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English only

Committee on the Peaceful Uses of Outer Space

Report on the United Nations/Japan Workshop on Space Weather "Science and Data Products for ISWI Instruments"

(Fukuoka, Japan, 2-6 March 2015)

I. Introduction

1. The United Nations Programme on Space Applications was established in 1971 to assist Member States with capacity-building in the use of space science, technology and its 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 and expert meetings focusing on environmental monitoring, natural resource

[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).

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.[2] 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 for ISWI Instrument 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 Center for Space Weather Science and Education (ICSWSE) of Kyushu University, which hosted the Workshop on behalf of the Government of Japan. The Workshop was supported by (1) the Japan Society for the Promotion of Science (JSPS), (2) the National Institute of Information and Communications Technology (NICT), (3) Tohoku University, (4) the Solar-Terrestrial Environment Laboratory (STEL) of Nagoya University, (5) the Fukuoka Convention & Visitors Bureau (FCVB), (6) the Ministry of Foreign Affairs of Japan (MOFA), and (7) the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

A. Background and objectives

6. The International Heliophysical Year 2007 (IHY) drew scientists and engineers from around the globe in a coordinated observation campaign of the heliosphere and its effects on planet Earth.[3] 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).

7. ISWI is a program of international cooperation to advance space weather science by a combination of instrument deployment, analysis and interpretation of space weather data from these instruments in conjunction with space data, space weather science education and capacity-building activities 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 NASA Goddard Space Flight Center, is coordinating the ISWI activities. A periodic ISWI newsletter is published by the International Center for Space Weather Science and Education (ICSWSE) of Kyushu University, Japan, and the ISWI website is maintained by the Bulgarian Academy of Sciences (see www.iswi-secretariat.org).

9. At the conclusion of the three-year workplan, the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space agreed at its

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[2] *Official Records of the General Assembly, Sixty-ninth Session, Supplement No. 20* (A/69/20), para. 81.

[3] See B. J. Thompson, N. Gopalswamy, J.M. Davila, H.J. Haubold (eds.), "Putting the 'I' in IHY: The United Nations Report for the International Heliophysical Year 2007 (Studies in Space Policy)", ISBN-10: 3211991794, Springer Wien New York, 2009.

session in 2012 that an item entitled “Space weather” should be introduced as a regular item on the agenda of the Subcommittee, in order to allow member States 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).

10. The key function of the present Workshop, which was organized in the framework of the Basic Space Science Initiative (BSSI) of the United Nations Programme on Space Applications, was to follow-up on the achievements of IHY and ISWI and to maintain the capacity-building momentum established by these initiatives. It also aimed to provide 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 as follows:

(a) To review the status of space weather instruments (in-situ, 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 encouraged 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; and

(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 33 countries: Australia, Brazil, Bulgaria, China, Côte d'Ivoire, Egypt, Ethiopia, France, India, Indonesia, Israel, Japan, Kazakhstan, Kenya, Malaysia, Mauritius, Morocco, Nigeria, Pakistan, Peru, Republic of Korea, Russia, Saudi Arabia, Slovakia, South Africa, Sri Lanka, Sudan, Switzerland, Thailand, the Philippines, the United States of America, Vietnam 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 (SOC) 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 International Space Weather Initiative website (http://iswi-secretariat.org).

19. The Workshop was also advertised on social media, including through various websites and Twitter (#UNOOSA, #UNJapanworkshop).

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, the Deputy Director-General for Policy Evaluation of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), on behalf of the Government of Japan, the United Nations

Expert on Space Applications and the Chair of the SOC 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) project, which is one of the major ISWI instrument arrays. ICSWSE would continue to contribute to space weather capacity-building in cooperation with COPUOS and space weather related institutions around the world.

22. In the second keynote address, the representative of NASA Heliophysics discussed NASA's effort to characterize, understand and predict space weather events and provided an update on international cooperation in space weather science, including the International Living With a Star (ILWS) programme and the cooperation activities in the framework of the Committee on the Peaceful Uses of Outer Space. She 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 of the representative of the Office for Outer Space Affairs on the Workshop background, objectives and programme and its linkage to the mandate of the United Nations Programme on Space Applications and on practical arrangements.

B. Space weather instrumentation

24. Under the ISWI instrument programme 17 space weather instrument arrays with more than 1000 instruments have been deployed worldwide, including in many developing countries. This session reviewed the status of some of the major instrument arrays.

25. The e-Callisto 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 Gbyte of solar radio data every year. The data was freely accessible to everybody (see http://e-callisto.org).

26. The Global Muon Detector Network (GMDN) was a network of four detectors to measure cosmic ray anisotropy. Cosmic ray precursor observation could possibly provide useful information for potential space weather forecast.

27. Other instrument arrays and instruments presented in this session included the MAGnetic Data Acquisition System (MAGDAS) project and reports on the status of its stations in Australia and Vietnam, the Multifrequency Interferometry Telescope for Radio Astronomy (MITRA), the Solar Sudden Ionoshpheric Disturbance (SID) Monitor, the Continuous H-alpha Imaging Network (CHAIN) project, the Yakutsk meridional chain of geophysical stations and the Nobeyama radioheliograph.

28. A representative of NASA Goddard Space Flight Center introduced the NASA Heliophysics Virtual Observatories (VxOs). The VxOs are discipline (x)-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 chairpersons of expert group C: 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 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 COPUOS a new space weather expert group 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 COPUOS 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 work plan of the space weather expert group 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 the Variability of the Sun and Its Terrestrial Impact (VarSITI) programme, SCOSTEP's scientific programme for 2014-2018. VarSITI is striving to promote international collaboration on data analysis, modelling, and theory to improve our understanding of how solar variability is affecting planet Earth (see http://varsiti.org).

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 contributed to space weather science capacity-building and to the deployment of a large number of instruments and created new opportunities for African researchers. It 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 space weather programme (Estudo e Monitoramento Brasileiro do Clima Espacial — EMBRACE) of the National Institute of Space Research (INPE) of Brazil, 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 the solar energetic particles and accompanied solar phenomena and focussed in particular on solar cycles 23 and 24, which had shown an unusual and unexpected weak solar activity. This demonstrated that our understanding of the science of the Sun is still insufficiently

complete and that further observations and research to develop improved theoretical models was required.

35. Solar cycle 24 exhibited unusually mild space weather when compared to previous solar cycles of the space age. The weaker Coronal Mass Ejections (CMEs) were due to weaker heliospheric total pressure, while the weaker sheat and corotating interaction region (CIR) fields were due to 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 micro-turbulence levels had been steadily declining for the past 19 years and were expected to continue to decline at least until 2020. Arguments were presented that indicated that we might be headed towards a Maunder-like grand minimum beyond solar cycle 25. In the past, weak solar cycles had been associated with large solar energetic proton events and super storms which could have consequential terrestrial impacts.

37. The final presentation in this session reviewed the 93 years history of geomagnetic data acquisition at the Huancayo Observatory of the Geophysical Institute of 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. They have important considerations 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 of the Earth’s magnetic field, observations of an equatorial ionization anomaly over Africa, total electron content (TEC) variability of low latitude ionosphere and the role of dynamical coupling, and coordinated, optical, radio and magnetic investigations of wave dynamics in the daytime upper atmosphere.

40. To help improve models of the complex coupling processes, it was necessary to maintain and further enhance the existing instrument networks, in particular Global Navigation Satellite System (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 the 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 (VIPIR) 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 TEC perturbations over the mid-to-low latitude regions during geomagnetic storms. Ionospheric scintillations and TEC 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, such error being referred to as "equatorial ionospheric anomaly". The results of research on the equatorial ionization anomaly (EIA) occurring within 15 degrees latitude North and South of the geographic equator and the associated strong scintillation activity was presented by space weather scientists from Ethiopia, Nigeria and Vietnam. 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 (ERG) 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 kg would be cost-efficient platforms for the in-situ observation of space weather, especially also 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 infrastructures 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 (GICs) 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 also not negligible at lower latitude locations.

48. Magnetic and ionospheric observations in the Russian far East region during the magnetic storm of 5 April 2010 were presented by the representative of the Russian Federation. This event was also related to the failure of the Intelsat Galaxy 15 satellite. The representative of Sudan presented a statistical analyses comparison study on the forecasting of electron fluxes at geosynchronous orbits via the observation of latitudinal global-mode geomagnetic ULF Pc 5 pulsations. The Pc 5 waves, which are quasi-sinusoidal waves with periods of 150-600s, 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 instrument network density would need to be increased to support further research. Another presentation considered a possible correlation between solar activity and seismic events. According to this study, the tendency of earthquakes at all magnitudes to occur at descending solar cycles is more than 60 per cent at times when the solar wind parameters are high. However, while geomagnetic pulsations and lorentz force produced by induced currents could be possible cause candidates, it is not yet known if and how the solar wind could trigger earthquakes.

50. The Gamma Ray Astronomy at PeV EnergieS Phase-3 (GRAPES-3), established under a research collaboration between India and Japan, was used to measure ultra-high 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 this data to predict the occurrence of coronal mass ejections (CMEs).

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. In this sessions a statistical study on the relationship between solar energetic particle event (SEP) intensities and solar phenomena was presented. The data of 44 SEP events that had taken place between 1997 and 2006 and that had been associated with strong flares (X and M classes) was analysed. The study yielded statistical evidence for a mixed flare-CME contribution to SEP 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 (LEO-NEqO) trapped particle observation system were presented. The model had an accuracy of 75-90 percent. The model and its modelling results were made available online at 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 solar-terrestrial environment (STE) data analysis workshop 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 IUGONET

55. The Inter-University Upper atmosphere Global Observation NETwork (IUGONET) was a cross-database search and integrated analysis system implemented by five Japanese institution/universities for a wide variety of data from long-term ground-based observations to promote upper atmosphere physics science and interdisciplinary research (see www.iugonet.org/en/). The workshop demonstrated how to access and analyse IUGONET data using the Space Physics Environment Data Analysis Software (SPEDAS).

K. Panel discussions

56. Panel discussions were held on the following topics: "ISWI instrument network and future of ISWI", "International Cooperation in Space Weather" and "Space Weather Data Utilization and Operational Use".

1. ISWI instrument network and future of ISWI

57. After reviewing the achievements made through ISWI, 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 made to date. These issues included the long-term viability of the instrument networks (only 40 per cent of the instruments are operational), the brain drain problem of qualified scientist leaving the field, in particular in the developing countries and also efforts to ensure that the ISWI instrument data was being utilized to the fullest extent possible.

58. It was agreed that continued collaboration of ISWI with ILWS and SCOSTEP was essential and 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 through better interacting with and mobilizing national COPUOS delegations in particular through 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 which goals such cooperation should help to accomplish. They also examined if the existing organizations and cooperation frameworks were sufficient to accomplish the desired goals or if alternate approaches were needed.

60. The panel chair started the discussions 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: (a) user needs; (b) targeted and tailored services; (c) adequate observing infrastructure; and (d) global coordination and consistent message.

61. The panellist agreed that international space weather cooperation could contribute to more efficient data sharing, the better coordination of observations, the

creation of a space weather roadmap and architecture framework, and education and capacity-building. All of these 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, and possibly with links to the recently established COPUOS space weather expert group, could be helpful in this context.

3. Space weather data utilization and operational use

62. The success of ISWI and, with it, the operational use of ISWI data was dependent on this data being freely available, accessible and usable under an open data policy. Presently there was no such policy in place and the present panel discussed the steps necessary towards an ISWI data policy.

63. Panellists considered what factors (financial, political, cultural, educational and/or technical) might hamper open access, usability and distribution of ISWI data, and what could be done to remove these barriers. They also discussed if 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. Presently there was only limited operational use of ISWI data in some countries and at the present there is no central clearinghouse for operational space weather data. The NASA Heliophysics Virtual Observatories could play a future 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 these requirements, such as the calibration, had an associated extra cost. A way forward might be to select successful examples of ISWI data use and use those 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 have been 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 in attendance of the Workshop 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 shows that the operational use of data not only contributes to operational space weather prediction services but also provides 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 in attendance of the Workshop also met for a CALLISTO mini-workshop during the week.

III. Observations and recommendations

69. The participants in the Workshop made the following general observations:

(a) Noted and 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 COPUOS under the agenda item on space weather (A/AC.105/1030, para. 23);

(b) Noted the candidate Guidelines developed by Expert Group C (Space Weather) under the COPUOS agenda item on the long-term sustainability of outer space activities (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 the initiative and its community.

A. ISWI instrument network

70. With regards 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 this 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 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 ISWI Secretariat Website) and the status of ISWI national points of contacts by the ISWI Secretariat;

(f) Agreed on the need for actions 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 stepwise approach;

(g) Recommended that the ISWI Steering Committee should solicit annual reports from member countries and instrument principal investigators and should publish them in the ISWI newsletter.

B. International cooperation

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

(a) Recalled the existing organizational frameworks for international cooperation in space weather activities (Coordination Group for Meteorological Satellites (CGMS), COPUOS, International Civil Aviation Organization (ICAO), World Meteorological Organization (WMO), ICSU/WDS (World Data System) and efforts on the research side (International Space Environment Service (ISES), ISWI, ILWS, COSPAR, VarSITI 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 policy makers;

(vi) On-going 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 these 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 regards 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) Took note of 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 (VxO) and the Space Physics Environment Data Analysis Software (SPEDAS) 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 VxO and SPEDAS, 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 and the NASA Heliophysics data policy, and that it should report the progress of its work during 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 present Workshop and expressed their appreciation to ICSWSE and to the Government of Japan for hosting the Workshop;

(c) Noted that the COSPAR/ILWS roadmap symposium would be held on the margins of the forthcoming session of the Scientific and Technical Subcommittee of the Committee 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;

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

(f) Welcomed the interest to organize future ISWI Workshops in the following countries: United States (2017), 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.