United Nations A/AC.105/904

General Assembly

Distr.: General
17 December 2007

Original: English

Committee on the Peaceful Uses of Outer Space

Report on the United Nations/Austria/European Space Agency Symposium on Space Tools and Solutions for Monitoring the Atmosphere in Support of Sustainable Development

(Graz, Austria, 11-14 September 2007)

Contents

V.07-89235 (E) 040208 050208

I. Introduction

1. Since 1994, the Office for Outer Space Affairs of the Secretariat, the Government of Austria and the European Space Agency (ESA) have been jointly organizing symposiums on space science and technology and their applications. The symposiums, held in Graz, Austria, have addressed a broad range of themes, including the economic and social benefits of space activities for developing countries, space industry cooperation with the developing world and enhancing the participation of youth in space activities. Information on the symposiums is available on the website of the Office of Outer Space Affairs (http://www.unoosa.org/oosa/SAP/graz/index.html).

2. Since 2003, the symposiums have promoted the benefits of using space science and technology and their applications to carry out the Plan of Implementation of the World Summit on Sustainable Development (Johannesburg Plan of Implementation).[1] A first series of three consecutive symposiums, held in 2003, 2004 and 2005, focused on water resources and sustainable water management (A/AC.105/844). A second series of three symposiums, which started in 2006, has focused on atmosphere-related issues.

3. The first symposium on atmosphere-related issues, the United Nations/Austria/European Space Agency Symposium on Space Tools for Monitoring Air Pollution and Energy Use for Sustainable Development, held in Graz, Austria, from 12 to 15 September 2006, addressed the benefits of using space technologies for monitoring air pollution and energy production (A/AC.105/877). Pursuant to General Assembly resolution 61/111 of 14 December, the United Nations/Austria/European Space Agency Symposium on Space Tools and Solutions for Monitoring the Atmosphere in Support of Sustainable Development was held in Graz, Austria, from 11 to 14 September 2007; it focused on issues such as air quality, climate change and the weather, ozone depletion and ultraviolet monitoring.

4. The symposium held in 2007 was hosted and co-sponsored by the Government of Austria through its Federal Ministry for European and International Affairs and its Federal Ministry for Transport, Innovation and Technology, the State of Styria and the city of Graz and ESA and supported by the National Aeronautics and Space Administration (NASA) of the United States of America. It was the fourteenth in a series of symposiums organized through the United Nations Programme on Space Applications in cooperation with those co-sponsors.

5. The information note, final programme, press releases and all presentations made at the symposium can be found on the website of the Office for Outer Space Affairs (http://www.unoosa.org/oosa/SAP/act2007/graz/index.html). The website also provides links made available by the symposium participants, to useful reference and tutorial materials, as well as to atmosphere-related data and websites.

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[1] *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 2, annex.

A. Background and objectives

6. One frequently used definition of sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (A/42/427, annex, para. 27). At the World Summit on Sustainable Development, held in Johannesburg, South Africa, from 26 August to 4 September 2002,[2] heads of State and Government reaffirmed their strong commitment to the full implementation of Agenda 21,[3] which had been adopted at the United Nations Conference on Environment and Development, held in Rio de Janeiro, Brazil, from 3 to 14 June 1992. They also committed themselves to achieving internationally agreed development goals, including those contained in the United Nations Millennium Declaration (General Assembly resolution 55/2). The Johannesburg Declaration on Sustainable Development[4] and the Johannesburg Plan of Implementation were both adopted at the World Summit.

7. In its resolution 54/68 of 6 December 1999, the General Assembly endorsed the resolution entitled "The Space Millennium: Vienna Declaration on Space and Human Development",[5] which had been adopted by the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), held in Vienna from 19 to 30 July 1999. UNISPACE III had formulated the Vienna Declaration as a nucleus of a strategy to address future global challenges using space applications. In the Vienna Declaration, the States participating in UNISPACE III noted the benefits and applications of space technologies in addressing the challenges to sustainable development, as well as the effectiveness of space instruments for dealing with the challenges posed by the pollution of the environment and the depletion of natural resources.

8. Space science and technology and their applications can provide important information in support of policy and decision-making for sustainable development. In some cases, space-based solutions are essential or afford the only or most cost-efficient means of collecting specific data. For example, the gathering and assessment of global environmental information can often only be accomplished by space-based sensors.

9. The implementation of the recommendations contained in the Vienna Declaration can therefore support a wide range of actions called for in the Johannesburg Plan of Implementation. Consequently, in 2002, the Office for Outer Space Affairs organized a symposium in Stellenbosch, South Africa, immediately prior to the World Summit on Sustainable Development to consider steps to carry

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[2] *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum).

[3] *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992* (United Nations publication, Sales No. E.93.I.8 and corrigenda), vol. I: *Resolutions adopted by the Conference*, resolution 1, annex II.

[4] *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 1, annex.

[5] *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), chap. I, resolution 1.

out actions proposed for inclusion in the Johannesburg Plan of Implementation. That symposium recommended that pilot projects should be launched to demonstrate the operational capabilities of space technologies to support sustainable development. Starting in 2003, as follow-up to that recommendation, the symposiums held in Graz, Austria, have been dedicated to promoting the benefits of using space science and technology and their applications to carry out the Johannesburg Plan of Implementation.

10. The themes of the symposiums are closely linked to the work of the Commission on Sustainable Development, an intergovernmental body set up in 1992 to consider the implementation of the recommendations on sustainable development made during major global conferences, such as the United Nations Conference on Environment and Development and the World Summit on Sustainable Development.

11. The Commission on Sustainable Development is pursuing a programme of work covering the period 2004-2017, which is split into two-year cycles, each cycle focusing on a thematic cluster and on a number of cross-cutting issues. Each cycle is made up of a review year, during which the Commission seeks to identify obstacles and constraints to implementation, and a policy year, in which the Commission decides on measures to accelerate implementation and to mobilize action to overcome the obstacles and constraints identified in the review year.

12. The thematic cluster for the period 2006-2007 includes the issues of air pollution, atmosphere and climate change, which coincide with the focus of the current series of symposiums. Thus, the recommendations and conclusions of the symposiums form part of the contribution of the Committee on the Peaceful Uses of Outer Space to the work of the Commission on Sustainable Development.

13. The symposium in 2007 was held at the Institute for Space Research of the Austrian Academy of Sciences, in Graz, Austria. The specific objectives of the symposium were:

(a) To inform about the framework of the World Summit on Sustainable Development and about the work of the Commission on Sustainable Development and to provide a comprehensive introduction to the context and role of atmosphere monitoring in support of sustainable development;

(b) To promote and inform about ongoing relevant national, regional and global initiatives (such as those of the Committee on Earth Observation Satellites (CEOS), the Group on Earth Observations (GEO) and the Global Earth Observation System of Systems (GEOSS), the Global Monitoring for Environment and Security (GMES), the United Nations Programme on Space Applications and World Meteorological Organization (WMO) programmes) and the uses of the demonstrated capabilities of space technology and their applications related to monitoring of the atmosphere, in particular in addressing air pollution, climate change and weather, ozone depletion and ultraviolet radiation;

(c) To examine the available tools, solutions and informational resources based on space technology (for example, operational and meteorological satellites, research satellites, data dissemination means through systems such as GEONETCast and the WMO integrated global data dissemination service) to address issues related to monitoring of the atmosphere and to accessing and utilizing those resources;

(d) To examine possibilities and strategies for including tools, solutions and informational resources based on space technology for making decisions on issues requiring information on the state of the atmosphere;

(e) To identify the type and level of available or desirable training for using the relevant tools, solutions and resources;

(f) To examine existing functional partnerships and cooperation opportunities, as well as the possible need for new frameworks for cooperation that could be established through voluntary actions that could include the promotion, by Governments, international organizations and other relevant stakeholders, of the use of space technologies for monitoring the atmosphere.

14. Participants in the Symposium were expected to gain:

(a) Understanding of the framework of the World Summit on Sustainable Development, the context of sustainable development, the role of atmosphere monitoring within that context, the capabilities of the relevant tools, solutions and informational resources based on space technology and strategies for including such resources in applicable decision-making processes;

(b) Knowledge of tools, solutions and informational resources based on space technology for monitoring the atmosphere; and knowledge of ways to utilize existing or establish new functional partnerships to promote the operational use of space technologies;

(c) Understanding of national, international and regional strategies, programmes and projects to promote sustainable development, in particular with regard to atmosphere-related issues.

B. Attendance

15. The Symposium was attended by 59 participants from the following countries: Algeria, Austria, Bangladesh, Belgium, Brazil, Cambodia, Cameroon, China, Ecuador, Egypt, Gambia, Germany, India, Indonesia, Iraq, Kenya, Lebanon, Mexico, Myanmar, Nepal, Nigeria, Pakistan, Philippines, Seychelles, Slovenia, South Africa, Sudan, Suriname, Syrian Arab Republic, Thailand, Tunisia, Uganda, United States, Uruguay, Uzbekistan and Viet Nam. The following intergovernmental, international and national organizations were also represented: the Central Institute for Meteorology and Geodynamics of Austria, the International Institute for Applied Systems Analysis, the Intergovernmental Panel on Climate Change, the International Year of Planet Earth, the European Commission, the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), ESA, NASA, the United States Geological Survey, WMO and the Office for Outer Space Affairs.

16. Funds allocated by the United Nations and the co-sponsors were used to cover the costs of air travel, daily subsistence allowance and accommodation of 29 participants from developing countries and countries with economies in transition. The co-sponsors also provided funds for local organization, facilities and transportation of participants.

17. Those participants who received financial support from the United Nations and the co-sponsors had to be in managerial or decision-making positions in Government or research institutions responsible for carrying out programmes or projects dealing with the theme of the symposium or had to be working in space or meteorology-related institutions or companies conducting activities concerned with monitoring the atmosphere. Individuals who had started or were involved in the implementation of atmosphere-related projects or outreach activities in their institutions and women carrying out any of the above responsibilities were particularly encouraged to apply.

18. In preparation for the symposium, participants were asked to become familiar with the Johannesburg Plan of Implementation and with the recommendations of UNISPACE III. The relevant documents were made available through the website dedicated to the symposium. Participants were also informed that they would be expected to actively contribute to preparing the conclusions and recommendations of the symposium (see chapter III below).

C. Programme

19. The initial draft programme for the symposium was prepared by the Office for Outer Space Affairs. It was subsequently refined and finalized by an international programme committee that met twice prior to the symposium.

20. The symposium programme included a series of technical presentations on examples of the successful application of tools based on space technology that provided cost-effective solutions or essential information for planning and implementing programmes or projects related to monitoring the atmosphere. The symposium was specifically designed to feature presentations focusing on the needs of end-users engaged in monitoring the impacts of air pollution, climate change and weather, ozone depletion and ultraviolet radiation and associated health risks.

21. Those participants who received financial support from the United Nations and the co-sponsors were asked to prepare short presentations on their professional work related to the symposium. The presentations were delivered as an integral part of the symposium programme.

22. For the first time, the symposium also featured an interactive training session on satellite tools and their applications for monitoring air quality, sponsored and organized for the participants by NASA.

23. Participants appreciated a small exhibition booth with information on the International Year of Planet Earth, 2008 (IYPE), which was declared by the General Assembly in its resolution 60/192 of 22 December 2005. Preparations for IYPE took place in 2007 and 2009 is expected to be a follow-up year. IYPE is a joint initiative of the United Nations Educational, Scientific and Cultural Organization and the International Union of Geological Sciences.

24. The opening ceremony included introductory and welcoming statements by representatives of the Austrian Academy of Sciences, the Federal Ministry for European and International Affairs and the Federal Ministry for Transport, Innovation and Technology of Austria, the city of Graz and the Office for Outer Space Affairs.

25. Representatives of the Intergovernmental Panel on Climate Change and the International Institute for Applied Systems Analysis made the keynote speeches. In her presentation entitled "Tomorrow's climate: today's challenge for sustainable development", the representative of the Intergovernmental Panel on Climate Change informed participants about the Panel's Fourth Assessment Report and summarized its latest findings: global warming was real and man-made, and efforts at achieving sustainable development would have to take climate change issues into account; the costs of stabilizing the climate were manageable if measures were taken immediately.

26. In his presentation, the representative of the International Institute for Applied Systems Analysis described the role that Earth observations could play in addressing and mitigating climate change and in promoting sustainable development. He noted that considerable economic benefits could be reaped if the potential of Earth observations were fully utilized and if information and facts gathered through Earth observations were used to guide policymaking and decision-making in support of sustainable development. He also pointed out that international efforts were being made to establish GEOSS in the framework of GEO.

27. Following the keynote speeches, the organizers recalled the objectives and organizational aspects of the symposium. Participants in the 2006 symposium then reviewed the highlights, outcome and follow-up activities of that year's symposium.

28. An introductory presentation reviewed the basic principles of Earth observations, satellite applications and atmospheric monitoring, which was helpful for better understanding the subsequent presentations, grouped into the following thematic sessions:

(a) Global and regional activities;

(b) Space tools for atmosphere monitoring;

(c) Air quality: the ozone and particulate matter;

(d) Climate change and the weather;

(e) Interactive training on satellite tools and applications for air quality.

29. A total of 24 speakers from both developing and developed countries were invited to give presentations; 18 funded participants also delivered presentations. Ample time was set aside in the programme for discussions among participants.

II. Summary of presentations in the thematic sessions

30. The present chapter provides a short summary of the main issues addressed by the speakers who were invited to give presentations in the thematic sessions. The symposium programme, background materials, presentations and reports of the sessions drafted by the rapporteur are available at the symposium website (http://www.unoosa.org/oosa/en/SAP/act2007/graz/index.html).

A. Global and regional initiatives

31. The purpose of the session on global and regional initiatives was to review those ongoing global and regional initiatives that addressed issues related to the theme of the symposium. Through the introductory presentations, participants were familiarized with the latest developments in the GEOSS of GEO.

32. In the session, the representative of WMO introduced the Space Programme of that organization, which he said was aimed at developing the space-based Global Observing System (GOS) and enhancing its applications and its benefits to users. It was noted that the scope of GOS was being expanded beyond operational meteorology to address the needs of climate monitoring and other WMO programmes, including, for instance, on atmospheric composition and air quality. The space-based GOS would rely on a variety of satellite constellations on geostationary, low sun-synchronous and non-sun-synchronous orbits, implying that a number of missions that were being planned or implemented as non-operational scientific missions should, in the future, be undertaken on an operational basis, with a commitment for long-term continuity and broad accessibility of data.

33. The progress made by the European Global Monitoring for Environment and Security (GMES) initiative and its atmosphere service was described by a participant representing both the European Commission and the European Environment Agency. GMES would provide wide-ranging information services using Earth observation techniques, thus responding to the needs of users. The atmosphere services offered by GMES complemented information supplied by meteorological services by addressing issues related to atmosphere composition, in particular, air quality, climate forcing, ozone and ultraviolet radiation. It would include global and European components. GMES also represented a coherent European approach within GEO, and many of its services would be made available globally.

34. Presentations made by participants in the session on global and regional initiatives addressed the following topics: the Indian space programme and its contribution to atmosphere and climate change monitoring for sustainable development (India); deriving the relationship between the normalized differenced vegetation index value of images gathered by the National Oceanic and Atmospheric Administration of the United States and biomass, dry mass, and range land capacity in the eastern part of the Syrian Arab Republic (Syrian Arab Republic); activities of the Ministry of Planning and Development Cooperation (Suriname); the environment information management system of the Gambia in support of sustainable development (Gambia); space tools and applications in the context of national spatial data infrastructure in Nepal (Nepal); small satellite technologies for atmospheric monitoring (Mexico and United Kingdom of Great Britain and Northern Ireland); activities of the Climate Prediction and Application Centre of the Intergovernmental Authority on Development (Kenya).

B. Space tools for atmosphere monitoring

35. The session on space tools for atmosphere monitoring familiarized participants with readily available space tools for monitoring the atmosphere. A priority criterion

for the selection of the presentations was the desire to provide useful, practical information tailored to the needs of the symposium participants.

36. A major issue for the use of space tools and solutions was the importance of being able to get reliable and near real-time access to environmental data. It was noted that GEONETCast was an initiative in the framework of GEOSS promoting networking with a view to disseminating environmental data. It was an affordable, satellite-based data dissemination solution building on the EUMETCast system of EUMETSAT, a generic, multi-mission dissemination system based on Internet Protocol over digital video broadcasting. GEONETCast was operational, had almost global coverage and was disseminating a wide range of data and products, with new data and products being added continuously. GEONETCast had been deployed to a number of countries where alternative data dissemination means, such as the Internet, were not available, not affordable or not reliable enough to receive vast amounts of environmental data. An operational GEONETCast station was displayed and demonstrated at the symposium.

37. In another presentation, the concept of the CEOS Virtual Constellations was introduced. It was noted that that concept was being developed by the members of CEOS in an effort to better coordinate various national space missions and was a contribution by CEOS to GEOSS. The concept defined a set of specific requirements to which satellite missions of a certain category needed to adhere in order to be accepted as part of one of the CEOS Virtual Constellations. It was expected that such a concept would motivate satellite operators to make their missions and data more compliant and interoperable. It was also noted that the Atmospheric Composition Constellation was one of several pathfinder constellations developed in that framework and that its goal was to collect and deliver data to develop and improve the predictive capabilities for coupled changes in the ozone layer, air quality and climate forcing associated with changes in the environment.

38. It was noted that the Protocol Monitoring for the GMES Service Element: Atmosphere (PROMOTE) project was constructing sustainable and reliable operational services to support informed decision-making on atmospheric policy issues. On the basis of user requirements and the maturity of satellite and ground-based observations, PROMOTE dealt with five themes: the ozone, ultraviolet radiation, air quality, climate and special services such as the monitoring of air particles emitted by volcano eruptions. PROMOTE provided the public sector and citizens with information. All data products and services were available online, free of charge (http://www.gse-promote.org).

39. The African Monitoring of the Environment for Sustainable Development (AMESD) project was launched to improve decision-making processes in the fields of environmental resource and risk management in Africa. It aimed to increase the information management capacity of African regional and national institutions responsible for environment-related sectors and to facilitate access to Africa-wide environmental information derived from Earth observation technologies. AMESD was considered a GMES component for Africa, making use of GEONETCast as its primary data dissemination method. AMESD also provided opportunities for other initiatives to be launched, for example, through the capacities built in the course of the project.

40. In a presentation on the use of satellite communications for ground monitoring, it was stated that environmental data, including data gathered on site, needed to be delivered to processing centres that, in turn, would further disseminate the processed data to users and decision makers. A comprehensive overview of operational satellite solutions for those requirements was presented.

41. Presentations by participants in the session addressed the following topics: products and services for sustainable development of the Philippine national meteorological and hydrological services (Philippines); space tools and solutions for atmosphere monitoring in support of sustainable development (Algeria); the recent activities in atmospheric chemistry remote sensing of the National Satellite Meteorological Center of the China Meteorological Association (China).

C. Air quality: the ozone and particulate matter

42. In an introductory presentation, entitled “Whose air do we breathe?”, it was pointed out that air pollution knew no boundaries and was a global problem. Ground-based information alone was limited in terms of availability and usefulness since, for example, it did not allow for tracing the origin of pollution. The speakers noted that space-based tools were the best way to map the global distribution of air pollution and highlighted the remote sensing by satellite of regional and intercontinental aerosol pollution as a particularly useful tool. The speaker also pointed out that without monitoring it was not possible to implement effective and efficient policies. For example, monitoring showed that gains made through domestic control strategies were often offset by the effects of transporting pollution over large distances.

43. Using the example of Nigeria, the challenges of monitoring the atmosphere faced by a developing country and the possible ways to overcome the difficulties were the focus of another presentation. It was noted that few measurements had been taken in the tropics to determine the base levels of stratospheric ozone depletion and the associated ultraviolet radiation penetration to the surface. Most equatorial regions were underdeveloped and so the means of monitoring ozone, ultraviolet or atmospheric aerosol levels in those regions were limited or non-existent. The Government of Nigeria was committed to using space technology for sustainable development. Efforts would be made to integrate surface observations with near real-time space-based data for delivering effective and efficient forecast services to the public.

44. The subsequent presentation described the status of satellite and ground-based aerosol monitoring in Pakistan. The negative health impact of aerosols and air pollution aggravated by monsoon rainfall provided a strong rationale for reducing air pollution in developing countries. As ground-based measurements were limited in space and time and particles were transported over long distances away from their sources, a combination of satellite and ground-based monitoring systems was essential for providing information for decision-making.

45. Participants were presented with case studies of the regional use of satellite data for air quality forecasting and for near real-time analysis, as demonstrated by the United States ambient real-time air monitoring and ambient air quality forecasting systems (AirNow, Infusing Satellite Data into Environmental

Applications (IDEA) and the Geostationary Operational Environmental Satellite (GOES) Aerosol and Smoke Product (GASP)) and the Mesoamerican Regional Visualization and Monitoring System (SERVIR).

46. The status of satellite-based air quality monitoring in South Africa and of urban air quality monitoring in the metropolitan area of Manila were the themes dealt with by the last two invited speakers.

47. Presentations by participants in the session addressed the following topics: research of atmospheric air quality in Uzbekistan (Uzbekistan); the use of software and geographic information systems for reducing greenhouse gas emissions and environmental pollution (Viet Nam); urban climate analysis on Land-Use and Land-Cover changes in Bandung, Indonesia, using remote sensing and geographic information systems (Indonesia); and remote sensing in Uganda (Uganda).

D. Climate change and the weather

48. The session included presentations on climate change and the weather. Representatives of the United States Geological Survey introduced the Center for Earth Resources Observation and Science and its activities in remote sensing and monitoring of the land surface for achieving sustainable development, including for addressing issues such as desertification, carbon sequestration and a range of other sustainable development interventions. The presentation also provided information on the regional centres and on continent-wide capacity-building efforts in Africa.

49. The valuable contributions that radio occultation measurements could make to climate change monitoring and atmospheric change analysis were addressed in another presentation. Operational radio occultation data from the meteorological operational satellite (Metop) ground-based regional augmentation system (GRAS) sensor had become available.

50. It was noted that Meteoalarm was a Europe-wide system for disseminating warnings about a wide range of meteorological events. It was an Internet-based operational system (http://www.meteoalarm.eu) that, in addition to the warnings, also provided advice on how to respond to a given situation. Meteoalarm was linked to the Severe Weather Information Centre of WMO. Lessons learned from the system were also being applied to European and South Asian river basins to enhance capacity and implement adaptive management approaches, such as that used by the integrated water resources management project Brahmatwinn.

51. In another presentation, participants were informed about the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER), a programme within the United Nations aimed at providing universal access to all types of space-based information and services relevant to disaster management.

52. Presentations by participants in the session addressed the following topics: the meteorological natural disasters warning system of Thailand (Thailand); the application of satellite imagery for monitoring atmospheric events and sustainable development in Bangladesh (Bangladesh); atmosphere monitoring of the marsh zones in Iraq to support the country's sustainable development (Iraq); satellite remote sensing for coastal engineering (Tunisia).

E. Interactive training on satellite tools and applications for air quality

53. The training session featured scenarios, data assessment and image analysis techniques and the use of relevant online resources to convey the benefits and challenges of using space-based tools in assessing actual atmospheric events. Participants grouped into small teams and worked through case studies, including a major wildfire, a large dust storm and regional air pollution events. The participants used space-based image data and software that were freely available on the Internet. Trainers guided and instructed the teams throughout the interactive training sessions.

54. During the feedback discussions, participants stressed the high value of the training, which had made them familiar with space-based data, information and tools of which they had been unaware. Several participants noted that the institutions they represented would benefit from the knowledge gained during the interactive training session.

III. Conclusions and recommendations

55. The final day of the symposium was dedicated to the discussion of follow-up activities and to working group meetings.

56. It was noted that capacity-building efforts in space science and technology were a major focus of the activities of the Office of Outer Space Affairs. Such efforts included providing support to the regional centres for space science and technology education, affiliated to the United Nations, whose goal was to develop, through in-depth education, an indigenous capability for research and applications in the core disciplines of: (a) remote sensing and geographical information systems; (b) satellite communications; (c) satellite meteorology and global climate; and (d) space and atmospheric sciences and data management. The regional centres were located in Morocco and Nigeria for Africa, in Brazil and Mexico for Latin America and the Caribbean and in India for Asia and the Pacific.

57. Representatives of the GEO User Interface Committee and the Asian Institute of Technology, Thailand, presented a proposal for an air quality training programme. The training programme would provide an introduction to satellite remote sensing and Earth observation and their application to air quality management and decision-making. It was designed for an audience of air quality managers, planners and forecasters and for people with technical knowledge of air quality planning, monitoring and forecasting. The proposed training programme, which could be held at the Asian Institute of Technology, would also build on the results of the 2006 and 2007 symposiums.

58. The participants then formed into two working groups, with one group focusing on training and capacity-building and the other on the availability and use of data and tools for atmosphere monitoring. Those two topics had been identified as major priority issues. The working groups were tasked to identify needs, possible follow-up actions and recommendations that they wished to bring to the attention of Member States through the present report. Based on the discussions held at the

symposium and in the working groups, the participants then adopted a set of recommendations and conclusions, which are detailed below.

A. Working group on training and capacity-building

59. The working group acknowledged that many training opportunities already existed for space applications experts, including those provided by the regional centres for space science and technology education, affiliated to the United Nations; the education and training programmes provided by WMO, including the training programmes of the WMO Regional Meteorological Training Centres; the programmes offered by regional and international organizations like EUMETSAT; the funds, programmes and regional commissions of the United Nations; the Regional Centre for Training in Aerospace Surveys; the programmes of the United Nations University; and the programmes of universities such as the Asian Institute of Technology and the International Institute for Geo-Information Science and Earth Observation. Many of the programmes provided scholarships to help applicants from developing countries.

60. It was noted that, prior to designing or launching new training programmes and to ensure that resources would be deployed efficiently, a survey should be conducted to assess whether suitable training opportunities were already being offered by existing training providers. If such opportunities were not readily available, institutions in need of the training should consider expressing their specific requirements to existing training providers. The two parties could then collaborate in adapting existing programmes to the particular needs of the requesting institutions. For that to work, the institutions would have to become more proactive in expressing their needs and avoid being the passive recipients of training programmes that were often designed on the basis of assumptions made by providers who were not necessarily familiar with the exact needs of the customer.

61. Participants in the working group also noted that ongoing GEOSS activities, in particular those being carried out within the GEO Capacity Building Committee and the GEO Communities of Practice, might provide a structured framework for bringing training needs to the attention of training providers. An advantage of that approach was that the GEO process was being conducted at a high level of visibility, involving officials at the highest level in developing countries.

62. The working group then focused its discussions on the type of training that developed capacity for the broader use of atmosphere and climate related satellite data and their interpretation for weather forecasts, air quality assessments and meteorology to benefit society by improving policymaking and decision-making. Participants expressed the need for that type of training and made the following recommendations:

(a) Since training was not effective if conducted in isolation and to support the introduction, integration and sustained use of satellite data into operational applications and for capacity-building, training should be conducted in the context of projects with well-defined needs and requirements. Moreover, it should be carried out by the relevant organizations in the country to ensure that project results were channelled into the relevant policymaking and decision-making processes. The aim of the project-based approach was to ensure the “sustainable involvement” of

the recipient of training and to guarantee that there was a means for ending the training;

(b) The training should be designed with a view to applying the information learned to concrete and realistic situations and to promote the sustained use of satellite data. The case studies conducted as part of the interactive training session of the symposium were noted as appropriate examples;

(c) A primary requisite for success in the delivery of training was the involvement of appropriate experts and decision makers, such as managers responsible for land use in a specific area and application experts, as well as individuals who could pass on their knowledge as future trainers;

(d) Training should include end-to-end services tailored to the needs of the project, linking requirements with data collection, and cover the relevant software and standard protocols for analysis, as well as data assimilation techniques and procedures. In that context, the training should also take into account the capacity of the customer. For example, it was not useful to provide training on software and applications that customers could not use in their home countries;

(e) The impact of each training programme should be monitored and evaluated. Programmes that did not have the desired impact should be modified or discontinued so that scarce resources could be concentrated on training that measurably contributed to capacity-building.

B. Working group on the availability and use of data and tools for atmosphere monitoring

63. The second working group discussed data needs, data availability, data access and data flow, infrastructure and the process leading from training to accessing data to implementation.

64. In terms of atmospheric monitoring, data was needed for measuring, modelling and forecasting volcanic ash, dust storms and industrial pollution. Data should make it possible to forecast such events well in advance. Participants noted that while they had a reasonably good understanding of their local conditions, there was a need for timely access to continental and intercontinental scale satellite data for the transport of pollution. However, in addition to satellite data, there remained a need for improved ground measurements of atmospheric composition.

65. To meet that need, a phased approach was suggested that would start with making use of available and readily accessible data and then progress to satellite and model-based forecasting.

66. In this context, the working group noted a number of challenges:

(a) Limited accessibility to the Internet and to adequate staffing and infrastructure in some areas. In particular, some countries needed to invest more in infrastructure to support access to data and images. In some instances the infrastructure for high-speed Internet access was readily available but unaffordable;

(b) Although relevant data were collected in some regions, such measurements were not done systematically and, often, the lack of adequate control measures meant that the quality of the data could not be guaranteed;

(c) The need to access data at a scale larger than the local or regional level raised the issue of data sharing. Regional or international cooperation might be needed for creating a unified and more effective system. Participants noted that there were complex issues related to the sharing of data between countries, as well as between organizations within a country. They acknowledged the importance of the GEO framework for discussions on data sharing;

(d) Access to space data needed to be simplified. While useful data were currently often made available free of charge over the Internet and through other means, such as GEONETCast, there was no comprehensive catalogue or portal listing what type of data was accessible and where to find the data. It was noted that the GEOPortal (http://www.geoportal.org) under development by GEO might address that issue;

(e) There was often a gap between the meteorological community and the entities responsible for air pollution monitoring that needed to be bridged in order to efficiently and effectively gather air quality information suitable for policymaking and decision-making.

67. Participants indicated their intention, following the symposium, to champion the cause in their regions and to contribute to bridging the distance between air pollution and meteorological entities in their countries and to raise awareness about local and transboundary pollution issues. As a first step, they decided to create an annotated list of links to websites that provided data and information on issues related to air pollution, such as long-range transport, and related sources of data and images. Those links had been published on the symposium website.

68. The working group noted that a reference manual describing the requirements and implementation guidelines for the establishment of monitoring observatories and for setting up measuring instruments to establish a basic capacity for atmosphere monitoring would be useful. Such a manual would help developing countries that did not have adequate monitoring systems.

69. Participants in the working group also concluded that countries needed to provide resources for training in air quality monitoring, including through e-learning. In this context, it was noted that Member States should do more to provide support for training to the regional centres for space science and technology education, affiliated to the United Nations, and to make better use of their infrastructures and resources.