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Committee on the Peaceful Uses of Outer Space

Report on the United Nations/Japan Workshop on Space Weather: Science and Data Products from International Space Weather Initiative Instruments

(Fukuoka, Japan, 2-6 March 2015)

I. Introduction

1. The United Nations Programme on Space Applications, implemented by the Office for Outer Space Affairs, was established in 1971 to assist Member States with capacity-building in the use of space science, space technology and space applications in support of sustainable development, and to promote international space cooperation. Since its inception, the Programme has organized several hundred training courses, workshops, seminars and meetings for the benefit of Member States. It has led to the establishment of six regional centres for space science and technology education, affiliated to the United Nations, and it cooperates with academic institutions around the world to offer long-term fellowship programmes.

2. The Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), 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 the regional and international levels, 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]

3. At its fifty-seventh session, in 2014, the Committee on the Peaceful Uses of Outer Space endorsed the programme of workshops, training courses, symposiums

[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).

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and expert meetings focusing on environmental monitoring, natural resource management, global health, global navigation satellite systems (GNSS), basic space science, basic space technology, climate change, human space technology and the socioeconomic benefits of space activities to be held in 2015 for the benefit of developing countries (A/69/20, para. 81). Subsequently, the General Assembly, in its resolution 69/85, endorsed the report of the Committee on the work of its fifty-seventh session.

4. Pursuant to General Assembly resolution 69/85 and in accordance with the recommendations of UNISPACE III, the United Nations/Japan Workshop on Space Weather: Science and Data Products from International Space Weather Initiative Instruments was held in Fukuoka, Japan, from 2 to 6 March 2015.

5. The Workshop was organized by the United Nations in cooperation with the International Centre for Space Weather Science and Education (ICSWSE) of Kyushu University, Japan, which hosted the Workshop on behalf of the Government of Japan. The Workshop was supported by the Japan Society for the Promotion of Science, the National Institute of Information and Communications Technology, Tohoku University, the Solar-Terrestrial Environment Laboratory of Nagoya University, the Fukuoka Convention and Visitors Bureau, the Ministry of Foreign Affairs, and the Ministry of Education, Culture, Sports, Science and Technology.

A. Background and objectives

6. The International Heliophysical Year 2007 drew scientists and engineers from around the globe in a coordinated observation campaign of the heliosphere and its effects on planet Earth.[2] Building on the success of the International Heliophysical Year 2007, the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space agreed at its 2009 session to consider, beginning at its forty-seventh session in 2010, a new agenda item entitled “International Space Weather Initiative” under a three-year workplan (A/AC.105/933, para. 168 and annex I, para. 16).

7. The International Space Weather Initiative (ISWI) is an international cooperation programme to advance space weather science that combines the deployment of instruments with the analysis and interpretation of space weather data obtained from those instruments in conjunction with space data; education and capacity-building in space weather science; and the communication of the results to the public (see A/AC.105/2013/CRP.11).

8. The ISWI steering committee, supported by an ISWI secretariat located at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center, is coordinating the ISWI activities. A periodic ISWI newsletter is published by ICSWSE and the ISWI website is maintained by the Bulgarian Academy of Sciences (see www.iswi-secretariat.org).

9. At its session in 2012, at the conclusion of the three-year workplan, the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space agreed that an item entitled “Space weather” should be introduced as a

[2] See B. J. Thompson and others, eds., *Putting the “I” in IHY: The United Nations Report for the International Heliophysical Year 2007*, vol. 3, *Studies in Space Policy* (Vienna, Springer, 2009).

regular item on the agenda of the Subcommittee, in order to allow States members of the Committee and international organizations having permanent observer status with the Committee to exchange views on national, regional and international activities related to space weather research with a view to promoting greater international cooperation in that area (A/AC.105/1001, para. 226). Furthermore, at its session in 2014, the Committee on the Peaceful Uses of Outer Space endorsed the establishment of the Expert Group on Space Weather under the agenda item that would take stock of relevant technology, information and observation systems around the world and propose recommendations, including areas for future study (A/69/20, para. 146).

10. The key function of the present Workshop, which was organized in the framework of the Basic Space Science Initiative of the United Nations Programme on Space Applications, was to follow up on the achievements of the International Heliophysical Year 2007 and ISWI and to maintain the capacity-building momentum established by these initiatives. The Workshop was also aimed at providing a global forum for space weather experts from developed and developing countries, including representatives of the major instrument operators and data providers, to discuss the latest results of space weather research, global observation, space weather data policy and use, and education on space weather, as well as to identify opportunities to expand ISWI activities, including from an operational point of view.

11. The objectives of the Workshop were:

(a) To review the status of space weather instruments (in situ and space-borne), data access, availability, and collection and modelling efforts to advance space weather research and improve space weather forecasting;

(b) To support the continued deployment of ground-based ISWI instrument arrays and data exploitation;

(c) To continue the development of space science schools and other space weather education activities, which encourage students to consider a career in space science, particularly in developing countries;

(d) To review the role of international cooperation in addressing space weather-related issues, such as possible further cooperation towards truly global space-weather monitoring capabilities;

(e) To consider opportunities for international cooperation in the standardization, sharing and wider and timely use of space weather data, including for operational purposes.

B. Attendance

12. Qualified space weather experts and scientists from developing and industrialized countries from all regions were invited by the United Nations to participate in and contribute to the Workshop. Invitations to participate in the Workshop were also disseminated through the worldwide offices of the United Nations Development Programme and permanent missions to the United Nations and through various space science and space weather mailing lists. Participants were

selected from among the applications received on the basis of their academic qualifications and professional working experience in the space weather field and the relevance of their contributions to the Workshop. Applications from qualified female applicants were particularly encouraged.

13. The Workshop was attended by 118 space weather experts from governmental and non-governmental institutions, universities and other academic entities from the following 34 countries: Australia, Brazil, Bulgaria, Canada, China, Côte d'Ivoire, Egypt, Ethiopia, France, India, Indonesia, Israel, Japan, Kazakhstan, Kenya, Malaysia, Mauritius, Morocco, Nigeria, Pakistan, Peru, Philippines, Republic of Korea, Russian Federation, Saudi Arabia, Slovakia, South Africa, Sri Lanka, Sudan, Switzerland, Thailand, United States of America, Viet Nam and Zambia.

14. Funds provided by the United Nations and the co-sponsors were used to defray, fully or partially, the costs of the air travel and board and lodging for some of the participants. The sponsors also provided funds for local organization, facilities and the transportation of participants.

C. Programme

15. The programme of the Workshop was developed by the Office for Outer Space Affairs of the Secretariat in cooperation with the scientific organizing committee of the Workshop. The scientific organizing committee included space weather experts and representatives of national space agencies, international organizations and academic institutions. An honorary committee and a local organizing committee also contributed to the successful organization of the Workshop.

16. The programme consisted of an opening session, seven technical sessions, two workshops, three panel discussions, poster presentations and discussions on observations and recommendations, followed by closing remarks by the co-organizers. The presentations in the sessions were chosen by the scientific organizing committee from among the abstracts submitted by Workshop applicants.

17. The chairs and rapporteurs assigned to the technical sessions and panel discussions provided their comments and notes as input for the preparation of the present report. The detailed programme, background information and full documentation of the presentations made at the Workshop have been made available on a dedicated website (www.unoosa.org/oosa/en/SAP/act2015/japan/index.html).

18. Copies of the oral and poster presentations made during the Workshop were also made available to all participants and subsequently posted on the ISWI website.

19. The Workshop was also advertised on social media, including through various websites and Twitter.

II. Summary of the Workshop programme

A. Opening session

20. At the opening session, chaired by the Director of ICSWSE, welcoming remarks were made by the President of Kyushu University, Japan, the Deputy

Director General for Policy Evaluation of the Ministry of Education, Culture, Sports, Science and Technology, who spoke on behalf of the Government of Japan, the United Nations Expert on Space Applications and the chair of the scientific organizing committee and Executive Director of ISWI.

21. In his keynote address, a representative of ICSWSE introduced the host city, Fukuoka, and presented the activities of ICSWSE at Kyushu University and the status of its Magnetic Data Acquisition System (MAGDAS), which is one of the major ISWI instrument arrays. ICSWSE would continue to contribute to space weather capacity-building in cooperation with the Committee on the Peaceful Uses of Outer Space and with space weather-related institutions around the world.

22. In the second keynote address, the representative of the NASA heliophysics division discussed the NASA effort to characterize, understand and predict space weather events. She provided an update on international cooperation in space weather science, including the International Living With a Star programme and the cooperation activities in the framework of the Committee on the Peaceful Uses of Outer Space. She also noted that, as humans and their robotic probes were moving into the solar system, the realm of space weather forecasting was rapidly expanding. Space weather science was no longer about the Sun-Earth system only, but had become interplanetary and even exoplanetary.

23. The keynote addresses were followed by a presentation by the representative of the Office for Outer Space Affairs on the background, objectives and programme of the Workshop, its relation to the mandate of the United Nations Programme on Space Applications, and practical arrangements.

B. Space weather instrumentation

24. Under the ISWI instrument programme, 17 space weather instrument arrays with more than 1,000 instruments have been deployed worldwide, including in many developing countries. This session reviewed the status of some of the major instrument arrays.

25. The Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory (e-Callisto), an international network of solar radio spectrometers, was continuing to grow, with more than 70 instruments in more than 39 locations and with active users in more than 110 countries. The network generated more than 60 gigabytes of solar radio data every year. The data were freely accessible to everybody.

26. The Global Muon Detector Network is a network of four detectors that measure cosmic ray anisotropy. Cosmic ray precursor observation could possibly provide useful information for space weather forecasting.

27. Other instruments and instrument arrays presented in this session included MAGDAS — reports on the status of its stations in Australia and Viet Nam were given — the Multifrequency Interferometry Telescope for Radio Astronomy, the Sudden Ionospheric Disturbance Monitor, the Continuous H-alpha Imaging Network, the Yakutsk meridional chain of geophysical stations and the Nobeyama Radioheliograph.

28. A representative of the NASA Goddard Space Flight Center introduced the NASA heliophysics virtual observatories, which are discipline-oriented web portals designed for accessing heliophysics data and information served by distributed data archives or data providers. They could also be used to distribute data from the ISWI instrument arrays, which would have the potential to dramatically increase the impact of ISWI science measurements.

C. Solar weather: national activities

29. This session reviewed the status of space weather-related activities at the international level as well as significant national activities in particular countries.

30. The Chairs of expert group C on space weather, established under the agenda item on the long-term sustainability of outer space activities in the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space, informed the participants about the work of the expert group and presented the expert group's working report and its recommendations contained in document A/AC.105/C.1/2014/CRP.15. Within the Committee, the new Expert Group on Space Weather had been established during the fifty-second session of the Scientific and Technical Subcommittee held in 2015. The new Expert Group would be reporting to the Committee under the new regular agenda item on space weather and would also consider ways and means to implement the recommendations of expert group C. The proposed mandate and workplan of the Expert Group on Space Weather was contained in document A/AC.105/C.1/2015/CRP.27.

31. The representative of the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) presented the status of Variability of the Sun and Its Terrestrial Impact, its scientific programme for 2014-2018. The purpose of the programme was to promote international collaboration on data analysis, modelling, and theory to improve our understanding of how solar variability affects planet Earth.

32. A representative of the National Space Research and Development Agency of Nigeria (NASRDA) reviewed the impact that ISWI activities had in the African region. ISWI had contributed to capacity-building in space weather science and to the deployment of a large number of instruments, and had created new opportunities for African researchers. It had also resulted in an increase in the number of published research papers authored and co-authored by African scientists.

33. The reports on national space weather activities included presentations on the instrument network and data products of the Brazilian Programme for the Study and Monitoring of Space Weather of the National Institute for Space Research (INPE), the current status of the space weather programme in Indonesia and an overview of past, present and future space weather research activities of the National Space Agency of Malaysia (ANGKASA).

D. Weak solar activity

34. The session discussed the solar cycle, including in relation to solar energetic particles and accompanying solar phenomena. It focused in particular on solar cycles 23 and 24, which had shown an unusual and unexpectedly weak solar

activity. This demonstrated that our understanding of the Sun is still insufficient and that further observations and research were required to develop improved theoretical models.

35. Solar cycle 24 exhibited unusually mild space weather when compared to previous solar cycles of the space age. The weaker coronal mass ejections were caused by weaker heliospheric total pressure, while the weaker sheath and co-rotating interaction region fields were caused by a weaker heliospheric magnetic field. The research results indicated that solar activity might remain weak in solar cycle 25.

36. Solar photospheric fields and solar wind microturbulence levels had been steadily declining for the past 19 years and were expected to continue their decline until at least 2020. It was argued that a Maunder-like grand minimum might occur beyond solar cycle 25. In the past, weak solar cycles had been associated with large solar energetic proton events and superstorms which could have consequential terrestrial impacts.

37. The final presentation in this session reviewed the 93-year history of geomagnetic data acquisition at the Huancayo Observatory of the Geophysical Institute, Peru. International cooperation had been an important component in ensuring the continuous acquisition of observational data.

E. Coupling processes

38. The interaction between the Earth's atmosphere and the solar and magnetospheric inputs are called "coupling processes". Coupling processes have important consequences for space weather, space climatology and solar influences on the Earth's climate.

39. Presentations discussed the Sun's impact on ionized layers and transient variations in the Earth's magnetic field, observations of an equatorial ionization anomaly over Africa, total electron content variability of low latitude ionosphere and the role of dynamical coupling, and coordinated, optical, radio and magnetic investigations of wave dynamics in the upper atmosphere during the daytime.

40. To help improve models of complex coupling processes it was necessary to maintain and further enhance the existing instrument networks, in particular GNSS stations and magnetometers.

F. Magnetosphere, ionosphere and atmosphere

41. The session addressed space weather-related phenomena in the magnetosphere, ionosphere and atmosphere.

42. Ultra-low-frequency (ULF) waves play an important role in radiation belt dynamics. The accurate specification of ULF waves' power is critical for the accurate modelling of the transport mechanism in the radiation belt. ISWI ground-based, real-time magnetometer measurements could provide important input data for the transport models and could become an operational space weather data product.

43. MAGDAS, the Scintillation Network Decision Aid (SCINDA) and vertical incidence pulsed ionospheric radar ionosonde instruments were used to investigate African low-latitude ionospheric dynamics in Kenya. In Zambia, MAGDAS magnetometers and a network of GNSS receivers were used to characterize perturbations in the total electron content over the mid-to-low latitude regions during geomagnetic storms. Ionospheric scintillations and total electron content characteristics were studied using SCINDA instruments in Côte d'Ivoire.

44. Ionospheric delay is the main source of error in using GNSS, especially over the equatorial region, and is referred to as the "equatorial ionospheric anomaly". The results of research on the equatorial ionization anomaly occurring within 15 degrees latitude north and south of the geographic equator and the associated strong scintillation activity were presented by space weather scientists from Ethiopia, Nigeria and Viet Nam. The inhibition of scintillations over Africa during a geomagnetic storm in October 2013 was discussed by a space weather scientist from Morocco.

45. Two of the presentations considered the use of satellites for in situ observation. The exploration of energization and radiation in geospace mission by the Japan Aerospace Exploration Agency (JAXA), scheduled for launch in 2015, would observe highly charged energy particles in the Van Allen radiation belt and how space storms developed. Tiny satellites in the mass range of approximately 10-20 kilograms would be cost-efficient platforms for the in situ observation of space weather, especially as part of a larger constellation of satellites. Insufficient conductive surfaces and contaminants pose a problem for the use of conventional Langmuir probes on small satellites. As a possible solution, the use of a modified electron temperature probe was proposed.

G. Space weather impact and awareness

46. Space weather can impact people and infrastructure on Earth and in space. For example, it can cause satellites or spacecraft to degrade or fail, disturb radio communications, expose airline passengers to increased radiation levels, cause electricity grid and transformer disruption and, through induced Earth currents, affect telecommunication cables and pipelines and their operation.

47. A representative of Côte d'Ivoire made a presentation on how geomagnetically induced currents, even at low and middle latitudes, could disrupt technological equipment. While such disruptions had previously been experienced in the high-latitude Scandinavian countries, observations showed that they were not negligible at lower latitude locations either.

48. Magnetic and ionospheric observations made in the Russian far eastern region during the magnetic storm of 5 April 2010 were presented by the representative of the Russian Federation. That event was also related to the failure of the Intelsat Galaxy 15 satellite. The representative of the Sudan presented a statistical analysis comparison study on the forecasting of electron fluxes at geosynchronous orbits via the observation of latitudinal global-mode geomagnetic Pc5 ultra-low-frequency pulsations. The Pc5 waves, which are quasi-sinusoidal waves with periods of 150 to 600 seconds, were extracted from MAGDAS instrument data.

49. Geomagnetic data could enable the detection of earthquake precursors. The MAGDAS instrument network was used in Sumatra, an earthquake-prone region, to study possible earthquake precursors. While the results obtained so far were encouraging, the density of the instrument network would need to be increased to support further research. Another study presented at the session considered a possible correlation between solar activity and seismic events. According to the study, the tendency of earthquakes of all magnitudes to occur at descending solar cycles is more than 60 per cent at times when solar wind parameters are high. However, while possible causes include geomagnetic pulsations and the Lorentz force produced by induced currents, it is not yet known if and how the solar wind could trigger earthquakes.

50. The Gamma Ray Astronomy at PeV Energies Phase 3 experiment, a collaborative research endeavour between India and Japan, was used to measure ultrahigh energy particles and cosmic ray solar modulation to study events in the universe at high energies. One research objective was to measure the flux change of cosmic rays and the possibility to use the data obtained to predict the occurrence of coronal mass ejections.

51. The session was concluded with a presentation on non-additive entropies, and the so-called q-statistics, a generalization of Boltzmann-Gibbs statistical mechanics. Several examples of how q-statistics had been applied to study various space weather-related phenomena were presented.

H. Sun-to-Earth space weather modelling

52. Improved models of the Sun-to-Earth space weather events were necessary for a better understanding of space weather. A statistical study on the relationship between solar energetic particle event intensities and solar phenomena was presented. The data of 44 solar energetic particle events between 1997 and 2006 that had been associated with strong flares (X and M classes) were analysed. The study yielded statistical evidence that not only the solar flares but also coronal mass ejections had contributed to the solar energetic particle events.

53. Space weather forecasting would also have to rely on accurate space weather modelling. The results of developing a low-Earth orbit/near equatorial orbit trapped particle observation system were presented. The model had an accuracy of 75-90 per cent. The model and its modelling results were made available online (see www.ukm.my/ukmtrapcast).

I. Workshop on solar-terrestrial environment data analysis

54. Following a presentation on the solar-terrestrial environment between June 2014 and March 2015, a data analysis workshop on the solar-terrestrial environment was held to promote collaborative analyses of observation and simulation data to study the cause-effect relationships between events at the Sun and on Earth.

J. Hands-on workshop: Introduction to the Inter-University Upper Atmosphere Global Observation Network

55. The Inter-University Upper Atmosphere Global Observation Network (IUGONET) is a cross-database search and integrated analysis system implemented by five Japanese universities and institutes for a wide variety of data from long-term ground-based observations to promote upper atmosphere physics science and interdisciplinary research. The workshop demonstrated how to access and analyse the Network's data using the space physics environment data analysis software package (SPEDAS).

K. Panel discussions

56. Panel discussions were held on the following topics: "ISWI instrument network and the future of ISWI", "International cooperation in space weather" and "Space weather data utilization and operational use".

1. ISWI instrument network and the future of ISWI

57. After reviewing the achievements, the panellists discussed measures to ensure the continuity of the ISWI instrument network and the future of ISWI. They agreed that ISWI had made important contributions to space weather capacity-building. It was essential to further build on these accomplishments and to address issues that could endanger or reverse the achievements to date. Those issues included the long-term viability of the instrument networks (only 40 per cent of the instruments are operational), the brain drain resulting from qualified scientists leaving the field, in particular in developing countries, and efforts to ensure that ISWI instrument data were being utilized to the fullest extent possible.

58. It was agreed that continued collaboration of ISWI with International Living with a Star and SCOSTEP was essential, and that capacity-building efforts needed to be continued. A major issue in many countries remained the problem of funding space weather activities. One way to address this could be to improve the interaction with and mobilization of national delegations to the Committee on the Peaceful Uses of Outer Space, in particular in relation to the discussions under the regular agenda item on space weather.

2. International cooperation in space weather

59. The participants in the panel discussed the purpose of international cooperation in space weather and the goals such cooperation should help to accomplish. They also examined whether the existing organizations and cooperation frameworks were sufficient to accomplish the desired goals, or whether alternate approaches were needed.

60. The panel chair started the discussion by proposing that the overarching goal of international cooperation in space weather should be to strengthen space weather resilience through improved services. To achieve this goal, four elements needed to be considered: user needs; targeted and tailored services; adequate observing infrastructure; and global coordination and a consistent message.

61. The panellists agreed that international space weather cooperation could contribute to more efficient data sharing, better coordination of observations, the creation of a space weather road map and architecture framework, and education and capacity-building. All of those would be essential for delivering improved space weather services. It was suggested that forming an international space weather action group within the existing space weather cooperation frameworks, possibly with links to the recently established space weather expert group of the Committee on the Peaceful Uses of Outer Space, could be helpful in that context.

3. Utilization and operational use of space weather data

62. The success of ISWI and, with it, the operational use of ISWI data, was dependent on those data being freely available, accessible and usable under an open data policy. Currently there was no such policy in place, and the panel discussed the steps necessary to create one.

63. Panellists considered what factors (financial, political, cultural, educational and/or technical) might hamper open access to ISWI data, their usability and their distribution, and what could be done to remove those factors. They also discussed whether the current set of data products was sufficient for space weather purposes, what space weather effects could not be captured by the existing ISWI instrument network, and what additional ground-based measurements, in terms of coverage and types, might be needed. Finally they also considered if coordination of ISWI with space-based observations should be formalized through agreements with various space agencies, given that ISWI data might be more useful and effective if used in conjunction with space-based observations.

64. The panellists agreed that data sharing was important and that an effort should be made to develop a formal ISWI open data policy, which could be based on already existing data policies. Currently, the operational use of ISWI data in some countries was only limited, and no central clearing house for operational space weather data existed. In the future, the NASA heliophysics virtual observatories could play a role in assisting with the archiving and versioning of ISWI data, which was not centrally coordinated.

65. The quality requirements for data suitable for operational use were also discussed. In general, data products needed to be calibrated, properly documented, stored for easy retrieval and in a format that readily allowed input into operational models. Panellists agreed that the vast majority of ISWI data was not yet fit for operational use. For example, it was pointed out that some of the requirements, such as calibration, brought extra costs. A way forward might be to select successful examples of ISWI data use, and to use those examples as pathfinders to work through the problems.

L. Poster session

66. As part of the Workshop, a poster session was organized. A total of 28 posters were presented and made available through the Workshop website (www.unoosa.org/oosa/en/SAP/act2015/japan/index.html).

M. Side meetings

67. During the Workshop, several side meetings were held. The more than 20 MAGDAS project participants from Africa, Asia and South America gathered for a general meeting. While MAGDAS has focused on research, the meeting specifically discussed the future operational use of MAGDAS data. The experience from one country showed that the operational use of data not only contributed to operational space weather prediction services, but also provided additional motivation and resources for maintaining and sustaining the instrument network. For example, supplying operational real time data to a government agency might encourage that agency to provide funds to help maintain the MAGDAS magnetometers.

68. The participants of the CALLISTO project also met for a CALLISTO mini-workshop during the week.

III. Observations and recommendations

69. The participants in the Workshop:

(a) Recalled the decision taken at the United Nations/Ecuador Workshop on the International Space Weather Initiative, held in Quito in October 2012, that ISWI should be continued and linked to the discussion in the Committee on the Peaceful Uses of Outer Space under the agenda item on space weather (A/AC.105/1030, para. 23);

(b) Took note of the candidate guidelines developed by expert group C on space weather under the agenda item on the long-term sustainability of outer space activities of the Committee on the Peaceful Uses of Outer Space (A/AC.105/C.1/2014/CRP.15);

(c) Noted the establishment of the Expert Group on Space Weather, endorsed by the Committee on the Peaceful Uses of Outer Space at its fifty-seventh session in 2014, its proposed mandate, workplan and report of its first meeting (A/AC.105/1088, paras. 163-169);

(d) Stressed the importance of continuing the publication of the ISWI newsletter and the maintenance of the ISWI secretariat website as essential means to support ISWI and its community.

A. ISWI instrument network

70. With regard to the ISWI instrument network and the future of ISWI, the participants in the Workshop:

(a) Recalled that the focus of ISWI was on science, capacity-building and outreach activities;

(b) Recalled in that regard the progress achieved by ISWI in different regions of the world (Africa, Asia and Latin America) and the cooperation with SCOSTEP;

(c) Welcomed the addition of three new ISWI instrument arrays, bringing the total number of instrument arrays to 17;

(d) Appreciated that the ISWI secretariat had been expanded to include a workshop coordinator and that the United States had committed additional resources to make ISWI data available to all scientists;

(e) Agreed on the need to review the status of ISWI instruments (see A/AC.105/2013/CRP.11 and the ISWI secretariat website) and the status of ISWI national points of contact by the ISWI secretariat;

(f) Agreed on the need for action to help bridge the gap between ISWI science and potential operational use of ISWI data (from data collection to data analysis and modelling), based on a step-by-step approach;

(g) Recommended that the ISWI steering committee should solicit annual reports from member countries and instrument principal investigators, and should publish such reports in the ISWI newsletter.

B. International cooperation

71. With regard to international cooperation in space weather, the participants in the Workshop:

(a) Recalled the existing organizational frameworks for international cooperation in space weather activities, namely the Coordination Group for Meteorological Satellites, the Committee on the Peaceful Uses of Outer Space, the United Nations Programme on Space Applications, the International Civil Aviation Organization, the World Meteorological Organization (WMO), the World Data System of the International Council for Science, and the research efforts undertaken by the International Space Environment Service, ISWI, International Living with a Star, the Committee on Space Research, and the Variability of the Sun and its Terrestrial Impact programme of SCOSTEP;

(b) Agreed on the need for coordination among those entities, in particular regarding the following international collaboration needs:

(i) Enhanced data availability, development of space weather services and improving the quality of data for services;

(ii) Space weather observation architecture to maintain complete and continuous observations;

(iii) Outreach and education;

(iv) Risk analysis and assessment of user needs;

(v) Improved communication with policymakers;

(vi) Ongoing capacity-building activities to enable more countries to contribute to space weather research and services;

(c) Agreed that an international space weather action group would be useful to organize the effort and to assess what is being done well today and where major gaps remained;

(d) Agreed that the activities should be accomplished in a manner that established synergy among all the participating countries and organizations and avoided duplication.

C. Data policy and operational use of data

72. With regard to data policy and operational use of data, the participants in the Workshop:

(a) Agreed that ISWI data must be available, accessible and independently usable;

(b) Noted the importance of the availability of real time data for operational use in line with established user requirements;

(c) Took note of the NASA heliophysics virtual observatories and the space physics environment data analysis software package and their potential role in ISWI;

(d) Recommended, in order to improve the accessibility of ISWI data, the establishment of an open data policy for ISWI;

(e) Recommended, in order to improve the availability of ISWI data, the establishment of an archiving policy for ISWI, which could be based on guidelines for submitting ISWI data to the NASA heliophysics virtual observatories and the space physics environment data analysis software package, and to existing data archives;

(f) Recommended, in order to improve the usability of ISWI data, that ISWI instrument principle investigators should make efforts to calibrate and document their data;

(g) Recommended that the ISWI steering committee should be tasked with drafting relevant guidelines and policies, for example, on the basis of WMO resolution 40 (Cg-XII) and the NASA heliophysics data policy, and that it should report on the progress of its work at the next ISWI steering committee meeting.

D. Future ISWI activities

73. Finally, the participants in the Workshop:

(a) Recommended that the ISWI steering committee should consider preparing an action plan, outlining goals, schedule and implementation of future ISWI activities;

(b) Noted the successful conclusion of the Workshop and expressed their appreciation to ICSWSE and to the Government of Japan for hosting the Workshop;

(c) Noted that the Committee on Space Research/International Living with a Star road map symposium would be held on the margins of the forthcoming session of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space to be held in Vienna in February 2016;

(d) Noted that the ISWI steering committee would also meet on the margins of the forthcoming session of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space;

(e) Noted that an ISWI school would be held near Mumbai, India, in November 2016;

(f) Welcomed the interest expressed by Member State representatives to organize future ISWI workshops in the framework of the United Nations Programme on Space Applications, in the following countries: United States (2017) and Brazil and Mauritius (2018/2019).

IV. Conclusions

74. The Workshop, by bringing together space weather experts and instrument hosts from around the world, contributed successfully to highlighting the need to better understand space weather events.

75. The observations and recommendations made by the participants will be brought to the attention of the scientific community and to the States members of the Committee on the Peaceful Uses of Outer Space during the discussion of space weather issues at the fifty-third session of the Scientific and Technical Subcommittee, in 2016.