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Committee on the Peaceful Uses of Outer Space

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

Note by the Secretariat

Addendum

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Canada

A. Milestones in 2004

1. Canada and the European Space Agency (ESA) celebrated the twenty-fifth anniversary of their cooperation in 2004. Activities organized throughout the year to commemorate the occasion culminated in a meeting of global space industry leaders, which took place during the International Astronautical Congress, held in Vancouver, Canada, in October. Canadian Space Agency (CSA) President Marc Garneau and ESA Director-General Jean-Jacques Dordain stated that the cooperation between the two agencies had resulted in significant technological, scientific and industrial discovery, exploration and applications that had, for a quarter century, delivered far-reaching social and economic benefits to humanity. A brochure on the 25 years of cooperation between Canada and ESA can be found at the CSA website (www.space.gc.ca/asc/pdf/canada-esa-25e.pdf).

2. October 2004 marked the twentieth anniversary of Canada's human presence in space. Canadians watched with pride on 5 October 1984 as Marc Garneau became the first Canadian to travel to space; he subsequently took part in three missions, spending a total of 29 days in space and travelling more than 12 million miles.

3. Canada hosted three major international space meetings in 2004: the International Symposium on Physical Sciences in Space/Spacebound in Toronto in May; the annual International Aeronautical Congress in Vancouver in October; and the fifth meeting of the intergovernmental ad hoc Group on Earth Observations, in Ottawa in November.

1. Space awareness and learning

4. A travelling exhibit for museums was created by CSA to mark the twentieth anniversary of Canada's human presence in space. This high-tech kiosk, shaped like the International Space Station, presents videos, models and a space quiz. It will increase awareness of Canada's space achievements, and, in keeping with the recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III),[1] help young people learn about the potential of space while inspiring them to pursue careers in science and technology. Another kiosk is being developed for 2005 as CSA continues to pursue partnerships with museums.

5. As part of its awareness and learning programme, CSA provides a rich variety of curriculum resources and learning opportunities for educators and students. The third annual Educator Training Event, held in August, offered teachers from across Canada presentations and hands-on activities for a wide variety of space subjects, from astronomy and the effects of microgravity on humans to critical thinking and the design of spacecraft. Regular distance-learning workshops with CSA scientists have engaged students all over Canada and in remote regions in critical thinking and hands-on learning. To formalize its relationship with the education community, CSA is now creating learning partnerships with provincial education departments: two agreements were signed in 2004, with more possible in 2005.

6. These formal partnerships will help schools integrate current space and technology subject matter into curricula across Canada. For example, with mentoring from CSA engineers, high-school students from the Province of New Brunswick are developing a robot that can perform tele-robotic surgery. The three-year project will eventually involve students elsewhere through remote access.

7. Launched in 2000, when Marc Garneau carried tomato seeds into space, the developing Tomatosphere project of CSA has students comparing the germination of these seeds to that of control groups. In 2004, over 165,000 students in some 6,000 classrooms participated. In 2005, students will study seeds from a space analogue environment in Canada's high arctic. This project involves partners from academia, government and industry.

2. Space science and exploration

8. Canada continues to develop its contributions to science experiments for the International Space Station, the world's largest microgravity laboratory. The Special Purpose Dexterous Manipulator (Dextre), one of the Canadian robotic contributions to the station, is now being prepared for launch.

9. The official opening ceremony of Canada's Mission Control Centre took place on 9 November 2004, at the John H. Chapman Space Centre, CSA headquarters in Longueuil, Quebec. The Remote Multi-Purpose Support Room monitors robotic operations on the International Space Station. From the Support Room, mission controllers work closely with their Houston counterparts to monitor systems as astronauts and cosmonauts operate Canadarm2 and its mobile base system; after its launch, scheduled for 2007, they will also provide support for the robotic manipulator, Dextre.

10. Canadian astronaut Robert Thirsk participated in the seventh mission of the United States National Aeronautics and Space Administration (NASA) Extreme Environment Mission Operations, an international underwater mission, to test remote surgery applications and equipment in a harsh environment. Tele-mentoring and tele-robotic surgery are techniques that could be used in long-duration, manned space flights, but also have more immediate applications here on Earth. Students of five faculties of medicine took part in a three-way videoconference to discuss the application of space technologies with Dr. Anvari of the Centre for Minimal Access Surgery in Hamilton, Ontario, Canada, who pioneered this technology, with Robert Thirsk, on board the underwater habitat, and with Canadian astronaut Dave Williams at Queen's University in Kingston, Ontario, Canada.

11. In September, Canada announced its participation in the James Webb Space Telescope, an international collaboration among CSA, ESA and NASA. The fine guidance sensor for the telescope will be designed by Canadian companies EMS Technologies and COM DEV International. The telescope will study the formation and evolution of galaxies and new stars.

12. The world's smallest space telescope, Microvariability and Oscillation of Stars (MOST), was launched in June 2003. This suitcase-sized Canadian satellite is forcing astronomers to rethink theories about certain stars and providing new insights into the mysterious giant planets that circle some stars. In summer 2004, MOST revealed that the star Procyon did not oscillate as some theories and observations made from Earth-based telescopes had suggested.

13. Canada's science satellite SCISAT-1, also launched in summer 2003, is carrying a customized Canadian-built Fourier Transform Spectrometer as part of the Atmospheric Chemistry Experiment (ACE) mission, which will run for at least two years. ACE will help scientists measure and understand the chemical processes that control the distribution of ozone in the Earth's atmosphere, especially at high latitudes. The data SCISAT records as it orbits the Earth assist Canadian scientists and policymakers in assessing environmental policy, developing measures for improving the health of Earth's atmosphere and in preventing further ozone depletion. The first series of articles on SCISAT results appeared in a special edition of *Geophysical Research Letters* in 2005.[2]

14. In February 2004, CSA celebrated the third anniversary of the launch and activation of the Optical Spectrograph and InfraRed Imaging System (OSIRIS) instrument on board the Swedish satellite Odin. That satellite, initially launched with a life expectancy of two years, is now preparing to embark on its fifth year of operation. OSIRIS has enabled scientists to precisely define atmospheric vertical structures and continues to capture precise data on ozone depletion. The instrument has resulted in unprecedented innovations in atmospheric tomography, producing the equivalent of a computerized axial tomography (CAT) scan of the atmosphere. From its data, scientists can produce maps of concentrations of aerosols and nitrogen dioxide, which are significant sources of atmospheric pollution, as well as daily, monthly and annual height profile maps of ozone for a given region.

3. Earth observation

15. Space-based Earth observation activities account for the largest single part of the CSA budget. Canada is increasing its commitment to Earth observation as the key to monitoring, understanding and protecting Earth's land, ice and marine environments, measuring the impact of climate change, supporting an international response to disasters and supporting sustainable development in Canada and abroad.

16. Canada has contributed to many Earth observation satellites, both optical and radar, but the measure of Canadian achievement is still the Synthetic Aperture Radar Satellite (RADARSAT)-1. Launched in 1995 with a five-year operational lifetime, the satellite is now in its tenth year and working well. It continues to provide timely images of disaster-affected regions.

17. Canada was the lead agency for the Charter on Cooperation to Achieve the Coordinated Use of Space Facilities in the Event of Natural or Technological Disasters (International Charter "Space and Major Disasters") when the earthquake and tsunami hit South-East Asia on 26 December 2004. CSA coordinated Charter activation response in terms of the provision of space-based imaging to assess the effects of the disaster and helping direct relief efforts on the ground. Canadian space industry partners RADARSAT International and Dendron Resource Surveys also contributed to the relief efforts by expediting RADARSAT-1 data and compiling and developing images showing the impact of the disaster.

18. RADARSAT-1 data were provided on other occasions when the Charter was activated, including in response to the floods in Colombia and Haiti, hurricanes in Haiti and the Caribbean, a major oil spill off the coast of Newfoundland, Canada, as well as forest fires in Bolivia.

19. Canada hosted the fifth plenary meeting of the intergovernmental ad hoc Group on Earth Observations in Ottawa at the end of November. Some 250 delegates from 35 countries and 25 international organizations attended. A 10-Year Implementation Plan was negotiated at the meeting and adopted a few months later at the third Earth Observation Summit, held in Brussels in February 2005. Canada is continuing to co-lead the development of the user requirements and interface model that will be used by the Group on Earth Observations in establishing priorities under the societal benefit areas outlined in the 10-Year Implementation Plan.

20. Canada participates in the service element of the ESA Global Monitoring for Environment and Security (GMES) programme. The GMES Northern View project aims to provide users with a "one-stop shop" to meet the needs of those concerned with northern issues, integrating Earth observation and other information as needed. The project's floe edge information service provides information to northern communities about the location and limits of land-fast ice or floe edges. Activities were expanded in 2004 to include Canada's western Arctic. The project, now named Polar View, benefits from the participation of a number of Scandinavian countries as well.

21. The Ocean's Pulse project studies ocean productivity. It uses satellite-sensed ocean colour data for resource management and the protection of marine environments. These data can help in identifying phytoplankton and in estimating chlorophyll-a, suspended sediment and dissolved organic matter. The project will also lead to better ocean environment models.

22. A Canadian defence exercise used RADARSAT-1 images to assist in a simulated crisis in the north of Canada. The exercise evaluated how RADARSAT-1 and other space-based satellites and telecommunications resources gather and distribute critical emergency information. The all-weather, day-or-night capabilities of RADARSAT-1 were demonstrated to perform ship, ice and change detection over the area.

23. The Government of Canada is committed to leading a number of initiatives in Africa. The Canadian Earth science community collaborates with African partners to focus on meeting the needs of community and regional planners for sustainable development. Recent activities include the development of a national geomatics programme in Tunisia and a topographic database for landmine detection in Mozambique, as well as malaria risk mapping in Kenya.

24. CSA launched Canada's participation in the United Nations Educational, Scientific and Cultural Organization (UNESCO) open initiative on the use of space technology for monitoring World Heritage and natural sites with the following two projects:

(a) Providing RADARSAT-1 imagery for the ESA-led project entitled "Build Environment for Gorilla". This project uses Earth observation resources to chart the mountain habitat of gorillas in various parks for African conservationists working in and around the parks;

(b) Contributing to the Belgian-led initiative called “Système de Gestion d’Information des Aires Protégées” (SYGIAP) (Information management system for protected areas) by providing RADARSAT-1 imagery and base mapping and monitoring World Heritage protected sites in the Democratic Republic of the Congo.

4. Satellite communications and satellite navigation

25. CSA and the Canadian company Telesat launched the Anik F2 telecommunications satellite in July 2004 from French Guiana. The satellite forms part of the National Satellite Initiative of the Government of Canada. This innovative, high-speed Ka-band, multimedia telecommunications satellite, in geostationary orbit above the equator, provides leading-edge telecommunications to Canada’s remote communities.

26. In February, Canada announced an innovative hybrid satellite platform that is scheduled for launch in 2007. The CASCADE, small satellite and ionospheric polar explorer (CASSIOPE) will provide large-volume data telecommunications through the CASCADE payload. It will also gather data on space storms in the upper atmosphere through the enhanced polar outflow probe (ePOP).

27. Canada’s air navigation service provider signed an agreement with the United States Federal Aviation Administration to host four Wide Area Augmentation System (WAAS) reference stations in Canada. The final WAAS network will include stations in Canada, Mexico and the United States. The WAAS signals, broadcast from geostationary satellites, support very precise approaches with vertical guidance to runways. These approaches will enhance safety and reduce flight disruptions at many Canadian airports south of about 60 degrees latitude, without the need to install costly ground-based guidance systems at each airport.

B. Plans for 2005

28. Canada was pleased to host the International Space Station Heads of Agency meeting in Montreal in January 2005, at which the way ahead for completing assembly of the International Space Station was discussed.

29. When the Space Shuttle returns to flight, it will carry the Canadian-built Inspection Boom, an extension of Canadarm that will enable astronauts to survey the Shuttle’s thermal protection system. The boom will be used in orbit to examine the tiles and wing leading-edge panels.

30. Canadian astronaut Robert Thirsk has been training as back-up flight engineer for the Soyuz TMA-6 mission to the International Space Station, which was scheduled for launch in April 2005 from Baikonur Cosmodrome. During the flight, Mr. Thirsk will be stationed at mission control in Oberpfaffenhofen, near Munich, Germany, where he will work as the crew interface coordinator.

31. Steve MacLean is currently training for his second space flight, mission STS-115, scheduled for launch in December 2005. Mr. MacLean will be the first Canadian astronaut to operate Canadarm2.

32. Canada is participating in a joint study on the effects of long-duration bed rest with ESA, the Centre national d’études spatiales of France and NASA. The study,

which will simulate the impact on the human body of long-duration space flight, began in early 2005. Two Canadian-led research projects will study the physiological changes that occur and the effects of countermeasures.

33. The Balloon-borne Large Aperture Submillimetre Telescope (BLAST) mission is set for launch in June from Antarctica. Canadian scientists are collaborating with those of Mexico, the United Kingdom of Great Britain and Northern Ireland and the United States. BLAST will map the interstellar cold dust in order to understand how stars form and will search the sky to look for galaxies at the farthest edge of the universe.

34. The NASA satellite CloudSat, scheduled for launch in July 2005, will use a special radar system to probe clouds. Its radar, with components built by the Canadian firms COM DEV and Communications and Power Industries, will sense cloud thickness, top and base altitudes, and water and ice content. The satellite will also measure the way light is absorbed by various layers of the atmosphere.

35. CSA is also contributing to the CryoSat ice mission of ESA, scheduled for launch in September 2005. CryoSat will measure changes in the elevation of ice sheets and changes in sea-ice thickness with unprecedented accuracy. In doing so, the mission will provide an assessment of the impact that climate change is having on the Earth's polar ice sheets.

36. Two Canadian glaciology teams are participating in the calibration and validation of the CryoSat radar altimeter. In 2004, these teams conducted field campaigns in the spring and autumn to measure surface topography and near-surface stratigraphy of snow and firn along a 48-kilometre stretch of the Devon Island ice cap. The field campaigns were coordinated with overflights by a European aircraft carrying versions of the CryoSat radar altimeter and laser altimeters. The following field campaign was planned for spring 2005, with two more in 2006. The information gathered will provide the basis for retrieving accurate land ice surface elevations from the CryoSat sensor. It will also provide valuable insight into seasonal and year-to-year surface elevation changes to help distinguish short-term variations in thickness from long-term trends.

37. Canada is taking part in the orbit validation phase of the ESA Galileo European satellite-based navigation system, for which a first launch was expected in 2005. Also in the navigation area, WAAS reference stations will be installed in Goose Bay and Gander in Newfoundland and WAAS operations will be approved by the Canadian aviation regulator. The Anik F1R satellite, to be launched in the third quarter of 2005, will carry a WAAS transponder.

38. Operations begin for Anik F2 in 2005, with testing and demonstration projects, including tele-learning in communities of the far north as part of Canada's National Satellite Initiative.

39. Canada's RADARSAT-2 satellite, the follow-on to RADARSAT-1, is scheduled for launch in 2006. It is undergoing testing and validation at the David Florida Laboratory, near Ottawa. This synthetic aperture radar satellite will be lighter than its predecessor, with improved capabilities for monitoring natural resources, coastal areas and ice conditions, while contributing to global resource management, sustainable development and environmental monitoring programmes.

40. Canada is a committed partner to the intergovernmental ad hoc Group on Earth Observations. An interdepartmental team is articulating the Canadian contribution to the Global Earth Observation System of Systems and is actively supporting the development and definition of the user requirements components of the system.

C. Internet addresses

41. The following website URLs are provided for reference:

Organization	*Website URL*
Government of Canada	www.gc.ca
Canadian Space Agency	www.space.gc.ca
Natural Resources Canada	www.nrcan-rncan.gc.ca
Environment Canada	www.ec.gc.ca
National Defence	www.forces.gc.ca
Communications Research Centre	www.crc.ca

Notes

[1] *Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 19-30 July 1999* (United Nations publication, Sales No. E.00.I.3).

[2] *Geophysical Research Letters*, vol. 32, No. 15, 2005.