqua and CloudSat, and with the French Polarization and Anisotrophy of Reflectances for Atmospheric Sciences, coupled with Observations from a Lidar (PARASOL) microsatellite, which together will make up an exceptional space observatory, the "A-Train", which is placed in a Sun-synchronous orbit at an altitude of 705 km and combines all active and passive measurement techniques.

17. The project continued in 2003 with assembly of the payload at Ball Aerospace and Technologies Corporation of Boulder, Colorado, United States, and the first atmospheric tests of the lidar were conducted successfully. The platform has also been assembled; the operations were carried out in Cannes, France.

18. At a bilateral meeting held at CNES headquarters on 18 June 2003, a memorandum of understanding relating to the CALIPSO mission was signed between the two national space agencies CNES and NASA.

19. The nominal launch date is set for February 2005; a United States Delta II launcher will be used.

(c) PARASOL

20. The PARASOL mission will complement the CALIPSO mission of France and the United States. The payload, a Polarization and Directionality of the Earth's Reflectances (POLDER) instrument, will be carried on a microsatellite from the Myriade series.

21. Uncertainties about the radiative impact of clouds and aerosols are currently one of the main factors limiting understanding of the climate system and the forecasting of possible changes. The Aqua, CALIPSO, CloudSat and PARASOL missions, in formation, will together form an exceptional space observatory that combines all the active and passive measurement techniques currently available.

22. The design review for the mission was conducted in June 2003 and the launch should take place in late 2004.

(d) Megha-Tropiques minisatellite

23. The development costs of the Megha-Tropiques project, which was developed by France and India, are currently being revised. The two countries are looking together at several options that would allow them to complete the project, which focuses on studying the water cycle and heat exchanges in the intertropical region and will help forecast cyclones.

(e) Detection of Electromagnetic Emissions Transmitted from Earthquake Regions

24. The Detection of Electromagnetic Emissions Transmitted from Earthquake Regions (DEMETER) satellite is designed for the study of electromagnetic phenomena associated with natural geophysical phenomena such as earthquakes, volcanic eruptions and tsunamis and for the analysis of disturbances in the electromagnetic environment of Earth that are linked to human activity. The DEMETER mission is exploratory in nature and aims primarily to detect electromagnetic signals associated with seismic activity, but also to determine accurately the conditions for observing them, their characteristics, such as the frequency spectrum, and propagation conditions. DEMETER is the first mission in the Myriade microsatellite series developed by CNES. The satellite is currently in the phase of integration and testing. Launch is planned for mid-2004 on a Russian Federation Dniepr launcher, which will place the satellite in a Sun-synchronous polar orbit at an altitude of approximately 700 km. It has a planned lifetime of two years. The mission is the result of close cooperation between CNES, the prime contractor for the satellite, the scientific community, which is responsible for the scientific payload, and the manufacturers involved in the development of the satellite.

(f) Soil Moisture and Ocean Salinity

25. The Soil Moisture and Ocean Salinity minisatellite in the series known as Plate-forme reconfigurable pour l'observation, les télécommunications et les usages scientifiques (PROTEUS) (reconfigurable platform for observation, telecommunications and scientific uses) will observe land-surface moisture and ocean salinity on a global scale. The mission will observe continental surfaces (surface moisture), the oceans (surface salinity) and high latitudes (cryosphere). It will make it possible to improve climatological and meteorological models and forecasting and to forecast extreme events such as floods and drought and plan water resource management.

26. The payload is a radiometer that uses an innovative interferometric technique and features a multiangular and dual polarization observational capability. It is being developed under the auspices of ESA by the prime contractor, EADS-CASA Espacio in Madrid. PROTEUS is a series of minisatellites of 300-500 kg developed under a partnership between CNES and Alcatel Space and produced by the latter.

3. Science and observation of the universe

(a) Microsatellite for observation of the principle of equivalence (MICROSCOPE)

27. The main scientific objective of the MICROSCOPE microsatellite mission is to test the principle of equivalence to an accuracy 100 times greater than that obtained in experiments carried out on Earth. The secondary objectives are the construction of a continuous drag-free and attitude-control system using electric propulsion units and the measurement of the accelerations on board the satellite to an accuracy greater than 10^{-12} milliseconds $(ms)^{-2}$. The two secondary objectives are a vital prerequisite for measuring the principle of equivalence. MICROSCOPE will be a microsatellite in the CNES Myriade series equipped with field emission electric propulsion units and two differential accelerometers.

(b) Atomic Clock Ensemble in Space (ACES)/Projet d'horloge atomique à refroidissement d'atomes en orbite (PHARAO) (Project for an atomic clock based on laser cooling of atoms in orbit)

28. The ESA Atomic Clock Ensemble in Space (ACES) is designed to be installed on an external platform of the Columbus science module of the International Space Station. The aim of the project is to demonstrate the great potential of a new generation of atomic clocks in space. The objectives are both technological (demonstration of a caesium atomic clock) and scientific.

(c) Convection, rotation and planetary transits

29. The convection, rotation and planetary transits (COROT) mission is a very-high-precision stellar photometry mission whose scientific objectives are to study stellar interiors through the analysis of stellar oscillation modes and measurement of their frequency, amplitude and lifetime by observing variations in luminous flux. COROT is also used to search for exoplanets, in particular telluric planets, through occultation or transits. The instrument on board is a white-light photometer that uses a reflector telescope outside the pupil reduction axis, a dioptric imaging objective and large defocused charge-coupled device detectors. PROTEUS ensures pointing accuracy in the focal plane, a few arc seconds, using angle-error measurement information from the instrument. The accuracy for asteroseismology, a frequency of 0.1 microhertz, requires a period of observation of 150 days on each star field selected. The orbit is inertial (i = 90 degrees) and circular at an altitude of 850 km.

30. Scheduled for launch in mid-2006, COROT will be a minisatellite in the PROTEUS series, after Jason and CALIPSO.

(d) European Space Agency Planck Surveyor mission

31. The Planck Surveyor mission is an astronomy mission involving the close study of the anisotropies of cosmic background radiation. It will provide key information on most fields of cosmology and astrophysics, making it possible to test models of the evolution of the early universe and the origin of cosmic structures. Two focal-plane instruments will be on board: a millimetre-channel heterodyne detector (low-frequency instrument), made by an Italian prime contractor and a submillimetre-channel instrument (high-frequency instrument) using bolometers cooled to 0.1 kelvin, developed by a French prime contractor.

(e) European Space Agency Herschel mission

32. Herschel will also provide different basic information about the formation of galaxies when the universe began to be formed, the physical chemistry of the interstellar medium and of the atmosphere of comets and planets, and the detection of planetary systems outside our solar system, objectives that are covered as a priority in the infrared and submillimetre domain.

33. Planck Surveyor and Herschel are ESA missions and will be launched together in 2007.

4. Space transport

(a) Ariane

34. The last launch of the Ariane-4 rocket, version A44L, took place on 15 February 2003 and placed the International Telecommunications Satellite Organization INTELSAT 907 satellite in orbit. Three launches carried out by the generic version of Ariane-5 placed in orbit the Indian National Satellite System INSAT-3A, Galaxy-XII, Optus and Defence C1, BSat-2C, INSAT-3E, *e-BIRD* and the Small Missions for Advanced Research in Technology 1 (SMART-1) satellites.

35. A recovery and consolidation plan for the Ariane-5 series has been under way since early 2003 to deal with the difficulties encountered by the launcher in December 2002. In particular, modifications have been made to the nozzle of the first-stage Vulcain 2 engine. The Ariane-5 Evolution development plan is currently being completed; it will make it possible to improve the performance of the launcher and to adapt it to evolving market demands. These changes relate to the thrust of the Vulcain engine, the addition of welded cylindrical sections to the solid booster stages, and the development of the Sylda 5 structure, the upper stage and the equipment bay. A qualification programme for the Ariane-5 ECA version (based on a Vulcain 2 engine and a reignitable storable-propellant stage) will be carried out for the first launch of the automated transfer vehicle to the International Space Station.

(b) Franco-Russian Federation cooperation on establishing the Russian Federation Soyuz launcher in French Guiana

36. France and Europe play an active role in cooperation on launchers. The resolution adopted by the Council of ESA in Montreal on 12 June 2002 and, more recently, the resolution adopted by the Council in Paris on 27 May 2003 demonstrate European will and the potential scale of this cooperation. The most visible element of the French and European desire to enhance the partnership with the Russian Federation is the establishment of the Soyuz launcher in French Guiana, which will require a European investment of 314 million euros, of which France will provide about 50 per cent.

37. The implementation of this decision made it necessary, in particular, for an agreement to be concluded between France and the Russian Federation to establish provisions on liability matters and, in particular, on security, safeguards, registration, certification and supervisory authorities. The intergovernmental agreement between France and the Russian Federation was signed by the prime ministers of those countries in Paris on 7 November 2003.

38. At the same time, an agreement is being negotiated between the Russian Aviation and Space Agency (Rosaviakosmos), Arianespace and Starsem on conditions for the establishment and commercial exploitation of Soyuz in French Guiana.

39. On the technical front, the preliminary design review of the Soyuz launch system in French Guiana, organized by CNES, Arianespace and Starsem, took place at ESA headquarters in Paris from 15 to 17 July 2003. The general progress of the project is satisfactory and the major options for establishing the launcher in French Guiana have been validated.

5. Radiocommunications

(a) European satellite navigation system

40. The member States of the European Union and ESA have agreed on funding conditions that have enabled the development and validation phase of the Galileo Satellite Navigation System programme to begin. During this phase, an experimental satellite known as the Galileo System Test Bed Version 2 (GSTB-V2) is due to be launched before June 2006. Thereafter, three satellites will be launched and the satellite navigation service will be validated in orbit.

41. In addition, the Galileo Joint Undertaking was founded in 2003, following decisions taken by the European Commission and the member States of ESA that are taking part in the ESA GalileoSat programme. The purpose of the Galileo Joint Undertaking is to supervise the development and validation phase of Galileo, the optimum integration of the European Geostationary Navigation Overlay Service (EGNOS), the European programme in the global navigation satellite system that supplements the Global Positioning System (GPS), the preparation of the subsequent GSTB-V2 experimental phases and the launches of the first three Galileo satellites and their in-orbit validation. The Galileo Joint Undertaking is focused on promoting value-added applications and services based on EGNOS and Galileo and on standardization and certification issues and downstream activities. It is also responsible for establishing the concessionaire that will operate the future Galileo constellation. For its part, in June 2003 ESA launched several industrial activities relating, for example, to the delivery of the GSTB-V2A and GSTB-V2B experimental satellites, for the development and validation phase of the study on the detailed design of the different segments of the Galileo system.

(b) Positioning and search and rescue

(i) Low-Earth Orbit Search and Rescue (LEOSAR) system

42. Four Search and Rescue Satellite-Aided Tracking (SARSAT) system instruments, in orbit on-board NOAA satellites, are operational. The integration in industry of three third-generation instruments (the SARSAT-3 project) is continuing for the Metop and NOAA satellite. The last two SARSAT-3 instruments are planned to be installed on the first two United States satellites in the National Polar-orbiting Operational Environmental Satellite System under the International Satellite System for Search and Rescue (COSPAS-SARSAT) agreement.

(ii) Geostationary Search and Rescue (GEOSAR) system

43. The European EUMETSAT Meteosat Second Generation 1 (MSG-1) satellite, equipped with a 406 megahertz (MHz) transponder, has been in operational use since late August 2003, thanks to round-the-clock reception at CNES. The results are highly satisfactory and a comprehensive review is scheduled for early 2004, with a view to declaring the system fully operational.

(iii) Medium Earth Orbit Search and Rescue (MEOSAR) system

44. In conjunction with the Galileo programme, the Search and Rescue/Galileo (SAR/Galileo) mission should enable improvements to be made to the existing LEOSAR and GEOSAR systems, in close coordination with their United States

counterpart, the SAR/GPS Distress Alerting Satellite System (DASS), and their Russian counterpart, the SAR/Global Navigation Satellite System (GLONASS).

(c) Precise positioning

(i) Doppler Orbitography and Radiopositioning Integrated by Satellite

45. The future Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) instruments for Jason-2 and Pléiades should come into operation in early 2004, with a view to meeting the schedule requirements for those projects. The supply of DORIS beacons to upgrade the ground network (project for third-generation beacons) is continuing on schedule, with delivery of 10 beacons having been made in late 2003 and the last 10 in February 2004.

(ii) AlphaBus

46. The AlphaBus programme is a new-generation, high-power, large-platform programme launched by CNES with industrial cooperation from Alcatel Space and EADS Astrium. It is aimed at developing innovative technologies in the field of satellite telecommunications for the benefit of industry and society. Work on designing the platform has progressed significantly in the past year. The two companies have agreed on sharing the technical responsibilities for the development of the platform's main functional chains.

6. Applications with benefits for society

(a) Global Monitoring for Environment and Security

47. Global Monitoring for Environment and Security (GMES) is an initiative of the European Commission and the major space agencies, including CNES and ESA. It has three objectives:

(a) To use ground and space data to establish services to provide environmental information to the public. Such services would be similar to those currently providing meteorological information;

(b) To establish information services to support action for the protection of people and property in the event of natural or man-made disasters;

(c) In the context of the Common Foreign and Security Policy of the European Union and the Petersberg tasks, to establish, in the long term, services to help European forces and organizations in humanitarian and peacekeeping interventions.

48. Three phases are planned. The initial phase was completed in late 2003 and consisted of identifying possible themes for the development of specific services. It concluded with a report by ESA and the European Commission to the ESA Council and the European Commission Research Council. The second phase, which will last until 2007, consists in setting up pilot demonstrations for some of these services in accordance with the priorities set by the European Commission. The third phase, which will begin in 2008, will focus on the actual establishment of GMES service centres according to themes, using funding not earmarked for research and development. The first services to be set up in 2008 will make use of existing ground and space infrastructure. The projects are funded by ESA or the European

Union. The following areas have been identified as priorities: ocean and coastal zone management; land use and monitoring of plant resources; and natural disasters. ESA has selected about 10 projects to fund and the European Commission has selected about 20; others will follow.

(b) Réseau Terre et Espace (Earth/Space Network)

49. The Réseau Terre et Espace (Earth/Space Network) is a French initiative that, through various projects, will provide some answers to the problems posed by GMES. The Network, under the aegis of the Ministry of Research and New Technologies of France, is designed to develop new services, through cooperation between industry and scientists, using, inter alia, data from space and space-based telecommunications and positioning facilities for natural and industrial risk management, precision agriculture and natural resource management (particularly water and forests), but also in emerging fields such as space-based epidemiology. The following projects have been established and are in development:

(a) *Cyclopes*. This project relates to the development of products from medium spatial resolution sensors and applications, and forms part of the Geoland initiative to create a thematic focus for land surfaces. It aims to develop biophysical products such as the leaf area index and the fraction of absorbed photosynthetically active radiation through the synergy between medium spatial resolution sensors such as the NOAA advanced very high resolution radiometer (AVHRR), SPOT-Vegetation, the Medium Resolution Imaging Spectrometer (MERIS)/Environmental Satellite (ENVISAT) and POLDER/Advanced Earth Observation Satellite (ADEOS). The products will be validated using a network of sites distributed around the globe. Two applications of the products are envisaged. They use the leaf area index fields produced to estimate carbon flux by model forcing and improvement of a land surface scheme;

(b) *Aide à la gestion intégrée des littoraux* (*AGIL*) (*Integrated coastal zone management aid*). This project is designed to establish a global, operational French capability in integrated coastal zone management, built around a multidisciplinary team with expertise in innovative methodologies and environmental information systems applied to the coast. The service, aimed at decision makers and managers, will be based on a network of skills relating to coastal matters and a technical platform that uses Earth observation data and information and communications science and technology;

(c) *Analyse multi-échelle et multi-temporelle en imagerie spatiale appliquée aux missions de gestion et de contrôle des forêts* (*METIS-Forêts*) (*Multi-scale and multi-temporal analysis in space imaging applied to forest management and control*). The main purpose of this project is to help improve forest monitoring and management using space techniques. Two major types of need are addressed:

(i) Priority national needs;

(ii) International protocols, in particular the Kyoto Protocol to the United Nations Framework Convention on Climate Change (FCCC/CP/1997/7/Add.1, decision 1/CP.3, annex);

(d) *Réseau souterrain d'observation unissant la ressource et les caractéristiques de l'eau* (*RESSOURCE*) (*Underground observation network linking the potential and characteristics of water*). This project should demonstrate how space telecommunications contribute to the collection of data on underground water resources. It is in line with the optimization of monitoring networks and with preparations in France to meet the quality- and quantity-monitoring requirements set out in the European Union Water Framework Directive;

(e) *Démonstrateur EGNOS de localisation du trafic aéroportuaire* (*DELTA*) (*EGNOS demonstrator for airport traffic positioning*). This is designed to demonstrate the use of EGNOS for airport vehicle management The DELTA project has made it possible to prototype a complete chain comprising the navigators on board, the wireless communication network and the processing centre, including the visualization of mobile objects moving around airport areas;

(f) *Conseil à l'irriguant par télédétection, radar et modélisation* (*CITRAM*) (*Advice for irrigators through remote sensing, radar and modelling*). Using information from the MSG meteorological satellite and the HYDRIX hydrometeorological radar, the general objective of the project is to make a service available via the Internet allowing end-users (agricultural technicians, farmers, and so forth) to monitor the precise water content of their land at half-daily intervals and to integrate information from their own land (soil type, crop stage, and so forth) and from weather forecasts in order to manage their crop irrigation more effectively;

(g) *Service d'analyse directe par l'agriculteur d'images satellites par Internet* (*SADAISI*) (*Service for direct analysis by farmers of satellite images via the Internet*). The general objective of the project is to make a service available via the Internet allowing end-users to access recent satellite images of their land and also tools for analysing these images using their own expertise in combination with other data;

(h) *Système de suivi de la canne à sucre par télédétection* (*SUCRETTE*) (*System for monitoring sugar cane through remote sensing*);

(i) *Transport espace et société* (*TESS*) (*Transport Space and Society*). The aim of this project is to develop a demonstration platform for innovative services that use satellite communication and positioning systems. This covers improvements in the safety of people and materials, dissemination of multimedia information and optimum management of traffic news services. The system will be validated while in operation in two sectors that are being used for demonstration purposes: public transport and road transport. Several vehicles and a central office will operate in each of these sectors;

(j) *TOPOPHYLLE*. This project is designed to update and validate a set of methods for relief reconstruction, giving digital elevation models of different levels of precision and using, in combination, techniques already available from the partners in the project, such as radar and laser. Experiments in a pilot area in French Guiana will make it possible to develop products throughout the territory, consolidate French production for export and obtain a laser/radar combination algorithm that distinguishes French exports;

(k) *Ultraviolet Forecasting Operational Service* (*UFOS*). This is a service for ultraviolet index forecasts and information. The project brings together specialists in radiative transfer, instruments for taking measurements on the ground and in space and modelling of atmospheric phenomena in order to make routine use of the measurements of stratospheric ozone distribution, cloud cover and the aerosol content of the atmosphere carried out by ENVISAT instruments MERIS and Global Ozone Monitoring by Occultation of Stars (GOMOS) to calculate the reduction in solar ultraviolet radiation reaching the ground;

(l) *Aide à la planification de l'occupation des terres à l'échelle régionale* (*APOGE*) (*Aid for land cover planning at the regional level*). This project involves developing a decision-making tool for planning land cover in rural areas, including diagnosis and scenarios for water and carbon;

(m) *Système de mesures précises de positionnement sous l'eau* (*GEODESEA*) (*System of precise measurements of underwater positioning*). GEODESEA is designed to develop a system of precise measurements of underwater positioning. The project aims to achieve accuracy to within a few centimetres over an average range of about 5 km, possibly with several buoys to cover the distance, depending on the topography of the sea floor. These measurements are linked with surface accuracy, via GPS, to markers on land or platforms at sea, or both. The project also opens up prospects for services for the future Galileo system relating to the transfer of satellite positioning to the underwater domain;

(n) *GEWED*. A web site with educational resources on geographic information and geographic information systems (GIS) for teachers, trainers and students. Its purposes are:

(i) The provision of multimedia educational geographic information resources to meet teaching and (self-)training needs;

(ii) The easy identification of georeferenced data resources using the concept and architecture of the Geography Network of the Environmental Systems Research Institute in the United States (www.geographynetwork.com);

(iii) The provision of access to downloadable georeferenced data (including satellite images) on preferential terms reserved for educational uses;

(iv) The provision of information about training in geomatics in the French language; and

(v) The organization of special forums and exchanges of experiences among teachers, trainers and students in the fields of geographic information, GIS, remote sensing, automatic mapping, and so forth;

(o) *Satellite-based location and data collection system for space surveillance of epidemics in West Africa* (*S2E Argos*). The aim is to set up an electronic network for epidemiological alerts by satellite, to specify and deploy an electronic system of epidemiological surveillance and early warning for priority diseases (meningitis, malaria, bloody diarrhoea) and environmental data, to study the links between environment and health in the sub-Sahelian zone and, lastly, to validate the concept;

(p) *Service multimédia de maintenance et d'assistance chirurgicale* (*SMMAC*) (*Multimedia surgical maintenance and assistance service*). The objectives of this project are to design and set up a web services platform for collaboration between expert and non-expert or trainee surgeons to provide remote technical or surgical assistance, or both. The ultimate objective is to market the service if it can be implemented and its value demonstrated on acceptable operational and economic terms;

(q) *Serveur d'applications et de formation évolutif et thématique d'images spatiales et aériennes* (*SAFE-TIMES*) (*Evolving thematic server for applications and training with space and aerial images*). The objectives of this project are to promote the use of space and aerial remote sensing for small and medium-sized enterprises and industries and inter-municipal associations by improving knowledge of its potential; to assist each user in the selection, processing and integration of space and aerial images; and to reduce the cost of carrying out remote sensing projects;

(r) *Suivi hydrologique et environnemental pour l'Amérique centrale* (*SHERPA*) (*Hydrological and environmental monitoring for Central America*). The proposed action is designed to develop, using the Coordination of Information on the Environment (CORINE) land-cover database, applications that meet specific needs and to demonstrate their practical use. This demonstration will take place on a pilot site: the Río Lempa watershed;

(s) *Service d'aide à la gestion des ressources halieutiques* (*SEAGERH*) (*Fish resource management aid service*). This project aims: to combine the skills and experience of the Research Institute for Development and Collecte Localisation Satellites in order to develop a comprehensive and competitive range of French space oceanography products for the fish market; and to offer a version of these products that meets the needs of fish resource management organizations, which constitute a new market; and

(t) *Réseau de suivi de subsidence urbaine et minière* (*RESUM*) (*Urban and mine subsidence monitoring network*). The aim of the RESUM project is to develop innovative ways of measuring soil deformation phenomena, such as mine subsidence, the impact of natural cavities and underground works, using a satellite observation technique: radar interferometry.

India

[Original: English]

1. The Indian Space Research Organization (ISRO) falls under the auspices of the Department of Space of the Government of India.

2. ISRO implements the space programme through:

(a) Research on and the development of space science and technologies;

(b) The design, manufacture, launch and operationalization of remote sensing and communication satellites;

(c) The design, manufacture and launching of satellite launch vehicles; and

(d) The conception and implementation of various applications for national development using space-based data and information.

3. India has been at the forefront of all the activities of the Committee on the Peaceful Uses of Outer Space, and actively contributed to the organization of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III). The representative of India served as President of the Conference.

4. The institutional mechanisms in place in India to implement the recommendations of UNISPACE III as described below. It may be noted that, in many areas, ISRO carried out many activities related to most of the recommendations of UNISPACE III, and therefore only the major initiatives are described in the present document.

1. Protecting the Earth's environment and managing its resources

5. The National Natural Resource Management System of India is administered by the Department of Space as the head agency. User agencies actively participate in the System, which periodically monitors and assesses natural resources and the environment. Ten standing committees on various thematic areas are chaired by secretaries of the respective government departments and guide the activities of the System.

6. The use of satellite remote sensing data for sustainable development is one of the most important areas of application for India. Land and water resources, the study of oceans and biodiversity and the monitoring of agriculture are all covered under this area of application. As it has a wide experience of this field, India has been chosen as the Chairman of the Action Team on the Management of Natural Resources, which was established by the Committee on the Peaceful Uses of Outer Space.

7. Meteorological observation of the Indian Ocean region is regularly carried out by ISRO using geostationary satellites. Those data and information are used at the national level by the Indian Meteorological Department for weather monitoring and prediction. India shares these data on the Indian Ocean region with the World Meteorological Organization.

2. Using Space Applications for Human Security, Development and Welfare

8. Space-based telemedicine projects are implemented by ISRO to connect rural hospitals with specialized hospitals in cities. A large number of telemedicine connections already exist. The telemedicine programme is centrally planned and executed from ISRO headquarters.

9. India utilizes space-based data and information for disaster management activities extensively. A Disaster Management Support programme at ISRO headquarters coordinates these activities. ISRO has become a signatory to the Charter on Cooperation to Achieve the Coordinated Use of Space Facilities in the Event of Natural or Technological Disasters (also known as the International Charter on Space and Major Disasters). Personnel at various ISRO centres were designated to assist in implementation of the Charter.

10. ISRO has, in the past, taken initiatives in literacy programmes and the enhancement of education in rural areas using satellite-related infrastructure. Recent major initiatives have included a 24-hour national satellite educational channel called Gyandarshan, which broadcasts curriculum-based programmes. Some of the states in India have also initiated satellite-based regional educational networks for the broadcast of programmes in the regional languages.

11. The Indian Institute of Remote Sensing of ISRO and the Department of Space provides expert training and capacity-building in the specialized area of remote sensing.

12. The Development and Educational Communication Unit of ISRO concentrates on and implements all the developmental educational programmes using communication satellites.

3. Advancing scientific knowledge of space and protecting the space environment

13. ISRO is an active member of the Inter-Agency Space Debris Coordination Committee (IADC). It has contributed to the development of the IADC space debris mitigation guidelines and also implements them.

4. Enhancing education and training opportunities and ensuring public awareness of space activities

14. The projects of ISRO are always oriented towards national development. The Indian space programme is application-oriented and its space applications are focused on national development.

15. Decision makers are part of the top-level policy formulation and review committees for the Indian space programme.

16. The headquarters of ISRO has a strong publications and public relations unit, which undertakes a number of programmes for public outreach, including space exhibitions and programmes to increase awareness of space activities among the general public.

5. Strengthening and repositioning of space activities in the United Nations system

17. To assist in the improvement of capacity-building processes in developing countries, ISRO undertakes a number of programmes under a scheme entitled “Sharing of Experience in Space” through which training in different applications of space technology is provided to scientists from developing countries. Under the scheme, selected candidates are reimbursed for their living expenses and given allowances by the Department of Space while the cost of international travel is borne by the sending country.

18. India hosts the Centre for Space Science and Technology Education in Asia and the Pacific, affiliated to the United Nations. The Centre was established in 1995 and is contributing significantly to capacity-building activities among developing countries. To date, more than 500 scholars from 29 countries have been trained. India spent approximately US $8 million building up the infrastructure for the Centre and provides about $500,000 as an annual grant to the Centre for the conduct of its activities.

6. Promoting international cooperation

19. India places great emphasis on working together with other countries and international bodies in promoting the development and use of space technology for different applications. ISRO implements this policy through bilateral agreements, participation in multilateral forums and participation in international professional organizations.

7. World Space Week

20. ISRO organizes World Space Week celebrations every year, in line with the recommendations of UNISPACE III.

Poland

[Original: English]

1. In 2003, Polish activities in space were conducted in the following fields: space physics, satellite geodesy, remote sensing and space technology. Activities on space education and on future perspectives are also reported below.

1. Space physics

(a) Space weather effects in the Earth's ionosphere

2. In the area of space physics in 2003, research activities in Poland continued on a wide range of issues, from the phenomena at the frontier of the solar system to the practical problems related to space weather effects in the Earth's ionosphere.

3. Among the most important results are the following: theoretically predicted magnetospheres of the outer planets (MoP) waves formed outside the heliopause in the process of the penetration of grains of interstellar dust into the heliosphere; discovery of the large-scale north-south asymmetry of the solar wind; study of the effects of the interstellar magnetic field on the termination shocks, heliopause and the bow shock under the condition of an aligned magnetohydrodynamic flow; analysis of the multifractal spectrum of the solar wind flow.

4. Solar physics studies were based on the results of the Polish experiment RESIK, aboard the CORONAS-F satellite. RESIK is a spectrometer of solar roentgen radiation in the range of 3.2 to 6.1 angstroms, developed in cooperation with the Naval Research Laboratory of the United States of America, Mullard Space Science Laboratory and Rutherford Appleton Laboratory of the United Kingdom of Great Britain and Northern Ireland and the Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation of the Russian Federation. Nearly one million spectra in the active solar regions and flares were registered. Preliminary analysis identified several unexpected elements such as potassium and chlorine. Broadband high-frequency emissions were used to characterize the global changes of the ionosphere under varying solar activity and man-made effects and the new methods were tested to forecast the total electron content in the ionosphere at discrete locations. The fine structure of the high-altitude polar cusp was studied from the tail probe of the INTERBALL satellite and from the Cluster satellites using waves and plasma measurements. It was also discovered from the POLRAD

radio-spectro-polarimeter on the INTERBALL-2 auroral probe that the dayside polar cusp and the low latitude boundary layer could be the source of auroral kilometric radiation as well as the auroral oval. The polarization characteristics of auroral kilometric radiation on the nightside compared to that on the dayside were also studied. The results of these experiments were published in 11 papers.

2. Planetological missions

5. In the area of planetology, the resonant dynamical evolution of small body orbits among the giant planets was evaluated. Tidal heating and convection in the medium-sized icy satellites were also studied.

6. Polish scientists participated in the following planetary missions, providing hardware and scientific interpretation of the obtained data:

(a) The Cassini mission of the European Space Agency (ESA) and the National Aeronautics and Space Administration of the United States, launched in October 1997: the thermal property metre sensor, built in Poland, which is part of a British surface science package experiment, has been installed on the lander of the Huygens mission to Titan, one of Saturn's moons, to measure temperature and thermal conductivity of gases and liquids in Titan's atmosphere and ocean;

(b) The ESA Mars Express mission for the study of the environment of Mars and Martian dust properties using the Planetary Fourier Spectrometer, which was built in cooperation with France, Germany, Italy and the Russian Federation. The instrument provides excellent spectra in the infrared range. The interpretation of the spectra is currently being undertaken;

(c) The ESA Rosetta project, a mission to the comet P/Wirtanen: Poland contributed to the Multi-Purpose Sensors for Surface and Subsurface Science (MUPUS) experiment in a MUPUS penetrator, which was intended to measure the density, temperature, thermal conductivity and mechanical properties of the cometary nucleus. The laboratory model has been constructed.

(a) Astrophysics

7. Polish astrophysicists are involved in the International Gamma-Ray Astrophysics Laboratory (INTEGRAL) project of ESA devoted to measuring deep space sources of X-rays and gamma-rays.

8. Polish scientists involved in the field of space physics published and submitted over 100 scientific papers in 2003.

(b) Hardware for future experiments

9. The further development of instrumentation for several future international space projects is continuing in Poland, mostly in the Space Research Centre of the Polish Academy of Sciences. Listed below are instruments to which Poland contributes:

(a) Venus Express project of ESA. The Planetary Fourier Spectrometer is being developed from the Martian instrument to study the atmosphere and surface of Venus;

(b) Herschel project of ESA. A study of the formation of the stars and planetary system, in particular the solar system, in the microwave range;

(c) DEMETER project of France. The objective of the project is to study electric phenomena in the ionosphere stimulated by earthquakes. Poland has contributed to the plasma wave experiment;

(d) Obstanovka project of the Russian Federation. The objective of the project is the study of the electromagnetic environment of the International Space Station;

(e) Compass project of the Russian Federation. The aim of the project is developing a radio spectrometer to study natural and artificial electromagnetic emissions in the ionosphere.

3. Satellite geodesy

10. The main activities of the Commission of Satellite Geodesy in 2003 were the following:

(a) Participation in the establishment of seven satellite permanent reference stations in the region of Silesia for geodetic surveying in the frame of the Active Geodetic Network (ASG-PL);

(b) Testing of the accuracy and reliability of geodetic positioning on Polish territory with the ASG-PL service;

(c) Development of the Ranging and Integrity Monitoring Station (RIMS) initial operational capability status of the European Geostationary Navigation Overlay Service (EGNOS) station in the Space Research Centre of the Polish Academy of Sciences in Warsaw;

(d) Conducting permanent satellite global positioning system (GPS) observations in three Polish stations working for the International GPS Geodynamic Service (IGS) and five Polish stations working for the European Reference Frame (EUREF) service;

(e) Studying the EGNOS System Test Bed (ESTB) European satellite navigation system during the development stage in the Central and Eastern European countries;

(f) Studying the accuracy, availability, reliability and continuity of GPS and EGNOS satellite dynamic positioning of cars, ships and aircraft;

(g) Participation in the Central Europe Regional Geodynamics Project (CERGOP) and in the Unification of Gravity Systems in Central and Eastern Europe (UNIGRACE) project;

(h) Continuing and upgrading satellite laser observations in the Astrogeodynamical Observatory in Borowiec of the Space Research Centre of the Polish Academy of Sciences;

(i) Continuing to study the parameters of the ionosphere at Lamkowko Observatory of the University of Warmia and Mazury in Olsztyn;

(j) Continuing Global Orbiting Navigation Satellite System (GLONASS) observations, time transfer and time comparison, data analysis and orbit

determination, modelling of the ionosphere and troposphere, satellite gradiometry, and so forth.

11. These activities were conducted mainly at the following research centres:

(a) The Department of Geodesy and Photogrammetry of the Agricultural University of Wroclaw;

(b) The Department of Mining, Surveying and Environmental Engineering of the Academy of Mining and Metallurgy in Krakow;

(c) The Department of Planetary Geodesy of the Space Research Centre of the Polish Academy of Sciences in Warsaw;

(d) The Faculty of Geodesy and Land Management of the University of Warmia and Mazury in Olsztyn;

(e) The Institute of Geodesy and Cartography in Warsaw;

(f) The Institute of Geodesy and Geodetic Astronomy, Warsaw University of Technology;

(g) The Naval University of Gdynia;

(h) Gdynia Maritime University;

(i) The Maritime University of Szczecin;

(j) The Polish Air Force Academy in Deblin.

4. Remote Sensing

12. The activities of the Department of Remote Sensing of the Institute of Geodesy and Cartography in Warsaw were concentrated on land applications of satellite data. In particular, special emphasis was placed on further development and the operational use of a remote sensing-based system for crop condition assessment and yield forecasting. Extensive studies on the application of multi-sensor data for analysis of soil moisture and vegetation conditions within wetland areas were also conducted. The main activities carried out in 2003 were the following:

(a) *Development of a crop condition assessment system for drought monitoring and yield forecasting. Modelling of crop-soil parameters from ENVISAT Advanced Synthetic Aperture Radar (ASAR) (various polarizations) and Medium-Resolution Imaging Spectrometer Instrument (MERIS) data*. The aim of the project is to obtain soil and vegetation parameters using a cloud-water model describing surface roughness and soil moisture. The project also involves modelling vegetation parameters such as leaf area index, biomass and vegetation using meteorological and satellite data and taking into account atmosphere heat fluxes. Maps of crops have been created on the basis of microwave images;

(b) *Developing methods for soil moisture assessment and classification of wetland areas on the basis of the synergic use of optical and microwave satellite data*. The project has been undertaken in cooperation with ESA project AO ID122. With this project, the method of soil moisture assessment for wetlands using information derived from microwave satellite data was invented. In parallel, the methodology of studying ecological changes within wetlands through the application of multi-source optical and microwave satellite data, was developed;

(c) *Developing a method of producing land-use maps on the basis of high-resolution satellite images*. Research on this project resulted in the development of a hybrid method of producing satellite-derived land-use and land-cover maps;

(d) *Methodology of studying the degradation of wetland ecosystems caused by peat fires, based on information derived from satellite data.* In this project, analyses were conducted on using different satellite data for detecting and monitoring wetland changes due to peat fires;

(e) *Multimedia Geoinformation for e-Communities in Rural Areas with Eco-Tourism*. The aim of this Information Society technologies project, conducted within the Fifth Framework Programme of the European Commission, is to develop an improved tourist information system for promoting the development of rural areas.

13. The activities of the Remote Sensing of the Environment Laboratory of the Faculty of Geography and Regional Studies of Warsaw University focused on the applications of satellite and aerial data. The projects aim to assess the potential of hyperspectral data in the analysis and monitoring of mountain environments, with special focus on the investigation of vegetation mapping and condition. The study is based on airborne hyperspectral imagery analysis, supported by a range of field remote sensing techniques and laboratory measurements within plant physiology. Current activities include the following:

(a) *Use of hyperspectral remote sensing for environment impact assessment and modelling in flood plains affected by mining wastes (in cooperation with the Geological Institute of Hungary, the International Institute for Geo-Information Science and Earth Observation of the Netherlands, the University of Debrecen in Hungary and the Joint Research Centre of the European Commission located in Ispra, Italy)*. The project aims to assess the potential of hyperspectral data in the analysis and monitoring of vegetation contaminated by heavy metals, with special focus on the investigation of vegetation mapping and condition. It also aims to study vegetation based on airborne hyperspectral imagery analysis, supported by a range of field remote sensing techniques and laboratory measurements;

(b) *Assessment of the suitability of the European Remote Sensing Satellites ERS-1 and ERS-2 repeat-pass interferometry for landslide studies in the West Carpathians*. The main goal of this study is to assess the possibility of charting and assessing the velocity of movement of the landslides in the Polish Carpathians using differential repeat-pass interferometry. The study area comprises the central part of the Lower Beskid Mountains and the neighbouring foothills of Pogórze Jasielskie, Obniżenie Gorlickie. The research work is carried out using data from the European remote sensing satellites ERS-1 and ERS-2 acquired during the summers of 1995 and 2003;

(c) *Assessment of the potential of hyperspectral data and techniques in mountain vegetation analysis*. The proposed study aims to assess the potential of hyperspectral data in the analysis and monitoring of mountain environments with special focus on the investigation of vegetation mapping and condition. The study of vegetation is based on airborne hyperspectral imagery analysis supported by a range of field remote sensing techniques and laboratory measurements within plant physiology. The study also integrates hyperspectral aerial imagery and satellite multispectral imagery (using geostatistics).

14. Research carried out in the Department of Photogrammetry and Remote Sensing Informatics of the University of Science and Technology in Krakow, Poland, in 2003 focused on three main areas:

(a) The integration of hyperspectral data;

(b) Monitoring of an open-cast mine environment by remote sensing; and

(c) Monitoring by satellite and close-range remote sensing for the detection of thermal anomalies over salt dome areas.

15. Space activity at the Institute of Meteorology and Water Management in Krakow related mainly to developing satellite data receiving and processing systems (focusing on meteorological satellites), their use in operational services for meteorology and hydrology and developing new methods of satellite product generation and data interpretation. The finalization of a project for the modernization of meteorological and hydrological services resulted in a completely new satellite infrastructure at the Institute. Certain research projects conducted during recent years reached the phase of operational implementation. One major activity of the Institute was close cooperation with the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) according to a Cooperating State Agreement signed in 1999. There is a Satellite Research Department at the Institute, which is responsible for reception, processing and distribution of satellite data to all users at the Institute.

16. Research activity in the satellite field focused mainly on the practical applications of new satellite sensors. It was divided into four main projects contributing to the group of projects of the Institute, entitled “Improvement of the operational systems of meteorological and hydrological forecasts for the reduction of the results of natural disasters and extraordinary hazards for people, the economy and the environment (including the use of satellite and radar information)”. The objectives of these projects are:

(a) To map precipitation using combined information from satellite data, mesoscale meteorological forecast models and synoptic and climatologic ground measurements (a geographic information system (GIS) approach);

(b) To improve systems of receiving, processing and distribution of meteorological satellite data;

(c) To improve methods of using satellite data for the early detection and monitoring of storms;

(d) To monitor total ozone amount by satellite.

17. In 2003, EUMETSAT helped to organize a training course on the practical applications of Meteosat Second Generation (MSG) satellite data in operational meteorological and hydrological forecasting, which was held at the Institute in Krakow from 12 to 15 November 2003. Thirty-five participants from 15 countries attended. The importance of this event has to be highlighted, in particular because MSG satellite data will become operational in 2004.

18. The initiative of Poland as a leading entity among the three States cooperating on the EUMETSAT Satellite Application Facility project to support operational hydrology and water management became a central focus of the activity of the

Institute after approval of the project by the EUMETSAT Council in December 2002. In 2003, a Working Group on a new Satellite Application Facility on Hydrology was created by EUMETSAT.

19. In 2003, the Satellite Research Department of the Institute was involved in various international projects and activities relating to satellite data use. Among the most important were the following:

(a) The International Precipitation Working Group created by the World Meteorological Organization and the Coordination Group for Meteorological Satellites;

(b) The International Television and Infrared Observation Satellite Operational Vertical Sounder Working Group;

(c) European Cooperation in the Field of Scientific and Technical Research Action 718 “Meteorological applications for agriculture”;

(d) European Cooperation in the Field of Scientific and Technical Research Action 719 “The use of geographic information systems in climatology and meteorology”. The Satellite Research Department of the Institute played an important role in this action by developing applications using satellite data and GIS;

(e) European Cooperation in the Field of Scientific and Technical Research Action 723 “Data exploitation and modelling for the upper troposphere and lower stratosphere” (started in 2003).

20. The Institute of Oceanology of the Polish Academy of Sciences is the leading government scientific institution on oceanography in Poland. Its research programme consists of a wide variety of oceanographic studies, with special attention focused on the study and modelling of physical, chemical and ecological processes in the Baltic Sea, as well as on research on climate changes. Remote sensing is an essential tool for this research and developing a methodology and techniques for remote sensing of water is one of the main goals achieved by the Institute. The Institute’s remote sensing activity is focused on the development and utility of ocean colour to estimate phytoplankton concentration, primary production and other ocean colour-related products in seawater. Access to ships and experience in marine optics allows the systematic validation of the remote sensing algorithms. The facilities of the Institute allow it to process satellite data from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) project, Moderate Optoelectrical Scanner (MOS), Moderate Resolution Imaging Spectroradiometer (MODIS) and other ocean colour sensors. Most of the data is processed with the use of the Institute’s own algorithms, which are more suited to local environmental conditions. The Institute is currently leading a national targeted project to develop a satellite method of monitoring the Baltic ecosystem.

21. The main topics investigated in 2003 by the Laboratory of Remote Sensing and Spatial Analysis of the Faculty of Biology, Geography and Oceanology at the University of Gdansk, using data from the advanced very high resolution radiometer (AVHRR), the SeaWiFS project and the meteorological satellite Meteosat were the following:

(a) Analysis of solar energy inflow and temperature distribution on the surface of the Baltic Sea based on satellite data, involving:

(i) A system of automatic registration and geometric correction of AVHRR data;

(ii) A procedure for the calculation of physical field parameters in areas temporarily unseen from satellite level;

(iii) Recognition of the possibility and accuracy of spectral irradiance calculation at sea level on the basis of satellite data using precise models of light transmission in the atmosphere such as the Moderate Spectral Resolution Atmospheric Transmittance Algorithm and Computer Model MODTRAN;

(iv) Investigations of the optical properties of atmospheric aerosols in the Baltic Sea area on the basis of Aerosol Robotic Network (AERONET) data;

(v) The review and verification of AVHRR sea surface temperature algorithms for the Baltic Sea area;

(b) The consequence of the phenomenon of coastal upwellings for biological productivity along the Polish coast of the Baltic Sea, involving:

(i) Surface water temperature during coastal upwelling along the Polish Baltic coast;

(ii) The influence of coastal upwelling on the concentration of chlorophyll-like pigments on surface water along the Polish coast of the Baltic Sea.

22. The TeraScan high-resolution picture transmission (HRPT)/SeaWiFS/weather facsimile (WEFAX) reception and processing system was mounted and gained a signal at the end of 2000. This acquisition system was developed and manufactured to receive and process the full range of data embedded within HRPT and SeaWiFS telemetry streams. The WEFAX telemetry involves the retransmission of data and is received in an analogue format.

23. The data obtained from HRPT and SeaWiFS sensors and Land Remote Sensing Satellite (Landsat) thematic mapper data are used in the following ways:

(a) For analysis of the South Baltic coastal circulation systems;

(b) For analysis of remote sensing of surface current;

(c) For the study of upwelling structure along the South Baltic coast;

(d) For multispectral investigations of land-cover changes;

(e) For Landsat thematic mapper multispectral data application for forest identification and mapping;

(f) For the study of changes in coastal ecosystems.

24. Data developed from the WIN-HRPT system from the meteorological satellites of the National Oceanic and Atmospheric Administration (NOAA) of the United States are used for scientific and educational purposes. The Laboratory of Remote Sensing and Spatial Analysis detected meteorological phenomena such as thunderstorms, atmospheric fronts, radiation fogs, foehns and various cloud systems. Special attention was paid to the Carpathians and Alps (one doctoral thesis). Some investigations concerning urban heat islands (two Master's degrees) and the normalized difference vegetation index (NDVI) were undertaken.

5. Space technology

25. Warsaw University of Technology and Surrey Satellite Technology of the United Kingdom are working on a project that may be co-financed by the European Community under the sixth Framework Programme. The aim of this project is to design and construct a small satellite for Earth observation and to establish a ground station in Poland. Satellite technology transfer is an integral part of the project. The satellite will be constructed at the premises of Surrey Satellite Technology by a joint team of engineers and scientists from Poland (Warsaw University of Technology and the Space Research Centre) and Surrey Satellite Technology and the ground station will be constructed in Poland by Polish engineers. The project is similar to others already completed by Algeria, Nigeria and Turkey.

26. A designed satellite will be placed in low-earth orbit (LEO) and will work as part of the Disaster Monitoring Constellation, which is an international system using small LEO satellites (7 or 8 satellites in one orbit) to observe the Earth, providing 32-metre multi-spectral imaging coverage anywhere in the world with a 24-hour revisit.

6. Activities in space education

27. In Poland, space research education is carried out at Warsaw University of Technology in three different faculties. In the Faculty of Geodesy and Cartography, advanced studies cover remote sensing and the evaluation of space-based pictures for geodesy, agriculture, urban planning, and so forth. The education programme of the Faculty also includes the theory of the motion of artificial satellites, the precise measurement of time and position and the measurement of variation of gravity. At the Faculty of Electronics and Information Technology, problems of satellite communications have been addressed as part of the teaching programme for several years.

28. A special programme of education in astronautics began 10 years ago at the Faculty of Power and Aeronautical Engineering. In this programme, detailed lectures on space research include lectures on the origin and evolution of the universe and the solar system, basic courses on space medicine, remote sensing, satellite telecommunications, GPS, space propulsion, the design of spacecraft, rockets and space-based instruments, and so forth. The level of education on astronautics will be officially raised this year by the Ministry of National Education and Sport of Poland and it will then be possible to include astronautics in the education programmes of all Polish universities that have sufficient staff to run an astronautics programme.

29. Besides this specialized space education, in most of the Polish universities that specialize in education, science and technology astronomy is included in physics and remote sensing and GPS technologies are included in geodesy. In many departments, satellite telecommunications is also taught. At Warsaw University, a course on space law is taught as well.

30. Students from the Faculty of Power and Aeronautical Engineering at Warsaw University of Technology participated five times in microgravity flights organized for students by ESA. They are also engaged in the student project Young Engineers' Satellite 2 (YES2) and plan to be active in other student activities organized by ESA. Students are also actively involved in promoting astronautics by coordinating with

the Polish Astronautical Society, as well as by participating in national and international conferences on the subject.

7. Future prospects

31. In 2003, the Committee on Space Research of the Polish Academy of Sciences and the National Space Office prepared a report outlining the prospects for the development of space activity in Poland after the accession of Poland to the European Union. The report summarizes the research and technology potential of the country, underlines some important achievements and proposes measures relevant to the new situation in Poland and the challenges of the twenty-first century.

32. The programme described in the report consists of three main elements: space science, application of space systems and space technology development. In space science, the following research activities will continue or be developed: space physics, space astrophysics, solar system exploration, satellite geodesy and remote sensing. Participation in the Rosetta, Herschel, Planck and XEUS ESA missions and the DEMETER mission of France, is supported. The recent success of the Mars Express mission validates the specialization of the Space Research Centre in optical spectrometry. Preparations and applications for future solar system missions are encouraged.

33. In space system application, the emphasis is placed on two European projects: Galileo and Global Monitoring for Environment and Security (GMES). While Galileo is an important topic for modern transport solutions, the development of the time transfer methods with GPS will continue as well. The Earth observation programme will use ESA satellites, as well as those of France, the United States and other countries. New methods of data analysis will be developed for environmental monitoring, agricultural applications and many other fields. Discussions are under way on a project to launch a minisatellite into low orbit in cooperation with a foreign commercial consortium.

34. The question of involving industry in the programme for space technology development is being discussed in the context of possible membership of ESA. An early political decision in this domain is needed.

35. The principal partners of Poland in space for the coming years will be ESA and the European Commission. Nevertheless, it is proposed to continue cooperation with the Russian Federation and Ukraine to the extent possible.

36. In the report on the development of space activity in Poland, special attention was paid to the legal and financial constraints of the programme of the European Union. The importance of the section addressing space in the draft treaty establishing a constitution for Europe was emphasized. According to the report, Poland must be prepared to fulfil the obligations resulting from the treaty.