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COMMITTEE ON THE PEACEFUL
USES OF OUTER SPACE

IMPLEMENTATION OF THE RECOMMENDATIONS OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

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

CONTENTS

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INTRODUCTION

1. In accordance with a recommendation of the Committee on the Peaceful Uses of Outer Space at its thirty-ninth session, Member States have submitted information on the following topics:[1]

(a) Those space activities that were or could be the subject of greater international cooperation, with particular emphasis on the needs of developing countries;

(b) Spin-off benefits of space activities.

2. The information on those topics submitted by Member States as of 30 November 1996 is contained in document A/AC.105/661.

3. The information on those topics submitted by Member States between 1 December 1996 and 22 January 1997 is contained in document A/AC.105/661/Add.1.

4. The present document contains information on those topics submitted by Member States between 23 January 1997 and 13 February 1997.

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[1]Official Record of the General Assembly, Fifty-first Session, Supplement No. 20 (A/51/20), para. 31.

REPLIES RECEIVED FROM MEMBER STATES *

FRANCE

[Original: French]

Space today is more than ever an interplay of scientific, technological, economic and political stakes. This has made the sector particularly sensitive to the major transformations that are taking place at the end of the twentieth century, whether it is a matter of geopolitical upheavals, following the end of East-West confrontation, the general trend towards a reduction in public deficits or the emergence of wholly new markets. All the great space powers have embarked on a process of adaptation in order to offer the best response to the new challenges.

Europe has proved no exception. Against this background, France, one of the main players in European space activities, aims to maintain a diversified space programme, in order to reinforce a scientific community of the highest calibre, ensure that its space industry is competitive and meet the growing needs of space users.

A. Key data

Space in France employs some 17,000 people in total, 14,000 of them in industry. Some 70% of jobs are provided by the main companies, including Aerospatiale, Alcatel Espace, Matra Marconi Space and SEP. The remainder are made up of the National Centre for Space Studies (CNES), the research sector and small- and medium-sized companies.

B. The cornerstones of French space policy

France has a policy which strikes a balance between its national programmes and its participation in the European Space Agency (ESA). Multilateral European cooperation is one of the major cornerstones of French space policy. France contributes about 30% of the ESA's budget. The greater part of its contribution is devoted to launcher programmes, notably the Ariane 5 development programme.

The aims of the European space policy for the next decade were decided at the conference of the ESA Council which took place, at ministerial level, in October 1995. Following the conference, France played a significant part in the International Space Station programme with three projects (Columbus Orbital Facility, Automated Transfer Vehicle and Crew Transport Vehicle). In the field of Earth observation, France is also the main contributor to the second generation Meteosat programmes, Envisat and Metop. Lastly, in the field of telecommunications, France is a participant in the Global Navigation Satellite System (GNSS) programmes for air navigation.

In the field of international cooperation, CNES has always had significant relationships, notably with the United States of America and the Russian Federation. Extending to Japan, and very recently to Brazil, the field of cooperation could lead further to the emergence of new space partners.

C. Industrial activity

Since 1992, the French space industry has progressively adapted to a difficult global environment, profiting from the growth sectors, especially launchers, telecommunications and Earth observation. In 1995,

*The replies are reproduced in the form in which they were received.

the staff levels were stabilized and turnover in the sector increased. The activity of the main companies is outlined below. They rely in this respect on companies of lesser size, but whose skills are indispensable, especially for the supply of equipment:

1. Aerospatiale

Aerospatiale is the industrial architect of the Ariane 4 and 5 programmes. It carries out the research and system testing. It also builds the first and third stages of Ariane 4 and the main cryogenic stage and solid booster stages of Ariane 5, and carries out the mission analyses for each launch, provides flight programmes and analyses the flight data.

Aerospatiale and Arianespace, for France, and the Russian Space Agency (RKA) and the Samara Space Centre for the Russian Federation have set up the Starsem company to market Soyuz launchers, in particular for launching small satellite missions into low orbit.

In preparing European manned flights, Aerospatiale is developing the Atmospheric Re-entry Demonstrator (ARD) which is an automatic capsule allowing testing of re-entry materials and landing and recovery systems. In July 1996, a model was released from a stratospheric balloon (altitude 23 km) above the Mediterranean. This test proved a successful start to operations.

Aerospatiale is the contractor developing the Automated Transfer Vehicle (ATV) to serve the Alpha station. In the context of a European Economic Interest Group, it is studying the European Crew Transfer Vehicle (CTV) for the ESA. It is the contractor for several telecommunications satellites: Arabsat 2 (Arab League), Turksat (Turkey), Nahuel (Argentina), Thaicom (Thailand), Agila (Philippines), Sirius 2 (Sweden), EUTELSAT 3 (W24) and Sinosat (China). It is also making the Meteosat weather satellites and the Huygens interplanetary probe to land on Titan (ESA mission).

Aerospatiale has been retained by the CNES as a partner to develop a small multi-mission platform (Proteus). The first application will be the Jason satellite, the successor to Topex-Poseidon. It is also making the platform for the Stentor experimental satellite for CNES.

2. Alcatel Espace

A subsidiary of Alcatel Telecom, Alcatel Espace holds an important place in the field of satellite telecommunications systems and telecommunications payloads. Alcatel Espace was chosen as the industrial architect and contractor by World Space Inc. (Washington, United States of America) to develop the first world digital broadcasting system via the Worldstar satellite. Composed of three geostationary satellites, Worldstar will broadcast sound, vision and multimedia information directly to small portable receivers, with a coverage of 80% of the world population.

Along with companies like Dacom, Hyundai (Korea), Daimler-Benz Aerospace (Germany), Loral, Airtouch (United States) and Vodaphone (Great Britain), Alcatel Espace is one of the strategic partners in the Globalstar system, the new world satellite mobile telephone system with worldwide coverage which will come into operation from 1988.

In 1995, Alcatel Espace was retained to develop the payload of the following telecommunications satellites:

- Mabuhaysat with Space Systems/Loral-Telecommunications (Philippines);
- MTSat with Space Systems/Loral - Air navigation assistance (for Japan);
- Sesat with NPO PM - Telecommunications for EUTELSAT (for the Russian Federation);
- Nilesat with Matra Marconi Space - Direct broadcasting (for Egypt);

- Sinosat with Aerospatiale - telecommunications (for China);
- Worldstar with Matra Marconi Space - worldwide digital broadcasting (for the United States).

3. Arianespace

For Arianespace, 1995 was a year of sustained activity: ten launches took place in ten months, allowing fifteen satellites to be successfully inserted in orbit. In addition, eighteen new contracts were signed, allowing Arianespace to confirm its number one place in commercial space transport. To meet the increase in demand, Arianespace ordered 29 more launchers from the European industry: 15 Ariane 4 to complete the series of 50 ordered in 1988 and 14 Ariane 5.

4. Matra Marconi Space (MMS)

MMS is the contractor in the CNES Spot programme, the Helios military reconnaissance programme and the platform for two ESA ERS satellites. MMS is developing parts of a multi-mission platform for mini-satellites (Leostar) and is taking part in the ESA programme by supplying the platform and three instruments: Asar - synthetic aperture radar, Gomos, an instrument to measure the vertical distribution of ozone in the atmosphere and MWR - a hyperfrequency radiometer. MMS will be the contractor for the EUMETSAT Metop programme which will be directed by ESA, and for which MMS will supply the platform and the MHS instrument (radiometer to measure surface temperature and humidity profile).

In the field of telecommunications, MMS is involved in the following programmes:

- As contractor: Telecom 2 (France), Silex (ESA-CNES optical intersatellite liaison system), Hot Bird (EUTELSAT), Skynet D,E and F (United Kingdom of Great Britain and Northern Ireland), Nilesat (Egypt), ST1 (Singapore and Taiwan Province of China), Astra 2 (CLT) and Nato 4 (NATO);
- As contractor for the payload: INMARSAT-3 and Koreasat (Korea);
- As major partner: Italsat (Italy) and Artemis (ESA).

With regard to ESA's scientific programmes, MMS was the contractor for three scientific satellites: Giotto (interception of Halley and Grigg-Skjellerup comets), Hipparcos (celestial cartography) and Soho (study of the Sun). MMS also participated in the CNES Pronaos programme (development of the telescope), Cluster (study of the plasma in the Earth's magnetic field) and Hubble (assembly and installation of the telescope and photon sensor in the camera for objects with low luminosity).

5. Société Européenne de Propulsion (SEP)

For SEP, the leading European company in the field of space propulsion, the main civilian activity concerns the Ariane 4 and Ariane 5 launchers. Due to the significant increase in the frequency of launches during the last two years, SEP had to increase its production capacity. At the end of 1995, SEP took part in the negotiations on the order for ten additional Ariane 4 launchers. Delivery of the engines for them will extend from the end of 1997 to the end of the first quarter of 1999.

During 1995, SEP also supplied propulsion systems for the Earth observation satellite, ERS 2. During 1995, SEP developed its activities in the field of braking using carbon-carbon brakes.

Under the Ariane 5 Evolution programme, SEP won a contract to develop the Mark 2 Vulcan engine, developed from the current cryogenic engine. The new engine will add some 800 kg to the planned increase of 1,400 kg in the satellite payload in geostationary transfer orbit.

6. Spot image

For 10 years, SPOT image has been distributing pictures from SPOT satellites to the world and, to date, 4,500,000 pictures have been captured and archived, forming a true memory of our planet. The SPOT system was conceived to provide a complete operational service and, for that purpose, has eighteen direct receiving stations around the world, while two main stations in Toulouse (France) and Kiruna (Sweden) also receive photographs stored on recorders on board satellites.

Cartography and agriculture were the first applications to become operational. Later, town and country planning, land use planning, coastal studies or mineral and oil exploration required reliable geographical information. This digital information, compatible with most geographical information systems, also found a place in new applications such as telecommunications, notably in the installation of cellular telephone networks which require a precise knowledge of relief and land use.

Very recently, SPOT image further developed its product to meet the needs of users more precisely. Hence the development of SPOT View products (cartographic products in digital or analogue form) meets a demand for satellite imagery for Geographic Information Systems.

D. Activities undertaken by CNES

This is a review of the activities undertaken in the national programme and in the context of France's participation in the ESA's programmes:

1. Radiocommunication

Space telecommunications, which are the primary field of commercial applications of space, involve major economic, political, cultural, strategic and industrial stakes. In the face of this, France has endeavoured to develop and maintain an effective industrial capacity and launchers, and the means of launching and maintaining telecommunications satellites:

- The Stentor programme of experiment and demonstration of new technologies (Stentor - Telecommunications satellite for experiments in new technologies in orbit) is designed to validate and test in orbit the latest techniques produced by research programmes. The main innovations relate to the use of active antennae, miniaturization of radioelectric functions and the introduction of new frequency bands;
- The Argos system, used for studies and environmental protection, is in the process of evolution. The system consists of two data collection instruments, developed by CNES and operated by CLS (a branch of CNES) each installed in two polar weather satellites (National Oceanic and Atmospheric Administration - United States). The NOAA-K satellite (planned launch at the beginning of 1997) will carry a new higher-capacity Argos payload. In addition, CNES is cooperating with NASDA (Japan) in loading a new instrument to allow bidirectional links on the ADEOS-II satellite;
- CNES and the Directorate General for Civil Aviation (DGAC) are behind the GNSS concept (Global Navigation Satellite System), which consists in using geostationary satellites to complement the GPS to enhance availability, integrity and precision of navigational signals. It is on the basis of this concept that the European Union, ESA and Eurocontrol are developing the GNSS1 programme, by which aircraft will be able to navigate in flight and will have improved landing and take-off conditions;
- The COSPAS-SARSAT programme is aimed at satellite assistance in search and rescue of ships, aircraft and land vehicles, anywhere on the globe. The programme involves four founding countries (United States, Canada, Russian Federation and France) and 21 other countries. A new generation of instruments (SARSAT 2) has been developed. The first model will be carried on the NOOA-K satellite.

2. Exploration of the Universe

For many years, successive space missions have enabled a better understanding of the universe and its evolution. Astronomy and solar physics should permit a global vision of the universe and a better understanding of how it evolved. In the field of exploration of the solar system, the French community is developing three areas of research concerning the origin of the system itself, the giant planets and the small planetary systems and comparative planetology.

(a) Astronomy

For more than twenty years, successive space missions have provided partial answers. CNES and the laboratories of the National Scientific Research Centre (CNRS), research institutions and universities have been developing the French scientific programme:

- Mission Intégral. This ESA mission, which is planned for launch in 2001, is a successor to Granat-Sigma (launched in 1989) whose most important instrument is the Sigma telescope designed to locate gamma sources (cooperation between the Russian Federation and France). The final payload was approved in mid-1995. France and Germany will make the spectrometer together, with CNES as contractor;
- ISO. The ESA ISO satellite (Infrared Satellite Observatory) was launched in November 1995 by an Ariane 4 launcher. France is participating in mission operations and archiving the data.

(b) Study of the solar system

In studying the telluric planets, the main activity involved preparing the Mars 96 mission, led by the Russian Federation, and undertaken in cooperation with some twenty countries. France, with Germany, is one of the main partners of the Russian Federation in this project. France contributed to carrying out about ten scientific experiments and provided the system on board the orbiter to relay the data from the stations to be set down on the surface of Mars. The launch, which took place on 16 November 1996, failed.

(c) Physics of ionized environments

A number of energy phenomena, observable from a distance by traditional astronomical methods, occur in an ionized plasma subjected to a magnetic field. This makes the study of space plasma in the solar system a quite separate area of astrophysics.

The four Cluster satellites were destroyed with the first launch of Ariane 5. Several scenarios are being studied to find a solution. In addition, the Interball project was carried out in cooperation with the Russian Federation. It consists of two pairs of satellites, one known as "eccentric", inserted in a high apogee orbit (200,000 km) and the other known as "auroral", inserted in a lower apogee orbit (20,000 km). Three French experiments were carried out on the auroral satellite (wave study, cold plasma study and hot plasma study). The eccentric pair were successfully launched in August 1995 and the two auroral satellites were also launched successfully in August 1996 by a Russian Molniya launcher.

3. Microgravity research

Freedom from gravity makes it possible to observe physical, chemical or biological phenomena which cannot be studied in Earth laboratory conditions. The weightlessness obtained in the space environment is not only an original means of experimentation for researchers, but also a constraint which must be incorporated into spacecraft design.

This programme covers the physics of matter condensed in microgravity, one aspect of which deals with managing fluids in space, and also life sciences in space, one aspect being space medicine.

(a) Introduction of the OG Airbus

An important element of the programme consists of suborbital experiments. In particular, parabolic aircraft flights, for both scientists and engineers, provide a good means of access to microgravity. The first flight of this aircraft took place in 1996.

(b) LMS Spacelab mission

During the LMS Spacelab mission of 20 July 1996, the French astronaut Jean Jacques Favier, from the French Atomic Energy Commission, also in charge of the Mephisto project, was a specialist payload. An experiment to study the relationship between the inner ear and vision was carried out using the French COIS instrument. Several solidification experiments were done in the ESA AGHF kiln, including two French experiments, as well as experiments on crystallization of proteins (ESA APCF instrument).

(c) Cassiopeia mission

The astronaut Claudie André-Deshays stayed on board the Mir Station from 14 August 1996 to 2 September 1996 to carry out, with the help of the Russian crew, a series of scientific and technological experiments. The mission lasted 16 days, 14 aboard the station. The programme of experiments was as follows:

Physiolab: cardiovascular physiology;
Cognilab: neurosensory and cognitive processes research;
Fertile: biology of development of vertebrates (amphibians);
Alice 2: physics of fluids close to the critical point;
Castor/Treillis: space technologies:
Castor/Dynalab: study of the behaviour of structures in orbit.

4. Earth observation

In the field of Earth observation, France primarily has the SPOT network (Earth observation satellite) with high resolution optical imagery. The programme was carried out in cooperation with Belgium and Sweden. The approach adopted in developing the applications of high resolution imagery was to develop and maintain and evolving operational branch operated by a commercial concern, SPOT image, mainly a subsidiary of CNES, MMS, the National Geographic Institute and SEP.

After the loss of Spot 3 in 1996 (launched in 1993 with a nominal life of 3 years), Spot 1 and 2 are now in operation. The launch of Spot 4 is now planned during the first quarter of 1998. The satellite will have a better operational life and recording capacity than its predecessors, and will have a new spectral band in the middle infrared spectrum. In addition, it will carry a "Vegetation" payload, co-financed by the European Union, France, Belgium, Sweden and Italy. The wide-scope and medium-resolution (1 km) imager will allow constant and repeated global observation of the continental biosphere.

In the field of observation of the oceans, there will be a follow-up to the Topex-Poseidon programme in cooperation with NASA. It involves the Jason satellite, which will be the first mission to use the Proteus platform (see section 8 below).

5. Space transport

France proposed to Europe that a launcher should be developed based on the experience gained by France. The family of Ariane launchers was then developed in the framework of the ESA under the direction of CNES. Production, marketing and launch services are provided by Arianespace. There have been successively more powerful versions, from Ariane 1, launched for the first time on 24 December 1979, to Ariane 4, which can launch 4.2 tonnes into geostationary transfer orbit for the most powerful configuration.

The Ariane 1, 2, 3 and 4 launchers have achieved a total of 85 successful launches out of 92 up to the end of 1996, including test flights. In the case of Ariane 4, 64 launches have been made since June 1988, 61 successfully, allowing 90 satellites to be inserted in orbit.

The new Ariane 5 launcher satisfies two objectives. Firstly, it increases the competitiveness of the Ariane family by increased performance, reduced launch costs, greater reliability and greater payload. Ariane 5 will be able to launch two 3-tonne satellites into geostationary transfer orbit simultaneously or a single satellite of 6.8 tonnes. Secondly, it will enable Europe, should the need arise, to insert manned vehicles or space station components into low orbit. The development of Ariane 5 began at the end of 1987. The first test launch (flight 501) took place on 4 June 1996. It was a setback due to a failure in the guidance system and particularly in the inertial reference systems. The commission of inquiry which was immediately set up submitted its report on 19 July 1996. It analyzed the causes of the failure and proposed corrective measures to be taken prior to the next launch due in July 1997.

6. International space station

The ESA ministerial-level Council (October 1995) decided on a programme for the development of the Columbus orbital laboratory (COP) and the transfer vehicle (ATV), studies on a crew-transfer-type vehicle (CTV) and preparation for use of the orbital laboratory. With regard to the ATV, the industrial contractor (Aerospatiale) is drawing up a detailed specification of the project. This phase should be completed by the end of the first quarter of 1997. The development of the CTV is included in the European Economic Interest Group (GIE) ARCA formed of Aerospatiale, MAN Technologies and Alenta Spazio. The CNES is not a partner in the GIE. It will be involved at various levels in the study of the ground control segment and support of the mission analysis.

Utilization of the station will begin with the installation of the United States laboratory in 1999, and will intensify with the installation of laboratories of other partners (Japan, Russian Federation and Europe) planned by 2002. For Europe, the operating phase will begin in 2002.

7. Balloons

Balloons are evolving at an altitude ranging from 15,000 to 45,000 metres, and are a necessary complement to satellite observation programmes. They can carry significant loads, with fairly long flight durations, in the fields of astronomy, space plasma, Earth physics and study of the atmosphere. More than 50 flights take place each year. The second flight in the Pronaos experiment (a two-metre diameter telescope and MPS - multiband-photometric-system focal instrument) was made successfully in the third quarter of 1996. It allowed remarkable observations in the field of microastronomy.

8. Research and technology

This involves improving competitiveness in telecommunications, continuing with the technological development of Earth observation, developing advanced scientific instrumentation, carrying out work in orbital infrastructures and acquiring techniques for future launchers.

In order to encourage the use of small satellites, CNES is developing a new platform intended for a wide variety of missions. This is the Proteus project (Reconfigurable Platform for Observation, Telecommunications and Scientific Purposes) which will be developed in partnership with Aerospatiale.

This platform, stabilized on three axes, will be able to carry payloads of up to 250 kg. In that case, the total mass at launch will be 500 kg for orbits at altitudes of between 450 and 1,500 km.

MOROCCO

[Original: French]

Morocco is continuing its policy of developing its space activities, extending its satellite network, diversifying its applications, organizing training and information displays and increasing the number of its international actions.

These activities cover, in particular, space telecommunications, Earth observation (remote sensing and meteorology), location and space technologies.

A. Space telecommunications

1. The current satellite network

Morocco, through its National Office for Post and Telecommunications (ONPT), is currently carrying out a broad programme to develop telecommunications and its infrastructure, mainly based on the use of new technologies and space technology.

The Mohammed V space station at Rabat (Shoul) has 3 satellite stations (ARABSAT, EUTELSAT and INTELSAT),which allow connection of the national telephone network and exchange of television programmes between Morocco and the Arab countries, Europe, the United States of America, Canada and African countries.

As well as the national liaison station at Rabat, the Laayoune and Dakhla Earth stations allow connection of the southern provinces to the national network and provide national radio and television broadcasting coverage to these provinces.

For retransmission of major national and international events and to meet a variety of needs, the ONPT also has an Earth mobile station which is used for occasional remote sensing and telephony, and which can operate with international and regional satellites.

Morocco recently linked up to the international Inmarsat network and the VSAT business communication network.

Under the COPINE project, directed by the Office for Outer Space Affairs, it is planned to set up satellite communications satellites in various African countries, including Morocco, for exchange of data between them and Europe, especially in the fields of environment, natural resources, education and medicine. The project is being coordinated at national level by the Centre Royal de Télédétection Spatiale (CRTS) (Royal Centre for Spaceborne Remote Sensing), which has set up a national users' committee and which participates in the technical committee set up by the Office for Outer Space Affairs.

2. Applications

(a) Dissemination of information

From the first quarter of 1997, the Maghreb Arab Press Agency (MAP) has been transmitting all its information services to subscribers in the Maghreb, the Middle East and Europe via the EUTELSAT satellite.

(b) Radiolocation

A programme for location and tracking of ships by satellite is currently being introduced by the Ministry of Marine Fisheries and Merchant Shipping. The programme will allow exchange of information between ships.

A project to introduce a system for management and tracking of trains by satellite is being studied by the Ministry of Transport under the programme to modernize the National Railway Office's data transmission systems.

B. Earth observation

1. Access to data

There are currently stations for receiving data from the METEOSAT meterological satellite, mainly in the National Department of Meteorology (DMN). A NOAA-HRPT station has also been set up in the DMN for meteorological studies. Another station of this type is planned for CRTS to receive AVHRR data, which is useful for agriculture, forestry and oceanography.

In order to access other Earth observation satellites, the CRTS, which is responsible for distributing satellite images throughout the Kingdom, has concluded contracts with international image distributors: SPOT IMAGE in France for Spot data, EURIMAGE in Italy for NOAA, LANDSAT, ERS data etc.

2. Applications

Projects to integrate space remote sensing and Geographic Information Systems (GIS) continue to be set up in the CRTS and in departments of various ministries. They meet the needs for inventory and management of natural resources, environmental protection and land planning in national and regional development programmes.

Depending on the stage of development, these applications take the form of pilot projects on specified sites, contracts for operational applications in defined regions or nationally, sometimes with foreign co-financing.

In the area of natural resources and the environment, the following projects have produced significant results in 1996:

- The national project to include satellite data in national agricultural statistics by the CRTS and the Ministry of Agriculture and Farming Promotion. In the 1995-1996 programme, the project made it possible for the first time in Morocco to estimate the area of cereal crops and cereal production with variances of less than 5% compared with the conventional methods of the Ministry of Agriculture;
- The GEOSTAT project on vegetation and road mapping in Morocco with the CRTS, the Ministry of Agriculture and the National Space Research Centre, which gave good results. Currently, the Observatory of the Sahara and Sahel (OSS) and the CRTS are seeking financing to extend this research

to 3 OSS action zones: North Africa - Maghreb Arab Union (UMA), East Africa (IGADD) and West Africa (CILSS);

- The SNAT project, on soil use mapping for the five main regions of the Kingdom, carried out by the CRTS and the Land Planning Department, under the National Land Planning Scheme. As a result of the study, maps on a scale of 1/100,000 and the corresponding statistical inventories (8 strata) were drawn up for a large part of the country.

The following projects for the coastline and sea areas have been initiated:

- The SIGL project, the System of Geographical Information on the Coastline, which aims at setting up a data bank on the Moroccan Coastline, led by the Ports Department (Ministry of Public Works), has launched a pilot project on the Mediterranean Coast;
- The GERMA project on developing a marine resources management system based on satellite images is currently being set up with co-financing from the European Union, the Ministry of Maritime Fisheries and Merchant Shipping (MPMMM) and the CRTS. To this end, the CRTS and the MPMMM signed an agreement in 1996 to carry out this project.

In meteorology, regional projects and studies are being carried out, including:

- The "Al Moubarak" project on the atmospheric phenomenon known as the "North Atlantic Oscillation", whose purpose is to forecast medium-term rainfall trends (3 months). The project is being carried out by the National Meteorological Department;
- Regional studies on the ocean-climate relationship are being carried out by the CRTS, using altimetric data on sea levels provided by the TOPEX-POSEIDON satellite, data on the surface temperature of the sea constructed from NOAA and wind data obtained from the ERS satellite.

3. Information, training, research

The CRTS is continuing its work to raise awareness and inform by regularly organizing conferences, exhibitions and information days, and publishing popular articles and a national newsletter on space activities.

These activities are intended for decision makers, managers and scientists as well as young people. In December 1996, the CRTS signed an agreement with the Ministry of National Education aimed at introducing young people to the utilization of space, under which the two partners undertake to organize an annual space day.

With regard to continuing training, the CRTS continues to organize short week-long modules and two-week schools on applications of space remote sensing and GIS in areas of priority concern to the Kingdom and the region. Participation by managers from Africa and the Middle East is important.

As a complement to these training programmes, the CRTS organizes targeted training at the request of users. Thus, in March 1997, the CRTS together with the Food and Agriculture Organization of the United Nations (FAO), the European Space Agency and the European Commission Institute for Space Applications is organizing a national workshop for decision makers from the Ministry of Agriculture on the use of space remote sensing and GIS in agricultural management.

Other continuing training sessions offered to technicians and engineers in the field are provided by the Hassan II Veterinary and Agronomic Institute. They can also be organized on request for specific subjects. Longer training periods, of several months, are provided by the Remote Sensing Centre in the Ministry of Agriculture for Ministry managers and technicians. In addition, basic remote sensing courses, advanced studies and research are regularly held by the various engineering schools and universities with CRTS support.

4. Regional activities - South/South cooperation

As part of its regional policy, Morocco continued in 1996 to undertake activities to reinforce scientific exchanges and South/South cooperation in spaceborne remote sensing in order to extend the community of users in the countries of the South.

CRTS thus participates as an expert in setting up FAO's AFRICOVER project on the African continent. It is a member of the working groups charged with implementing the project and took part in various workshops in 1996.

CRTS also organized in May 1996, jointly with the French National Centre for Space Studies, the Centre Nationale d'Etudes Spatiales (CNES), SPOT IMAGE, the European Space Agency and EURIMAGE, an exhibition on the Arab world seen from space at the Institute of the Arab World in Paris. This exhibition, which took a new and original view of the Arab world, combining high technology and art, showed the 22 Arab capitals seen from the SPOT satellite and many regions observed by United States, European and Russian satellites. The exhibition, which lasted a month, was a real success and attracted a large number of visitors, scientists, students and representatives of Arab embassies in Paris. A day was set aside for lectures on the subject of "advanced technology for sustainable development" given by various organizers.

The CRTS publishes a weekly scientific review "Geoobservateur" containing articles on work and research recently carried out in developing countries based on space remote sensing and GIS. This magazine, which is distributed for a nominal price, contains practical applications and essentially concerns arid and semi-arid countries.

C. Space technology

In Morocco, space technology is a recent sector of activity, of critical importance in terms of technology transfer and its applications. Currently, the scientific infrastructure in this area is in its initial stages of development.

1. Development of a microsatellite

The CRTS is undertaking the building of the first national microsatellite, experimental in nature, which will be launched in low orbit, with a payload of messaging and Earth observation equipment. The work is being carried out with the collaboration of the Berlin Technical University (TUB) which is providing the TUBSAT-C platform for the project. Installation of the component systems is expected to be completed in 1997.

The CRTS has also had discussions and taken steps to make a launch in polar or quasi-polar orbit.

2. Training and research

Various research projects involving universities and specialist institutions are in progress or in preparation, including:

- Feasibility study for a telecommunications mini-satellite;
- Feasibility study for a commercial satellite receiving station.

In 1992, the Mohammadia Engineering School (EMI) introduced space technology in the Ministry of Higher Education, its main aim being the acquisition of know-how in the field. To that end, a multidisciplinary team of teachers/researchers was trained in space technology (payloads, platforms, Earth segments, product assurance for space systems, management of space projects). The team then carried out the feasibility study for an experimental project in collaboration with national partners and the French space agency, CNES. This study ended with a preliminary review which was evaluated positively by a panel of CNES experts. Space activity in the EMI was recently structured with the formation of the Centre for Space Studies (CES) for training of managers and scientific research.

In addition, the National Institute for Post and Telecommunications, in collaboration with the CRTS, is carrying out research projects in this field, in particular data compression, satellite broadcasting systems and receiving stations.

3. International activities

In 1997, the CRTS is organizing jointly with the International Space University and the Berlin Technical University an international workshop providing an introduction to and training in designing and developing micro-satellites.

The CRTS is also holding discussions with the International Academy of Astronautics (IAA) on holding at Rabat in 1998 an international conference on small satellites, aimed at developing countries in Africa and the Middle East. The Office for Outer Space Affairs is expected to participate.

D. General and international activities

In developing its cooperation and exchange activities, Morocco continues to expand its international network and strengthen its North/South cooperation activities.

Agreements between CRTS and CNES (France) and between CRTS and the Indian Space Research Organization (India) are currently the subject of discussion.

Morocco, through the CRTS, has been a member of the International Astronautical Federation (IAF) since October 1996 and a member of the International Space University (ISU) since May 1996. The CRTS is currently the ISU liaison office in Morocco and the region.

Morocco, through the CRTS, regularly publishes a newsletter on space remote sensing, extended in January 1997 to all space activities.

In the context of the third TOKTEN meeting (Transfer of Knowledge through Expatriate Nationals), the Ministry of Foreign Affairs and Cooperation organized, with the collaboration of the CRTS, workshops on the theme "Utilization of space: what it means for Morocco". This event, which took place in Rabat on 11 and 12 July 1996, brought together Moroccan specialists and experts resident abroad and local bodies to evaluate what was involved at national level, the country's needs and the feasibility of projects. The meeting was an opportunity to stimulate coordinated reflection on the subject and possible strategies, as well as a means of achieving synergy of different expertise in order to optimize the work in hand and set up future projects in the field. The work took the form of workshops on the following subjects: space telecommunications, remote sensing and exploration, astrophysics and astronomy and space industries. The participants closed the discussions with a series of recommendations and conclusions, notably the setting-up of a follow-up group of national and expatriate experts which will seek to reinforce the development of Morocco's space activities.

In October 1997, the CRTS is organizing at Rabat, in association with EURISY, the Council of Europe, the European Commission, the European Space Agency and other European national space agencies, a symposium on "space technologies for major risks" in the European and Mediterranean region. This forum will present the latest international results on possible utilization of space technologies (telecommunications, remote sensing, meteorology, location, navigation etc.) to prevent or mitigate the effects of disasters, especially floods, forest fires, desertification and locusts.

RUSSIAN FEDERATION

[Original: Russian]

The space activities of the Russian Federation in 1996 were conducted under the Federal Space Programme and also as part of international scientific-technical cooperation and commercial agreements.

The Federal Space Programme in 1996 was directed towards priority tasks relating to the exploration and utilization of outer space for the purpose of developing science and technology, improving the country's security and intensifying its international cooperation activities.

These priority tasks include the following:

- The implementation of international agreements on the establishment of the International Space Station (ISS) and planetary research;
- The development of an orbital manned flight programme and the refinement of technology for the production of new materials and high-purity substances in outer space;
- The undertaking of basic scientific research in astrophysics, planetology, solar physics and solar-terrestrial interaction;
- The maintenance of a global communications system and the relaying of television programmes throughout the Russian Federation;
- Monitoring of the natural environment, rescuing of vessels and aircraft in distress, disaster monitoring and management, exploration of natural resources, furnishing of meteorological data and provision at any time of day of high-precision coordinate and time references.

During the first 11 months of 1996, 29 space objects of various kinds were launched, including:

- Eight artificial Earth satellites from the Cosmos series (Cosmos 2327 to Cosmos 2334);
- Two manned spacecraft from the Soyuz TM series (Soyuz TM-23 and Soyuz TM-24);
- Three unmanned cargo spacecraft from the Progress series (Progress M-31, Progress M-32 and Progress M-33);
- The Priroda research module for the Mir manned station;
- Nine telecommunications and television-relaying satellites, including three Gonets-D1 satellites, two Gorizont satellites, one Ekspress, Molniya-1, Molniya-3 and Raduga satellite, respectively, and one Prognoz-M2 satellite (Russian Federation) for space exploration, as well as a number of commercially launched spacecraft: Astra-1F (SES, Luxembourg), Magion-5 (Czech Republic), MSAT (Argentina), INMARSAT-3 (belonging to the international organization Inmarsat) and UNAMSAT-B (Mexico).

The above-mentioned space objects were injected into orbit by 24 launches of the Proton, Soyuz, Zenit, Molniya, Tsiklon and Cosmos-type carrier rockets.

In the case of several launches, a number of satellites were placed in orbit by a single carrier rocket:

19 February 1996—Three Gonets and three Cosmos satellites orbited by the Tsiklon carrier rocket;
29 August 1996—The Prognoz-M2 satellite and Magion-5 (Czech Republic) and MSAT (Argentina) subsatellites orbited by a Molniya carrier rocket;
5 September 1996—A Cosmos satellite and the UNAMSAT-B (Mexico) subsatellite orbited by a Cosmos carrier rocket.

An unsuccessful attempt was made to launch the Mars-96 space station on 16 November 1996.

A. Manned space flight programme

The 35th anniversary of Yuri Gagarin's historic flight was celebrated on 12 April 1996. On 13 May 1996 the 50th anniversary of the rocket and space sector was commemorated in the Russian Federation.

The achievements of Russian cosmonautics were fittingly symbolized by the 10th anniversary of successful operation of the permanently functioning Mir space station, the base unit of which was injected into orbit on 20 February 1986.

In 1996 work connected with the Mir manned scientific research station continued under the programme for the 20th, 21st and 22nd principal expeditions (EO-20, EO-21 and EO-22), and also under international cooperation programmes conducted jointly with the National Aeronautics and Space Administration of the United States of America (NASA), the European Space Agency (ESA) and the French National Centre for Space Studies (CNES).

The 20th principal expedition began on 3 September 1995 with the launch of the Soyuz TM-22 manned transport craft with a crew of three consisting of Yuri Gidzenko (commander), Sergei Avdeev (flight engineer) and Thomas Reiter (an astronaut and researcher from ESA).

The planned duration of the 20th principal expedition was originally 135 days (until 16 January 1996), but was subsequently extended to 179 days (until 29 February 1996), which was possible thanks to the use of the United States reusable spacecraft Atlantis STS-74 in addition to the cargo transport craft Progress M-29 and Progress M-30 for the delivery of payload to the station; the Atlantis docked with the Mir station and undertook a short joint flight with it under the Mir-NASA programme in November 1995.

A number of features distinguished the 20th principal expedition, namely the stay of the ESA astronaut and research scientist as a member of the crew of this expedition throughout the entire period of work on the station; the docking of the Atlantis STS-74 spacecraft with the Kristall module; the reception of the three Progress M transport craft; and, finally, the three space walks performed by the cosmonauts lasting a total of eight hours and fifty-one minutes.

During the expedition, the ESA astronaut assisted in flight control and station operation, and in the performance of research and experiments, partly under the Euromir-95 programme, one of the purposes of which is to perform operations on the external surface of the station.

The Euromir-95 programme forms an integral part of the joint work undertaken by the Russian Federation and western European countries under a cooperation agreement relating to manned space infrastructure and space transport systems. A place of cardinal importance in this programme is occupied by medical experiments in various areas: metabolism; research on the vestibular apparatus; bone tissue; the respiratory and cardiovascular system, etc.

Experiments were performed to investigate radiation levels on board the Mir and their effect on the operation of the instruments on board the station.

With a view to the investigation of materials under the conditions of the space environment, a multi-stage ESEF experiment was performed to study cosmic dust and debris, the space environment around the station and the effect of ultraviolet radiation on organic molecules.

Altogether, more than 520 scientific experiments have been carried out under the Euromir-95 programme, using equipment with a total mass of 497 kg delivered by the Progress M-28, Progress M-29 and Soyuz TM-22 transport craft.

In connection with the orbital station maintenance programme, the crew of the 20th principal expedition carried out loading and unloading operations on the Progress M-29 and M-30 craft launched on 8 October and 18 December 1995, respectively.

From 15 to 18 November 1995, a joint flight was performed by the Mir station and the United States Atlantis STS-74 spacecraft, during which the following operations were performed:

- Approach and docking of the Atlantis to the Kristall module of the Mir station;
- Delivery and emplacement on the Kristall module of the Russian docking module in order to permit subsequent docking operations by the Space Shuttle;
- Mounting on the external surface of the docking module of two solar arrays with a view to their subsequent mounting on the Kvant module;
- Delivery to the station of scientific apparatus, drinking water and distilled water, new clothes for the cosmonauts, and other cargo;
- A joint programme of research and experiments, including studies aimed at determining the noise level on board the Mir station, the stability of the relative orientation of the Mir station and the Atlantis spacecraft when docked together, and the condition of the initial and recycled water in the station's life-support system;
- The undocking and circling of the Atlantis twice around the Mir station for the purpose of inspecting the condition of the station's external components;
- The return to Earth on board the Atlantis of the data-recording devices carrying the research results, and of other scientific apparatus and Russian equipment.

The next principal expedition was the 21st expedition, which began on 21 February 1996 with the launch of the manned craft Soyuz TM-23 with two Russian cosmonauts on board: Y. I. Onufrienko (commander) and Y. V. Usachev (flight engineer). The Soyuz TM-23 docked on 23 February 1996, and the crews of the 20th and 21st principal expeditions, five cosmonauts in all, worked on board the orbital station for a period of six days.

The 20th principal expedition was concluded with the landing of the Soyuz TM-22 spacecraft, with the cosmonauts Y. P. Gidzenko, S. V. Avdeev and Thomas Reiter on board, on 29 February 1996 in the precalculated region.

The 21st principal expedition lasted 194 days. The third docking of the Shuttle with the Mir station took place during this expedition in March 1996. The launch of the Atlantis STS-76 took place on 22 March 1996. During the 21st expedition again, the crew received the Progress M-31 and Progress M-32 transport craft.

The Atlantis (STS-76) delivered the United States astronaut Shannon Lucid to the Mir station. During her stay on board the Mir, Dr. Lucid worked as an astronaut and research scientist as part of the crew of the 21st principal expedition.

In its payload module, the Atlantis delivered the SPACEHAB module, which was docked with the Mir station for five days. This was the first flight made by the SPACEHAB module to the Mir station. While the Atlantis and the Mir station were docked together, the astronauts Linda Godwin and Michael Clifford performed a successful space walk during which they transferred three instruments from the Atlantis to the external surface of the Mir station and checked the condition of the functional units for the future International Space Station (ISS). During the flight of the Atlantis STS-76, operations were performed using a simplified version of the equipment to be operated during extravehicular emergency situations.

On 26 April 1996 the crew of the 21st principal expedition received the Priroda module, on which 936 kg of scientific equipment was installed for the use of the United States astronaut-research scientists on board the Mir station, together with Russian instrumentation for the experiments conducted on behalf of the Russian Space Agency (RSA), and also ESA scientific instrumentation.

With the incorporation of the Priroda research module as part of the Mir complex the final stage was completed of the creation of an integrated permanently operating space station consisting of five specialized modules and a base unit.

The joint scientific research programme conducted during the 21st expedition included experiments relating to the vital functions of the human organism, microgravity, basic biological research, advanced technologies and Earth sciences.

Yuri Onufrienko and Yuri Usachev worked on board the Mir station for over six months; for five of these months they were joined by the NASA astronaut Shannon Lucid. During this time they carried out joint research and experiments under the Russian programme and also under the Mir-NASA international project. The Russian cosmonauts performed five space walks, during which they succeeded in mounting a new telescopic loading boom on the external surface of the station, together with supplementary scientific instrumentation, and also transferred fresh a solar array, fitted with United States photoelectric elements, from the docking unit to the Kvant astrophysics module.

The date of 17 August 1996 had been planned for the launch of the Soyuz TM-24 craft with the crew of the 22nd principal expedition consisting of the commander, Gennady Manakov, flight engineer Pavel Vinogradov and the medical doctor Claudie André-Deshays, an astronaut and research scientist from CNES in France. However, owing to the indisposition of Gennady Manakov, the first crew was replaced by a substitute crew; Valery Korzun was appointed commander of the crew, with Aleksandr Kaleri his flight engineer and Claudie André-Deshays the astronaut and research scientist. The Soyuz TM-24 was launched on 17 August 1996, the planned duration of the 22nd principal expedition being 192 days. The French astronaut and research scientist remained on board the Mir station for 14 days.

During a two-week crew shift from 16 to 30 August 1996, six individuals from three countries were engaged in work on board the Mir station: two members of the 21st principal expedition, one United States astronaut and research scientist, two Russian crew members of the 22nd principal expedition and the French astronaut and research scientist. The Russian cosmonauts from the 21st expedition and the French astronaut and research scientist completed this stage of the 21st expedition on 30 August 1996, and returned to Earth on board the Soyuz TM-23.

Under the joint Mir-Shuttle flight programme, it had been planned that in August 1996, after her five-month stay on board the Mir station, Dr. Lucid would return to Earth on board the Shuttle. However, the take-off of the Atlantis STS-79 was postponed from 1 August to 12 September 1996 because of technical problems in the solid-fuel boosters during take-off in June 1996 under the STS-78 expedition programme. The take-off of the Atlantis STS-79 was subsequently postponed two further times, initially to 14 September 1996, then to 16 September 1996, because of unfavourable weather forecasts in the region of the Kennedy Space Center launching facility in the State of Florida.

The United States astronaut and research scientist Shannon Lucid continued her research, started during the joint Mir-Shuttle flight, with the newly arrived Russian crew members of the 22nd expedition until the Atlantis STS-79 arrived in September. As a result of these delays, Shannon Lucid remained on board the Mir station for six months rather than five, thus setting a new women's world record for space endurance.

Under the revised programme, the Atlantis STS-79 was launched on 16 September 1996, and docked with the Mir station three days later on 19 September 1996. The duration of the joint flight by the Atlantis and the Mir was five days, during which the following operations were performed:

- Approach and docking of the Atlantis spacecraft and the Mir station;
- Delivery to the station of the United States astronaut John Blaha;
- Completion of a joint programme of experiments and research;
- Delivery to the station of components for the life-support system, together with Russian instrumentation and consumables;
- The return of the United States astronaut Shannon Lucid to Earth;
- The return to Earth of data-recording devices carrying the results of the scientific research conducted.

The Mir orbital station is currently manned by the crew of the 22nd principal expedition consisting of two Russian cosmonauts—commander Valery Gregorevich Korzun and flight engineer Aleksandr Yurevich Kaleri—and a second flight engineer, the United States citizen John Blaha. Colonel Blaha is the third United States astronaut to be performing scientific experiments in the course of this long orbital flight and is currently continuing his research on board the Mir as part of the 22nd expedition. Thus, starting in March 1996, there has been a constant succession of NASA astronauts engaged in work on board the Mir.

John Blaha's return to Earth on board the Atlantis STS-81 was scheduled for the end of January 1997.

B. Applied space technology programmes

1. Space communications, television transmission and navigation

The orbital network of the space communications, television transmission and navigation system comprises the Gorizont (communications and television), Ekspress (communications and television), Ekran-M (television) and Nadezhda (navigation and rescue) spacecraft and the GLONASS system.

In 1996 the operation of the long-range telephone and telegraph communication system was maintained, as was the relaying of radio and television programmes and the transmission of data on behalf of various sectors and official authorities of the Russian Federation and international communications by means of the Gorizont, Ekspress, Gals and Ekran-M spacecraft. Two satellites from the Gorizont series and one Ekspress satellite were inserted into geostationary orbit on 25 January 1996, 25 May 1996 and 26 September 1996, respectively.

To ensure operation of the long-range telephone and telegraph communication system and transmission of television programmes to points on the Orbita network, in the interests of international cooperation and also for other economic purposes, a satellite from the Molniya-1 series was orbited on 14 August 1996.

With a view to establishing a low Earth orbit satellite communications system, three Gonets-D1 space objects were launched into artificial Earth satellite orbit on 19 February 1996.

The year 1996 saw the continued operation of the global navigation system (GLONASS) used for navigation by civil aircraft and by naval and fishing vessels, as well as in other areas of the economy.

A total of 25 spacecraft from the Cosmos series are now in orbit as part of the GLONASS system. Of these, 21 spacecraft are being used for special purposes, while the remaining four have been removed from the system to enable checks to be carried out on their condition.

The Nadezhda satellites continued operating within the COSPAS-SARSAT international system for tracking and rescuing sea vessels and aircraft in distress.

2. Remote Earth sensing, meteorological observation and environmental monitoring

The main priorities set in connection with the monitoring of the Earth's natural environment are as follows:

- Monitoring of factors governing weather;
- Environmental monitoring;
- Monitoring of man-made and natural disasters;
- Rational management of natural resources.

The following satellites have been designated in the Russian Federation for current monitoring operations: Meteor-2, Meteor-3, Resurs-01, Okean-01, Resurs-F1, Resurs-F2, Oblik and Elektro. Photographs of the Earth's surface are being taken from on board the Mir manned orbital station.

The aim is to direct the development, production and operation of more sophisticated remote sensing space facilities towards ensuring mutually advantageous cooperation with other countries and organizations possessing extensive experience in the production and operation of similar facilities. In order to achieve this aim, it will be necessary to institute effective and economic forms of multilateral international cooperation in the field of environmental monitoring and disaster warning.

Forms of international cooperation which will make a worthwhile contribution during the initial stages are the exchange of space data and the joint elaboration of international projects aimed at coordinating national space resources within a single comprehensive international remote sensing system.

Issues relating to the environment, the rational utilization of natural resources and the establishment of a natural disaster and catastrophe warning system have acquired enormous importance. Work is being done in this area with a view to the establishment or modernization of all-weather high-resolution Earth observation satellites, and to the use of the defence complex for the benefit of areas of the national economy as part of the process of conversion.

One major problem in using the results of remote Earth sensing is presented by the delays experienced in the establishment and development of the ground-based data-reception and -processing system.

In addition to the speedy use of satellite data in weather analysis and forecasting, research is also being conducted with a view to developing and refining technology for the reception of hydrometeorological and natural-resource data transmitted by satellite.

By means of the Okean-01 satellite, the ice situation in Russia's inland water areas is subject to regular monitoring; ice maps are plotted once per week for the entire Arctic Ocean (on the basis of satellite images in the visible, infrared and ultra-high frequency bandwidths of the spectrum), and are distributed promptly to users for assistance in planning and conducting operations at sea and other economically productive activities such as fishing and mineral exploration and extraction in the shelf areas of the ocean, as well as the production of ice forecasts.

On the basis of thematic processing of radiophysical information received from the Okean-01 satellite, regular use has been made of data on the velocity of sea-surface winds in areas of particularly high precipitation in order to achieve greater precision in the forecasting of hazards over areas of water.

Regular calculations have been made of the temperature fields on the surface of the Indian Ocean using infrared data received from the Elektro satellite.

In satellite agrometeorology, work is continuing to provide a prompt service to users at different hierarchical levels, furnishing information on the condition of agricultural sown crops which is obtained by processing and interpreting data received from meteorological satellites. The technology involved in the processing and interpretation of digital satellite information and data obtained on the ground for the purposes of evaluation of crop condition and yield—technology which is applied in an experimental operational system (in a real-time regime)—makes it possible during the vegetation growing period to make a qualitative and quantitative analysis of the state of crops in 25 regions of the Russian Federation.

In 1996, within the framework of a joint ESA-RSA project, research was carried out on the possibility of monitoring ice cover on the basis of data transmitted from a side-looking radar from the Okean-01 satellite and the ESA ERS-1 satellite (satellite radar monitoring of the ice situation along the North Sea route in real time).

3. Space technologies

Studies in the sphere of space technology and the physics of weightlessness were directed towards the production under microgravity conditions of new organic and inorganic materials and the refinement of the technologies and equipment required for their production, including commercial production. The use for these purposes of both manned and unmanned spacecraft has made it possible to grow crystals with properties which are unobtainable on Earth, thus providing the requisite scientific and technical process stock for the transition to the experimental-industrial production of materials in space. The main purpose of establishing the planned space assembly is to complete the development of basic technologies for producing test parts for semiconductors and other preparations with practical industrial applications.

The space technology programme is being conducted by means of the Foton spacecraft with the participation of ESA member countries. Semiconductor materials produced under microgravity conditions (cadmium telluride, gallium arsenide, zinc oxide, silicon, etc.) have properties representing an improvement on their Earth counterparts by a factor of 50-70. The biological preparations obtained are 5 to 10 times purer than their Earth counterparts.

In addition to operation of the Foton spacecraft, work is also being done with a view to completing the new generation of Nika-T facilities for the purpose of continuing research and experimental-industrial production of new materials under microgravity conditions.

C. Space research programmes

Fundamental research on celestial bodies and outer space contributes to our knowledge of the Universe, the processes at work in it and their impact on the Earth. Such research will assist future human endeavours in space and on the celestial bodies, and will provide a basis for future manned flights to Mars.

A programme of flight experiments is being successfully conducted at the Granat orbital observatory. During seven years of operation a detailed study has been made of several dozen galactic and extra-galactic sources, representing possible black holes, neutron stars (X-ray bursters and X-ray pulsars), X-ray novae, and accumulations of galaxies and quasars; a number of extremely interesting and hitherto unknown objects have been discovered. For the first time sources emitting radiation in the annihilation gamma line of positronium have been localized.

At present the observatory is operating in the scanning regime and is continuing to transmit valuable information.

Solar research is of exceptional scientific importance. The Sun is our principal source of energy and the "generator" of all the main natural processes on Earth and in circumterrestial space. Furthermore, it is the star most accessible to study, being observable from the Earth as an extended object.

The Sun and its corona provide a vast natural laboratory for the study of the fundamental properties of substances in the plasma state. Research conducted on spacecraft from the AUOS (Automated Universal Orbital Station) series using new and sophisticated configurations of scientific instrumentation are substantially improving our understanding of the mechanisms of solar flare activity, and are making it possible to locate the active parts on the Sun's surface and to identify phenomena reliably heralding flares. All of this provides a basis for reliable forecasting of solar activity. A different area of research, that of helioseismology, is based on the recording of mechanical solar oscillations. The resulting data will yield a qualitatively new class of information for the construction of scientifically sound models of the star's internal structure.

Work is continuing in connection with the solar research programme under the international Coronas-I project (research on dynamic, active processes and the properties of solar cosmic radiation and electromagnetic solar radiation in the radio, visible, ultraviolet, X-ray and gamma bandwidths). This project will enable the active parts on the Sun to be located and will make it possible to search for and identify phenomena reliably heralding solar flares and, hence, to produce reliable forecasts of solar activity levels.

Work is also continuing in connection with the international APEX (AUOS-3) project, started in 1991 with the launch of the Intercosmos-25 satellite and the Magion-3 subsatellite, the aim of the project being to study the effects of the artificially generated modulated electron streams and plasma beams on the Earth's ionosphere and magnetosphere. The valuable information yielded by such research is being processed with a view to the identification of meaningful patterns.

Under the Interball international project, the Prognoz-M2 N2 (Auroral Probe) was launched on 29 August 1996. This satellite was launched together with Magion-5 (Czech Republic) subsatellites and the MSAT (Argentina) microsatellite to supplement the Prognoz-M2 N1 (Tail Probe) satellite and the Magion-4 subsatellite operating in orbit since August 1995. This satellite system in space is making it possible to conduct long-term basic research on processes taking place under the influence of solar radiation in the geomagnetic tail (upper and tail ends) of the Earth's magnetosphere. This research forms an integral part of the international programme for investigating the nature and mechanisms of solar-terrestrial interaction by means of spacecraft and ground-based observatories in various countries.

The station has been fitted with scientific instruments designed by scientists and specialists from Austria, Bulgaria, Canada, Cuba, Czech Republic, Finland, France, Germany, Greece, Hungary, Italy, Kyrgyzstan, Poland, Romania, Russian Federation, Slovakia, Sweden, Ukraine, United Kingdom of Great Britain and Northern Ireland and Uzbekistan, and also from ESA.

The results of the research are extremely promising as there is evidence to suggest that changes in the Earth's magnetosphere may be responsible for changes in atmospheric pressure and lead to the occurrence of droughts, cold snaps in various regions of the world and cyclone formation. There is a correlation between these types of phenomenon and fluctuations in animal populations, epidemic cycles, agricultural crop yields and climatic changes. The investigation and identification of patterns and mechanisms of interaction in the behaviour of the Sun and circumterrestrial plasma will provide the key to a closer understanding of the “secret” of life on Earth.

In 1996 it was planned to embark on the major international scientific project Mars-96 devoted to study of the solar system. It was proposed to launch a spacecraft or “orbiter” destined for Mars and to place it in orbit around the planet, whence two small landers and two penetrators would be jettisoned onto the surface of the planet for the purpose of continuing investigations of the physical and chemical properties of its atmosphere, surface and subsurface layer. The release of the small landers was to have taken place four to five days before the arrival at Mars and the release of the penetrators seven to twenty-eight days after the arrival.

A large number of Russian scientific and industrial organizations have been involved in the work on this spacecraft. The main organization concerned with the orbiter was the S.A. Lavochkin Scientific-Production Association (Lavochkin Association), while the Space Research Institute of the Russian Academy of Sciences was involved in the development of the scientific instrumentation of the orbiter and landers. The V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry was responsible for the scientific instrumentation of the penetrators.

For the purposes of the scientific side of the programme, a large number of foreign specialists have been involved in the development, manufacture and installation of the scientific instrumentation.

During the night from 16 to 17 November 1996 the unmanned interplanetary station with a booster module was launched by the Proton rocket carrier into artificial Earth satellite orbit. With the first ignition of the booster engines system the space vehicle was transferred in the standard manner into the basic circular satellite orbit. In the completion phase of the first revolution it was planned that a second ignition of the booster module engine would transfer the Mars-96 station into its Mars flight trajectory. However, the necessary booster impulse was not achieved in the second ignition and the Mars-96 station therefore remained in orbit. There subsequently occurred a separation of the booster module from the space vehicle. Both these objects then entered the dense layers of the atmosphere, where they broke up, their individual fragments falling into the water areas of the Pacific Ocean.

Research continued on the biomedical problems of space activity. In addition to studies conducted on the Mir station or using the Bion spacecraft, pure and applied research is being undertaken in the field of space biology and medicine, and radiation physics and radiation biology experiments, in which biological specimens are returned to Earth. Bion spacecraft have been in operation since 1973, and work is currently under way to prepare the next such spacecraft for launching. Bion experiments, in which specialists from the United States, France and Canada and from ESA have been involved, make it possible to perform detailed neurophysiological investigations of the mechanisms responsible for vestibular disorders and changes in the cardiovascular system. These experiments are aimed at laying the practical foundations for enabling human beings to spend prolonged periods of time under conditions of space flight (studies on radiation safety, strain on the human support and locomotive system, determination of the mechanisms involved in vestibular disorders and changes in the cardiovascular system, and development of methods for their prevention or treatment).

D. International cooperation

One of the most important components of Russia's space programme is international cooperation, which, under the conditions emerging with respect to the international division of labour in space, is called upon to fulfil the missions of assisting States in managing their budgetary resources, accelerating progress in science and technology, and ensuring that the results of space activities are used constructively for the benefit of mankind as whole.

In the Russian Federation, the Russian Space Agency and a number of other interested ministries and national authorities are engaged in the programme for the development of international cooperation in space between the Russian Federation and other countries and international organizations.

Working contacts have been established between Russian companies and organizations and a number of the world's leading aerospace firms and international consortia.

The international space activity of the Russian Federation currently covers virtually all the areas of its Federal Space Programme, in other words: basic space research, research and experiments on the Mir manned station involving the participation of foreign astronauts, the establishment of the International Space Station (ISS), the use of Russian facilities for launching foreign payloads, space biology and medicine, materials science and meteorology, space communications and navigation, launching technology and ground-based space infrastructure, investigation from space of terrestrial natural resources and environmental conditions, and the use of space as a basis for experimental-industrial production.

The following are concrete examples of the international cooperation efforts of the Russian Federation in various fields of space activity:

- Successful launches in 1996 of the foreign satellites INMARSAT-3 and Astra-1F by means of the Russian Proton carrier rocket;
- The implementation according to schedule of a programme of international manned flights on board the Russian orbital station Mir with the participation of astronauts from France and the United States and ESA;
- The successful completion of international space research programmes in the field of astrophysics (Interball), biomedicine (Bion) and space meteorology (Meteor-3);
- The implementation of a number of international projects for remote Earth sensing from space (Scarab), space materials science (Foton) and communications and navigation (SESAT and COSPAS/SARSAT).

The Law on Space Activity is currently in effect in the Russian Federation and work is under way to establish an integrated legislative and regulatory framework with a view to attracting investment by foreign partners on a mutually advantageous basis and permitting extensive penetration of the world space market by Russian enterprise.

With the entry into force of the Law of the Russian Federation on Space Activity and of ordinances and regulations of the Government of the Russian Federation defining State clients, regulating State support and guarantees to foreign investors and establishing a licensing regime in respect of space activity, a steady growth has been discernible in the number of contracts for complex international projects in the field of space calling for warranties and incoming inspections on the part of State clients and the State itself.

Examples of such contracts are those concluded with NASA in respect of work on the Mir station and the ISS and the contract between the M.V. Khrunichev State Scientific and Production Rocket and Space Centre and the Boeing Company for the planning, development and manufacture of a functional energy block for the ISS.

As a result of expanding cooperation between the Russian Federation and foreign partners during the 1993-1995 period, over 80 contracts and agreements were concluded and signed, and around 10 joint companies were established by Russian enterprises together with foreign firms in the space and rocket technology sector.

One such joint enterprise actively engaged in space activity is the company International Launch Services, which provides commercial launching services of the Russian Proton carrier rocket.

In June 1996 the RSA and the State Scientific and Production Rocket and Space Centre TsSKB-Progress (Samara Space Centre), together with the French companies Aerospatiale and Arianespace, set up a joint stock company for the commercial use of the Soyuz family of carrier rockets.

The Russian Federal Space Programme envisages further development and expansion of international cooperation in the field of space, to be achieved with government support through the RSA in the following forms:

- Provision of services in connection with launches of foreign spacecraft using Russian orbiting facilities;
- Installation of scientific instrumentation on behalf of foreign clients on board Russian spacecraft for the purposes of scientific and technological research;
- Use of Russian satellites for various specific purposes on behalf of foreign clients;
- Organization of the reception, processing and utilization of satellite data on behalf of foreign clients;
- Leasing of spacecraft and ground-based infrastructure;
- Joint planning, development and manufacture of spacecraft with foreign partners;
- Joint international pure and applied research;
- Mutually advantageous exchange of information and space technologies in various areas of space activity;
- Flights by cosmonauts and astronauts on board manned Russian spacecraft;
- Training of foreign specialists in the exploration and use of outer space;
- Establishment of a scientific and technical prototype base for the future development of space and rocket technology;
- The use of the Russian experimental base on behalf of foreign clients on a commercial or other, non-commercial basis.

Under the Federal Space Programme, the Russian Federation will be working together with other States to tackle global problems in the following areas:

- The international space environmental monitoring system;
- The space system for forecasting hazardous natural phenomena and monitoring man-made disasters;
- The global satellite system for search and rescue of sea vessels and aircraft in distress;
- The satellite system for tracking the movement of particularly important loads and moving objects;
- The global system of control, monitoring and reduction of technogenic pollution of circumterrestrial space in the interests of ensuring the safety of space flights;
- The unified space system for monitoring compliance with international treaties and agreements.