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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

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II. Replies received from Member States

Cuba

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1. Space activities carried out by Cuba in 2009

The annual objectives of the space activities in Cuba have been satisfactorily met despite the difficult economic situation facing the country following three hurricanes that devastated the country during the past year, causing losses in the order of \$15 billion, according to the latest official data. The situation was exacerbated by the embargo by the United States of America. This year the country's recovery has continued in a spirit of confidence that this complex situation will be overcome thanks to the measures initiated by the Government with the support of the entire population. Below is a brief account of the results obtained in Cuba in 2009 in developing space research and the peaceful uses of outer space.

2. Space meteorology

The country has accorded priority to meteorology, since hurricanes are the natural disaster that causes the greatest damage, and has modernized its meteorological stations and radar installations.

The Institute of Meteorology of the Ministry of Science, Technology and the Environment (CITMA) has continued to improve its weather forecasting, achieving over 90 per cent accuracy, thanks to the work of the eight radar installations, 68 meteorological stations and satellite information.

The timely and systematic dissemination of weather forecasts in the mass media and the measures organized by the civil defence authority have been the main strategy for protecting the population against disasters.

3. Remote observation of Earth

The Institute of Tropical Geography developed a number of remote detection applications in environmental research, especially in the analysis of the spatial changes in the territory. Digital processing of the images captured by the Landsat satellite Thematic Mapper and Enhanced Thematic Mapper (ETM+) sensors established the various changes in land use in the area covered by the Sierra del Rosario Biosphere Reserve from 1985 to 2001. It was also possible to determine the principal changes in mangrove cover of the cays situated to the north of the province of Ciego de Ávila in relation to the region's development. A preliminary analysis was also carried out for automatic detection of changes in the area covered by the Metropolitan Park of Havana using Landsat images. The digital information processing was carried out with ENVI 4.5 software and culminated in supervised and non-supervised classification. Work was also done on the geographical information systems (GIS) MapInfo 9.0 and ArcGis 9.2 for map superimposition, reclassification and production.

The Institute of Tropical Geography applied remote sensing in the digital mapping of the Protected Areas of Cuba, starting with the space images of the Landsat 7 ETM+ satellite, digital processing of which produced an updated chart of Cuba's coastline and cays. The information obtained from the digital processing of the images was correlated to natural elements of the landscape, such as vegetation cover of national protected areas, and socio-economic aspects, such as the road system, the hydrographical network and human settlements.

The Institute of Tropical Geography and the Institute of Ecology and Systematics studied land-use change in the La Coca protected area caused by the degradation of the natural vegetation and the introduction of invasive species of weeds such as marabou and aroma, resulting in the loss of cuabal (a serpentinite xeromorphic thorny shrub), a resource that caused the zone to be declared a protected area that is important to preserve. Maps of land use and the degradation level of that resource were prepared using satellite image change-detection techniques and GIS tools for different years. This permitted analysis of the most important changes that took place during the period 1985-2005, providing a vital contribution to management and protection of the area.

Using the continental fire-detection system with the Queimadas satellites of Brazil's National Institute for Space Research, which provides information in real time on the Internet and stores it on the system's databank, the Institute of Meteorology developed an application for the various users needing information on fire focuses and their dispersion. The geo-referenced information on fires, obtained from the aforementioned databank in "shape" (.shp) format, was transferred to a GIS. A determination was made of the MapInfo GIS procedures and options for data processing and cartographic output that contribute most to an evaluation of the spatial distribution of fires, the context and environment in which they develop, their possible evolution and existing resources for fighting them, through multilayer analysis of mapping information. Any user in Cuba can receive full information on fires detected through this application via a popular medium such as e-mail.

The Higher Institute of Technologies and Applied Sciences and the Institute of Meteorology developed a methodology for monitoring forest fires in Cuba, using an advanced very high resolution radiometer (AVHRR) sensor of the United States National Oceanic and Atmospheric Administration (NOAA) satellite receiving station. Monitoring of this type of natural disaster (such as the forest fire that broke out in the Nueva Paz area of La Habana province) revealed, inter alia, the fire focus, the area covered and the movement of the fire front, all carried out with the GIS IDRISI for Windows 2.01 on the basis of satellite images.

The Institute of Tropical Geography and the Institute of Geophysics and Astronomy developed a methodology for atmospheric correction of Landsat 7 images, using the MODTRAN4 atmospheric correction model in the Fast Line-of-Sight Atmospheric Analysis of Spectral Hyper Cubes module of the ENVI 4.6 software. It was based on rigorous resolution of the radiative transfer equation that connects the scattering and absorption processes. The information produced is a calibrated image with surface reflectance values, a water vapour image, a cloud map and a file of the detailed procedure.

On the basis of image sequences from satellites such as the Earth Probe total ozone mapping spectrometer (EP/TOMS) and the Ozone Monitoring Instrument on

the Aura satellite, it was possible to determine that dust transport from the Sahara over the Atlantic to the Caribbean and Cuba is associated with synoptic-scale processes and shows marked stationarity and a well-defined time-space progression, which is very similar to the time-space progression of dust storm occurrence over the Sahara and Sahel. Given the composition of this dust, the 17 per cent increase in rates of asthma in the Caribbean in recent years is attributed to the high frequency of such clouds, making the area an asthma corridor. The study of the behaviour of these dust clouds in the Caribbean and Cuba in recent years and their influence on the number of cases of respiratory infections, all using digital imaging and multivariate statistical techniques, has been developed by the Institute of Meteorology and the results have been placed at the disposal of the country's health authorities.

The Environment Agency, with its research institutes and centres, launched the project "Development and implementation of the special environment space data infrastructure" as a contribution to the Space Data Infrastructure of the Republic of Cuba portal. A project to identify areas that might be affected by desertification in the country, using Landsat images, is under way. Implementation of the SIG Citricos GIS has continued and is being extended to various agricultural enterprises in the country, offering them a tool for tasks such as monitoring harvesting, improving crop quality, planning planting campaigns and carrying out land-use and environmental studies.

Use of the multilayer perceptron model with artificial neural network (ANN) feed and multispectral imaging with high spatial and radiometric resolution is continuing in studies of soil salinity within the framework of project EI-479, financed by the Flemish Interuniversity Council of Belgium.

Geostatistical models and artificial neural network techniques were used in the temporal and spatial evaluation of evapotranspiration in Cuba. Using the Kriging (optimum interpolator) method in combination with artificial neural networks, it was possible to adjust the thematic information obtained to a higher level of reality.

With the use of special data (thermal images from the NOAA High Rate Picture Transmission (HRPT) satellites), aerial data (thermal images obtained with thermovisors) and land-based data (point measurements of infrared (IR)-thermal radiation temperature taken with IR-thermal thermometers and surface temperature measurements taken with contact probes) and thermal images obtained with thermovisors from the ground and dominant heights, the lowest-level temperature has been determined and, by means of spatial zoning, a thematic map (space map) has been elaborated, which will make it possible to study, inter alia, dissimilar phenomena associated with drought and forest fires and to quantify and monitor changes in the physical characteristics of the land cover.

The project to update Cuba's national land registry using high-resolution satellite images has continued with the help of multispectral images for updating cartography and land use through satellite information by supervised and non-supervised classification methods. It will thus be possible to create a legend linking land occupation categories to the land uses specified in the uniform nomenclature of land uses of the national land registry.

4. Space sciences

During the year under consideration, the regular observations conducted by the Geomagnetic Observatory, the station for vertical monitoring of the ionosphere and the Havana Radioastronomy Station, under the auspices of the Institute of Geophysics and Astronomy (IGA) of CITMA were continued. The data obtained were shared with the international scientific community.

Cooperation between IGA and the Institute of Geophysics of the National Autonomous University of Mexico (UNAM) was further enhanced, and significant improvements were obtained in the quality of the signal of the radio interferometer signal for the interplanetary scintillation array of the Mexican Array Radio Telescope (MEXART).

A study was carried out of the P73/Schwassmann-Wachmann 3 comet on the basis of 27 direct images of fragment C taken with the Isaac Newton telescope at the Roque de Los Muchachos Observatory on the island of La Palma, Spain, and visual observations of the fragments made by the International Astronomical Union (IAU) Central Bureau for Astronomical Telegrams. One interesting result was the observation of a sudden 50-degree change in the orientation of the isophotes close to the nucleus, which took place within the space of only 12 minutes. This could be interpreted as a new emission of gases in a region of the nucleus other than that already emitting or an effect caused by the rotation of the nucleus. This work was supplemented by an analysis of the light curves and their comparison with the behaviour of fragment B. This made it possible to determine the absolute magnitude, the growth rate, the diameter of the comet and formulae for estimating future brightness and the size of the fragments in question.

The photometric characterization of symbiotic stars aimed at finding candidate stars for such systems in the galactic plane is being continued by an IGA doctoral student at the Roque de Los Muchachos Astronomical Observatory in Spain. Of the candidates, 65 have undergone spectral analysis and been classified; they include 11 new symbiotic stars and a number of rare objects in the galaxy.

Specialists at IGA continued to study the directionality of the intensity of protonic energy events exceeding 10 MeV and the distribution of arrival times of plasmoids (interplanetary coronal mass ejections) in the immediate neighbourhood of Earth according to their positions in the Sun, using data from the international solar patrol and satellite observations, following the step-by-step multiple regression method with variation analysis in the preparation of the material.

The Institute has continued to study solar noise storms and proposes a method for segregating their fundamental and sporadic components based on the essence thereof and minimizing the specialist's subjective criteria. The method guarantees replicability of the results and has been successfully applied to a signal with known characteristics. In-depth study of the quasi-periodic structures of solar radio emissions associated with solar bursts has continued with the determination of some of its principal parameters, and inferences concerning the mechanism of generation and the source of the associated radio emissions have been drawn.

The Department of Aerospace Studies of the Institute of Technology and Applied Sciences will soon begin its first degree course in space technology and sciences, with the aim of promoting higher professional skill levels among

specialists, officials and professionals and the conduct of research projects in those areas.

5. International Year of Astronomy

A number of activities and events have been organized to commemorate the International Year of Astronomy, such as the following:

(a) Information on the International Year of Astronomy appeared in various articles on the subject in the print media. There was also a weekly radio programme on astronomy, and a series of seven television programmes on the subject was broadcast during the school holiday period;

(b) The “Cuban postal rocket, heritage and astronomy” event was held to promote knowledge and study of the Cuban postal rocket, establish a link between astronomy and the postal and philatelic fields and fix the memory of the Cuban postal rocket as part of the country’s postal and philatelic heritage in the minds of children, young people and adults. A postage stamp was issued to commemorate the International Year of Astronomy;

(c) A planetarium and science and technology cultural centre are under construction in the heart of the old city of Havana and will be officially opened in December. The project has been developed by the Office of the City Historian, with the support of the Ministry of Science, Technology and the Environment. Its aim is to make the accumulated knowledge of humankind in the fields of astronomy, physics, mathematics and other fields available to ordinary citizens in a pleasant and creative form;

(d) During the year, work took place on a project for the revitalization of the astronomical observatory of the University of Havana with a view to stimulating interest in scientific subjects among the general public, particularly children and young persons. The strategic objective is to awaken interest among students taking general courses in natural and exact sciences, using astronomy as a motivator;

(e) A number of presentations, lectures and discussions for specialists and the general public were held in connection with the Year in cultural, scientific and educational centres. Several scientific and technical festivals, with a special focus on astronomy, were organized for children, young persons and the general public.

6. World Space Week

Events held or planned for World Space Week included the following:

(a) The eighth National Workshop on Outer Space and its Peaceful Uses took place in the Sala Jimaguayú in Havana. Twenty-three presentations were made by various Cuban scientific institutions;

(b) The 16th National Meeting of Amateur Astronomers was to have been held during the Week, but was postponed until December;

(c) The COSMOS Group of the Youth Communist League Youth Technical Brigades met with IGA specialists and researchers to learn about current activities. The Cenit bulletin was presented at the meeting;

(d) The Fotogramas television programme screened the documentary film *Journey to the End of the Universe*.

Once again, no World Space Week posters were received. As in the previous year, the embargo imposed on Cuba by the United States Government prevented their arrival.

Spain

[Original: Spanish]
[19 November 2009]

The Strategic Plan for the Space Sector, covering the period 2007-2011, has as its main objective increasing the dimensions and capacity of the Spanish space industry in order to reach a level in keeping with Spain's position in the world economy. During 2009, Spain has continued work on the initiatives enumerated in the Plan.

Within the Strategic Plan, particular mention should be made of the National Programme for the Observation of the Earth by Satellite, the purpose of which is the development of a national system of satellites capable of producing images on the basis of the two space-based observation technologies: optical and radar observation. The programme involves two satellites, a civilian satellite using optical technology (INGENIO) and a military satellite with radar technology (PAZ). They are expected to be operational in 2014 and 2012, respectively, and will provide information to the Spanish community of users, both civil and military. In the development of these satellites, maximum use is being made of the Spanish space industry, which has assumed the role of principal contractor for the system, the platform and the main instrument. The two satellites will form part of the Spanish contribution to the Global Monitoring for Environment and Security (GMES) programme, the European initiative for Earth observation and security.

During recent years, increased participation by Spain in projects of the European Space Agency (ESA) has been promoted, and Spain has become the main contributor to some projects, such as the Space Situational Awareness programme. This has enabled the Spanish space industry to play a more important role in several projects, while the scientific community has been able to participate more actively in decisions regarding missions. Within the context of this increase in Spain's role on the European space stage, the ESA European Space Astronomy Centre (ESAC), located in Madrid, has been recognized by the Agency as a top-level centre.

Spanish participation in other international projects has also continued. Particular mention should be made of Galileo and GMES, the two projects on which the European Union and ESA are cooperating. Both programmes are of fundamental importance for Spain, which has therefore taken an active part both in terms of contribution and with regard to the participation of Spanish industry.

Two other major initiatives with an important Spanish presence are:

(a) The Meteosat third generation programme, concerned with the development of the third generation of Meteosat satellites. Spain is the

fourth contributor to this programme, the total value of which will exceed 2.4 billion euros;

(b) The Small Geostationary Satellite programme, the purpose of which is to develop a new platform for telecommunications satellites, in which a very important role is played by the Spanish operator HISPASAT, together with the Spanish space industry, responsible for the payload.

Mention should also be made of the launching of two satellites:

(a) The Soil Moisture and Ocean Salinity satellite, an ESA satellite to be launched in November 2009. This is an important venture both for the Spanish administration and for Spanish industry and scientific circles, the SMOS mission being considered the project with the greatest scientific, technological and industrial significance among those so far implemented in Spain for ESA;

(b) Amazonas 2, a communications satellite of HISPASAT, which incorporates a version of the intelligent processor AmerHis — for advanced broadband services — developed by Spanish industry. Amazonas 2 is the largest satellite with pan-American coverage, including 64 transponders.

In addition, Spain has cooperated directly with other countries on international missions such as the Mars Science Laboratory, PRISMA and the World Space Observatory/Ultraviolet, implemented, respectively, in cooperation with the United States of America, France and the Russian Federation.