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Committee on the Peaceful Uses of Outer Space

Report on the Fifth United Nations/European Space Agency/National Aeronautics and Space Administration/Japan Aerospace Exploration Agency Workshop on Basic Space Science and the International Heliophysical Year 2007

(Daejeon, Republic of Korea, 21-25 September 2009)

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I. Introduction

A. Background and objectives

1. The Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), in particular through its resolution entitled “The Space Millennium: Vienna Declaration on Space and Human Development”, recommended that activities of the United Nations Programme on Space Applications should promote collaborative participation among Member States, at both the regional and the international level, in a variety of space science and technology activities, by emphasizing the development and transfer of knowledge and skills to developing countries and countries with economies in transition.¹

2. At its fifty-first session, in 2008, the Committee on the Peaceful Uses of Outer Space endorsed the programme of workshops, training courses, symposiums and conferences planned for 2008.² Subsequently, the General Assembly, in its resolution 63/90, endorsed the activities of the United Nations Programme on Space Applications for 2009.

3. Pursuant to Assembly resolution 63/90, and in accordance with the recommendations of UNISPACE III, the United Nations/European Space Agency/National Aeronautics and Space Administration/Japan Aerospace Exploration Agency Workshop on Basic Space Science and the International Heliophysical Year 2007 was held in Daejeon, Republic of Korea, from 21 to 25 September 2009. The Korea Astronomy and Space Science Institute hosted the Workshop on behalf of the Government of the Republic of Korea.

4. Organized by the United Nations, the European Space Agency (ESA), the National Aeronautics and Space Administration (NASA) of the United States of America and the Japan Aerospace Exploration Agency (JAXA), the Workshop was the fifth in a series of workshops on basic space science and the International Heliophysical Year 2007 proposed by the Committee on the Peaceful Uses of Outer Space, on the basis of discussions of its Scientific and Technical Subcommittee, as reflected in the report of the Subcommittee (A/AC.105/848, paras. 181-192). The four previous workshops in the series were hosted by the Governments of the United Arab Emirates, in 2005, India, in 2006, Japan, in 2007, and Bulgaria, in 2008 (A/AC.105/856, A/AC.105/882, A/AC.105/902, A/AC.105/919, respectively).³ Those workshops were a continuation of the series of workshops on basic space science that were held between 1991 and 2004, hosted by the Governments of India (A/AC.105/489), Costa Rica and Colombia (A/AC.105/530), Nigeria (A/AC.105/560/Add.1), Egypt (A/AC.105/580), Sri Lanka (A/AC.105/640), Germany (A/AC.105/657), Honduras (A/AC.105/682), Jordan (A/AC.105/723),

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), chap. I, resolution 1, sect. I, para. 1 (e) (ii), and chap. II, para. 409 (d) (i).

² *Official Records of the General Assembly, Sixty-third Session, Supplement No. 20* (A/63/20), para. 76.

³ Information on the International Heliophysical Year 2007 and the United Nations Basic Space Science Initiative is available on the website of the Office for Outer Space Affairs (www.unoosa.org/oosa/SAP/bss/ihy2007/index.html).

France (A/AC.105/742), Mauritius (A/AC.105/766), Argentina (A/AC.105/784) and China (A/AC.105/829).⁴

5. The main objective of the Workshop was to provide a forum in which participants could comprehensively review achievements and plans for basic space science, the International Heliophysical Year 2007 and the International Space Weather Initiative and assess recent scientific and technical results, with a view to reporting on the status of implementation of follow-up projects for the promotion of basic space science (A/AC.105/766) and the International Heliophysical Year 2007 and International Space Weather Initiative (A/AC.105/882).

B. Programme

6. At the opening of the Workshop, statements were made by the representative of the Korea Astronomy and Space Science Institute, the representative of the Mayor of Daejeon on behalf of the Government of the Republic of Korea, and representatives of the International Heliophysical Year secretariat, NASA and the Office for Outer Space Affairs. The Workshop was divided into plenary and parallel meetings, each focusing on a specific issue. Presentations by invited speakers, describing their achievements in organizing events and carrying out research, education and outreach activities related to basic space science, the International Heliophysical Year 2007 and the International Space Weather Initiative, were followed by brief discussions. One hundred and forty-nine papers and posters were presented by the invited speakers, some of whom came from developing countries and others from developed countries. Poster presentation sessions provided participants with an opportunity to focus on specific problems and projects related to basic space science, the International Heliophysical Year 2007 and the International Space Weather Initiative.

7. Workshop sessions focused on the following topics: basic space science worldwide; International Heliophysical Year overview; ground-based observations; International Heliophysical Year instruments and applications; space climatology and cosmic rays; Sun and solar wind; magnetosphere and ionosphere; space weather; and participation of States in basic space science, the International Heliophysical Year 2007 and the International Space Weather Initiative.

8. In a ceremony, organizers of the Workshop expressed their appreciation and awarded certificates for long-term, substantive contributions made to basic space science and the International Heliophysical Year 2007, particularly for the benefit of developing countries, by a number of distinguished scientists.

9. In another ceremony, representatives of the International Heliophysical Year secretariat awarded certificates to a number of distinguished scientists.

⁴ Details of all the workshops of the United Nations Basic Space Science Initiative organized jointly with ESA have been made available on the Internet (www.seas.columbia.edu/~ah297/un-esa/).

C. Attendance

10. Researchers and educators from developing and developed countries from all regions were invited by the United Nations, ESA, NASA, JAXA and the Korea Astronomy and Space Science Institute to participate in the Workshop. Workshop participants, who held positions at universities, research institutions, national space agencies, planetariums and international organizations, were involved in implementing activities in the framework of the International Heliophysical Year and all the aspects of basic space science covered by the Workshop. Participants were selected on the basis of their scientific background and their experience in programmes and projects in which basic space science and the International Heliophysical Year played a leading role. The preparations for the Workshop were carried out by an international scientific organizing committee and a local organizing committee.

11. Funds provided by the United Nations, NASA, JAXA and the Korea Astronomy and Space Science Institute were used to cover the travel, accommodation and other costs of participants from developing countries. A total of 201 specialists in basic space science, the International Heliophysical Year and the International Space Weather Initiative were invited to attend the Workshop.

12. The following 34 Member States were represented at the Workshop: Armenia, Austria, Azerbaijan, Brazil, Bulgaria, Cameroon, China, Côte d'Ivoire, Ecuador, Egypt, France, Georgia, India, Iran (Islamic Republic of), Iraq, Israel, Japan, Korea (Republic of), Mozambique, Nepal, Nigeria, Pakistan, Peru, Romania, Russian Federation, Slovak Republic, Sri Lanka, Sudan, Turkey, United Arab Emirates, United Kingdom of Great Britain and Northern Ireland, United States of America, Uzbekistan and Viet Nam. Puerto Rico was also represented.

II. Summary of deliberations

A. Workshops on basic space science

13. It was recalled the United Nations Basic Space Science Initiative was a long-term effort for the development of space science and regional and international cooperation in this field on a worldwide basis, particularly in developing nations. A series of workshops on basic space science had been held from 1991 to 2004 (see para. 4 above), addressing the status of space science in Asia and the Pacific, Latin America and the Caribbean, Africa, Western Asia and Europe.

14. It was noted that one major recommendation emanating from these basic space science workshops was that small astronomical telescope facilities should be established in developing nations for research and education programmes at the university level. Subsequently, materials for teaching and observing programmes for small optical telescopes had been developed or recommended, and astronomical telescope facilities had been inaugurated in a number of nations.

15. It was also noted that such workshops on basic space science emphasized the particular importance of astrophysical data systems and the virtual observatory concept for the development of astronomy on a worldwide basis.

B. Workshops on the International Heliophysical Year 2007

16. It was recalled that, pursuant to recommendations of the United Nations Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee, since 2005 United Nations Basic Space Science Initiative workshops had focused on the International Heliophysical Year 2007. Workshops had been held in the United Arab Emirates, in 2005, India, in 2006, Japan, in 2007, Bulgaria, in 2008 and South Korea, in 2009.

C. Workshops on the International Space Weather Initiative

17. It was observed that, starting in 2010, the United Nations Basic Space Science Initiative workshops would focus on the International Space Weather Initiative, as recommended in a three-year workplan as part of the deliberations of the Committee on the Peaceful Uses of Outer Space. Such workshops had been prospectively scheduled to be hosted by Egypt in 2010 for Western Asia, Nigeria in 2011 for Africa and Ecuador in 2012 for Latin America and the Caribbean.

D. International Heliophysical Year 2007

18. It was recalled that in 2004, the Scientific and Technical Subcommittee of the Committee had agreed that solar-terrestrial physics was important in exploring the solar corona and understanding the functioning of the Sun; understanding the effects that the variability of the Sun can have on the Earth's magnetosphere, environment and climate; exploring the ionized environments of planets; and reaching the limits of the heliosphere and understanding its interaction with interstellar space. The Subcommittee had agreed that, as society became increasingly dependent on space-based systems, it was vital to understand how space weather, caused by solar variability, could affect, among other things, space systems and human space flight, electric power transmission, high-frequency radio communications, global navigation satellite system (GNSS) signals and long-range radar, as well as the well-being of passengers in high-altitude aircraft. In the period from 2005 to 2009, the Committee had implemented the International Heliophysical Year 2007, a worldwide campaign to better understand solar-terrestrial interaction.

19. The International Heliophysical Year 2007 was described as an international programme of scientific collaboration involving thousands of scientists from all United Nations Member States, conducted from 2005 to 2009. Along with programmes devoted to research, outreach, and historical preservation of the International Geophysical Year 1957, activities of the International Heliophysical Year 2007 included the deployment of new instrumentation arrays, especially in developing countries, and an extensive education and public outreach component.

20. It was acknowledged that early in the planning of the International Heliophysical Year 2007 the understanding of the global ionosphere and its linkage to the near-Earth space environment had been limited by the lack of observation in key geographical areas. To address this need, a series of United Nations Basic Space Science Initiative workshops had been held to facilitate collaboration between

research scientists in scientifically interesting geographic locations and researchers in countries with expertise in building scientific instrumentation.

21. It was observed that science teams had emerged from those workshops, implementing so-called coordinated investigation programmes. Each team consisted of a lead scientist who provided the instruments or fabrication plans for instruments in the array. Support for local scientists, facilities and data acquisition was provided by the host nation. As a result of the International Heliophysical Year 2007 programme, scientists from many countries continued to participate in instrument operation, data collection, analysis and publication of scientific results.

22. It was affirmed that the instrument deployment programme was one of the major successes of the International Heliophysical Year 2007. Arrays of small instruments such as magnetometers to measure the Earth's magnetic field, radio antennas to observe solar coronal mass ejections, Global Positioning System receivers, very low frequency radio receivers and muon particle detectors to observe energetic particles had been installed around the world. These arrays continued to provide global measurements of heliospheric phenomena.

E. International Space Weather Initiative

23. It was noted that, in 2009, the Committee on the Peaceful Uses of Outer Space had endorsed a recommendation of its Scientific and Technical Subcommittee to implement the International Space Weather Initiative under a three-year workplan.

24. It was recalled that, building on the instrument arrays, and to continue coordinated heliophysics research, in February 2009 the International Space Weather Initiative had been proposed as a new agenda item to be addressed by the Scientific and Technical Subcommittee of the Committee. Through the Initiative, coordinated international research would continue on universal processes in the solar system that affected the interplanetary and terrestrial environments, and there would be continued coordination on the deployment and operation of new and existing instrument arrays aimed at understanding and predicting the impacts of space weather on the Earth and the near-Earth environment. The International Space Weather Initiative agenda item had been endorsed by the Committee in June 2009 and by the General Assembly in October 2009.

25. It was noted that participation in the International Space Weather Initiative was open to scientists from all countries as either instrument hosts or as instrument providers. The Initiative would be governed by a Steering Committee and would be supported by the United Nations, ESA, NASA, JAXA and the International Committee on Global Navigation Satellite Systems.

1. Objectives

26. The expectation was expressed that the International Space Weather Initiative would help to develop the scientific insight necessary to understand the physical relationships inherent in space weather, to reconstruct and forecast near-Earth space weather and to communicate this knowledge to scientists and to the general public. This would be accomplished, as successfully proven for the International Heliophysical Year 2007, by (a) continuing to deploy new instrumentation,

(b) developing data analysis processes, (c) developing predictive models using International Space Weather Initiative data from the instrument arrays to improve scientific knowledge and to enable future space weather prediction services and (d) continuing to promote knowledge of heliophysics through education and public outreach.⁵

2. Instrument array development

27. It was noted that the International Space Weather Initiative would continue to expand and deploy new and existing instrument arrays, following the successful practices of the International Heliophysical Year 2007. Each instrument team was led by a single scientist. The lead scientist or principal researcher, funded by his or her country, provided instrumentation (or fabrication plans) and data distribution. In a few cases, where resources allowed, the host country would pay for the instrument. The host country provided the workforce, facilities and operational support necessary to operate the instrument. This would typically be at a local university or government laboratory. Host scientists became part of the science team. All data and data analysis activities were shared within the science team, and all scientists participated in publications and scientific meetings where possible. Through workshops and other means, the International Space Weather Initiative would actively seek to identify additional instruments and instrument providers that could benefit from the International Space Weather Initiative process, as well as new hosts for instruments.

3. Data coordination and analysis

28. It was observed that the International Space Weather Initiative programme would promote the coordination of data products in a form useful for input into physical models of heliospheric processes. These data would be used for both retrospective analysis aimed at physical understanding of space weather, and for models to predict future space weather conditions. To be useful for space weather prediction, data must be available in near real time. However, in many locations in the developing world, Internet connections were intermittent or slow, making near-real-time data return impossible. Eventually, as Internet connectivity improved, these data would be made available in near real time in a form that could be incorporated into predictive models. In the near term, other strategies, such as data transfer by means of the Internet during selected time periods, or by means of recorded media such as DVDs and tapes, would be adequate for the retrospective scientific studies of space weather events and the development of physical models.

29. It was observed that data from the instrument arrays would be deposited in publicly available archives. For the most part, these would be existing data archives, such as the virtual observatory systems currently under development. This would make data from International Space Weather Initiative instruments available to the broader community of researchers. To improve the coordination of the data and to enhance their value for future real-time prediction services, planning would begin for the availability and the interoperability of these data. Although the infrastructure and the institutional resources might not yet exist in many locations to support the real-time dissemination of quality-controlled data, it was important to begin the

⁵ See <http://www.iswi-secretariat.org/>.

discussion now of data standards and the expectation of continuous operation so that data systems could be developed and future resource allocations could be discussed with this goal in mind.

4. Training, education and outreach

30. It was recalled that during the International Heliophysical Year 2007, space science schools in a number of countries had provided related training to hundreds of graduate students and new researchers. The International Space Weather Initiative would continue to provide support for space science schools and to promote space science and the inclusion of space science curricula in universities and graduate schools. This had been most effective when combined with the installation of instrumentation at universities.

31. It was stated that the International Space Weather Initiative would continue to support public outreach projects. It was essential to communicate the excitement and the relevance of heliophysical research to scientists from other disciplines, and to the public at large. Public outreach materials unique to the International Space Weather Initiative would continue to be developed, and their distribution would be coordinated through individual contacts and outreach workshops.

5. Monitoring solar-terrestrial interaction at the United Nations Office at Vienna

32. It was recalled that the Earth's ionosphere reacted strongly to the intense X-ray and ultraviolet radiation released by the Sun during solar events. The Stanford University Solar Center had developed inexpensive space weather monitors that scholars around the world could use to track changes to the Earth's ionosphere.

33. It was pointed out that two versions of the monitors existed: a low-cost version called Sudden Ionospheric Disturbances (SID), designed to detect solar flares, and a more sensitive version called Atmospheric Weather Electromagnetic System of Observation, Modeling and Education (AWESOME), which provided both solar and nighttime research-quality data. Through the United Nations Basic Space Science Initiative, such monitors had been deployed to high schools and universities in developing nations for the International Space Weather Initiative. The monitors come preassembled, and the hosts built their own antennas, and provided personal computers to record the data and an Internet connection to share their data with worldwide network of SIDs and AWESOMEs. These networks were advancing the understanding of the fundamental heliophysical processes that govern the Sun, Earth and heliosphere, particularly phenomena of space weather. Monitoring the fundamental processes responsible for solar-terrestrial coupling was vital for understanding the influence of the Sun on the near-Earth environment.

34. It was stated that a SID monitor was successfully operating at the United Nations Office at Vienna and would be upgraded to an AWESOME shortly. This project would also be supported by the programme on GNSS applications, implemented through the International Committee on Global Navigation Systems.